A WATER SUPPLY AND SANITATION STUDY

OF THE VILLAGE OF GOUANSOLO IN MALI, WEST AFRICA

By

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A REPORT

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This report “A Water Supply and Sanitation Study of the Village of Gouansolo in Mali, West Africa,” is hereby approved in partial fulfillment of the requirements for the Degree of MASTER OF SCIENCE IN ENVIRONMENTAL ENGINEERING.

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Preface

D↘↘ni d↘↘ni k_↘n↘ni be ≓_aga da.

Bambara proverb

This study was conducted during my Peace Corps service in the village of Gouansolo in Mali, West Africa, where I served as a volunteer in the Water/Sanitation sector from 1999-2001. It was conceived during one of many "Why am I here?" episodes during my Peace Corps service. I conducted an assessment of the water supply and sanitation situation in the village in an attempt to find out why I was there and what I could do.

This report was submitted to complete my master's degree in environmental engineering from the Master's International Program in Civil and Environmental Engineering at Michigan Tech. This program combined Peace Corps service with a master's degree, two things on my To Do list. I was the first student in this program, a title that I am honored and proud to have.

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Acknowledgements

First I would like to thank the village of Gouansolo for treating me as a *d͡guden*, "a child of the village." There were many times that I did feel like a child, literally, but the village treated me as one of their own and took good care of me. There are too many *Gouansolokaw* to name, but I would especially like to thank my host father, Sayon K.˙ita, for treating me as his daughter, and my counterpart, Daouda Camara, for assisting me with data collection for the survey. *Aw ni ce! Aw ni b≒r≒ji!*

On this continent, special thanks goes to my advisor, Jim Mihelcic. Without him, none of this would have been possible and I would not be who I am and where I am today (as I am writing this, I am a tired graduate student, spending another late night in my office ☺ just kidding, Jim). I would also like to thank my committee: Blair Orr, Tom Van Dam, and Alex Mayer. Their interest and support throughout my time in Houghton and Mali is greatly appreciated.

Last but not least, I would like to thank my friends and family. Without them I would also not be who I am and where I am today. Thanks for writing letters, sending packages, and not forgetting about me while I was in Mali. Thanks to my Mali PCV friends and Team Siby for just being there.

Thanks to everyone who helped me through "the toughest job you'll ever love."

Abstract

Water supply and sanitation are two of the most important sectors in development. Access to water supply and sanitation are basic human needs and rights. Worldwide, 71% of the rural population has access to improved water supply and 38% has access to improved sanitation. In rural Africa, 47% of the population has access to improved water supply and 45% has access to improved sanitation, and in rural Mali the percentages are 61% and 58%, respectively.

The objective of this study was to assess the water supply and sanitation situation in the village of Gouansolo, a rural village in the southwestern part of Mali, West Africa. By conducting an assessment one can determine water supply and sanitation coverage and identify water supply and sanitation problems in the village and then propose solutions to improve water supply and sanitation coverage. Water supply coverage is defined as the percentage of the population with access to safe (improved) water supplies that provide 20 liters/person/day within one kilometer of the household compound. Sanitation coverage is defined as the percentage of the population with access to adequate (improved) sanitation facilities that hygienically separate human excreta from human contact.

When this study was conducted, the village had a population of 836 and was comprised of 46 households with an average household size of 18 persons. Forty-four households were included in the survey. There were 38 water sources in the village. The two types

of water supply technologies present were hand dug wells and borehole pumps. There are three types of hand dug wells: improved traditional wells, not improved traditional wells, and modern wells. Well depths ranged from 5.2 to 9.0 meters. Twenty-seven of the 38 water sources had water available year round, and all households had access to a water source with year round availability. The distance traveled to collect water ranged from 3 to 260 meters and the average distance traveled was 44 meters. Although all households had reasonable access to a water supply, not all households collected water from an improved source. The only improved water supply technologies in the village were two borehole pumps. Simple pit latrines were the only type of sanitation facilities present in the village and they are considered to be improved sanitation technologies. The findings of this study determined that 48% of the households in Gouansolo used improved water supplies (i.e., borehole pumps) and 91% used improved sanitation facilities (i.e., simple pit latrines).

The most common water supply problems reported were erosion at the top and bottom of traditional hand dug wells and seasonal availability of water in these wells. The most common sanitation problem reported was deterioration of latrine floors. It was proposed that the most appropriate improved water supply and sanitation technologies to use in the village are protected hand dug wells and simple pit latrines. The cost of cement to construct a 9-meter protected hand dug well was estimated to be $260 U.S., which exceeds Mali's gross national income per capita, $240 U.S. The cost of cement to construct a simple pit latrine was estimated to be $10 U.S. These estimates did not include the costs of other materials, tools, equipment, labor, and operation and

maintenance (O&M). Lack of financial means was identified to be the main obstacle to the improvement of water supply and sanitation and the achievement of 100% coverage in the village.

1.0 Introduction and Objectives

Water supply and sanitation are among two of the most important sectors of development (Bendahmane 1993). Development of community water supplies and sanitation results in improved social and economic conditions and improved health (Davis et al. 1993). The benefits of improved water supply and sanitation are many, including prevention of disease, improved basic health care, better nutrition, increased access to institutions such as health centers and schools, improved water quality, increased quantity of and access to water, reduction in time and effort required for water collection, promotion of economic activity, strengthening of community organization, improvements in housing, and ultimately, improved quality of life (Okun 1988).

At the beginning of 2000, one-sixth (1.1 billion people) of the global population did not have access to improved water supply and two-fifths (2.4 billion people) did not have access to improved sanitation. The majority of these people live in Asia and Africa. Africa has the lowest water supply coverage of the global regions (Africa, Asia, Latin America and the Caribbean, Oceania, Europe, and North America) and is second to Asia in terms of lowest sanitation coverage. In Africa, 62% of the population have access to improved water supply and 60% have access to improved sanitation, but the situation is worse in rural areas—only 47% of the rural population have access to improved water supply and 45% have access to improved sanitation (WHO/UNICEF 2000).

The objectives of this project were: 1) to assess the water supply and sanitation situation in the rural village of Gouansolo in Mali, West Africa and 2) to identify water supply and sanitation problems in the village and propose solutions to improve the village water supply and sanitation situation. The purpose of a baseline study such as this is to examine the existing water supply and sanitation systems and gather information in order to conduct a needs assessment and provide a starting point for potential water supply and sanitation improvement projects. This report provides an evaluation of the water supply and sanitation systems in the small, rural Malian village where I lived for two years, serving as a Peace Corps Volunteer water/sanitation extension agent.

In this report, Chapter 2 provides background information on Mali, including geographical, demographic, historical, political, and economic information on the country. Next, information on the water supply and sanitation coverage in Mali is presented. Coverage is defined as the percentage of people with access to safe and adequate water supply and adequate means of sanitation (WHO/AFRO 2000). Then, the purpose and objectives of Peace Corps Mali's Water/Sanitation Sector project are explained and a brief discussion of the activities that I performed during my Peace Corps service is included.

Chapter 3 discusses the methods used in this study. First it describes the theory and methods used while conducting fieldwork in developing countries. It then presents a literature review of references on methods that were consulted for this study. Finally it describes the survey used, the questions asked, and the means for conducting the survey.

Chapter 4 presents the results of this study, first describing the study area, the village of Gouansolo, in detail. It provides background information on the village and describes the current water supply and sanitation situation in the village. Problems with village water supply and sanitation are discussed and methods to improve the situation are described. Then the results of my survey are presented and a comparison is made to statistical data on water supply and sanitation coverage obtained from the WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation, and their similarities and differences are discussed. Selected methods to improve the village water supply and sanitation situation are proposed, along with the obstacles to improvement. Finally, suggestions for future work are presented.

Chapter 5 reviews the main findings of this study. Then I comment on the possibility of success of improving the water supply and sanitation situation in the village of Gouansolo and in other similar rural communities.

2.0 Background

This chapter provides geographical, demographic, historical, political, and economic background information on Mali and describes the water supply and sanitation situation in Mali. Then a brief history of Peace Corps Mali's Water/Sanitation sector and its purpose and objectives are presented.

2.1 Geography

The Republic of Mali is located in West Africa. It is a landlocked country that borders Algeria, Niger, Burkina Faso, C↖te d'Ivoire, Guinea, Senegal, and Mauritania (See Figures 2.1 and 2.2). It has an area of 1.24 million square kilometers, which is slightly less than twice the size of the state of Texas (CIA 2002).

The country is divided into three natural geographical and climatic zones: the southern, cultivated Sudanese or savannah; the central, semiarid Sahel; and the northern, arid Sahara Desert that covers approximately 60% of the total land area. The climate ranges from subtropical in the south to arid in the north. There are three main seasons: the hot, dry season from March to June; the rainy, humid, and mild season from June to October; and the cool, dry season from November to March (CIA 2002).

Natural hazards that the country are susceptible to are the harmattan, which is the dry, dusty wind which comes from the northwest coast of Africa during the dry season, and recurring droughts. Current environmental issues in Mali include deforestation,

desertification, soil erosion, declining soil fertility, poaching, and inadequate supplies of potable water (CIA 2002).

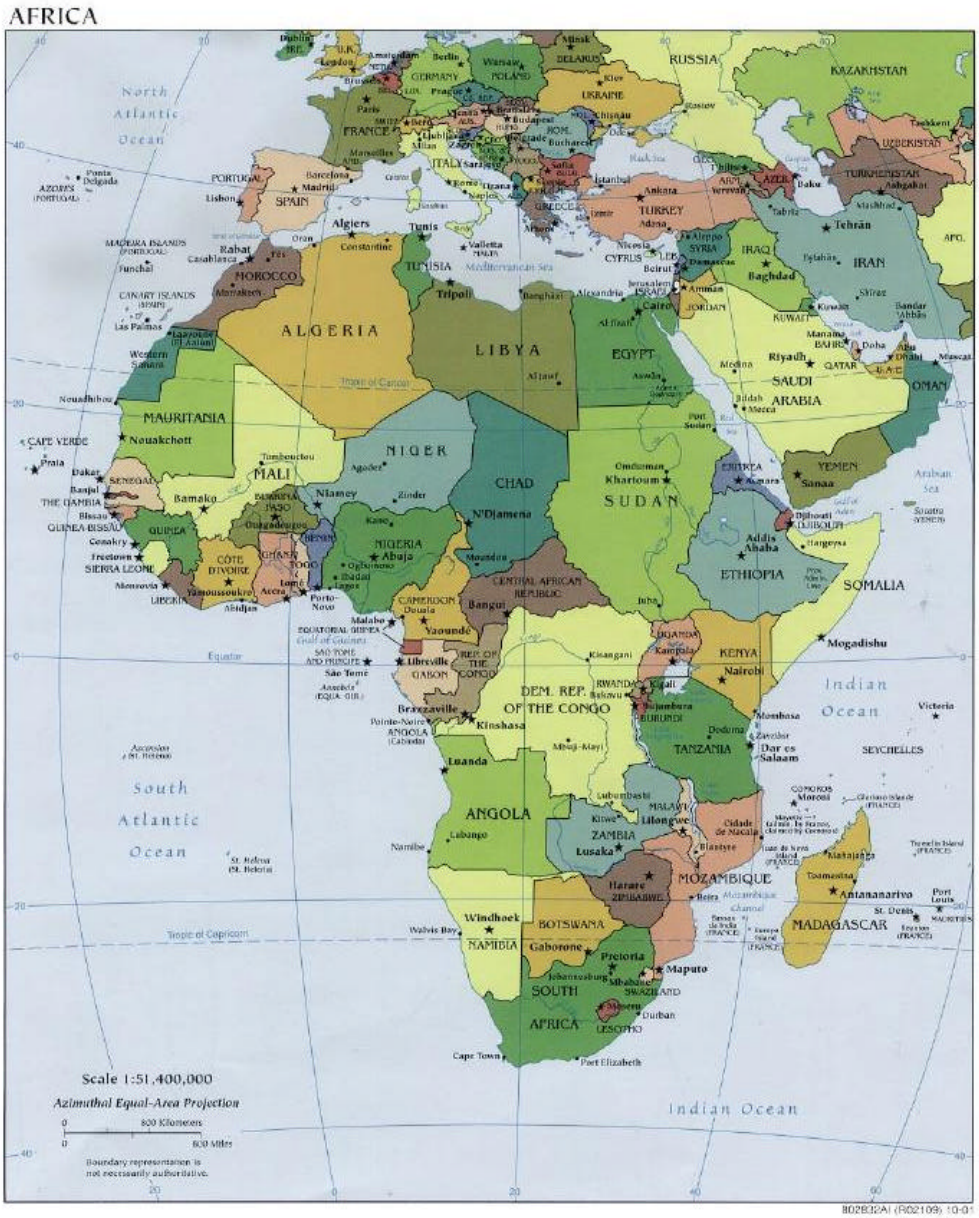

Figure 2.1: Map of Africa

Source: http://www.lib.utexas.edu/maps/africa.html

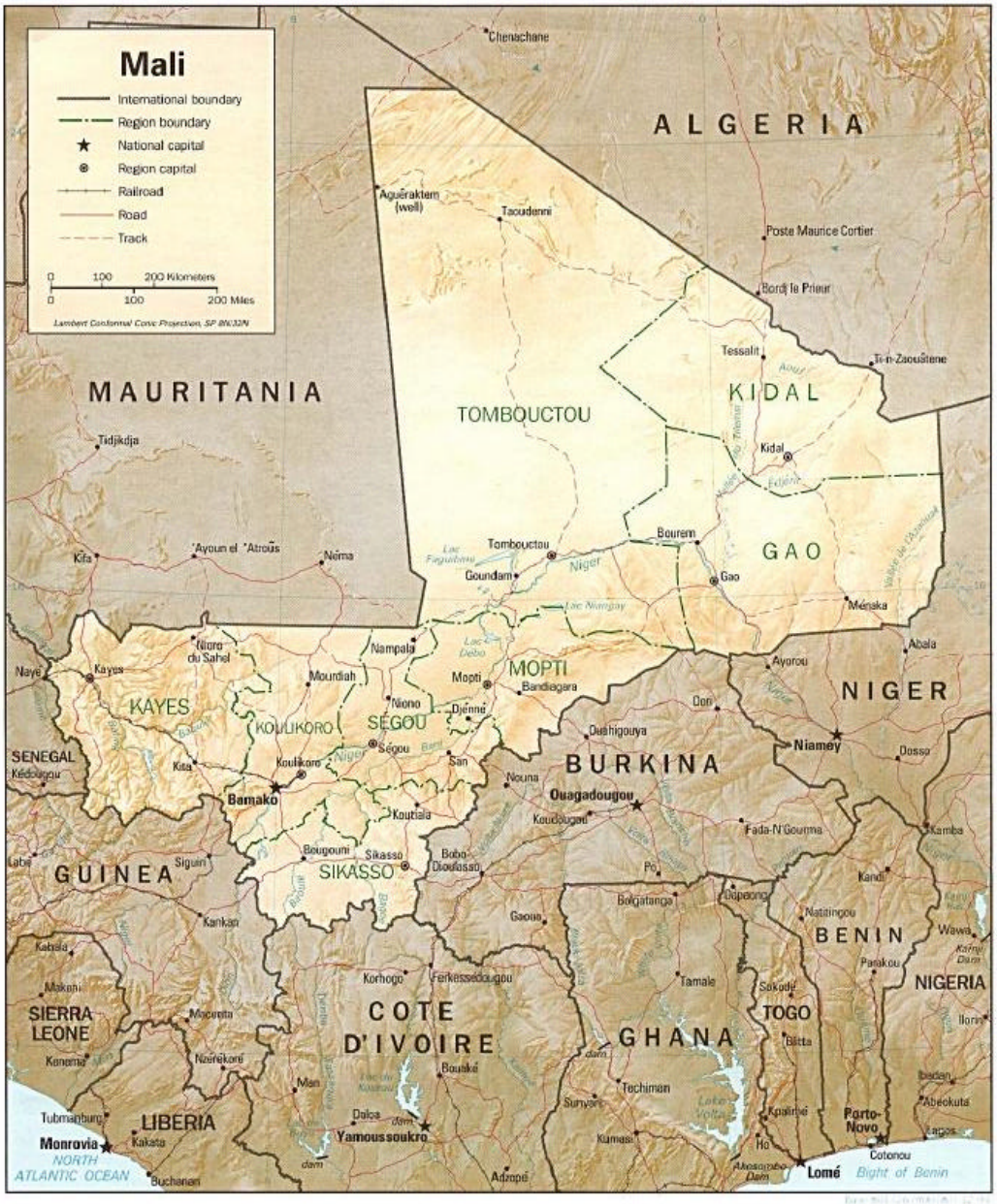

Figure 2.2: Map of Mali

Source: http://www.lib.utexas.edu/maps/africa/mali_pol94.jpg

2.2 Demography

Mali has a population of over 11 million according to July 2001 estimates (CIA 2002). The population is comprised of a mixture of ethnic groups: Mandɔ (Bambara, Malinkɔ, and Soninkɔ) 50%, Peul (Fulani) 17%, Voltaic (Senoufo and Minianka) 12%, Songhay 6%, Tuareg and Moor 5%, and other smaller ethnic groups 10% (U.S. Department of State 2000). French is the official language of Mali but Bambara is spoken by approximately 80% of the population and there are numerous other indigenous African languages spoken (CIA 2002). Mali's urban population consists of approximately 3.4 million people and its rural population is approximately 7.9 million (WHO/UNICEF 2000).

In order to understand the condition of human development in Mali a brief mention of some social indicators follows. According to 2001 estimates, the annual population growth rate is approximately 3%. The life expectancy of the Malian population is about 47 years (CIA 2002). Infant mortality rate is 142 per 1000 live births, and the fertility rate is about 7 children born per woman (UNICEF 2002). As of 1999, the literacy rate is 40%, and 28% of school aged children are enrolled in school (UNDP 2001).

