Republic of Rwanda

Rwanda Environment Management Authority

Tool and Guideline # 1

Practical Tools for Sectoral Environmental Planning

Kigali, 2010

PREFACE

In 2010, REMA prepared 11 practical technical tools intended to strengthen environmental management capacities of districts, sectors and towns. Although not intended to provide an exhaustive account of approaches and situations, these tools are part of REMA's objective to address capacity-building needs of officers by providing practical guidelines and tools for an array of investments initiatives. Tools and Guidelines in this series are as follows:

#	*TOOLS AND GUIDELINES*
1	Practical Tools for Sectoral Environmental Planning : A - Building Constructions B - Rural Roads C - Water Supply D - Sanitation Systems E - Forestry F - Crop Production G - Animal Husbandry H - Irrigation I - Fish Farming J - Solid Waste Management
2	Practical Tools on Land Management - GPS, Mapping and GIS
3	Practical Tools on Restoration and Conservation of Protected Wetlands
4	Practical Tools on Sustainable Agriculture
5	Practical Tools on Soil and Water Conservation Measures
6	Practical Tools on Agroforestry
7	Practical Tools of Irrigated Agriculture on Non-Protected Wetlands
8	Practical Tools on Soil Productivity and Crop Production
9	Practical Technical Information on Low-cost Technologies: Composting Latrines & Rainwater Harvesting Infrastructure
10	Practical Tools on Water Monitoring Methods and Instrumentation
11	11.1 Practical Tools on Solid Waste Management of Imidugudu, Small Towns and Cities : Landfill and Composting Facilities
	11.2 Practical Tools on Small-scale Incinerators for Biomedical Waste Management

These tools are based on the compilation of relevant subject literature, observations, experience, and advice of colleagues in REMA and other institutions. Mainstreaming gender and social issues has been addressed as cross-cutting issues under the relevant themes during the development of these tools.

The Tool and Guideline # 1 provides practical tools for sectoral environmental planning for these types of investments: building constructions, rural roads, water supply, sanitation systems, forestry, crop production, animal husbandry, irrigation, fish farming, and solid waste management. It is intended to be a tool for integrating environmental considerations in planning initiatives. The tool can be adapted and used for the identification of environmental effects, appropriate mitigation measures, and guidelines for specific sectors of activity and can also be useful for the completion of environmental impact assessments.

These tools could not have been produced without the dedication and cooperation of the REMA editorial staff. Their work is gratefully acknowledged.

Dr. Rose Mukankomeje
Director General, Rwanda Environment Management Authority

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Practical Tools for Sectoral Environmental Planning

INTRODUCTION

The tools are intended to be used for integrating environmental considerations in planning initiatives.

The sectoral tools can be adapted and used for the identification of environmental effects, appropriate mitigation measures, and guidelines for specific sectors of activity. These tools are not intended to provide an exhaustive account of all situations.

Prior to using these tools, it is best to have clear indications as to an initiative's proposed activities. These tools can help identify the major environmental concerns and potential adverse environmental effects of specific sectors of activity. They can be used as field guides or as checklists of elements for discussion. They also present guiding principles on environmentally responsible siting, planning and design, as well as mitigation measures for the identified major environmental effects, and environmental indicators.

These tools can also be useful for the completion of environmental impact assessments.

Sectoral tools have been prepared for these themes:

- Planning Tool # A: Building constructions
- Planning Tool # B: Rural roads
- Planning Tool # C: Water supply (including wells and other structures)
- Planning Tool # D: Sanitation systems
- Planning Tool # E: Forestry
- Planning Tool # F: Crop production
- Planning Tool # G: Animal husbandry
- Planning Tool # H: Irrigation
- Planning Tool # I: Fish farming
- Planning Tool # J: Solid waste management (including biomedical wastes)

A. Building Constructions

This sectoral tool provides an outline that can be used to identify the major, potential, adverse environmental effects, as

sociated mitigation measures, and guidelines, as well as environmental indicators, for the construction of buildings, such as schools,

health clinics, community centers, small-scale facilities for small businesses, and agro-processing facilities.

A. What ar

e the major environmental concerns?

These are some of the key issues in Rwanda in relation to domestic and industrial buildi

ng s.

How can the construction of buildings, such as schools, health clinics, community centers, small-scale facilities fo

rs small businesses, and agro-processing facilities activities affect the human environment?

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can the construction of buildings, such as schools, health clinics, community centers, small-scale facilities for small business

es, and agro-processing facilities activities affect the natural environment?

B. How can siting, planning, and design be environmentally responsible?

By addressing such concerns early in the initiative’s cycle, they will have better chances of success and long-term sustainability, help to prevent negative outcomes, and avoid rehabilitation costs.

The following guiding principles are useful to avoid adverse environmental effects associated with

siting, planning, and design. *You can check the items that are relevant to the proposed initiative.*

C. What are the major potential adverse environmental effects? What can be

done to mitigate or avoid them? Mitigation measures are measures that effectively control, eliminate, or significantly reduce an

initiative’s adverse environmental effects. Not all the measures identified in this table have to be used—only those that are releva

nt and contextually pertinent to the initiative and its setting. The chosen mitigation measures can be underlined in the following tabl

e. When documenting the chosen mitigation measures, it is pertinent to provide details about how they will be achieved.

Major ad

verse effects
Associated mitigation measures
Ecosystem and soil degradation (e.g. erosion, compaction, and change

s in drainage) may occur as a result of construction activities. Soil degradation is a problem particularly where soils are fine or weak, or have complex drainage cycles. Heavy precipitation and steep slopes also present issues. In many cases, soil erosion can be associated with increased sedimentation in waters. Promote socially and environmentally responsible practices for building siting, planning, and design.

- Promote socially and environmentally responsible practices for building siting, planning, and design.
- Minimize vegetation clearing.
- Avoid inappropriate use of heavy machinery.
- Promote soil erosion control measures (e.g. balance cut and fill for minimum deposition of earth; minimize time when soil surfaces are exposed to rain and wind; stabilize soil for example with mulch on vulnerable surfaces; resurface and revegetate exposed areas; implement buffer zones of vegetation on slopes and surrounding bodies of water; implement soil stability structures; keep the mining of clay and limestone for brick making to a minimum, and ensure adequate drainage control and water recycling for this type of activity).
- Ensure proper and timely management of construction materials and wastes (promote the re-use of products when possible).
- Establish and enforce design and construction standards to ensure that the building is able to withstand extreme weather-related or geology-related events.

Nuisances (e.g. noise, airborne dust, vibrations, traffic), health risks, and risks of accidents may arise during construction activities Plan construction activities according to a schedule that is compatible with the climatic conditions and the population's activities.

Nuisances (e.g. noise, airborne dust, vibrations, traffic), health risks, and risks of accidents may arise during

construction activities

labour force, and ensure proper health and safety training for the use of construction materials and equipment.

- Ensure proper training for the management of possible construction wastes, as well as for soil degradation control.
- If brick making takes place, promote measures to limit emissions of dust and combustion gases from the kilns (e.g. consider less damaging sources of energy, improved efficiency of kilns, and re-use of generated ashes).
- Use machinery that emits less dust and noise.
- Avoid using dynamite during construction.

Pollution (soil, water, air) and human health sensitivities may arise, depending on the building's operational activities Avoid creating stagnant water ponds which can be highly odorous and provide breeding grounds for mosquitoes.

Pollution (soil, water, air) and human health sensitivities may arise, depending on the building's operational activities Avoid creating stagnant water ponds which can be highly odorous and provide breeding grounds for mosquitoes.

- Avoid creating stagnant water ponds which can be highly odorous and provide breeding grounds for mosquitoes.
- Promote proper health and safety training, equipment (e.g. masks, ear plugs, gloves, and boots), workspace layout, and work periods.
- Implement proper cleanliness, maintenance, accident, spill, overheating, fire and/or explosion control measures.
- Ensure proper training on environmental issues and waste management (see # J-Waste Management planning sectoral tool, if required).
- Implement conservation and efficiency measures for

h-pressure nozzles, biological and equitable certification, environmentally friendly packaging).

- Implement pollution prevention or control devices to limit the harmful effects of pollutants (liquid, solid, or atmospheric), for example, biological wastewater treatment, drainage systems, air filters, proper ventilation, improved stoves, alternative energy sources (for example, solar energy), recycling of scraps, minimal use of dangerous products (e.g. chemicals, laboratory products, solvents, lubricants, oil, batteries, dyes, glue, acids, heavy metals, and radioactive substances) and their appropriate management (e.g. secured storage areas away from vulnerable elements, storage of flammable products away from all sources of heat or ignition, labelled leak proof containers with covers that are understandable locally).
- Ensure that sanitation facilities are located away from water sources, steep slopes, and vulnerable areas (see # D- Sanitation Systems sectoral planning tool, if needed).
- Promote waste segregation practices to enable the re-use of certain products, recycling of other products, composting of biodegradable wastes, and appropriate storage, transportation, treatment and disposal of other wastes (see # J- Waste Management planning sectoral tool).

D. How to develop a

n Environmental Management Plan (EMP)?

For some industrial and infrastructure building projects, the environmental management plan will set out the objectives to be achieved and provide the measures to be taken to mitigate environmental damage during the site preparation, construction, operations, and abandonment. The need for a follow-up program should also be included as well. The environmental management plan should cover the entire life-cycle of the production process, including raw materials, products and wastes. It ensures the adoption of a coordinated and efficient approach to environmental issues. A growing number of industries and organizations recognize the value of such a plan. For example, the International Standards Association has developed international standards (ISO 14000) for environmental management systems.

The environmental management plan could include the following elements in particular:

- *Objectives of the plan:* The objectives of the environmental management plan should be described. Performance must be measured on the basis of environmental indicators.
- *Mitigation strategy:* Describe how environmental impacts are to be addressed and lists the mitigation measures. Internal regulations and control measures should be adopted to: improve energy efficiency; minimize waste production and water consumption; replace or eliminate toxic products; promote recycling and recovery of wastes and waste water; reduce the adverse effects of plant operations on the environment.
- *Compliance:* Indicates the legislation, regulations and, in some cases, the guidelines, codes of practice and policies.
- *Environmental effects monitoring program:* The

measures, procedures and management mechanisms proposed to e

the measures designed to protect employees and lists the existing emergency response equipment. The plan also describes the operational safety measures and environmental practices adopted.

- *Emergency response plan:* This plan permits rapid and effective response in the event of an accident. Its thoroughness determines the organization's capacity to protect employees or the environment in the event of an emergency.
- *Human resources and training:* This section deals with the human resources and training required to ensure application of the environmental management plan.
- *Responsibility:* The authorities responsible for mitigation measures and general supervision must be clearly identified.

E. How to plan follow-up and monitoring of environmental aspects?

When planning the environmental follow-up and monitoring of an initiative, the following should be addressed.

- *Items to be monitored*: What items will be monitored? Potentially significant environmental effects, sensitive components of the environment, any uncertainties, and mitigation measures (their implementation and effectiveness) are generally monitored.
- *Follow-up / monitoring methods*: How, where, and according to what schedule will follow-up / monitoring take place to help identify unforeseen effects and to assess the implementation and effectiveness of the chosen mitigation measures? Sufficient flexibility is

required for additional measures when necessary.

- *Follow-up /*

How and when will the results are reported to enable the analysis of lessons learned and their feedback into future initiatives? Who will be responsible for these aspects?

An indicator is a measurement, number, fact, standard, opinion or perception that helps measure progress toward achieving results. Not all the indicators identified in this table have to be used—only those that are relevant and contextually pertinent to the initiative and its setting. The chosen indicators can be:

- *Environmental indicators:* Surface water characteristics (suspended sediments, pH, transparency, chemicals); soil texture and composition characteristics; increase in vegetative cover; rate of water use; quantities of solid waste generated; quantities of re-used or recycled products; and extent of energy use per type of energy source.
- *Human well-being indicators:* Incidence of human illness or disease; and frequency of accidents during the building's operational activities.

Reference and Useful Resources

- REMA (2009): Rwanda State of Environment and Outlook Report, Rwanda Environment Management Authority, P.O. Box 7436 Kigali, Rwanda http://www.rema.gov.rw/soe/
- CIDA, Environmental Handbook for Community Development Initiatives (2002), Second Edition of the *Handbook on Environmental Assessment of Non-Governmental Organizations and Institutions Programs and Projects (1997)* http://www.acdi-cida.gc.ca/acdi-cida/ACDI-CIDA.nsf/eng/JUD-47134825-NVT
- USAID, Environmental Guidelines for Small-Scale Activities in Africa: Environmentally Sound Design for Planning and Implementing Development Activities, U.S. Agency for

International Development, Office of Sustainable Development, Draft Version, January 2005, www.encapafrica.org.

- Tsunokawa, Koji and Christopher Hoban (Eds.) (1997) *Roads and the Environment: A Handbook. World Bank Technical Paper No. 376*. World Bank, Washington, D.C. http://www.worldbank.org/transport/publicat/reh/toc.htm

B. Rural Roads

This sectoral tool provides an outline that can be used to identify the major, potential, adverse environmental effects, as

sociated mitigation measures, and guidelines, as well as environmental indicators, for initiatives involving the construction or upgr

ading of rural roads and trails.

A. What are the major environmental concerns?

These are some of the key issues in Rw

and a regarding rural roads.

vironment and Outlook, increased population outlook will require proper infrastructure including rural roads. The network of secondary un-surfaced roads generally lacked adequate roadside drainage and lead to land degradation. Many of these roads have inadequate roadside drainage and so collect surface overland flow that generates significant run-off. Poor road conditions leads to a major obstacle of efficient transportation.

How can the construction or upgrading of rural roads and trails affect the human environment?

- Conflicts over existing or planned land uses, activities, and infrastructures (both "legal" and "illegal") may arise.
- Induced population movements (migration, resettlement) may occur.
- Nuisances (e.g. noise, foul odours, airborne dust, vibrations, air pollution), health risks (e.g. communicable diseases and water-borne diseases), and risks of accidents may arise due to (increased) traffic.

How can the construction or upgrading of rural roads and trails affect the natural environment?

- Soil degradation (affecting its stability or structure), erosion, and compaction may arise.
- The health of terrestrial ecosystems may be negatively affected, especially if soil denudation, erosion, vegetation clearing, or displacement/reduction in wildlife occur.
- Water quality may be degraded and the health of aquatic ecosystems may thus be negatively affected through increased sedimentation, the possible run-off of products

and alterations to hydrology.

B. How can Sting, planning, and design be environmenta

lly responsible?

By addressing such concerns early in the initiative’s cycle, they will have better chances of success and long-te rm sustainability, help to prevent negative outcomes, and avoid rehabilitation costs. The following guiding principles are usef ult to avoid adverse environmental effects associated with siting, planning, and design. *You can check the items that are releva*

nt	*to the proposed initiative.* • Take into account the population density and the pattern and characteristics of land occupation, as well as soil characteristics (e.g. stability, texture, and drainage), proximity to water bodies, topography, climatic conditions, intended road uses, and expected traffic characteristics when planning the road siting, its width, surfacing material, and structures (such as viaducts, tunnels, bridges, contour canals, ditches, culverts, cuts, embankments). • Avoid siting in areas prone to natural disasters or hazards (e.g. flooding, heavy rain, intense storms, earthquakes, volcanic eruptions, and landslides). • Avoid infringing on or giving unplanned access to vulnerable sites or sites of economic, ecological, cultural, archaeological or historical importance (e.g. water bodies, waterways, slopes, wooded areas, coastal areas, arid and semi-arid areas, wetlands, biodiversity hotspots, and habitats of endangered species). • Avoid uncontrolled and unplanned urbanization and commercial development, disruption in the organizational structure or means of subsistence, and disruption of the marketing system for traditional products. • Avoid sites that would lead to unacceptable population displacements and/or loss of territory (e.g. migrations, expropriations, eviction of tenants or squatters, effects on population densification along the road, and loss of agricultural lands). • Avoid sites that would accentuate social inequalities (e.g. depending on the means and availability of

transportation for proposed users, for localities through wh

demands for local public infrastructure and services or pros

s, and conflicts with respect to property rights and land te

planting, and restoration of degraded sites).

- Adapt sustaina

ncy principles during construction.

- Ensure that internationa

of the road).

C. What are the major potential adverse environmental effects? What can be done to mitiga

te or avoid them? Mitigation measures are measures that effectively control, eliminate, or significantly reduce an initiative's ad

verse environmental effects. Not all the measures identified in this table have to be used—only those that are relevant and contex

tually pertinent to the initiative and its setting. The chosen mitigation measures can be underlined in the following table. When docu

menting the chosen mitigation measures, it is pertinent to provide details about how they will be achieved.	
Major adverse effect	

s
Associated mitigation measures
Health risks and risks of accidents for the population.

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- Promote education on avoiding communicable diseases (that may be associated with additional influx of workers and road users).
- Ensure proper training for the regular maintenance of the road and its structures.
- Avoid creating congested and unsafe road conditions at intersections, and in villages and towns (especially close to schools and dense neighbourhoods).
- Ensure culturally pertinent warnings or signs are used alongside the road.
- Implement proper accident, spill, fire, and explosion control measures.
- Minimize the use of roadside herbicides and chemical maintenance materials.

