Applying Life Cycle Thinking to International Water and Sanitation Development Projects:

An assessment tool for project managers in sustainable development work

By

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A REPORT

Submitted in partial fulfillment of the requirements
For the degree of

MASTER OF SCIENCE IN ENVIRONMENTAL ENGINEERING

MICHIGAN TECHNOLOGICAL UNIVERSITY

2006

This report “Applying Life Cycle Thinking to International Water and Sanitation Development Projects: An assessment tool for project managers in sustainable development work” is hereby approved in partial fulfillment of the requirements for the Degree of MASTER OF SCIENCE IN ENVIRONMENTAL ENGINEERING.

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Preface

The motivation for this research came out of my experience while serving as a Peace Corps Volunteer for 25 months in Mali, West Africa from January 2004 to March 2006. I worked as a water and sanitation extension agent in the rural village of Zambougou-Fouta, within the region of Segou. I collaborated with the mayor's office in the commune capital of Tesserela and consulted on a project being implemented by a chapter of Engineers Without Borders- USA.

This report is submitted to complete my master's degree in Environmental Engineering from the Master's International Program in Civil and Environmental Engineering at Michigan Technological University. This paper is derived from lessons I learned through my involvement in a variety of projects in my village and the surrounding areas. Although most of my work was centered on construction for water and sanitation improvements, such as the repair of existing wells, soak pits for sanitation, and rainwater harvesting, I was also involved in hygiene education efforts at the school and the establishment of a community health center in my village.

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Acknowledgements

This paper is a compilation of experiences, advice, discussions, and lessons learned during my two years as a Peace Corps volunteer in Mali, West Africa. The framework of this paper arose from long and repeated conversations with teammates and friends on the ins and outs of development work. I would like to dedicate this paper to the volunteers in Mali who are living these lessons on a daily basis.

Thank you to the people of Zambougou-Fouta for welcoming me into their homes and sharing their lives with me. Special thanks to my counterpart Adama Diarra, my host father Madou Coulibaly, and my best friend Tata Diarra. Without their patience, understanding and support I would never have made it through the two years. Ala ka here to an fe. Ala k'an nogonye nogoya.

I am grateful to my advisor and mentor, Jim Mihelcic for years of advice and encouragement. He pushed me to try for the best, kept me going when I hit roadblocks, and always believed that I could get this done. I would like to thank Dave Watkins, Linda Phillips, and Brad Baltensperger, my graduate committee, for their advice and encouragement. In addition, I would like to thank the National Science Foundation Graduate Research Fellowship Program for funding during my time at Michigan Tech.

Finally, I would like to thank friends and family back home for all the letters, packages, and prayers that kept me going in Mali. Thank you especially to my parents for their constant love and support through all of my crazy endeavors.

Abstract

The United Nations Millennium Development Goals have called the issues of water and sanitation to the forefront of international development efforts. Engineers and other development workers are answering this call in increasing numbers. Yet, in order to achieve these goals it is necessary to overcome the historically low sustainability rates of development projects. This paper presents a logical framework for breaking down and analyzing the factors that affect sustainable development of water and sanitation projects. It identifies five sustainability factors that are common throughout development literature and the policies of international aid organizations: socio-cultural respect, community participation, political cohesion, economic sustainability, and environmental sustainability. A life cycle thinking approach is chosen to assess how the sustainability of a project can be affected at each stage of its life. Five stages are identified to represent the life of a development project: needs assessment, conceptual designs and feasibility, design and action planning, implementation, and operation and maintenance.

Using the defined sustainability factors and life cycle stages, an assessment tool is developed in the form of a matrix. The matrix allows the sustainability factors to be assessed individually at each stage in the life cycle. A series of guidelines for each matrix element are given as a method for scoring the sustainability of a project. The guidelines were derived from best practice approaches to effective international development and personal experience during two years as a water and sanitation Peace Corps volunteer in Mali, West Africa. The proposed sustainability matrix allows development workers to evaluate the strengths and weaknesses of their projects during each of the five stages of the project life. Use of this framework will assist engineers and other development workers in implementing sustainable project approaches.

1.0 Introduction

"… the root causes of global environmental degradation are embedded in social and economic problems such as pervasive poverty, unsustainable production and consumption patterns, inequity in distribution of wealth, and the debt burden… success in combating environmental degradation is dependent on the full participation of all actors in society, an aware and educated population, respect for ethical and spiritual values and cultural diversity, and protection of indigenous knowledge"

Ministers of the Environment, First Global Ministerial Environment Forum, Malmö, Sweden, May 2000

This chapter provides background information on the motivation and need for study. It explains the current theories of sustainability and life cycle thinking along with the potential for applying them to international development projects.

1.1 Motivation for Study

For the past two years, I served as a water and sanitation extension agent for the United States Peace Corps. I was stationed in a rural village of 1,500 people in central Mali, West Africa. The program in Mali is designed to help communities meet their needs for improved water supply and public sanitation. The majority of Malians rely on groundwater sources, typically hand dug wells, for water supply. Sanitation services generally consist of pit latrines and soak pits for grey water disposal. I was involved in projects to repair and cover existing wells, construct soak pits, and increase the potential water supply through the harvest of rainwater.

Mali is a land-locked country in West Africa with a population of 11 million (Figure 1). Over half of Mali's land mass, an area the size of Texas, is covered by the Sahara desert while the rest is semi-arid savanna. The majority of the population lives in the southern portion of the country where relatively more abundant rainfall allows for subsistence farming. Approximately 90% of the population is tied to the land through agriculture and animal husbandry. It is among the 10 poorest countries in the world with a per capita gross domestic product (GDP) of $277. The high level of poverty,

accentuated by variable climate conditions, and relatively stable political situation makes Mali a prime candidate for foreign aid.

Figure 1: Map of Mali
(Source: http://www.lib.utexas.edu/maps/africa/mali_pol94.jpg)

During my time in Mali, I had the opportunity to observe and work with a variety of communities and aid institutions. There is a long history of water and sanitation intervention in Mali, but little documented evidence of the benefits. The region is littered with broken hand pumps, failed community gardens, and overflowing soak pits.

Everyone has a different theory on why projects fail and a new method to increase effectiveness the next time around. Yet, most of these theories only address a single issue in the complex web of development work. I noticed the tendency of aid organizations and volunteers to focus on a single project goal or methodology, often to the exclusion of the larger context in which they were working. For example, Peace Corps volunteers often become so focused on encouraging community participation that they do not connect with other organizations in the area that could provide administrative support. Foreign donors on the other hand may be well connected politically, but do not understand the socio-cultural constraints that will determine if the project is acceptable to the users. There is a need for a unifying framework that can integrate a variety of development approaches. The framework must recognize the merit of different practices and connect them together under the larger goal of sustainability.

1.2 Definition of Need

After a half century of international attention, lack of improved water and sanitation sources remains a serious world health and environmental issue. Over 1.1 billion people use water from unimproved sources, and 2.4 billion have no access to any form of improved sanitation (United Nations, 2005). According to the World Health Organization, 2.2 million people in developing countries, most of them children, die every year from diseases associated with lack of safe drinking water and inadequate sanitation and hygiene. Improvements in these services could reduce mortality rates due to diarrheal diseases by an estimated 65% and related morbidity by 26% (WHO, 2000). The lack of sanitation services is also compounding problems of environmental degradation and associated poverty levels around the world. In response to this crisis, international organizations have listed water and sanitation interventions among the top development priorities. The United Nations Millennium Goals (United Nations, 2000) specifically target water and sanitation measures, and the United Nations General Assembly proclaimed the years 2005 to 2015 as the International Decade for Action 'Water for Life'.

The engineering community is beginning to respond to this call for action. There is a growing movement recognizing the role that engineering can play in addressing international concerns over poverty, health, and environmental sustainability. The World Federation of Engineering Organizations has stated that "engineers play a crucial role in improving living standards throughout the world [and] can have a significant impact on progress towards sustainable development." The result is a rising number of organizations dedicated to international engineering, such as Engineers Without Borders (EWB), Engineers for a Sustainable World (ESW), and the Millennium Water Alliance. Since its founding in 2000, EWB-USA has grown to 143 professional and student chapters with over 40 projects in 22 countries, while ESW has chapters at 21 universities and impending chapters on another 29 campuses. In addition, water and sanitation projects located in the developing world are now becoming part of the capstone senior design experience and graduate school research (Hokanson et al., 2006). In the international setting, engineers have entered a field of development that reaches beyond technology. Development in this case can be defined as any process that promotes the dignity of people and their capacity to improve their own lives (Peace Corps, 2002). Responsible engineering in this context must integrate technology into a social framework that incorporates issues of cultural respect, education, and capacity building.

In this new thrust for development engineers are still struggling to find an approach that will yield sustainable results. Historically, water and sanitation projects have a low success rate. Between 50-66% of water supply and sanitation project evaluated by the World Bank were deemed to be satisfactory, and less than half were rated likely to be sustainable (World Bank, 2003). For years, foreign donors have poured money into developing countries without much thought for the political and social institutions that will support and sustain these projects. Projects consistently fall into disrepair because communities do not feel they are responsible or because they do not have the capacity to sustain the system (Breslin, 2003; Ratner and Gutierrez, 2004; Howe and Dixon, 1993). Project planners also fail to understand cultural and political obstacles or make appropriate adjustments to account for local conditions. There is often undue

emphasis on getting projects constructed without enough attention to selecting appropriate technology or planning for long-term sustainability (Howe and Dixon, 1993). Generally speaking, projects fail because they do not recognize a broad range of factors that affect the sustainability of a project throughout its lifetime.

1.3 Defining a Framework

There is a growing awareness within the international community of the need for sustainable approaches to project design and implementation. Sustainable development was first described as process which meets the needs of the present generation without compromising the ability of future generations to meet their needs (WCED, 1987). In the years since it was introduced, the concept of sustainability has become a unifying theory in development work worldwide. The United Nations recognizes it as an essential approach to meeting development goals and has called for broad public participation in sustainability at all levels (UNCED, 1992). Proponents of the concept break sustainability into three main components: environment, economic and social protections. Sustainability is reached at the intersection, where all three spheres are considered and respected (Figure 2).

The theory of sustainability is widely accepted, but the practical application and methodology of it varies greatly between regions and institutions. Industry focuses on the business ethics of sustainability, referring to it as the triple bottom line. While in international development work, a sustainable project is one that the community can continue on its own, without outside support. Engineers in development define it as appropriate technology, which can be made at an affordable price by ordinary people using local materials to do useful work in ways that do the least possible harm to both human society and the environment (McGraw-Hill, 2003). Just as sustainability offers a unifying theory, there is now a need for a unifying framework for practical application that will assist development workers in analyzing current practices and developing sustainable implementation approaches.

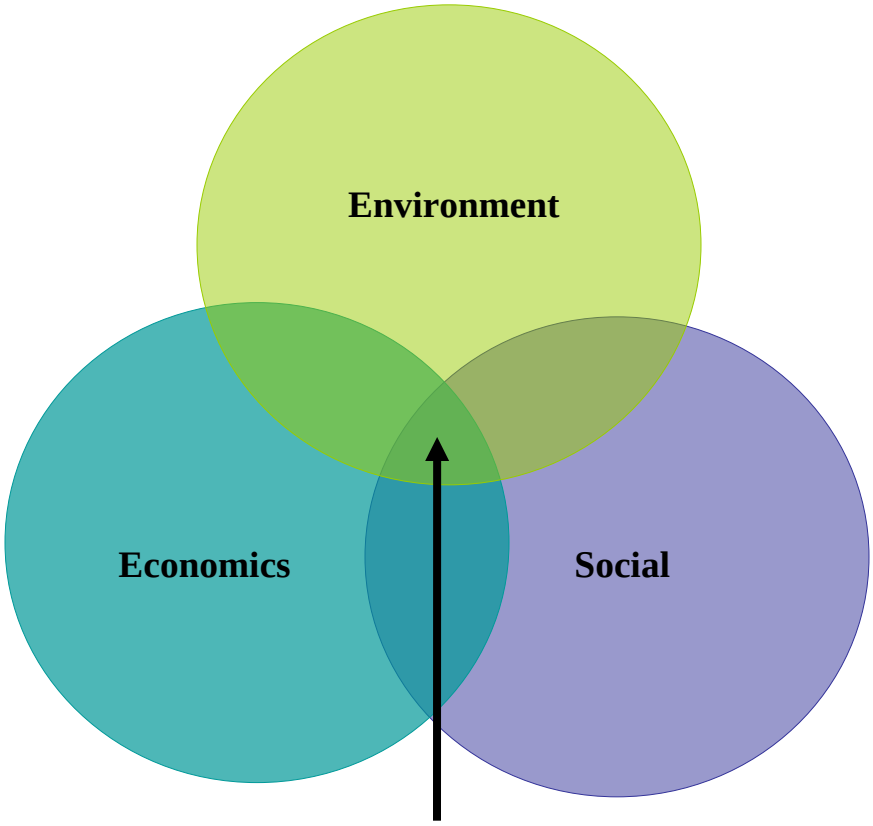

Figure 2: Interconnected pillars of sustainability. Sustainability is reached at the intersection where all three components are considered.

A potential framework for learning and decision making in sustainable development work is life cycle thinking. Life cycle thinking is a holistic approach that considers sustainability factors over the entire life of a product or process, from conception through use and disposal. The system approach of life cycle thinking is a prerequisite to any sound sustainability assessment, as it does not allow for shifting of detrimental effects to other timeframes or phases in the life cycle (Klöpffer, 2003) Perhaps the most well known applications of life cycle thinking are the Life Cycle Assessment (LCA) tools that were developed by industrial ecologists to evaluate the environmental impacts of products and services during all phases of their life. The methodology behind LCA is well defined and includes international standards, such as ISO 14040 (1997). The results have provided companies and engineers with a broader

view of the environmental impacts of products and services. Recognition of the interconnectedness of different industrial processes has allowed decision makers to identify areas of greatest importance and intervene for maximum results.

While the advances in environmental sustainability assessment are impressive, efforts to integrate the other two spheres of sustainability into life cycle approaches are less advanced. Life Cycle Costing (LCC) has recently emerged as a promising tool for considering economic factors in project sustainability, and researchers are beginning to integrate social assessments (Hunkeler and Rebitzer, 2005). Future efforts in life cycle approaches will work to extend the LCA model to address economic and social aspects of sustainability. Such an integrated life cycle thinking tool could be the framework that international development workers need to improve the sustainability of their projects.

The objective of this paper is to put life cycle thinking into practice by designing a procedural tool to evaluate the sustainability of international water and sanitation development projects. The results will assist engineers and other development workers in recognizing factors that affect sustainability and suggest ways to mitigate them over the course of the project life. Previous attempts to apply social indicators to life cycle management have recommended checklists and guidelines as a means to overcome data limitations and the qualitative nature of social factors (Labuschagne and Brent, 2006). Similar to existing procedural tools in LCA, such as Eco-design and Design for Environment (UNEP, 2005), the proposed assessment will develop a series of checklists and guidelines to evaluate the social, economic, and environmental sustainability of water and sanitation development projects. The guidelines are derived from best practice approaches to effective international development and my personal experience during two years as a water and sanitation Peace Corps volunteer in Mali, West Africa. The guidelines and scoring mechanism serve as self-assessment and educational tools in the process of development project implementing. It is hoped that this tool will increase the capacity of project managers to learn from mistakes and improve project sustainability.

2.0 Approach to Research

The objective of this research is to use the concepts of sustainability and life cycle to build an inclusive framework that can assess the effectiveness and viability of international water and sanitation projects. There is an increasing need for such assessment, as more engineers and other development workers become involved in the efforts to meet the UN Millennium Development Goals for water and sanitation. Many of these engineers lack experience in international development, just as other development workers may lack engineering knowledge. By combining life cycle thinking with concepts of sustainable development this framework will merge approaches that are familiar to both groups. This assessment tool will allow engineers and development workers to quantify the sustainability of their projects through a series of checklists. The results will reveal strengths and weaknesses in project approaches, and provide guidance toward a more sustainable approach to planning and implementing water and sanitation projects.

Existing methodologies in life cycle evaluations were initially considered for adaptation to water and sanitation development projects. However, tools such as Life Cycle Assessment (LCA) and Life Cycle Costing (LCC) are too limited in scope for useful application in developing countries. The success of development projects depends heavily on a variety of social, political, and economic factors that are not adequately considered in current life cycle tools. The existing methods are also data intensive, making them impractical for development work. A life cycle evaluation of development projects must incorporate diverse factors in a practical and qualitative manner. The tool must be consistent with successful development practices and simplified for use as a common tool. The selected tool is a matrix approach that uses life stages and factors in sustainability as the matrix dimensions.

This chapter defines the criteria required for sustainable development and the life stages of a typical project. These key dimensions are used to build an evaluation framework. The framework is based on a matrix approach in which the matrix

dimensions are defined by the sustainability factors and project life stages. The matrix approach allows each sustainability factor to be considered throughout the life of the project. Therefore, each matrix element defines how a certain sustainability factor can be dealt with at each point in the project life. Using this framework, a series of checklists are developed as an assessment tool to evaluate sustainability. The checklists are qualitative and derived from best practice literature and personal experience in development work. A water and/or sanitation project can be scored based on how well sustainability factors are taken into account during each life stage. The scoring system allows users to quantify project strengths and weaknesses, in order to learn from the past and improve the process of future project implementation.

2.1 Sustainability Factors

Sustainable development is defined as the design of human and industrial systems to ensure that humankind's use of natural resources and cycles do not lead to diminished quality of life due either to losses in future economic opportunities or to adverse impacts on social conditions, human health, and the environment (Mihelcic et al., 2003). The World Summit on Sustainable Development offers an abridged definition by recognizing the existence of three interdependent and mutually reinforcing pillars of sustainability: economic development, environmental protection, and social development (United Nations, 2002). Sustainable development occurs at the intersection of these three interests (Figure 2).

The first two pillars of sustainability are consistently defined throughout literature, but social sustainability has been widely interpreted. It has been implicated in issues of cultural sensitivity, conflict resolution, community-building, institution-building, and political stability (Estes, 1993). Industrial ecologists working on life cycle assessment tools can identify 18 criteria for social sustainability (Labuschagne and Brent, 2006). Many international development agencies define general categories related to social sustainability and the specific criteria needed for improved development efforts (Table 1). National level agencies tend to focus on the importance of community participation in capacity building and the need for improved donor coordination (CIDA, 2002). While others organizations combine factors in succinct criteria for sustainability. For example, Engineers Without Borders (EWB) combines donor agency coordination and good governance under the heading of political sustainability (EWB, 2005). Some agencies identify the factor of cultural sustainability, which includes community participation, as development that remains consistent with core values, expectations, and morals of the society (Estes, 1993). The United States Peace Corps breaks social sustainability down one step further by separating out the issue of managerial sustainability, or the capacity of the community to continue a project after the departure of donor agencies (Peace Corps, 2002).

Table 1: Social Sustainability in Development Literature

Organization	General Category	Criteria
United Nations (Millennium Declaration, 2000)	Fundamental Values	Freedom Equality Solidarity Tolerance Respect for Nature Shared Responsibility
Canadian International Development Agency (CIDA, 2002)	Principles of Effective Development	Local Ownership Improved Donor Coordination Stronger Partnerships Results-based Approach Greater Coherence Good Governance Building Capacity Engaging Civil Society
United States Peace Corps (2002)	Factors in Sustainable Development	Cultural Political Managerial
Engineers Without Borders (EWB, 2005)	Dimensions of Sustainable Development	Cultural Political

Social sustainability is a complicated issue that defies a single definition. For that reason it is broken into three factors for the purpose of this study: socio-cultural respect, community participation, and political cohesion. The social factors are defined by combining similar principles from published literature and personal experience. Many studies combine socio-cultural issues and community participation together under the blanket of cultural sustainability, believing that if the community is involved they will choose a technology that is culturally appropriate. This may not always be the case, as most communities will not refuse a gift when it is offered, even if they have to jump

through some hoops to get it. There is an essential difference between the two factors. Community participation aims to foster local ownership and managerial skills, while socio-cultural respect attempts to integrate the project into the existing fabric of society. The remaining social factor, political cohesion, accounts for the larger political environment in which the project takes place. It recognizes the call for coordinated development efforts by the international development community and the role that local politicians can play in project success. It is about ownership beyond the community, an international responsibility for development. Sustainability can therefore be defined by five key factors: socio-cultural respect, community participation, political cohesion, economic sustainability, and environmental sustainability (Table 2). Dividing the concept of sustainability in this manner allows for greater ease in developing practical implementation methods.

