APPROPRIATE WATER TREATMENT FOR THE NYANZA PROVINCE OF KENYA

by

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Submitted to the Department of Civil and Environmental Engineering in Partial Fulfillment of the Requirements for the Degree of

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ABSTRACT

In 2000 the Centers for Disease Control and Prevention (CDC) in conjunction with CARE International began working with several local non-governmental organizations (NGOs) in the Nyanza Province of Kenya to reduce the rate of waterborne diseases. In 2002, CDC partnered up with the Society for Women and AIDS in Kenya (SWAK), a local NGO, to implement safe water treatment in SWAK-affiliated communities. SWAK is seeking ways to improve and expand sales of safe water treatment products in all of its communities. The water treatment sales expansion study has two components:

- A technical component that addresses the most appropriate treatment
- A business component that addresses marketing and sales of the products.

This study focuses on the technical component. Its purpose is to evaluate the most appropriate water treatment in SWAK communities in the Nyanza Province. Three water treatment products were assessed – WaterGuard®, PuR®, and an alternative naturally occurring coagulant made of seeds from the Moringa tree. WaterGuard® is a chlorine-based disinfectant; PuR® is a coagulant and chlorine-based disinfectant. Both are already being marketed by SWAK. Moringa trees are indigenous to the region.

Research was conducted in the United States and Kenya from October to April 2005. Field evaluation in Nyanza during January consisted of surveys that addressed water treatment practices, and water quality tests, specifically turbidity which interferes with the effectiveness of chlorine-based disinfection. Research revealed that rainwater is the best water source, and WaterGuard® is the best water treatment. PuR® was hardly used, and Moringa needs to be studied further for cost-efficiency and availability. A set of recommendations were drawn up and presented to SWAK communities, based on the results. These include promotion of rainwater treatment, retreatment of water every 24-48 hours, and health education programs.

Thesis Supervisor: Dr E. Eric Adams
Title: Senior Research Associate, Department of Civil and Environmental Engineering

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I would like to dedicate this thesis to all the forces that have made me possible and continually inspire me to be better. You are the reason that I am.

Special thanks to everyone who allowed me to be a part of their lives this year. Dr Eric Adams, Susan Murcott, Daniele Lantagne, Dr Richard Locke, Dr Pete Shanahan, the M.Eng Class of 2005, the G-Lab group, the Course 1 staff, Anne Graham, the Government of Kenya, Alie, SWAK, PSI, CDC, St Anna's Guesthouse, and many more. You have made this year so special. I will take you with me wherever I go.

Thanks to the reader who makes the time to ingest this, you have chosen wisely!

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1 INTRODUCTION

The purpose of the research outlined in this thesis is to recommend the most appropriate water treatment option in the Nyanza province of Kenya.

1.1 Background

In October 2004, the Centers for Disease Control and Prevention (CDC) approached an interdisciplinary team of graduate students in the Civil and Environmental Engineering (CEE) Department at the Massachusetts Institute of Technology (MIT) and the MIT-Sloan Business School, with a proposal to address water safety issues in Nyanza (Figure 1.1 and Figure 2.1). CDC's field station in Nyanza, Western Kenya, studies infectious diseases including diarrhea, malaria, and HIV in order to develop and assess strategies for controlling these diseases.

In western Kenya, diarrheal diseases are a major cause of morbidity and mortality among children younger than 5 years, largely because of inadequate water treatment and human waste disposal infrastructure.[1] A 1999 health survey revealed that 66% of the population in rural Nyanza lacked access to safe drinking water, and 47% of children younger than 5 years had experienced diarrhea in the preceding 2 weeks.

Mortality from water related diseases is further exacerbated by the increased HIV/AIDS rates in the region. Doctors and social workers interviewed during field research believe the HIV/AIDS rate to be anywhere from 25-40%. Already immuno-compromised, those affected are extremely susceptible to water-related diseases such as malaria, typhoid, cholera and other diarrheal diseases that typically result in mortality. Thus, morbidity can be reduced by making the water safer to drink.

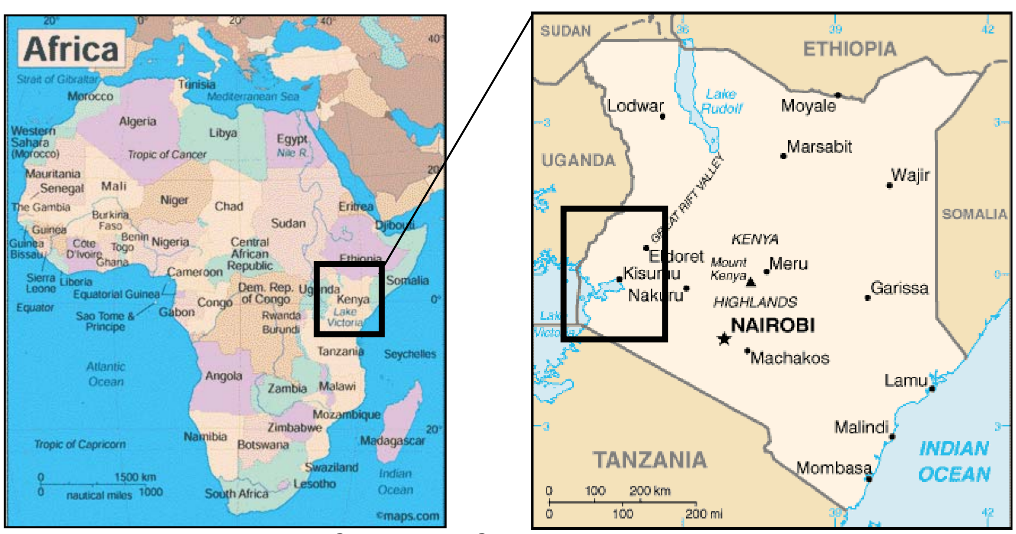

Figure.1.1: Map of Africa[2] and Kenya[3]. Kisumu is the capital of Nyanza Province.

The high HIV/AIDS rates are a result of several historical, socio-economic and cultural factors in the region. Appendix 1 outlines these issues in greater detail.

In 2000, CDC began implementing the Safe Water System (SWS) in conjunction with CARE International in communities in the Nyanza province. SWS is a three-component approach to improve water quality and hygiene practices in the home, which includes treatment of drinking water with dilute sodium hypochlorite, safe storage and hygiene education.

In order to promote SWS, CDC joins forces with local NGOs (Non Governmental Organizations) to penetrate into regions that need SWS the most. One such NGO that CDC works with is SWAK (Society for Women and AIDS in Kenya). Headquartered in Nairobi, SWAK has offices in every province of Kenya including Nyanza where the author's project is located. Since October 2002, SWAK-Nyanza has been working to promote the use of SWS in some communities. They are currently seeking ways to improve upon and expand the sales of SWS into all of their communities.

The overall goal of this project was to outline a set of recommendations to improve penetration and adoption of water treatment products in the SWAK communities. It was divided into two components:

- A technical component: Work included gauging the water quality in the communities, addressing technical problems the communities have with the treatment products and recommending the best available water treatment option for the communities.

- A business component: Work included gauging the markets, current business practices and outlining a set of best practices/recommendations to improve sales of the water treatment products in the communities.

The research outlined in this thesis forms the technical component and was conducted by the author.

The business component was addressed by a team of second year MIT-Sloan Business students – Mark Chasse, Jody Gibney, Rachel Greenblatt, and Ellen Sluder – who have multiple of years of prior business experience. Their report is included in Appendix 7.

This multidisciplinary team traveled to Nyanza, Kenya in January 2005 to conduct field work in SWAK communities there. Results from the data collected in the field were presented to all stakeholders before the team's return to the United States.

1.2 The Technical Component

The goal of the technical component is to find the most appropriate water treatment product for the SWAK communities in Nyanza.