Adverse effects on animals and wildlife due to disruption of their movements and increase in road kills. Avoid encroaching on and segmenting known animal and wildlife habitats and movement routes that are critical (e.g. those used for spawning, breeding, feeding, or migrations).

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- Avoid encroaching on and segmenting known animal and wildlife habitats and movement routes that are critical (e.g. those used for spawning, breeding, feeding, or migrations).
- Promote the installation of animal/wildlife crossing warnings or signs, and night-time speed limits.
- Rehabilitate degraded areas nearby as wildlife habitat.

Soil degradation (e.g. erosion, compaction, changes in drainage, and gully formation) and degradation of vegetation and ecos

ystems. Soil degradation is particularly a problem where soils are fine or weak, or have complex drainage cycles. Heavy precipita tion and activities on or around steep slopes also present issues. In many cases, soil erosion can be associated with increased se

dimentation in waters (which degrades surface water quality and the health of aquatic ecosystems).	

ially and environmentally responsible practices for road siting, planning, and design (see Section B).

- Limit vegetation clearing to a minimal pathway.
- Keep a safe distance from water bodies and other vulnerable areas.
- Avoid inappropriate use of heavy machinery.
- Line receiving surfaces with stones or concrete.
- Install culverts and bridges in dry season.
- Ensure proper and timely design and maintenance of culverts and surface drainage structures or crossings to handle maximum anticipated water flows (which can vary in time and space and according to soil, climatic, and aquatic characteristics).
- Ensure proper and timely maintenance of road surface, bridges, roadside slopes, roadside vegetation, and other road structures.
- Promote soil erosion control measures (e.g. balance cut and fill for minimum deposition of earth, limit earth movement, minimize time when soil surfaces are exposed, site roads to follow hill contours, stabilize road surface with rocky surfacing material, stabilize soil for example with mulch on vulnerable surfaces, resurface and revegetate exposed areas, implement buffer zones of vegetation on slopes and surrounding bodies of water, and promote windbreaks).
- Collect and recycle used lubricants (e.g. during construction activities with equipment that requires the use of such products).
- Establish measures to avoid accidental spills (e.g. oil, fuel, lubricant from construction equipment, and dangerous products or wastes that may be transported on the road), and properly contain them if they do happen.

ittering of the road and its vicinity.

- Use machinery that emits less dust and noise.
- Avoid using dynamite during construction.

Effects associated with exploitation of quarries and borrow pits

Effects associated with exploitation of quarries and borrow pits

Restore quarries and borrow pits to avoid soil erosion and landscape and ecosystem degradation.

- Restore quarries and borrow pits to avoid soil erosion and landscape and ecosystem degradation.

D. How to develop an Environmental Management Plan (EMP)?

For ro

ad construction projects, the environmental management plan will set out the objectives to be achieved and provide the measures to be taken to mitigate environmental damage during the site preparation, construction, operations, and abandonment. The need for a follow-up program should also be included as well. The environmental management plan should cover the entire life-cycle including site selection, construction and maintenance of the roads.

The environmental management plan could include the following elements in particular:

- *Objectives of the plan:* The objectives of the environmental management plan should be described. Performance must be measured on the basis of environmental indicators.
- *Mitigation strategy:* Describe how environmental impacts are to be addressed and lists the mitigation measures. Internal regulations and control measures should be adopted to: improve energy efficiency and minimize waste production and water consumption during construction; assure proper road maintenance.
- *Compliance:* Indicates the legislation, regulations and, in some cases, the guidelines, codes of practice and policies.
- *Environmental effects monitoring program:* The measures, procedures and management mechanisms proposed to ensure effective implementation of the environmental measures.
- *Health and safety plan:* The operational safety plan is developed to prevent emergency situations. This plan describes the measures designed to protect employees during construction and lists the existing emergency response equipment. The plan also describes the operational safety measures and

environmental practices adopted.

- *Emergency response plan:* Thi

t of an emergency.

- *Human resources and training:* This section deals with the human resources and training required to ensure application of the environmental management plan.
- *Responsibility:* The authorities responsible for mitigation measures and general supervision must be clearly identified.

E. How to plan follow-up and monitoring of environmental aspects

When planning the environmental follow-up and monitoring of an initiative, the following should be addressed.

- *Items to be monitored*: What items will be monitored? Potentially significant environmental effects, sensitive components of the environment, any uncertainties, and mitigation measures (their implementation and effectiveness) are generally monitored.
- *Follow-up / monitoring methods*: How, where, and according to what schedule will follow-up / monitoring take place to help identify unforeseen effects and to assess the implementation and effectiveness of the chosen mitigation measures? Sufficient flexibility is required for additional measures when necessary.
- *Follow-up / monitoring roles and responsibilities*: Who will be responsible for implementing these tasks and ensuring that the results are acted upon?
- *Follow-up / monitoring reporting methods:* How and when will the results be reported to enable the analysis of lessons learned and their feedback into future initiatives? Who will be responsible for these aspects?

An indicator is a measurement, number, fact, standard, opinion or perception that helps measure progress toward achieving re

sults. Not all the indicators identified in this table have to be used—only those that are relevant and contextually pertinent to the in

itiative and its setting. The chosen environmental indicators can be underlined in the following table. It is pertinent to provide details

and specifications on how they will be used.

	of suspended sediments in surface waters and other characteristics (pH, transparency); productivity of ecosystems in the road's vicinity (e.g. number of breeding areas/species, number of plant shoots); quality of ecosystems in the road's vicinity (which can be evaluated through a qualitative scale); degree of biodiversity (number of species and an appreciation of their populations) in the road's vicinity; extent of critical or wildlife habitats (in hectares, for example); and degree of wildlife habitat fragmentation (number of fragmented areas, for example). • *Human well-being indicators*: Incidence of human illness or disease; frequency of traffic accidents involving vehicles, pedestrians, fires, or product spills; incidence of commercial activity per groups involved; and human population density in the road's vicinity.

Reference and Useful Resources

- REMA (2009): Rwanda State of Environment and Outlook Report, Rwanda Environment Management Authority, P.O. Box 7436 Kigali, Rwanda http://www.rema.gov.rw/soe/
- CIDA, Environmental Handbook for Community Development Initiatives (2002), Second Edition of the *Handbook on Environmental Assessment of Non-Governmental Organizations and Institutions Programs and Projects (1997)* http://www.acdi-cida.gc.ca/acdi-cida/ACDI-CIDA.nsf/eng/JUD-47134825-NVT
- USAID, Environmental Guidelines for Small-Scale Activities in Africa: Environmentally Sound Design for Planning and Implementing Development Activities, U.S. Agency for International Development, Office of Sustainable Development, Draft Version, January 2005, www.encapafrica.org.
- Tsunokawa, Koji and Christopher Hoban (Eds.) (1997) *Roads and the Environment: A Handbook. World Bank Technical Paper No. 376.* World Bank, Washington, D.C. http://www.worldbank.org/transport/publicat/reh/toc.htm

C. Water Supply[1]

This sectoral tool provides an outline that can be used to identify the major, potential, adverse environmental effe

[1] Tool and Guideline # 9 provides practical technical information on low-cost technologies such as rainwater harvesting infrastructure.

cts, associated mitigation measures, and guidelines, as well as environmental indicators, for the implementation of water supply

systems designed to supply drinking water to the population (including groundwater as well as surface water extraction).

A. Wh

at are the major environmental concerns?

These are some of the key issues in Rwanda regarding water supply.

- As reported in the 2009 Rwanda State of the Environment and Outlook, the pressure on water resources primarily result from utilizing the natural resources to meet basic needs as well as social-economic development. It is estimated that water demand over the next decade will double in Kigali and rural areas and more than double for the semi-urban settlements.
- Water stress is likely to be accentuated by projected increases in water demand across all sectors. Water use is projected to expand 5.5 folds by 2020. The most significant increase in water demand is clearly from the agricultural sector. Given the country's substantial water resource base, Rwanda's water predicament can be readily tackled with an appropriate combination of governance, technological, ecosystem restoration and market-based responses.
- Rwanda's drinking water problem is essentially one of improving access efficiency. Resolving this challenge does not necessarily require major infrastructure investments. While 71 percent of the Rwandan population currently has access to safe drinking water, this figure drops significantly in rural areas. Access issues are linked to the limited water distribution infrastructure as well as the high costs of paying for safe drinking water. Access issues are accentuated by problems of drinking water contamination. The main problem is biological contamination of drinking water sources.

How can the implementation of water supply systems designed to supply drinking water to the population affect the human en

vi ro n m en t?

ollute water sources) may arise.

- Activities may negatively affect existing community water management practices and relationships.
- Contamination of water sources and creation of stagnant water ponds may lead to the spread of illness and disease (water-borne diseases and infections).

How can the implementation of water supply systems designed to supply drinking water to the population affect the natural environment?

- The quality and quantity of surface water / groundwater may be degraded. Water resources can de degraded by many means such as oil spills, pesticides, fertilizers, pollution from industries, etc (e.g. it has been reported that drugs appear in water supply as waste products).
- Soil degradation and erosion, as well as degradation of the watershed or wooded areas, may arise (e.g. deforestation, loss of biodiversity, and wetland conversion).
- The health of aquatic, river and wetland ecosystems may be negatively affected (e.g. alterations to hydrology and flow and the presence of structures may have an adverse effect on the ecological regulatory functions of the aquatic ecosystem, including its capacity to dilute pollutants, and on the species that are part of that ecosystem).
- Notes: Using the points above as a guide, describe the major environmental sensitivities or areas of concern relating to the proposed initiative.

B. How can siting, planning, and design be environmentally responsible?

By addressing such concerns early in the initiative's cycle, they will have

better chances of success and long-term sustainability, help to prevent negative outcomes, and avoid rehabilitation costs. The

following guiding principles are useful to avoid adverse environmental effects associated with siting, planning, and design. T

ake into account the population density in relation to available water supply, based on current and historical data (and which may

vary between seasons), its quality, and sanitation practices, as well as the socio-economical and technical production capacities of the communities. *You can check the items that are relevant to the proposed initiative.*

- Avoid siting close to vulnerable sites or sites of economic, ecological, cultural, archaeological, or historical importance (e.g. slopes, wooded areas, wetlands, coastal areas, biodiversity hotspots, and habitats of endangered species).
- Avoid sites and activities that would lead to unacceptable population displacements and/or loss of territory (e.g. migrations, expropriations, eviction of tenants or squatters, effects on settling of nomads, and induced uncontrolled urbanization).
- Avoid sites and activities that would accentuate social inequalities (e.g. cases where specific groups of the population, such as women, farmers, livestock producers have not been consulted; where the number of beneficiaries is limited; and where there would be an increase in women's workload).
- Avoid sites and activities that would lead to incompatible uses of land and resources and/or unacceptable social conflicts (e.g. between common ownership of public or ancestral lands and "ownership" of water structures; between different types of water uses in the same area or different areas; between water users upstream and downstream from water source; between potentially pollutant activities and drinking water supply activities; between industrial uses and domestic uses). To ensure maximum benefits, such initiatives should take into account the improvement of human waste disposal systems and sanitation systems (see # D- Sanitation Systems planning sectoral tool).

	• Choose water supply systems (e.g. wells, boreholes, reservoi

er soil texture, stability, and composition; slope; seasonal

the quality of the water supply.

- Integrate environmental con

and national/local policies, standards, and regulations are

C. What are the major potential adverse environmen

tal effects? What can be done to mitigate or avoid them? Mitigation measures are measures that effectively control, eliminat	

e, or significantly reduce an initiative's adverse environmental effects. Not all the measures identified in this table have to be used—

only those that are relevant and contextually pertinent to the initiative and its setting. The chosen mitigation measures can be underli

ned in the following table. When documenting the chosen mitigation measures, it is pertinent to provide details about how they will

be achieved.

Major adverse effects

Associated mitigation measures

Conflicts over land uses and surface or ground water supplies, as well as negative effects on existing community water management practices and relationships. Consider water conservation measures instead of or in addition to a new water supply initiative, for example by upgrading or renovating existing systems (e.g. deepen and clean existing wells, reduce leakage, evaporation and seepage losses) and by promoting water recycling and re-use, where appropriate.

- Consider water conservation measures instead of or in addition to a new water supply initiative, for example by upgrading or renovating existing systems (e.g. deepen and clean existing wells, reduce leakage, evaporation and seepage losses) and by promoting water recycling and re-use, where appropriate.
- Ensure sufficient community participation and organization for effective planning and management of the water supply system, and for equitable water distribution (e.g. with a community management committee, including local representatives from different user groups and affected areas; community prioritization of intended uses; upstream/downstream user agreements; and user fees).
- Determine and maintain adequate water flow levels to ensure continued access to water of downstream populations (and ecosystem health).
- Develop supply sources where water availability is adequate and the initiative will not conflict with existing human, livestock or wildlife water uses (especially during dry seasons) and so that withdrawals do not lead to major alterations of the surface water hydrology or exceed the groundwater recharge rate.

Human health sensitivities to water-borne diseases and infections (if creating habitats for disease carriers such as mosquit

oes and snails, and increasing the likelihood of water-related diseases such as malaria, schistosomiasis (bilharzia), onchocer ciasis (river blindness), or gastro-intestinal diseases). Ensure good drainage around water supply points and avoid creating stagnant water ponds (e.g. through the appropriate design, installation, use, and maintenance of drains and soak-away pits).

- Ensure good drainage around water supply points and avoid creating stagnant water ponds (e.g. through the appropriate design, installation, use, and maintenance of drains and soak-away pits).
- Construct a spigot or similar system that prevents people from touching impounded water with their hands or mouths.
- Monitor disease occurrence and other public health indicators related to water-borne diseases and infections, and take corrective measures as needed (e.g. physical changes to water supply and sanitation systems, public education, and medical intervention).
- Ensure water is fit for drinking, for example, based on World Health Organization (WHO) guidelines, and ensure regular ongoing water testing by the community (of the water source and at various points along the water supply system).
- Ensure locally adapted water treatment where water potability may present issues.
- Avoid the entry of contaminants into the water source / supply system (see next item on water quality).

Degradation of surface water or groundwater quality and quantity (see # D- Sanitation Systems planning sectoral tool). In the case of groundwater extraction, it should be noted that areas where the water table is high (closer to the soil surface), where soils have a high clay or sand content, and coastal and insular areas present challenges.

Degradation of surface water or

groundwater quality and quantity (see #D - Sanitation Systems planning sectoral tool). In the case of groundwater extraction.

it should be noted that areas where the water table is high (closer to the soil surface), where soils have a high clay or sand content, and coastal and insular areas present challenges.

Promote water conservation practices (e.g. consider availability of water supplies, hydrology of surface waters or groundwater recharge rate, other uses, water recycling and re-use where appropriate, rationing during the dry season, use of control valves and reducer pipes).

- Promote water conservation practices (e.g. consider availability of water supplies, hydrology of surface waters or groundwater recharge rate, other uses, water recycling and re-use where appropriate, rationing during the dry season, use of control valves and reducer pipes).
- Monitor water levels in wells or impoundment structures.
- Limit diversion of surface waters and alterations to hydrology in fish migration and spawning areas.
- Ensure that the water supply system is in line with silting patterns, flow rates, and flood cycles of the surface waters.
- Avoid salinization from groundwater use that exceeds its recharge rate (consider spacing and number of wells).
- Implement a community education, training, and capacity building program to properly operate and maintain the system, as well as to improve hygiene and sanitation practices (see # D-Sanitation Systems planning sectoral tool).
- Reduce possible leakage, evaporation, and seepage losses through appropriate design, installation, use, and maintenance of structures.
- Avoid the entry of contaminants into the water source / supply system:
    - Ensure activities associated with

vicinity of the water source and supply system.

- Locate latrines, septic systems (or other similar activities) and animal pens or areas of livestock concentration at least 30 m away from water source and supply system.
- Locate water system well away from waste-generating activities or waste disposal areas.
- Ensure that water extraction for crop production, bathing, laundering, and animal watering takes place in adequate predetermined areas, in order to avoid the possible entry of contaminants in the water source or supply system, and to avoid over extraction.
- Protect the water source and supply system from run-off or seepage of contaminants by using lids or covers on wells, well casing above ground level, fences, lined distribution pipes and wells, covered drains, soak-away pits for domestic grey waters or spillage from wells, and treatment systems.

Ecosystem/watershed degradation (e.g. deforestation, loss of biodiversity, increased sedimentation in waters) and soil degradation (e.g. erosion, compaction, and changes in drainage). Soil degradation is a problem particularly where soils are fine or weak, or have complex drainage and fertility cycles. Heavy precipitation and activities on or around steep slopes also

present issues. Ecosystem/watershed degradation (e.g. deforestation, loss of biodiversity, increased sedimentation in water	

s) and soil degradation (e.g. erosion, compaction, and changes in drainage). Soil degradation is a problem particularly where soils are fine or weak, or have complex drainage and fertility cycles. Heavy precipitation and activities on or around steep slopes also present issues. Minimize soil exposition (e.g. minimize vegetation clearing; minimize time when soil surfaces are exposed to rain and wind; resurface and revegetate exposed areas; implement buffer zones of vegetation; and use proper bedding materials for pipes).