Engineers in development work are most often concerned about appropriate technology. The term appropriate can be interpreted in many ways, but it is in essence about sustainability. Therefore, appropriate technology can be defined as technology that is adapted for sustainable application in the environment and culture it is meant to support. Application of the five sustainability factors throughout the project life will result in the design and implementation of appropriate technology. Detailed descriptions of the five factors in sustainability development are given in the following sections.

Table 2: Five Factors in Sustainable Development

Social Sustainability	Socio-Cultural Respect	A socially acceptable project is built on an understanding of local traditions and core values.
	Community Participation	A process which fosters empowerment and ownership in community members through direct participation in development decision-making affecting the community.
	Political Cohesion	Involves increasing the alignment of development projects with host country priorities and coordinating aid efforts at all levels (local, national, and international) to increase ownership and efficient delivery of services.
Economic Sustainability		Implies that sufficient local resources and capacity exist to continue the project in the absence of outside resources.
Environmental Sustainability		Implies that non-renewable and other natural resources are not depleted nor destroyed for short-term improvements.

2.1.1 Socio-cultural Respect

Socio-cultural respect recognizes the important role that cultural differences can play in project development. At a base level, water and sanitation projects work to address issues of basic needs and public health, but overlying layers of cultural tradition and local custom often complicate these issues. Technology that works in one country may be inappropriate in another. This is especially true when behavior change is demanded for project implementation. An understanding of local customs, beliefs, taboos, gender roles, and seasonal calendars are critical for sustainability. Gathering cultural information during the needs assessment and building on these considerations throughout the project life increases sustainability. Project design, construction, and operational methods need to be culturally appropriate and respectful of local customs so as to cultivate a social willingness to adopt the new system.

2.1.2 Community Participation

The importance of community participation in international development is widely recognized, and there are a range of methodologies based on a participatory approach to gather data, evaluate and address development needs: Rapid Rural Appraisal (RRA), Participatory Rural Appraisal (PRA), Participatory Analysis for Community Action (PACA) (Selener et al., 1999; Peace Corps, 2000a). A participatory process that engages the civil society throughout the project life cycle leads to self-empowerment, local ownership, and increased local capacity. Public awareness and participation in the project will stimulate interest in the importance of improved water and sanitation systems, leading to educational benefits beyond the physical system itself. Participation also increases the managerial capacity of the community to improve and operate the system on their own. Working with the community to identify needs that are recognized by the local population will increase understanding and support of the project. When the need for intervention is recognized by the community they will be more motivated to participate for change. In the next stage, project designs and plans can be presented for community feedback. Incorporating community suggestions and concerns into the project design will result in a more appropriate product. Community participation can also include capacity building in the form of education, training and skills transfer. Including learning elements throughout the project life cycle will improve sustainability through enhanced understanding, leadership and ownership mentalities.

2.1.3 Political Cohesion

There is a growing awareness within the international community of the need to coordinate development efforts to increase efficiency (Paris High-Level Forum, 2005). The objective is to build a support network of joint ownership that will increase the long-term sustainability of development projects. A cohesive effort between government officials, non-governmental organizations (NGO), and local authorities minimizes the chances of projects becoming redundant or isolated islands of influence. Many countries

have national strategic plans and nationally identified areas of intervention to streamline development aid and guide donor agencies in project selection. By working with government and non-government organizations, development workers will increase interest and a sense of ownership in the process. Partnering institutions can share development techniques, obstacles, and lessons learned. Stronger, coordinated aid partnerships can also create a system of checks and balances that will encourage good governance and financing of projects at both the local and international levels. The role of each partner organization can vary greatly, from financier to consultant, contractor to educator. Each increase in the number of stakeholders will provide a wider range of solutions and support. Project managers who work within a broad web of political support throughout the life cycle will increase the effectiveness and longevity of their project.

2.1.4 Economic Sustainability

A sustainable development projects will be economically feasible for both the local population and the supporting agency. International development projects generally have a greater than average number of risk factors associated with them, and therefore require more information to offset and evaluate these risks. A successful project will fit the local economic situation, based on available resources, both monetary and non-monetary (labor, tools, and supplies). Important steps in the pre-implementation stages include cost estimates, economic feasibility assessments and willingness-to-pay studies. Resourcefulness in the design and implementation phases will include considering use of local labor and resources to lower costs and increase the project efficiency. The community must be willing and able to contribute to the project construction and maintenance. It is essential to have an economic community contribution to the implementation and operation of the project, which increases local ownership and appreciation for the project.

2.1.5 Environmental Sustainability

The populations of many developing countries are comprised of subsistence farmers whose livelihoods and quality of life are closely tied to the environment. Income derived from ecosystems offers a fundamental stepping stone in the economic empowerment of the rural poor (WRI, 2005). Protecting the environment therefore lies at the heart of achieving an improved, sustainable quality of life. In order to ensure the environmental sustainability of a project, planners must adapt the design to the local environment, including issues of ecosystem deterioration and resource constraints. The use of technology that relies on renewable and locally available resources is critical. In many cases, resource availability will affect the feasibility of a design. Minimizing pollution and depletion of resources is essential to sustaining the local environmental. Environmental education can also play an important part in increasing awareness of environmental issues and reinforcing sustainable practices.

2.2 Life Cycle Stages

Although the idea of a project life cycle is familiar in industry, the definition of separate stages varies. The emphasis each agency places on certain life stages determines the detail and number of independent steps in the cycle. However, it is possible to identify a generic set of stages that are present in most project cycles. The life cycle of water and sanitation development projects can be divided into five stages: needs assessment, conceptual designs and feasibility studies, design and action planning, implementation, and operation and maintenance (Figure 3).

Each project begins with a needs assessment, which determines the motivation for intervention and the extent of need. The result of this phase will be a commitment to project action. This is followed by the development of conceptual designs and feasibility studies. A list of possible solutions is generated and evaluated during this phase. The outcome of the second stage is the selection of an appropriate technology to implement.

The third step is design and action planning, where the details for the technical design and implementation (action) plan are finalized. Action planning may uncover logistical constraints that affect the feasibility of the selected design. There is potential, therefore, for simultaneous and iterative planning between stages two and three. The design and planning stages are followed by the physical implementation of the project. Project implementation will include both resource procurement and construction. Actual use of the improved system is defined by the operation and maintenance stage, which includes project monitoring and evaluation. Many life cycle approaches include an end-of-life stage involving the disposal or recycling of the product. However, in development work, donor agencies and foreign project managers are frequently no longer involved in the project at this stage, and will have difficulty evaluating end-of-life consequences. Due to the difficulties in evaluation, end-of-life considerations are included in the feasibility studies rather than a separate life stage.

2.2.1 Needs Assessment

The purpose of a needs assessment is to determine if sufficient demand exists for the project and to begin collecting the necessary background information for project development. Generally, this stage is initiated by a request for intervention, either from within or outside the community. The request is followed by an information gathering period to understand the motivations and expectations behind the demand, in addition to defining an adequate level of improvement. Background information on the social, cultural, and political situation along with environmental and technical constraints to the current system will help assess the extent of need and potential for improvement. Generally, information is collected through a series of site visits, participatory evaluation tools, interviews, observations, and relevant literature reviews during which the opinions of a variety of stakeholders (community leaders, council members, men, women, youth, and development workers) are solicited. At the end of the needs assessment project planners will decide, based on the information gathered, whether or not to proceed.

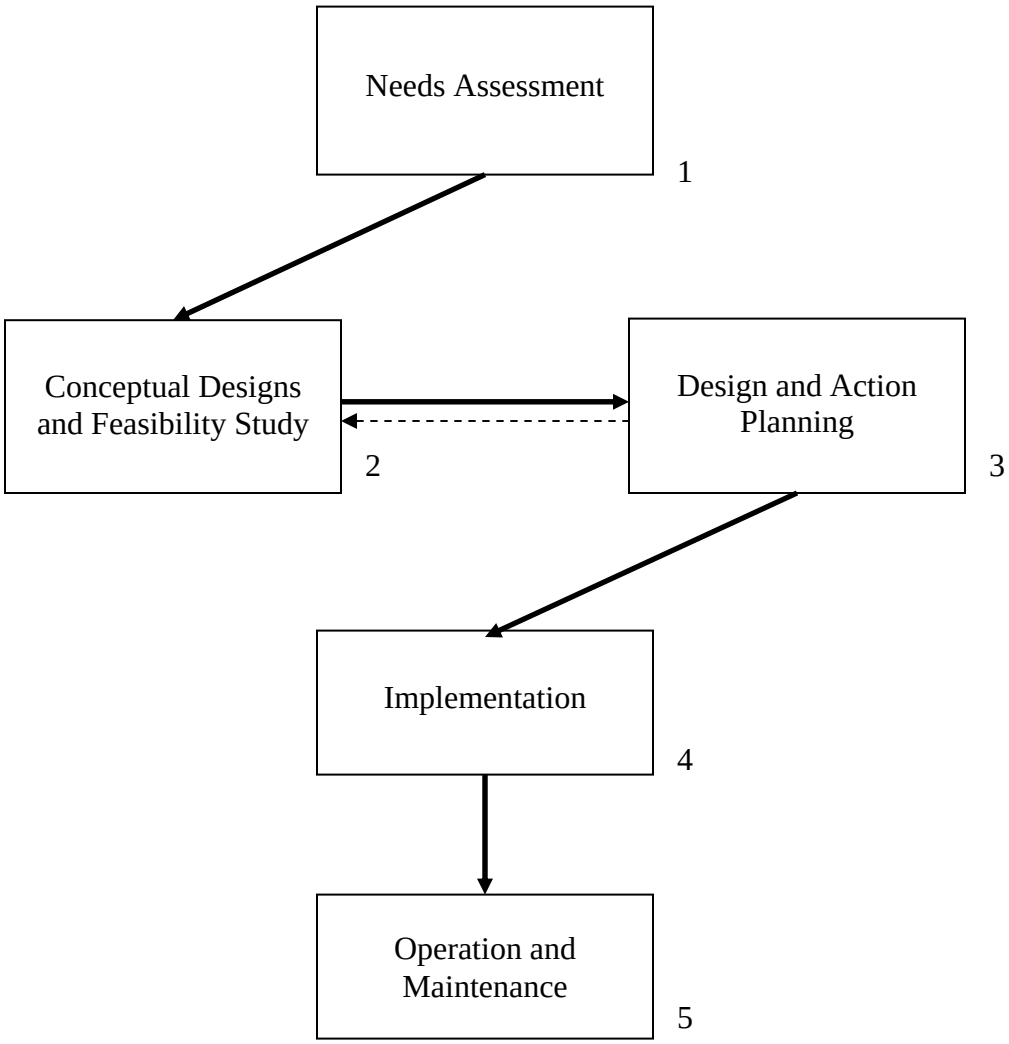

Figure 3: Five life cycle stages for development work. Solid arrows indicate the flow of the life cycle process. The dotted arrow indicates the potential for iteration between stages 2 and 3.

2.2.2 Conceptual Designs and Feasibility Study

The conceptual design phase is an iterative process in which alternative plans are developed and assessed for feasibility and acceptability. The objective is to select an appropriate technology that is technically sound, economically feasible, and acceptable to the community. This life stage may begin with a brainstorming session to identify potential solutions. Multiple conceptual designs will be considered, preferably covering

a range of improvement levels, from small changes to the existing system to introducing new technology. The feasibility of each conceptual design will be determined based on social, economic, and environmental constraints, and advantages and disadvantage of each technology. The feasibility study will consider sustainability issues from later stages in the project life cycle. The feasibility studies will have to consider parameters for operation, maintenance, and the eventual disposal of the system. In this sense, the project life cycle is non-linear and forward thinking. The feasibility of conceptual designs may be adjusted as understanding of the project constraints increases throughout the design and planning processes. However, for the purpose of life stage definition, the decision point of design selection based on feasibility studies will serve as the boundary between stages 2 and 3.

2.2.3 Design and Action Planning

In this stage the selected design is finalized and an action plan prepared for project implementation. A detailed technical design is developed, including sketches, schematics, construction and operation budgets, and resource inventories. The action planning phase occurs in conjunction with project design, since action plan constraints may affect the final design. The action plan is defined by three steps: identification of tasks, assigning roles and responsibilities, and sequencing tasks in a timeline (Peace Corps, 2000b). The action plan covers tasks to be completed during implementation, including financing arrangements, the procurement of land and resources, recruitment of laborers, site preparation, and actual construction. Identified tasks can be assigned to appropriate project participants. The action plan also provides a timeline for task completion. Clearly defining roles and responsibilities of individuals and institutions involved prior to implementation increases project effectiveness.

2.2.4 Implementation

Project implementation includes both the pre-construction and construction processes. Pre-construction involves the procurement of supplies and financing, site preparation, and potentially the manufacture of construction supplies (e.g. breaking large rocks into gravel or sawing trees into lumber). The construction process itself must remain flexible to adjust for unanticipated circumstances regardless of action plan guidelines. Maintaining communication lines is critical for progress monitoring and evaluation. Implementation also includes technical training and community education components.

2.2.5 Operation and Maintenance

The operation and maintenance life stage considers the use of the project. It includes operational, management and financial issues. An organization with the capacity for adaptive management and ability to make adjustments for unexpected problems will oversee operation and maintenance programs. This stage may include continued technical training and education to support use of the system. The measurement of project objectives, financial and environmental burdens of upkeep, community perception of usefulness, and other evaluations are an important part of this stage.

2.3 Matrix Framework

A matrix framework is an effective assessment tool because it allows each element of the matrix to be evaluated separately. An assessment of individual elements can highlight strengths and weaknesses in project approaches, allowing decision makers to identify key areas for improvement. The matrix dimensions are defined by the sustainability factors (socio-cultural respect, community participation, political cohesion, economic sustainability, environmental sustainability) in one direction, and the project life stages (needs assessment, conceptual designs and feasibility, design and action planning, implementation, operation and maintenance) in the other (Table 3).

The matrix elements represent distinct opportunities to address sustainability factors during each life stage. A series of checklists within each matrix element are used to quantify sustainability. The checklists are derived from a variety of best-practice guidelines (Peace Corps, 2000b/2002; EWB, 2005; CIDA, 2002; Pickford, 1995; Cairncross, 1992) and personal experience. In each element there are four recommended actions for increased project sustainability. Performing the recommended actions during project implementation increases the numeric score for the project. Increasing project scores reflect greater probabilities of project success.

This assessment approach offers a rapid evaluation of project strengths and weaknesses. The matrix framework can also provide guidelines for initiating new projects. An understanding of the life cycle approach and sustainability recommendations will aid in planning for future projects. Descriptions of the matrix elements and scoring guidelines are provided in the following sections.

2.4 Scoring Guidelines

This section provides details and scoring criteria for each element of the matrix (Table 3). A brief description of the context of each element is provided, followed by four recommendations for improving sustainability. Further details and sample rhetorical questions for each sustainability recommendation are provided in Appendix A. To determine the score of a project the evaluator assigns a rating (0-4) to each matrix element, depending on the number of sustainability recommendations (check boxes) completed. If none of the recommendations are met the matrix element is 0 (poor evaluation). If all of the recommendations are met the matrix element is 4 (excellent evaluation). The potential score for each sustainability factor or life stage is 20, while the total possible score is 100.

Table 3: Sustainability Assessment Matrix. The matrix dimensions show five life stages and five factors of sustainability.

	Sustainability Factor					
Life Stage	Socio-cultural Respect	Community Participation	Political Cohesion	Economic Sustainability	Environmental Sustainability	Total
Needs Assessment	1,1	1,2	1,3	1,4	1,5	20
Conceptual Designs and Feasibility	2,1	2,2	2,3	2,4	2,5	20
Design and Action Planning	3,1	3,2	3,3	3,4	3,5	20
Implementation	4,1	4,2	4,3	4,4	4,5	20
Operation and Maintenance	5,1	5,2	5,3	5,4	5,5	20
Total	20	20	20	20	20	100

Element: 1,1 (Needs Assessment, Socio-cultural Respect)

A needs assessment is essentially information gathering, in an attempt to comprehend the cultural fabric of society. It is especially important for foreign aid workers to look objectively at differences in cultural perceptions of social roles, hygiene, and proper water usage. Information can be gathered from a variety of sources, including literature, site visits, and community surveys. General information on socio-cultural issues (unemployment, payment of taxes, illiteracy, and health care) can be gathered from publications such as the Human Development Reports (e.g. UNDP, 2005). More specific information is best gathered on-site. A yearly calendar of work and social life can provide a good cultural introduction. It can also be used to infer the seasonal changes in labor supply and water use. Water and sanitation practices are often closely intertwined with religious, traditional or superstitious beliefs. It is important to understand the local beliefs and taboos centered on water and waste. The needs assessment will evaluate the level of health education and understanding of the role of water and sanitation in disease transmission. Gender roles and preferences can be particularly distinct on water and sanitation issues and are important to recognize in project planning and implementation. The following specific tasks are recommended to satisfy this element:

□ Generate a yearly calendar of work and social life in the community.

□ Identify social preferences and traditional beliefs associated with water supply and sanitation practices.

□ Determine the level of health education in the community.

□ Recognize differences in gender roles in water and sanitation.

Element: 1,2 (Needs Assessment, Community Participation)

Community ownership is achieved by involving the community in every stage of the project. This can be initiated through a participatory needs assessment (see Appendix A). Participatory assessments are important methods for obtaining locally specific and community gathered data. This assessment clarifies the priorities of both the community and the development workers. The accuracy of the needs assessment can be improved by identifying and including a variety of stakeholders in the discussions (men, women, youth, elders, specific ethnic groups, community leaders, and water organizations). Another essential step is to determine the political and organizational capacity of the community. Subsequent community participation steps will depend on the ability and willingness of the community and development workers to work together. By recognizing the type of political organization in the community (egalitarian, hierarchist, individualist, fatalist), project planners can adapt the management model to the existing structure (Biggs and Smith, 2003). Addressing issues of community priorities, demographics, leadership and consensus provides development workers with critical background information, and helps the community better understand its own capacities. The outcome of this stage is the conceptualization of priorities and constraints on a participatory project approach. The following specific tasks are recommended to satisfy this element:

□ Conduct a participatory needs assessment at the local level to determine local development priorities.

□ Identify stakeholders and community leaders.

□ Determine the type of political organization and cohesion at the community level.

□ Reach a consensus with community members that project intervention is appropriate.

Element: 1,3 (Needs Assessment, Political Cohesion)

In the modern world, communities are no longer isolated entities that ignore the world beyond their backyard. Project planners need to coordinate their work with national, regional and local development schemes. The needs assessment will collect information on the local political situation, national policies and existing institutions (government, non-government, private enterprises) in the field. The first step is to situate the project in the national or global context, by acknowledging widespread political issues and problems. Project managers need to consider how their project can be integrated into nationally identified development plans and policies, such as National Poverty Reduction Strategy Papers (PSRPs), National Strategic Plans, Sector-Wide Approaches (SWaps), and local development schedules. It is beneficial to examine the history of development institutions in the area. Perhaps certain projects have been tried before or certain groups have expertise that could be useful in project planning and implementation. Information gathering is facilitated by making contacts and communicating with the agents directly. The following specific tasks are recommended to satisfy this element:

□ Conduct a situational analysis of regional and national issues, such as political structure and stability, government policies, and foreign aid.