Three water treatment products were assessed. Two were already being marketed by SWAK in their communities – PuR® and WaterGuard®. The third, an herbal product consisting of seeds from the Moringa tree family, was considered as a possible alternative mainly for financial reasons.

WaterGuard® was designed by CDC in conjunction with PSI and CARE International for water disinfection. It consists of 1% Sodium Hypochlorite (NaOCl) solution. PuR® was designed by Proctor & Gamble to reverse engineer a water treatment plant and to provide high quality drinking water at the point-of-use. PuR® consists of Ferric Sulfate ($Fe_2(SO_4)_3$) for coagulation and Calcium Hypochlorite ($Ca(OCl)_2$) for disinfection. PuR® is important because Nyanza has naturally high turbidity levels in surface and groundwater. Moringa trees are locally available. Their seeds are proven to be natural coagulants.

Over the three week field research period in January 2005, fourteen SWAK communities were assessed using field surveys, and chlorine and turbidity tests in order to gauge personal preferences, product knowledge, current water practices and water quality. Upon return to the United States, the data was analyzed and further research was done to substantiate the results.

1.3 Thesis Outline

The second chapter outlines the water situation in Kenya and particularly, Nyanza. The chapter starts with an overview of water resources in Kenya before focusing on Nyanza's water issues, and provides an in-depth look into the water treatment products which have been briefly outlined above.

The third chapter outlines the methodology used for research. It is followed by chapter four which highlights the results of research conducted thus far.

This thesis concludes with chapter five where the final set of recommendations for SWAK is presented and the most appropriate treatment for use in the SWAK communities in Nyanza is discussed.

2 WATER ISSUES IN KENYA AND NYANZA

This chapter will highlight the water availability issues in Kenya and Nyanza.

2.1 Kenya: Geography, Rainfall and Water Resources

This section briefly highlights the salient water resources across Kenya. All data provided below is from Reference 4.

Kenya is located in Eastern Africa and shares borders with Ethiopia, Somalia, Sudan, Uganda and Tanzania. It covers a total area of 582,646 square kilometers and is home to the second highest mountain in Africa, the snow-capped Mt. Kenya, with an altitude of 5199 meters. A physical map of Kenya is provided in Figure 2.1.

Kenya can be divided into four geographic regions: Lake Victoria Basin, Rift Valley and Western Highlands, Northern Kenya and Eastern Highlands, and the Coastal Belt. The country goes through two rain cycles each year – long rains that run March through May, and the shorter rains that run October through December.

The Lake Victoria Basin, where the Nyanza Province is located, is next to the second largest lake in the world. It is generally considered the wettest region in Kenya. The rainfall is seasonal with an average of 60 mm in January, and 200 mm in April, and an annual rainfall of 1000 to 1300 mm. Temperatures range from a minimum average of 14 Celsius to 34 Celsius.

The Coastal Belt has an average temperature of 28 Celsius, and an average rainfall of 1100 mm, with a minimum of 20 mm in February and a maximum of 240 mm in May.

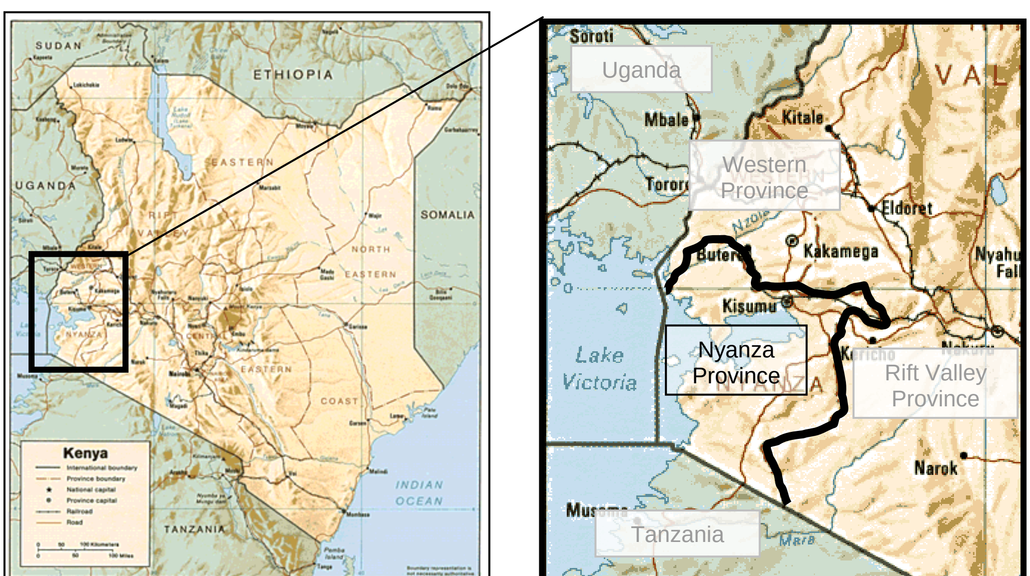

Figure 2.1: Physical Map of Kenya and Nyanza Province.[5]

The Rift Valley and the Western Highlands have the most moderate climate, with temperatures ranging from a high of 26-27 Celsius to a low of 12-15 Celsius in Nairobi and mean temperatures of 12-18 Celsius, and night temperatures of 0 Celsius in Mt. Kenya. The rainfall varies from 21 mm in July to 200 mm in April. The Highlands are the most fertile areas of Kenya.

Northern Kenya and the Eastern Highlands, home to the nomads, have the harshest climate with very little rainfall, ranging from a minimum of 0 mm in July to a maximum of 80 mm in November. Temperatures vary from 22 Celsius to 34 Celsius.

Detailed information on rainfall in Kenya can be found in Figure 2.2 and Appendix 3. Table 2.1 gives a brief look at the water resources and withdrawals in Kenya.

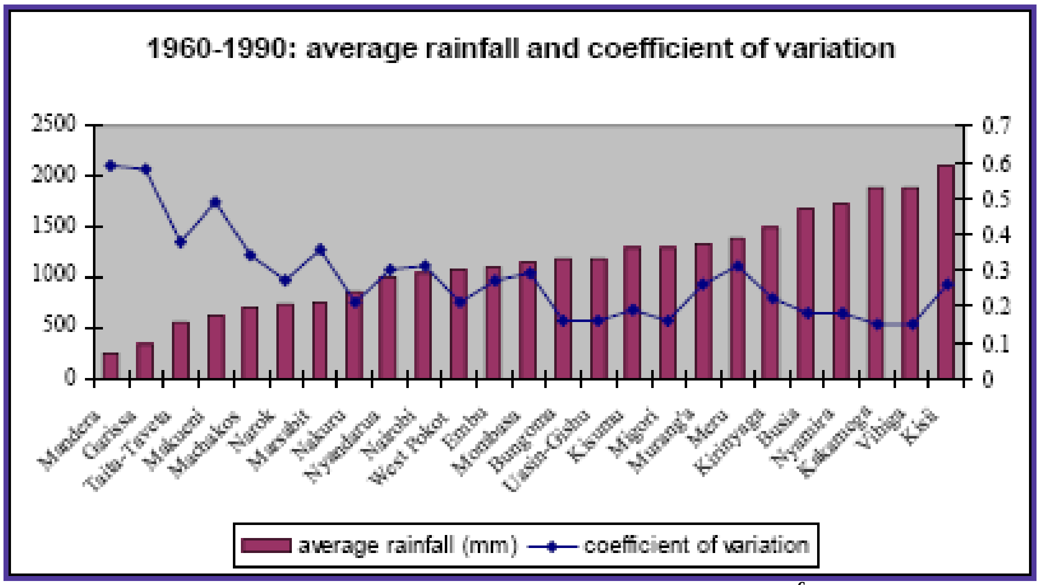

Figure 2.2: Average Rainfall in Kenya 1960-1990.[6]

2.2 Nyanza: Water Issues and Resources

This section addresses Nyanza's water situation, sources used, and issues with access and availability. Information presented here is based on the author's observations and interviews conducted in the field with Nyanza residents, unless otherwise cited.