- Minimize soil exposition (e.g. minimize vegetation clearing; minimize time when soil surfaces are exposed to rain and wind; resurface and revegetate exposed areas; implement buffer zones of vegetation; and use proper bedding materials for pipes).
- Implement soil protection measures and anti-erosion measures around the water source or the water supply system (such as avoiding improper use of heavy machinery, reforestation and revegetation, small-scale contouring or terracing, drainage structures with cobbled stone, gravel, or concrete).
- Promote a watershed or river bank or water source improvement program to enhance retention capacities in soils (e.g. revegetation, reforestation).

D. How to develop an E

nvironmental Management Plan (EMP)? For water supply projects, the environmental management plan will set out

the objectives to be achieved and provide the measures to be taken to mitigate environmental damage during the site preparation,

construction and operations. The need for a follow-up program should also be included as well. The environmental management

plan should cover the entire life-cycle of the project. The environmental management plan could include the following ele

m en ts in pa rti cu la r:

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When planning the environmental follow-up and monitoring of an initiati

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An indicator is a measurement, nu

mber, fact, standard, opinion or perception that helps measure progress toward achieving results. Not all the indicators identifie

d in this table have to be used — only those that are relevant and contextually pertinent to the initiative and its setting. The chosen envi

ronmental indicators can be underlined in the following table. It is pertinent to provide details and specifications on how they will be

used.

Reference and Useful Resources

- REMA (2009): Rwanda State of Environment and Outlook Report, Rwanda Environment Management Authority, P.O. Box 7436 Kigali, Rwanda http://www.rema.gov.rw/soe/

- CIDA, Environmental Handbook for Community Development Initiatives (2002), Second Edition of the *Handbook on Environmental Assessment of Non-Governmental Organizations and Institutions Programs and Projects (1997)* http://www.acdi-cida.gc.ca/acdi-cida/ACDI-CIDA.nsf/eng/JUD-47134825-NVT
- WHO web site on water and sanitation: (http://www.who.int/water_sanitation_health/publications/en/)
- *Guidelines for the Development of Small Scale rural Water Supply & Sanitation Projects In East Africa.* Warner. D, Abate. C July 2005. http://www.encapafrica.org/documents/Wat0509_e.pdf
- USAID, Environmental Guidelines for Small-Scale Activities in Africa: Environmentally Sound Design for Planning and Implementing Development Activities, U.S. Agency for International Development, Office of Sustainable Development, Draft Version, January 2005, www.encapafrica.org.
- *FID Guidance Manual on Water Supply and Sanitation Programmes* (1998). United Kingdom Department for International Development (DFID). http://www.lboro.ac.uk/well/resources/Publications/guidance-manual/guidance-manual.htm
- WELL - Research Centre Network for Water, Sanitation and Environmental Health. http://www.lboro.ac.uk/well/
- IRC International Water and Sanitation Centre. http://www.irc.nl/
- Water Supply and Sanitation Collaborative Council. http://www.wsscc.org/
- NETWAS: Network for Water and Sanitation. Hosting the International Training Network for Water and Waste Management (ITN - Africa). http://www.netwas.org/

D. Sanitation Systems[2]

This sectoral tool provides an outline that can be used to identify

[2] Tool and Guideline # 9 provides practical technical information on low-cost technologies such as composting latrines.

the major, potential, adverse environmental effects, associated mitigation measures, and guidelines, as well as environmental in

dicators, for the implementation of sanitation systems (e.g. individual or community latrines, small-scale septic tanks an

d leach field systems, soak-away pits for household wastewater).

A. What are the major environmental concerns?

These are some of the key environmental issues in Rwanda relating to sanitation systems.

How can the implementation of sanitation systems affect the human environment?

How can the implementation of sanitation systems affect the natural environm

en t?

B. How can siting, planning, and design be environmentally responsible?

By

addressing such concerns early in the initiative's cycle, they will have better chances of success and long-term sustainability, help

to prevent negative outcomes, and avoid rehabilitation costs. The following guiding principles are useful to avoid adverse envi

ronmental effects associated with siting, planning, and design. *You can check the items that are relevant to the proposed initiat*

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e.

C. What are the major pote

ntial adverse environmental effects? What can be done to mitigate or avoid them? Mitigation measures are measures that

effectively control, eliminate, or significantly reduce an initiative’s adverse environmental effects. Not all the measures identified

in this table have to be used—only those that are relevant and contextually pertinent to the initiative and its setting. The chosen mitiga

tion measures can be underlined in the following table. When documenting the chosen mitigation measures, it is pertinent to provid e details about how they will be achieved.

Major adverse effects

Associated mitigation measures

Soil degradation

(e.g. erosion, compaction, and changes in drainage). Soil degradation is a problem particularly where soils are fine or weak, or have complex drainage and fertility cycles. Heavy precipitation and activities on or around steep slopes also present issues. Minimize soil exposition during construction of structures (e.g. minimize vegetation clearing; minimize time when soil surfaces are exposed to rain and wind; resurface and revegetate exposed areas; implement buffer zones of vegetation; and use proper bedding and lining materials).

- Minimize soil exposition during construction of structures (e.g. minimize vegetation clearing; minimize time when soil surfaces are exposed to rain and wind; resurface and revegetate exposed areas; implement buffer zones of vegetation; and use proper bedding and lining materials).
- If there are risks of soil instability, another choice of location or stability structures/lining are usually required.
- Implement soil protection measures and anti-erosion structures around the sanitation systems (e.g. reforestation and revegetation; drainage structures with cobbled stone, gravel, or concrete).

Human health sensitivities to water-borne diseases and gastro-intestinal diseases (if creating habitats for disease carriers such as mosquitoes and snails, and increasing the likelihood of gastro-intestinal diseases such as infectious diarrhea, dysentery, cholera, typhoid) and other nuisances (such as foul odours and flies).

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odours and flies). Various wastewater treatment options exist for domestic greywaters, ranging from soak-away pits an d other physical filtering drainage systems to wastewater stabilization ponds, controlled release lagoons, and engineered wetl ands with native and adapted species. Avoid creating stagnant water ponds to reduce risks of water-borne diseases.

- Avoid creating stagnant water ponds to reduce risks of water-borne diseases.
- Monitor disease occurrence and other public health indicators related to water-borne diseases and gastro-intestinal diseases, and take corrective measures as needed (e.g. physical changes to water supply and sanitation systems, public education, and medical intervention).
- Ensure existing water sources remain fit for drinking (e.g. based on WHO guidelines) and ensure regular ongoing water testing by the community (of the water source and at various points along the water supply system).
- Ensure locally adapted water purification where water potability may present issues.
- Ensure daily cleaning and adequate ventilation in latrines, for example the design of VIP (ventilated improved pit) latrines includes a ventilation pipe or air inlet (where the length and/or orientation will depend on the proximity of neighbours and predominating winds; it is generally recommended that an air inlet or pipe face the direction of prevailing winds to maximize air intake) and a mesh or fly screen at its exterior extremity as a barrier for insects.
- Avoid defecation in open areas and disposal of excreta or wastewater directly on land or into water sources without adequate treatment.
- Avoid seepage, infiltration and direct contact with contaminants from sanitation systems (see next item for details).

Degradation of surface water or groundwater quality. Measures to avoid such degradation are especially important where the water table is high (closer to the soil’s surface) or where soils have a high clay or sand content.

In the specific case of composting latrines: maintain humidity of composting material above 60 percent and supplement excreta with generous quantities of dry leaves, dry grass, or straw—so that the pile remains aerobic (i.e. with oxygen), odour-free, and insect-free; if using a fixed-batch system, construct sealed vaults to hold composting material; if using a movable-batch system, check removable containers for leaks before installation; allow sufficient residence time in mature chamber (this may vary from six months in warm climates to 18 months in cooler climates); test samples from active chamber and mature chamber (after fallow period) for Ascaris eggs and fecal coliforms to assess level of pathogens.

In the specific case of dry latrines: maintain humidity of composting material above 20 percent and supplement excreta with alkaline material such as ashes or lime (so that the pile remains odour-free and insect-free and that the pathogens are destroyed); construct sealed vaults to hold dehydrating and curing material; allow sufficient residence time in mature chamber (this may vary from six months in warm climates to 18 months in cooler climates); test samples from active chamber and mature chamber (after fallow period) for Ascaris eggs and fecal coliforms to assess level of sterilization. Avoid defecation in open areas and disposal of excreta or wastewater directly on land or into water sources without adequate treatment.

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- Avoid defecation in open areas and disposal of excreta or wastewater directly on land or into water sources without adequate treatment.
- Ensure that the sanitation systems are used specifically for biodegradable human wastes (these systems are not intended for toxic, hazardous, or non-biodegradable wastes).
- Avoid locating sanitation systems where the water table is high (it is usually recommended that the bottom of the pit be separated from the water table by at least 2 m of unsaturated soil) or where soils have a high clay or sand content (which is typically a sign of permeability).
- Ensure adequate spacing between latrines and soak-away pits.
- Avoid the entry of contaminants from the sanitation system into the water source / supply system.
  - Locate latrines at

y system, as well as downhill from the water supply.
    - Protect water source and supply system from run-off or seepage of contaminants by using lids or covers on wells, well casing above ground level, fences, lined distribution pipes and wells, covered drains, soak-away pits for domestic grey waters or spillage from wells, and treatment systems.
- Implement a community education, training, and capacity building program to properly use, operate, and maintain the sanitation systems (maintenance includes for example, monthly verifications of the integrity of the mesh or fly screen of latrines, of the opening of ventilation pipes or air inlets of latrines; daily cleaning of the inside of latrines), as well as to improve hygiene attitudes and behaviour.
- Ensure the use of a reliable and safe system for emptying latrines or septic tanks and transporting the collected material off-site for treatment (e.g. a mechanized vacuum pump, associated tank or container, use of stones to avoid collapse of the pit during emptying, and the use of protective clothing, long-sleeved shirts and pants, boots, rubber gloves, and masks / eye protectors, when needed, as well as access to adequate washing facilities with soap and warm water).
- Ensure that maintenance workers are also trained in first-aid measures and relevant occupational health and security topics.
- Ensure that the material collected from latrines or septic tanks is adequately

ned for composting, it is usually recommended that latrines be used in alternation so that natural decomposition of the excreta and elimination of pathogens can occur (which can generally take up to two years, depending on the circumstances).

- Ensure a proper resting period or decommissioning of latrines when they are filled to 0.5 m from the top (e.g. do not leave pits open, and fill in unused capacity with rocks or soil, in case of decommissioning).

D. How to develop an Environmental Management Plan (EMP)?

For some large scale sanitation systems, the environmental management plan will set out the objectives to be achieved and provide the measures to be taken to mitigate environmental damage during the site preparation, construction, operations, and abandonment. The need for a follow-up program should also be included as well. The environmental management plan should cover the entire life-cycle of the project.

The environmental management plan could include the following elements in particular:

- *Objectives of the plan:* The objectives of the environmental management plan should be described. Performance must be measured on the basis of environmental indicators.
- *Mitigation strategy:* Describe how environmental impacts are to be addressed and lists the mitigation measures. Internal regulations and control measures should be adopted to: minimize waste production and water consumption; promote recycling and recovery of wastes and waste water; ensure proper maintenance of

to ensure effective implementation of the environmental measures.

- *Health and safety plan:* The operational safety plan is developed to prevent emergency situations. This plan describes the measures designed to protect employees and lists the existing emergency response equipment. The plan also describes the operational safety measures and environmental practices adopted.
- *Emergency response plan:* This plan permits rapid and effective response in the event of an accident. Its thoroughness determines the organization's capacity to protect employees or the environment in the event of an emergency.
- *Human resources and training:* This section deals with the human resources and training required to ensure application of the environmental management plan.
- *Responsibility:* The authorities responsible for mitigation measures and general supervision must be clearly identified.

E. How to plan follow-up and monitoring of environmental aspects

When planning the environmental follow-up and monitoring of an initiative, the following should be addressed.

- *Items to be monitored*: What items will be monitored? Potentially significant environmental effects, sensitive components of the environment, any uncertainties, and mitigation measures (their implementation and effectiveness) are generally monitored.
- *Follow-up / monitoring*

equired for additional measures when necessary.

- *Follow-up / monitoring roles and responsibilities*: Who will be responsible for implementing these tasks and ensuring that the results are acted upon?
- *Follow-up / monitoring reporting methods*: How and when will the results be reported to enable the analysis of lessons learned and their feedback into future initiatives? Who will be responsible for these aspects?

An indicator is a measurement, number, fact, standard, opinion or perception that helps measure progress toward achieving results. Not all the indicators identified in this table have to be used — only those that are relevant and contextually pertinent to the initiative and its setting. The chosen environmental indicators can be underlined in the following table. It is pertinent to provide details and specifications on how they will be used.

- *Environmental indicators*: Water quality (e.g. fecal matter or coliforms, suspended sediments, and oxygen); number of persons trained in environmental issues (such as hygiene, sanitation system maintenance, and water quality monitoring).
- *Human well-being indicators*: Incidence of human illness or disease (associated with gastro-intestinal diseases); and number of complaints of foul odours.

Reference and Useful Resources

- REMA (2009): Rwanda State of Environment and Outlook Report, Rwanda Environment Management Authority, P.O. Box 7436 Kigali, Rwanda http://www.rema.gov.rw/soe/
- CIDA, Environmental Handbook for Community Development Initiatives (2002), Second Edition of the *Handbook on Environmental Assessment of Non-Governmental Organizations*

and Institutions Programs and Projects (1997) http://www.acdi-cida.gc.ca/acdi-cida/ACDI-CIDA.nsf/eng/JUD-47134825-NVT

- WHO web site on water and sanitation: (http://www.who.int/water_sanitation_health/publications/en/)
- *Guidelines for the Development of Small Scale rural Water Supply & Sanitation Projects In East Africa.* Warner. D, Abate. C July 2005. http://www.encapafrica.org/documents/Wat0509_e.pdf
- USAID, Environmental Guidelines for Small-Scale Activities in Africa: Environmentally Sound Design for Planning and Implementing Development Activities, U.S. Agency for International Development, Office of Sustainable Development, Draft Version, January 2005, www.encapafrica.org.
- *FID Guidance Manual on Water Supply and Sanitation Programmes* (1998). United Kingdom Department for International Development (DFID). http://www.lboro.ac.uk/well/resources/Publications/guidance-manual/guidance-manual.htm
- IRC International Water and Sanitation Centre. http://www.irc.nl/
- Water Supply and Sanitation Collaborative Council. http://www.wsscc.org/
- NETWAS: Network for Water and Sanitation. Hosting the International Training Network for Water and Waste Management (ITN - Africa). http://www.netwas.org/
- Water and Sanitation Program Knowledge Network http://www.wsp.org/
- *A Guide to the Development of On-Site Sanitation* (1992). R. Franceys et al. Geneva: WHO. http://www.who.int/water_sanitation_health/hygiene/envsan/onsitesan.pdf

E. Forestry[3]

This sectoral tool provides an outline that can be used to identify the major, potential, adverse environmental effect

[3] Tool and Guideline # 6 provides practical information on agroforestry.

s, associated mitigation measures, and guidelines, as well as environmental indicators, for nursery initiatives for the reforestation

of trees and shrubs and subsequent forest harvesting activities.

What are the major environmental concerns?

These are so

me of the key issues in Rwanda in the forestry sector.

almost entirely in protected areas account for only 5.3 percent of the land area. The wide variety of forest and woodland ecosystems found in Rwanda is due to the highly variable relief and latitude, soil types, and rainfall.

- As reported in the 2009 Rwanda State of the Environment and Outlook, the main threats to forests are mainly governance issues, inadequate legal framework, and population pressures that result in encroachment and deforestation for settlement, agriculture and grazing land. These activities are likely to impact on forest ecosystem services such as timber provision, fuel wood, regulation of water flow, climate moderation, soil erosion control and fertility. Other threats to forest include forest fires, mining activities and poaching.
- The governance of the forestry sector is currently undergoing major review and restructuring. Therefore, institutional mandates and policies are still under development. Presently, forest management is regulated by the Forestry Law of 1988 under the auspices of MINIRENA. Only trees from plantations are exploitable; extraction from natural forests is prohibited. Logging any area greater than 2 ha is subject to a felling permit regardless of whether the plantation is on public or private land. The sale certificate and transport permit are supplied free of charge. A ministerial ordinance of 2004 sets the rules for joint forest management of public tree plantations with the private sector.
- High demands for arable land results in extensive deforestation, reducing the total forest cover. Deforestation is most severe

sites. Restoration measures are usually very costly; therefore, priority should be given to rehabilitating rainforests because of their high conservation value. Rehabilitation of gallery forests is also important for protecting riverbanks and biodiversity. Rehabilitation of forests and the afforestation of degraded sites should be seen as important measures for disaster risk reduction, especially in the context of climate change and increasing frequency and severity of natural disasters.

- Developing sustainable forest management will require a change in mindset that recognises the livelihood potential of forests. Alternative livelihoods based on forests could provide much needed new income sources for rural communities and reduce their dependency on agricultural activities. Three ways of harnessing the livelihood potential of forests are: maximising the potential for agroforestry, harvesting mature pine plantations; and involving local communities in the management of public tree plantations.