2.3 History

Present day Mali is the "heir" to the succession of a number of early African empires, including the Ghana, Mali, and Songhay Empires that occupied West Africa and flourished between the 9th and 19th centuries (See Figure 2.3). These empires controlled the trans-Saharan trade which linked the North (European and Middle Eastern centers of

civilization) to Sub-Saharan Africa. The Ghana Empire, dominated by the Soninkɔ people, was a powerful trading state centered around the Mali-Mauritania border that lasted from the 9th and 12th centuries, reaching its height in the 11th century (Imperato 1996) and then falling to Muslim Berbers from Mauritania and Morocco (Lonely Planet 2002).

The medieval empire of Mali then emerged as the powerful state of the Malinkɔ people between the 12th and 17th centuries (Imperato 1996). It reached its height in the early 14th century and was a center of Muslim scholarship, with the cities of Tombouctou (Timbuktu) and Djennɔ being important centers of trade, learning, and culture (Encyclopedia.com 2002). Mali attracted the best architects and most renowned scholars in the Muslim world; mosques, universities, and libraries were built throughout the empire. The Mali Empire was also one of the world's chief gold suppliers. It spanned from the Atlantic Ocean in the west, almost to the present-day country of Chad in the east, from the Sahara Desert in the north, and to the rain forests in the south, covering more than three million square kilometers, and was centered around the Great Bend of the Niger River (Peace Corps/Mali Invitation Booklet 1999).

The Mali Empire was overtaken by the Songhay Empire which was centered around the city of Gao and rose to great power in the late 15th century. It encompassed much of the area that had belonged to the Mali Empire and part of the present-day country of Nigeria. The empire was destroyed by a Moroccan invasion in 1591 (U.S. Department of State

2000). During this time, European ships had been plying the coast of West Africa, circumventing the trans-Saharan trade route (Lonely Planet 2002).

France began to invade the area in the 1880s and by 1898 Mali, then called French Sudan, was a French colonial territory under complete control of the French and French Sudan became part of the Federation of French West Africa (Encyclopedia.com 2002). During French colonial rule numerous changes were made to the country's borders. In 1958 French Sudan joined the French Community as the autonomous Sudanese Republic, and in 1959 the Sudanese Republic joined Senegal to form the Mali Federation, taking its name from the Manding (Malinkʊ) empire of Mali (Imperato 1996). In 1960 Senegal seceded from the Mali Federation, the Sudanese Republic was renamed the Republic of Mali, and Mali obtained its independence from France (U.S. Department of State 2000).

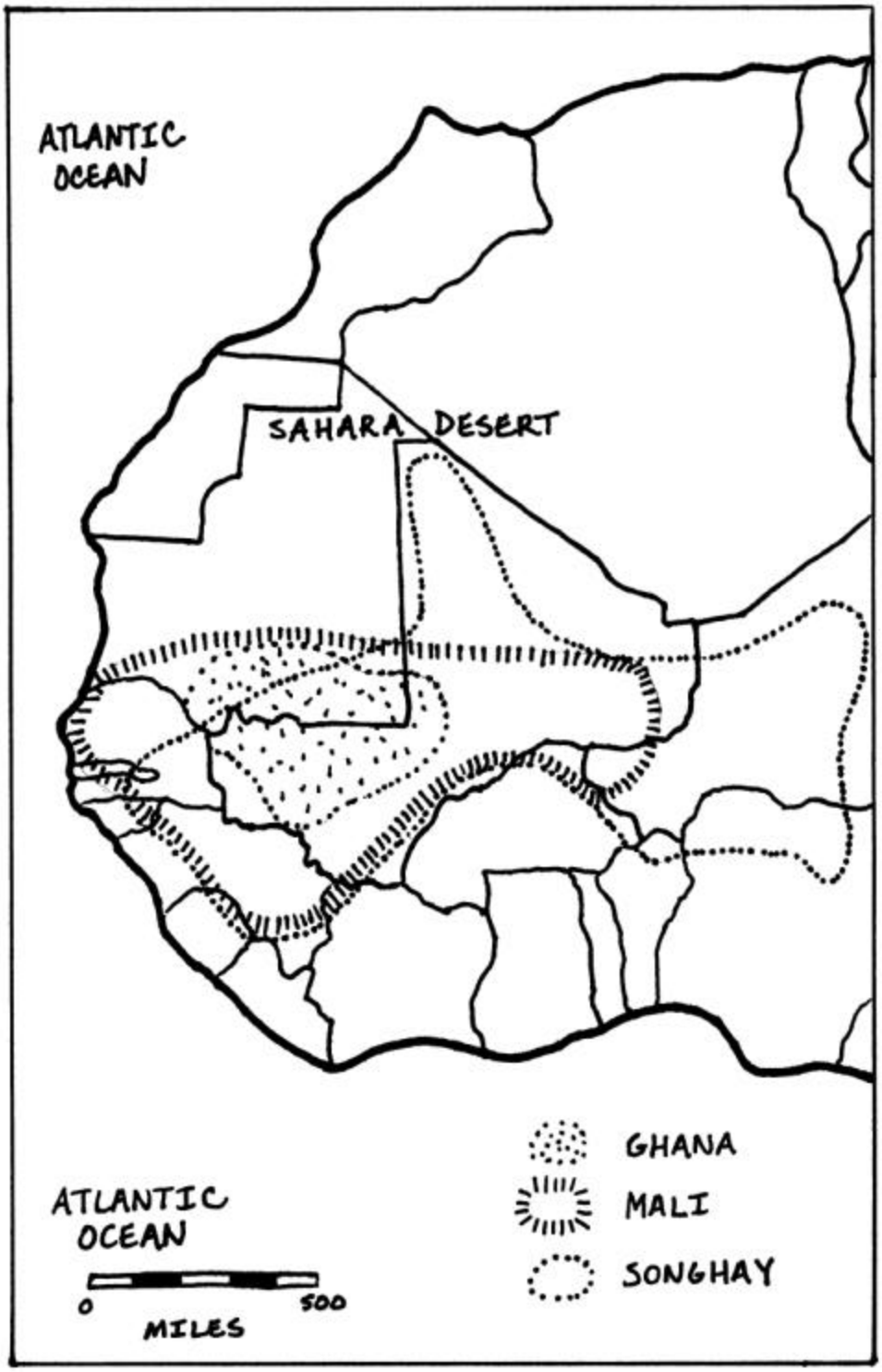

Figure 2.3: Map of the Ghana, Mali, and Songhay Empires

Adapted from: McKissack and McKissack (1994)

2.4 Government and Political Environment

The current president of Mali is General Amadou Toumani Touré. Touré was elected in May 2002. Mali had its first democratic presidential election in 1992, and since then President Touré's predecessor, Alpha Oumar Konaré, has continued to promote the democratization process, carry out political and economic reform, and fight corruption (CIA 2002). At present, the country is in the process of decentralization.

The capital of Mali is the district of Bamako. Administratively, Mali is divided into eight regions: Kayes, Koulikoro, Sikasso, Ségou, Mopti, Tombouctou, Gao, and Kidal. Each region consists of five to nine districts (or *Cercles*) and the *Cercles* are divided into communes that are further divided into villages (U.S. Department of State 2000).

2.5 Economy

Mali is known as being among the poorest countries in the world and is heavily dependent on foreign aid. It is ranked 153 out of 162 countries in the United Nations Development Program's (UNDP) Human Development Index which measures a country's achievements in terms of life expectancy, educational attainment, and adjusted real income (UNDP 2001).

The gross domestic product (GDP) per capita purchasing power parity (PPP) is $850 U.S. (CIA 2002) and the gross national income (GNI) per capita is $240 U.S. (World Bank 2001) according to 2000 estimates. As of 1999, about 73% of the population lives on an

income of less than $1 U.S. per day (UNDP 2001). The basis of Mali's economy is agriculture (Imperato 1996). In 1998 approximately 80% of the labor force was engaged in agriculture and fishing, and agricultural activities made up 46% of the GDP. Small-scale traditional farming dominates the agricultural sector and subsistence farming occurs on about 90% of the land under cultivation (U.S. Department of State 2000). Industry and services accounted for 21% and 33% of the GDP, respectively (CIA 2002). Mali is vulnerable to fluctuations in the world prices of cotton, which accounts for 50% of its exports (1999 estimate). The country's other main exports are gold and livestock (CIA 2002).

2.6 Water Supply and Sanitation

In the literature on water supply and sanitation, the terms "safe," "adequate," and "improved" are used to describe water supply and sanitation coverage. Coverage is defined as the percentage of the population with access to safe (improved) water supplies and adequate (improved) sanitation facilities. The *Global Water Supply and Sanitation Assessment 2000 Report* by WHO/UNICEF differentiates between the term "improved" and the terms "safe" and "adequate" because of the lack of information on the safety and adequacy of water supplies and sanitation facilities. As a result, it was assumed in their study that certain types of technologies are safer or more adequate than others, and the term "improved" was used to describe the different types of water supply and sanitation technologies that are considered as coverage. Table 2.1 lists the water supply and sanitation technologies that are considered to be "improved" and "not improved"

(WHO/UNICEF 2000). In this study, the terms "safe," "adequate," and "improved" are used interchangeably.

Table 2.1: Improved and Not Improved Water Supply and Sanitation Technologies

Improved Technologies

Water Supply	Sanitation
Household connection	Connection to a public sewer
Public standpipe	Connection to a septic system
Borehole	Pour-flush latrine
Protected dug well	Simple pit latrine
Protected spring	Ventilated improved pit latrine
Rainwater collection	

Not Improved Technologies

Water Supply	Sanitation
Unprotected well	Service or bucket latrines
Unprotected spring	Public Latrines
Vendor-provided water	Open Latrine
Bottled water	
Tanker truck provision of water	

Source: WHO/UNICEF (2000)

Mali's national water supply and sanitation policy that was adopted in 1996 has the following main objectives: provide water supply to urban and rural areas by 2002; establish an institutional and legal framework for the sector based on community participation, decentralization, and devolution as well as private sector participation (PSP); supply the rural area with a minimum of 20 liters per day per capita for villages of less than 2,000 inhabitants; establish a long term program for sanitation; provide more finances to public hygiene programs; increase the sanitation coverage ratio; and have community based organizations play a central role in the promotion of hygiene (WHO/AFRO 2000).

According to the UNDP Human Development Report 2001, in 1999 65% of the Malian population were using improved water sources and 69% of the population were using adequate sanitation facilities. The population using improved water sources was defined as the percentage of the population with reasonable access to an adequate amount of drinking water (availability of at least 20 liters per person per day from a source within one kilometer of the user's dwelling) from improved sources. The population using adequate sanitation facilities was defined as the percentage of the population using improved sanitation facilities that are private and hygienically separate human excreta from human contact (UNDP 2001).

In Mali, water supply and sanitation coverage is lower in rural areas than in urban areas; 74% of the urban population and 61% of the rural population have access to safe water, and 93% of the urban population and 58% of the rural population have access to adequate sanitation (WHO/UNICEF 2000). Table 2.2 compares these statistics on Mali's water supply and sanitation coverages to those of Africa, collectively, and to those worldwide.

Table 2.2: Comparison of Water Supply and Sanitation Coverages in Mali, Africa, and the World

	% Water Supply Coverage			% Sanitation Coverage		
	Total	Urban	Rural	Total	Urban	Rural
Mali	65	74	61	69	93	58
Africa	62	85	47	60	84	45
World	82	94	71	60	86	38

Source: WHO/UNICEF (2000)

2.7 Peace Corps Mali

Peace Corps has been in Mali since 1971. Initially, assistance was requested in the area of agricultural development. The first water supply projects began in 1974 with the construction of wells for village water supply and watering points for migratory herders and their livestock. For the next 11 years, Rural Community Development Volunteers incorporated simple water supply activities in their agricultural projects. In 1985 the Water Resource Management project was launched, and in 1993 a Water/Sanitation project was implemented.

Since 1993, the Water/Sanitation project has focused on four primary technical areas: construction and repair of hand-dug wells using inexpensive and easily transferred construction techniques; promotion of basic health practices to improve drinking water quality and hygiene; promotion of better environmental sanitation practices through the

construction and maintenance of improved pit latrines, the establishment of improved domestic waste disposal practices, and the implementation of improved community waste disposal systems; and introduction of alternative water-lifting devices for domestic and agricultural use.

In 1999 the Water/Sanitation project was redesigned to emphasize local capacity building. In accordance with the Malian government's development objectives, Peace Corps Mali's Water/Sanitation project focuses on building capacities at the local level to enable a more effective and efficient management of limited water resources and improved environmental sanitation through the transfer of appropriate technologies, skills and knowledge. Through technology, skills, and knowledge transfer, local communities can become increasingly able to effectively assess and address their water supply and sanitation needs. Peace Corps Volunteers are trained to use and promote a systematic approach to project planning, implementation, and evaluation, which is an important skill that can be used by local communities to accomplish the long-range goal of improving the quality of life in Mali (Peace Corps/Mali Volunteer Assignment Description 1999).

Prior to my arrival in Mali, the village of Gouansolo submitted a request to Peace Corps for a water/sanitation volunteer. They specified that they wanted the volunteer to assist with the construction and reparation of wells and provide health and hygiene education *animations* (educational presentations) at the school. During my Peace Corps service my main project was a well repair. It is common for traditional (unprotected and unlined) hand dug wells to erode at either the top or bottom and they are susceptible to pollution

from the surface. Peace Corps Mali's approach to this problem is to line the well with concrete bricks and to build a concrete wellhead consisting of a headwall and drainage apron (Cairncross and Feachem 1993). A villager asked me to help him repair his well that was eroded at the bottom and dried during the hot season. I organized and trained a well repair team in the village and we worked on the aforementioned well. The goal of the project was to provide technical assistance and transfer technology and skills in the areas of well construction and the repair of hand dug wells in order to improve village water supply. I also taught groups of women how to treat drinking water with chlorine bleach and encouraged improved hygiene and sanitation practices by promoting the importance of surface water drainage and the elimination of stagnant water. During my service I did not work with the school because the villagers did not like the school director.

3.0 Methods

This chapter provides an explanation of the methods used in this study. First it describes the importance of social and cultural factors in water supply and sanitation development projects and the research methods used in this type of fieldwork in developing countries. Then a literature review presents the references that were consulted for this study and the methods and types of information they suggest to use and obtain to conduct a water supply and sanitation study. Finally it describes the survey that was used to conduct this baseline study.

3.1 Research Methods

The purpose of this study was to assess the water supply and sanitation situation in the village of Gouansolo. This is an initial step of a water supply and sanitation development project, but before beginning a community development project it is important to know the people, their culture, their country, and their language (Bourne 1984) and gain "an understanding of the local context of water and sanitation projects" (Simpson-Hébert 1983). The first year of my service was focused on doing this, getting to know people in the village and learning Bambara, the local language.

Although water supply and sanitation development projects are perceived primarily as engineering activities, there are social science factors that need to be considered. They are interdisciplinary projects, involving the fields of engineering, public health, sociology, economics, and anthropology (Cairncross et al. 1991). Most anthropological

research takes a year or more of fieldwork because it takes that long "to get a feel for the full round of people's lives…settle in, learn a new language, [establish] rapport, and be in a position to ask good questions and to get good answers" (Bernard 2002). While doing fieldwork in developing countries, "it is considered imperative for the fieldworker to live as closely as possible to the community being studied—in order not just to observe, but to participate actively in community life." The willingness to live among the community "breaks down barriers," and allows the fieldworker to learn the language, gain insight into personal relationships, and participate in activities of daily life (Devereux and Hoddinott 1993).

As part of the arrangement with Peace Corps, the village built my house and chose a host family and work counterpart (*homologue*) for me. My host family was a well-respected family in the village. Although I lived in my own compound, separate from my host family, I was effectively accepted and treated as a member of the family. There is a Bambara proverb that states: "If you are a stranger in a village and you say that you have no father in this village, it is because you have not accepted someone's father as your own" (Peace Corps/Mali Volunteer Assignment Description 1999). Devereux and Hoddinott (1993) state that "households and communities in the Third World exist and function in complex webs of inter-dependence." Thus, being considered as a member of a family aided in my cultural integration into the community. My *homologue* was a farmer and mason by occupation and an important member of the community. He was one of the more educated people in the village and was probably chosen to work with me due to his knowledge of French and his ability to read and write.

3.1.1 Participant Observation

The preliminary data gathering fieldwork was done by participant observation, which "involves getting close to people and making them feel comfortable with your presence so that you can observe and record information about their lives." It involves going out, learning a new language, experiencing the lives of the people you are studying, and "establishing rapport and learning to act so that people go about their business as usual when you show up." "Participant observation involves immersing yourself in a culture and learning to remove yourself every day from that immersion so you can intellectualize what you've seen and heard, put it into perspective, and write about it" (Bernard 2002). The researcher establishes residence in the community being studied and observes and records the activities and events of daily life and seeks out information relevant to the data that is needed. He/she participates in community life and is effectively a member of the community.

A form of participant observation that can be adapted to water supply and sanitation projects is to take an "environmental sanitation walk" in the community "to get a general feel for conditions" by visiting water sources, noting street conditions, visiting inside homes and public buildings, asking to use the latrine, etc. During these walks there is also the opportunity to ask questions about water supply and sanitation issues (Simpson-Hŭbert 1983). Through participant observation, I was able to gather background information on the village and study and collect information on the current water supply and sanitation situation and practices throughout my entire stay there.

3.1.2 Surveys and Interviews

Surveys are another method of data gathering. They are useful for collecting demographic data, systematically quantifying the occurrence of observable objects or characteristics, and estimating the prevalence of particular attitudes, beliefs, and values. The surveys were conducted by interviewing. Participant observation reveals information such as who should speak for the family at interviews and the best times to find people at home to conduct interviews (Simpson-Hübert 1983). The two types of interviews that were initially used were: informal interviews and unstructured interviews.