For the most part, the population of Nyanza has had a history of difficulty with regards to water access and distribution. While water itself is abundant, access is limited. Nyanza (Figure 2.1) has access to several freshwater sources, including one of Kenya's main rivers – the Nzoia, and Lake Victoria, the second largest freshwater lake in the world.

Lake Victoria is 68,870 square kilometers in size and contains 2,760 cubic kilometers of water. The lake lies within an elevated plateau in the western part of Africa's Great Rift Valley and is subject to territorial administration by Tanzania, Uganda and Kenya.

Unfortunately, Lake Victoria is home to a highly impacted and polluted ecosystem, making the water unsafe to drink.[7]

Rainfall is another source of water for Nyanza residents. From Figure 2.2, rainfall in Kisumu, the capital of Nyanza, is estimated to receive around 1150mm per year. Many NGOs are encouraging rainwater harvesting in order to capitalize on this resource. Nyanza residents typically use corrugated metal roofs to collect water. Wealthier residents have gutters along the roof that collect the water and store it in a tank. The poorer residents usually collect the runoff in buckets placed under the periphery of the roof.

Nyanza residents, particularly those in the lower socio-economic bracket, use several sources other than rain, lake and river water. Women and children (who typically fetch water) choose from the sources that are nearest to them. This includes ponds, boreholes, open wells, earthpans (typically large depressions in the ground where water has collected), springs, streams and even ditches. There is a poor distribution system, particularly in the urban areas, that serves the wealthier sections of the community.

Table 2.1: Water Resources in Kenya.[8]

Internal Renewable Water Resources (IRWR),1977-2001:	• Surface water produced internally: 17 km^3 • Groundwater Recharge: 3 km^3 • Overlap (shared by groundwater and surface water): 0 km^3 • Total Internal Renewable Water Resources (surface water + groundwater – overlap): 20 km^3 • Per capita IRWR, 2002: 633 m^3
Natural Renewable Water Resources	• Total, 1977 – 2001: 30 km^3 • Per capita, 2002: 947 m^3/person
Annual River Flows	• From other countries: 10 km^3
Water withdrawals (1990)	• Total withdrawals: 2 km^3 • Withdrawals per capita: 87 m^3 • Withdrawals as a percentage of Actual Renewable Water Resources: 9.2% • Withdrawals by Sector: Agriculture (76%), Industry (4%), Domestic (20%)

Water quality is another issue that Nyanza residents must combat. Turbidity in the region is unusually high. Data collected across Nyanza by CDC showcased turbidity levels averaging 205 Nephelometric Turbidity Units (NTUs).[9] However, note that for this study, the most turbid sources of water in the region were deliberately sought out. This data is included under Appendix 2. The predominantly silty soil located in the region could be one of the factors responsible for the high levels of turbidity.

Turbidity in the water is caused by suspended matter such as clay, silt, and organic matter and by plankton and other microscopic organisms that interfere with the passage of light through the water.[10] Turbidity limits the efficacy of disinfecting agents, such as chlorine because pathogens are able to hide in the suspended particles. For this reason, the United States Environmental Protection Agency's (USEPA) Surface Water Treatment Rule requires systems using surface water or ground water under the direct influence of surface water to (1) disinfect their water, and (2) filter their water or meet criteria for avoiding filtration so that at no time can turbidity go above 5 NTUs. Systems that filter must ensure that the turbidity go no higher than 1 NTU (0.5 NTU for conventional or direct filtration) in at least 95% of the daily samples in any month.[11] Nyanza's turbidity levels are significantly higher as previously said and pose a serious safety issue.

Water quality is further compromised by waterborne pathogens. Diarrheal diseases are a major cause of morbidity and mortality among children younger than five years of age, largely because of inadequate water treatment and lack of sanitation. A 1999 health survey revealed that 66 percent of the population in the rural Nyanza Province lacked access to safe drinking water, and 47 percent of children under the age of five had suffered from diarrhea in the preceding two weeks.

Many NGOs are combating waterborne diseases by implementing safe water treatment in the home, or point-of-use water treatment. SWAK, one such NGO, began their safe water program in 2002 with CDC, CARE and PSI. Now they are interested in scaling up their pilot project which markets water treatment technologies to their patrons. We will discuss SWAK in greater detail in the next section.

2.3 SWAK

This section introduces SWAK, its operations and how it is involved with promulgating water treatment in the community. Information presented here comes from interviews conducted in January 2005 with Alie Eleveld, the secretary of SWAK-Nyanza, and other SWAK staff, unless otherwise cited.

SWAK is the Kenyan affiliate of a much larger continental organization called SWAA or the Society for Women and AIDS in Africa. SWAA was born in 1988, during the 4th International AIDS Conference in Stockholm, Sweden. Since then it has grown to include 40 African countries, including Kenya.[12]

SWAK is SWAA's Kenyan subsidiary. It was founded in Nairobi in 1996 by a group of women who were HIV positive and others who were affected by the epidemic. In addition to advocacy for women and children affected by AIDS, the group offers a wide range of services to women and families, including HIV education, counseling and support, children's activities, home-based care, nutritional products and training, training in income-generating activities, etc. SWAK has grown to include an office in all the 12 Kenyan provinces. The regional offices are largely decentralized since financial independence is the only way for survival. However, the offices share a supportive relationship with the national office, regularly communicating their activities and progress. We worked closely with one of these regional offices—SWAK-Nyanza.

SWAK-Nyanza was founded in February 2000 in Kisumu, capital of Nyanza. It started with 10 volunteers and today counts over 3200 group members, all part of 160 registered groups, and 2000 individual members scattered across the Province. At the moment, it is headed by Alie Eleveld and a group of dynamic male and female volunteers, who work tirelessly to keep the organization going.

SWAK-Nyanza works by identifying community support groups for women, youth, widows, orphans, and families coping with HIV/AIDS. They teach these groups how to positively handle the disease by providing nutrition information, healthy living, income-generation training and other ways that primarily address the issue of AIDS. All of SWAK's programs are geared towards community development.

One support method used is micro-finance. Members buy health-based products like salves, high-protein flour, immune boosters, condoms, treated mosquito nets, soap, and safe water products at wholesale prices and then sell them at a small profit. This profit is generally used for community projects. This system fulfills two needs in the community: a profit margin for the community, and more importantly, desperately needed health products. Most members told the author that they are involved in SWAK programs primarily to help their communities.

In an effort to promote safe water treatment in the community, SWAK is selling WaterGuard® and PuR®. Both are point-of-use water treatment products that will be addressed in detail in the following section.

2.4 Point-Of-Use (POU) Water Treatment

This section introduces POU treatment and highlights its importance in developing countries like Kenya.

POU water treatment is an in-home water treatment system. The devices are generally cheap, effective, sustainable, and easy to use. In most developing countries, residents lack access to continuous sources of water, and thus must store water in their homes. It is for these populations that POU water treatment is developed.

The most common form of POU water treatment is boiling. It is convenient and preferred because it uses the stove, which is already needed for cooking food. However, it has two disadvantages - boiled water is subject to recontamination even as it cools; and it expends fuel.

Two POU treatment products were examined for this project - WaterGuard® and PuR®. Both are being marketed by Population Services International (PSI), a nonprofit international organization based in the United States that has pioneered social marketing.[13] In addition, a third, naturally occurring option was considered – Moringa seeds. All of these will be discussed later in this section.

First, the concepts of disinfection and chlorination will be examined as they explain how PuR® and WaterGuard® work.

2.4.1 Disinfection and Chlorination

This subsection introduces the concepts of disinfection and chlorination, the different types of disinfectants available, how chlorination works and its relevance to Nyanza. Primary references for this subsection are Reference 16 and , unless otherwise cited.

As the term suggests, disinfection is the act of ridding infection. This is done by killing microorganisms (Merriam-Webster) in water, air, on surfaces, etc.