□ Ensure that proposed project is consistent with regionally identified development priorities and plans.

□ Research the history of NGO and government projects in the area.

□ Establish communication lines with existing NGO and/or government institutions in the area.

Element: 1,4 (Needs Assessment, Economic Sustainability)

The objective of this element is to understand the economic situation of the community, its resource base, and willingness-to-pay for project improvements. Some information is available in published literature from organizations such as the United Nations, the World Bank, or international aid organizations (e.g. UNDP Human Development Reports and USAID country reports). Supplement literature reviews with information gained during a site visit. It is important to gain a basic understanding of how money and resources flow within the community, in particular, how water and sanitation costs fit into local spending and budgets. Identifying the local resource base is best done during a site visit and with community input. Working with the community to identify resources gives a clearer picture of resource availability and increases the community's appreciation of their own assets. It is important to separate monetary and non-monetary resources since these are generally valued very differently by both communities and donors. Finally, assessing the community willingness-to-pay for various projects will help in determining project feasibility and the potential for community contributions. The following specific tasks are recommended to satisfy this element:

□ Understand the local and national economic situation (poverty level, employment, cost of living, flow of resources).

□ Understand how the community economic situation is affected by water and sanitation issues.

□ Identify sources of monetary and non-monetary resources (materials, labor, and tools) within the community.

□ Assess the community willingness-to-pay in both monetary and non-monetary terms for current water and sanitation services.

Element: 1,5 (Needs Assessment, Environmental Sustainability)

This assessment includes gathering basic information on water and sanitation resources, the local environment and the community interaction with it. The emphasis is on water and sanitation issues, but other issues such as desertification, deforestation, erosion, and overgrazing cannot be ignored. A survey can be conducted to inventory current water and sanitation resources; including sources of water, water use, water needs and supply, and sanitation practices. A second survey can identify environmental concerns at a broader level. Much of this information will be gathered during site visits, and supplemented with the observations of residents and literature searches on regional trends. The needs assessment is the time to gather information on climate and environmental constraints (soil conditions, groundwater levels, topography, population trends, water demand assessment, rainfall, temperatures, evaporation, and runoff) that will factor into the project design and sustainability studies. Finally, it is important to understand the community perception of existing environmental problems and the willingness to change their behavior for environmental benefits. The following specific tasks are recommended to satisfy this element:

□ Identify local resources for water and sanitation.

□ Collect data on climate and environmental constraints that will factor into project design.

□ Identify potential environmental concerns at the local and regional level.

□ Determine community understanding of environmental problems and the willingness to correct them.

Element: 2,1 (Conceptual Designs/Feasibility, Socio-cultural Respect)

This project element is about assessing the cultural feasibility and appropriateness of the project design. An assessment of each design should be performed that considers the socio-cultural constraints identified in the needs assessment (seasonality of labor, ethnic divisions, gender roles, and traditional perceptions on water, sanitation, and health). The designs will build on existing technical systems and cultural values. It is helpful to estimate how a new system will affect the roles and responsibilities of individuals within the society, by considering the level of behavior change that the improved system will demand. The willingness and capacity of the community to operate, maintain, or dispose of the proposed systems needs to be evaluated. For example, certain sanitation technologies require handling of feces which may be unacceptable in some cultures. Other systems may require technical expertise that is currently beyond the learning capacity of the community. Care should be taken that a new system will not undermine or interfere with traditional gender roles, so that it will be acceptable to both men and women. It is also important to recognize that bias towards certain technologies may exist on behalf of donors and local residents. Understanding the reasoning behind these biases (desire for prestige, system familiarity, cultural preferences in quality, or political pressure) can have important ramifications for design selection and user support. The following specific tasks are recommended to satisfy this element:

□ Assess how the proposed interventions will affect daily activities and socio-cultural roles within the community.

□ Evaluate the willingness and capacity of the community to perform operation, maintenance, and disposal requirements for each design.

□ Design recognizes and respects traditional gender roles.

□ Recognize why biases exist towards certain technologies by donors and/or locals.

Element: 2,2 (Conceptual Designs/Feasibility, Community Participation)

The community needs to be involved in the development of conceptual designs and feasibility studies. This requires strong communication skills on behalf of both the community and the development workers. It helps to designate a clear community liaison to facilitate communication exchanges. At the start of the preliminary design process the scope is defined through mutually agreement on project objectives and expected outcomes. In most water and sanitation projects the technical designs are developed by outside consultants. However, feasibility studies require feedback and evaluation from community members. Community input can be solicited on conceptual designs through a local user's committee or representative community organization. The feedback sessions will be most beneficial when community members are given time to reflect on design proposals and allowed to express their concerns and opinions. Their suggestions and concerns can then be incorporated into the feasibility analysis, design revisions, and the selection of an appropriate design. The following specific tasks are recommended to satisfy this element:

□ The project goals are clearly defined and understood by the community and development workers.

□ Identify a representative committee that can act as the community liaison throughout the project.

□ Present several technically feasible alternatives for community evaluation and feedback.

□ Community members formally select a design based on an understanding of the constraints involved in the selection process.

Element: 2,3 (Conceptual Designs/ Feasibility, Political Cohesion)

It is important to foster good relationships within the development community early in the planning process. Opening communication lines gives organizations access to a broader array of information for decision making. Partner institutions can be government agencies, non-governmental organizations (NGOs), or private enterprises. It is preferable that at least one partner organization is based in the host country. Working with partner organizations during the planning process ensures that the efforts of all organizations are complementary, not redundant or conflicting. It is possible that similar projects have been attempted or implemented in the local area. The conceptual design process can be improved by consulting the work of other projects and institutions. Promotional efforts for the new project can be improved by collaborating with existing technology or programs in the area. For example, if the design needs a pump, investigate the possibility of using local pumps, or those being promoted by local NGOs. Health initiatives may also offer educational services and trainings that complement the project. This is also the stage to begin contacting potential partners and exploring the availability of funding for the project. The following specific tasks are recommended to satisfy this element:

□ Develop a working relationship with partner organization(s), including at least one that is based in the host country.

□ Consult the plans and designs of other organizations on similar projects.

□ Explore options to integrate existing technologies or programs into conceptual designs.

□ Contact potential partner institutions for project financing.

Element: 2,4 (Conceptual Designs/Feasibility, Economic Sustainability)

The economic feasibility of each conceptual design is based on a series of cost estimates and willingness to pay studies. The cost estimates for implementing each alternative should be comprehensive and include labor, materials, equipment, transportation, political fees, and training. It is helpful to have the community involved in pricing and cost calculations as they know the prices and availability of local resources. Cost reduction and long-term sustainability of the project can be achieved by minimizing outside resources, especially if they will have to be replaced. It is equally important to consider the projected operation and maintenance costs for potential designs. The end-of-life costs for disposal, recycling, and reuse also factor into feasibility studies. Feasibility compares costs of the conceptual designs against the willingness of the community to contribute to construction, operation, and maintenance. Many designs are based on the theory of local ownership through control of operation and maintenance. The community should understand this commitment and be willing to pay it. In determining willingness to pay, it may help to explain labor and materials contributions in equivalent monetary terms. Finally, the economic feasibility of the alternative designs can be assessed by examining the gap between estimated costs and the willingness to pay for them during construction, operation, and maintenance (refer to Appendix A for more details). The following specific tasks are recommended to satisfy this element:

□ Estimate the implementation costs of each conceptual design.

□ Estimate operation, maintenance, and disposal costs for each conceptual design.

□ Assess the community willingness-to-pay in both monetary and non-monetary terms for each improved system.

□ Conduct an economic feasibility assessment to evaluate long-term project viability based on cost estimates, projected operation and maintenance costs, community willingness to pay, the need for outside resources, and the availability of outside funding.

Element: 2,5 (Conceptual Designs/Feasibility, Environmental Sustainability)

This project element assesses the environmental sustainability of the design alternatives. An appropriate design is one that does not jeopardize the future of water use in the area through over-consumption or pollution of existing water sources. A feasible project is one that is designed to handle seasonal variations in water supply, demand, and environmental stressors (groundwater table, soil conditions, flooding). Conceptual designs consider the land requirements, the location of available land, and socio-environmental repercussions for the displacement of existing land uses. In many instances the location of the project will affect the user acceptance and demand for the system. A site impact analysis of each design and site location will identify issues of ecological disturbance, contamination, waste disposal, and energy use (fuel, batteries). The feasibility studies must weigh the environmental concerns to select the alternative that minimizes potential impacts. The following specific tasks are recommended to satisfy this element:

□ Assess the capacity for sustainable water use in the geographic area.

□ Consider how seasonal variation in water supply, demand, and environmental conditions will affect each conceptual design.

□ Consider land needs and availability of suitable land for each alternative.

□ Conduct a site impact analysis for each alternative.

Element: 3,1 (Design/Action Planning, Socio-cultural Respect)

Developing an action plan can be a challenge, especially when the development workers are from outside the community. There are often large differences in expectations and organizational philosophies. Understanding the action plan within the traditional framework of the local society may reduce frustrations. Local planners can assist in identifying traditional roles in community projects and who fills them. Roles will include both leadership and support roles, such as a foreman, chief, and treasurer, and skilled and unskilled laborers. There are culturally determined roles that must be respected and understood when assigning responsibilities, especially those of management and leadership. The action plan timeline must also consider the seasonality of labor and how it will be affected by agriculture, religious holidays, and climate. There is often a discrepancy between the level of women's involvement in project organization and in day-to-day water and sanitation issues. Exploring possibilities to increase the involvement of women throughout the project process, without overstepping traditional gender boundaries, will increase acceptance and understanding to the system. Other equity issues are also considered when dividing project contributions among the beneficiaries. The following specific tasks are recommended to satisfy this element:

□ Understand the traditional structure of community projects.

□ Consider the seasonality of labor in setting the timeline.

□ Explore options for increasing gender equity in project roles and capacity building.

□ Confirm that labor and resource contributions are equitably divided.

Element: 3,2 (Design/Action Planning, Community Participation)

This element will finalize community acceptance of the project design and develop an action plan for its implementation. The selected project design will be reviewed with community members for feedback and refinement. The design will be approved through a process of community consensus. This illustrates community buy-in to the project and acts as an advertising tool to increase general knowledge of what is planned. An action plan is discussed with the community to clarify the roles and responsibilities of all parties involved. The action plan includes a list of tasks that will be performed and the timeframe in which they need to be completed (before, during, or after construction). The action plan should be as detailed as possible, so that all tasks are taken into account. It is important that the community participates in assigning the roles and responsibilities to the appropriate individuals. Development workers may help by clarifying certain technical responsibilities and roles to fill, but the ultimate decisions will rest with the community. A project timeline will be discussed and agreed upon between project participants. It is important that participants approve of the action plan and are aware of their responsibilities. The following specific tasks are recommended to satisfy this element:

□ Community input is solicited in refining the selected technical design.

□ Final technical design is approved through a process of community consensus.

□ Community members are involved in identifying and sequencing tasks that will be incorporated into an action plan.

□ The community members and development workers approve of the timeline and responsibilities laid out in the action plan.

Element: 3,3 (Design/Action Planning, Political Cohesion)

Developing an action plan at the institutional level requires the same steps as at the community level. Partner institutions will be involved in identifying the tasks and delineating the separate roles and responsibilities of each group involved in the project (supervising, funding, information exchange, progress reporting, oversight and monitoring). It is important to remember that the role of some partners may merely be to be informed (government officials, religious leaders). The action plan includes financial arrangements, a realistic timeline for funding paid, work completion, and reporting requirements that considers the limitations and deadlines of each organization. Ultimately, a written action plan that defines tasks and responsibilities needs to be approved by the coordinating officials. In some areas it will be necessary to get the technical design approved by the authorities. The following specific tasks are recommended to satisfy this element:

□ The roles and responsibilities of partner institutions are defined in a detailed action plan.

□ Agree on financial commitments.

□ A timeline is drafted that meets the requirements of all institutions involved.

□ Final project design and action plan are presented to partner institutions and local, regional, and/or national level authorities.

Element: 3,4 (Design/Action Planning, Economic Sustainability)

This element includes confirmation of the budget and planning for resource procurement. The design and action plan are interconnected and several iterations may be necessary to increase cost effectiveness. Planning for the cost and choice of materials, procurement methods, and construction techniques may result in adjustments to the project design. The costs and availability of resources must be verified before the budget can be finalized. Cost effectiveness can be increased by using local prices, resources and labor whenever possible. A community liaison can suggest market prices and the possibility of manufacturing supplies or equipment on site. Many communities have local craftsmen that are ingenious at improvising tools or replicating work. The community contribution is finalized during the planning process. Commitments must be made for monetary and non-monetary contributions prior to the start of construction. Non-monetary contributions can consist of labor, tools, building supplies, and transportation. When the supply list and the community contribution have been discussed, the budget can be finalized to reflect the local situation. An action plan for resource procurement can be developed with a detailed schedule for material purchase, transporting, and manufacturing. Allow sufficient time for unexpected delays so that the construction process is not held up by deficiencies in resources. The following specific tasks are recommended to satisfy this element:

□ Verify the costs and availability of resources.

□ Confirm the community contribution for money, materials, equipment, tools, and labor.

□ Finalize budget based on local costs, available resources, and community contribution.

□ Develop an action plan for resource procurement.

Element: 3,5 (Design/Action Planning, Environmental Sustainability)

The final design and action plan propose methods for minimizing ecological impacts and encouraging the use of renewable resources during the construction and use stages. If the final design is changed from the conceptual design, a site impact assessment should be repeated. Efforts to control and minimize waste, energy use, and ecological disturbance are part of the final design. The project is designed to operate on renewable and/or recyclable local resources. The abundance of these resources is considered, so that increased use does create other problems of resource scarcity (wood, water, fuels). The action plan includes environmentally responsible methods for resource procurement, construction, and future use. The action plan may be dictated in part by the seasonality of resource availability and site access. Certain resources may not be accessible at various times of the year due to flooding, snow, or drought. Construction related planning identifies potential environmental impacts and mitigation techniques (erosion control, temporary water sources, and waste disposal methods). The following specific tasks are recommended to satisfy this element:

□ The final project design minimizes ecological disturbance, energy use and waste emissions.

□ The project design uses renewable and/or recyclable local resources.

□ The action plan considers the seasonality of resources.

□ Develop an environmental action plan to mitigate impacts during construction.

Element: 4,1 (Implementation, Socio-cultural Respect)

Throughout the construction process it is important to respect the normal routine and customs of the local community. Traditional work hours and ethics are assessed and a realistic work schedule set accordingly. Conflicting demands for labor or equipment will affect the construction timetable. The work schedule should also accommodate for unexpected delays and work stoppages, such as funerals, religious observances, or markets. Attempts must be made to involve beneficiaries in some part of the construction process to foster an early sense of ownership. The role of women is often neglected during this life stage. Methods for encouraging the involvement of women need to be explored. Public gatherings can be used during construction to review the benefits of the project and eventual operation and maintenance needs. Other topics in water and sanitation (proper water use, waste disposal, and hygiene) can also be covered throughout the construction process, possibly including the training of community members to continue this education. The following specific tasks are recommended to satisfy this element:

□ Set a realistic work schedule, based on available resources and preferred work styles.

□ Scheduling includes float time to allow for the unexpected.

□ Encourage the involvement of women throughout the construction process.

□ Use public gatherings to review benefits of the project, promote education, and discuss operation and maintenance.

Element: 4,2 (Implementation, Community Participation)

Much of the community participation in construction is focused on increasing the local knowledge base and management capacity through technical and organizational training. Capacity building can be achieved through education and skills transfer throughout the construction process. Management capacity will be increased by allowing the community to implement the action plan they developed. Community leaders will meet regularly with the development workers throughout the construction process to review the action plan, make program changes, and address any unforeseen issues. Both sides should ask for evaluations of progress and feedback on any adjustments that might be needed. Project managers need to work closely with the local foreman or supervisor to manage work crews and control daily construction activities. Training local laborers in new techniques or tools introduced during construction will increase the local capacity to perform operation and maintenance. Once the system is built, community members can finalize plans to manage the system. The following specific tasks are recommended to satisfy this element:

□ Involve the community in revisions of the action plan, program changes, and problem solving.

□ Work with a local foreman or work supervisor in organizing labor.

□ Train local laborers in any new techniques and tools that are introduced.

□ Finalize the management plan with respect to the “built” system.

Element: 4,3 (Implementation, Political Cohesion)

The objective of political cohesion during implementation is to maintain the communication networks that were set up during the planning phases. It is important to continue knowledge transfer and information sharing between agencies. Other local organizations can provide assistance by sharing construction experience, promotional techniques, education or technical skills. They may be able to provide local trainers, skilled laborers, or advice on unforeseen problems. The appropriate authorities are informed of the commencement of construction and any major changes in the design. As a way of showing respect and encouraging involvement, local government and NGO officials are invited to view the construction site. Throughout the construction process, it is important to continue planning discussions with the partner organizations who will be concerned with operation and maintenance. The following specific tasks are recommended to satisfy this element:

□ Contact institutions in the area for assistance in training and labor requirements.

□ Inform partner institutions of the start of construction, project milestones and major changes.

□ Invite local government and NGO officials to view the construction site.

□ Discuss partner roles in operation and maintenance.

Element: 4,4 (Implementation, Economic Sustainability)

Economic efficiency during construction translates into monitoring expenditures and keeping track of resources. The community assists in the project implementation through labor or resource contributions. Resource contributions are provided prior to the start of construction to keep the project on schedule. The quality of materials and equipment is rechecked during procurement, to insure the durability of tools and physical structures. A reliable person or committee is in charge of gathering, storing, and monitoring the use of money and resources throughout the implementation phase. The budget and financial action plan guide the use of resources, especially concerning the use of community contributed labor, supplies, tools, lodging, and food. However, the design and schedule may need to be adapted for unforeseen events. In some instances it may be necessary to explore options for improvising tools and equipment with local resources in order to stay within budget. At the end of construction a final report on the budget, including community costs, is shared with community members so that they can appreciate the value of their inputs. The following specific tasks are recommended to satisfy this element:

□ Community members contribute to project implementation.

□ Recheck the quality of materials and equipment during resource procurement.

□ Monitor spending and budget restrictions throughout the project implementation phase.

□ Draft final report on the budget and share with community members and partner organizations.

Element: 4,5 (Implementation, Environmental Sustainability)

Environmental sustainability issues during construction center on ensuring that construction does not increase stress on the environment. Construction must minimize ecosystem disturbance by avoiding the destruction or contamination of natural areas (deforestation, excess runoff and erosion during construction, waste production). It is important to recheck physical and environmental constraints on the design because conditions may have changed since the design was finalized. Special precautions are taken to avoid contaminating existing water resources. A waste management plan can reduce environmental damage by organizing the disposal of any wastes that are produced. Involving the community in the development and implementation of a waste management program for construction encourages awareness of environmental issues. Project implementation also includes restoration of any areas that are disturbed during construction. The following specific tasks are recommended to satisfy this element:

□ Recheck physical and environmental constraints used in the project design and make design corrections if necessary.

□ Take precautions to avoid contaminating existing water resources and minimize environmental impacts during implementation.

□ Involve the community in waste management and environmental education.

□ Restore any areas disturbed during construction.

Element: 5,1 (Operation/Maintenance, Socio-cultural Respect)

It is difficult to judge the community acceptance of a project until it is put into use. There will inevitably be unforeseen cultural constraints (power struggles, unwillingness to pay, inconvenient operating schedule, or technology preferences). Community leaders and development workers must work together to identify and address as many of these as possible. There may be separate cultural issues behind use of the system and maintenance schedules. Alternatively, certain aspects of the project may be more successful than others. Socio-cultural constraints can be revisited and discussed now that the system is more fully understood by all parties. There may be differences in how men and women use the system or perceive its benefits. A reassessed of gender roles can ensure proper use and understanding of the system. Community acceptance of the system is strengthened when project benefits and costs are shared equitably among the users. All user groups (men, women, ethnic minorities) should be satisfied with their share and their role in operation and maintenance. The following specific tasks are recommended to satisfy this element:

□ Discuss unanticipated constraints to system use.