Informal interviewing is characterized by total lack of structure or control and is the method of choice at the beginning of participant observation fieldwork. The researcher just tries to remember conversations in the field, which requires "constant jotting…[ducking] into private corners a lot (so you can jot things down) and [using] a lot of deception (to keep people from knowing that you're really at work, studying them)" (Bernard 2002). In an unstructured interview there is no formal questionnaire; instead there are a series of topics from a checklist that are discussed in any order that seems natural. This method is useful during the early stages of fieldwork to reveal important background information and the concerns of people (Devereux and Hoddinott 1993). Unstructured interviewing is used in situations when there is time to interview people on many separate occasions (Bernard 2002).

For the latter part of this study semistructured interviews were used. Semistructured interviews are similar in characteristic to unstructured interviews, which are simply interviews based on a plan with minimum control over the interviewees' responses so

that they "open up and…express themselves in their own terms, at their own pace." The difference between semistructured and unstructured interviews is that semistructured interviews are based on the use of an interview guide, a written list of questions and topics that need to be covered in a particular order. According to Bernard (2002), semistructured interviewing is best in situations where there is only one chance to interview someone.

3.2 Literature Review

This study was primarily based on the field studies structure outlined in *Evaluation for Village Water Supply Planning* by Cairncross et al. (1991) and the preparatory investigation methods presented in *Just Stir Gently: The way to mix hygiene education with water supply and sanitation* by Marieke T. Boot (1991).

The structure of the field studies for an evaluation of a rural water supply program that is presented by Cairncross et al. (1991) is comprised of three elements: the study area, the technical field survey, and the detailed village survey. Table 3.1 provides a summary of the field studies structure. The methodology used in the field studies is a mixture of formal questionnaires and informal interviewing and observation. The field studies structure that is presented can be applied to a study area ranging from a large scale to a small scale (country, state, region, province, group of villages, single village). For this project, it was applied to evaluate the water supply and sanitation situation in a single village.

Table 3.1: Field Studies Structure

1. Define study area and obtain the following information:
   - Maps indicating village location, topography, surface water, communications, and ethnic or linguistic regions
   - Village populations
   - Major agricultural activities
   - Wealth
   - Locations of schools, clinics, and rural industries
   - Access to government services
   - Climate
   - Tourism potential
   - Health
   - Type of water supply or source
   - Type of water supply organization
2. Conduct technical field survey to assess technical characteristics of improved and traditional water supplies by:
   - Asking the villagers whether the water supply is working satisfactorily, what problems have occurred with the water supply in the past, and what suggestions they have for improving the water supply or other similar schemes to be built
   - Inspecting the water supply
   - Identifying current and potential problems with the water supply
3. Conduct detailed survey of village and obtain the following information:
   - Maps indicating locations of houses, schools, clinics, water sources, and other relevant features
   - Census data (name of household head, size of household, composition of household)
   - Description of water source
   - Distance to water source
   - Status of household
   - Indices of wealth
   - Use of latrine

The first element of the field studies is the definition of the study area, the geographically defined region where the water supply program is being investigated. Information on the study area to be gathered include: maps indicating village location, topography, surface water, communications, and ethnic or linguistic regions; village populations; major

agricultural activities; wealth; locations of schools, clinics, and rural industries; access to government services; climate; tourism potential; health; type of water supply or source; and type of water supply organization.

The second element is the technical field survey which is considered to be the backbone of the field studies. It involves visiting as many villages as possible with the primary aim of assessing the technical characteristics of improved and traditional water supplies. The villages selected for the technical field survey should be representative of the study area, and the selection depends on the size of the study area and the scope and scale of the evaluation. Villagers should be questioned about whether the water supply is working satisfactorily, what problems have occurred with it in the past, and what suggestions they have for improving it or other similar schemes to be built. The first people who should be consulted are local authorities, leaders, or village representatives responsible for the water supply. The next activity is to inspect the water supply, identifying current and potential problems, and take notes.

The third element is the detailed survey of villages which are defined as those villages in which more detailed studies are conducted than in the technical field survey studies—they are a sub-sample of the villages included in the technical field survey. Information to be gathered for the detailed survey include: maps (indicating locations of houses, schools, clinics, water sources, and other relevant features); census data (name of household head, number in household, household composition {age and sex of household

members}); description of water source; distance to water source; status; indices of wealth; and use of latrine.

The methods of investigation presented by Boot (1991) include observation and communication to collect qualitative and quantitative information regarding water supply and sanitation. Information can be collected by informal discussions with individuals and groups, interviews with individuals, group interviews, household surveys using a questionnaire, observation at household and community level, participant observation, and screening available documentation and statistical data. A mixture of these methods is best to collect information for the baseline study.

Boot (1991) presents a list, shown in Table 3.2, of possible useful information on social and health-related aspects of water supply and sanitation that is adapted from *Methods for gathering socio-cultural data for water supply and sanitation projects* by Mayling Simpson-Hübert (1983). The subject matters include demography, housing, physical infrastructure, health, water availability, water use practices, sanitation practices, occupation, organization and participation, level of interest, willingness and ability to pay, local technology and resource availability, and education and communication.

Table 3.2: List of Possible Useful Social and Health Information

1. Demography
   - Population size, density, growth rate, mobility (males, females)
   - Population groups (social, economic, ethnic, religious)
   - Household size and composition (special features such as women heads of household, multi-family households)
   - Division of tasks and responsibilities in households, role of women
2. Housing
   - Settlement structure
   - Types of houses, their physical condition and layout
   - Types of building materials used
   - Space available inside and outside the house
   - In-house water and sanitation facilities
3. Physical infrastructure
   - Road, road conditions/public transport
   - Primary school for girls/boys, secondary school for girls/boys
   - Primary health care center, health clinic
   - Shops, market, post office
   - Religious centers (mosque, church, temple), community centers
   - Small scale industries, industrial plants
   - Water supply and sanitation facilities (public, private)
   - Needs/obstacles to improve present facilities
4. Health
   - Major health problems and relative importance of water and sanitation-related diseases (related to gender, age and socio-economic groups)
   - Seasonal variations
   - Knowledge and perceptions about diseases and health (related to gender, age, and socio-economic groups)
   - Use of government and non-government health services (related to gender, age and socio-economic groups)
   - Availability of health personnel (gender, level of education and training)
   - Ongoing formal and informal health education activities, target groups
   - Specific environmental health dangers
5. Water availability
   - Water source(s), water point(s), distance, accessibility, reliability, quantity, quality (related to socio-economic characteristics)
   - Seasonal variations
   - Cost of water, water vending
   - Protective measures/health risks as water sources/points
   - Water rights and water source management

6. Water use practices (related to gender, age and socio-economic groups)
    - Preferred sources of water by purpose
    - Water collection, transport and storage practices
    - Personal and domestic use of water (drinking, hand washing, bathing, clothes washing, dish washing, vegetable washing, cleaning, anal cleansing)
    - Water use for animals, gardening and other productive activities
    - Quantity of water by purpose, reuse of water
    - Criteria applied to decide on suitability of water for different purposes
    - Obstacles to adoption of improved practices
7. Sanitation practices (related to gender, age and socio-economic groups)
    - Existing defecation practices
    - Cleansing and ablution materials and practices (also prevalence of bathing in latrines)
    - Beliefs and restrictions related to latrine use (e.g. location, sharing)
    - Latrine cleaning and maintenance practices
    - Latrine emptying and sludge reuse practices
    - Wastewater and solid waste disposal practices
    - Food storage, handling and preparation practices
    - Household/kitchen hygiene
    - Availability and use of soap for personal hygiene
    - Obstacles to adoption of improved practices
8. Occupation
    - Major occupations and approximate distribution (males, females)
    - Seasonality of employment
9. Organization and participation
    - Local organizations and type of membership
    - Local leaders (males, females) and leadership structures, local decision-making
    - Informal leaders and key-persons (males, females)
    - Major local political or social factors which might affect participation
    - Previous interest and participation in water and sanitation or other development activities (related to gender, age and socio-economic characteristics)
    - Important characteristics that would determine the acceptability of outsiders working on projects in the area
    - Local traditions and practices for operation, maintenance and repair of water supply, sanitation and other structures

10. Level of interest
    - Evidence of popular interest (males, females) in improving water supply and sanitation, compared to other potential improvements in the community
    - Evidence of leadership commitment to improvements
    - Evidence of equal access to project resources and activities
11. Willingness and ability to pay (related to gender and socio-economic characteristics)
    - Ownership of land, house, personal property
    - Income
    - Expenditure patterns
    - Borrowing and saving customs
12. Local technology and resource availability
    - Local availability of building materials
    - Availability of skilled and unskilled labor (males, females, noting seasonal variations)
    - Availability of technology-related inputs (such as water for pour-flush latrines)
13. Education and communication (related to gender and socio-economic characteristics)
    - Education and literacy levels
    - Numbers of school-going children (boys, girls), dropouts
    - Numbers of teachers, level of education and training
    - Adult education and vocational training
    - Availability and relative importance of communication channels (from mouth-to-mouth to television)

World Health Organization's *Minimum Evaluation Procedure (MEP) for Water Supply and Sanitation Projects* (1983) also provides guidelines for data collection. Two categories of data to be collected are data on the functioning of the water supply and sanitation facilities and data on the utilization of the facilities. The functioning of water supply facilities are described by water quantity, water quality, availability of water, and convenience of water points. The functioning of sanitation facilities are described by the number of households with improved latrines, the cleanliness of the latrine, and the reliability of the latrine. Utilization of water supply facilities is described by the number

of households using the facility, the volume of water used, and water usage. Utilization of sanitation facilities is described by the number of people using latrines. Several data gathering techniques are presented and it is mentioned that the least cost method for obtaining household information on the functioning and utilization of facilities is to combine observation studies and conversational interviews.

Developing and Managing Community Water Supplies by Davis et al. (1993) is another reference on methods that was used in this study. The method of information gathering for the baseline study is a combination of formal surveys using questionnaires and interviews together with less formal techniques. Issues in data collection that are considered include accounting for seasonal variations when planning surveys and obtaining a representative cross-section of the community (women, men, children, the elderly, the poor, the wealthy, the influential, the disadvantaged, etc.). The categories of information required for the planning of a community water supply are socio-economic and technical information. Socio-economic information includes: level of community support; number of beneficiaries; community health; awareness of the relationship between water and health; sanitation practices; water collection practices; community willingness to pay; and community structures. Technical information includes: hydrology, geology, and topography of the area; water sources; water quality; seasonal variations; availability of local technical skills; availability of construction materials; and availability of local services.

The *Water, Sanitation, and Health Care Survey* by the Kenya-Finland Primary Health Care Programme (1986) presents the methods and results of a mini-survey and an in-depth survey that were conducted in Kenya. A description of the study area includes information on topography, transport and communication, economy, soils, climate, people, primary production, land tenure, and homestead patterns. The results presented include data on demography (ethnic composition, age/sex composition, household composition, fertility and mortality, and migration); socio-economic factors (land tenure, sources of livelihood, level of education, allocation of income, indicators of wealth, building materials, and nutrition); water supply (types of water supplies, distance, regularity, quantity, existence of cover on water container, and adequacy); and sanitation (cleanliness of household, existence of dish rack, and the existence, condition, and utilization of latrines).

3.3 Implementation of the Study

Information on the study area and much of the social, economic, and anthropological information was obtained from my Peace Corps training, other Peace Corps volunteers, numerous Malians, personal research, and participant observation at various times throughout my Peace Corps service. The technical and detailed information were obtained from surveys that were conducted during the later part of my service.

3.3.1 Cultural Integration

Cultural integration, or adjustment, was necessary to conduct this study and to be an effective Peace Corps volunteer. Peace Corps provides cross-cultural training to

volunteers in order to aid in their cultural adjustment. Peace Corps cross-cultural trainers identify five stages of cultural adjustment (Table 3.3); four levels of cultural awareness; and changes in attitudes toward cultural difference, from ethnocentrism to ethnorelativism, as being part of the process of adjusting successfully, professionally and personally, to a new physical and cultural environment (Peace Corps ICE).

Table 3.3 The Five Stages of Cultural Adjustment

Stage	Time Frame	Characteristics
Initial Enthusiasm	First week or two in host country	Exposure to country and culture is limited. Excitement and enthusiasm abound. Everything is exotic and quaint. Attitude toward host country is generally positive. Little is expected of the Peace Corps Volunteer (PCV).
Initial Country & Culture Shock	First few weeks; first half of training	Wider exposure to country and culture means more realistic and mixed reactions. Enthusiasm is tempered with frustration. Feelings of vulnerability and dependence are common. Homesickness is frequent. Nothing is routine. Limited language ability undermines confidence.
Initial Adjustment	Second half of Training	Routines are reestablished. Some aspects of the country and culture are now seen as normal. Adjustment to the physical aspects of the host country is better. PCV is somewhat more self-reliant. PCV is more positive about his/her ability to function in country.
Further Culture Shock	First few months after training; settling-in period	PCV experiences post-training withdrawal symptoms. PCV is adjusting to being on his/her own in country. It is PCV's first experience taking care of himself/herself in country. PCV is having first encounters with the work-related aspects of culture, with initial surprises and frustrations. PCV misses daily contact with Americans and host country nationals (HCNs) who understand him/her and his/her version of the local language.
Further Adjustment	Post settling-in	PCV is getting used to being on his/her own. PCV is better able to take care of himself/herself. PCV is making friends in the community. PCV speaks the language better. PCV is more effective at work because he/she understands the culture better.

Adapted from: Peace Corps ICE

As the PCV goes through the stages of cultural adjustment, his/her cultural awareness increases. The four levels of cultural awareness are: unconscious incompetence, conscious incompetence, conscious competence, and unconscious competence (Peace Corps ICE).

Unconscious competence has been called "the state of blissful ignorance." During this stage, the PCV is unaware of cultural differences and cultural mistakes or misinterpretations that he/she may be making. During the stage of conscious incompetence, the PCV is aware of cultural differences though he/she may not fully understand them, and he/she "may start to worry about how hard it's going to be to figure these people out" (Peace Corps ICE).

During the third stage, conscious competence, the PCV is even more aware of the cultural differences and tries to adjust his/her own behavior accordingly. The PCV has to "make a conscious effort to behave in culturally appropriate ways," and he/she is "in the process of replacing old instincts with new ones." During the last stage, unconscious competence, the PCV "no longer [has] to think about what [he/she is] doing in order to do the right thing," culturally appropriate behavior is "second nature," he/she "can trust [his/her] instincts because they have been reconditioned by the new culture," and "it takes little effort…to be culturally sensitive" (Peace Corps ICE).

The other aspect of cultural adjustment is the change in attitudes toward cultural difference. As cultural awareness increases, the PCV's attitude toward cultural difference "evolves," changing from ethnocentrism to ethnorelativism.

Ethnocentrism is comprised of three stages: denial, defense, and minimization. During the denial stage, the PCV "[doesn't] really believe in cultural differences…and [thinks] people who are behaving differently don't know any better." The PCV may try "to impose [his/her] own value system on others," thinking that he/she is "right" and his/her behavior is "natural and normal" and that other people are "confused" and their behavior is "wrong and misguided." During the defense stage the PCV believes in the existence of cultural difference, but he/she is "threatened by it…believes that other cultures are decidedly inferior…and views other cultures negatively, [preferring] to have little or no contact with those who are different." The PCV thinks that "'this may be how things are, but it is not the way things *should* be.'" During the last stage of ethnocentrism, minimization, the PCV is still threatened by cultural difference, but he/she tries to minimize it and believes "that as different as people are, they are still more similar than dissimilar [and that people] are different on the surface, but underneath [they] share many of the same values and beliefs." "If people in the denial stage deny difference and people in the defense stage accept but demonize difference, then people in the minimization stage try to trivialize difference" (Peace Corps ICE).

The three stages of ethnorelativism are: acceptance, adaptation, and integration. During the acceptance stage the PCV accepts the cultural differences; he/she may still find some

differences difficult to accept, but he/she is neither threatened by them nor judges them as "wrong or bad." The PCV is "more tolerant and sympathetic…[and] neutral…about differences." In the last stages of ethnorelativism, adaptation and integration, the PCV's behavior and attitudes change. The PCV is positive, instead of neutral, about cultural differences, accepts the differences, is "willing and able to adjust [his/her] own behavior to conform to different norms…[and] empathizes with people from different cultures." He/she becomes "bicultural or multicultural, effortlessly adjusting [his/her] own behavior to suit the culture of the people [he/she is] with…[and] certain aspects of the other culture…become part of [the PCV's] identity" (Peace Corps ICE).

After one year in the village I felt ready to conduct the baseline study. By then, I felt that my language skills and integration into the community were adequate. The stages of adjustment, levels of cultural awareness, and the change in attitudes toward cultural difference are part of the cultural integration phenomena I experienced. At this time in my service, I was at the stage of further adjustment, the levels of conscious and unconscious competence, and the stages of ethnorelativism.

3.3.2 The Survey

The water supply and sanitation survey was conducted between the months of January and September 2001, although much of the background information on the study area was obtained at various times during my two-year service. In January 2001, I began taking village walks and visiting households to sketch a village map, examine water sources, and pre-test survey questions. Cairncross et al. (1991) advises that it is

imperative to pre-test questions in order to: 1) establish the appropriateness of the questions and the feasibility of asking them; 2) serve as training for the surveyor so that he/she can experience the difficulties, seek guidance, and practice interviewing technique; and 3) establish the time required per household or per interview so that the surveyor can plan the logistics of the survey. This was also a means to meet people that I did not know very well and visit parts of the village that I was not very familiar with. I chose to conduct a complete survey, a survey in which every household is included, due to the small size of the community and the advantage of gaining statistical confidence from having surveyed all the households. Complete surveys also have social and political advantages because no household is excluded (Simpson-Hébert 1983).

During my initial village walks and household visits in the months of January and February 2001, I conducted informal and unstructured interviews with the people who were at home in order to practice my interviewing skills and to get an idea of the types of responses I would receive. The end of the harvest season occurred during these months and many villagers were working in the fields during the day so I interviewed whoever was present and willing to talk with me. During this period, I learned the locations of households and the names of the heads of households. I made general inquiries about the water sources, water uses, and water availability, and I took notes on the types, conditions, and locations of the water sources.