Water is a medium for a variety of pathogens or "vectors" of pathogens (like mosquitoes) that are harmful to humans. These include microsporidia, mosquitoes, bacteria, viruses, amoeba, etc., which cause a range of water-related diseases including cholera, dysentery, diarrhea, giardiasis, typhoid, malaria, etc. Waterborne diseases like cholera and diarrhea are contracted when contaminated water is ingested. The only way to make water safe is to filter out or kill the microorganisms that are in the water.

There are many disinfectants that are used to make water safe. They can be divided into physical and chemical disinfectants. Physical disinfectants include ultraviolet radiation, electronic radiation, sound, heat, and gamma radiation. Chemical disinfectants include:[14]

- Chlorine compounds: chlorine (Cl_2), chlorine dioxide (ClO_2), hypochlorite (OCl^-), chloramines
- Halogens: bromine (Br_2), iodine (I)
- Other oxidizing agents: ozone (O_3), potassium permanganate ($KMnO_4$), hydrogen peroxide (H_2O_2)
- Metals: copper (Cu^{2+}), silver (Ag^+)
- Other chemicals: phenols, alcohols, soaps and detergents, and several acids and bases

This project focuses on the use of chlorine compounds, a procedure known as chlorination. Chlorination can leave a residual and keep water safe long after administration (depending on the concentration added). Chlorine compounds are generally easy to generate, cheap and widely available. For all these reasons, chlorine compounds are being used in POU water treatment products such as PuR® and WaterGuard®.

Chlorine is a highly reactive element. It is a green diatomic gas in its elemental state. Chlorine, chlorine dioxide, and hypochlorite are all oxidizing biocides. Chlorination inactivates microorganisms by disrupting the transport of nutrients across the cell wall of the microorganism, not by disruption of a metabolic process.[15]

Chlorine gas was used for disinfection world-wide earlier in the 19th century, but it brought on a whole set of issues. Storage was cumbersome, and it was difficult to transport. Hence other variations were sought out that had the disinfection ability of Chlorine gas, but were more stable. Hypochlorites (OCl^-) are chloro-compounds that are more stable, easier to store, and in some ways, less reactive. Sodium hypochlorite ($NaOCl$) and calcium hypochlorite ($Ca(OCl)_2$) are the most common hypochlorites. Sodium hypochlorite is the main disinfectant used in WaterGuard®; calcium hypochlorite is used in PuR®.

NaOCl is commonly known as liquid bleach or soda bleach liquor and is the most widely used of the hypochlorites for potable and waste water disinfection. It is liquid, requires more storage space and is more costly to transport over long distances than $Ca(OCl)_2$ which is granular. However, NaOCl is much easier to handle and gives the least maintenance problems. NaOCl is prepared by a very simple procedure involving the reaction of chlorine (Cl_2) with caustic soda ($NaOH$) as follows: [16]

$$2NaOH + Cl_2 \rightarrow NaOCl + NaCl + H_2O$$

Sodium hypochlorite is mixed with water for use at different concentrations. In the case of WaterGuard®, the solution is 1% NaOCl with a pH greater than 11.9.

$Ca(OCl)_2$ is a white crystalline powder commonly known as bleaching powder. It is the most expensive means of chlorination, but is less bulky and more cost efficient to transport than other forms of chlorination. It has to be stored very carefully because the chemical is highly exothermic and it decomposes rapidly. Calcium hypochlorite generation is relatively complicated compared to that of NaOCl. Its generation can be described through the following equation, mixing calcium hydroxide with chlorine gas to get calcium hypochlorite, calcium chloride and water:

$$2Ca(OH)_2 + 2Cl_2 \rightarrow Ca(OCl)_2 + CaCl_2 + 2H_2O$$

The hypochlorites work in the following way. When mixed with water, they hydrolyze to form hypochlorous acid, HOCl:

$$NaOCl + H_2O \rightarrow Na^+ + OH^- + HOCl$$

$$Ca(OCl)_2 + H_2O \rightarrow Ca^{2+} + 2OH^- + 2HOCl$$

HOCl is the most germicidal of all chlorine species, except for chlorine dioxide. Hypochlorous acid (HOCl) is a weak acid that partially hydrolyzes in water to form:

$$HOCl + H_2O \leftrightarrow H^+ + OCl^-$$

The dissociation and availability of all three species (HOCl, H^+, and OCl^- ions) is based on the temperature and pH of the water. The ions combine to replenish the supply of HOCl, which is based on the equilibrium of the equation above.

The amount of hypochlorites added for disinfection depends on the "chlorine demand" of the water. Figure 2.3 shows how chlorine dosage relates to the amount of chlorine that is left for disinfection. Chlorine is a strong oxidizing agent. Once HOCl ionizes in water, the chlorine quickly reacts with reduced compounds that naturally exist in the water like ammonia, metals, and organic compounds like humic and fulvic acids to form other products, including chloroamines and chloro-organic products. This amount of chlorine usage can be defined as the "chlorine demand" of the water.

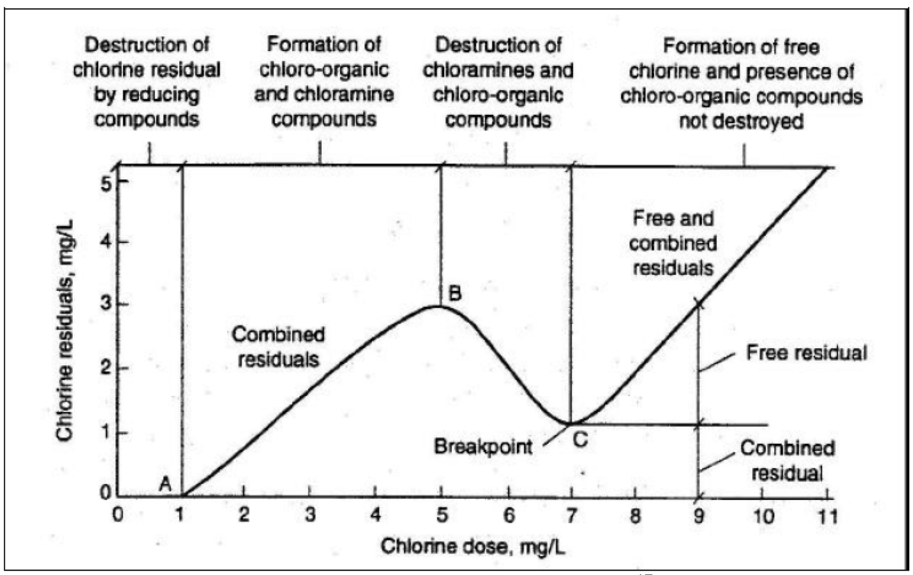

Figure 2.3: Chlorine Dose Curve.[17]

Any chlorine still left (shown at point "C" onwards) that can be used for disinfection after all the demand has been met is called "residual" or "total chlorine." Residual chlorine can be divided into two parts:

- Free chlorine: The amount of HOCl and OCl^- that is available after meeting the chlorine demand and combined chlorine demand of the water. This is very important for determining the safety of water, since this amount is typically used for disinfection.
- Combined chlorine: When ammonia or organic nitrogen is present in the water, chloramines known as monochloramine, dichloramine, and trichloramine will quickly form. Chloramines are also known as combined chlorine.[18]

Good disinfection always accounts for chlorine demand and ensures that a safe level of free chlorine is available in the water.

2.4.2 WaterGuard® and the SWS

This subsection discusses WaterGuard® - what it is, why it was developed, and how it works. The primary references for this section are Reference and , unless otherwise cited .

WaterGuard® is a chemical component of the SWS program implemented by CDC. It was developed by the CDC in conjunction with the Pan American Health Organization (PAHO), primarily to combat waterborne bacteria and viruses in homes. The key factors in its development were its ease of use and efficacy at disinfection.