□ Discuss unexpected limitations to maintenance schemes.

□ Reassess how gender roles affect the proper use and perceived benefits of the system.

□ Ensure that costs and benefits are equitably distributed within the community.

Element: 5,2 (Operation/Maintenance, Community Participation)

The community must be involved in performing and overseeing the operation and maintenance of the project and support structures. Community members must be trained on how to properly operate and maintain the project. The training should foster the technical capacity for maintaining training levels, retraining, upgrading skills, and training replacements. It is important to solicit community feedback on project goals and results through a participatory project evaluation. The results will identify problems and provide suggestions for improvement in project implementation, operation, and maintenance. A community management committee is needed to implement suggestions and solutions identified in the evaluations. The community selects representatives to serve in management and oversight capacities. In some cases it is possible to build on existing roles and strengths within the community by empowering the local users' organization, such as a water board or women's committee. The committee plans for turnover, collection of fees, managing workers, and maintenance schedules. Community management encourages ownership of the system and allows operation and maintenance schedules to be adapted as needed. Control of the system will empower certain individuals in the community. These people should be selected based on their traditional position in society, as well as their skills, dedication, and dependability. The following specific tasks are recommended to satisfy this element:

□ Community members are actively involved in performing the necessary operation and maintenance.

□ Conduct a participatory evaluation to get community feedback and suggestions for improvements.

□ A community organization exists with the capacity to make decisions regarding the operations and maintenance of the system.

□ The system is controlled by culturally appropriate and traditionally respected people.

Element: 5,3 (Operation/Maintenance, Political Cohesion)

An important step at the beginning of the operation stage is the opening ceremony. This symbolic event is a chance to pass over the "keys" to the local community and authorities. Local government officials and partner institutions, especially those involved in project planning, financing and implementation, need to be invited to attend this event. Ultimately, successful systems are integrated into a regional support network throughout their life. Developing a unified approach to operation, maintenance, monitoring, and evaluation will improve the overall governance of the system. Organizations that play active or supporting roles during the operational stage are active in this stage. There may be potential for coordinating technical training sessions, skill upgrading, education, and cross training between institutions. If institutional aid is required, the donors should commit to the funding for the operational life of the project or plan for financial turnover to appropriate authorities. Execute a formal agreement that specifies the roles and expectations of the coordinating organizations. Using a locally based organization for monitoring and evaluation can improve accuracy and frequency of reporting. The monitoring reports and project evaluations can be shared with all partner institutions so future projects can build on the existing body of knowledge. The following specific tasks are recommended to satisfy this element:

□ Invite officials to the opening ceremony.

□ Coordinating institutions sign a formal agreement that defines their roles and expectations in operation and maintenance of the system.

□ A locally based institution is involved in project monitoring.

□ Share monitoring reports and project evaluations with partner institutions.

Element: 5,4 (Operation/Maintenance, Economic Sustainability)

The finished system often includes modifications to the original design, so it is important to revisit the original cost estimations for operation and maintenance and adjust them appropriately. Based on the revised information a realistic financing scheme is developed to cover the costs of operation and maintenance. The financing scheme covers monetary, resource, and labor costs for operation and repairs. Financing options include user fees, community taxes, income generation, and institutional aid. If the project is not financially self-sufficient, it must be supplemented by user fees and/or institutional aid. Community user fees must be affordable given the local economy and community willingness to pay. A financial management organization can oversee system operation by arranging for the payment of fees and encouraging economic incentives for system upkeep. This organization has the ability to regulate access to project benefits in accordance with contributions to operation and maintenance costs. Finally, financing needs to be reviewed regularly and updated to account for unforeseen costs and changes in the economic environment. The following specific tasks are recommended to satisfy this element:

□ Estimate realistic, long-term operation and maintenance costs based on the "built" system.

□ Financing exists to cover projected operation and maintenance costs.

□ A financial management organization exists to manage operational/maintenance costs and the distribution of benefits.

□ Regularly review and adjust the financing system.

Element: 5,5 (Operation/Maintenance, Environmental Sustainability)

The project needs to be environmentally sustainable throughout its operational life. It is important to minimize and treat waste products to avoid pollution and negative impacts on the local ecosystem. Adaptive environmental management techniques can evaluate the impacts of the system and explore options for improvement. Operation and maintenance schedules must include monitoring plans for waste discharges, natural resources protection, and material use. Pay special attention to secondary environmental impacts that were not anticipated in project planning. Explore alternative plans for reducing the use of consumables, including replaced parts and energy or fuel consumption (batteries, fuel products, plastics, chemicals), and implement them where appropriate. The results of environmental impacts and management evaluations can be included in on-going community education. Continuing conservation and hygiene education during operation and maintenance reinforces behavioral change and encourage environmental stewardship. The following specific tasks are recommended to satisfy this element:

□ Minimize, treat, and dispose of waste properly.

□ Explore alternative plans for reducing the use of consumables.

□ Monitor and evaluate environmental impacts.

□ Continue environmental and hygiene education efforts.

3.0 Case Studies

During my time in Mali, I was involved in several different water and sanitation projects. I have selected two of these projects as case studies to illustrate the use of life-cycle thinking in project evaluation. The first project was a top-well repair and wash area construction project in the village of Kodougouni, the site of a fellow Peace Corps volunteer. I assisted in the design, planning and implementation of this project. The second project was a rainwater harvesting pond instigated in my village of Zambougou-Fouta with the help of an American engineering organization. I acted as a consultant and translator between the engineers and my villagers. Both of these projects were implemented in rural villages with the help of Peace Corps volunteers living in the communities. The main difference is the involvement of an outside organization in the rainwater harvesting project.

3.1 Kodougouni Top-Well Repair and Wash Area

The people of Kodougouni are subsistence farmers in the semi-arid, central region of Mali. They depend on a single rainy season for their food supply. In this dry environment, the people of Kodougouni rely on annual crops of millet, corn, peanuts, and cotton for their livelihood. The village of Kodougouni has a population of about 200 people and is served by two wells. The area rests upon a layer of rock that makes digging wells by hand nearly impossible. There is one well with concrete casing that was blasted over twenty years ago, and the original traditional well that was dug generations ago. The villages tried six times to dig wells in various areas, and were not able to reach water. The maintenance and protection of the existing wells to ensure a continuous water supply is among the villagers' top priorities.

Agricultural Peace Corps volunteer, Amy DiPasquale was placed in Kodougouni to assist the village in renovating a community garden that was started years ago by a foreign non-governmental organization (NGO). The garden wells dug by the NGO were not deep enough to provide water for gardening and were impossible to deepen without

dynamite (which is not allowed for a Peace Corps project). She contacted other NGO and government organizations about drilling or blasting new wells, but found the costs to be prohibitive for such a small community. Therefore, Amy began looking for other potential projects in her village. An examination of the traditional well, which consists of an unlined well shaft framed at the top by a layer of logs, revealed significant health hazards (Figure 4). The open mouth and prominent erosion under the support logs, made it potentially dangerous for women and children to collect water. Dishes and clothes are washed on the ground surrounding the well, creating an area of stagnant water that attracts mosquitoes and bees. Since the well lacked a concrete casing, apron, or soak pit around the well, stagnant wash water, combined with animal feces, infiltrated into the well, greatly reducing water quality. Meetings with community leaders confirmed their knowledge and concern over the condition of their well.

Figure 4: Amy examining the traditional well

The proposed solution was to stabilize the top of the well by lining it with concrete bricks and to reduce standing water around the well by installing a wash area and soak pit. The project would also increase the local capacity to promote village sanitation and protect the water supply by training a team of masons in top well repair and wash area/soak pit construction. The well shaft would be stabilized to prevent further erosion and covered to improve the water quality. The wash area and soak pit built nearby would create a sanitary area to clean household clothes and dishes. The soak pit and top well repair

together would reduce standing water at the well and create a safer water supply. The village quickly agreed to this plan with minimal discussion.

The project was funded through Peace Corps and village contributions. The community contributed tools, transportation of supplies, aggregate for the concrete work, and labor. The Peace Corps funding paid for cement, rebar, tools not available in the village, and the services of a professional trainer. The entire project was coordinated by the Peace Corps volunteers and village leaders, with technical support from the Peace Corps training staff.

Figure 5: Dutch bricks casing on the Kodougouni well

The top well repair was accomplished by removing the logs covering the well shaft and excavating the area around the shaft to a depth below the worst erosion (2m). An anchor of reinforced concrete was laid before casing the walls of the well using Dutch bricks (Figure 5). After backfilling behind the bricks a reinforced slab with a trap door was used to cover the well (Figure 6). The wash area and soak pit were constructed at the same time as the well repair. The wash area was a 4m x 2m sloped concrete slab draining into a large pit ($8m^3$) filled with rocks.

Figure 6: Girls pulling water from the completed well in Kodougouni. The reinforced slab with an access hatch and concrete apron are shown.

There were many problems and delays during project implementation, mostly resulting from poorly made equipment and the technical inexperience of the volunteers. Many of the construction supplies were of poor quality and had to be either replaced or remade. The Dutch brick model was incorrectly manufactured so bricks did not fit properly. There were also several questions about the extent (depth and diameter) of the top well repair that were raised late in the process. The cotton truck showed up twice during the construction week and all of the laborers had to load the truck, which greatly slowed the construction time. There was also an inter-village soccer match that interrupted work.

The project was completed over budget due to increased construction time and additional expenditures on equipment replacement. However, the community was pleased with the finished well and wash area. The men were so motivated after the well repair that they built a watering trough for the cows with the leftover construction

supplies. The women continued using the well as they had previous to construction, but enjoyed washing away from the well on the new wash area. A sanitation committee was not set up to oversee treating of the well with bleach or periodic cleaning of the wash area. It is unlikely that either of these activities were carried out past the departure date of the volunteer (3 months after completion of the project).

Table 4: Assessment of the Kodougouni Top-Well Repair and Wash Area

	Sustainability Factor					
Life Stage	Socio-cultural Respect	Community Participation	Political Cohesion	Economic Sustainability	Environmental Sustainability	Total
Needs Assessment	4	3	3	3	4	17/20
Conceptual Designs and Feasibility	3	3	1	3	3	13/20
Design and Action Planning	3	2	0	4	4	13/20
Implementation	2	3	0	3	2	10/20
Operation and Maintenance	4	1	0	0	2	7/20
Total	16/20	12/20	4/20	13/20	15/20	60/100

The project in Kodougouni was evaluated using the matrix approach and the detailed guidelines provided in Appendix A. The results are shown in Table 4. The project scores highest during the needs assessment (17/20) and significantly lower in the operation and maintenance stage (7/20). Peace Corps projects tend to do well at needs assessment and incorporating socio-cultural respect, as can be seen in this evaluation. Since the volunteers live in the community and interact on a daily basis many constraints become obvious. However, volunteer sites are somewhat isolated and it is difficult to coordinate efforts with other organizations. This is evident in the low score for political

cohesion. Although the project was successfully implemented, it is likely that many concerns could have been alleviated by seeking outside technical expertise during the planning and implementation stages.

Aside from neglecting the political cohesion factor, the feasibility (13/20) and planning stages (13/20) score well. Social and environmental factors were considered in the design, and a detailed budget and action plan including community contributions were developed. The area of weakness during these stages was in soliciting community participation to finalizing the design. Once the community had agreed to a top-well repair, the volunteers finalized the design without further community input. This lapse probably contributed to technical problems later concerning the extent of the work, as the community certainly had better knowledge of soil conditions around the well than did the volunteers. It also resulted in minor discontentment with the final product. The covered opening was smaller than that of the original well, and the women complained of difficulties when many women pulled water simultaneously.

The implementation stage (10/20) scores slightly worse than the preceding stages. There were numerous problems with faulty equipment or items that were neglected in purchase planning. Physical constraints were not rechecked, such as the extent of excavation needed and the well diameter at that depth, before starting work. Quality checks prior to the start of construction, or technical support from an experienced well worker, would have been an improvement. A Peace Corps technical trainer was employed for part of the work, but not during the initial construction work. Failure to double check equipment quality and physical constraints, combined with the lack of education on waste management during construction, reduced the scores for the economic and environmental factors. Socio-cultural respect receives its lowest score (2) during the implementation stage. The budget neglected provisions for unexpected events in the project timeline, so the unannounced arrival of the cotton truck, combined with the soccer game and multiple funerals, put the project several days behind schedule. The trainer had to be paid overtime for the delay, contributing to expenditures over the project budget.

Women were not involved during construction. Gender roles are clearly delineated in Mali and construction is traditional men's work. So it is difficult to bring women into the process, but the divide between who built the well and the primary users probably contributed to difficulties in the management of the finished product.

The operation and maintenance stage (7/20) scores the worst. This stage lacks political support beyond the community, and any economic plan to support potential repairs or maintenance. Although traditional wells do not require daily maintenance, they do need monthly chemical treatments and occasional minor repairs. For example, the access hatch covering the well broke and has not been fixed. The wash area also has low operational needs, but will require periodic cleaning, as will the soak pit. The lack of organization to finance treatments or repairs is reflected in poor scores for community participation (1) during this stage. The improved well and wash area are popular with the women and are used daily, but no one has taken ownership for cleaning the area, treating the well, or assigning responsibilities for other maintenance measures. Likewise, there are no arrangements to monitor the functioning of the soak pit or continue environmental and hygiene education efforts. While the durability of the well construction will allow it to provide benefits for many years, it is unlikely that the wash area benefits will last beyond the filling of the soak pit. Better efforts should have been made to prepare the community for the responsibility of maintenance and to follow through with them after construction. However, the political isolation of Peace Corps volunteers and their short time in the community makes it difficult to address these issues. Coordinating the project with other organizations would have improved the sustainability of this project.

3.2 Zambougou-Fouta Rainwater Harvesting Pond

Zambougou-Fouta is a rural village of 1,500 in the region of Segou, central Mali (Figure 1). The community is entirely agrarian, subsisting off the proceeds of their fields (millet, peanuts, and cotton) and livestock. The primary concern in the village is the reduced water supply during the hot season (March-May). Zambougou is served by four deep wells (35m) with hand pumps and dozens of shallow, hand-dug wells (8-14m deep). The shallow wells frequently run dry during the hot months leading up to the rainy season (June-September) and the hand pumps often fall into disrepair. If the four deep wells are functioning properly they can provide enough water for domestic use in the village. However, there is not enough supply to provide water for the livestock or the small gardens that many families use to supplement their income between harvests. Rainwater harvesting is being promoted as a way to increase the potential water supply without putting pressure on the aquifer.

An American engineering organization has been involved in Zambougou-Fouta since 2002. They were brought to the village at the request of another American non-governmental organization (NGO) to help meet the water needs of the community. In 2003, following two previous site assessment trips, a team of engineers spent two weeks in Zambougou constructing a soil-cement lined basin for rainwater collection. However, when I arrived in the village in 2004, the basin was no longer functional. During my initial conversations with villagers and representatives of the engineering organization, the faults of the first project were generally recognized, as was the desire to keep working on the problem. I acted as a community liaison and consultant for the engineering organization during a year-long planning process leading up to a site visit by representatives of the organization in December of 2004.

The engineers were already familiar with the community when I arrived. They had conducted baseline health surveys during pervious site visits and were generally familiar with the water and sanitation priorities of the community. By living and working in the community, I was able to supplement their knowledge of the socio-cultural

constraints and conditions in the village. I was also able to discuss the feasibility of several proposed designs for rainwater harvesting with the village council. The designs revolved around the central idea of providing a water storage unit for captured rainwater that could be used to irrigate a garden or water the livestock. The concept of rainwater harvesting is relatively new to the community and months of discussion on conceptual designs had not resulted in agreement on an appropriate project. The engineering organization had been planning an implementation for December, 2004, but after failure to agree on a project plan, they revised the trip to be a second round of site assessments. The hope was that a series of face-to-face meetings would be able to clarify the priorities and concerns of both parties, resulting in an agreement on how to proceed.

Figure 7: Men of Zambougou-Fouta digging out the rainwater pond (January 2005)

A team of engineers spent five days in Zambougou in mid-December. The visit consisted of several meetings with village representatives and the gathering of information on health, water chemistry, and hydrology. During one of the discussions

with the villagers, a new idea for rainwater capture was introduced. The intent was to deepen some of the natural depressions in the area to increase their capacity to hold water after the rains stop in October. Many depressions become temporary ponds during the rainy season due to the high clay content of the soil, which results in very low infiltration rates. Most of the water loss in these depressions is due to evaporation. By increasing the depth it was hoped that these ponds could provide additional water for agriculture and livestock for several months after the end of the rains.

The villagers quickly agreed to this idea and within a few hours had picked out three depressions outside of town that they could dig deeper. Excavation on one new pond started before the engineers left the village. Over the following months, I worked with the community to complete the excavation of one depression. The 10-meter diameter pond was dug to a depth of 2 meters in the center with stepped sides to allow cattle access to the water (Figure 7). The excavated dirt was carted back to village for use in building and repairing houses. Sandbags were placed along the edge of the pond to reduce silting due to runoff (Figure 8). The plan was that the pond water could be used for livestock following the rainy season. When the pond starts to go dry, the men could make bricks with the mud at the bottom, thereby digging it deeper and increasing the storage capacity for the next year. Eventually, a community garden could be started next to the pond and the water used for irrigation. There was also discussion of a floating cover to reduce evaporation rates.

The following rainy season, the pond filled to a foot or two above the sandbagging (Figure 9). It was used to water the village cattle for several months after the end of the rains (early October 2005) and held water until early January, 2006, over two months longer than the unimproved ponds in the area. There were some issues with cattle getting stuck in the mud at the edge of the pond, which reduced its popularity as a watering hole. There was still water in the pond after the men were finished working the harvest, but bricks were never made at the pond. When I left the village at the end of February, 2006, the villagers agreed that the deepened pond held several more months of water, but they showed no inclination to continue to maintain the pond or work to

increase the current depth. The engineering organization is committed to continuing work with Zambougou-Fouta and hopes to find an acceptable solution that the community will use.

Figure 8: The rainwater pond after the first rain of the season (June 2005)

The rainwater harvesting project in Zambougou-Fouta is evaluated using matrix guidelines and details provided in Appendix A. The results are shown in Table 5. The project scores highest in the needs assessment stage (18/20). Since the engineering organization had several years experience working in the village this result is not surprising. Partnering the project with a Peace Corps volunteer on the ground also increased the information available for the needs assessment, which supports such a high score. The only low mark during the needs assessment occurred in the political cohesion factor (2). This is because the project failed to address the potential for collaborating with nationally identified development schemes.

Table 5: Assessment of the Zambougou-Fouta Rainwater Pond

	Sustainability Factor					
Life Stage	Socio-cultural Respect	Community Participation	Political Cohesion	Economic Sustainability	Environmental Sustainability	Total
Needs Assessment	4	4	2	4	4	18/20
Conceptual Designs and Feasibility	2	3	3	1	3	12/20
Design and Action Planning	3	2	1	1	4	11/20
Implementation	3	2	1	2	2	10/20
Operation and Maintenance	2	1	2	0	2	7/20
Total	14/20	12/20	9/20	8/20	15/20	58/100

The conceptual designs and feasibility stage (12/20) scores well. This result reflects the involvement of the community and partner organization (Peace Corps) in evaluating potential designs and giving feedback. This stage scored lowest in socio-cultural respect (2) and economic sustainability (1). Evaluation of conceptual designs neglected issues of traditional gender roles and how the additional water source might affect daily activities and cultural roles. Feasibility studies also failed to estimate operation and maintenance costs or the community willingness to pay for proposed systems.

The final three life stages score lower than the initial stages. This may be the result of an informal and hasty design selection process, action plan and implementation. The project idea was introduced, planned and implemented within a five-day site visit. The excavation process had actually started before the engineers and the community had worked out details for the final design and plans for operation. It is likely that if planning

time and communication had increased during the action planning and implementation stages, the entire project would have been more sustainable.