As mentioned earlier, I started the baseline study when I felt comfortable with my French and Bambara language skills and cultural integration into the community, but this did not

change the fact that I was a foreigner. During this initial stage of fieldwork I realized that I could not conduct the survey on my own due to the limits of my language skills and my concerns over cultural barriers. Therefore, I decided to seek the assistance of my *homologue* as an interpreter. According to Devereux and Hoddinott (1993), working entirely without help is not feasible unless the fieldworker fully understands the local language and has a good understanding of the local culture. Having a rudimentary understanding of the language helps the fieldworker detect obvious mistakes in translations and "when words are being put into the respondent's mouth." My *homologue's* role went beyond translator—he provided "vital contextual information about the village, local culture or subtleties of language," and he acted as an "ambassador at large," introducing me to the community and explaining my presence to people. His assistance during the interviews allowed me to "concentrate on writing down responses, taking comprehensive notes, and thinking about further areas to probe."

The hot season (February to June) would have been an ideal time to conduct the next phase of interviews because during this time more people are present in the village during the day since there is no farming work to be done in the fields. During the hot season, people garden, do house construction and maintenance work, and various other income generating activities. Between the months of March and June 2001, I worked on a well repair project (see Figure 3.1) in the village so there was a brief hiatus in this study. I discussed my plans with my *homologue* and made arrangements to start the interviews in July 2001. The rainy season (planting season) begins in June, so like during harvest

season when I conducted the initial interviews, I was faced with the problem of few people being present in the village to interview during the day.

Figure 3.1: Well Repair Project

Data collection for the household survey was carried out by semistructured interviewing. Starting with the household of the village chief, we conducted the interviews over a number of evenings. Evening was the best time to interview because most people, including my *homologue*, worked in the fields during the day. After dinnertime we visited households and conducted interviews until one of us was tired, and then we would decide when to schedule the next interviews. Due to time constraints, I chose to interview only the heads of households (males). Prior to the interview, my *homologue*, would explain to the interviewee the purpose of the interview, to assess the water supply and sanitation situation in the village. I asked the survey questions in French and then

my *homologue* would translate them into Bambara. During the interview period, I also took village walks during the day to obtain data on distances to water sources and well depths. I measured distances to water sources by counting my steps, and I measured wells with a rope and tape measure.

Two interviews were conducted per household. I intended to interview each household only once, but after examining the notes of my results from the first interviews I found that I needed to collect more information. The first interviews served as another pre-test of the survey. They were another phase in the continuous process of gathering information. The second interviews were an opportunity to refine and complete the study.

The first interviews took place in July 2001. During the first interview, I obtained census data, including the name of household head, number in household, and household composition (age and sex of household members). Then I asked the general questions of where their water source is, if they had a latrine, and if they had any problems with their water source or latrine. Table 3.3 summarizes the questions asked during the first interviews. My *homologue* and I interviewed an average of nine households per evening over five evenings.

Table 3.4: First Interview Questions

- Name of household head
- Number in household
- Household composition (age and sex of household members)
- What is the household water source(s)?
- Does the household have a latrine(s)?
- Are there problems with the water source(s) or latrine(s)?

The second interviews took place in August and September 2001. During the second interview, I repeated the questions from the first interview, but this time around I took more comprehensive notes and did more probing. Pertaining to water supply, I asked about the location(s) of their water source(s), what the water is used for, if water was available year round, and if there were problems with their water source(s). Pertaining to sanitation, I asked if they had a latrine(s) and if there were problems with their latrine(s). I ended the interviews with the open-ended question of what they wanted for themselves, their family, or the community, and I told the interviewee that his response did not have to be related to water supply or sanitation. The reason for doing this was to get an idea of what the priorities of the villagers are and where water supply and sanitation ranks qualitatively. Table 3.4 summarizes the questions asked during the second interviews. For the second interviews, we averaged six households per evening over eight evenings. Table 3.6 shows the survey data that was collected.

Table 3.5: Second Interview Questions

- What is the household water source(s)?
- Where is the household water source(s)?
- What is the water used for?
- Is water available year round?
- Are there problems with the water source(s)?
- Does the household have a latrine(s)?
- Are there problems with the latrine?
- Is there something that the household head would like for himself, his family, or the village?

4.0 Results and Discussion

This chapter presents the results of the water supply and sanitation study that was conducted in the village of Gouansolo. First, it describes the study area in detail, providing background information on the village location, population, economy, institutions, infrastructure, and households. Next it describes the current water supply and sanitation situation in the village and various methods to improve water supply and sanitation that are presented in the referenced literature. Then, the results of the survey are presented and compared to water supply and sanitation coverage data provided by WHO/UNICEF (2000). Based on findings of the survey, methods to improve village water supply and sanitation coverage are proposed, as well as the obstacles to their improvement. Finally, there is a brief discussion on qualitative data analysis, and suggestions for future work are presented.

4.1 Description of the Study Area

4.1.1 Location

Gouansolo is a rural village located in the southwestern part of Mali, approximately 65 kilometers southwest of the capital, Bamako (See Figure 4.1). The area can be described as woodland savanna interspersed with hills, cliffs, and rocky outcrops. There are some seasonal streams in the area that are used for fishing and as water sources for animals.

Figure 4.1: Map of Mali

Source: http://www.odci.gov/cia/publications/factbook/geos/ml.html

4.1.2 Population

At the time of the study, the village had a population of 836. The dominant ethnic group of the area is the Mandʊ, including the Malinkʊ and the Bambara, and Malinkʊ and Bambara are the languages predominantly spoken. The main religion in the area is Islam although there is a strong presence of traditional animist beliefs. Approximately 48% of the population are males and 52% of the population are females. Forty-one percent of the

population are in the 0-12 years age group, 52% in the 13-60 years age group, and 7% in the 60+ years age group. Table 4.1 summarizes the age/sex composition of the population of Gouansolo.

Table 4.1: Age/Sex Composition of Gouansolo

Age Group	Number Of Males	% of Population (Male)	Number Of Females	% of Population (Female)	Total	% of Population (by Age Group)
0-12	181	21.6	163	19.5	344	41.1
13-60	187	22.4	244	29.2	431	51.6
60+	31	3.7	30	3.6	61	7.3
Total	399	47.7	437	52.3	836	100

4.1.3 Economy

The villagers are subsistence farmers, growing primarily millet, sorghum, corn, rice, and peanuts, and they engage in income-generating activities such as gardening, raising livestock, and growing cotton. The men are financially responsible for the family, although women may partake in small income-generating activities and keep this money for themselves. In terms of household duties, the men are responsible for providing food, shelter, clothing, health care, and education, and the women are responsible for raising the children, cooking, cleaning, and collecting water.

4.1.4 Institutions and Infrastructure

The village is part of the Commune of Bancoumana, *Cercle* of Kati, and Region of Koulikoro. The nearest towns are Siby (Sibi), which is located 15 km to the northeast of Gouansolo, and Bancoumana (Bankoumana), which is 18 km to the southeast (See

Figures 4.2 and 4.3). Local government institutions, such as the mayor's office, post office, and community health care centers known as CSCOMs (*Centre de Santé Communitaire*), are located in these towns. Instead of going to the CSCOM for health care, villagers sometimes choose to go to traditional medicine men in other villages. These towns are also where villagers go for weekly markets and where they have access to principal roads and transportation.

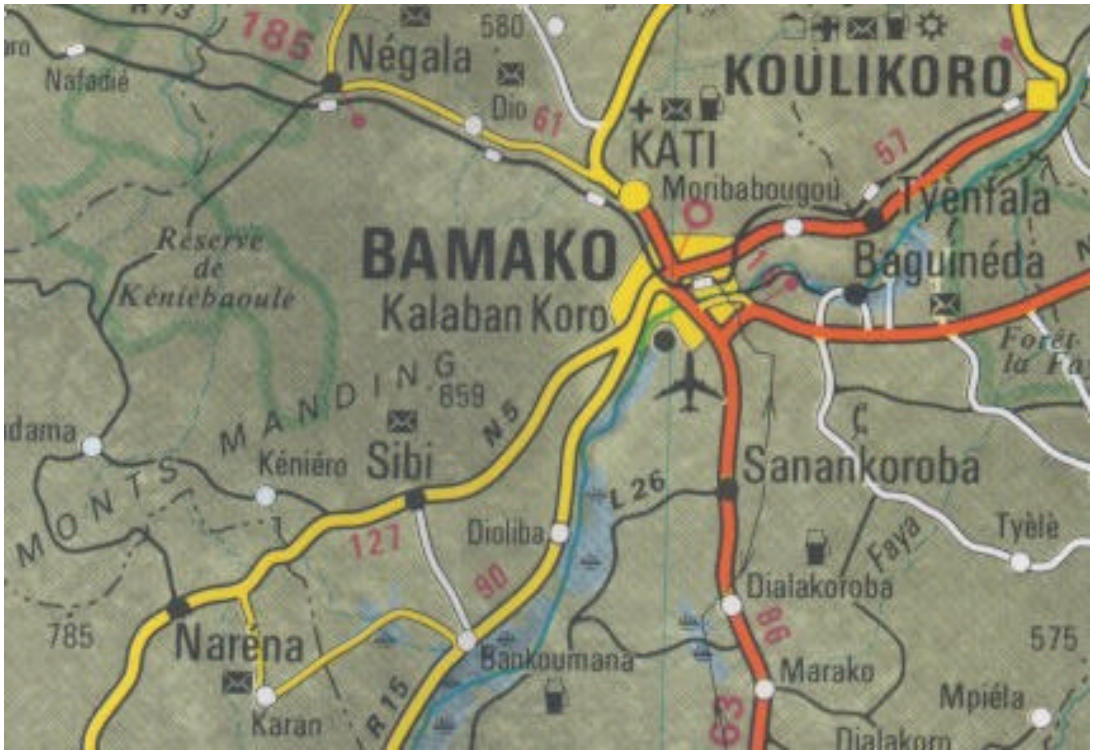

Figure 4.2: Map of Bamako, Sibi, and Bankoumana

Source: L'Institut Géographique National – France (1993)

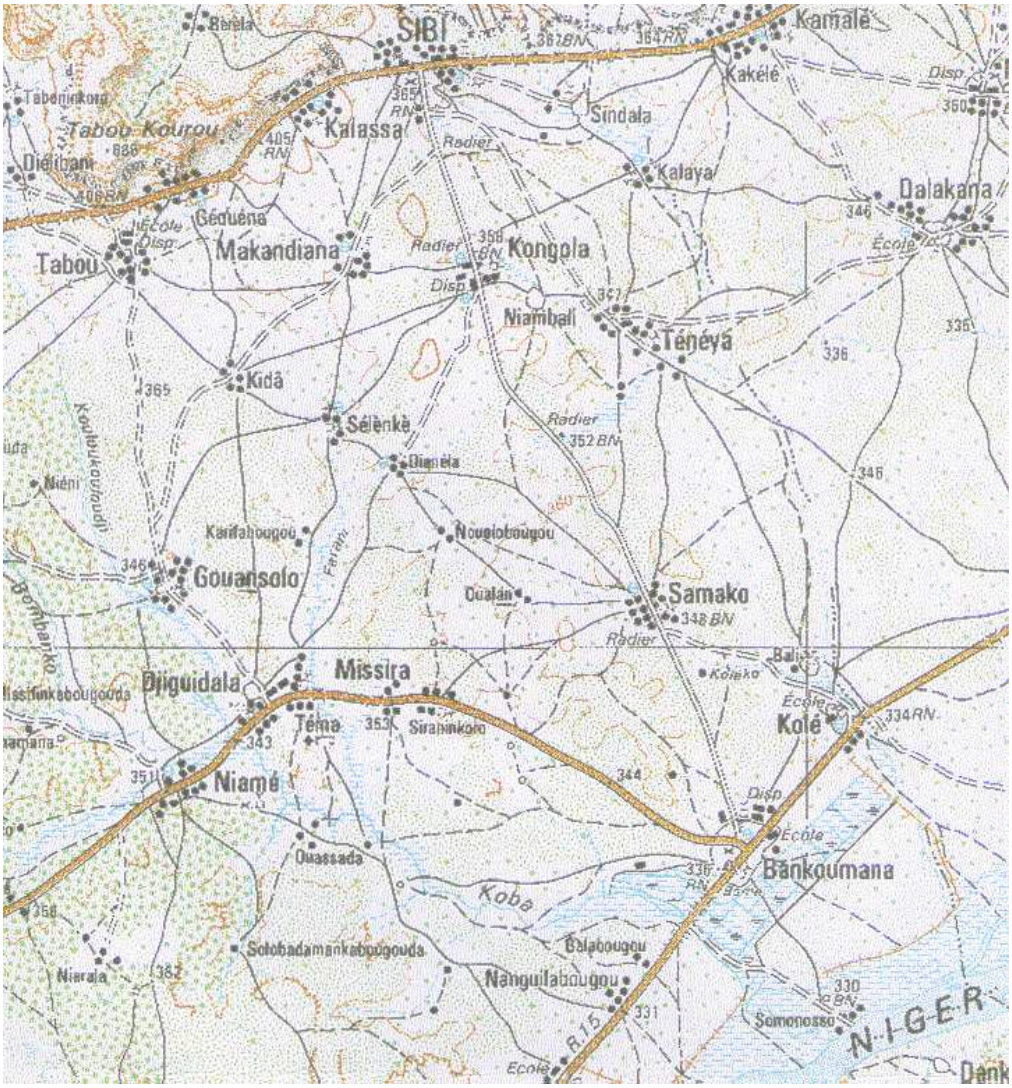

Figure 4.3: Map of Gouansolo and Vicinity

Source: L'Institut GÜographique National – France (1986)

The community leaders are the village chief (*chef de village*) and his two counselors (*counseillers*), the young men's group leader (*chef de jeunesse*), the women's group leader (*chef de femmes*), and the Islamic prayer leader (*Imam*). Decisions in the village are made by a council of community leaders and the heads of households, with the ultimate decision-making resting with the village chief. Village institutions include a

primary school, a Koranic school, an adult literacy school, and two mosques. There is no running water, electricity, or telecommunication in the village. The nearest road is about 4 km away at the village of Djiguidala to the southeast (see Figure 4.3), and access to the village by vehicle is limited to the dry season by way of Djiguidala.

The village has three *quartiers*, or neighborhoods: Sokoura, Djinkono, and Djomogola, and it also has a hamlet located about five kilometers away. The village is comprised of 46 households. Eighteen households are located in Sokoura, 20 households in Djinkono, and 8 households in Djomogola.

4.1.5 Household Information

The society is patrilineal and husbands practice polygamy. The average household size is 18 persons. The household compound is made up of several huts. Each husband has a hut, and each wife has a hut that she shares with her children and a hut for cooking. Young, unmarried men in the household also build huts of their own when they are able to, and separate huts are also built for older boys.

Most houses are made of mud bricks and are either rectangular or circular. The walls are plastered with a mixture of clay and cow dung. The roofs are made of wood and thatched with grass (See Figures 4.4 and 4.5). The houses of wealthier men are rectangular with corrugated metal roofs, and they are sometimes made with concrete bricks (See Figure 4.6). A metal roof is the most apparent indicator of wealth. The huts are arranged to form the perimeter of a household compound. Granaries are also structures that make up

part of the compound. My house in Gouansolo is pictured in Figure 4.4 and its construction style demonstrates that I had living conditions similar to those of average villagers.

Figure 4.4: Rectangular Huts of My House in Gouansolo

Figure 4.5: Circular Hut

Figure 4.6: House with Corrugated Metal Roof

Household wells, where present, are located either centrally within the perimeter of the compound or outside of the perimeter of the compound. Latrines and enclosed bathing areas also make up part of the compound structures and they are located next to the

housing structures. It is assumed that the relative locations of household wells and latrines provide sufficient distance to prevent contamination of the wells by the latrines. The general rule is that latrines should be located no less than 15 meters from a water source, but in some situations there is no danger of contamination if the latrine is closer. The safe distance between a latrine and a well is location specific, depending on soil type and groundwater movement (Pickford 1995).

4.2 Description of Village Water Supply

The two types of water supplies that exist in the village are hand dug wells and borehole pumps. There are two types of hand dug wells in the village: traditional and modern. Traditional hand dug wells are unlined and unprotected holes, generally less than 15 meters deep, that are hand-dug with picks and shovels into the water table. These wells are very common in rural areas, but they are subject to contamination by various means, often yielding water of unacceptable quality, and they are a continuous potential health risk to users (Morgan 1990).

During the rainy season, runoff water carrying many forms of contamination from the surrounding area can drain into the well. The water-logged conditions of the ground surface surrounding the openings of many of these wells are a source of contamination from the feet of users or animals that may be attracted to the surrounding pools of water. This water can seep through the ground and enter the well, and this contamination can be carried into the well by the water collection vessels, such as buckets and ropes, that usually lie around the unhygienic opening of the well. Spilt water generated while collecting water can splash against the feet of users, picking up contamination, and fall back into the well (Cairncross and Feachem 1993). These uncovered wells are also unsafe because children, animals, and foreign objects can fall into them. In addition, they are subject to structural failure because the interior is unlined; during construction the well can collapse on well diggers working inside the well or after completion the well can collapse under the users collecting water (Watt and Wood 2001).

There are two types of traditional hand dug wells in the village: not improved and improved (Here, the term "improved" also refers to technology type, but it does not have the same meaning as WHO/UNICEF's definition of improved water supply technologies). Not improved traditional wells are lined at the mouth with pieces of wood, as shown in Figure 4.7. The wood provides a more stable surface to stand on when collecting water. It also raises the mouth of the well a small amount above the surrounding ground surface so that runoff and spilt water are diverted from the opening of the well. This helps to prevent runoff and spilt water from entering and contaminating the well and eroding the top of the well.