The SWS system consists of the following:

- POU water treatment: Patrons are encouraged to use sedimentation, followed by filtration over a clean cotton cloth. This is meant to decrease turbidity and filter out cryptosporidia, giardia and mosquito larvae, among other things. Only after that are patrons encouraged to disinfect their water with WaterGuard®. CDC encourages patrons to administer WaterGuard® using the following guidelines. For treating water with turbidities
    - less than 30 NTUs, use single dose of WaterGuard®
    - more than 30 NTUs, but less than 100 NTUs, use double dose of WaterGuard®
    - more than 100 NTUs, use PuR®
- Safe Water Storage: A safe storage system is necessary to slow down the dissipation of chlorine and to prevent pests, dirt, contaminated hands, etc, from recontaminating the water. CDC, in conjunction with several local NGOs, has developed safe storage containers that are closed, protected, and have spigots for water access (as opposed to using hands or containers to dip into the containers to access water).
- Behavioral Change Education: These techniques include community mobilization (like SWAK) and social marketing (like PSI) to penetrate the market providing educational links between water and disease and the need for hygiene.

CDC found the rate of diarrhea decreased by 24% to 71% when SWS was used correctly. Countries in these studies include Zambia, Bolivia, Bangladesh, Uzbekistan, and Pakistan. In a study conducted in Malawi, a 69% reduction of microbiological indicators (fecal/thermotolerant coliforms, and E. coli) was noted in users of the Safe Water System. Studies in Bolivia and Pakistan show similar results.

In the year 2000, CDC implemented the SWS program in Nyanza, Kenya. With the help of CARE, several governmental agencies, PSI, SWAK and Jet Chemicals, it has slowly become a nationally available product.

WaterGuard® is a disinfectant, consisting of 1% sodium hypochlorite (NaOCl) solution. It was originally marketed under the name of Klorin by CARE. In October 2004, PSI branded the same product under the name of WaterGuard®. There are no differences between the products. During the course of this project, Klorin was in the process of being phased out and WaterGuard® was phasing in.

WaterGuard® disinfects through chlorination as outlined in Section 2.4.1 Disinfection and Chlorination. It consists of 1% NaOCl solution sold in 500 ml bottles and retails for 45 Kenyan Shillings (Ksh) ($0.56; $1 = 80 Ksh, as of January 2005). The bottles were designed to last a family of six for about three months, or treat around 2500L of water. The price was about 10 Ksh lower until October 2004, when the Government of Kenya instituted a VAT (Value Added Tax) which raised it to the current price of 45 Ksh. This has been a significant raise since the average income of the communities we were examining was less than 32 Ksh per day.

PSI makes their products locally in order to keep prices low. For example, it produces WaterGuard® through a local partner called Jet Chemicals. The bottles are sold in crates of 20, at a wholesale price of 40 Ksh per bottle. This gives a net profit of 5 Ksh per bottle to the SWAK members.

WaterGuard® dosages are developed by CDC in conjunction with PSI and are based on water conditions of the area. In Kenya and most of Africa, WaterGuard® is 1% NaOCl (10,000 ppm) added to water. For comparison, Clorox Bleach is approximately 5.25% to 6.00% NaOCl.

WaterGuard® is administered by mixing half a bottle cap (4 ml) to 20 L of water. The water is stirred and left to disinfect for about 30 minutes. Chlorine levels are typically high enough to sustain a safety factor (meaning a detectable amount of free chlorine) for a period of 24 hours.[19] In the case of turbid water, where turbidity is visible, patrons are instructed to double the dosage of WaterGuard® from one capful to two (8mL). CDC believes this method to be effective up to a turbidity of 100 NTUs. This is to ensure that there is enough free chlorine in spite of the turbidity.

WaterGuard®/Klorin has deficiencies. It was not developed to combat turbidity. It is defenseless against mosquito larvae, cryptosporidia oocysts, and other microsporidia. Chlorine can kill these pathogens only at very high concentrations, at which point the water becomes very bitter. Also, the chlorine is unstable. The residual dissipates over time, leaving water that is not sealed or covered, susceptible to contamination.

2.4.3 PuR®

This subsection examines the definition and operation of PuR®, and its importance in Nyanza. Primary references are 20, 21, 22, and 23, unless otherwise cited.

PuR® is the latest water product to be added into SWAK's safe water initiative. It was developed by the Proctor and Gamble Health Sciences Institute (PGHSI) in Mason, OH, in collaboration with CDC. It was primarily designed for regions with highly turbid waters, like in Nyanza where drinking water turbidities can average about 205 NTUs.

PuR® was developed in response to customers who wanted more visible signs of water treatment, more control of their water treatment and affordability. The engineers at PGHSI took all the methods of a conventional water treatment system and reverse-engineered them to fit into a small sachet. PGHSI developed a new flocculent-disinfectant technology for treating water in the home that incorporates techniques used in municipal water purification. PuR® uses ferric sulfate $Fe_2(SO_4)_3$ for coagulation and calcium hypochlorite $Ca(OCl)_2$ for disinfection. It removes heavy metals, organic matter, and microorganisms; and leaves free chlorine residual in water. After decanting, the treated water is microbiologically and chemically cleaner and looks clearer. The immediate improvement in clarity may encourage more people to treat their water. A three-week pilot study in November 2000 demonstrated the microbiologic efficacy and short-term acceptability of this technology in rural Guatemalan households. Results from this study have been provided in Appendix 4.

PuR® is not as yet commercially marketed in Kenya, except through SWAK-Nyanza. PSI-Nairobi informed the author in January 2005, that PuR®'s launch had been postponed due to lack of funding. SWAK-Nyanza was first introduced to PuR® during pilot studies conducted by CDC, between 2002 and 2004. After the pilot study ended SWAK-Nyanza began obtaining their supplies from PSI-Uganda, where the product is commercially marketed.

PuR® comes in a thumb-sized plastic sachet and retails for about 8 Ksh. Each sachet can treat 10 L of water. To administer PuR®, a patron will place the contents of the powder in 10 L of water and stir vigorously for five minutes. The water is left so that the flocs can settle. The water is then filtered over a clean cotton cloth and left to disinfect for 30 minutes, after which it is ready to drink. Figure 2.4 a and b show changes to water as PuR® is administered. In Kenya, water with turbidities as high as 1850 NTUs have been successfully reduced to 3.2 NTUs with a single treatment, as shown in Figure 2.5.

Statistically, PuR® has demonstrated amazing pathogen removal rates as shown in Table 2.2 a and b. Additional test results are shown in Appendix 4: PuR® Test Results. In addition, studies conducted by CDC in Guatemala have found dramatic reduction in diarrhea as shown in Figure 2.6.

Unfortunately, PuR® comes at a high cost, and is very expensive for the SWAK communities. For a month of drinking water, a family of six will have to invest approximately 1200 Ksh. This complicates matters severely and limits the usability of

PuR®. The fact that it is not commercially available complicates matters further, since the stock cannot be easily replenished.