Evaluation of the individual sustainability factors indicates where to emphasize improvements. The highest scores show acceptable concern for socio-cultural (14/20) and environmental (15/20) issues. Environmental sustainability scored highest because the engineers were conscious of the environmental constraints of the area and the chosen technology was benign. Community participation (12/20) scores well because of the villagers' involvement in the needs assessment and discussions on conceptual design. It also receives points for the community leadership in project selection and implementation. However, there was not a formal selection process or planning session for future use. The result can be seen in the low community participation (1) during operation and maintenance. A low score at this stage indicates a lack of ownership and community support for the project. Since the selection process was quickly done without a formal consensus, there were many in the community who did not believe that it would work and were reluctant to continue the maintenance required.

The engineering organization addressed issues of political cohesion (9/20) by recruiting the involvement of Peace Corps in the project. Government officials were also contacted early in the process. Political cohesion therefore scores relatively high during the first two life cycle stages (2 and 3, respectively). The low scores in the later life cycle stages reflect the lack of definition in the roles and responsibilities of the two organizations involved. The scores could also be improved by involving government agencies and other institutions to establish broader political support.

The low economic sustainability score (8/20) is mostly the result of a failure to plan for operation and maintenance or assess the community willingness to pay. It was assumed that the community would provide free labor for construction (true), but it was not formally discussed that this was their contribution, nor was it discussed how that would fit into the financing scheme for the entire project. The speed in which the project was implemented also reduced the possibility for economic planning. The

implementation stage scores relatively well economically (2) because it was a low cost project. The majority of the cost was labor for excavation, which was provided by the community. However, the economic benefits and costs of use were never established. There was not an economic management plan to determine who would use the pond (receive benefits) or pay for it (labor to dig it deeper). The apparent lack of ownership exhibited by the community at the end of the project can be the result of insufficient economic incentive for proper operation and maintenance or realistic evaluations of the community willingness to pay. Although the project cost little monetarily, the failure to consider other economic stressors throughout the project life cycle makes economic sustainability the weakest link in the project.

Figure 9: The full rainwater pond during the rainy season (September 2005), seven months after completion of the excavation.

3.3 Review of Case Studies

Evaluations of the work in Kodougouni and Zambougou-Fouta illustrate strengths and weaknesses in the project approaches. Assessment overviews are presented by life stage (Figures 10-11) and sustainability factors (Figures 12-13). The project scores are similar when evaluated by life stage. Both projects score strongly during the needs assessment stage and in dealing with issues of socio-cultural respect and environmental sustainability throughout the process. Project planners worked to remedy a recognized community priority within the social and environmental context of the community. However, the projects score lowest in the operation and maintenance stage, especially in community participation, political cohesion, and economic efficiency. The scores of both projects decline over the course of the life cycle, reflecting the failure to transfer ownership of the project. A successful project will see increasing involvement of local players throughout the life stages, until community members take control during the operation and maintenance stage. The failure to properly address operation and maintenance is most evident in the evaluation of the stage itself, but both projects missed points related to planning for use of the system in the earlier stages. The planning and implementation stages did not build up management organizations to encourage community ownership and financial support for repairs. The sustainability of these projects could have been improved by increasing attention to operation and maintenance requirements earlier in the life cycle.

Differences in projects approaches become evident when comparing the sustainability factors (Figures 12-13). Both projects are strongest in socio-cultural respect and environmental sustainability. The Kodougouni project shows significant weakness in political cohesion, while the Zambougou-Fouta project is weakest in economic sustainability. Political cohesion and economic sustainability are the two lowest factors in both projects. The sustainability of these projects could have been improved by bringing in political support from government and nationally based NGOs and improved economic planning. Intervention to improve these sustainability factors

will be most effective during the life stages that also scored poorly (e.g. operation and maintenance).

Project Breakdown by Life Stages

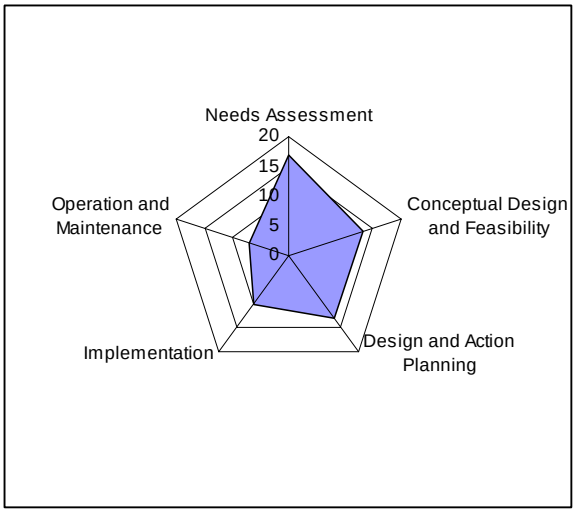

Figure 10: Assessment overview of Kodougouni well repair by life stage.

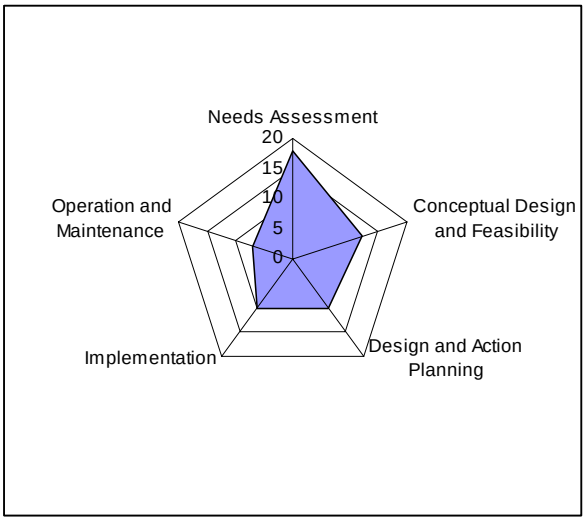

Figure 11: Assessment overview of Zambougou-Fouta rainwater project by life stage.

Project Breakdowns by Sustainability Factors

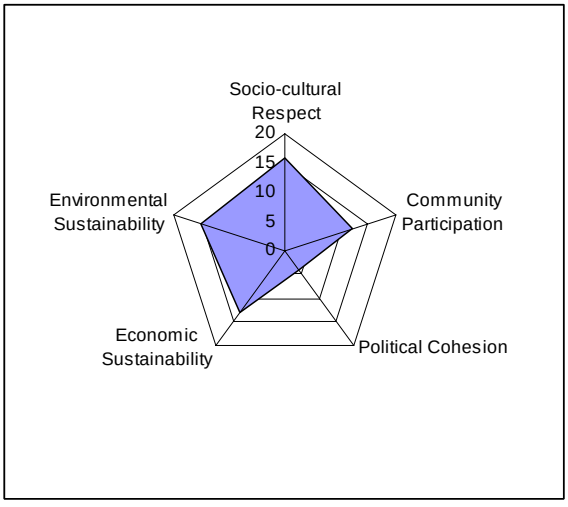

Figure 12: Assessment overview of Kodougouni well repair by sustainability factor.

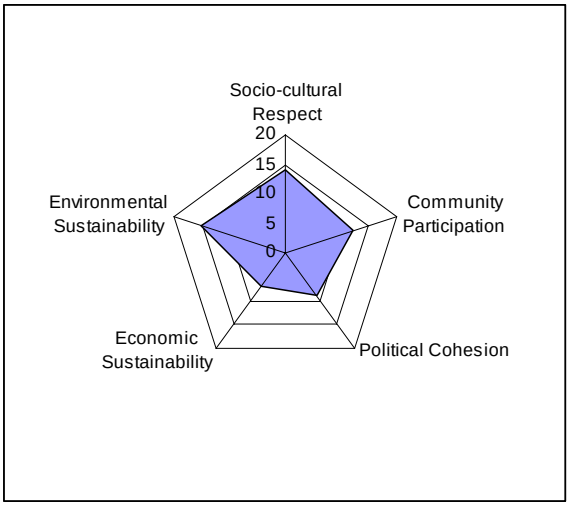

Figure 13: Assessment overview of Zambougou-Fouta rainwater project by sustainability factor.

Although there is not a guarantee that addressing these issues will eliminate potential problems with the projects, working to incorporate more of the sustainability factors into the entire process will increase the potential life of the project. Closer study of the project evaluations can suggest intervention methods that could maximize improvements. For example, the Kodougouni project lacks political cohesion and a sustainable approach to operation and maintenance. Both of these problems could have been dealt with by involving the local government or an NGO in efforts to strengthen community organization. There are numerous programs in Mali that seek to empower local communities through the promotion of health committees and education. A village health community could gain prestige and influence through management of the wash area and well or traveling health workers could assist in promoting maintenance measures. These sorts of collaborations could have improved the potential for sustainable operation and maintenance, especially after the volunteer had left.

A development project is a process that takes time and effort. Building the relationships needed for political cohesion takes time, as does an accurate needs assessment and planning process. A project is not finished after implementation. It requires a continued level of effort to ensure proper operation and maintenance. There are numerous factors that affect project sustainability at a variety of points in its life cycle. A successful project requires effort on a diverse set of issues at all times. A responsible project is one that respects the complexity of the life cycle process by using sufficient time and resources to make sure that the project benefits will endure.

4.0 Conclusions

This research developed an evaluation framework for water and sanitation projects in developing countries. The framework is based on a life cycle thinking approach to sustainability assessment. It considers the multi-faceted aspects of sustainability in development work and is not data intensive, making it a suitable alternative to existing life cycle assessment tools. Sustainability factors are evaluated using a series of qualitative guidelines derived from literature and personal experience. The scoring checklist has the potential for use as an educational or self-assessment tool in both post-project evaluation and in pre-project planning.

The guidelines can aid development workers in identifying the tasks that need to be accomplished and in assigning the roles and responsibilities of coordinating parties throughout the process. However, caution should be taken in using the guidelines in this way. International development work is dynamic, and there are potential problems that can not be dealt with in this assessment tool. For example, long-range community planning processes can be difficult to implement in communities that have no experience with them. The project success depends heavily on individual circumstances and the ability of project participants to find creative solutions to difficult problems, such as involving a local organization that has experience implementing culturally appropriate planning practices. The framework can act as a guide and may help answer questions of who is in charge of performing certain actions in each life stage. Ultimately its usefulness will depend on individual characteristics of the parties involved.

While there are many advantages to using a life cycle tool to assess project sustainability, there are several limitations to this framework. By creating guidelines for sequential project steps, there is a danger of planning for each life stage separately. The divisions between the life cycle stages are based on arbitrary decision points and changes in levels of involvement and effort. However, the life cycle itself is a continuum in which the life stages interact and affect each other. Project planners need to be aware of the entire process all the time. The planning stages will need to consider future stages of

implementation and operation, and the later life stages will rely on information gathered early in the process. The sustainability of a project will be increased by reading ahead in the guidelines and reviewing completed work during planning for each step.

There is also the quandary of how to address sustainability factors that may be in conflict with each other. For instance, a technology that is economically sustainable may not be environmentally sustainable, or one that is environmentally sustainable might not be politically sustainable. There are also potential conflicts between involving women and respecting traditional gender roles or between political players inside and outside the community. Just as the life stages can not be treated completely independently, decision-makers will need to be aware of potential trade-offs and interactions between sustainability factors. Successful development work demands a certain level of flexibility and creativity that can not be integrated into an assessment tool.

This life cycle framework does not address the weighting of sustainability factors in the scoring section. However, there may be unconscious weighting of certain factors when they are related to multiple checkboxes. For example, the importance of estimating operation and maintenance costs is stressed in element 2,4. If these estimates are not performed, the economic feasibility assessment can not be done, giving a maximum score of two for that element. Social sustainability is also weighted strongly in the sense that it is represented by three factors as opposed to one for environmental and economic sustainability. Social factors are stressed because there is greater potential for cultural problems when working in a foreign country. They are also the factors that often get the least amount of attention. Due to the variety of situational factors present in development projects, it is difficult to introduce additional weighting that would be universally applicable. Each project manager will need to weigh for themselves the consequences of trade-offs between sustainability factors.

The scoring system may also be arbitrary, depending on how users interpret the level of involvement from different organizations. It is possible that two individuals involved in the same project could score it differently. However, the objective in the

development of this framework is not to provide a universal tool for comparing the success of water and sanitation projects, but rather to aid individuals and organizations in improving their project approach. International development projects are highly dependent on local conditions and each project will have to be approached independently. This framework offers a logical approach to managing the complexities in achieving sustainability in development work. Ultimately, it may not be practical for engineers and other development workers to address all of the sustainability recommendations. Indeed, the size and complexity of the project will affect how important each recommendation is to the overall sustainability. However, an increased awareness of the larger picture will always augment the potential for a successful project.

This paper presents a logical method for breaking down and analyzing the factors that affect the sustainability of water and sanitation development projects. It identifies five sustainability factors that are common throughout development literature and the policies of international aid organizations. By definition, a sustainable project is one that addresses the long and short term consequences of its actions. Therefore, life cycle thinking offers a suitable approach for assessing sustainability. The proposed sustainability matrix allows development workers to evaluate the strengths and weaknesses of their projects during each of the five stages of the project life. Use of this framework will assist engineers and other development workers in implementing sustainable project approaches. While, this matrix was designed to assess the process of implementing water and sanitation systems, it could be adapted and applied to a broader range of development projects or expanded to assess the feasibility of alternative designs. By underlining the complexities involved in development work, it will force development workers to recognize the need for increasing the scope and timeline of projects. Meeting the Millennium Development Goals is a challenge, but it becomes more approachable when broken into achievable pieces that can be worked on separately to improve the outcome of the whole.

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Appendix A
Sample Questions for Matrix Evaluation

The following is a list of rhetorical questions and explanatory statements to clarify the scoring guidelines of the sustainable life cycle matrix. The examples and questions are certainly not exhaustive nor will they all be relevant for every project. They are meant to guide practitioners and stimulate discussion on a sustainable project process. Not all of the questions following a sustainability recommendation need to be answered in order to obtain a positive score. Instead, the questions and statements are meant to provide the project manager a sense of the depth and scope that each guideline encompasses. If the reader feels that the general essence of the guideline has been addressed in project planning then a positive score can be given. To determine the score of a project, assign a rating (0-4) to each matrix element, depending on the number of sustainability recommendations (check boxes) that are completed. If none of the recommendations are met the matrix element is 0 (poor evaluation). If all of the recommendations are met the matrix element is 4 (excellent evaluation). The potential score for each sustainability factor or life stage is 20, while the total possible score is 100.

Table 4: Sustainable Life Cycle Matrix

	Sustainability Factor					
Life Stage	Socio-cultural Respect	Community Participation	Political Cohesion	Economic Sustainability	Environmental Sustainability	Total
Needs Assessment	1,1	1,2	1,3	1,4	1,5	20
Conceptual Designs and Feasibility	2,1	2,2	2,3	2,4	2,5	20
Design and Action Planning	3,1	3,2	3,3	3,4	3,5	20
Implementation	4,1	4,2	4,3	4,4	4,5	20
Operation and Maintenance	5,1	5,2	5,3	5,4	5,5	20
Total	20	20	20	20	20	100

Element: 1,1 (Needs Assessment, Socio-cultural Respect)

A needs assessment is essentially information gathering, in an attempt to comprehend the cultural fabric of society. It is especially important for foreign aid workers to look objectively at differences in cultural perceptions of social roles, hygiene, and proper water usage. Information can be gathered from a variety of sources, including literature, site visits, and community surveys. General information on socio-cultural issues (unemployment, payment of taxes, illiteracy, and health care) can be gathered from publications such as the Human Development Reports (e.g. UNDP, 2005). More specific information is best gathered on-site. A yearly calendar of work and social life can provide a good cultural introduction. It can also be used to infer the seasonal changes in labor supply and water use. Water and sanitation practices are often closely intertwined with religious, traditional or superstitious beliefs. It is important to understand the local beliefs and taboos centered on water and waste. The needs assessment will evaluate the level of health education and understanding of the role of water and sanitation in disease transmission. Gender roles and preferences can be particularly distinct on water and sanitation issues and are important to recognize in project planning and implementation. The following specific tasks are recommended to satisfy this element:

□ Generate a yearly calendar of work and social life in the community.

- How is a year defined?
- How are the seasons identified?
- What are the characteristics of each season?
- What is the primary employment in the area?
  - For men?
  - For women?
  - For children?
- Is this work constant throughout the year or seasonal?
- What time of year is the busiest? Are other seasons very slow?
- Are there patterns of seasonal migration?

- What is the primary religion in the area?
- When are the major holidays?
- When do weddings, baptisms, and other social ceremonies take place?

□ Identify social preferences and traditional beliefs associated with water supply and sanitation practices.

- Are certain water sources preferred over others?
- Is there folklore or old stories associated with water sources or water use?
- Are there traditional methods for protection a water source?
- Do people add things to their water? At the source or at home?
- Do people consider sanitation issues around the water sources?
- Are there social caste issues about the use of water from certain sources?
- Is there a history of filtering or screening water sources?
- Are there seasonal changes in the quality of the water supply? How are they explained?
- What is the preferred sanitation method in the community?
- What are preferred methods of anal cleansing?
- How do people feel about handling excreta (even when decomposed)?
  - Will people transport it?
  - Will they reuse it?
  - How will this affect maintenance issues?
- Are the religious constraints to be considered?
  - A traditional rule is that Muslims should not defecate facing or with their backs towards Mecca.
- Do people believe that excreta are harmful?
  - Many people believe that children's excreta are less harmful than that of adults.
  - Others believe that disease is "an act of God", therefore sanitation and hygiene practices are irrelevant.
- Are people afraid to use latrines? Why?

    - Snakes, insects, and other animals
    - Black magic
    - Smells
    - Collection of excreta in a single place is “unsanitary”
    - Belief that women using a pit latrine will become infertile
  - Are there taboos associated with washing hands with soap? (In Mali, this practice was believed to wash away a person’s wealth)
  - For further examples refer to Pickford, 1995.

□ Determine the level of health education in the community.
  - Have community members been involved in answering questions on community health? In formal and informal settings?
  - What is their education background?
  - What health education issues are covered in schools?
  - Who receives education? Men or women? (Note: that there may be discrepancies between who receives education and who performs water/sanitation related tasks)
  - How often do people get sick in the community?
  - Why do people get sick? (According to them)
  - Do people connect water and sanitation issues with disease?
  - What is the community motivation for improved water and sanitation services?
  - Are there health care facilities available?
  - How is the quality of the water? How is quality perceived in the community?
  - How do you perceive the cleanliness of the community? How do community members perceive it?
  - Do they wash their hands with soap?
  - Do they have a latrine?
  - Do they use a latrine? Do the children?

□ Recognize differences in gender roles in water and sanitation.
  - How do men use water? How much?

- How do women use water? How much?
- Who provides water for the household? Agriculture? Business?
- How much time do men/women spend per day on water collection?
- Do men and women follow separate sanitation practices?
- Are there separate latrines for men and women?
- Who is in charge of the children's hygiene?

Element: 1,2 (Needs Assessment, Community Participation)

Community ownership is achieved by involving the community in every stage of the project. This can be initiated through a participatory needs assessment (see Appendix A). Participatory assessments are important methods for obtaining locally specific and community gathered data. This assessment clarifies the priorities of both the community and the development workers. The accuracy of the needs assessment can be improved by identifying and including a variety of stakeholders in the discussions (men, women, youth, elders, specific ethnic groups, community leaders, and water organizations). Another essential step is to determine the political and organizational capacity of the community. Subsequent community participation steps will depend on the ability and willingness of the community and development workers to work together. By recognizing the type of political organization in the community (egalitarian, hierarchist, individualist, fatalist), project planners can adapt the management model to the existing structure (Biggs and Smith, 2003). Addressing issues of community priorities, demographics, leadership and consensus provides development workers with critical background information, and helps the community better understand its own capacities. The outcome of this stage is the conceptualization of priorities and constraints on a participatory project approach. The following specific tasks are recommended to satisfy this element:

□ Conduct a participatory needs assessment at the local level to determine local development priorities.