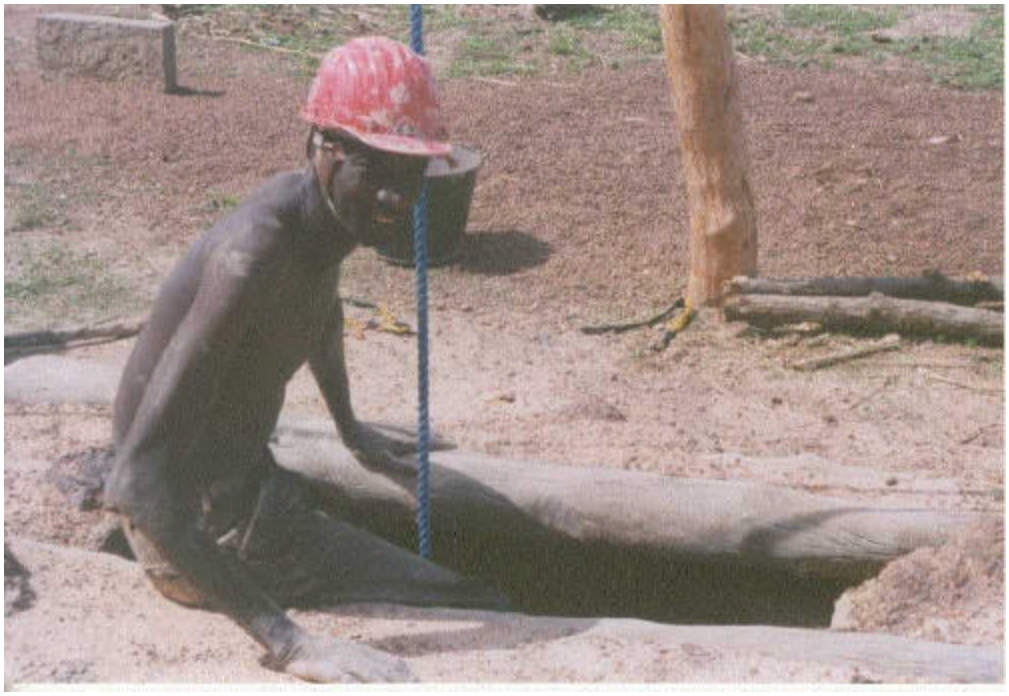

Figure 4.7: Not Improved Traditional Well

Improved traditional wells are raised further above the ground surface by a wellhead constructed of rocks and mortar, as shown in Figure 4.8. Because the mortar and rock

wellhead of the improved traditional well is higher above the ground surface than the wood wellhead of the not improved traditional well, it provides more protection from contamination by runoff and spilt water and the eroding action caused by this water. The mortar and rock are also more structurally sound and permanent than wood. Since this type of wellhead is higher from the ground surface, it is more visible so the chances of people or animals falling into the well are reduced, and it is less likely that foreign objects will fall into the well.

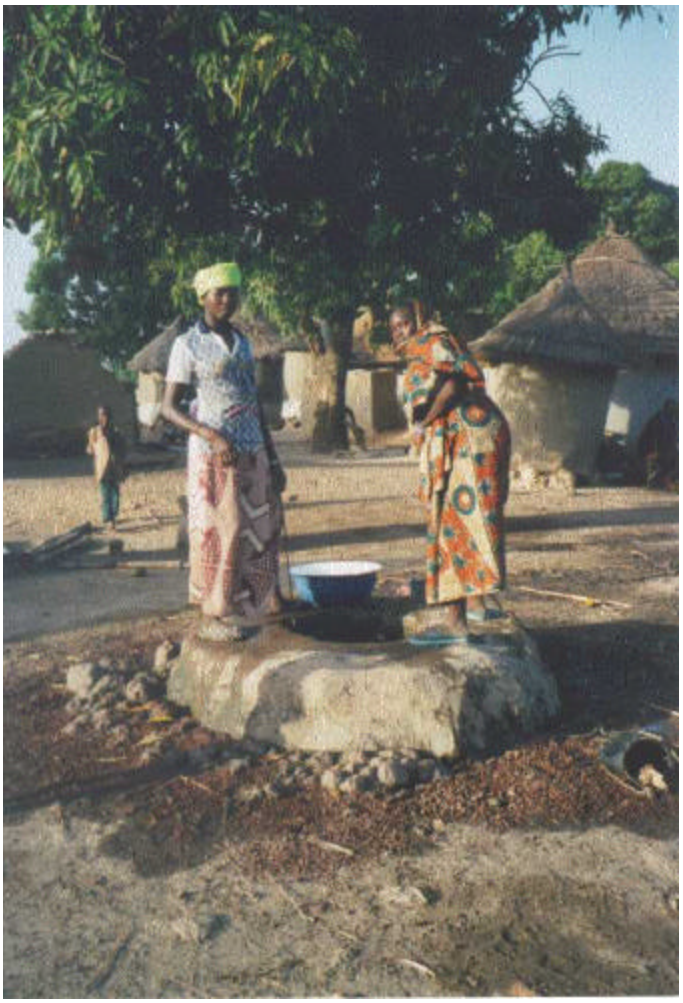

Figure 4.8: Improved Traditional Well

There are two modern hand dug wells in the village that are lined with concrete rings. The two wells were constructed by international aid agencies and only one of these wells is in use. The other well has been deemed unusable by the villagers because it is in need of repair, and they would like an aid agency to repair it.

4.3 Methods to Improve Village Water Supply

A hand dug well can be divided into three parts: intake, shaft, and wellhead (See Figure 4.9). The intake is the bottom section of the well that taps into the aquifer, supports the exposed section of the aquifer, and permits water to flow in while preventing solids from entering into the well. In stable geological formations (e.g. in sandstone or fissured rock) it is possible to eliminate this component, but in conditions where the aquifer is made of sand or gravel it is necessary for the functioning of the well (Watt and Wood 2001).

The shaft is the middle section of the well. The lining of the shaft serves to retain the well walls in place, prevents inflow of potentially contaminated water near the surface, and provides a foundation for the wellhead. Even if a well is sunk into self-supporting rock, the top few meters should be lined and made watertight to avoid the risk of collapse at the top of the well. The intake is sometimes built telescoped and "floating" inside the shaft lining in order to prevent cracking or collapse of the shaft lining if the intake settles. The wellhead is the top section of the well which seals the well and prevents foreign objects from entering the well (Watt and Wood 2001).

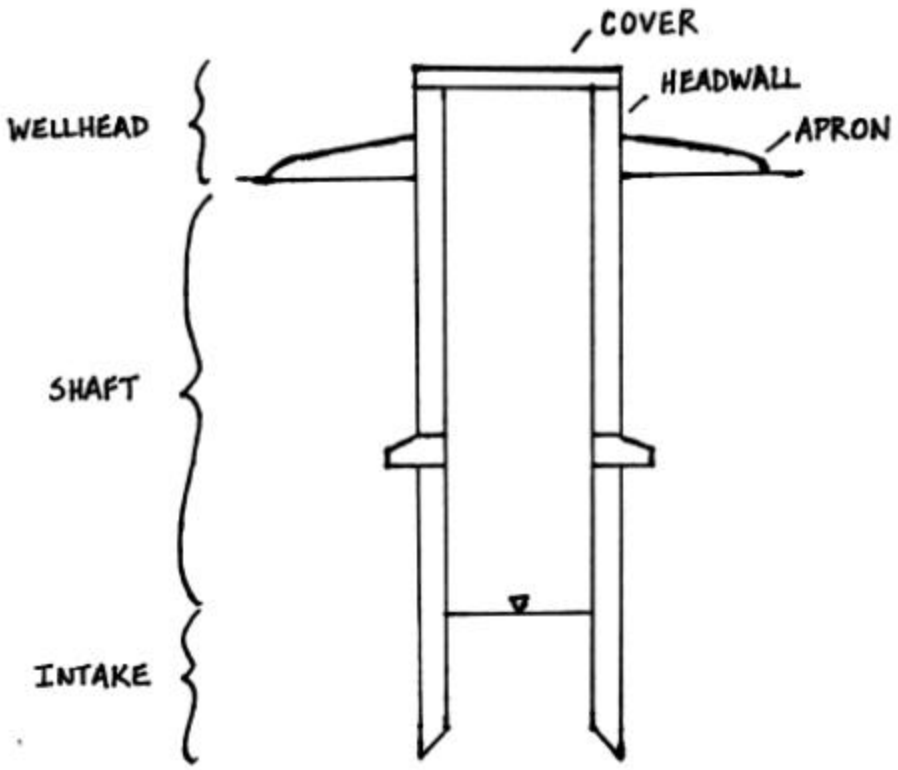

Figure 4.9: Diagram of Hand Dug Well

There are many ways to improve the safety, permanence, and water quality of traditional hand dug wells. The simplest, but most important improvement to an existing well is the construction of a wellhead consisting of a headwall and a drainage apron, as depicted in Figure 4.10. This single measure can eradicate guinea worm (Watt and Wood 2001) and significantly reduce other health risks, such as the transmission of hookworm (Pickford 1998). Raising the wellhead above the surrounding ground surface by the construction of a headwall prevents runoff water and spilt water from entering the well and reduces the chances of people or animals falling into the well. The addition of a drainage apron diverts water away from the wellhead area, preventing water from pooling at the surface near the well opening, and provides a structurally sound and more hygienic surface for

well users to walk on and rest their water collection vessels (Watt and Wood 2001). Users should also be instructed to not stand on the headwall while drawing water in order to reduce the chance of contaminated spilt water from entering the well (Cairncross and Feachem 1993).

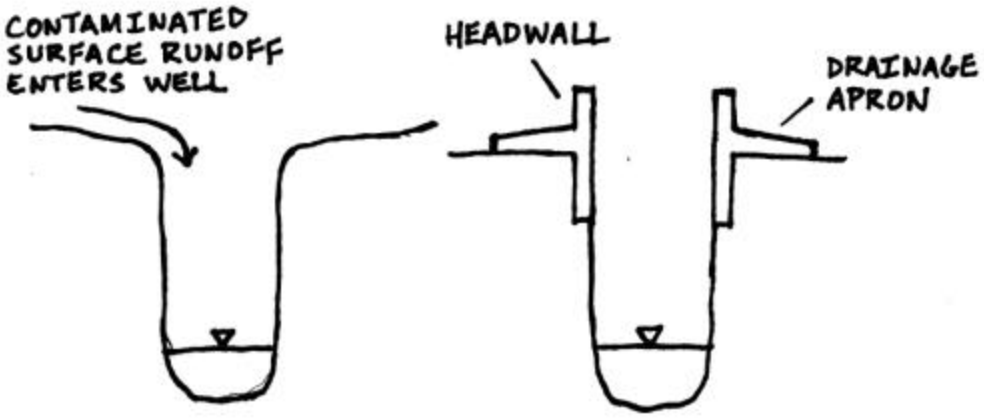

Figure 4.10: Improvement of Hand Dug Well

Adapted from: Watt and Wood (2001)

Placing a cover slab made of wood or concrete on the well reduces the risk of foreign objects falling into the well, and the addition of a lid further reduces the risk. Lining the well with concrete, bricks, or stones prevents well collapse. A watertight lining at the top of the well eliminates the risk of contaminated seepage water from the surface from entering the well (Morgan 1990).

Contamination from the water collection vessels can be reduced by placing them on a raised concrete or brick collar surrounding the well or hanging them when they are not in

use. This prevents the vessels from picking up contamination from an unhygienic wellhead and polluting the well when collecting water. Hanging the water collection vessels allows them to dry and get heated by the sun which dramatically reduces the number of bacteria on them (Morgan 1990).

Although many wells in rural areas have been constructed with some protective features, very few are built with all these features combined and thus yield water of questionable quality. Upgraded hand dug wells can be constructed using traditional and local skills and materials, cement being the main imported and most expensive material. Sealing the well and installing a pump is the best and most expensive way to prevent contamination and ensure a clean water supply, but upgraded hand dug wells used properly can yield water of good quality without the need of a handpump (Morgan 1990). Figure 4.11 shows one of the three pumps in the village that were installed by an international aid agency. Two of the three pumps in the village are operational, and they are located in the Sokoura and Djinkono *quartiers*. The third, non-operational pump is near the Djinkono *quartier*, at an inconvenient location, far from households, and the villagers have deemed it useless to pay for its repair.

Figure 4.11: Borehole Pump

4.4 Description of Village Sanitation

Village sanitation facilities are traditional pit latrines. The common pit latrine is usually a hole dug in the ground, with a cover slab made of wood, mud (or occasionally mortar) overlaying the wood, and some sort of structure built for privacy. This latrine can work well if the pit is deep, the inside of the structure is dark, the slab floor is a smooth and impervious surface that is kept clean, and a cover plate is used to prevent flies from entering the pit. However, in most cases the pit is shallow, the structure allows a lot of light in, the slab is not clean and is simply an mud and wood floor, and a cover plate is not used. Most pit latrines are open pits that smell bad and are a breeding area for flies that can carry disease (Morgan 1990). In Africa the most common type of "unimproved" latrine has a slab made of wood that is covered with mud to make a floor, as shown in Figures 4.12 and 4.13 (Pickford 1995).

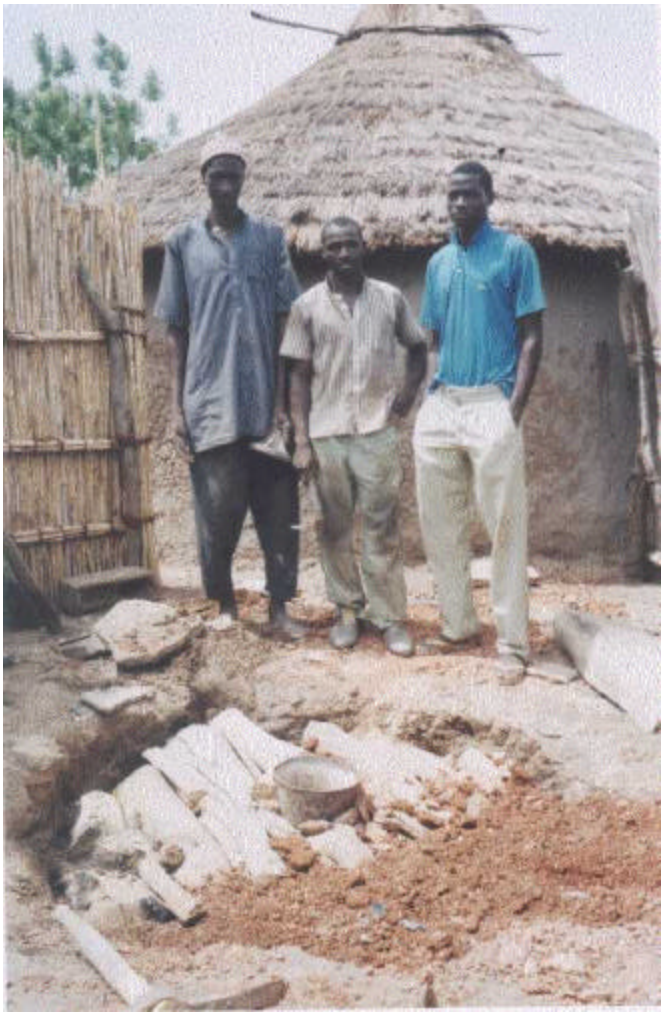

Figure 4.12: Wood Slab of Traditional Latrine Floor

Figure 4.13: Traditional Latrine

A pit latrine that is too shallow or too full, with the contents too close to the user, smells bad and there is a greater chance of the spread of disease. The wood and mud floor of a traditional latrine is difficult to keep clean, and a floor that is not clean and does not allow water to drain away is unsanitary and provides a breeding ground for mosquitoes and hookworm larvae. The floor of a traditional latrine is also subject to deterioration from weathering. Pit latrines without supported sides can collapse from the inflow of surface water that erodes the sides, and the wood slab is subject to attack from termites or rot which can cause collapse (Pickford 1998).

4.5 Methods to Improve Village Sanitation

There are many ways to improve traditional latrines. Simple pit latrines can be improved by plastering the mud floor with mortar, making the floor surface smooth, impervious, and sloping (Pickford 1995). This makes the floor easier to clean and allows for water to drain. According to Cairncross and Feachem (1993), the simplest and cheapest improvement to a pit latrine is to install a prefabricated reinforced concrete slab. Figure 4.14 is a picture of my latrine with a reinforced concrete slab. This makes the latrine more structurally sound and easier to clean. A mortar or concrete floor can also prevent hookworm transmission. Another possible improvement is the use of footrests which make it easier for users to position themselves over the hole and prevents them from fouling the slab. Covering the hole with a tight-fitting lid aids in the control of flies.

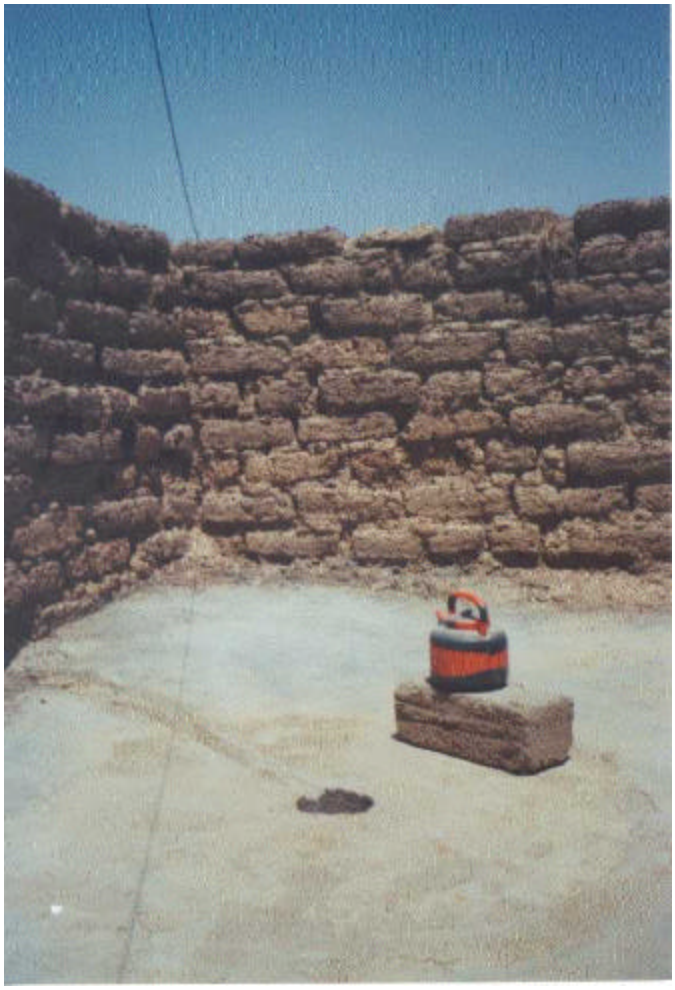

Figure 4.14: My Latrine

The cost of improving a latrine can be reduced by decreasing the amount of rebar used, eliminating the use of rebar, or reducing the amount of concrete used. The need for concrete reinforcement, as used in a flat slab, can be reduced or even avoided by making the slab slightly domed or conical in shape (See Figure 4.15). A traditional latrine with a strong floor made of wood and mud can be improved by placing a small slab, or "finishing slab," over the center. Since this slab is not a structural bridge over the pit it does not need reinforcement (Cairncross and Feachem 1993).