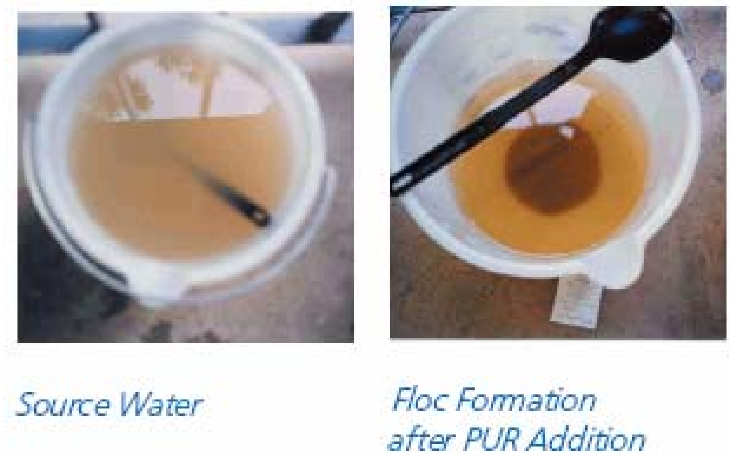

Figure 2.4 a: Source Water immediately before and after PuR® is added.[21]

Figure 2.4 b: Source Water after Complete Administration of PuR®.[21]

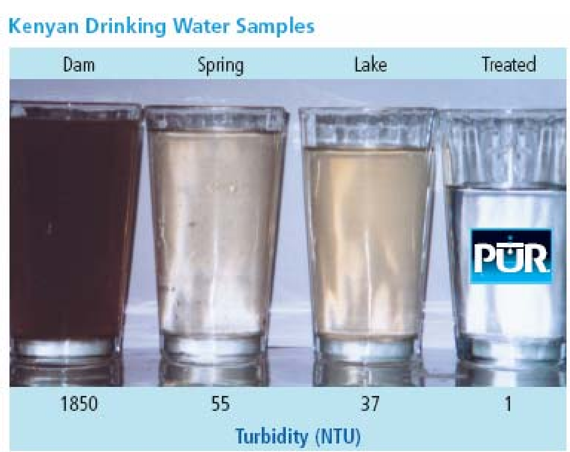

Figure 2.5: Turbidity Removal of PuR®.[21]

Table 2.2 a: Virus Removal Efficacy of PuR®.[21]

Virus	Initial Viral Count/ml (log 10)	Mean Log Reduction
Poliovirus	7.1	>5.0
Rotavirus	7.9	>5.0

Table 2.2 b: Bacterial Removal Efficacy of PuR®.[21]

Bacteria	Initial (org/liter)	Post-Treatment
E. coli	2.0×10^8	ND
10 common fecal bacteria	9.2×10^9	ND
Salmonella typhi	1.6×10^8	ND
Vibrio cholerae	1.2×10^8	ND
Shigella sonnei	2.2×10^8	ND
Klebsiella terrigena	2.8×10^8	ND
Campylobacter jejuni	2.0×10^8	ND

ND = None Detected

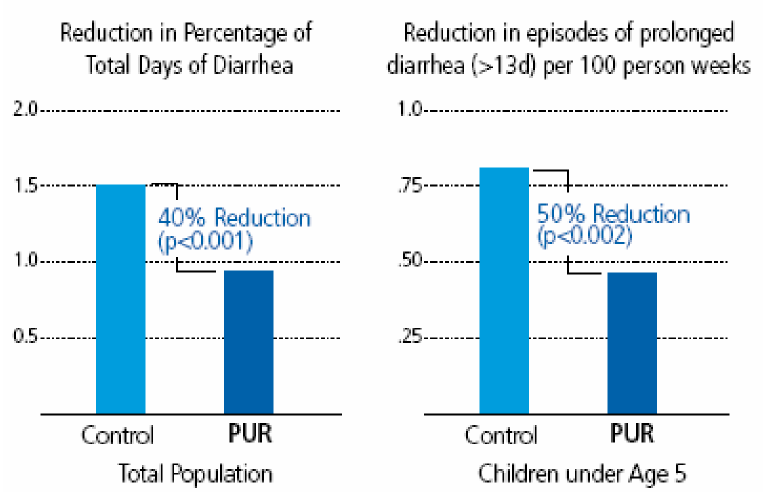

Figure 2.6: CDC Data on Diarrhea Reduction from use of PuR® in Guatemala.[21]

2.4.4 Moringa

This subsection examines the desirability of alternative water treatment technologies in Nyanza and how Moringa fills that need.

In 2002 the average per capita income in Kisumu, was only 14,160 Ksh[24] (~ $177). This is more than 50% below the "dollar a day" poverty line set by the World Bank[25]. Since SWAK communities are low income communities, it can be safely assumed that their average income is significantly below this average. Both PuR® and WaterGuard® are significant investments for the people. Therefore other more locally available models of POU water treatment are being considered. Moringa (Figure 2.7) is an option that seemed most viable due to its local availability.

Moringa is a gnarled tree that has been linked to multiple benefits. Used in India to cure blood pressure and in West Africa for diabetes, this plant sounds like a wonder drug. Moringa flowers, leaves, and roots are used in folk remedies for tumors, the seed for abdominal tumors. The root decoction is used in Nicaragua for dropsy (edema); root juice is applied externally as rubefacient or counter-irritant. The leaves are applied as poultice to sores, rubbed on the temples for headaches, and said to have purgative properties. The bark, leaves and roots are acrid and pungent, and are taken to promote digestion. The bark is regarded as antiscorbic, and exudes a reddish gum with properties of tragacanth; it is sometimes used for diarrhea. The roots are bitter; they act as a tonic to the body and lungs, and act as an emmenagogue, expectorant, mild diuretic and stimulant for paralytic afflictions, epilepsy and hysteria. Probably what is most amazing about moringa is its ability to clear turbidity in water, and soften hard water by creating flocs when added to water. [26]

Of the 13 species of moringa identified thus far, about six are native and abundantly found in Kenya.[27] There are reported cases of moringa being used for water treatment in parts of Ghana and Malawi. Scientists at the University of Leicester in the United Kingdom have done extensive research to better understand the water treatment processes of Moringa.

For water treatment purposes, the seed pods are allowed to dry naturally on the tree prior to harvesting. After shelling the pods, the seeds are crushed and sieved using traditional techniques employed in the production of maize flour. Approximately 50-150 mg of ground seed are needed to treat a liter of water, depending on the quantity of suspended matter. A small amount of clean water is then mixed with the crushed seed to form a paste. Dosing is usually according to a 1-3 percent solution. The crushed seed powder, when added to water, yields water soluble proteins that possess a net positive charge. The solution therefore acts as a natural cationic polyelectrolyte during treatment. Results showed that at this rate water with turbidities between 270 and 380 NTUs were consistently reduced to below 4 NTUs in the treated water.[28]

Moringa trees have more advantages than just health and turbidity-reduction competence. They grow very easily and are incredibly drought resistant. A moringa sapling can mature to a full-grown tree in about 15 months. Every part of the plant can be used for something. It's multipurpose uses include providing wood, food, nutrition and water treatment capabilities for the community.

There are disadvantages to moringa being used as a water treatment product. It has to be harvested, ground and sold. Since cash crops are the focus of most communities, moringa trees are considered a waste of land space. A market for it is not yet available since it is a home remedy. There is also a certain disdain associated with local, holistic remedies that lack the packaging and hype that accompany products like WaterGuard® and PuR®. Finally it takes more time and effort (since it is not pre-packaged) to use for water treatment. And if used, moringa lacks the ability to disinfect. That means that after turbidity removal, it would have to be paired up with WaterGuard® ($NaOCl$) or $Ca(OCl)_2$ to ensure safety.

There are other issues as well. Most turbidity research has been conducted on *Moringa Oleifera*, the most prevalent and useful species in the world. Even the Moringa trials being conducted by the University of Leicester in Malawi and Ghana use *Moringa Oleifera*.[29] This species is still not widely available in Kenya or at least it hasn't been mapped yet. Very little research has been done on *Moringa Stenopetala*, the more abundant species in Kenya. While tests have shown that *Moringa Oleifera* is effective for turbidities of 400 NTUs, little is known beyond that range. In addition, it is not known how widely available Moringa is in the Nyanza region. With this amount of unknown information, it is difficult to say if this approach can be a viable, cost-efficient factor in turbidity removal.

Figure 2.7: (L-R) Moringa Oleifera Tree, Pods, and Seeds.[30]

3 METHODOLOGY

This project was conducted in conjunction with a team of MIT-Sloan Business students. Project planning and research began in late October 2004. In January 2005, the team traveled to the Nyanza Province where field research was conducted across the area for three weeks. Upon return in February, the team began data analysis and research necessary to substantiate results.