- Did you use a participatory approach to needs assessment?
  There are a range of methodologies based on a participatory approach to evaluate development needs, for example: Rapid Rural Appraisal (RRA), Participatory Rural Appraisal (PRA), and Participatory Analysis for Community Action (PACA). In general, they all aim to identify community problems and to plan solutions with the active participation of the community members (Selener et al., 1999). Each method uses a set of "tools" to assist the locals in analyzing the characteristics of their community (community map, social calendars), identifying

problems (problem lists, priority analysis), and developing possible solutions (solution brainstorming, feasibility matrix). Participatory tools are most useful when a representative group of community members are involved (men, women, youth, elders, ethnic groups, community leaders and organizations). The participatory needs assessment must take place in the community itself. In depth literature can be found on all of these methods. It is not necessary that all techniques be used during the needs assessment. In fact, development workers should select the tools that are the most applicable to the community. Whatever tools are used the result should still be the identification of the top community needs.

- Is the group involved in the needs assessment representative? Are they influenced by local power groups?
- Can the following types of questions be answered by community members?
  - What are the general characteristics of this community? (employment, services available, ethnic groups, community history)
  - What are the strengths of the community?
  - What are the problems in the community?
  - What is the present level of satisfaction with the existing water/sanitation system?
  - What are the causes and effects of these problems?
  - Which problems have priority for the community?
  - What can be done to address the problems?
  - Does the community have knowledge of options for improved water/sanitation systems?
  - What are the preferred options?
  - What technical, financial, and capacity building assistance does the community need to reach these solutions?

□ Identify stakeholders and community leaders.

- Who will be directly affected by project intervention?
- Who will be indirectly affected?
- Who will pay?
- Are both genders considered?
- Are all age groups considered?
- Are there ethnic groups with varying needs? Can they be equally or proportional represented in the project process?
- Who are the community leaders?
- Who are the local influential people (LIPs)?
- Are there people with veto power? (mayor, village chef)
- Are there influential people without official titles who will affect how others accept the project? (leading scorer on the soccer team, favorite old man, people of wealth or connections)
- Are all these people behind the project? What will make them agree?
- Are there any existing water/sanitation committees?

□ Determine the type of political organization and cohesion at the community level.

- How is the community governed?
- Who are the decision makers in the community? Official? Unofficially?
- How representative is the community government?
- What is the level of participation in community decision making?
- Who implements the decisions?
- What are the rules and procedures governing community action?
- What is the level of participation in community activities?

□ Reach a consensus with community members that project intervention is appropriate.

- Is there a perceived need for water and/or sanitation intervention within the community?
- Do community members understand the project possibilities?

- Is the community aware of the capabilities/limitations of the development workers?
- Are community priorities in line with development workers' area of expertise?
- Is there agreement within the community to participate in project intervention?

Element: 1,3 (Needs Assessment, Political Cohesion)

In the modern world, communities are no longer isolated entities that ignore the world beyond their backyard. Project planners need to coordinate their work with national, regional and local development schemes. The needs assessment will collect information on the local political situation, national policies and existing institutions (government, non-government, private enterprises) in the field. The first step is to situate the project in the national or global context, by acknowledging widespread political issues and problems. Project managers need to consider how their project can be integrated into nationally identified development plans and policies, such as National Poverty Reduction Strategy Papers (PSRPs), National Strategic Plans, Sector-Wide Approaches (SWaps), and local development schedules. It is beneficial to examine the history of development institutions in the area. Perhaps certain projects have been tried before or certain groups have expertise that could be useful in project planning and implementation. Information gathering is facilitated by making contacts and communicating with the agents directly. The following specific tasks are recommended to satisfy this element:

□ Conduct a situational analysis of regional and national issues such as political structure and stability, government policies, and foreign aid.
- Are there any overwhelming local/regional issues that may affect the project?
  - War
  - Drought
  - Disease (AIDS and other epidemics)
- How stable is the national government?
- What is the financial situation of the country?
  - Debt levels
  - Inflation rates
- What is the structure of the national government?
- What do community members think about the government?

- How active are government officials in the community?
- Does the government address water and sanitation issues?
- Are there government programs/initiatives in water/sanitation?
- How transparent are government finances and policies?
- How prominent are foreign aid projects?
- Are there NGO programs/initiatives in water/sanitation in the area?
- Have you looked at potential information sources such as: UNDP Human Development Report, local interviews, government and NGO reports?

□ Ensure that proposed project is consistent with regionally identified development priorities and plans.

- What are the priorities outlined in the National Poverty Reduction Strategy Papers (PSRPs), National Strategic Plans, and/or Sector-Wide Approaches (SWaps)? These are national initiatives that outline the development priorities for the country. There will be more government funding and institutional support for projects that address these priorities.
- Are there local development schedules within the community or region? (check with mayor, village counsel, community leaders)
- What is the availability of grants or aid money for water and/or sanitation intervention?

□ Research the history of NGO and government projects in the area.

- What NGOs have worked in the community before?
- What type of project were they involved in?
- Were they successful?
- What work has the government done in the area?
- How was the community involved in the project implementation?
- Are past project reports available?
- Are the projects on-going?

□ Establish communication lines with existing NGO and/or government institutions in the area.

- Have government officials in the area been contacted?
- Have NGOs with a history in the area been contacted?
- Are they familiar with your organization?
- What initiatives/projects are they currently working on in the area?
- What advice do they have for working in the area?

Element: 1,4 (Needs Assessment, Economic Sustainability)

The objective of this element is to understand the economic situation of the community, its resource base, and willingness-to-pay for project improvements. Some information is available in published literature from organizations such as the United Nations, the World Bank, or international aid organizations (e.g. UNDP Human Development Reports and USAID country reports). Supplement literature reviews with information gained during a site visit. It is important to gain a basic understanding of how money and resources flow within the community, in particular, how water and sanitation costs fit into local spending and budgets. Identifying the local resource base is best done during a site visit and with community input. Working with the community to identify resources gives a clearer picture of resource availability and increases the community's appreciation of their own assets. It is important to separate monetary and non-monetary resources since these are generally valued very differently by both communities and donors. Finally, assessing the community willingness-to-pay for various projects will help in determining project feasibility and the potential for community contributions. The following specific tasks are recommended to satisfy this element:

□ Understand the local and national economic situation (poverty level, employment, cost of living, flow of resources).

- What is the primary source of employment?
  - National?
  - Locally?
- How stable is the employment level?
- What is the average income?
- How is wealth distributed? (ratios of high/low income, inequality in wealth)
- What is the average cost of living in the community?
- What do people spend money on? When?
- Do people rent or own their property?

- What are indicators of wealth? (livestock, vehicle, improved home, multiple wives)

□ Understand how the community economic situation is affected by water and sanitation issues.

- Is income lost due to disease?
- How do people compensate for the loss of children?
- How much time is spent gathering water or dealing with sanitation?
- What percentage of income is spent on water and/or sanitation services?
- Do community members understand the economic consequences of water and sanitation systems?
- Would improved services provide economic gains?

□ Identify sources of monetary and non-monetary resources (materials, labor, and tools) within the community.

- How do people make money?
  - Paid salary
  - Agriculture
  - Trade
  - Small enterprises (hand crafts, food sales at market, odd jobs)
- How constant is the income?
  - Does it vary by season?
  - Can people save money?
- Does this vary by gender?
- Are there construction tools (wheelbarrows, shovels, picks, masonry tools) available?
- Is aggregate (sand, gravel, or rock) or lumber available?
- Can a community labor force be organized?
- Does the community have the means to transport supplies?

□ Assess the community willingness-to-pay in both monetary and non-monetary terms for current water and sanitation services.

- What do people pay for water and sanitation services?
  - In cash
  - In organized community labor
  - In materials
- If there are fees (monetary or otherwise) for current services do community members pay them?
- Are current services considered adequate?
- Would people be willing to pay for an improved water supply or sanitation services?
- Do people rent or own their property?
  - It can affect how much they are willing to pay for improvements to the property
  - Will landlords charge higher rent if water/sanitation services are improved?
  - Are tenants willing to pay higher rent for improved services?

Element: 1,5 (Needs Assessment, Environmental Sustainability)

This assessment includes gathering basic information on water and sanitation resources, the local environment and the community interaction with it. The emphasis is on water and sanitation issues, but other issues such as desertification, deforestation, erosion, and overgrazing cannot be ignored. A survey can be conducted to inventory current water and sanitation resources; including sources of water, water use, water needs and supply, and sanitation practices. A second survey can identify environmental concerns at a broader level. Much of this information will be gathered during site visits, and supplemented with the observations of residents and literature searches on regional trends. The needs assessment is the time to gather information on climate and environmental constraints (soil conditions, groundwater levels, topography, population trends, water demand assessment, rainfall, temperatures, evaporation, and runoff) that will factor into the project design and sustainability studies. Finally, it is important to understand the community perception of existing environmental problems and the willingness to change their behavior for environmental benefits. The following specific tasks are recommended to satisfy this element:

□ Identify local resources for water and sanitation.

- What is the present system for water supply?
- What are potential water sources in the area?
  - How reliable are they?
  - What quantity and quality of water can they produce?
  - Where are they located?
- What systems are present for sanitation (excreta, grey water, and refuse disposal)?
  - How many people are served?
  - Are the systems well used?
- Where is water used? And reused?
- How do water or sanitation needs compare to the supply?

□ Collect data on climate and environmental constraints that will factor into project design.

- Did you consider the following set of data?
  - Soil conditions
  - Groundwater levels
  - Topography
  - Physical size of village
  - Population trends
  - Seasonal climate variations (Rainfall, Temperature ranges)
  - Stream and river flow rates
  - Evaporation and run-off data
- Can community members assist in the collection of this data?

□ Identify potential environmental concerns at the local and regional level.

- Are any of the following current environmental concerns? Is there potential that they will become issues?
  - Desertification
  - Deforestation
  - Erosion
  - Overgrazing
  - Soil salination
  - Aquifer depletion
  - Ecosystem/watershed deterioration
  - Loss of biodiversity
- How severe are the impacts?

□ Determine community understanding of environmental problems and the willingness to correct them.

- How does the community perceive the threats to the environment?
- Can they identify potential environmental concerns?
- Are they concerned about ecosystem loss or climate change?

- What they received education concerning environmental problems?
- Would they be willing to change their behavior patterns for environmental benefits?

Element: 2,1 (Conceptual Designs/Feasibility, Socio-cultural Respect)

This project element is about assessing the cultural feasibility and appropriateness of the project design. An assessment of each design should be performed that considers the socio-cultural constraints identified in the needs assessment (seasonality of labor, ethnic divisions, gender roles, and traditional perceptions on water, sanitation, and health). The designs will build on existing technical systems and cultural values. It is helpful to estimate how a new system will affect the roles and responsibilities of individuals within the society, by considering the level of behavior change that the improved system will demand. The willingness and capacity of the community to operate, maintain, or dispose of the proposed systems needs to be evaluated. For example, certain sanitation technologies require handling of feces which may be unacceptable in some cultures. Other systems may require technical expertise that is currently beyond the learning capacity of the community. Care should be taken that a new system will not undermine or interfere with traditional gender roles, so that it will be acceptable to both men and women. It is also important to recognize that bias towards certain technologies may exist on behalf of donors and local residents. Understanding the reasoning behind these biases (desire for prestige, system familiarity, cultural preferences in quality, or political pressure) can have important ramifications for design selection and user support. The following specific tasks are recommended to satisfy this element:

□ Assess how the proposed interventions will affect daily activities and socio-cultural roles within the community.

- Can you brainstorm potential social advantages and disadvantages of potential systems?
- Will the new system elevate or lower the social status of any group or individual? (By giving them new responsibilities or eliminating their roles?)
- Does the new system have the potential to shift social values? Is this positive or negative?
- How can designs address these concerns so that the system will be culturally acceptable?

- Will the system result in increased or decreased free time? For whom?
  - Water supply systems can reduce the amount of time spent transporting water to households.
  - Yet, hand pumps installed on borehole wells in Mali often yielded less water per hour than the women could pull by hand from hand-dug wells.
  - Improved sanitation systems may be more convenient, but will they require increase time for cleaning and structure maintenance.
- How will these changes in free time affect the lives of community members?
  - Will increased free time allow for gainful economic employment?
  - Will it affect social time? (Women often socialize together at the water source)
  - Will it affect how children are employed in household chores? (If children no longer fetch water, what will they do? Is it reasonable to expect that they will be able to go to school?)
- Will the new system affect political or power roles in the community?

□ Evaluate the willingness and capacity of the community to perform operation, maintenance, and disposal requirements for each design.

- How much technical knowledge is required to operate the system?
  - Does this knowledge exist within the community?
  - Can people be trained to operate this system?
  - Do people want to be trained?
  - Will trained people remain in the community? (Labor forces can be migratory. Educated people tend to be drawn to urban centers where there are better job opportunities.)
- Are cultural and traditional preferences and taboos considered and respected?
  - Consider how favorite aspects of the current system can be incorporated into the design (location, taste of water, ease of operation, privacy). People are most willing to accept something with which they are familiar.
  - Refer to information gathered during needs assessment

    - Ex: Certain sanitation systems may require handling of excreta that may be unacceptable in some cultures.
- When will the system require maintenance? (Daily, monthly, seasonally)
    - Will people have the time to perform maintenance?
    - Will this vary depending on the season? (seasonality of labor)
    - Ex: During the harvest people are very busy and will be unwilling to take on any additional tasks.
    - Can maintenance schedules be timed to coordinate with labor availability?

□ Design recognizes and respects traditional gender roles.

- Women are often in charge of household water supply, while men are involved in construction and technology. Will a new system interfere with the traditional gender power balance?
- What will be the role of men and women in the new system?
- How can the project encourage ownership by both gender groups?
- Are separate facilities provided for men and women if necessary?

□ Recognize why biases exist towards certain technologies by donors and/or locals.

- Are certain improved systems associated with prestige and wealth?
- Are there political pressures/incentives to adopt certain technologies?
- Are some systems more acceptable because of their familiarity to either residents or donor agencies?
- What significance is placed on system convenience, privacy, comfort, or aesthetics?
- Are there differences in cultural standards of quality or cleanliness that need to be reconciled?
- Remember that not all biases are negative. Some may be helpful in promoting the use and general acceptance of the system.

Element: 2,2 (Conceptual Designs/Feasibility, Community Participation)

The community needs to be involved in the development of conceptual designs and feasibility studies. This requires strong communication skills on behalf of both the community and the development workers. It helps to designate a clear community liaison to facilitate communication exchanges. At the start of the preliminary design process the scope is defined through mutually agreement on project objectives and expected outcomes. In most water and sanitation projects the technical designs are developed by outside consultants. However, feasibility studies require feedback and evaluation from community members. Community input can be solicited on conceptual designs through a local user's committee or representative community organization. The feedback sessions will be most beneficial when community members are given time to reflect on design proposals and allowed to express their concerns and opinions. Their suggestions and concerns can then be incorporated into the feasibility analysis, design revisions, and the selection of an appropriate design. The following specific tasks are recommended to satisfy this element:

□ The project goals are clearly defined and understood by the community and development workers.

- What need had the highest priority?
- How do community members visualize the expected benefits? How do the development workers?
  - Increased health?
  - Increased incomes?
  - Reduction in seasonal migrations?
  - Time and labor savings?
- Who will benefit from the project?
  - Will all members benefit equally?
  - Are all the beneficiaries represented in community discussions?
- Are community members and development workers in agreement?

□ Identify a representative committee that can act as the community liaison throughout the project.

- Can this committee present the community opinions and views to the project planners?
- Will they be responsible for reporting project plans back to the community, including explanations of alternatives?
- Is the committee capable of performing (or assigning the responsibility for) the following roles?
  - Assisting in feasibility studies
  - Gathering of field data
  - Organizing community education
  - Generating support for the project.
- Can an existing committee fill this role?
- Is it necessary to create a new committee? (Note: there is a danger of too many committees within a community. It can lead to a confusion of roles.)
- Does this group represent all beneficiaries? (men, women, ethnic diversity)
- Are members of this committee respected within the community?
- Does this committee operate according to local customs?

□ Present several technically feasible alternatives for community evaluation and feedback.

- Does the presentation of each design include a technical description, estimated costs, installation time, and operation and maintenance needs?
- Is the potential for long-term management of each system emphasized?
- Are presentations of alternatives done in a fair and balanced way?
- Does the community understand the proposed technology?
- Are advantages and disadvantages of each design understood and discussed?
- Does the community think that they can manage and maintain the system on their own?
- What education, training or support services would be necessary for the proposed designs?

- Are there any community concerns not addressed in the conceptual designs?
- Are there legal issues surrounding use of the water source or necessary land?
- Is there sufficient knowledge within the community to manage the systems being considered?

□ Community members formally select a design based on an understanding of the constraints involved in the selection process.

- Are community members allowed to judge the advantages and disadvantages of differing systems?
- Are decision-makers given time to reflect before selecting a design?
- How is the decision reached? Democratic process? Leader decides?
- Is this process consistent with traditional methods of community decision making?
- Is the decision influenced by outside forces?
- Is it possible to judge if the design was chosen on technical merit or political motivation?
- Do community members seem happy with the selected design?

Element: 2,3 (Conceptual Designs/ Feasibility, Political Cohesion)

It is important to foster good relationships within the development community early in the planning process. Opening communication lines gives organizations access to a broader array of information for decision making. Partner institutions can be government agencies, non-governmental organizations (NGOs), or private enterprises. It is preferable that at least one partner organization is based in the host country. Working with partner organizations during the planning process ensures that the efforts of all organizations are complementary, not redundant or conflicting. It is possible that similar projects have been attempted or implemented in the local area. The conceptual design process can be improved by consulting the work of other projects and institutions. Promotional efforts for the new project can be improved by collaborating with existing technology or programs in the area. For example, if the design needs a pump, investigate the possibility of using local pumps, or those being promoted by local NGOs. Health initiatives may also offer educational services and trainings that complement the project. This is also the stage to begin contacting potential partners and exploring the availability of funding for the project. The following specific tasks are recommended to satisfy this element:

□ Develop a working relationship with partner organization(s), including at least one that is based in the host country.
- Have local government officials, NGOs, or private enterprises been contacted?
- Do partner organizations have compatible programs and agendas?
- What is the expected level of support and interaction from all parties?
- Do partners have suggestions or feedback on the designs?
- Are government officials kept informed?
- Can the basic goals of the working relationship be written in a Memorandum of Understanding (MOU)? (EWB, 2005)

□ Consult the plans and designs of other organizations on similar projects.

- Have similar projects been implemented in the area?
- Will the project be redundant or in conflict with another project?
- What technical designs are working in nearby communities?
- What constraints did they use?
- Were there problems? How were they resolved?
- How long did the projects take?

□ Explore options to integrate existing technologies or programs into conceptual designs.

- What water supply and sanitation technologies are being promoted by government or NGO programs in the area?
- What is the potential to use these technologies in the design?
- Could other programs offer education or training support?
- Are there institutions pushing health initiatives that could provide educational services and support?

□ Contact potential partner institutions for project financing.

- Are there grants or low-interest loans available?
  - For agencies?
  - For individuals?
- What are the conditions for receiving funding?
- Are funds available for operation and maintenance?
- Are programs and funding available for supportive health/sanitation education?