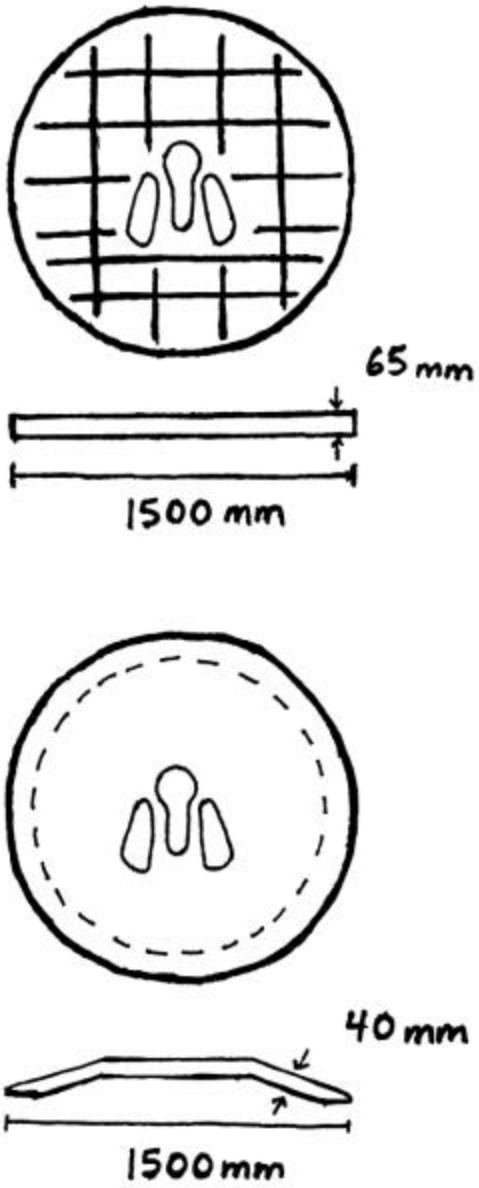

Figure 4.15: Plan Views and Cross-sections of Reinforced (top) and Unreinforced (bottom) Concrete Slabs

Adapted from: Pickford (1998)

Ventilated improved pit (VIP) latrines (See Figure 4.16) reduce the two main disadvantages of conventional pit latrines, the smell and the flies (or mosquitoes). Due to the action of wind passing over the vent pipe, inside air rises and escapes to the outside,

creating a downdraft of air through the hole in the slab (Cairncross and Feachem 1993). If the latrine in situated where there is no wind, the pipe can be placed on the sunny side of the latrine and painted black (if the pipe is not made of a dark material) so that the air inside the pipe is heated by the sun and rises. This circulation of air removes odors emanating from the pit (Pickford 1995).

The screened vent pipe prevents flies that are attracted to the odors from flying into the pipe and entering the pit. Some flies may enter through the hole in the slab, but the screened vent pipe prevents flies that are trapped in the pit from escaping as they fly towards the light at the top of the vent pipe and they will eventually die in the pit (Cairncross and Feachem 1993).

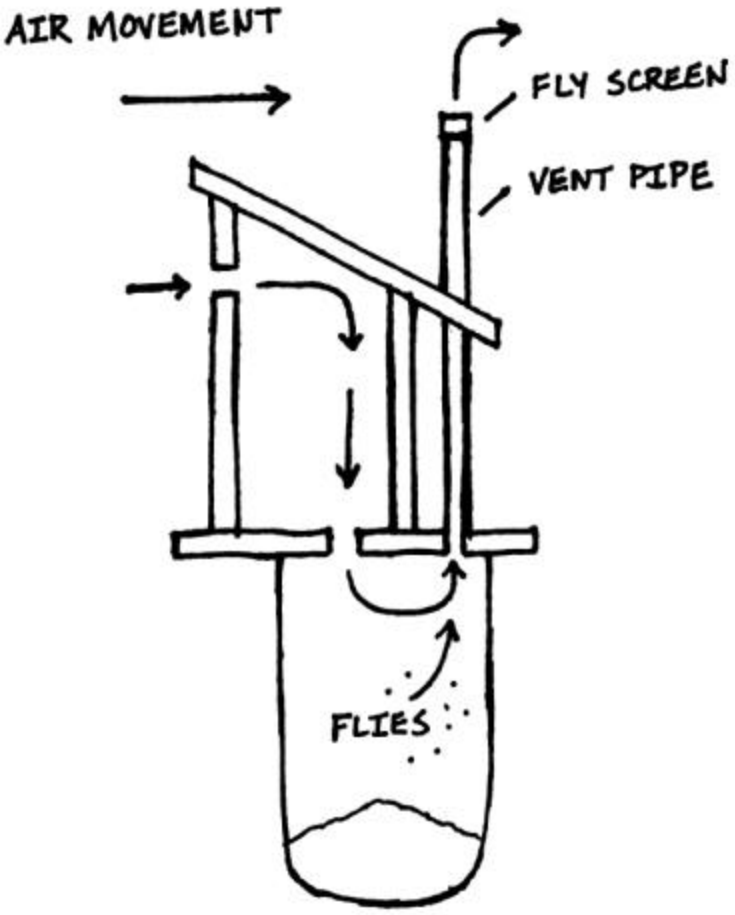

Figure 4.16: VIP Latrine

Adapted from: Pickford (1998)

4.6 Results of the Village Water Supply and Sanitation Survey

The results of the village water supply and sanitation survey are located in the appendix. Only 44 of the 46 households are represented in the results because I was not able to conduct final interviews with 2 households due to time constraints. The following sections summarize the results of the survey.

4.6.1 Types of Water Sources

There are 38 potential water sources in the village, but there are also a borehole pump that the village has deemed useless to repair and a modern hand dug well that the village would like to have an aid agency repair. Table 4.2 lists the types of water sources in the village, the quantity of each type of water source, and which *quartier* of the village they are located in. There are 16 water sources for the 18 households in Sokoura, 17 water sources for the 20 households in Djinkono, and 5 water sources for the 8 households in Djomogola. Of the water sources that are functioning and/or that the villagers would like to repair, there are 28 improved traditional hand dug wells, 7 not improved traditional hand dug wells, 1 modern hand dug well, and 2 borehole pumps. All of the hand dug wells in the village are unprotected wells and are therefore considered to be not improved water supply technologies according to WHO/UNICEF (2000). The only improved water supplies in the village are the borehole pumps.

Table 4.2: Number of Water Sources by Type and Village *Quartier*

Type of Water Source	Number Present	Village *Quartier*		
		Sokoura	**Djinkono**	**Djomogola**
Not improved traditional hand dug well	7	3	4	0
Improved traditional hand dug well	28	11	13	4
Modern hand dug well	1	1	0	0
Borehole pump	2	1	0	1
Total	38	16	17	5

4.6.2 Availability of Water

Of the 38 water sources previously mentioned, 27 have water available year round, as summarized in Table 4.3. All of the households have access to a water source with year round availability. Eleven households reported the need to use a secondary water source due to seasonality, and in all these cases the secondary source was farther than the primary source. As defined earlier, coverage is the percentage of the population with reasonable access to an adequate amount of drinking water from improved sources. "Reasonable access to an adequate amount of drinking water" is defined as availability of at least 20 liters per person per day from a source within one kilometer of the user's dwelling (UNDP 2001). The water sources that were reported to have year round availability are assumed to provide at least 20 liters per person per day.

Table 4.3: Availability of Water by Type of Water Source and Village *Quartier*

Type of Water Source	Village *Quartier*					
	Sokoura		Djinkono		Djomogola	
	Year round	Seasonal	Year round	Seasonal	Year round	Seasonal
Not improved traditional well	1	2	3	1	0	0
Improved traditional well	6	5	10	3	4	0
Modern well	1	0	0	0	0	0
Borehole pump	1	0	0	0	1	0
Total	9	7	13	4	5	0

As part of this survey, well depths were measured and this data can be found in the appendix. Well depths ranged between 5.2 and 8.0 meters in the Sokoura *quartier*, 6.9 and 8.3 meters in the Djomogola *quartier*, and 6.7 and 9.0 meters in the Djinkono *quartier*. While I was measuring well depths, a villager who resides in Djinkono commented that the wells in Djinkono are deeper than those in Sokoura in order to ensure year round availability of water. He said that if the wells dry up there are problems because the Sokoura and Djomogola pumps are far, the Djinkono pump is broken, and there is no communal water source with year round availability in Djinkono, like the pumps in Sokoura and Djomogola. Table 4.3 shows that there are a greater number of wells with year round availability of water in Djinkono. Year round availability of water occurs in only 8 out of 15 wells in Sokoura and it occurs in 13 out of 17 wells in Djinkono. All of the wells in Djomogola have year round availability of water.

4.6.3 Distances to Water Sources

The distances that households travel to collect water are provided in the appendix. The average distance that a household travels to a water source is 44 meters, the closest is 3 meters, and the farthest is 260 meters. All households have access to a water source within one kilometer of the household compound. As described in Chapter 3, distances to water sources were measured by counting my steps (three of my steps is approximately equal to 1 meter). The locations of household water sources are described earlier in this chapter. If the water source was a household well that is centrally located in the household compound, the distance was measured from the well to a hut at the perimeter of the compound. If the water source was located outside of the compound, the distance was measured from the center of the compound to the water source by way of footpaths.

4.6.4 Usage of Water

Only domestic uses of water were considered in this survey. Domestic uses of water include drinking, cooking, ablutions, bathing, clothes washing, and dish washing. Water that is suitable for drinking is also used for cooking and religious ablutions. Information on the different uses of water for each household and their water source(s) can be found in the appendix. Fifteen households reported obtaining their drinking water from a borehole pump, and fifteen households reported using a different water source for drinking water from other domestic uses.

Table 4.4 lists the households that collect drinking water from a different water source, and it compares the types of water sources that water is collected from and the distances

traveled to collect water according to its different uses. Twelve of these households collect drinking water from a borehole pump and the remaining three households collect drinking water from an improved traditional hand dug well. Thirteen of the fifteen households travel farther to their drinking water source.

The households that regularly collect drinking water from a borehole pump travel distances ranging from 18 to 182 meters, averaging 82 meters. Of the households that collect drinking water from a different source, those that go to a borehole pump travel an average of 61 meters more to collect water, and those that go to an improved traditional hand dug well travel an average of 18 meters more. The additional distance traveled to collect drinking water from a borehole pump ranges between 18 and 113 meters, and the additional distance traveled to collect drinking water from an improved traditional hand dug well is between 8 and 27 meters.

In the case of Household 1, the distance to their drinking water source is shorter than the distance to their other water source. Based on my observation, it appeared that this household collected its water for clothes and dish washing from the farther water source because there is an area to wash their clothes and dishes next to the water source. In the case of Household 28, the distances traveled to their drinking water source and their other water source were identical.

Table 4.4: Distances in Meters Traveled by Households that Collect Drinking Water from a Different Source

Household ID Number	Distance to Drinking Water Source	Type of Drinking Water Source	Distance to Other Water Source	Type of Other Water Source	Difference in Distances
1	18	Borehole pump	22	Improved traditional well	4
3	40	Borehole pump	22	Improved traditional well	18
4	43	Borehole pump	12	Improved traditional well	31
7	47	Borehole pump	12	Improved traditional well	35
29	37	Borehole pump	12	Improved traditional well	25
32	92	Borehole pump	13	Improved traditional well	79
36	120	Borehole pump	8	Not improved traditional well	112
40	97	Borehole pump	52	Improved traditional well	45
41	80	Borehole pump	33	Improved traditional well	47
42	127	Borehole pump	18	Improved traditional well	109
43	130	Borehole pump	17	Improved traditional well	113
45	125	Borehole pump	63	Improved traditional well	62
12	18	Improved traditional well	10	Not improved traditional well	8
16	40	Improved traditional well	13	Improved traditional well	27
28	28	Improved traditional well	28	Improved traditional well	0

4.6.5 Problems with Village Water Supply

Table 4.5 lists the reported problems with water supplies for each type of water source and the number of times that these problems were reported during the survey. The most common problems reported for not improved and improved traditional hand dug wells are erosion at the bottom of the well and seasonal changes in the availability of water. The next most commonly reported problems were either erosion of the wellhead or at the top of the well.

As described earlier, improved traditional wells have a wellhead structure consisting of a headwall built up with rocks and compacted dirt that is plastered with mortar. Erosion of the wellhead occurs over time as the mortar begins to crack and crumble and the headwall deteriorates. Erosion at the top of the well can occur due to either the lack of a wellhead or the lack of a watertight seal at the top of the well.

Over one-third of the traditional hand dug wells in the village are eroded at the bottom. Erosion at the bottom of the well is caused by the action of the rising and lowering of the water table and the instability of the geological conditions of the aquifer. I was told by villagers that these hydrogeological conditions are characteristic of the area and this is confirmed by the occurrences of this problem. Over one-third of the traditional hand dug wells are also reported to dry up or have unacceptable water quality due to low water levels during the hot season.

Table 4.5: Types of Water Sources and Reported Problems

Type of Water Source	Problem	Number of Times Reported
Not Improved Traditional Well	During hot season well dries up and water is not good	3
	Bottom of well eroded	2
	Top of well eroded	1
Improved Traditional Well	During hot season well dries up and water is not good	10
	Bottom of well eroded	10
	Wellhead eroded	4
	Worms occasionally present in water	2
	Top of well eroded	1
	Water dirty from debris falling into well	1
	During rainy season runoff water enters well and water is not good	1
	Lack of cover	1
	Water is dirty	1
	Water does not taste good	1
	Too many users	1
Modern Well	Children throw things into well	1
Borehole Pump	No problems reported	0

4.6.6 Existence of Latrines

Forty of the 44 households that are included in this survey reported the existence of a simple pit latrine in the household compound. Although I did not inspect the latrines as part of this study, based on my observations and usage of latrines in the village and in other similar villages in the area, the majority of the latrines have a wood slab and mud floor. Simple pit latrines are considered to be an improved sanitation technology because they are private and hygienically separate human excreta from human contact, as defined in Chapter 2.

4.6.7 Problems with Village Sanitation

The two problems with latrines that were reported are that the latrine floor is broken or the latrine pit is full. As described earlier, traditional latrines in the village are constructed with a simple mud and wood floor that can easily deteriorate from the eroding action of water, weather, and general use, attack by termites, or rotting of the wood.

4.6.8 Village Needs Assessment

The final interview question asked was, "Is there something you would like for yourself, your family, or for the village?" Table 4.6 lists the various responses to this needs assessment question and the number of households that gave each response. The responses that each household gave are listed in the appendix. From the 44 households included in this study there were 22 different responses. The most popular responses were a village maternity, a household latrine, a village health care center, a road to Djiguidala, the reparation of a household well, a household well, and a school. The village had submitted proposals to aid agencies for assistance with the construction of a maternity and a road to Djiguidala but they were rejected.

Among the other water supply and sanitation related responses, three households requested the construction of an improved large diameter well in the Djinkono *quartier* (due to the lack of a conveniently located communal water source in this *quartier*, unlike the borehole pumps in the Sokoura and Djomogola *quartiers*), two households requested another borehole pump for the village (to be used in lieu of wells for cleaner water), one

household requested a latrine with a concrete floor, one household requested to learn about water treatment with chlorine bleach, and one household requested sullage drainage at the pump in the Sokoura *quartier*. There were also water supply related responses associated with potential economic development—six households requested the construction of large diameter wells for gardens and two households requested motorized pumps for watering their gardens (gardening is an income generating activity).

Half of the responses were water supply or sanitation related, and 37 out of 44 (84%) households expressed a need to improve their water supply or sanitation. Improvement of water supply was requested by 30 households, improvement of sanitation by 21 households, and improvement of both water supply and sanitation were requested by 14 households.

Table 4.6: Village Needs Assessment Responses

Need Expressed	Number of Households Expressing Need
Maternity	25
Latrine	20
Health care center	19
Road	14
Well	10
Bottom well repair	10
School	10
Large diameter garden well	6
Top well repair	3
Large diameter well for Djinkono	3
Metal roof for house	3
Livestock	3
Borehole pump	2
Motorized pump for water garden	2
Fencing for garden	2
Farming tools and equipment	2
Carts	2
Sullage drainage at borehole pump	1
Cemented latrine	1
Training in water treatment	1
House	1
Fencing for animals	1

4.7 Village Water Supply and Sanitation Coverage

Based on the definitions of "coverage" and "improved" water supplies and sanitation facilities from the WHO/UNICEF (2000) report, 48% of the village households use improved water supplies and 91% of the households use improved sanitation facilities. The only improved water supplies in the village are the two borehole pumps. The improved sanitation facilities in the village are simple pit latrines.