How can forestry activities affect the human environment?

- Conflicts over existing or planned land uses, tenure, management practices, and extraction activities (both “legal” and “illegal”, for both “private” and “communal” property or rights, related to firewood collection or multiple uses) may arise.
- Conflicts over socio-cultural behaviours, practices, or rules relating to forest heritage and historical or religious aspects may also arise.
- Conflicts over surface or groundwater supplies (e.g. increased withdrawal in certain areas at the expense of others) may arise.

(e.g. noise, airborne dust, air pollution, vibrations) and risks of accidents or to health and occupational safety may arise, depending on the characteristics of possible extraction activities.

How can forestry activities affect the natural environment?

- Areas supporting critical, valued, vulnerable, or protected species and habitats may be degraded, encroached upon, or destroyed.
- Biodiversity and endemic species of an area may be negatively affected.
- Soil degradation, erosion, loss of fertility, and pollution by chemical inputs may arise, depending on the characteristics of the planting activities and possible extraction activities.
- The quality and quantity of surface water and groundwater may thus be degraded.

B. How can siting, planning, and design be environmentally responsible?

By addressing such concerns early in the initiative's cycle, they will have better chances of success and long-term sustainability, help to prevent negative outcomes, and avoid rehabilitation costs. The following guiding principles are useful to avoid adverse environmental effects associated with siting, planning, and design. *You can check the items that are relevant to the proposed initiative.*

- Avoid siting close to vulnerable sites or sites of economic, ecological, cultural, archaeological, or historical importance (e.g. water bodies, waterways, slopes, wooded areas, wetlands, protected areas, biodiversity hotspots, and habitats of endangered species), unless the intent is to protect or restore such sites if they are degraded (a proper

		mited). • Avoid sites and activities that would lead to incompatible uses of land and resources, unacceptable social conflicts, value conflicts, and conflicts with respect to property rights (e.g. loss of subsistence territory and displacement; between common ownership of public or ancestral lands and private ownership of products; if the benefits are not equitably distributed; between various users of the forest; between nursery owners, owners of the reforested site, other members of the community, and people passing through the area). • Choose species and systems in accordance with the socio-economical and technical production capacities of the communities and the characteristics of soils, climate, and natural ecosystems (e.g. consider a variety of multi-purpose and fast-growing endemic, culturally significant and/or locally adapted species, water and nutrient requirements, space requirements, symbiotic species, vulnerability, maintenance requirements, origin, possibilities of invasion by exotic species, and fires in the area). • Promote multiple uses of trees and shrubs, and the various functions of forests and woodlands (e.g. non-timber extraction activities — fodder, fruits, and medicinal plants; timber extraction activities; eco-tourism and educational purposes; intercropping; companion plants; agroforestry; taking into account the need for fuelwood/charcoal and the workload of women). • Integrate environmental conservation and restoration measures (e.g. if there are extraction activities, ensure that an integrated, responsible, and long-term sustainable management plan, including

del forest management; minimize the use of chemical inputs;

national and national/local policies, standards, and regulat

Ecoforesty — a principle to consider!

Ecoforestry’s main principle is to maintain or restore the fo rest to standards where the forest may still be harvested for products on a sustainable basis. Ecoforestry is forestry that emphasizes holistic practices which strive to protect and restore ecosystems rather than maximize economic productivity. Sustainability of the forest also comes with uncertainties. There are other factors that may affect the forest furthermore than that of the harvesting. There are internal conditions such as effects of soil compaction, tree damage, disease, fire, and blow down that also directly affect the ecosystem. These factors have to be taken into account when determining the sustainability of a forest. If these factors are added to the harvesting and production that comes out of the forest, then the forest will become less likely to survive, and will then become less sustainable.

Ecoforestry has many principles within the existence of itself. It covers sustainable development and the fair harvesting of the organisms living within the forest ecosystem. There have been many proposals of principles outlined for ecoforestry. They are covered over books, articles, and environmental agencies. All of the principles relate to the idea that in ecoforestry, less should be harvested, and diversity must be managed. Through harvesting less, there is enough biomass left in the forest, so that the forest may stay healthy and still stay maintained. It will grow at a sustainable level annually, and thus it will be able to still be harvested the following year. Through management of the diversity, species may cohabitate in an ecosystem where the forest may feed off of other species in its growth and production.

The Principles of Ecoforestry may be found below.

Number	**Principle**
1	One must consider retention. It must be the first consideration in any planned removal of trees from a stand. By placing retention at the beginning of a planned removal, one makes sure that they know

what must be left to ensure the protection of such things as rare species, sites of native cultural significance, riparian zones.

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tion. It must be the first consideration in any planned removal of trees from a stand. By placing retention at the beginning of a planned removal, one makes sure that they know what must be left to ensure the protection of such things as rare species, sites of native cultural significance, riparian zones.

2

2 Riparian zones should not be touched. It is a sensitive area, thus tree removal should not occur there. This protects the water quality. Water quality is protected by not altering the drainage pattern of the zones. No tree removal should take place in the most sensitive areas.

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3

3 The composition and structures should be upheld so that forests may fully function. This may be subject to large old trees, snags, and large fallen trees. These pieces of the ecosystem are upheld through letting them grow and die out into a timber extraction area.

The composition and structures should be upheld so that forests may fully function. This may be subject to large old trees, snags, and large fallen trees. These pieces of the ecosystem are upheld through letting them grow and die out into a timber extraction area.

4

4 When removing trees, the lowest impact should be used. This means not compacting the soil in the forest and building small or no roads if at all possible. This takes away the disturbance that would be done to the foundation of the forest’s grounds.

When removing trees, the lowest impact should be used. This means not compacting the soil in the forest and building small or no roads if at all possible. This takes away the disturbance that would be done to the foundation of the forest’s grounds.

5

5 Plan in terms of the needs of the larger watershed. The watershed zone plan designates areas where tree removal is not permitted. It also designates the areas where removal is possible, and the different types of removal available.

Plan in terms of the needs of the larger watershed. The watershed zone plan designates areas where tree removal is not permitted. It also designates the areas where removal is possible, and the different types of removal available.

6

6 Prohibit clear cutting. Clear cutting is not ecologically correct. There are methods for cutting trees to maintain structure, and to allow the trees to cohabitate in a healthy ecosystem.

Prohibit clear cutting. Clear cutting is not ecologically correct. There are methods for cutting trees to maintain structure, and to allow the trees to cohabitate in a healthy ecosystem.

7

7 Select trees as candidates for removal by considering how abundant and redundant their structures and functions are to the rest of the forest as a whole, leaving potential wildlife trees (to become snags and large woody debris).

Select trees as candidates for removal by considering how abundant and redundant their structures and functions are to the rest of the forest as a whole, leaving potential wildlife trees (to become snags and large woody debris).

8

8 The forest should be allowed to regenerate trees through the seeds from the trees in the logged areas. This allows tree planting to be taken out of the ecoforestry principles, allowing a natural regeneration.

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9

9 Ecological succession should be kept at all times. This will protect biological diversity. This even means eliminating the process of brush control.

Ecological succession should be kept at all times. This will protect biological diversity. This even means eliminating the process of brush control.

10

10 No slash burning. Fire may be used as a tool in landscapes that have a history of naturally occurring fires. Although this may be true, fire should still be used with caution.

No slash burning. Fire may be used as a tool in landscapes that have a history of naturally occurring fires. Although this may be true, fire should still be used with caution.

11

11 No pesticide use. The forest needs disease, insects, and shrub/herb vegetation. They are essential parts of a fully functioning forest, even though they involve the forest’s decay in some cases. They are natural parts that allow the ecosystem to operate as a whole.

No pesticide use. The forest needs disease, insects, and shrub/herb vegetation. They are essential parts of a fully functioning forest, even though they involve the forest’s decay in some cases. They are natural parts that allow the ecosystem to operate as a whole.

12

12 Maintain and restore topsoil quality. This can be done through leaving sufficiently large and small debris on the

forest grounds.

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13 Maintain beauty and other natural aesthetic qualities in the visual, sound, and odor landscapes. This includes not taking away the wildlife, the	

plants, or structural layout of the ecosystem.

14

14 Always look at the forest as a whole. Each part of the forest contributes to its overall needs and health. That is how the forest would have survived without human interference.

Always look at the forest as a whole. Each part of the forest contributes to its overall needs and health. That is how the forest would have survived without human interference.

15

15 Rely more on people and markets. Use accounting and budgeting as a solution to rely less on the destruction or harvesting from the forests.

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16

16 Don’t do wrong. If it feels wrong, then it is probably wrong. Don’t allow ignorance to persevere. Recognize that the ecosystem needs tending to. If the forest is not preserved, then it cannot be harvested forever.

Don’t do wrong. If it feels wrong, then it is probably wrong. Don’t allow ignorance to persevere. Recognize that the ecosystem needs tending to. If the forest is not preserved, then it cannot be harvested forever.

C. What are the major potential adverse environmental effects? What can be done to mitigate or avoid them?

Mitigation measures are measures that effectively control, eliminate, or significantly reduce an initiative’s adverse environmental effects. Not all the measures identified in this table have to be used — only those that are relevant and contextually pertinent to the initiative and its setting. The chosen mitigation measures can be underlined in the following table. When documenting the chosen mitigation measures, it is pertinent to provide details about how they will be achieved.

Major adverse effects Associated mitigation measures

Associated mitigation measures

Biodiversity loss and soil degradation (e.g. erosion, compaction, changes in drainage, fertility, water-holding

capacity). Soil degradation is a problem particularly where soils are fine or weak, or have complex drainage and fertility cycles.

Heavy precipitation and activities on or around steep slopes also present issues. In many cases, soil erosion can be associated with increased sedimentation in waters. Promote sustainable forestry and silviculture based on land-use capacity and vocation, and choose species and their management/harvesting in accordance with the carrying capacity of ecosystems (i.e. what an ecosystem and its components can sustain without compromising their growth, regeneration, and roles in ecological regulatory functions).

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- Promote sustainable forestry and silviculture based on land-use capacity and vocation, and choose species and their management/harvesting in accordance with the carrying capacity of ecosystems (i.e. what an ecosystem and its components can sustain without compromising their growth, regeneration, and roles in ecological regulatory functions).
- Ensure the protection of natural forests and conserve vegetation on steep slopes and

ally significant and/or locally adapted species.

- Promote intercropping, companion planting, and agroforestry.
- Rejuvenate soils through the use of compost (proper design, siting, training, fencing, and aeration are required to avoid pollution and nuisances).
- Plan harvesting activities outside of extreme seasons.
- Implement anti-erosion structures and use techniques such as bunding or mulch to control erosion and enhance water infiltration.
- Promote selective, sustainable, and careful harvesting of trees in small, unconnected blocks to minimize exposed soils and enhance opportunities for natural regeneration from adjacent forest, and respect the mosaic and diversity of the wooded area.
- Avoid soil salinization from groundwater use that exceeds its recharge rate and from improper irrigation practices (see planning sectoral tool # H –Irrigation, # C Water Supply, and # D Sanitation Systems).
- Avoid improper use of heavy machinery and use low-impact equipment and methods for management and harvesting.
- Minimize skid trail distances, construct tracks during the dry season, keep road gradients low but sufficient for natural drainage, locate access roads far away from vulnerable areas, leave vegetated strips along roadsides, and reseed or revegetate disturbed areas (see # B- Rural Roads planning sectoral tool).

Degradation of surface water and groundwater quality and quantity (see relevant planning sectoral tools # H – Irrigation, # C- Water Supply, and # D Sanitation Systems).

Degradation of surface water and groundwater quality and quantity (see relevant planning sectoral tools # H – Irrigation, # C- Water Supply, and # D Sanitation Systems).

ability and renewal of water, and other uses).

- Use species adapted to the local climatic, soil, and water characteristics.
- Ensure chemical inputs, such as fertilizers, pesticides, and other dangerous products, are appropriately used (see next item for details).

Environmental degradation, as well as human health sensitivities, associated with chemical inputs such as fertilizers, pesticides (e.g. herbicides, insecticides, and fungicides) and other chemical or dangerous products. Promote composting and use the adequate fertilizer for the species and the type of soil (excessive and long-term use of nitrogen fertilizers can lead to soil acidification).

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- Promote composting and use the adequate fertilizer for the species and the type of soil (excessive and long-term use of nitrogen fertilizers can lead to soil acidification).
- Minimize pesticide input by using physical and biological alternatives to these dangerous products (e.g. traps, bait, weeding, crop rotation, companion planting, natural enemies, and attractants or repellents).
- Promote the study of pests, their abundance, habitats, life cycle and resistance to pesticides (resistance can be due to excessive, repeated application of broad-spectrum and other pesticides).
- Promote efforts to manage pests, rather than eliminate them, and promote the

limination of beneficial non-target organisms; species-specific pesticides with a short active period can offer alternatives) and pesticides that can lead to bioaccumulation of toxic products in the food chain (concentration in fats, particularly in carnivores).

- Do not use banned or unauthorized pesticides.
- Apply fertilizers and pesticides at the correct time, in correct amounts, and with appropriate equipment and measures (e.g. overalls, gloves, glasses, masks, and ear plugs).
- Do not apply any type of chemical product too close to steep slopes, streams, other water bodies, and drinking water sources.
- Do not wash any type of chemical product container in water bodies or drinking water sources, and do not use any type of chemical product container for storing food or water.
- Ensure that phytosanitary labels and chemical labels, on leak proof containers with covers in secured storage areas, are understood and contextually relevant.
- Implement a training program in the safe and rational storage, handling, use, and disposal of all types of chemical products that may be used (e.g. fertilizers, pesticides, lubricants, oil, fossil fuels, glues, varnishes, and preservation products).

Nuisances, environmental degradation, and risks of accidents or risks to health and occupational safety, depending on the possible extraction activities.

For example, if a mobile sawmill is planned, proper siting (i.e. away from vulnerable or valued areas) is essential, as are environmentally friendly harvesting, erosion control, the optimization of ligneous debris, nuisance control, alternative energy

sources, proper maintenance, and accident preparedness. Nuisances, environmental degradation, and risks of accidents or risks	

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Implement an environmental training program on the importance of integrated, responsible, and long-term management (including regeneration aspects) of forests and woodlands.

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- Ensure that the intensity and characteristics of harvesting respect the carrying capacity of local ecosystems, that is, what an ecosystem and its components can sustain without compromising their growth, regeneration, and roles in ecological regulatory functions.
- Promote environmental awareness and training in the safe and appropriate maintenance and use of extraction equipment.
- Implement pollution prevention or control devices to limit the harmful effects of pollutants (liquid, solid or atmospheric) and of nuisances (dust, noise, and vibrations).
- Implement proper cleanliness, maintenance, accident, spill, overheating, fire and/or explosion control measures.

Prevention and management of bushfire.

Prevention and management of bushfire.

tion, detection, suppression, and control measures).

- Support municipalities in the long-term prevention and management of forest and bush fires (databases, management strategies and information how to reduce possible forest or bush fires).

D. How to plan follow-up and monitoring of environmental aspects?

When planning the environmental follow-up and monitoring of an initiative, the following should be addressed.

- *Items to be monitored*: What items will be monitored? Potentially significant environmental effects, sensitive components of the environment, any uncertainties, and mitigation measures (their implementation and effectiveness) are generally monitored.
- *Follow-up / monitoring methods*: How, where, and according to what schedule will follow-up / monitoring take place to help identify unforeseen effects and to assess the implementation and effectiveness of the chosen mitigation measures? Sufficient flexibility is required for additional measures when necessary.
- *Follow-up / monitoring roles and responsibilities*: Who will be responsible for implementing these tasks and ensuring that the results are acted upon?
- *Follow-up / monitoring reporting methods*: How and when will the results are reported to enable the analysis of lessons learned and their feedback into future initiatives? Who will be responsible for these aspects?

An indicator is a measurement, number, fact, standard, opinion or

perception that helps measure progress toward achieving results. Not all the indicators identified in this table have to be used—on

ly those that are relevant and contextually pertinent to the initiative and its setting. The chosen indicators can be:

ency); soil quality (e.g. fertility, texture, chemicals); surface water flows and groundwater table levels in area; rate of water use; rate of increase in mixed vegetative cover; net rate of increase in forest cover (through natural regeneration and/or tree planting); degree of biodiversity in the watershed (number of species and an appreciation of their populations); extent of critical habitats (in hectares, for example); number of persons trained in environmental issues and responsible forest management.

- *Human well-being indicators*: Incidence of human illness or disease (associated with chemical inputs); and incidence of accidents or fires.