Element: 2,4 (Conceptual Designs/Feasibility, Economic Sustainability)

The economic feasibility of each conceptual design is based on a series of cost estimates and willingness to pay studies. The cost estimates for implementing each alternative should be comprehensive and include labor, materials, equipment, transportation, political fees, and training. It is helpful to have the community involved in pricing and cost calculations as they know the prices and availability of local resources. Cost reduction and long-term sustainability of the project can be achieved by minimizing outside resources, especially if they will have to be replaced. It is equally important to consider the projected operation and maintenance costs for potential designs. The end-of-life costs for disposal, recycling, and reuse also factor into feasibility studies. Feasibility compares costs of the conceptual designs against the willingness of the community to contribute to construction, operation, and maintenance. Many designs are based on the theory of local ownership through control of operation and maintenance. The community should understand this commitment and be willing to pay it. In determining willingness to pay, it may help to explain labor and materials contributions in equivalent monetary terms. Finally, the economic feasibility of the alternative designs can be assessed by examining the gap between estimated costs and the willingness to pay for them during construction, operation, and maintenance (refer to Appendix A for more details). The following specific tasks are recommended to satisfy this element:

□ Estimate the implementation costs of each conceptual design.

- Are training costs included?
- How much will materials and equipment cost?
- What local materials can be used? What will it cost?
- How can non-local materials be obtained?
- What will transportation of materials, equipment, and laborers cost?
- What will labor cost? Skilled and unskilled?
- Will food be provided for labor crews? What will it cost?
- Can community members provide local cost information?

- Will there be political fees that should be included in the budget?
- How should development workers' time be included?
- What about costs for promoting use of the system or health education?

□ Estimate operation, maintenance, and disposal costs for each conceptual design.

- Include costs for materials, replacement parts, and skilled laborers.
- Can these parts and materials be found locally?
  - If not, include cost estimates for transportation of supplies or displacement of people to get supplies
- How often will materials and parts need replacement?
- What are the minimum costs to keep the system running?
  - Daily
  - Weekly
  - Monthly
  - Annually
- How will recurrent costs be recovered?
  - Fees
  - Outside aid

□ Assess the community willingness-to-pay in both monetary and non-monetary terms for each improved system.

There are a number of methods in use for determining willingness-to-pay: contingent valuation surveys, estimations based on a percentage of income or current expenditures. (Goldblatt,1999: Raje et al., 2002: Whittington et al., 1991/1990) The community willingness to pay should be determined on more than a "rule of thumb" based on a percentage of household income. It should be voiced by community members themselves, either directly in interviews or indirectly by costs that they currently pay for services.

- What do people pay for water and sanitation services?
- What is considered an adequate level of service?
- How much money are people willing to pay to obtain this service?
  - Construction/Implementation fee?
  - Monthly?
  - Yearly?
  - Per use?
- What are people willing to contribute to construction and start-up capital costs?
  - Monetary
  - Non-monetary items
  - Are people willing to work to obtain this service? (labor, supplies, construction material, tools)
- What are people willing to pay to maintain an improved system?
  - Indirectly: service fees
  - Directly: labor for maintenance or repairs, replacement parts or materials

□ Conduct an economic feasibility assessment to evaluate long-term project viability based on cost estimates, projected operation and maintenance costs, community willingness to pay, the need for outside resources, and the availability of outside funding.

An economic feasibility assessment is suggested in place of a traditional cost-benefit analysis. In international water and sanitation projects, benefits are often hard to quantify. There are data limitations that make it difficult to estimate the health and economic benefits that would traditionally be used to justify costs. The larger question in developing countries is the sustainability of the project. The measurable benefits will be negligible if the project is not maintained. In fact, sanitation systems such as latrines can have negative health impacts if they are not properly cleaned and used (Pickford, 1995). An economically sustainable project is one that offers long-term benefits (i.e. remains in operation) at an affordable price. The definition of an affordable price will be determined by what beneficiaries and government officials

are willing to pay. There are many methods for determining the community willingness to pay (see above). Willingness to pay on the part of the government (or other aid organizations) can be determined based on the amount of grants, subsidies, or other funding currently directed at water and sanitation systems (see element 2,3).

In an economical feasibility assessment, the project viability is determined by weighing cost estimates for construction, operation and maintenance, versus the willingness of the government and community to pay for it. For example, an unsustainable project may have sufficient funding and community support to construct the system, but operational costs exceed what the community and aid institutions are willing to pay. Decision makers will have to evaluate the long-term viability of the project based on the gap between anticipated support and expected costs.

- What is the total cost to implement the project?
- What can the community contribute to these costs?
- What funding is available to implement the project?
- What is the estimated start-up cost?
- What are realistic estimations of operation and maintenance costs?
  Note the danger of investing more money up front (high technology) to avoid operation and maintenance costs. The high cost of fixing these systems when they do require maintenance (and they will) may be quite inhibitory (Howe and Dixon, 1993).
- What is the total annual cost per household (including capital and recurrent costs)? (for more details refer to Pickford, 1995)
- What percentage of this is the community willing to pay?
- Will outside resources be needed for operation and maintenance?
- Will these resources be available?

Element: 2,5 (Conceptual Designs/Feasibility, Environmental Sustainability)

This project element assesses the environmental sustainability of the design alternatives. An appropriate design is one that does not jeopardize the future of water use in the area through over-consumption or pollution of existing water sources. A feasible project is one that is designed to handle seasonal variations in water supply, demand, and environmental stressors (groundwater table, soil conditions, flooding). Conceptual designs consider the land requirements, the location of available land, and socio-environmental repercussions for the displacement of existing land uses. In many instances the location of the project will affect the user acceptance and demand for the system. A site impact analysis of each design and site location will identify issues of ecological disturbance, contamination, waste disposal, and energy use (fuel, batteries). The feasibility studies must weigh the environmental concerns to select the alternative that minimizes potential impacts. The following specific tasks are recommended to satisfy this element:

□ Assess the capacity for sustainable water use in the geographic area.

- Can the water source provide an adequate supply throughout the year?
- How will use of the water source affect the aquatic ecosystem?
- How will the watershed be protected?
- Will sanitation practices endanger existing water sources?

□ Consider how seasonal variation in water supply, demand, and environmental conditions will affect each conceptual design.

- Does water availability vary by season?
- How does demand for water vary throughout the year?
- Will evaporation rates affect the project design?
- How much does the water table fluctuate during the year?
    - How will this affect designs for sanitation systems? (latrine depth, septic systems, infiltration rates for soak pits)

    - How will this affect water sources? (necessary well depth, recharge of surface water)
  - Is the area subject to flooding?
  - How will these variations affect the feasibility and cost of conceptual designs?

□ Consider land needs and availability of suitable land for each alternative.

  - Is the necessary land available?
  - Is the available land suitable as a project site?
  - Is the available land in a convenient location? How far from users?
  - What are the potential repercussions of displacing other land uses?

□ Conduct a site impact analysis for each alternative.

  - How will resource gathering (lumber, aggregate, water) affect the site environment?
  - How invasive are proposed construction techniques?
  - How will the operation of the system affect the environment? At the site? In surrounding areas?
    - Water contaminant
    - Waste discharges
    - Disposal of used parts and fuel containers (Where? How?)
    - Ecosystem disturbance
    - Resource consumption (fuel, batteries, water, chemicals)
  - How susceptible is the site to environmental damage?
  - What is the potential for remediation/mitigation of damage?

Element: 3,1 (Design/Action Planning, Socio-cultural Respect)

Developing an action plan can be a challenge, especially when the development workers are from outside the community. There are often large differences in expectations and organizational philosophies. Understanding the action plan within the traditional framework of the local society may reduce frustrations. Local planners can assist in identifying traditional roles in community projects and who fills them. Roles will include both leadership and support roles, such as a foreman, chief, and treasurer, and skilled and unskilled laborers. There are culturally determined roles that must be respected and understood when assigning responsibilities, especially those of management and leadership. Sometimes a role may be ceremonial and only carry the responsibility of being informed or publicly acknowledged (Peace Corps, 2000b). The action plan timeline must also consider the seasonality of labor and how it will be affected by agriculture, religious holidays, and climate. There is often a discrepancy between the level of women's involvement in project organization and in day-to-day water and sanitation issues. Exploring possibilities to increase the involvement of women throughout the project process, without overstepping traditional gender boundaries, will increase acceptance and understanding to the system. Other equity issues are also considered when dividing project contributions among the beneficiaries. The following specific tasks are recommended to satisfy this element:

□ Understand the traditional structure of community projects.

- Is there a history of community projects? (people working together for the common good)
- How are community projects traditionally organized?
- Who determines what projects will require community effort? (Local action planners, leaders)
- Who directs the work? (foreman, village chief, committee)
- Who performs the work?
- Are there culturally determined roles that must be respected?

- Do all households contribute? How?

□ Consider the seasonality of labor in setting the timeline.

- When will laborers be available?
- Consider employment schedules, migratory patterns, planting, harvest, holidays, weather

□ Explore options for increasing gender equity in project roles and capacity building.

- What role do women traditionally play in community projects?
  - Construction projects
  - Communal agricultural efforts (harvest, planting, irrigation)
  - Operation of water and sanitation services
- What roles do women feel comfortable playing?
- Are there ways to increase the involvement of women in the current project?
  - Ex: Bringing water to the site for mixing concrete or cleaning the work site.
  - Ex: Train them in operation and maintenance

□ Confirm that labor and resource contributions are equitably divided.

- Among households?
- Among ethnic groups?

Element: 3,2 (Design/Action Planning, Community Participation)

This element will finalize community acceptance of the project design and develop an action plan for its implementation. The selected project design will be reviewed with community members for feedback and refinement. The design will be approved through a process of community consensus. This illustrates community buy-in to the project and acts as an advertising tool to increase general knowledge of what is planned. An action plan is discussed with the community to clarify the roles and responsibilities of all parties involved. The action plan includes a list of tasks that will be performed and the timeframe in which they need to be completed (before, during, or after construction). The action plan should be as detailed as possible, so that all tasks are taken into account. It is important that the community participates in assigning the roles and responsibilities to the appropriate individuals. Development workers may help by clarifying certain technical responsibilities and roles to fill, but the ultimate decisions will rest with the community. A project timeline will be discussed and agreed upon between project participants. It is important that participants approve of the action plan and are aware of their responsibilities. The following specific tasks are recommended to satisfy this element:

□ Community input is solicited in refining the selected technical design.

□ Final technical design is approved through a process of community consensus.

□ Community members are involved in identifying and sequencing tasks that will be incorporated into an action plan.

- What concrete tasks need to be accomplished?
  - Gathering supplies and finances
  - Arranging legal requirements for project work (land/water rights)
  - Storing materials and equipment
  - Recruiting skilled and unskilled laborers
  - Construction work

    - Construction supervision
- Who will be in charge of completing these tasks?
    - Community members or someone from outside the community?
    - Managerial roles (oversight, consulting, informing other of the work, managing resources)
    - Labor roles
- Is there a management system in place?
    - Is there an existing water board or committee?
    - Will it be necessary to establish a governing board for the system?
- When do these tasks need to be completed?
    - Develop a timeline
    - Set a schedule for task completion
- How will the project be promoted in the community?
- Who will receive technical/ operational training?
- Who will receive health education (hygiene, hand-washing, proper use of system)?
- Are assumptions in roles and contributions explicitly stated? (Ex: If community members will provide labor, meals for workers, or tools)

□ The community members and development workers approve of the timeline and responsibilities laid out in the action plan.

- Are the roles and responsibilities of individuals and organizations explicitly stated?
    - Performing the work
    - Overseeing progress
    - Consulting
    - Informing others of the work
    - Managing resources
- Are all parties aware of their own roles and responsibilities, as well as, those of everyone else?

- Are the skills, knowledge and attitude of individuals factored into role assignments?
- Does the timeline include tasks to be completed by both community members and development workers?
- Does the timeline include dates for the community monetary contribution paid, resource gathering, start of work, expected progress, completion?

Element: 3,3 (Design/Action Planning, Political Cohesion)

Developing an action plan at the institutional level requires the same steps as at the community level. Partner institutions will be involved in identifying the tasks and delineating the separate roles and responsibilities of each group involved in the project (supervising, funding, information exchange, progress reporting, oversight and monitoring). It is important to remember that the role of some partners may merely be to be informed (government officials, religious leaders). The action plan includes financial arrangements, a realistic timeline for funding paid, work completion, and reporting requirements that considers the limitations and deadlines of each organization. Ultimately, a written action plan that defines tasks and responsibilities needs to be approved by the coordinating officials. In some areas it will be necessary to get the technical design approved by the authorities. The following specific tasks are recommended to satisfy this element:

□ The roles and responsibilities of partner institutions are defined in a detailed action plan.

- What level of involvement is each organization willing to commit to?
  - Financial support
  - Consulting
  - Sub-contracting
  - Training and Education
  - Direct community involvement
- What specific reporting or procedural requirements does each organization need?
  - Progress and monitoring reports
  - Contracts
  - Site visits
  - Education or capacity building activities
  - Other paperwork
- Who needs to be informed of project activities?
- Who will supervise the project?

- Who will monitor progress?
- Who will work directly with the community?
- Who will recruit skilled laborers?

□ Agree on financial commitments.

- Who will contribute to project financing?
  - How much?
  - When will funds be available?
- Who will control the project budget?
- What strings are attached to institutional funds?
  - Earmarks
  - Reporting requirements

□ A timeline is drafted that meets the requirements of all institutions involved.

- What are the funding and reporting schedules of the institutions?
- When will work start?
- When are progress and final reports due?
- When will work be completed?
- Are institutional deadlines respected?

□ Final project design and action plan are presented to partner institutions and local, regional, and/or national level authorities.

- Are all parties aware of their role and the timeline agreed upon?
- Have all parties seen the finalized design? (Even if they are not directly involved, they appreciate being informed.)

Element: 3,4 (Design/Action Planning, Economic Sustainability)

This element includes confirmation of the budget and planning for resource procurement. The design and action plan are interconnected and several iterations may be necessary to increase cost effectiveness. Planning for the cost and choice of materials, procurement methods, and construction techniques may result in adjustments to the project design. The costs and availability of resources must be verified before the budget can be finalized. Cost effectiveness can be increased by using local prices, resources and labor whenever possible. A community liaison can suggest market prices and the possibility of manufacturing supplies or equipment on site. Many communities have local craftsmen that are ingenious at improvising tools or replicating work. The community contribution is finalized during the planning process. Commitments must be made for monetary and non-monetary contributions prior to the start of construction. Non-monetary contributions can consist of labor, tools, building supplies, and transportation. When the supply list and the community contribution have been discussed, the budget can be finalized to reflect the local situation. An action plan for resource procurement can be developed with a detailed schedule for material purchase, transporting, and manufacturing. Allow sufficient time for unexpected delays so that the construction process is not held up by deficiencies in resources. The following specific tasks are recommended to satisfy this element:

□ Verify the costs and availability of resources.

- Present an itemized budget for review by community members (they understand the local market)
- What are the local prices?
- Do they fluctuate? By how much? (It is best to verify prices as close to the purchasing time as possible)
- What is the currency conversion rate in the country? (Check the rate on the open market as it can differ from the official rate)
- Can anything be improvised or constructed on site?

- What about transportation costs?
- What do laborers cost? Unskilled? Skilled?
- Does the cost of labor vary depending on the time of year? (issue of availability)
- Are costs for training included in the budget?

□ Confirm the community contribution for money, materials, equipment, tools, and labor.

- Who will provide the monetary contribution? How much?
- Who will provide tools and equipment?
- Is there a storage area for large tool and construction supplies?
- How many laborers can the community contribute?
- Will meals be provided for laborers? By whom?
- Who will provide for food and housing for trainers from outside the community?
- Are individual contributions consistent with their ability to pay?
- The community makes a formal commitment to the agreed contribution.

□ Finalize budget based on local costs, available resources, and community contribution.

- Include a contingency plan for unexpected costs.
- Can the budget adjust for alternative plans if required materials become unavailable?

□ Develop an action plan for resource procurement.

- When will materials be required throughout the construction process?
- Where will materials be purchased? By whom? When?
- How will they be transported to the site?
- Is manufacture of materials required?
  - Ex: breaking rocks into gravel or blacksmithing of parts
  - How long will it take?
  - How far in advance can it be performed?

- Are skilled laborers required?
  - When are they available?
  - Is a signed contract required?
- Who will arrange for unskilled laborers?

Element: 3,5 (Design/Action Planning, Environmental Sustainability)

The final design and action plan propose methods for minimizing ecological impacts and encouraging the use of renewable resources during the construction and use stages. If the final design is changed from the conceptual design, a site impact assessment should be repeated. Efforts to control and minimize waste, energy use, and ecological disturbance are part of the final design. The project is designed to operate on renewable and/or recyclable local resources. The abundance of these resources is considered, so that increased use does create other problems of resource scarcity (wood, water, fuels). The action plan includes environmentally responsible methods for resource procurement, construction, and future use. The action plan may be dictated in part by the seasonality of resource availability and site access. Certain resources may not be accessible at various times of the year due to flooding, snow, or drought. Construction related planning identifies potential environmental impacts and mitigation techniques (erosion control, temporary water sources, and waste disposal methods). The following specific tasks are recommended to satisfy this element:

□ The final project design minimizes ecological disturbance, energy use and waste emissions.

- How different is the final design from the conceptual design? Does the site impact assessment still hold true?
- Have all environmental impacts been considered during the design process?
- Have efforts been made to reduce these impacts?
- Is energy saving technologies used?
- Are secondary treatment options implemented where appropriate?
- Are there methods for monitoring environmental impacts during the project life?

□ The project design uses renewable and/or recyclable local resources.

- Are local alternatives to imported materials considered during the design development?

- Are these resources abundantly available?

□ The action plan considers the seasonality of resources.

- When is the site or resource accessible?
  - Will flooding affect site accessibility; by boat, by road?
  - Ex: Sand may only be available when the rivers are low.
- Will the size, availability, and productivity of the labor pool vary with the season?
- What time of year is best for construction?
  - Rain
  - Temperature

□ Develop an environmental action plan to mitigate impacts during construction.

- Use of erosion control techniques
- Consideration of temporary water sources
- Non-invasive construction methods
- Waste disposal
- Site restoration needs after construction

Element: 4,1 (Implementation, Socio-cultural Respect)

Throughout the construction process it is important to respect the normal routine and customs of the local community. Traditional work hours and ethics are assessed and a realistic work schedule set accordingly. Conflicting demands for labor or equipment will affect the construction timetable. The work schedule should also accommodate for unexpected delays and work stoppages, such as funerals, religious observances, or markets. Attempts must be made to involve beneficiaries in some part of the construction process to foster an early sense of ownership. The role of women is often neglected during this life stage. Methods for encouraging the involvement of women need to be explored. Public gatherings can be used during construction to review the benefits of the project and eventual operation and maintenance needs. Other topics in water and sanitation (proper water use, waste disposal, and hygiene) can also be covered throughout the construction process, possibly including the training of community members to continue this education. The following specific tasks are recommended to satisfy this element:

□ Set a realistic work schedule, based on available resources and preferred work styles.

- What is a typical work day?
- What time do communal work projects normally start? And finish?
- What are expectations for breaks and meal times?
- Are there certain days of the week that work can not be performed?
  - Religious observances
  - Markets
- Are there conflicting labor demands (harvest, planting, regular jobs) that affect the availability of personnel?
- How will the availability of equipment limit work?
  - Ex: How many shovels are there? (It will limit the number of workers at one time.)

□ Scheduling includes float time to allow for unexpected.

- Is time allowed for unplanned social functions such as, funerals, soccer games, or religious observances?
- What are the consequences of not planning for unexpected events?
  - Incomplete project requirements
  - Going over budget
  - Angering people by working through social events
  - Conflicts between development workers and community members

□ Encourage the involvement of women throughout the construction process.

- Can they collect sand and gravel? Or sift the sand and gravel?
- Can they bring water to the construction site?
- Can they fill management roles?
- Are they included in capacity building exercises? (Including technical and managerial skills.)

□ Use public gatherings to review benefits of the project, promote education, and discuss operation and maintenance.

- Are all project beneficiaries included?
- Can the project functions and benefits be demonstrated?
- Are project updates given?
- Can hygiene education or other health topics be presented?
- Can people be trained in health education?
- Can this time be used to plant the seeds of operation and maintenance requirements and organizational needs?