Table 4.7 compares the water supply and sanitation coverage in the village of Gouansolo, determined from this study, to coverage data for rural Mali, rural Africa, and the rural

world. The water supply coverage for the village of the Gouansolo is similar to the reported percentage of rural Africa. There is a significant difference between the sanitation coverage for the village and the other reported coverages. A possible reason for this is the limited extent of the sanitation portion of this study, which is explained at the end of this chapter as a possibility for future work.

Table 4.7: Comparison of Water Supply and Sanitation Coverages in the Village of Gouansolo, Rural Mali, Rural Africa, and the Rural World

	% Water Supply Coverage	% Sanitation Coverage
Village of Gouansolo	48	91
Rural Mali	61	58
Rural Africa	47	45
Rural World	71	38

Source of Rural Mali, Rural Africa, and Rural World Coverage data: WHO/UNICEF (2000)

4.8 Improvement of Village Water Supply and Sanitation Coverage

As discussed earlier in this chapter, the simplest and most important improvement to a traditional hand dug well is the construction of a headwall and drainage apron, and the well should be covered in order to protect the water supply. A headwall, drainage apron, and cover protect the well by preventing contamination from entering the well and preventing erosion at the top of the well. The improved traditional hand dug wells with a mortared wellhead that are currently in the village are an adaptation of this improvement.

The headwall should be about one meter high. The drainage apron should extend about two meters around the wellhead (Watt and Wood 2001). A simpler method for

improving drainage that I encountered is to surround the wellhead with rocks, gravel, sand, etc. A woman in the village asked me to help with a sullage drainage problem around the household well and I recommended that she do this. Sullage is defined as household wastewater that has been used for washing, cooking, or cleaning purposes (Pickford 1998). It is common for households to do their clothes and dish washing near the water source. In addition to the runoff and spilt water that create water-logged conditions around the well, the drainage problem worsens due to the lack of a washing area near the well that has adequate drainage.

During the survey, one household commented on the importance of using a well cover by identifying the lack of a cover on the household well as a problem. During one of my village walks, a group of women who were using the modern well in the village also identified the need to cover wells because of the problem of children throwing things and spitting into this well.

The problem of erosion at the bottom of the well can be solved by lining the well with either concrete bricks or rings which are subsequently sunk into the aquifer, as explained in the description of my work as a Peace Corps Volunteer in Chapter 2. Sinking the well deeper can improve its yield during the dry season, but there are limits to the extent that this can be done using only hand dug methods (Watt and Wood 2001). One villager reported that prior to the construction of the modern well in the village, the household collected water from a neighbor's not improved traditional well. He stated that the well is better because it is lined with concrete and therefore the water is cleaner.

The simplest improvement to a traditional latrine is to either cover the floor with mortar or install a concrete slab. Traditional latrines with mud and wood floors serve their purpose and may be in good condition if termite-resistant and rot-proof wood is used, but the floors are virtually impossible to keep clean and they deteriorate easily (Pickford 1995). A latrine floor with mortar or concrete creates a smooth, impermeable surface that is easy to clean and is structurally sound and less susceptible to deterioration.

Based on the findings of this study, it is proposed that the best method to improve the existing village water supply situation is to construct protected hand dug wells that have a wellhead consisting of a headwall, apron, cover, and lid, are lined with either concrete rings or bricks, and are sunk sufficiently deep to ensure year round availability of water. These measures can eliminate the problems of contamination entering the well, erosion at the top and bottom sections of the well, and seasonal availability of water. The best method to improve the existing sanitation situation is to construct simple pit latrines with a mortar or concrete floor. This can eliminate the problem of deterioration of the latrine floor.

Although there were more households that expressed the need for a well than a borehole pump, another possible way to improve village water supply coverage is to install another handpump in the Djinkono *quartier* of the village, in a more convenient location approved by villagers. Possible reasons for the preference of a well over a borehole pump are the greater cost of a pump and the fewer maintenance problems of a well (Manou-Savina 1998).

The pumps in the village are India Mali brand pumps. The World Bank-funded Mali Rural Water Supply Project that was completed in 1992 provided this type of pump to 220 villages in the districts of Kita, BafoulabŬ, and KŬniŬba in the western part of Mali.

These villages were responsible for part of the cost of the handpumps and for all of the maintenance. According to the performance audit report of this project, 228,000 people were provided with 628 pumps, and on average each pump was shared by 363 villagers, with villagers tending to collect water at the same times of the day. Based on pump specifications, in order to provide villagers with 20 liters of water per person per day it is necessary to follow a staggered schedule for water collection, but villagers could not follow this schedule because of agricultural work and other tasks. Therefore, water supply coverage was still considered insufficient (World Bank OED 1997).

The populations of the Djinkono, Sokoura, and Djomogola *quartiers* are 326, 371, 139, respectively. The number of people sharing the pumps in Sokoura and Djomogola are 204 and 128, respectively. Based on the performance of the pumps in Sokoura and Djomogola and the information from the aforementioned project it can be assumed that the installation of a borehole pump would provide only some of the villagers in Djinkono with access to an improved water supply.

4.9 Obstacles to Improvement of Village Water Supply and Sanitation Coverage

"Water supply and sanitation development takes place in a real-world setting of scarce funds, competing priorities, human-resource and other institutional limitations, and social and political systems that both shape it and determine its eventual successes"

(Bendahmane 1993). Water supply and sanitation standards depend on factors such as the users' perceived needs, affordability, population density, soil conditions, local hydrology, and institutional capacities. Improvements in water supply and sanitation are often ranked below a number of other needs. Needs vary according to the influence of social, cultural, economic, physical, and technical location specific factors involved (Dangerfield 1983).

The needs assessment that was conducted as part of this study revealed that half of the responses were water supply and sanitation related. The other half of the responses were health related (construction of a health care center and maternity), education related (construction of a school), infrastructure related (construction of a road), agriculture related (farming tools and equipment, fencing for gardens and livestock), housing related (metal roofs, a new house) and wealth related (livestock, carts).

As mentioned earlier, 84% of the households identified an improvement of water supply and/or sanitation as a need, so it appears that villagers have identified this as a priority. It is rare for individual rural communities to be able to afford the cost of improving water supply and sanitation facilities (Davis et al. 1993). Efforts to improve water supply and sanitation are "obviously frustrated by poverty" (Dangerfield 1983). The following four stories demonstrate how lack of financial means is an obstacle to improving water supply and sanitation.

One household requested assistance with the construction of a latrine with a concrete slab floor, and I met with the head of the household to discuss this potential project. When I asked him if he knew how to construct a concrete slab he replied yes, but he wanted an aid agency to pay for it. Upon finding out that I could not finance this project, he said that he would just wait for an aid agency that could. In another instance, one of the heads of households who expressed a need for a new latrine during the survey told me that he had already gotten a cost estimate for the construction of a latrine, but it was too expensive for him so he was waiting for money from either a relative or a year when he is better off financially.

During an earlier part of my service, some villagers had asked for assistance with repairing an unimproved traditional well. During a village walk when this survey was conducted, I found that the well was now an improved traditional well. I inquired about how this was done and was told that a relative had provided the finances to upgrade the well. Another time during my service, both of the functioning borehole pumps in the village were in need of repair at the same time. A pump repairman was summoned from the town of Siby to repair the two pumps and the villagers asked him to look at the Djinkono pump for a repair cost estimate. The Sokoura and Djomogola pumps were repaired, but it was decided that it was too expensive to repair the Djinkono pump.

Of the water supply and sanitation technologies that are considered to be improved by WHO/UNICEF (2000), protected dug wells and simple pit latrines appear to be the most appropriate technologies for the village, based on the findings of this study. Watt and

Wood (2001) present "rule of thumb" figures for estimating materials for the construction of a concrete lined protected hand dug well:

- Cement – 120 kg per meter depth of well, plus 200 kg for wellhead and apron
- Reinforcing rods – 30 meters of 8 mm diameter rod per meter depth, plus 50 meters of 15 mm diameter for the intake
- Gravel – 0.5 cubic meters per meter depth
- Sand – 0.25 cubic meters per meter depth
- Construction labor – 2 working days per meter depth, plus 10 working days for preparation, wellhead, and clearing site

Based on the well depth data for wells in the village that have year round availability of water, it appears that sinking a well to a depth of 9 meters is sufficient to ensure year round water supply. Based on Watt and Wood's figures, the amount of cement required for a 9 meter well is 1280 kg. In Mali, cement is available in 50 kg bags and during the time I was in Mali, one bag of cement was about $10 U.S. For a 9 meter well, 26 bags of cement are needed, and the total cost of cement is $260 U.S. It was stated in Chapter 2 that the gross national income (GNI) per capita in Mali is $240 U.S. Thus, the cost of cement alone exceeds the GNI per capita. In addition to the materials, other expenses include tools and equipment. Brikkø et al. (1997) state that an 8 meter well in Ghana cost $820 U.S. in 1992.

The cost of a borehole pump is significantly greater than that of a well, possibly exceeding $2300 U.S. (Brikkø et al. 1997). In 1990, the cost of an India Mali pump was

$2070 U.S. (Reynolds 1992). Parker and Skytta (2000) reported that the cost of an improved India Mark II pump, which is similar to the India Mali pump, is about $1200 U.S., not including the cost of installation. They also reported that their study did not find a beneficiary village of the previously mentioned Mali Rural Water Supply Project that was ready to cover the costs of a major overhaul or the complete replacement of the pump's most expensive components.

Based on my experience as a Peace Corps Volunteer in the Water/Sanitation sector, construction of a simple pit latrine requires 1 bag of cement for the slab. According to Pickford (1995), a concrete slab in Ethiopia cost $40 U.S.

These cost estimates for the construction of a well and a latrine also demonstrate how funding limitations are an obstacle to the improvement of water supply and sanitation. Table 4.8 shows the ranges of construction costs in Africa for some of the water supply and sanitation technologies included in this report.

Table 4.8: Construction Costs of Water Supply and Sanitation Technologies

Water Supply Technologies	**Construction Costs per Capita per Person Served**
Protected well	$3 – 200 U.S.
Borehole with handpump	$10 – 60 U.S.
Sanitation Technologies	**Construction Costs per Capita per Person Served**
Simple pit latrine	$5 – 100 U.S.
VIP latrine	$25 – 300 U.S.

Source: WHO/AFRO (2000)

Additional costs that also need to be considered are operation and maintenance (O&M). According to Brikkϋ et al. (1997) the O&M costs of a protected dug well and a basic improved traditional latrine are very low, ranging from zero to $2 U.S. per capita per year, and preventative maintenance costs for a borehole pump ranges between $12-60 U.S. per pump per year for spare parts and materials, excluding labor. The study by Parker and Skytta (2000) found that only 1 out of the 15 sample villages in Mali that were beneficiaries of the World Bank's Rural Water Supply Project performed maintenance on its pumps, like cleaning the pump area and lubricating and adjusting the pumps, and only 1 out of the 21 pumps inspected had ever been lubricated. Preventative maintenance is still not a part of village culture, routine maintenance of the pumps is not performed, and the pumps are used almost incessantly, resulting in the premature wear and breakage of the most expensive components of the pumps (World Bank OED 1997).

Although all of the villagers have access to improved water supplies, two borehole pumps, not everyone uses them. Four households stated that health improved after the installation of these pumps. Five households with improved traditional wells stated that their water comes from the well because the pump is far, and two of these households requested another borehole pump because the water from a pump is cleaner. Fourteen households reported questionable water quality of their drinking water source and four of these households did not collect water from a different source. Of these four households, three collected water from an improved traditional well and one collected water from a modern well. Based on my survey data and knowledge of the village, these four households would not have to travel farther than the household that travels the farthest

distance to a pump, an improved water source. Some people are not willing to walk farther to collect water from an improved source "when they have closer sources that appear reasonably clean or that they have always used in the past," even though they may say that the improved source is better (Bourne 1984).

Parker and Skytta (2000) reported several factors that limited the efficacy of the World Bank Mali Rural Water Supply Project that was previously mentioned. Some beneficiaries did not like the taste of the water from the pumps and preferred "the more complex taste" of the water from their regular water source. Another factor that limited access to improved water sources was ease of use. It was observed that the families who lived closest to the pumps used them regularly and the families who considered the time and distance to collect water from the pumps to be excessive preferred to collect water from traditional sources. In addition, in some villages the pumps were installed next to the compounds of powerful families who claimed ownership of the pump and restricted access to it by reserving access to friends, relations, and people who were willing to pay.

"Nonacceptance" or lack of implementation of water supply and sanitation improvements is often perceived as failure upon the part of the development worker. Behavioral change is the main obstacle to development, and the only thing that a development worker can do is "to be willing to meet people's actual requirements as far as possible" and not blame the obstacle of behavioral change on ignorance, backwardness, or cultural difference (Bourne 1984).

4.10 Qualitative Data Analysis

The results of this study include both quantitative and qualitative data. Much of the data in this study is qualitative in nature, based on "'raw' experience, which is then converted into words…[which] are based on *observation, interviews, or documents* (or as Wolcott [1992] puts it, 'watching, asking, or examining')." The data is usually collected "in close proximity to a local setting for a sustained period of time" (Miles and Huberman 1994). This study was based on my experience in the village of Gouansolo.

There are epistemological issues concerning the reliability and validity of qualitative data. The nature of this data is dependent upon "the significance of the context of collecting information—who the respondent is, who the fieldworker is, how they get on, how each thinks the other thinks, what the question means to both people, [and] who else was there." "The best way of cross-checking data is to adopt a variety of approaches to the same issues: different questions, similar questions asked at different times, different respondents and different methodological tools" (Devereux and Hoddinott 1993).

4.11 Future Work

In order to make this study more comprehensive, there are a number of things that can be done:

- Inspect latrines
- Interview women
- Conduct survey during the hot season
- Identify wealth indicators
- Test water quality
- Identify water and sanitation-related health problems
- Conduct needs assessment at different time
- Ask villagers to rank their needs

Inspection of the latrines would allow for a more complete assessment of the sanitation situation by confirming if any households have improved latrines with mortar or concrete floors, examining the cleanliness and condition of the latrines, and verifying the reported problems with the latrines. Because latrines are enclosed and there are privacy issues, unobtrusive visual inspection of them is not possible. Water sources, which are in the open, are easier to observe.

Women play a central role in water supply, sanitation, and hygiene. They are the main collectors and users of water, and they are also responsible for household cleaning. Davis et al. (1993) note that traditional forms of consultation, that often exclude women, need to be respected. In many traditional patrilineal West African societies community issues

are discussed at village meetings that are open to men only. I was able to attend some of these meetings with my host dad probably due to my role in the village as a development worker, transcending traditional gender roles. Davis et al. provides recommendations on how women's views can be heard. Had there been time I would have attempted to interview women for this study, but regardless, the male heads of households would have to be consulted first.

Davis et al. (1993) also present the issue of accounting for seasonal variations when planning surveys. As discussed in Chapter 3 of this report, due to problems with time I conducted the surveys during the planting and harvest season, when most people are working in the fields away from the village during the day and are very tired in the evenings. Generally, during the hot season more people are present in the village during the day and they have more free time and a lighter workload. Thus, more people are available for interviews. To make the study even more complete, surveys could be conducted during each of the seasons in order to get a more complete assessment of the changes in water supply and sanitation throughout the year and confirm villager reports.

The references presented in Chapter 3 suggest a number of other types of information that can be included in a water supply and sanitation study, such as indicators of wealth, water quality, and health, and the methods for obtaining this information. Household indicators of wealth can show possible links between wealth and improved water supply and sanitation. Testing water quality can confirm villager reports on water quality, scientifically and quantitatively, and reveal any differences in quality between improved

and not improved water sources. Improvement of health is the main reason for improving water supply and sanitation facilities. Testing water quality and identification of water and sanitation-related health problems can aid in the determination of what improvements in water supply and sanitation need to be made.

The last question asked of heads of households during the final interviews of this study was a means of conducting a village needs assessment. As explained in Chapter 3, the question was open-ended and the respondent was told that his response(s) did not have to be related to water supply or sanitation, in order to determine if improving village water supply and sanitation is a need and a priority. Although I attempted to eliminate the potential for biases toward water supply and sanitation-related responses with this clarification, the needs assessment question could have been asked at a different time, either at the beginning of the survey or independently of it. Water supply and sanitation-related needs were identified during the survey, but asking the respondents to rank their needs would determine if improvements in water supply and sanitation are a high priority.

5.0 Conclusions and Recommendations

This chapter reviews the main findings of this study. The objective of this study was to assess the water supply and sanitation situation in the village of Gouansolo, Mali in order to identify water supply and sanitation problems in the village and potential water supply and sanitation improvement projects as solutions.

This study provided an assessment of the water supply and sanitation situation of Gouansolo, the village where I served as a Peace Corps Volunteer from November 1999 to October 2001. The study was conducted by the use of participant observation, interviews, and surveys. Information on the village and the current water supply and sanitation situation were collected during the time I was in Mali. Participant observation and informal and unstructured interviews allowed for the collection of information throughout my service. The water supply and sanitation survey was conducted by semistructured interviewing between the months of January and September 2001. Forty-four of the forty-six households in the village are included in the survey.

This study determined that 48% of the households in Gouansolo use improved water supplies and 91% use improved sanitation facilities. This compares to 61%, 47%, and 71% water supply coverage and 58%, 45%, and 38% sanitation coverage for rural Mali, rural Africa, and the rural world, respectively (WHO/UNICEF 2000). According to WHO/UNICEF (2000), the improved water supply technologies in the village are the two borehole pumps, and all of the latrines in the village are considered to be improved

sanitation technologies though most are believed to have mud and wood floors, not mortar or concrete floor slabs.

All of the village households have reasonable access, as defined in UNDP (2001), to a water source that provides 20 liters per person per day within one kilometer of the household compound, but not all households obtain their water from an improved water source. The distance households traveled to collect water from any type of water source ranged between 3 and 260 meters and averaged 44 meters. The distance traveled to collect drinking water from a borehole pump averaged 82 meters and ranged from 18 to 182 meters. Approximately one-third of the households collect drinking water from an improved water source. Twenty-five percent of the households are willing to walk farther to collect drinking water from an improved water source. Ninety-one percent of the village households have adequate sanitation, as defined in UNDP (2001), simple pit latrines that are private and hygienically separate human excreta from human contact.