Reference and Useful Resources

- REMA (2009): Rwanda State of Environment and Outlook Report, Rwanda Environment Management Authority, P.O. Box 7436 Kigali, Rwanda http://www.rema.gov.rw/soe/
- CIDA, Environmental Handbook for Community Development Initiatives (2002), Second Edition of the *Handbook on Environmental Assessment of Non-Governmental Organizations and Institutions Programs and Projects (1997)* http://www.acdi-cida.gc.ca/acdi-cida/ACDI-CIDA.nsf/eng/JUD-47134825-NVT
- USAID, Environmental Guidelines for Small-Scale Activities in Africa: Environmentally Sound Design for Planning and Implementing Development Activities, U.S. Agency for International Development, Office of Sustainable Development, Draft Version, January 2005, www.encapafrica.org.
- Agroforestry Extension Manuals. A Survey of their use in Kenya. Stachys N Muturi 1999. Technical Report No. 21 The Regional Land Management Unit, RELMA/Sida. ISBN 9966-896-41-1. 60pp (http://en.sl.life.ku.dk/dfsc/Extensionstudy/EXT-835.HTM)
- Agroforestry Extension Manual for Kenya, 1994, International Centre for Research in Agroforestry (ICRAF), (http://opentraining.unesco-ci.org/cgi-bin/page.cgi?g=Detailed%2F2619.html;d=1)
- World Agroforestry Tree Database, The World Agroforestry Centre (formerly the International Center for Research in Agroforestry, or ICRAF) is located in Nairobi, Kenya, and provides information on including a tree component in farming systems. Like CIFOR, this center is a member of the CGIAR system. Its offerings include an "agroforestree" database, useful for screening specific tree species' suitability for application in different countries. http://www.worldagroforestry.org/
- The Forest Stewardship Council (International) http://www.fsc.org/en/ have extensive information on forest certification.
- The World Wildlife Fund-World Bank Forest Alliance is a partnership to promote forest conservation and best practices in forest management. http://www.worldwildlife.org/what/globalmarkets/forests/worldbankalliance.html
- The UN Food and Agriculture Organization (FAO) Forestry Department in Rome has long been a center of excellent information for forestry sector development in the developing

world. Their INFOSYLVA database offers a summary of forestry sector statistics and information on a country-by-country basis. See the database at http://www.fao.org/forestry/infosylva/en/ or contact the Forestry Department, Community Forestry-Oriented Forests, Trees and People Programme at http://www.fao.org/forestry/index.jsp

- World Bank (2002). *"Market-Based Mechanisms for Conservation and Development."* Environment Matters. 26-27. http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/ENVIRONMENT/EXTENVMAT/0,,menuPK:3011413~firsttime:true~pagePK:64168427~piPK:64168435~theSitePK:3011351,00.html
- Zimmerman, R.C. (1982). *Environmental Impact of Forestry: Guidelines for Its Assessment in Developing Countries.* FAO Conservation Guide No. 7. Rome: Food and Agriculture Organization of the United Nations. 30 pp. + appendices. http://www.fao.org/documents/show_cdr.asp?url_file=/docrep/t0550e/t0550e00.htm

F. Crop Production[4]

This sectoral tool provides an outline that can be used to identify the major, potential, adverse environmental

[4] Tool and Guideline # 8, provides practical information on soil productivity and crop protection and possible adoption of organic farming principles to reduce the impact of fertilizers and pesticides on air and water quality (surface and underground)

effects, associated mitigation measures, and guidelines, as well as environmental indicators, for crop production or optimization initi

atives.

A. What are the major environmental concerns?

These are some of the key environmental issues in Rwanda in relat

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ronment and Outlook, the main issues putting pressure on agriculture production include high population density on the limited land resource. This has lead to land fragmentation and reduction of farm sizes, continued intensive cultivation of land with no fallow and soil erosion, over cultivation without restoration of soil nutrients, weak extension and research services and increased vulnerability to climatic shocks like drought or heavy rains. The use of fertilizer and agricultural chemicals has polluted water; and agriculture activities and general mismanagement of the wetlands have further degraded and destroyed them.

- Acute land scarcity has led to the over-cultivation of land. Fallow periods have grown much shorter or have become non-existent. In many cases, cultivation periods have been extended, up to two to three times per year, with very limited soil inputs or soil conservation measures. Over-cultivation has had a major impact on reducing soil fertility and productive capacity. Farmer response to offset low production yields by over-cultivation creates negative feedback loops that only worsen land degradation. A practical way to break out of this cycle is to increase both soil nutrient capital and soil organic matter through the simultaneous application of organic inputs (e.g. animal manure) and chemical fertilisers.
- Agricultural activities in the face of the high demographic pressure on limited land resources has resulted into land fragmentation, reduction of farm sizes and continued intensive cultivation of land with no fallow subjecting land to alarming soil erosion. Agriculture practised on the slopes of hills and mountains

ted on rural livelihoods and the national economy. Land degradation continues to worsen in the country despite efforts to prevent it.

How can crop production activities affect the human environment?

- Conflicts over existing or planned land uses, activities, and infrastructures (both “legal” and “illegal”) may arise (e.g. high population density has fuelled a shortage of arable land, led to decreasing farm size, shortage of arable land and the adoption of intensive agricultural practices on land with declining soil fertility).
- Conflicts over surface or groundwater supplies may arise (e.g. increased irrigation in certain areas at the expense of others; increased use of chemical inputs or manure that may pollute water sources).
- Activities may negatively affect community land use/management practices and relationships (e.g. one of the main threats to forests is from population pressures that result in encroachment and deforestation for agriculture).
- Agricultural activities involving improved or new, more sophisticated technologies may also disrupt social organization. In fact, introduction of new technologies may not be afforded and adopted by the poorest households or communities, or may eliminate work opportunities.
- Activities involving the use of water through irrigation infrastructures may negatively affect community water management practices and relationships.
- Agricultural activities involving fertilizers, pesticides (such as herbicides, insecticides and fungicides) and the creation of stagnant

How can crop production activities affe

ct the natural environment?

quantity of surface water and groundwater may be degraded (e.g. coffee growing contributes to water pollution both during the growing phase and processing and washing stages).

- The health of aquatic and terrestrial ecosystems may be negatively affected (e.g. loss of biodiversity; deforestation; desertification; degradation of marginal lands, coastal areas, and wetlands).
- Agricultural activities can favour growth of invasive species because of increase use of nitrogen fertilizer which ends up in the aquatic ecosystem (e.g. water hyacinth, an aquatic weed is threatening lakes and rivers in Rwanda. It grows rapidly to form thick mats on water surfaces, increases swamps areas, reduces water supply and undermines transport, hydroelectricity power production, fisheries and fish breeding).

B. How can siting, planning, and design be environmentally responsible?

By addressing such concerns early in the initiative's cycle, they will have better chances of success and long-term sustainability, help to prevent negative outcomes, and avoid rehabilitation costs. The following guiding principles are useful to avoid adverse environmental effects associated with siting, planning, and design. *You can check the items that are relevant to the proposed initiative.*

- Take into account the population density in relation to available arable lands and to the degraded soils.
- Avoid siting close to vulnerable sites or sites of economic, ecological, cultural, archaeological or historical importance (e.g. water bodies, waterways, slopes, wooded areas, wetlands, coastal areas, biodiversity hotspots, and

		hat would lead to unacceptable population displacements and/or loss of territory (e.g. migrations, expropriations, eviction of tenants or squatters, and effects on local population). • Avoid sites and activities that would accentuate social inequalities (e.g. cases where specific groups of the population have not been consulted; where the number of beneficiaries is limited; where there would be an increase in women's workload; and where women are limited in their choice of arable land or are restricted to subsistence activities or low-income processing activities). • Avoid sites and activities that would lead to incompatible uses of land and resources, unacceptable social conflicts, value conflicts, and conflicts with respect to property rights (e.g. between industrial and agricultural areas, between common ownership of public or ancestral lands and private ownership of agricultural products, between producers and breeders). • Choose technologies and plant crops in accordance with aims of food security, the socio-economic and technical production capacities of the communities, and the characteristics of soils and natural ecosystems (e.g. consider water and nutrient requirements, growth rate, space and maintenance requirements, range and depth of root system, symbiotic species, vulnerability to climate and insects, accumulation and reaction to toxins, origin, and seed treatment). • Promote land use optimization : land use for multiple purposes such as agro-silvo-pastoral or agroforestry systems; planting live fences; combining fruit trees, nitrogen-fixing plants, or medicinal plants and

C. What are the major potential adverse environmental effects? What can be done to mitigate or avoid the

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mental effects. Not all the measures identified in this table have to be used—only those that are relevant and contextually pertinent

to the initiative and its setting. The chosen mitigation measures can be underlined in the following table. When documenting the ch

osen mitigation measures, it is pertinent to provide details about how they will be achieved.	
Major adverse effects ***Associate***	

dmitigation measures Human health sensitivities to water-borne diseases and infections.	

Ecosystem and soil degradation (e.g. erosion, compaction, changes in drai	

nage, fertility, water-holding capacity). Soil degradation is a problem particularly where soils are fine or weak, or have complex drainage and fertility cycles. Heavy precipitation and activities on or around steep slopes also present issues. In many cases, soil erosion can be associated with increased sedimentation in waters. Minimize vegetation clearing.

- Minimize vegetation clearing.
- Avoid overly frequent soil tillage, inappropriate burns, and improper clearing techniques.
- Avoid improper use of heavy machinery.
- Avoid monoculture systems and annual field crops on vast areas which expose soils to risks of erosion.
- Avoid use of groundwater that exceeds its recharge rate and avoid improper irrigation practices (see sectoral planning tools # H- Irrigation, # C- Water Supply, and # D- Sanitation Systems).
- Choose the quantity and spacing of species in accordance with the carrying capacity of soils.

Rejuvenate soils through the use of agricultural residues, compost, or green fertilizers; for composting activities, proper design, siting, training, fencing, and aeration are required to avoid pollution by run-off and to avoid nuisances (e.g. odours, vermin).

- Rejuvenate soils through the use of agricultural residues, compost, or green fertilizers; for composting activities, proper design, siting, training, fencing, and aeration are required to avoid pollution by run-off and to avoid nuisances (e.g. odours, vermin).
- Create fallow lands, multiple purpose systems / locally adapted diverse crops, crop rotation, intercropping, and companion planting.
- Plant live fences, windbreaks, fruit trees, nitrogen-fixing plants and implement anti-

erosion structures (e.g. side hill ditches, diversion structures, gully plugs, small-scale contouring or terracing).

- Plan harvesting activities outside of extreme seasons.

Degradation of surface water and groundwater quality and quantity (see relevant sectoral planning tools: H- Irrigation, C- Water supply, & D- Sanitation Systems).

Degradation of surface water and groundwater quality and quantity (see relevant sectoral planning tools: H- Irrigation, C- Water supply, & D- Sanitation Systems).

Promote water conservation practices and appropriate technologies that minimize water needs and reduce water loss (e.g. consider availability and source of water supplies, groundwater recharge rate, and other uses by the community).

- Promote water conservation practices and appropriate technologies that minimize water needs and reduce water loss (e.g. consider availability and source of water supplies, groundwater recharge rate, and other uses by the community).
- Use crops that are adapted to local climatic, soil, and water characteristics.
- Ensure that chemical inputs, such as fertilizers and pesticides, and organic inputs are appropriately used (see next item for details).

Soil and water degradation, as well as human health sensitivities, associated with chemical inputs such as fertilizers and pesticides (including herbicides, fungicides, parasiticides, insecticides) and with organic inputs (such as manure).

Soil and water degradation, as well as human health sensitivities, associated with chemical inputs such as fertilizers and pesticides (including herbicides, fungicides, parasiticides, insecticides) and with organic inputs (such as manure).

Promote and provide training in organic agriculture and the

biological alternatives to these dangerous products (e.g. traps, bait, weeding, crop rotation, companion planting, natural enemies, attractants or repellents).

- Promote the study of pests, their abundance, habitats, life cycle, and resistance to pesticides (resistance can be due to excessive, repeated application of broad-spectrum and other pesticides).
- Promote efforts to manage pests rather than eliminate them, and promote the principles of integrated pest management.
- Avoid broad-spectrum pesticides (which can lead to pest resistance and the elimination of beneficial non-target organisms; species-specific pesticides with a short active period can offer alternatives) and pesticides that can lead to bioaccumulation of toxic products in the food chain (concentration in fats, particularly in carnivores).
- Do not use banned or unauthorized pesticides.
- Use the appropriate fertilizer for the crops and in accordance with the type of soil (excessive and long-term application of nitrogen fertilizers can lead to soil acidification).
- Apply organic inputs, fertilizers, and pesticides at the correct time (before field crops are planted for fertilizers, and when the study of pest abundance warrants it for pesticides; avoid windy conditions), in correct amounts, and with appropriate application measures.
- Do not apply organic or chemical inputs too close to steep slopes, streams, ponds, other water bodies, and drinking water sources — besides health and pollution risks, this can also lead to the eutrophication of water bodies (i.e. when organic material

accumulate and there is a proliferation of algae and/or other aquatic plants and bacteria at the water's surface, thus depleting oxygen in deeper waters), subsequent imbalances in aquatic ecosystems, and problems with the availability of quality water supplies.

- Do not wash chemical product containers in water bodies or drinking water sources.
- Do not use chemical product containers for storing food or water.
- Promote the use of protective clothing (e.g. overalls, gloves, glasses, masks).
- Ensure that phytosanitary labels are understood and contextually relevant.
- Promote environmental awareness and training in the safe and rational storage, handling, use, and disposal of chemical products.

D. How to plan follow-up and monitoring of environm

ental aspects? When planning the environmental follow-up and monitoring of an initiative, the following should be addresse

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Reference and Useful Resources

- REMA (2009): Rwanda State of Environment and Outlook Report, Rwanda Environment Management Authority, P.O. Box 7436 Kigali, Rwanda http://www.rema.gov.rw/soe/
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- Sustainable agriculture extension manual for Eastern and Southern Africa: (http://www.mamud.com/sustagafrica.htm)
- The UN Food and Agricultural Organization (FAO) Aquastat Web site: http://www.fao.org/nr/water/aquastat/main/index.stm
- FAO. Agriculture Food and Nutrition for Africa: A Resource Book for Teachers of Agriculture: http://www.fao.org/docrep/W0078E/w0078e00.htm
- The African Conservation Tillage Network (http://www.act.org.zw/) is a network of practitioners who promote adoption of conservation tillage practices in Africa to assure a more sustainable use of soil resources, combat desertification, improve food security and alleviate rural poverty.

G. Animal Husbandry

This sectoral tool provides an outline that can be used to identify the major, potential, adverse environmental effects, associated mitigation measures, and guidelines, as well as environmental indicators, for animal production and management initiatives (involving cattle, poultry, goats, sheep, hogs, and wild animals), using confined, fixed, or transhumance systems.

A. What are the major environmental concerns?

These are some of the key environmental issues in Rwanda in relation to animal husbandry.

- As reported in the 2009 Rwanda State of the Environment and Outlook, the production of livestock products has increased; demand stills outstrip supply, especially for milk and eggs, which contributes to food insecurity. Hides and skins production increased 60%.
- Livestock are an integral part of subsistence farming in Rwanda. Livestock production is mostly located in the east and in some southern parts of the country. Three major types of livestock are grown, namely: cattle, sheep, and goats. Patterns of livestock ownership, particularly of cattle, mirror levels of household prosperity. Larger farms in the east and central region have greater numbers of cattle, in contrast to in the north, west, and southwest. In the most impoverished regions, such as the Southern Province, farm sizes are generally less than 0.5 ha per household and few farms own cattle. Consequently, there is a shortage of animal products, including milk, meat, and manure. In these areas the One Cow, One Household programme aims to increase agricultural production by supplying manure and reduce child malnutrition through milk production.
- Despite government efforts to reduce the size of cattle herds, overgrazing remains a serious problem. Overgrazing is characterised by a significant reduction in plant cover, soil organic matter content, and soil biological activity. As a consequence, there is increased exposure to erosion by rainfall, which degrades the soil physical structure and reduces soil nutrients.

How can animal husbandry activities affect the human environment?

- Conflicts over existing or planned land uses, activities and infrastructures (both “legal” and “illegal”) may arise.
- Conflicts over surface or groundwater supplies (e.g. increased water use for herds in certain areas at the expense of other areas or uses; pollution of soils and water sources with manure) may arise.
- Activities may negatively affect community land use/management practices and relationships.
- Activities involving the use of water may negatively affect community water management practices and relationships.
- Cultivating feed involving fertilizers, pesticides (such as herbicides, insecticides, and fungicides), and the creation of stagnant water ponds may lead to human health sensitivities, as well as water-borne diseases and infections.
- Animal pests (such as ticks) and diseases (e.g. trypanosomiasis, brucellosis, anthrax, and fevers) may also lead to human health sensitivities.

How can animal husbandry activities affect the natural environment?

- Soil degradation, erosion and compaction may arise.
- The health of terrestrial ecosystems and of wildlife may be negatively affected, especially if soil denudation, vegetation degradation and/or desertification occur as a result of overgrazing, or if activities lead to a displacement or reduction in wildlife and/or biodiversity. Inappropriate livestock species in fragile ecosystems also present risks of degradation (e.g. raising sheep in semi-arid areas of slow vegetation regeneration, since sheep pull grasses out by roots).
- The quality and quantity of surface water and groundwater may be degraded by organic wastes and liquid effluents; the health of aquatic ecosystems may also be negatively affected.

B. How can siting, planning, and design be environmentally responsible?

By addressing such concerns early in the initiative's cycle, they will have better chances of success and long-term sustainability, help to prevent negative outcomes, and avoid rehabilitation costs. The following guiding principles are useful to avoid adverse environmental effects associated with siting, planning, and design. You can check the items that are relevant to the proposed initiative.