The specific goal of the engineering component was to gauge the needs of the community based on source water quality and consumer preferences. Consequently, water testing and household surveys were used to measure these variables.

3.1 Preliminary Phase

The preliminary phase ran from late October through early December. Research included a literature review, book research, and equipment orientation; regular team meetings with the Sloan Business team, and stakeholders involved including CDC-Atlanta, and SWAK-Nyanza. Deliverables were identified and schedules were outlined.

3.2 Data Collection

This section discusses the methodology and location of field work.

Data collection took place in Nyanza over the course of three weeks in January 2005. It started with preliminary interviews in Nairobi, with PSI-Nairobi and SWAK-Kenya. The purpose of the interviews was to understand the organizations' national operations, their programs, marketing/operation strategies, consumer base and products, vis-à-vis WaterGuard® and PuR®.

The team then moved to the Nyanza Province, where they worked out of Kisumu, the capital of Nyanza. Over the course of 15 days, 15 different communities were visited (Table 3.1). These communities were located across the province and randomly identified by SWAK. One community group (potter group) and was visited for information on the construction of safe water pots, not for product analysis. Figure 3.1 provides the approximate location of communities surveyed.

Communities were located in urban, semirural and rural localities. A total of 75 households were visited for surveys and water tests. One household declined the survey, leaving a group of 74.

At the end of field work, data (discussed in Chapter 4) was quickly analyzed and put into a presentation for all stakeholders involved, particularly SWAK communities that had been involved in the research, and PSI-Nairobi. The purpose of this presentation was to give immediate feedback to the communities before the team's return to the United States. This plan ended up being very successful because discussions with the community members were still fresh and many of them were keenly interested in the recommendations of the team.

Table 3.1: SWAK Groups in Nyanza Visited for Field Work.

Group Name	Date Visited	No. of Households Visited	Area
Kazi Ngumu Women's Group	4 Jan 05	7	Kisumu, urban
Menyatta B Widows Group	5 Jan 05	5	Kisumu, urban
Okok Widows Group	5 Jan 05	5	Kisumu, rural
Mambo Youth Group	6 Jan 05	6	Kisumu, semirural
King Pin Youth Group	6 Jan 05	7	Kisumu, semirural
Hawi Project	7 Jan 05	6	Asembo, rural
Potters Group	7 Jan 05	N/A	Asembo, rural
Kasiri Youth Group	10 Jan 05	4	Asembo, rural
St. Mary's Widows and Orphans	10 Jan 05	6	Asembo, rural
Barchando HIV/AIDS and Poverty Eradication	11 Jan 05	5	Asembo, rural
Rufah Program	11 Jan 05	5	Asembo, rural
Aluor Moyie Post-Test Club	12 Jan 05	5	Gem, rural
Dienya CBD	12 Jan 05	4	Gem, rural
Saloo Women's Group	13 Jan 05	5	Gem, rural
Rise & Shine Women's Group	13 Jan 05	5	Gem, rural

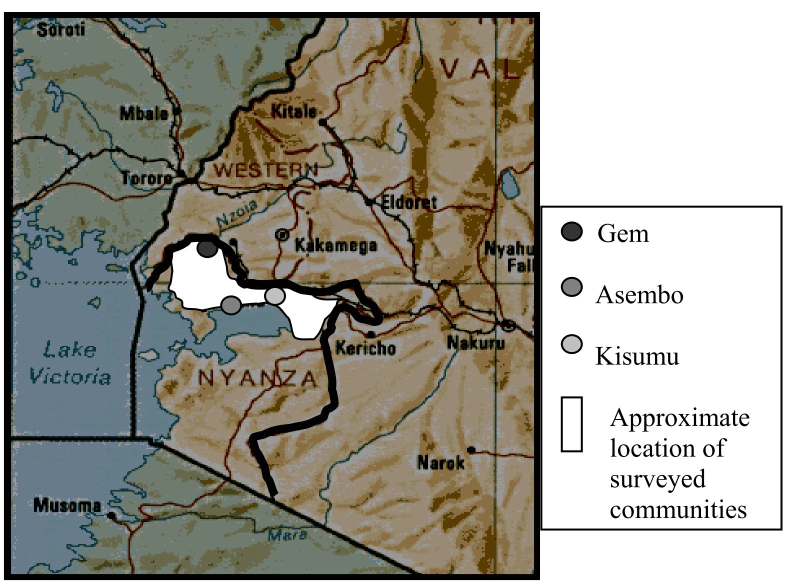

Figure 3.1: Approximate Location of Surveyed SWAK communities.[5]

3.3 Field Tools

This section discusses the tools employed and the capacity in which they were used in the field.

The goal of field research was to gain an understanding of consumer preferences and their knowledge of water treatment. Households were randomly visited in a selected community and assessed using two tools:

1. **Field Survey**: The purpose of the field survey was to understand the consumers' current practices with regards to water treatment, their understanding of WaterGuard® and PuR®, source water preferences, treatment preferences and ease of use. The survey has been enclosed in Appendix 5.

   The survey consisted of a series of open-ended questions and included both qualitative and quantitative components. The author (or the translator upon the author's prompting) would ask the questions in order and then wait for the respondent to answer. If answers were vague or not specific enough, the respondents were prodded for more details. For example, for Question #3 (Where do you get your source water(s) from?), a respondent might answer "borehole". The respondent was prodded further for other water sources he/she might have accessed in the past, which was often the case. Or, when asked about whether she treated or boiled her drinking water, she would respond "yes"; she would be prodded on her methodology to gauge "correctness" of the model.

   The field survey team consisted of at least three members: the author, a local translator who accompanied the author to all households, and a community leader who typically led the way to the houses. The community leaders were instructed to pick houses at random, but generally they picked houses based on who was home. Occasionally, other curious community leaders, or a Sloan Business student would accompany the group and ask further questions.

   The surveys took anywhere from 15 to 40 minutes, depending on household. Unfortunately, surveys were limited by time constraints. In the end only an average of 5 households were surveyed per community. This is because the distances were typically extensive between households.

2. **Water Testing**: After the surveys, water was collected from the household drinking water supply if the respondent had used WaterGuard® or PuR®. This drinking water was tested for total and residual chlorine levels. The purpose of chlorine testing was to determine if the treatment products were being administered correctly.

   Two different chlorine testing kits were used. First a Hach Digital Titrator (Item no. 16900-01) was used, but the equipment proved to be cumbersome, and tests were erroneous. It was replaced on 7 January 2005 by a simpler Lamotte Chlorine Colorimeter DC 1200-cl (calibrated with Lamotte standard solutions of 0.0, 0.1, 1.0, and 2.65 mg/L). The colorimeter was borrowed from the CDC staff in Kenya.

In addition, source waters and household water samples treated with PuR® were assessed for turbidity levels. The purpose of this was to gauge:

- whether PuR® was being administered correctly,
- turbidity of source waters in the area.

For turbidity tests, a Hach 2100 P Portable Turbidimeter from MIT was used for testing in the beginning. It had trouble calibrating, and default calibrations were used. It was replaced on 7 January 2005 by a Lamotte 2020 Turbidimeter (calibrated at 1, 10, and 100 NTUs) borrowed from the CDC staff in Kenya.

In all communities, an average of one sample was tested twice to gauge precision of the equipment and results; an average was recorded.

3.4 Data Analysis

Field research was officially closed on 26 January 2005. Upon return to MIT, the team met several times to analyze collected data for the compilation of the business model. From a technical perspective, the focus of the project became more defined; data analysis and research followed suit.

3.5 Challenges

There were many challenges encountered during the course of the field work. Consequently tools had to be changed and some of the results recalibrated.