The most common water supply problems reported were erosion at the top and bottom sections of traditional hand dug wells and seasonal availability of water in these wells. These structural and seasonal problems were not influenced by whether a traditional well is improved or not improved. The most appropriate technology to use to alleviate these problems is a protected hand dug well, with a headwall, apron, and cover with lid, that is concrete lined and sunk sufficiently deep to ensure year round water supply. The main sanitation problem that was reported is deterioration of latrine floors. The most

appropriate technology to use to improve this situation is a simple pit latrine with a mortar or concrete slab floor.

A wide range of cost estimates for the water supply and sanitation technologies included in this report was presented. This range covers a number of African countries with diverse social, economic, political, and environmental conditions, institutions and infrastructure. Cost information specific to Mali was limited so the amounts presented are used only as a guide.

It was observed that the main obstacle to the improvement of village water supply and sanitation and the achievement of 100% coverage in both of these areas is the lack of financial means. Funding limitations are the most critical constraint to the water supply and sanitation sector in Africa. The next most important constraint is inadequate operation and maintenance. These constraints are related for the most part to inadequate financial, human, and material resources, problems that have remained essentially the same in Africa over the past 30 years (WHO/AFRO 2000). Behavioral change is another obstacle to improvement of water supply and sanitation. Although improvement of water supply and sanitation facilities were recognized as needs, they were not necessarily identified as the highest priorities and were competing with other needs reported in the village needs assessment.

Based on my experience as a Peace Corps Volunteer, it seems that improvements in village water supply and sanitation can only be achieved with outside assistance from aid

agencies. Types of aid include technical and financial assistance. There should be a shared responsibility between aid agencies and communities. Successful development projects are those that are adapted to local practices and traditions, have community participation in the project planning, design, implementation, management, and operation, and have a community contribution so that there is a sense of community ownership of the water supply and sanitation facilities (World Bank OED 2002).

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Note: All graphics from web sites do not have copyright restrictions.

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APPENDIX:
Results of the Water Supply and Sanitation Survey

Household ID Number	Quartier	Number of People in Household	Household Composition 0-12 M	0-12 F	13-60 M	13-60 F	60+ M	60+ F	Water Source ID	Type of Water Source	Depth of Well (meters)	Availability of Water	Distance to Water Source (steps)	Distance to Water Source (meters)	Usage of Water	Problems with Water Source	Number of Latrines	Problems with Latrine	Water and Sanitation Comments
1	Sokoura	38	4	5	9	16	2	2	KK	borehole pump		year round	55	18	drinking, cooking, ablutions, bathing	no problems	6	no problems	would like to drain pool of stagnant water near pump, would like to repair well
									A	improved traditional well	6.5	year round	65	22	clothes washing, dish washing	wellhead eroded, water is dirty from debris falling into well			
2	Sokoura	8	2	0	2	3	1	0	KK	borehole pump		year round	80	27	all purposes	no problems	1	no problems	would like to construct new well
									B	improved traditional well	7.3	seasonal	65	22	not used	too many people use well			
3	Sokoura	30	7	9	7	6	0	1	B	improved traditional well	7.3	seasonal	65	22	clothes washing, dish washing	bottom of well eroded, water is dirty, well dries up if not enough rain	1	latrine is full	would like to repair well, would like to construct new latrine
									KK	borehole pump		year round	120	40	drinking, cooking, ablutions, bathing	no problems			
4	Sokoura	19	3	7	3	5	1	0	C	improved traditional well	6.5	seasonal	35	12	clothes washing, dish washing, bathing	wellhead eroded, well dries during hot season	1	latrine is broken	would like to construct new latrine
									KK	borehole pump		year round	130	43	drinking, cooking, used for all purposes when well is dry	no problems			
5	Sokoura	27	5	4	7	8	1	2	D	improved traditional well	5.7	seasonal	30	10	all purposes	when well dries up must dig deeper	2	latrines are full	would like another pump for the village
									KK	borehole pump		year round	140	47	used for all purposes when well is dry	no problems			

Household ID Number	Quartier	Number of People in Household	Household Composition 0-12 M	0-12 F	13-60 M	13-60 F	60+ M	60+ F	Water Source ID	Type of Water Source	Depth of Well (meters)	Availability of Water	Distance to Water Source (steps)	Distance to Water Source (meters)	Usage of Water	Problems with Water Source	Number of Latrines	Problems with Latrine	Water and Sanitation Comments
6	Sokoura	16	5	2	4	5	0	0	E	improved traditional well	7.2	seasonal	25	8	all puposes	during hot season well dries up	4	1 latrine is broken	would like to construct another latrine
									KK	borehole pump		year round	145	48	used for drinking water when water level in well is low, used for all purposes when well is dry	no problems			
7	Sokoura	46	6	5	15	17	0	3	B	improved traditional well	7.3	year round	35	12	clothes washing, dish washing, bathing	no problems	4	no problems	none
									KK	borehole pump		year round	140	47	drinking, cooking, ablutions	no problems			
8	Sokoura	13	1	3	2	6	1	0	F	not improved traditional well	7.2	seasonal	25	8	all purposes	bottom of well eroded, during hot season water level is low and water is not good	1	eroded at top by runoff water that enters latrine, latrine is broken	would like to repair well, would like to construct new latrine
									KK	borehole pump		year round	180	60	used for all purposes when water level level is low or water is bad	no problems			
9	Sokoura	8	1	0	3	3	0	1	II	modern well	8	year round	65	22	all purposes	children throw things into well	1	latrine is broken	would like to construct new latrine
10	Sokoura	15	7	0	3	4	0	1	G	improved traditional well	6.7	year round	30	10	all purposes	no problems	1	latrine is broken	would like to construct new latrine

Household ID Number	Quartier	Number of People in Household	Household Composition 0-12 M	0-12 F	13-60 M	13-60 F	60+ M	60+ F	Water Source ID	Type of Water Source	Depth of Well (meters)	Availability of Water	Distance to Water Source (steps)	Distance to Water Source (meters)	Usage of Water	Problems with Water Source	Number of Latrines	Problems with Latrine	Water and Sanitation Comments
11	Sokoura	12	1	3	3	4	0	1	H	improved traditional well	5.5	year round	40	13	all purposes	wellhead eroded, during rainy season runoff water enters well and water is not good	2	no problems	would like to repair well
12	Sokoura	24	3	3	11	7	0	0	I	not improved traditional well	5.2	seasonal	30	10	used for clothes washing, dish washing, and bathing when water is available	top of well eroded, during hot season well dries up	3	no problems	would like to repair well located nearer to compound, would like to construct 2 new latrines
									J	improved traditional well	6.7	year round	55	18	drinking, cooking, ablutions, used for all purposes when well dries up	top and bottom of well eroded			
13	Sokoura	19	2	1	8	7	1	0	J	improved traditional well	6.7	year round	45	15	all purposes	top and bottom of well eroded	5	no problems	none
14	Djinkono	10	1	1	2	5	1	0	K	improved traditional well	7.1	year round	25	8	all purposes	bottom of well eroded	1	latrine is filling up	would like to construct new latrine
15	Djinkono	14	3	3	3	5	0	0	L	improved traditional well	7	year round	10	3	all purposes	no problems	1	no problems	none
16	Djinkono	11	6	2	1	2	0	0	M	improved traditional well	6.7	year round	40	13	clothes washing, dish washing, bathing	water does not taste good, water sometimes has worms	1	no problems	would like to construct household well, would like potable water
									W	improved traditional well	7.5	year round	120	40	drinking, cooking, ablutions	no problems			

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17	Djinkono	20	3	7	3	6	0	1	M	improved traditional well	6.7	year round	70	23	all purposes	bottom of well eroded, water does not taste good	1	latrine floor is falling apart, holes in floor, wood is rotting	would like a large diameter well for the Djinkono quartier, plans to move household to another location in village and would like to construct well and latrine at new location
18	Djinkono	17	0	3	8	5	1	0	N	improved traditional well	7	year round	30	10	all purposes	no problems	1	latrine is broken, latrine is filling up	would like to construct new latrine, would like cemented latrine
19	Djinkono	25	3	1	9	9	1	2	O	improved traditional well	7.5	seasonal	45	15	all purposes	during hot season water level is low	3	no problems	none
									KK	borehole pump		year round	675	225	used for all purposes when water level in well is low	no problems			
20	Djinkono	21	3	2	5	6	1	4	P	improved traditional well	8.6	seasonal	75	25	all purposes	during hot season water level is low	3	2 latrines are broken, wood is broken	none
									KK	borehole pump		year round	780	260	used for all purposes when water level in well is low	no problems			
21	Djinkono	32	7	6	6	11	1	1	Q	improved traditional well	7.4	year round	35	12	all purposes	bottom of well eroded	0	not applicable	would like to repair well

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22	Djinkono	13	3	1	4	4	1	0	R	improved traditional well	not measured	seasonal	30	10	not used	bottom of well eroded, during hot season well dries up	1	no problems	would like to repair well that is closer to household
									S	not improved traditional well	9	year round	120	40	all purposes	no problems			
									Q	improved traditional well	7.4	year round	255	85	used for all purposes when old well was dry and before new well was dug	no problems			
23	Djinkono	8	2	3	2	1	0	0	T	not improved traditional well	7.7	seasonal	15	5	all purposes	bottom of well eroded, during hot season well dries up	0	not applicable	would like to repair well, would like to construct a latrine
									BB	improved traditional well	8	year round	115	38	used for all purposes when water level in well is low	no problems			
24	Djinkono	15	0	4	6	4	1	0	U	improved traditional well	7.4	year round	75	25	all purposes	no problems	1	no problems	would like a large diameter well for the Djinkono quartier
25	Djinkono	20	1	4	6	7	1	1	V	improved traditional well	8.8	year round	20	7	all purposes	no problems	1	latrine is filling up	would like to construct new latrine, would like to treat well with chlorine bleach
26	Djinkono	25	2	3	8	11	0	1	W	improved traditional well	7.5	year round	40	13	all purposes	wellhead eroded, during hot season water level in well is low and worms are sometimes present	2	1 latrine is full, 1 latrine is broken	would like to construct new latrine, would like to repair well, would like another pump

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27	Djinkono	7	2	3	1	1	0	0	W	improved traditional well	7.5	year round	75	25	all purposes	no problems	0	not applicable	would like to construct well, would like to construct latrine
28	Djinkono	33	10	5	9	8	1	0	W	improved traditional well	7.5	year round	85	28	drinking, cooking, ablutions, bathing, dish washing	no problems	2	no problems	would like to construct well
									M	improved traditional well	6.7	year round	85	28	clothes washing	no problems			
29	Sokoura	38	8	14	4	10	1	1	X	improved traditional well	7	year round	35	12	clothes washing, dish washing, bathing	bottom of well eroded	2	no problems	would like to construct another latrine, would like to repair well, would like to construct large diameter well in Djinkono quartier
									KK	borehole pump		year round	110	37	drinking, cooking, ablutions	no problems			
30	Djinkono	15	2	5	2	5	1	0	Y	improved traditional well	7	year round	20	7	all purposes	no problems	1	no problems	none
31	Djinkono	14	2	7	1	3	1	0	II	modern well	8	year round	70	23	all purposes	no problems	1	no problems	none

Household ID Number	Quartier	Number of People in Household	Household Composition 0-12 M	0-12 F	13-60 M	13-60 F	60+ M	60+ F	Water Source ID	Type of Water Source	Depth of Well (meters)	Availability of Water	Distance to Water Source (steps)	Distance to Water Source (meters)	Usage of Water	Problems with Water Source	Number of Latrines	Problems with Latrine	Water and Sanitation Comments
32	Sokoura	23	10	3	4	5	1	0	Z	improved traditional well	6.7	seasonal	40	13	clothes washing, dish washing, bathing	well dries up when there is not enough rain	3	no problems	would like to repair well
									CC	not improved traditional well	8	year round	100	33	used for clothes washing, dish washing, bathing when well is dry	no problems			
									KK	borehole pump		year round	275	92	drinking, cooking, ablutions	no problems			
33	Sokoura	23	9	8	2	3	1	0	KK	borehole pump		year round	120	40	drinking, cooking, ablutions	no problems	1	no problems	not available for interview
									A	improved traditional well	6.5	year round	80	27	clothes washing, dish washing, bathing	no problems			
34	Sokoura	10	5	0	1	3	1	0	AA	improved traditional well	6.9	year round	35	12	all purposes	well is not covered	1	no problems	would like to construct another latrine
35	Djinkono	13	2	4	3	2	1	1	BB	improved traditional well	8	year round	25	8	all purposes	bottom of well eroded, during hot season water level is low and water is not good	1	latrine is full	would like to repair well, would like to construct new latrine
									KK	borehole pump		year round	530	177	used for all purposes when water level in well is low and water is bad	no problems			

Household ID Number	Quartier	Number of People in Household	Household Composition 0-12 M	0-12 F	13-60 M	13-60 F	60+ M	60+ F	Water Source ID	Type of Water Source	Depth of Well (meters)	Availability of Water	Distance to Water Source (steps)	Distance to Water Source (meters)	Usage of Water	Problems with Water Source	Number of Latrines	Problems with Latrine	Water and Sanitation Comments
36	Sokoura	2	0	0	0	1	1	0	CC	not improved traditional well	8	year round	25	8	clothes washing, dish washing, bathing	no problems	1	no problems	would like to cement wellhead, would like to build new latrine
									KK	borehole pump		year round	360	120	drinking, cooking, ablutions	no problems			
37	Djinkono	6	2	1	1	1	0	1	DD	not improved traditional well	8.5	year round	50	17	all purposes	no problems	1	latrine is broken	none
									EE	not improved traditional well	not measured	year round	400	133	used for all purposes when well dried up	no problems			
38	Djomogola	14	3	3	1	4	2	1	LL	borehole pump		year round	205	68	all purposes	no problems	1	no problems	would like to construct household well
39	Djomogola	11	4	1	3	3	0	0	FF	improved traditional well	7	year round	25	8	all purposes	bottom of well eroded	1	latrine is broken	would like to repair well, would like to construct new latrine
									GG	improved traditional well	6.9	year round	135	45	animals	no problems			

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40	Djomogola	21	4	7	3	5	1	1	FF	improved traditional well	7	year round	155	52	clothes washing, dish washing, bathing	no problems	1	latrine is starting to fall apart	would like to construct household well, would like to construct new latrine, would like potable water
									LL	borehole pump		year round	290	97	drinking, cooking, ablutions	no problems			
41	Djomogola	39	16	9	3	9	2	0	JJ	improved traditional well	7	year round	100	33	clothes washing, dish washing, bathing	no problems	1	no problems	would like to construct household well, would like clean water
									LL	borehole pump		year round	240	80	drinking, cooking, ablutions	no problems			
42	Djomogola	30	14	3	2	8	1	2	HH	improved traditional well	8.3	year round	55	18	clothes washing, dish washing, bathing	no problems	1	latrine is falling apart	would like to construct new latrine
									LL	borehole pump		year round	380	127	drinking, cooking, ablutions	no problems			
43	Djomogola	10	3	1	3	2	0	1	JJ	improved traditional well	7	year round	50	17	clothes washing, dish washing, bathing	bottom of well eroded	1	latrine is broken	none
									LL	borehole pump		year round	390	130	drinking, cooking, ablutions, used for all purposes when well dries up	no problems			
44	Djomogola	4	1	1	1	1	0	0	LL	borehole pump		year round	545	182	all purposes	no problems	0	not applicable	would like to construct well, would like to construct latrine

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45	Djomogola	10	1	4	1	2	1	1	LL	borehole pump		year round	375	125	drinking, cooking, ablutions	no problems	1	no problems	would like to construct well
									FF	improved traditional well	7	year round	190	63	clothes washing, dish washing, bathing	no problems			
46	Djinkono	7	2	2	2	1	0	0											not available for interview

Household ID Number	Needs Assessment Responses
1	well repair, drainage of stagnant pool of water near pump
2	well, secondary school, health care center, maternity
3	well repair, latrine, large diameter garden well
4	latrine, large diameter garden well
5	borehole pump, health care center
6	latrine, health care center
7	maternity, fencing for garden, road to Djiguidala
8	latrine, well repair, health care center, house with metal roof
9	latrine, maternity
10	latrine, maternity
11	well repair, health care center, maternity
12	well repair, maternity
13	health care center, maternity
14	latrine, maternity
15	house with metal roof, farming equipment, road to Djiguidala, school, health care center
16	well, maternity, school, road to Djiguidala, potable water
17	large diameter well for Djinkono quartier, help with moving, well and latrine at new house, maternity, road to Djiguidala
18	cemented latrine, new latrine, health care center
19	maternity
20	maternity, large diameter garden well, motorized pump to water garden
21	well repair, maternity, school made with concrete bricks, road to Djiguidala
22	well repair, maternity, road to Djiguidala
23	well repair, latrine, road to Djiguidala, health care center
24	large diameter well for Djinkono quartier, maternity
25	latrine, treat well with chlorine bleach, health care center, maternity
26	latrine, well repair, roads to Djiguidala and Selengue, health care center, pump
27	well, new house, school, large diameter well and pump for garden
28	well, health care center, cart, maternity, school, road to Djiguidala
29	latrine, well repair, large diameter well for Djinkono quartier, maternity, raise chickens
30	large diameter garden well, fencing for garden, road to Djiguidala
31	cattle, carts, school, health care center
32	well repair, school, maternity
33	not available for interview
34	latrine, house with metal roof, maternity, road to Djiguidala
35	well repair, latrine, health care center
36	latrine, maternity
37	fence for animals
38	well, maternity
39	new latrine, well repair, road to Djiguidala, school, health care center, maternity
40	well, latrine, maternity, potable water
41	well, school, clean water
42	latrine, large diameter garden well, health care center
43	cattle, health care center, maternity, road to Djiguidala
44	well, latrine, health care center
45	farming equipment, well, road to Djiguidala, health care center
46	not available for interview