- Take into account the herd's population composition and density in relation to human population density, wildlife characteristics, available arable lands, and the land to be rehabilitated.
- Adopt zero grazing principles (zero grazing means feeding freshly cut forage to housed animals).
- Avoid siting close to vulnerable sites or sites of economic, ecological, cultural, archaeological, or historical importance (e.g. water bodies, waterways, slopes, wooded areas, coastal areas, arid and semi-arid areas, wetlands, biodiversity hotspots, and habitats of endangered species).
- Avoid sites and activities that would lead to unacceptable population displacements and/or loss of territory (e.g. migrations, expropriations, eviction of tenants or squatters, and effects on local population).
- Avoid sites and activities that would accentuate social inequalities (e.g. cases where specific groups of the population have not been consulted; where the number of beneficiaries is limited; where women or the poorest families are restricted to remote, and low-productivity pasture land).
- Avoid sites and activities that would lead to incompatible uses of land and resources, unacceptable social conflicts, value conflicts, and conflicts with respect to property rights and land tenure (e.g. between users and owners of water sources and plants; between farmers and livestock breeders; between nomadic herders, sedentary breeders, and hunters; between the various uses of livestock; and between common ownership of lands and private property).
- Choose herd species, population, and production systems in accordance with the socio-economic and technical production capacities of the communities and the characteristics of lands, climate, and the carrying capacity of ecosystems (e.g. consider water and nutrient requirements in relation to seasonal availability; growth rate; reproduction rate; possible use of antibiotics, hormones and vaccines; soil and plant vulnerabilities to various types of browsers; spatial and temporal distribution of vegetation; competition and predation; the positive aspects of plant/herbivore relationships, such as seed dispersal and germination).
- Promote land use optimization (e.g. land use for multiple purposes such as agro-silvo-pastoral systems that involve, for instance, using manure as fertilizer, combining forage crops and multi-purpose trees, using agricultural residues as livestock feed during the dry season, and planting live fences).
- Integrate environmental conservation and restoration measures (e.g. study and control of animal movements, erosion control, tree planting, and water conservation).
- Adopt bio-security measures in animal husbandry to prevent possible transmission of diseases (e.g. monitoring, surveillance, isolation, elimination, eradication and prevention).
- Ensure international and national/local policies, standards, and regulations are respected (e.g. land use, protected areas and species, and water quality).

C. What are the major potential adverse environmental effects? What can be done to mitigate or avoid them?

Mitigation measures are measures that effectively control, eliminate, or significantly reduce an initiative's adverse environmental effects. Not all the measures identified in this table have to be used — only those that are relevant and contextually pertinent to the initiative and its setting. The chosen mitigation measures can be underlined in the following table. When documenting the chosen mitigation measures, it is pertinent to provide details about how they will be achieved.

Major adverse effects	***Associated mitigation measures***
Human health hazards or nuisances (foul odours) by the introduction of diseases and the possible contamination of water supplies for human use by animal manure and urine.	• Keep manure and urine away from household areas and water bodies, and adequately collect and store manure for composting. • Consider using a biogas system (methane). • Avoid creating stagnant water ponds. • Implement disease control measures.
Ecosystem and soil degradation (e.g.	• When cultivating feed: minimize vegetation clearing;

erosion; compaction; changes in drainage, fertility, and water-holding capacity) and loss of biodiversity associated with overpopulation, over-grazing, trampling, excess harvesting of fodder and forage, and removal of vegetation. Soil degradation is a problem particularly where soils are fine or weak, or have complex drainage and fertility cycles. Heavy precipitation and activities on or around steep slopes also present issues. In many cases, soil erosion can be associated with increased sedimentation in waters.	avoid overly frequent soil tillage, inappropriate burns and improper clearing techniques; avoid improper use of heavy machinery; avoid exposing soils to risks of erosion; choose the quantity and spacing of species in accordance with the carrying capacity of soils; rejuvenate soils through the use of agricultural residues, compost, or green fertilizers (for composting activities, proper design, training, fencing, and aeration are required to avoid pollution and nuisances); create fallow lands, multiple purpose systems / locally adapted diverse crops. • Use cut-and-carry feed from elsewhere. • Limit animal numbers, mix species to maximize use of forage potential and choose the size and the composition of herds according to the seasonal and temporal availability of water and plants. • Control the length of grazing time and succession of use in particular areas (rotational grazing to allow plant re-growth, and use of dry-season grazing reserves). • Restrict animal access to unstable or fragile areas (e.g. steep slopes, degraded areas, where soils are fine or weak, or have complex drainage and fertility cycles) by defining and/or fencing off critical areas. • Promote soil erosion control measures (e.g. plant live fences or wind-breaks; promote reforestation and vegetated buffer strips; promote the reseeding of grasses; implement anti-erosion structures, such as terracing).
Degradation of surface water and groundwater quality and quantity (see relevant sectoral planning tools # H-Irrigation, # C- Water Supply, and # D-Sanitation Systems).	• Promote water conservation practices (e.g. consider availability, other uses by the community). • Develop many small-capacity water points, place them strategically to spread the effect, and control their use. • Fence off permanent water sources from animals, especially when temporary sources are available during the wet season. • Ensure that manure and chemical inputs, such as fertilizers and pesticides, are appropriately used (see next item for details).
Soil and water degradation, as well as human health sensitivities, associated with chemical inputs such as fertilizers and pesticides (e.g. herbicides, insecticides, and fungicides) used to cultivate feed, or pollution by manure and organic wastes.	• Promote and provide protective clothing and equipment (e.g. overalls, gloves, glasses, and masks) to minimize danger to field workers applying agro-chemicals. • Promote and provide training in organic agriculture and the appropriate use of manure. • Study pests, their abundance, habitats, life cycle, and resistance to pesticides (resistance can be due to excessive, repeated application of broad-spectrum and other pesticides). • Promote efforts to manage pests rather than eliminate them, and promote the principles of integrated pest management (e.g. by minimizing chemical inputs, when feasible). • Avoid broad-spectrum pesticides (that can lead to pest resistance and the elimination of beneficial non-target organisms; species-specific pesticides with a short active period can offer alternatives) and pesticides that can lead to bioaccumulation of toxic products in the

	food chain (concentration in fats, particularly in carnivores). • Do not use banned or unauthorized pesticides. • Use the appropriate fertilizer for the crops and in accordance with the type of soil (excessive and long-term application of nitrogen fertilizers can lead to soil acidification). • Apply manure, fertilizers, and pesticides at the correct time (when the study of pest abundance warrants it for pesticides; avoid windy conditions), in correct amounts and with appropriate application measures. • Do not apply manure and chemical inputs too close to steep slopes, streams, water bodies, and drinking water sources – besides health and pollution risks, this can also lead to the eutrophication of water bodies (i.e. when organic material accumulates and there is a proliferation of algae and/or other aquatic plants and bacteria at the water's surface, thus depleting oxygen in deeper waters), subsequent imbalances in aquatic ecosystems, and problems with the availability of quality water supplies. • Do not wash chemical product containers in water bodies or drinking water sources, and do not use chemical product containers for storing food or water. • Ensure that phytosanitary labels are understood and contextually relevant. • Implement a training program in the safe and rational storage, handling, use, and disposal of chemical inputs.
Adverse effects on wildlife, such as loss of habitat, disruption of migratory stop-over points, competition, increased poaching and killing, and the introduction of diseases to wildlife.	• Plan and implement range management strategies (choice of species, animal numbers, and grazing areas) that minimize adverse effects on wildlife and avoid excessive competition. • Rehabilitate degraded areas nearby as wildlife habitat. • Investigate and consider management of wildlife ranching in order to protect wildlife resources. • Consider wildlife ranching, tourism, and controlled hunting as alternatives to animal production.

D. How to plan follow-up and monitoring of environmental aspects?

When planning the environmental follow-up and monitoring of an initiative, the following should be addressed.

- *Items to be monitored:* What items will be monitored? Potentially significant environmental effects, sensitive components of the environment, any uncertainties, and mitigation measures (their implementation and effectiveness) are generally monitored.
- *Follow-up / monitoring methods:* How, where, and according to what schedule will follow-up / monitoring take place to help identify unforeseen effects and to assess the implementation and effectiveness of the chosen mitigation measures? Sufficient flexibility is required for additional measures when necessary.
- *Follow-up / monitoring roles and responsibilities:* Who will be responsible for implementing these tasks and ensuring that the results are acted upon?
- *Follow-up / monitoring reporting methods:* How and when will the results are reported to enable the analysis of lessons learned and their feedback into future initiatives? Who will be responsible for these aspects?

An indicator is a measurement, number, fact, standard, opinion or perception that helps measure progress toward achieving results. Not all the indicators identified in this table have to be used — only those that are relevant and contextually pertinent to the initiative and its setting. The chosen indicators can be:

- *Environmental indicators:* Liquid effluent and receiving water quality (e.g. nutrients, chemicals, salinity, pH, and transparency); soil quality (e.g. fertility, texture, and chemicals); surface water flows and groundwater table levels in area; rate of water use; qualitative appreciation of the productivity of aquatic environments receiving liquid waste; rate of vegetation clearing or desertification; rate of increase in mixed vegetative cover; incidence of wildlife habitats (for example, in hectares); rate of fodder use from cultivated areas and from "natural" ecosystems; ratio of surface areas where compost/manure is applied; and number of breeders trained on environmental issues.

- *Human well-being indicators:* Incidence of human and animal illness or disease (associated with chemical inputs, diseases, pests); and improvements in balanced diets.

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H. Irrigation[5]

This sectoral tool provides an outline that can be used to identify the major, potential, adverse environmental effects, associated mitigation measures, and guidelines, as well as environmental indicators, for the implementation of irrigation initiatives that include diversion of surface water, spate systems (which rely on occasional flooding of a stream or river to collect water) and/or the use of groundwater, rain-fed systems, building canals or water distribution systems, pumping stations (lift systems), and small reservoirs or water catchment areas.

A. What are the major environmental concerns?

These are some of the key environmental issues in Rwanda in relation to irrigation.

- As reported in the 2009 Rwanda State of the Environment and Outlook, approximately 92,000 of the total 165,000 hectares of non-protective wetlands (or marshlands) are used for agriculture. Most of the Rwanda marshlands are under traditional cropping. Some of these wetlands have been reclaimed increasingly for rice production and sugar cane growing. Given the land shortage in Rwanda, wetlands have been put under cultivation for other crops such as flowers, sweet potatoes, and Eucalyptus. The use of fertilizer and agricultural chemicals can pollute water; and agriculture activities and general mismanagement of the wetlands can further degraded and destroyed them.
- Expansion of irrigation schemes will increase water demand and use. Agriculture is therefore a logical target for water savings and demand management, including improving yields of subsistence rain-fed agriculture, use of more efficient techniques such as drip irrigation and treadle pumps, and cultivation of less water-demanding and drought resistant crops.
- Use of fertilizers and agricultural chemicals can pollute water, springs and wetlands. The intensive agricultural policy is geared to increased use of mineral and organic fertilizers, pesticides and selected seeds. Misuse of agro-chemical products has harmful consequences on natural and artificial biocenosis and on man's health. The effects of these products may also become apparent through deep changes in biological balance.
- Adverse environmental impacts on downstream marshlands need to be considered when screening and selecting proposed sites for further development.

How can irrigation initiatives affect the human environment?

- Conflicts over land uses and management, land tenure system, and surface or groundwater supplies (e.g. increased extraction in certain areas at the expense of others) may arise (e.g. high population density has fuelled a shortage of arable land, led to decreasing farm size, shortage of arable land and the adoption of intensive agricultural practices on land with declining soil fertility).
- Contamination of water sources by agro-chemicals or other agricultural inputs and creation of stagnant water ponds in canals, ditches, or fields may lead to health problems and the spread of water-borne diseases and infections.

How can irrigation initiatives affect the natural environment?

- Soil degradation and erosion (including compaction, negative changes in drainage, permeability and/or water-holding capacity), as well as losses of soil productivity may arise (e.g. in cases of over-irrigation, and poor soil drainage) and may lead to water logging and salinization of the soils.
- The quality and quantity of surface water / groundwater may be degraded.
- Cultivation of marshland affects their chemical, physical and hydrological nature. The use of chemical fertilisers, fungicides and insecticides has modified the chemical composition of these hydrologically-connected water resources. These chemicals seep through the wetlands and join other water sources of which form rural domestic water supply points such as wells and streams.

[5] Tool and Guideline # 7 provides irrigation techniques with merits and disadvantages of irrigated agriculture on non-protected wetlands

- The health of aquatic ecosystems may be negatively affected (alterations to hydrology and flow and the presence of structures may have an adverse effect on the ecological regulatory functions of the aquatic ecosystems, including their capacity to dilute pollutants, and on their species, biodiversity, and ecological productivity).
- Irrigation activities can favour growth of invasive species because of increase use of nitrogen fertilizer (e.g. water hyacinth, an aquatic weed is threatening lakes and rivers in Rwanda. It grows rapidly to form thick mats on water surfaces, increases swamps areas, reduces water supply and undermines transport, hydroelectricity power production, fisheries and fish breeding).

B. How can siting, planning, and design be environmentally responsible?

By addressing such concerns early in the initiative's cycle, they will have better chances of success and long-term sustainability, help to prevent negative outcomes, and avoid rehabilitation costs. The following guiding principles are useful to avoid adverse environmental effects associated with siting, planning, and design. *You can check the items that are relevant to the proposed initiative.*

- Take into account the population density, existing practices and crops, the socio-economic and technical production capacities of the communities, as well as irrigation demands in relation to available water supply (based on current and historical data, and which may vary between seasons) and its quality.
- Avoid siting close to vulnerable sites or sites of economic, ecological, cultural, archaeological, or historical importance (e.g. slopes, wooded areas, wetlands, coastal areas, biodiversity hotspots, and habitats of endangered species). The major threats to the biodiversity and genetic resources in Rwanda are mainly linked to population pressure and the problem of land scarcity. In areas with acid sulphate soils, irrigation removes certain elements (cations) from the soil, and reduces nutrient availability to plants.
- Avoid sites and activities that would lead to unacceptable population displacements and/or loss of territory (e.g. migrations, expropriations, eviction of tenants or squatters, effects on local population, settling of nomads, and induced uncontrolled urbanization).
- Avoid sites and activities that would accentuate social inequalities, for example, cases where specific groups of the population, such as women, farmers, livestock producers, landowners, tenants, communal owners, "tail-enders" (i.e. users whose fields are farthest from the water source) have not been consulted; where the number of beneficiaries is limited; and where there would be an increase in women's workload.
- Avoid sites and activities that would lead to incompatible uses of land and resources and/or unacceptable social conflicts (e.g. between common ownership of public or ancestral lands and "ownership" of irrigation structures; between different types of water uses in the same area or different areas; between farmers and livestock herders; and between water users upstream and downstream from water source).
- Choose irrigation systems in accordance with the characteristics of the water supply, soils, geology, topography, and climate (e.g. consider soil texture, stability, and composition; drainage; humidity and evaporation; slope; seasonal water dynamics; if area is prone to landslides, flooding, drought, or other hazards).
- Integrate environmental conservation and restoration measures (e.g. water conservation, multiple-use irrigation, pollution prevention structures, erosion control, tree planting, and rehabilitation of watershed).
- Ensure that international and national/local policies, standards, and regulations are respected (e.g. land use, protected areas, surface and underground water quality, and water extraction).

C. What are the major potential adverse environmental effects? What can be done to mitigate or avoid them?

Mitigation measures are measures that effectively control, eliminate, or significantly reduce an initiative's adverse environmental effects. Not all the measures identified in this table have to be used — only those that are relevant and contextually pertinent to the initiative and its setting. The chosen mitigation measures can be underlined in the following table. When documenting the chosen mitigation measures, it is pertinent to provide details about how they will be achieved.