Element: 4,2 (Implementation, Community Participation)

Much of the community participation in construction is focused on increasing the local knowledge base and management capacity through technical and organizational training. Capacity building can be achieved through education and skills transfer throughout the construction process. Management capacity will be increased by allowing the community to implement the action plan they developed. Community leaders will meet regularly with the development workers throughout the construction process to review the action plan, make program changes, and address any unforeseen issues. Both sides should ask for evaluations of progress and feedback on any adjustments that might be needed. Project managers need to work closely with the local foreman or supervisor to manage work crews and control daily construction activities. Training local laborers in new techniques or tools introduced during construction will increase the local capacity to perform operation and maintenance. Once the system is built, community members can finalize plans to manage the system. The following specific tasks are recommended to satisfy this element:

□ Involve the community in revisions of the action plan, program changes, and problem solving.

- Is everyone aware of their responsibilities?
- Do development workers meet regularly with community leaders to review the action plan and program changes?
- Are mid-way evaluations and progress monitoring conducted?

□ Work with a local foreman or work supervisor in organizing labor.

- Can a local representative help with the following activities?
  - Organize procurement and storage of materials and equipment.
  - Manage work crews and daily construction activities.
  - Daily briefing on the task to be accomplished.
  - Monitor and correct public safety concerns.

□ Train local laborers in any new techniques and tools that are introduced.

- Can health and hygiene education be included in the training?
- Does the training include construction techniques and procedures for operation and maintenance?
- Can operation personnel be selected from laborers who show the most aptitude for the system?

□ Finalize the management plan with respect to the “built” system.

- Is the community given complete specifications for the equipment and operating system, including manuals and specific training for operation and maintenance?
- Are community members involved in planning for operation and maintenance?
- Is responsibility for the system officially transferred to community?

Element: 4,3 (Implementation, Political Cohesion)

The objective of political cohesion during implementation is to maintain the communication networks that were set up during the planning phases. It is important to continue knowledge transfer and information sharing between agencies. Other local organizations can provide assistance by sharing construction experience, promotional techniques, education or technical skills. They may be able to provide local trainers, skilled laborers, or advice on unforeseen problems. The appropriate authorities are informed of the commencement of construction and any major changes in the design. As a way of showing respect and encouraging involvement, local government and NGO officials are invited to view the construction site. Throughout the construction process, it is important to continue planning discussions with the partner organizations who will be concerned with operation and maintenance. The following specific tasks are recommended to satisfy this element:

□ Contact institutions in the area for assistance in training and labor requirements.

- Do they have training instructors who speak the local-language?
- Can they provide technical training or supportive education programs?
- Do they have skilled laborers for hire?
- Can they benefit from involvement in the project? (shared trainings)
- Are partner institutions invited to be involved in training exercises?

□ Inform partner institutions of the start of construction, project milestones and major changes.

- Are progress reports and evaluations shared?
- Is consideration given to how major changes in the design or implementation schedules may affect partner interventions or the government regulatory processes?

□ Invite local government and NGO officials to view the construction site.

- Are the "right" officials invited?
- Are efforts made to include everyone that could be interested or have a stake in the project?

□ Discuss partner roles in operation and maintenance.

- Is agency involvement necessary?
- What role can government and donor agencies play in operation and maintenance of the system?
  - Monitoring and evaluations
  - Promotional activities
  - Financial support
  - Providing training and/or payment for maintenance personnel
  - Equipment or support services
  - Ex: Can the municipality (or private company) provide vacuum tanker trucks for emptying latrines?
  - Ex: Can they train technicians to fix the hand pumps next to the community wash area?
- Do partner agencies have the capacity to address these roles?
- Do other agencies need to be recruited to help with operation and maintenance issues?
- Can a tentative agreement be made on an action plan for system operations?

Element: 4,4 (Implementation, Economic Sustainability)

Economic efficiency during construction translates into monitoring expenditures and keeping track of resources. The community assists in the project implementation through labor or resource contributions. Resource contributions are provided prior to the start of construction to keep the project on schedule. The quality of materials and equipment is rechecked during procurement, to insure the durability of tools and physical structures. A reliable person or committee is in charge of gathering, storing, and monitoring the use of money and resources throughout the implementation phase. The budget and financial action plan guide the use of resources, especially concerning the use of community contributed labor, supplies, tools, lodging, and food. However, the design and schedule may need to be adapted for unforeseen events. In some instances it may be necessary to explore options for improvising tools and equipment with local resources in order to stay within budget. At the end of construction a final report on the budget, including community costs, is shared with community members so that they can appreciate the value of their inputs. The following specific tasks are recommended to satisfy this element:

□ Community members contribute to project implementation.

- Are resources (monetary or non-monetary) collected prior to the start of construction?
- Is labor for construction provided?
- Is someone keeping track of all contributions? (cash, labor, food shelter, land, materials, and water rights)

□ Recheck the quality of materials and equipment during resource procurement.

- How sturdy are the tools? Can the hold up under strong use?
- What is the quality of the aggregate? Is it acceptable? Does it require cleaning/sifting?
- Are better quality options available? What will they cost?

- If not, will the design need to be modified?

□ Monitor spending and budget restrictions throughout the project implementation phase.

- Is someone keeping track of when material and equipment purchases are over budget?
- Is a reliable person or committee is in charge of gathering and keeping track of resources?
- Can a respected community member with accounting experience (i.e. village treasurer) be used?
- Are they able to keep records of resources, collect receipts, and arrange for the storage of materials?
- Is a culturally appropriate system of accountability discussed?
- Is a responsible party in charge of labeling and storing spare parts after construction?
- Are procurement and construction schedules processing on-time?
- Are extra fees required to keep the project on schedule?
- Can the budget be adjusted to accommodate for changes?
- How much can the contingency plan cover?
- Are options to improvise tools and equipment explored when necessary?

□ Draft final report on the budget and share with community members and partner organizations.

- Are final costs calculated?
- Is an itemized list of community contributions and their cash equivalents included? Is it shared with community?
- Are financial repayment schedules reviewed? (if individual or community loans were used to finance the project)

Element: 4,5 (Implementation, Environmental Sustainability)

Environmental sustainability issues during construction center on ensuring that construction does not increase stress on the environment. Construction must minimize ecosystem disturbance by avoiding the destruction or contamination of natural areas (deforestation, excess runoff and erosion during construction, waste production). It is important to recheck physical and environmental constraints on the design because conditions may have changed since the design was finalized. Special precautions are taken to avoid contaminating existing water resources. A waste management plan can reduce environmental damage by organizing the disposal of any wastes that are produced. Involving the community in the development and implementation of a waste management program for construction encourages awareness of environmental issues. Project implementation also includes restoration of any areas that are disturbed during construction. The following specific tasks are recommended to satisfy this element:

□ Recheck physical and environmental constraints used in the project design and make design corrections if necessary.

- Groundwater levels
- Soil infiltration rates
- Soil conditions
- Temperature
- Stream and river flow rates
- Evaporation rates

□ Take precautions to avoid contaminating existing water resources and minimize environmental impacts during implementation.

- Are erosion control methods used during resource extraction (sand, gravel, rock, timber) and construction?
- How can energy or fuel use be reduced? (transportation, extraction needs)
- Can the transport of materials (esp. of heavy equipment) be minimized?

- Can packaging be recycled?
- Are wells covered near the construction sites?
- Are temporary water sources and/or sewage disposal methods used?

□ Involve the community in waste management and environmental education.

- Are there plans to properly dispose of any waste that is produced?
- Are efforts made to minimize solid waste and energy use?
- Can community members implement the waste management plan?
- Are community members educated on waste management practices?
- Can other environmental issues be discussed?
- Can down time during construction be used for informal education sessions?

□ Restore any areas disturbed during construction.

- Is the site cleaned-up after construction?
- Are disturbed ecosystems restored?
- Is maintenance of these areas needed and planned for?

Element: 5,1 (Operation/Maintenance, Socio-cultural Respect)

It is difficult to judge the community acceptance of a project until it is put into use. There will inevitably be unforeseen cultural constraints (power struggles, unwillingness to pay, inconvenient operating schedule, or technology preferences). Community leaders and development workers must work together to identify and address as many of these as possible. There may be separate cultural issues behind use of the system and maintenance schedules. Alternatively, certain aspects of the project may be more successful than others. Socio-cultural constraints can be revisited and discussed now that the system is more fully understood by all parties. There may be differences in how men and women use the system or perceive its benefits. A reassessed of gender roles can ensure proper use and understanding of the system. Community acceptance of the system is strengthened when project benefits and costs are shared equitably among the users. All user groups (men, women, ethnic minorities) should be satisfied with their share and their role in operation and maintenance. The following specific tasks are recommended to satisfy this element:

□ Discuss unanticipated constraints to system use.

- Why do people not use the system?
  - Distance from home
  - Latrines are full
  - Insufficient water
  - Inconvenient operating schedule
  - Unwillingness to pay
  - Smell or insects
- Is the system being used properly?
  - Is it cleaned?
  - Is it used for the intended purpose?
  - Ex: latrines: Are they being overloaded with water or additional waste? Is the use of twin pits alternated?
- Did people receive instruction on proper use of the system?

□ Discuss unexpected limitations to maintenance schemes.

- Did people trained in system maintenance leave the community?
- Is performing maintenance seen as shameful or dirty work?
- Are there traditions, taboos, or fears that were overlooked in project planning?
  - Ex: Cultural unwillingness to handle excreta (even when decomposed)

□ Reassess how gender roles affect the proper use and perceived benefits of the system.

- Are both men and women aware of proper operating rules?
- Have both men and women adopted appropriate behavior changes?
  - Ex: A study in Ghana found that men had changed their latrine habits due to a hygiene education program, but women, who were not involved, kept up bad practices (Pickford, 1995).
- Who cleans the system?
  - Ex: Study of latrine cleanliness in Dar es Salaam found that conditions were better when the male head of the household cleaned rather than a wife or child (Pickford, 1995).
- How can differences be addressed?

□ Ensure that costs and benefits are equitably distributed within the community.

- Are equitable user fees and operating rules agreed on within the community?
- Do community members have equal access or opportunity to receive services?
  - Ethnic groups
  - Gender
  - Income groups/Casts

Element: 5,2 (Operation/Maintenance, Community Participation)

The community must be involved in performing and overseeing the operation and maintenance of the project and support structures. Community members must be trained on how to properly operate and maintain the project. The training should foster the technical capacity for maintaining training levels, retraining, upgrading skills, and training replacements. It is important to solicit community feedback on project goals and results through a participatory project evaluation. The results will identify problems and provide suggestions for improvement in project implementation, operation, and maintenance. A community management committee is needed to implement suggestions and solutions identified in the evaluations. The community selects representatives to serve in management and oversight capacities. In some cases it is possible to build on existing roles and strengths within the community by empowering the local users' organization, such as a water board or women's committee. The committee plans for turnover, collection of fees, managing workers, and maintenance schedules. Community management encourages ownership of the system and allows operation and maintenance schedules to be adapted as needed. Control of the system will empower certain individuals in the community. These people should be selected based on their traditional position in society, as well as their skills, dedication, and dependability. The following specific tasks are recommended to satisfy this element:

□ Community members are actively involved in performing the necessary operation and maintenance.

- Are the operation/maintenance tasks handles locally?
- Has staff been trained?
- Are operation/maintenance requirements documented and available to the community?
- Is a transition plan in place to train replacement staff?
- Are continuing training plans in place?
- Are operation/maintenance responsibilities clear?

□ Conduct a participatory evaluation to get community feedback and suggestions for improvements.

- Are a variety of community members involved in the evaluation?
- Was the project perceived as a success? Why? Why not?
- How can system functioning be improved?
- How can utilization of the facilities be improved?
- Were their suggestions for improvements taken into account on the existing system?
- Does the feedback provide suggestions for improving future projects?

□ A community organization exists with the capacity to make decisions regarding the operations and maintenance of the system.

- How will the community contribute to system maintenance?
- Who will take care of preventive maintenance, and repairs?
- Can the community control who is hired to operate and maintain the system?
- Is an attendant necessary to oversee the system (i.e. public water taps or latrines)?
- How will the attendant be paid?
- Who collects fees?
- Who will keep records and accounting reports?
- Can the community implement suggestions for improvement?
- Can the organization contact other agencies for help if needed?

□ The system is controlled by culturally appropriate and traditionally respected people.

- Do community leaders determine roles and responsibilities of an oversight committee?
- How are operation and maintenance managers selected?
- Are they selected for their dedication and dependency? Or political reasons?
- Is the oversight committee susceptible to elite capture?

Element: 5,3 (Operation/Maintenance, Political Cohesion)

An important step at the beginning of the operation stage is the opening ceremony. This symbolic event is a chance to pass over the "keys" to the local community and authorities. Local government officials and partner institutions, especially those involved in project planning, financing and implementation, need to be invited to attend this event. Ultimately, successful systems are integrated into a regional support network throughout their life. Developing a unified approach to operation, maintenance, monitoring, and evaluation will improve the overall governance of the system. Organizations that play active or supporting roles during the operational stage are active in this stage. There may be potential for coordinating technical training sessions, skill upgrading, education, and cross training between institutions. If institutional aid is required, the donors should commit to the funding for the operational life of the project or plan for financial turnover to appropriate authorities. Execute a formal agreement that specifies the roles and expectations of the coordinating organizations. Using a locally based organization for monitoring and evaluation can improve accuracy and frequency of reporting. The monitoring reports and project evaluations can be shared with all partner institutions so future projects can build on the existing body of knowledge. The following specific tasks are recommended to satisfy this element:

□ Invite officials to the opening ceremony.

- Are all participants from planning and implementing stages included?
- Are appropriate local and regional officials included?
- Is credit and thanks given to all who helped?

□ Coordinating institutions sign a formal agreement that defines their roles and expectations in operation and maintenance of the system.

- What roles will government and donor agencies play in operation and maintenance of the system?
  - Monitoring and evaluation reports
  - Promotional activities

    - Financial support
    - Providing training and/or payment for maintenance personnel
    - Equipment or support services
  - Who will fill these roles?
  - How often are services or support expected?

□ A locally based institution is involved in project monitoring.

  - Do they double-check/monitor technical aspects?
  - Can they help in refining management structures?
  - Do they keep in touch with any changes in local practice?
  - Are partners contacted for follow-up and adjustments if problems arise?
  - Do they reach out to regional peers to share knowledge and resources?

□ Share monitoring reports and project evaluations with partner institutions.

  - Are periodic reports on operations and maintenance shared?
  - Are financial report shared, if appropriate?

Element: 5,4 (Operation/Maintenance, Economic Sustainability)

The finished system often includes modifications to the original design, so it is important to revisit the original cost estimations for operation and maintenance and adjust them appropriately. Based on the revised information a realistic financing scheme is developed to cover the costs of operation and maintenance. The financing scheme covers monetary, resource, and labor costs for operation and repairs. Financing options include user fees, community taxes, income generation, and institutional aid. If the project is not financially self-sufficient, it must be supplemented by user fees and/or institutional aid. Community user fees must be affordable given the local economy and community willingness to pay. A financial management organization can oversee system operation by arranging for the payment of fees and encouraging economic incentives for system upkeep. This organization has the ability to regulate access to project benefits in accordance with contributions to operation and maintenance costs. Finally, financing needs to be reviewed regularly and updated to account for unforeseen costs and changes in the economic environment. The following specific tasks are recommended to satisfy this element:

□ Estimate realistic, long-term operation and maintenance costs based on the "built" system.

- Are costs for materials, replacement parts, and skilled personnel included?
- What labor efforts are needed to keep the system running?
  - Cleaning
  - Emptying for latrines
  - Oiling of mechanical parts
  - Repair of supply lines, tanks, and other physical structures
- How often will materials and parts need replacement?
  - Chemicals for water treatment
  - Spare parts
- Where will replacement materials and parts be purchased?
- What about transport costs?

- What are the minimum costs to keep the system running?
  - Daily
  - Weekly
  - Monthly
  - Annually

□ Financing exists to cover projected operation and maintenance costs.

- Are there monetary needs to keep the system running? Labor needs?
- How will these needs be met?
  - User fees
  - Community taxes
  - Labor contributions
  - Institutional aid
- What is an appropriate fee for use? What are people willing to pay?
- Who collects the fees?
- Who will provide labor for upkeep and repairs?
- Is outside aid provided?
- Are there mechanisms for getting outside aid if needed?
- Are there options for cost recovery?
  - Ex: Sale of latrine waste for fertilizer
  - Ex: Raising fish in irrigation ponds

□ A financial management organization exists to manage operational/maintenance costs and the distribution of benefits.

- Does this organization have the capacity to collect and account for monetary contributions? Labor contributions?
- Can it keep track of the beneficiaries?
- Is there a correlation between payments and benefits received?
- Is this organization controlled by the community?
- Is the role of this organization recognized and respected at all levels of governance?

- Is the organization appropriate to the project size and community?

□ Regularly review and adjust the financing system.

- Is the financing system reviewed on a regular basis?
- Can it be adjusted for inflation and changes in resource availability?
- Can it adjust for changing demands and perceptions of the project benefits?
- Can it adjust for social constraints (non-payment of fees, under/over utilization)?
- Can fees/labor needs be changed?
- Can support from partners be adjusted?

Element: 5,5 (Operation/Maintenance, Environmental Sustainability)

The project needs to be environmentally sustainable throughout its operational life. It is important to minimize and treat waste products to avoid pollution and negative impacts on the local ecosystem. Adaptive environmental management techniques can evaluate the impacts of the system and explore options for improvement. Operation and maintenance schedules must include monitoring plans for waste discharges, natural resources protection, and material use. Pay special attention to secondary environmental impacts that were not anticipated in project planning. Explore alternative plans for reducing the use of consumables, including replaced parts and energy or fuel consumption (batteries, fuel products, plastics, chemicals), and implement them where appropriate. The results of environmental impacts and management evaluations can be included in on-going community education. Continuing conservation and hygiene education during operation and maintenance reinforces behavioral change and encourage environmental stewardship. The following specific tasks are recommended to satisfy this element:

□ Minimize, treat, and dispose of waste properly.

- Is there waste resulting from the use of the project?
- Is waste properly treated?
- Is the creation and disposal of project related waste monitored and reported?
  - Wastewater
  - Runoff water/Grey water
  - Used parts and equipment
- Are monitoring reports and treatment procedures checked by a managing organization?

□ Explore alternative plans for reducing the use of consumables.

- What consumables are used during operation/maintenance of the project?
  - Chemicals in water/sanitation treatment
  - Spare parts

    - Fuel/Batteries
    - Plastics (PVC, liners, bottles)
    - Filters
    - Packaging
  - Are there ways to reduce the amount of material consumed?
  - Are alternative sources of parts, materials, or energy periodically explored?
  - How does usage of consumable parts and energy compare with similar projects?
  - Are potential alternatives tested?

□ Monitor and evaluate environmental impacts.

  - Is the site periodically surveyed to check for impacts?
  - Is a methodology in place for impact assessments?
  - Are secondary impacts considered?
    - Does an improved water supply change disposal habits for grey water? Where? How much?
    - If water sources are closer to home, does it bring sanitation problems closer to home?
    - Are there runoff problems around the tap stands?
    - Are people using more water now than before?
  - Are the systems functioning properly?
    - What are the environmental impacts if the system malfunctions?
    - Sanitation systems in particular can have negative impacts if not properly maintained.
  - Were restoration areas restored properly? And maintained?
    - If trees were replanted, are they watered?
    - If water was diverted from a source, is there enough overflow water to maintain the stream habit?

□ Continue environmental and hygiene education efforts.

  - Are community member aware of improvements since the system became operational? Or deterioration?

- Are supporting behavioral changes reinforced? (hand washing, proper trash and grey water disposal)
- Do people understand the benefits of improved systems?
- Are people motivated to continue to work for environmental improvements?
- Are people aware of their own role in maintaining a healthy environment?