Major adverse effects	Associated mitigation measures
Conflicts over land uses and management, land tenure system, and surface or groundwater supplies.	• Consider water conservation measures instead of, or in addition to, a new irrigation initiative, for example, by upgrading or renovating existing systems (reduce evaporation, seepage losses) and by promoting water recycling and re-use, where appropriate. • Ensure community involvement for effective planning and management of the irrigation system, and for equitable water distribution (e.g. with a community management committee, including representatives from different user groups and affected areas; volume-based user fees; and upstream/downstream user agreements). • Encourage crops with lower water demands. • Locate and size irrigation systems where water availability is adequate and the initiative will not conflict with existing human, livestock and wildlife water uses (especially during the dry season), and so that withdrawals do not lead to major alterations of the surface water hydrology or exceed the groundwater recharge rate.
Human health sensitivities to agro-chemicals (e.g. pesticides and fertilizers), water-borne diseases, and infections (if creating habitats in canals and ditches for disease carriers such as mosquitoes and snails responsible for spreading diseases such as malaria and schistosomiasis/bilharzia), and other infections or diseases associated with the inappropriate use of irrigation canals for drinking water supply, bathing, or human waste disposal.	• Avoid creating stagnant water ponds (e.g. site and orient water works, fields, and furrows to ensure adequate natural drainage of surface water; use spigots, lined canals, and pipes; avoid unsuitable gradients; construct straight or only slightly curved canals; install gates at canal ends to allow flushing; ensure adequate sub-surface drainage of fields; avoid over-irrigation; maintain water works, and clear sediments and weeds regularly; and use intermittent drying-out periods). • Ensure alternate facilities for drinking and domestic water supply, bathing, and wastewater disposal. • Monitor disease occurrence and other public health indicators related to water-borne diseases and infections, and take corrective measures as needed (e.g. modifications to water works, education, medical action). • Implement a training program for farmers and other community members in irrigation health risks; the efficient use of irrigation water; the maintenance of irrigation and drainage works; various agro-ecological methods; proper storage, handling, use, and disposal of agro-chemicals; and integrated pest management (see # F- Crop Production sectoral planning tool). • Avoid nutrient loading of waters and the entry of agro-chemicals and other contaminants into the system (see # F-Crop Production or # E- Forestry sectoral planning tools, and next item for details).
Degradation of surface water or groundwater quality and quantity and its potential negative effects on the health of aquatic ecosystems.	• Promote water conservation practices (e.g. consider water availability, water recycling and re-use where appropriate, rationing during the dry season, use of control valves and reducer pipes, drip or trickle irrigation, and dawn/evening sprinkler irrigation. • Limit diversion of surface waters and alterations to hydrology, as well as blockage of fish migration and fish access to spawning areas (where there are reservoirs, water releases and/or habitat improvements may be required to

	sustain fish populations). • Ensure irrigation system (and its reservoirs and spillways) is in line with silting patterns, flow rates, and flood cycles of the surface waters. • Avoid deterioration of reservoir water by extracting and using vegetation from the reservoir area before flooding and by avoiding entry of eroded soils and agro-chemicals. • Reduce possible leakage, evaporation, and seepage losses through appropriate design, installation, use, and maintenance of structures. • Protect water source from run-off or seepage of contaminants (e.g. by using lined distribution pipes, covered drains, soak-away pits) and prevent surface drainage of fields into water bodies.
Soil degradation and erosion, as well as losses of soil productivity. Soil degradation is a problem particularly where soils are fine, thin or weak, or have complex drainage and fertility cycles. Heavy precipitation and activities on or around steep slopes also present issues	• Minimize soil exposition (minimize vegetation clearing; minimize time when soil surfaces are exposed to rain and wind; resurface and revegetate exposed areas; implement buffer zones of vegetation; promote watershed and river bank restoration; and use proper bedding materials for pipes). • Implement soil protection and anti-erosion measures around the water source and the irrigation system (e.g. avoiding improper use of heavy machinery; avoiding unsuitable gradients and over-irrigation; appropriate design and layout of furrows; use of sediment traps in fields and canals to capture sediment for return to fields where appropriate; reforestation and revegetation; drainage structures with cobbled stone, gravel, or concrete; small-scale terracing and other agricultural / soil moisture conservation strategies). • Avoid water logging of soils through the implementation of water conservation practices, adequate surface and sub-surface drainage, and lined canals or pipes (water logging may be due to a rise in the groundwater table caused by improper irrigation that exceeds the crops' water needs and lacks appropriate drainage measures, or to the loss of water from canals that are not watertight, or if the soil is poorly drained – for example, in clay or lateritic soils). • Avoid salinization of soils through the implementation of water conservation practices, mulching of exposed soil surfaces to reduce evaporation and the regular flushing of irrigated land (especially in arid and semi-arid areas). • Implement an operation program that controls the two previous issues.

D. How to plan follow-up and monitoring of environmental aspects?

When planning the environmental follow-up and monitoring of an initiative, the following should be addressed.

- *Items to be monitored:* What items will be monitored? Potentially significant environmental effects, sensitive components of the environment, any uncertainties, and mitigation measures (their implementation and effectiveness) are generally monitored.
- *Follow-up / monitoring methods: How*, where, and according to what schedule will follow-up / monitoring take place to help identify unforeseen effects and to assess the implementation and effectiveness of the chosen mitigation measures? Sufficient flexibility is required for additional measures when necessary.
- *Follow-up / monitoring roles and responsibilities:* Who will be responsible for implementing these tasks and ensuring that the results are acted upon?

- *Follow-up / monitoring reporting methods:* How and when will the results are reported to enable the analysis of lessons learned and their feedback into future initiatives? Who will be responsible for these aspects?

An indicator is a measurement, number, fact, standard, opinion or perception that helps measure progress toward achieving results. Not all the indicators identified in this table have to be used — only those that are relevant and contextually pertinent to the initiative and its setting. The chosen indicators can be:

- *Environmental indicators:* Water quality (e.g. nutrients, agro-chemicals, salinity, and suspended sediments) in water sources and irrigation canals; reservoir oxygen levels; physical and chemical properties of irrigated soils; variations in erosion of the watershed; surface water flows and groundwater table levels in area; rate of water use; degree of biodiversity; variations in fish populations or number of fish deaths; and number of persons trained in environmental issues.
- *Human well-being indicators:* Incidence of human illness or disease (associated with water-borne diseases); and access to irrigation water and potable water.

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I. Fish Farming

This sectoral tool provides an outline that can be used to identify the major, potential, adverse environmental effects, associated mitigation measures, and guidelines, as well as environmental indicators, for fish farming and aquaculture initiatives (raising and harvesting of fish and aquatic species, such as crustaceans or molluscs, under controlled circumstances) in fresh water and in natural and/or artificial environments.

A. What are the major environmental concerns?

These are some of the key environmental issues in Rwanda in relation for fish farming and aquaculture initiatives.

- As reported in the 2009 Rwanda State of the Environment and Outlook, wetlands and lakes constitute an important fish habitat and may support large populations of fish. Many local communities depend on these fish for their livelihood. Experimental fishing is being trialled in Lac Ihema.
- Wetlands are amongst the most productive ecosystems in Rwanda in terms of plant matter, fisheries and supporting freshwater biodiversity. They provide critical services; they feed lakes and rivers, trap and filter sediments and nutrients, absorb floodwaters, buffer croplands and settlements from strong run-off, and replenish rivers and streams during the dry season. The main problem is biological contamination of water resources including wetlands.
- In some lakes, the decline of aquatic habitats and resident species, including fish and amphibians is common. Aquaculture activities involving artificially produced seed is required.

How can fish farming activities affect the human environment?

- Conflicts over existing or planned land uses, tenure, and management practices (both “legal” and “illegal”, for either “private” and “communal” property or rights) may arise.
- Conflicts over surface or groundwater supplies and their management practices (e.g. increased withdrawal in certain areas at the expense of others) may arise.
- Aquaculture activities involving artificially produced seed, specially made feed, or large quantities of fish meal, antibiotics, drugs, hormones, parasiticides, herbicides, and other chemical/dangerous products, anti-fouling agents, or pesticides may lead to human health sensitivities; human health sensitivities may also be associated with water-borne diseases and infections.

How can fish farming activities affect the natural environment?

- The quality and quantity of surface water or groundwater may be degraded. Intensive and semi-intensive aquaculture systems often require large quantities of fresh water.
- Areas supporting critical, valued, vulnerable or protected species and habitats may be degraded, encroached or destroyed. Biodiversity and endemic species of an area may thus be negatively affected (e.g. deterioration of water quality from aquaculture discharges and large concentrations of exotic species, which can escape into wild populations that are important for local ecology and food supply, may lead to the decline of aquatic habitats and resident species, including fish, and amphibians). Natural aquatic environments are especially at risk (such as wetlands, which play important ecological roles in stabilizing coastlines, reducing storm erosion, acting as spawning and nursery areas for many aquatic species, and supporting a diverse population of plants, birds, and other land-based and aquatic animals; they also offer renewable resources for local communities).

B. How can siting, planning, and design be environmentally responsible?

By addressing such concerns early in the initiative’s cycle, they will have better chances of success and long-term sustainability, help to prevent negative outcomes, and avoid rehabilitation costs. The following guiding principles are useful to avoid adverse environmental effects associated with siting, planning, and design. *You can check the items that are relevant to the proposed initiative.*

- Site well away from vulnerable sites or sites of economic, ecological, cultural, archaeological, or historical importance (e.g. protected water bodies and waterways, protected wetlands, swamps, lagoons, marshes, mud flats, biodiversity hotspots, and habitats of endangered species).

- Avoid cases where artisanal fishing practices would be negatively affected by the introduction of “modern” techniques, or where the positive aspects of existing environmental management methods, such as selective fishing, are not taken into account.
- Avoid sites and activities that would accentuate social inequalities and/or would lead to unacceptable population displacements (e.g. cases where all representative groups of the population have not been consulted; and where the number of beneficiaries is limited).
- Avoid sites and activities that would lead to incompatible uses of land and resources, unacceptable social conflicts, value conflicts, and conflicts with respect to property rights (e.g. loss of subsistence territory; between various users of water, aquatic ecosystems, and resources; navigational and industrial hazards).
- Choose species and production system in accordance with the socio-economic and technical production capacities of the communities, the quality and quantity of water sources, the climate, as well as the characteristics of existing / “natural” ecosystems (e.g. consider the characteristics of existing and exotic fish species and other species, such as abundance, age classes, life cycle, habitats, vulnerability; consider the hydrographic characteristics such as flows, renewal rates, seasonal variations floods and currents; consider culturally significant and/or locally adapted species; take into account their nutrient requirements, space requirements, life cycle, vulnerability, maintenance requirements, origin, possibilities of invasion, reproduction, competition, and predation).
- Promote multi-purpose systems and the optimization of resources (e.g. appropriate re-use of pond water for agricultural irrigation, aquaculture combined with rice production, using pond bottom sludge as agricultural fertilizer, if properly decomposed and non-toxic).
- Integrate environmental conservation and restoration measures (e.g. ensure that an integrated, responsible, and long-term management plan exists for fisheries and/or aquaculture; that there is minimal use of chemical inputs, antibiotics, drugs, and growth hormones; that wastewater is adequately treated; that already degraded areas are protected or restored; that harvesting, processing, storage, and transportation include environmental considerations).
- Ensure that international and national/local policies, standards, and regulations are respected (e.g. land use, protected areas and species, water quality, health and safety, and chemical inputs).

C. What are the major potential adverse environmental effects? What can be done to mitigate or avoid them?

Mitigation measures are measures that effectively control, eliminate, or significantly reduce an initiative’s adverse environmental effects. Not all the measures identified in this table have to be used — only those that are relevant and contextually pertinent to the initiative and its setting. The chosen mitigation measures can be underlined in the following table. When documenting the chosen mitigation measures, it is pertinent to provide details about how they will be achieved.

Major adverse effects	***Associated mitigation measures***
Conflicts over existing or planned land uses, land tenure, and the associated management practices as well as conflicts over surface or ground-water supplies, and the associated management practices.	• Consider protection and restoration of natural habitats and fisheries instead of “artificial” means of production or the introduction of new species. • Encourage the use of existing cleared land, depressions, hollows, and ditches to create artificial ponds. • Limit areas converted to ponds, as well as surface area of ponds and enclosures. • Avoid premature abandonment and digging of new ponds by optimizing the design, construction, and maintenance of the planned production system. • Locate and size production systems where water availability is adequate (also keep in mind the possible effect of the environment on the initiative, such as climate, pollution, degradation, existing species) and the initiative will not conflict with existing various water uses (especially during the dry season and/or downstream), and so that water withdrawals do not lead to major alterations of the surface water hydrology or exceed the groundwater recharge rate. • Combine water uses and promote water conservation

	practices, recycling, and re-use, where appropriate (e.g. appropriately treated pond water used for irrigation of crops; consider the availability and source of water supplies, and groundwater recharge rate). • Ensure community involvement for effective planning, operation, and management of the production system.
Environmental degradation, as well as human health sensitivities, associated with artificially produced seed, large quantities of fish meal, antibiotics, drugs, hormones, parasiticides, herbicides and other chemical / dangerous products, anti-fouling agents or pesticides, as well as with water-borne diseases and infections.	• Assess ecology of water-borne disease vectors. • Ensure good drainage around water supply, ponds, and drainage works. • Promote the use of filter feeders and species that feed on disease vectors. • Monitor disease occurrence and other public health indicators related to water-borne diseases and infections, and take corrective measures as needed (e.g. physical changes to structures, education, medical action). • Ensure adequate water quality, e.g. ensure chemical inputs, antibiotics, drugs, growth hormones, and other dangerous products are appropriately chosen, used, and stored (see next item for details).
Degradation of surface water and groundwater quality and quantity. Keep in mind that molluscs are particularly vulnerable to biocides, leachates, metals, and pesticides.	• Promote water conservation practices. • Keep species densities in enclosures and ponds at moderate levels. • Line bottoms and sides of ponds, levees, and canals with impervious material; and design the structures to prevent overflow discharges, and storm and flood damage. • Avoid deterioration of pond water by extracting and using vegetation from pond area before flooding, where applicable. • Ensure training in the safe and rational storage, handling, use, and disposal of all types of chemical products that may be used (including fuel and oil for boats). • Do not use banned products, and minimize the use of chemical inputs, antibiotics, drugs, and hormones (use such inputs only when required, for example, to control an outbreak rather than on a routine preventive basis, in correct amounts and with safe application measures; promote the integrated management of pests; dig ponds deep enough to control weed growth). • Avoid broad-spectrum pesticides (that can lead to pest resistance and the elimination of beneficial non-target organisms) and substances that can lead to bioaccumulation of toxic products in the food chain (concentration in fats, particularly in carnivores). • Ensure that chemical labels on leak proof containers with covers in secured storage areas are understood and contextually relevant. • Use quality feed with low waste generation; use feed of the appropriate size for the age of the stock; feed the right amounts at the right time; distribute feed evenly; and use feed pellets designed to float longer in the water column. • Maintain water quality firstly with aeration or other destratifying methods, sustainable stocking rates, controlled feeding rates and minimal chemical inputs, and secondly, with water exchanges. • Release pond water into water body with adequate dilution and dispersal capability and after adequate settling and/or treatment. • Time water releases with period of high water levels or flows

	(areas of high currents tend to minimize waste accumulation through dispersal; currents also help replenish oxygen levels. • Avoid an increase in sedimentation and/or eutrophication (including toxic algal blooms) caused by the high input of particles, wastes and changes in the nutrient cycle generated by high stock concentrations, longline cultures of crustaceans, and certain structures such as floats and piers (e.g. periodically move enclosures to different locations; manage stock wastes through bag systems, fallowing, vacuuming, or harrowing, where appropriate). • Alternate freshwater ponds, where appropriate, and allow ponds to dry out, lie fallow, or grow a crop to reduce the need for sludge and nutrient removal.
Degradation of natural environments and associated biodiversity loss. If local fuelwood is used to dry fish, ensure its integrated and sustainable management and consider a complementary community forestry initiative (see appropriate sectoral tool). If other sources of energy are used, implement air pollution control measures and consider renewable or alternative energy sources.	• Ensure protection of natural habitats and species (e.g. enhance or protect other nearby habitats to offset possible losses at the site of the initiative; site ponds; avoid disturbing water flows to and from wetlands; avoid inappropriate stake or longline cultures that slow water movements and cause a subsequent accumulation of sand; limit diversion of surface waters and alterations to hydrology as well as blockage of migration, feeding, spawning, and nursery areas with piers or floats; ensure that the production system is in line with silting patterns, flow rates, currents, and flood cycles of the surface waters; situate ponds away from areas subject to flooding; avoid shallow waters and areas with aquatic vegetation; consider double nets or other techniques to avoid predation by birds and aquatic species; choose a size of net mesh that will prevent entanglement of wild species; use properly tensioned net pen lines, thick ropes or protective netting and weights to avoid entanglement of wild species; avoid abandoned lines, nets, cages, and traps). • Avoid large-scale aquaculture systems. • Choose species and their management/harvesting in accordance with the carrying capacity of ecosystems (i.e. what an ecosystem and its components can sustain without compromising their growth, regeneration, and roles in ecological regulatory functions) and while respecting the mosaic and diversity of the area. • Use hatchery stock where possible. • Promote the use of locally adapted species, indigenous species and/or culturally significant species rather than introduced species as stock (use non-native species only where escape is impossible) and consider cultivating herbivorous species. • Avoid loss of ground cover and erosion (restrict area cleared; construct ponds during dry season; stabilize exposed soil with indigenous vegetation; avoid fragile, thin, or unstable soils and slopes; ensure good drainage and erosion control around ponds; promote buffer zones near shores exposed to wave action; use low impact equipment and methods for management, harvesting and transportation; and take into account climatic conditions). • Choose sites with soils that will retain water and be suitable for building dikes (clay-loam or sandy-clay soils, preferably); soils should be alkaline (acidic organic soils are not suitable). · • Ensure stock is kept healthy (isolation of diseased individuals may be required) and confined (with screens at the entrances and exits of structures). • Ensure environmental training in the importance of integrated,

	responsible and long-term management as well as in safe and appropriate harvesting, processing, storage, and transportation methods (including proper cleanliness, waste management, maintenance, accident and spill prevention, and emergency response). • Implement pollution prevention or control measures to limit pollutants, nuisances, and risks of accidents or to health and occupational safety associated with cultivating, harvesting, processing, storage, and transportation.

D. How to plan follow-up and monitoring of environmental aspects?

When planning the environmental follow-up and monitoring of an initiative, the following should be addressed.

- *Items to be monitored*: What items will be monitored? Potentially significant environmental effects, sensitive components of the environment, any uncertainties, and mitigation measures (their implementation and effectiveness) are generally monitored.
- *Follow-up / monitoring methods*: How, where, and according to what schedule will follow-up / monitoring take place to help identify unforeseen effects and to assess the implementation and effectiveness of the chosen mitigation measures? Sufficient flexibility is required for additional measures when necessary.
- *Follow-up / monitoring roles and responsibilities*: Who will be responsible for implementing these tasks and ensuring that the results are acted upon?
- *Follow-up / monitoring reporting methods*: How and when will the results are reported to enable the analysis of lessons learned and their feedback into future initiatives? Who will be responsible for these aspects?

An indicator is a measurement, number, fact, standard, opinion or perception that helps measure progress toward achieving results. Not all the indicators identified in this table have to be used — only those that are relevant and contextually pertinent to the initiative and its setting. The chosen indicators can be:

- *Environmental indicators:* Water quality in pond drainage and/or effluents (e.g. nutrients, chemicals, suspended solids, transparency, turbidity, salinity, and oxygen); surface water flows and groundwater table levels in area; rate of water use; degree of biodiversity in the aquatic habitats (e.g. number of species and an appreciation of their populations); extent of critical habitats; number of persons trained on environmental issues and responsible aquaculture management.
- *Human well-being indicators:* Incidence of human illness or disease (associated with chemical inputs and water-borne diseases and infections).

Reference and Useful Resources

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J. Solid Waste Management[6]

This sectoral tool provides an outline that can be used to identify the major, potential, adverse environmental effects, associated mitigation measures, and guidelines, as well as environmental indicators, for small-scale solid waste management initiatives, including reduction of wastes at source, collection, sorting, storage, reclamation (re-use, composting, and recycling), and elimination or final disposal. Approximately 70 percent of all solid wastes are organic in origin and can therefore be composted. This sectoral tool also includes information relevant to solid healthcare/biomedical wastes, which are dangerous and therefore entail more specific measures.

A. What are the major environmental concerns?

These are some of the key environmental issues in Rwanda in solid waste management.

- As reported in the 2009 Rwanda State of the Environment and Outlook, waste management is a big problem in urban and rural areas. In some areas, there is a system of collection and transportation of solid wastes, there is no segregation system and the management of dumping sites is a serious problem. Existing disposal sites are overflowing.
- The major environmental and health concerns associated with inadequate solid waste management relate to the spontaneous combustion of waste and the escape of leachate from dump sites. In many open disposal areas, fires can burn and smoulder over a prolonged period thereby releasing methane, carbon monoxide, nitrogen oxide, sulphur oxide and dioxins into the atmosphere. The main problem, however, is leachate and it's potential for ground and surface water contamination. Leachate is the liquid that drains from a landfill site; its chemical properties are determined by waste composition.
- As reported in the 2009 Rwanda State of the Environment and Outlook, expired drugs are been discarded in waste water. It has been reported that drugs people use appear in water supply as waste products. Proper management of expired drugs is required.

How can solid waste management initiatives affect the human environment?

- Conflicts over existing or planned land uses, activities, and infrastructures (both "legal" and "illegal") may arise.
- Nuisances (e.g. noise, foul odours, airborne dust, traffic), health risks (transmission of diseases), and risks of accidents may arise.

How can solid waste management initiatives affect the natural environment?

- Soil degradation (affecting its stability, structure, drainage characteristics) and erosion may arise.
- Degradation of ecosystems and habitats may occur, especially if soil denudation or vegetation clearing takes place.
- Water quality (both surface and underground waters) may be degraded and the health of aquatic ecosystems may thus be negatively affected through increased sedimentation, eutrophication, and the possible run-off of wastes. It has been reported that drugs appear in water supply as waste products.

B. How can siting, planning, and design be environmentally responsible?

By addressing such concerns early in the initiative's cycle, they will have better chances of success and long-term sustainability, help to prevent negative outcomes, and avoid rehabilitation costs. The following guiding principles are useful to avoid adverse environmental effects associated with siting, planning, and design. *You can check the items that are relevant to the proposed initiative.*

- Take into account the population density, the characteristics of land occupation and uses (e.g. proximity of residences), the existing solid waste management practices (integrate informal reclamation/re-use and recycling/composting), the socio-economic and technical production

[6] Tool and Guideline # 11 provides practical tools on solid waste management of Imidugudu, small towns and cities: landfill, composting facilities & small-scale incinerators.

capacities of the communities, as well as soil characteristics (stability, texture, drainage, and permeability), proximity to water bodies, topography, climatic conditions when selecting the solid waste management site and designing the system.

- Take into account the nature and quantities of the solid wastes to be managed (by category, such as organic and compostable, hazardous, and recyclable) when designing the solid waste management system, and ensure separate collection, treatment, and disposal of hazardous wastes.
- Avoid siting in areas prone to natural disasters or hazards (flooding, heavy rain, intense storms, earthquakes, volcanic eruptions, and landslides).
- Avoid infringing on vulnerable sites or sites of economic, ecological, cultural, archaeological, or historical importance (e.g. water bodies, waterways, slopes, wooded areas, coastal areas, wetlands, biodiversity hotspots, habitats of endangered species, and floodplains).
- Avoid uncontrolled and unplanned human settlements.
- Avoid sites that would accentuate social inequalities (e.g. the selection of a solid waste elimination and/or reclamation site in poorer urban marginal areas without the prior consultation and involvement of residents) and/or would lead to unacceptable population displacements (e.g. as a result of the nuisances associated with a solid waste elimination site or the appropriation of this site, migrations, expropriations, eviction of tenants or squatters).
- Integrate environmental conservation and restoration measures (e.g. erosion control; tree planting; restoration of degraded sites; creation of buffer zones; promotion of waste reduction, reclamation/re-use, recycling/composting).
- Ensure that international and national/local policies, standards, and regulations are respected (e.g. siting, design, and operation of solid waste facilities; hazardous and toxic wastes; land use; protected areas; health and safety standards; and water quality standards).

C. What are the major potential adverse environmental effects? What can be done to mitigate or avoid them?

Mitigation measures are measures that effectively control, eliminate, or significantly reduce an initiative's adverse environmental effects. Not all the measures identified in this table have to be used — only those that are relevant and contextually pertinent to the initiative and its setting. The chosen mitigation measures can be underlined in the following table. When documenting the chosen mitigation measures, it is pertinent to provide details about how they will be achieved.

Major adverse effects	***Associated mitigation measures***
Conflicts over existing or planned land uses, activities, and infrastructures.	• Ensure community involvement in locating and preparing the initiative's sites and access routes, as well as in developing responsibilities for managing the initiative's operations (including possible collection fees). • Design the initiative to provide alternatives for affected individuals (e.g. local employment, and alternate livelihoods).
Nuisances (e.g. noise, foul odours, airborne dust, traffic), health risks (transmission of diseases), and risks of accidents. See appropriate sectoral tool (rural roads) for more details on access roads.	• Plan site preparation/construction activities and operations according to a schedule compatible with the climate and the population's activities. • Locate solid waste management site(s) well away from and downwind of human settlements and vulnerable areas. • Promote environmental training, health and safety training, as well as the use of adequate protective clothing and equipment (e.g. masks, overalls, resistant gloves, and boots with thick soles). • Prevent access to solid waste management site(s) by unauthorized persons and wildlife (through vigilance, control of incoming and outgoing traffic, warning signs, and security fences). • Minimize the handling of waste and quantities of waste to be disposed of; ensure adequate solid waste segregation; and maximize containment.

	• Provide specific and regularly cleaned and maintained enclosed collection vehicles or carts (with tarpaulin covers), and ensure collection is sufficiently frequent (in line with quantities and climate). • Provide specific enclosed areas for vehicle unloading and refuse sorting (for recovery/re-use and recycling/composting); ensure good ventilation, dust suppression, ground impermeability, and worker protection, as well as accident and emergency preparedness; and avoid excessive traffic. • Ensure adequate composition, aeration, and maintenance of compost. • Study disease carriers and monitor disease occurrence and other public health indicators, and take corrective measures as needed. • For solid waste landfills: spread and compact adequately sorted incoming refuse, and cover with soil, daily; provide for safe ventilation, recovery, and treatment of decomposition gases (such as methane, which is a product of decomposition and is explosive), and consider their possible use as an alternative energy source (biogas). • For solid waste incinerators: install appropriate, effective equipment for complete combustion and air pollution control (air filters or scrubbers), while ensuring that only wastes adequate for incineration are burnt (e.g. pressurized containers, halogenated plastics – PVCs, tires, and wastes containing heavy metals are not to be incinerated).
Ecosystem and soil degradation (e.g. erosion, compaction, and changes in drainage) may occur. Soil degradation is particularly a problem where soils are fine or weak, or have complex drainage cycles. Heavy precipitation and steep slopes also present issues.	• Ensure training in soil degradation control and implement appropriate erosion control measures during site preparation (e.g. minimize time of exposure of areas cleared or excavated, especially during rainy and windy periods; stabilize and revegetate disturbed areas; when stockpiling soil, promote the creation of small mounds; implement buffer zones of vegetation; and install adequate surface drainage control measures). • Maintain erosion and drainage control during operations. • Minimize vegetation clearing. • Avoid inappropriate use of heavy machinery.
Degradation of water quality.	• Ensure training in environmental issues, solid waste management, as well as health and safety topics (including site preparation/construction, operations, proper cleanliness and hygiene practices, first-aid measures, protective clothing and equipment, maintenance, waste segregation, collection, storage, transportation, treatment, disposal, accident and emergency response, reporting, as well as proper closure and restoration), and raise community awareness of the importance of waste reduction, recovery/re-use and recycling to reduce waste disposal requirements and extend the life of disposal sites. • Promote reduction of wastes at source as well as waste segregation to enable the re-use of certain products, recycling of other products, composting of biodegradable wastes (for example through vermiculture

	of vegetable food waste) and appropriate collection, storage, transportation, treatment, and disposal of other wastes. • Implement pollution prevention or control devices to limit the harmful effects of pollutants (for example, drainage and surface run-off systems), as well as leachate recovery and treatment systems (leachate is the soluble portion of decomposing solid wastes and may be treated through physical, chemical, or biological means, for example, with a sewage treatment facility, recirculation that sprays leachate from the bottom of the landfill onto its surface, and evaporation of leachate through a series of open ponds or lagoons). • For solid waste landfills: siting where the underlying soils are relatively impermeable and have a high capability for containing contaminants (e.g. clays); siting well above the underground water table and where topography is relatively flat; use a landfill liner/sealer (e.g. clay or geosynthetic) if leachate risks entering groundwater; siting well away and down gradient from surface waters and groundwater recharge areas or sources (according to the distance required to promote the receiving water's capability for dilution and dispersal of potential contamination); install test well(s) at landfill perimeter, and monitor water quality during operations, for early identification and mitigation of emerging adverse effects. • Ensure separate collection, storage, transportation, treatment, and disposal of hazardous wastes (e.g. biomedical, heavy metals, tires, oil, batteries, paint, solvents, and acidic solutions.

Biomedical Wastes from Small-Scale Health Care Initiatives and Their Major Environmental Issues

- Biomedical wastes must be segregated first from "regular" wastes and then according to the following categories: 1) non-sharp infectious waste (such as laboratory cultures and objects contaminated by blood or body fluids); 2) pathological waste (such as human body parts, blood, and body fluids); 3) sharp infectious waste (such as needles, scalpels, and infusion equipment); 4) pharmaceutical waste (such as drugs, vaccines, and serums); 5) chemical waste (such as formaldehyde); 6) waste containing heavy metals (such as thermometers and blood pressure gauges); 7) radioactive waste (such as radionuclides); 8) genotoxic waste (such as cytotoxic products used in cancer therapies); and 9) health care wastewater (which is treated through physical or chemical means, biological purification, lagooning, or sand filtering).

- Biomedical wastes are associated with the same types of environmental effects as other types of wastes. However, in the case of biomedical waste the potential for disease transmission is greater. Biomedical wastes may lead to injuries (through sharp waste), short-term and long-term health problems (e.g. related to radioactive waste), as well as to the spread of diseases (e.g. hepatitis, HIV/AIDS, cholera, diphtheria, and other communicable respiratory, gastro-intestinal, ocular, and skin diseases). Environmental and health and safety training (including first aid measures, good hygiene practices, and the use of protective clothing and equipment) are essential, as is the assignment of specific tasks and responsibilities for the management of biomedical wastes (including its segregation, collection/handling, storage, transportation, treatment, and final disposal, as well as accident, spill, and emergency response).

- Source reduction of biomedical wastes is important. For example, to avoid generating pharmaceutical wastes in the form of expired medication, small amounts of the required products should be ordered in a centralized manner, and products should be used in the order of their expiration dates. Only products designed specifically for re-use are to be re-used after appropriate cleaning and sterilization (through an autoclave, for example).

- The segregation of the different categories of biomedical wastes entails the use of specific containers in all areas where the wastes may be generated. Storage areas must have a restricted access, be able to withstand climatic conditions, be adequately ventilated, and be far away from food storage areas and water sources. The floor of the storage areas must also be impermeable, and cleaning and protective equipment must be available. Containers must be hermetic and leak proof (as well as puncture-proof in the case of sharp infectious waste). Containers are typically yellow and accompanied by the international symbol for infectious substances. They are typically sent to treatment and disposal when they are three-quarters full.

- For small-scale initiatives, minimal requirements typically call for the incineration, encapsulation and/or safe burial of biomedical wastes, considering the context. Other more efficient and/or more sustainable methods of treatment and disposal of biomedical wastes exist (such as chemical disinfection, wet thermal treatment, microwave irradiation, authorized sanitary landfills and inertization). However, these tend to be more complex and more expensive. If on-site incineration is the preferred option of treatment, considering the context, it should take place preferably in a static-grate, single-chamber on-site incinerator. As a secondary option, on-site incineration may take place in a drum or brick on-site incinerator. Appropriately controlled incineration is generally adequate for non-sharp infectious wastes, pathological wastes, and sharp infectious wastes. The residues from burning (or ashes, which should contain less than 3 percent of unburned matter) are then buried using safe on-site burial methods or disposal in an authorized sanitary landfill. Incineration is generally not recommended for pharmaceutical wastes, chemical wastes, genotoxic wastes and radioactive wastes. Furthermore, pressurized containers, halogenated plastics (PVCs), and wastes containing heavy metals are not to be incinerated. On-site encapsulation is a method of treatment and disposal sometimes recommended for sharp infectious wastes and small amounts of pharmaceutical wastes. Encapsulation alone is not recommended for non-sharp infectious wastes, but may be used in combination with and after their incineration. Encapsulation is generally not recommended for pathological wastes, chemical wastes, genotoxic wastes, radioactive wastes, and wastes containing heavy metals. Safe on-site burial may be conducted for small amounts of non-sharp infectious wastes, small amounts of pathological wastes, small amounts of sharp infectious wastes (and ashes from the incineration of these three categories of biomedical wastes), and small amounts of pharmaceutical wastes (with the same protective and control measures as those proposed for landfills). Safe, on-site burial of prescribed wastes is practicable for only relatively limited periods of time (e.g. one to two years) and for relatively small quantities of such wastes (approximately up to 5 to 10 tonnes in total).

- For more information on the technical aspects of biomedical waste management, refer to: Prüss, A., Giroult, E. and Rushbrook, P. (1999). *Safe management of wastes from health-care activities*. Geneva: World Health Organization.

D. How to plan follow-up and monitoring of environmental aspects?

When planning the environmental follow-up and monitoring of an initiative, the following should be addressed.

- *Items to be monitored*: What items will be monitored? Potentially significant environmental effects, sensitive components of the environment, any uncertainties, and mitigation measures (their implementation and effectiveness) are generally monitored.
- *Follow-up / monitoring methods*: How, where, and according to what schedule will follow-up / monitoring take place to help identify unforeseen effects and to assess the implementation and effectiveness of the chosen mitigation measures? Sufficient flexibility is required for additional measures when necessary.
- *Follow-up / monitoring roles and responsibilities*: Who will be responsible for implementing these tasks and ensuring that the results are acted upon?

- *Follow-up / monitoring reporting methods*: How and when will the results are reported to enable the analysis of lessons learned and their feedback into future initiatives? Who will be responsible for these aspects?

An indicator is a measurement, number, fact, standard, opinion or perception that helps measure progress toward achieving results. Not all the indicators identified in this table have to be used — only those that are relevant and contextually pertinent to the initiative and its setting. The chosen indicators can be:

- *Environmental indicators*: Concentrations of pollutants in air; concentrations of pollutants in surface and groundwaters; noise and dust levels; quantities of re-used or recycled products; increase in composting activities; and number of persons trained on environmental issues.
- *Human well-being indicators*: Incidence of human illness or disease; frequency of accidents; and number of complaints.

Reference and Useful Resources

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