The first issues encountered were with lab equipment. The initial turbidimeter was not calibrating correctly, so the default calibration had to be used. The default calibration proved to have an error of ±3 NTUs. The turbidimeter was replaced on 7 January, 2005 with another one loaned by Daniele Lantagne from CDC. Similarly, the original chlorine-testing equipment was left in the hotel room, instead of being taken into the field. Samples collected during the day were tested within a twenty-hour period. However, the chlorine in the samples typically evaporated within thirty minutes of collection, immediately invalidating all test results collected until then. On January 7, 2005, the equipment was replaced with one obtained by Daniele Lantagne from CDC.

There were several time constraints that affected the household surveys. First, all the research had to be finished over the course of 15 days. Second, the technical research team had to follow the same time-frame as the business research team (who conducted focus groups, rather than in-depth surveying). Both issues forced time constraints on the length of the survey and the number of surveys possible. The survey consisted of mostly open-ended questions and relied on the prompting of the surveyors for detailed answers (as shown in Appendix 5). The purpose of the survey was to gauge and communicate knowledge of water treatment/products in a very short period of time.

4 RESULTS

This chapter summarizes the results of the research conducted in the field during January 2005. Methodology consisted of household surveys and water quality tests as described in Chapter 3. The chapter will start with a summary of communities surveyed, followed by a section on field observations. It will conclude by outlining challenges that the author believes have affected the results and conclusions. A collection of tabulated survey results are presented in Appendix 6.

4.1 Summary of Communities

Total number of communities assessed = 14
Overall number of households visited for assessment = 74
Average number of households per community = 5

Profile of an average household:

- Household consists of 6 members
- Family uses about 6 Jerry Cans of water per day (120 L)
- 1 Jerry Can of drinking water lasted a family 3.5 days
- Household income = 960 Ksh/month

Cost of materials/products for treatment:

- Sachet of PuR® costs 8 Ksh. Each sachet treats 10 L of drinking water, which provides a family of 6 enough water for 1 day
- Bottle of WaterGuard® costs 45 Ksh. It treats 2500 L of water, which typically takes a family of 6 through three months.
- A bundle of firewood costs 20 Ksh, and typically provided fuel for boiling water (and other needs such as cooking, fire, and heat) for one day
- A bag of charcoal costs 300 Ksh; it was used as fuel for a month.

4.2 Turbidity levels in Correspondence to Sources

Most communities used multiple sources of water. Sources and their corresponding turbidity levels are included in Table 4.1.

From Table 4.1, rainwater can be discerned to be the most popular water source, used in thirteen of the fourteen communities surveyed. While the most turbid source was a borehole at 96 NTU, the source with the consistently highest turbidities across all the communities (based on the weighted average) is river water.

Figure 4.1 provides a good comparison between source usage and turbidity levels. It highlights the importance of continued rainwater harvesting and treatment, since it has the best user-turbidity ratio.

Table 4.1: Source Waters and their Turbidities.

Source	No. of communities that used source	No. of Households that used source	Highest turbidity measured (NTU)	Lowest turbidity measured (NTU)	Weighted average turbidity of source (NTU)
Tap	4	18	1.96	0.76	1.06
Borehole	6	23	95.7	0.45	9.58
Lake	1	4	22.4	22.4	22.40
Spring	2	6	4.78	2.5	2.88
River	3	10	59.6	3.7	38.01
Tank	1	1	25.4	25.4	25.40
Pond/earthpan	5	24	42	4.1	24.26
Rainwater	13	59	6	0.1	2.36
Weighted Average of Overall Turbidity=					**11.09**

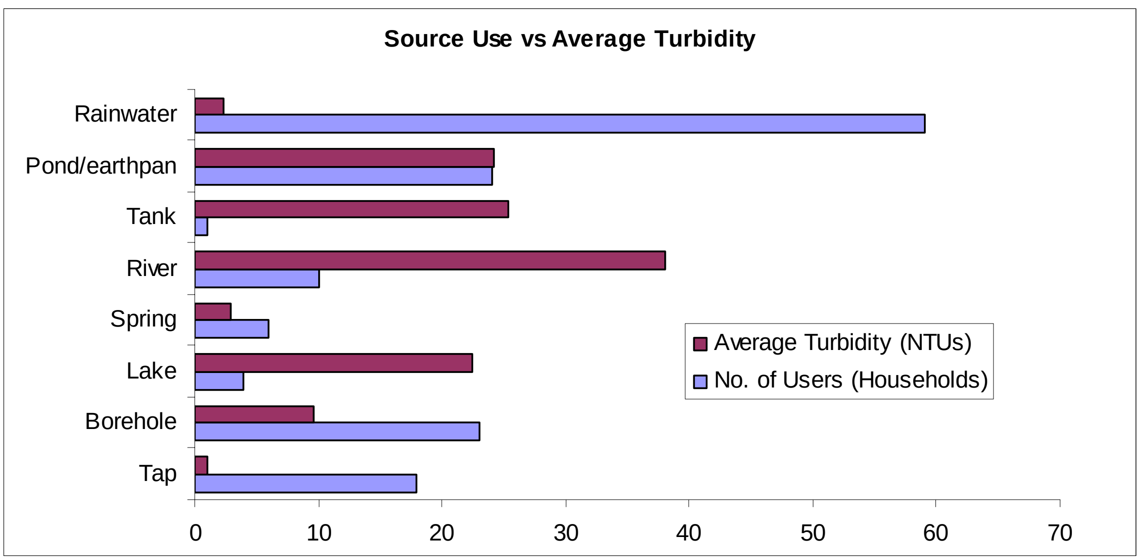

Figure 4.1: Source Use versus Average Turbidity of Source.

4.3 Rainwater Usage:

Rainwater posed a challenge to water treatment because there is a prevailing notion that the rain is pure. The contamination encountered en route to storage/usage is neglected.

Total number of users: 59
Total number of rainwater users who boil or treat their rainwater: 30

In other words, about half of the population that uses rainwater does not boil or treat it before consumption (Figure 4.2). This could be a serious water safety hazard because of the potential contamination of rainwater during collection and storage.

4.4 User Preferences:

Overall, WaterGuard® seemed to be the most utilized product (Figure 2.3). Patrons seemed satisfied and safe with the product, ensuring continued use of the product. 100% of WaterGuard® users self-reported an elimination of stomach ailments upon continued use. All WaterGuard® users said that they were satisfied with the product. The only complaint voiced was that it made the water taste and smell different, and took a little adjustment. It turned out that the two communities that were most vocal about this issue were overdosing by nearly 4 times the required amount.

No. of households surveyed who use WaterGuard®/Klorin = 33
No of people preferring to boil = 27
No. that use PuR® = 1*
No. that use Moringa = 1*

**both respondents had used the product very briefly and sporadically, and both preferred and used WaterGuard® regularly. For analysis, they are incorporated into both PuR®, Moringa and WaterGuard® groups.*

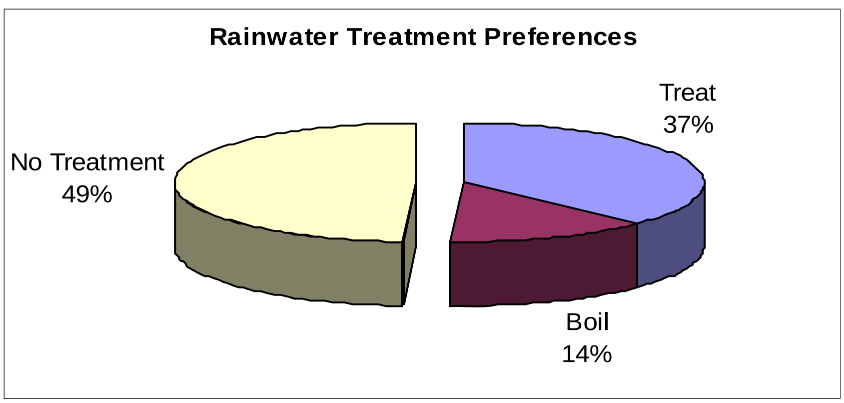

Figure 4.2: Percent of Population that Treated Rainwater

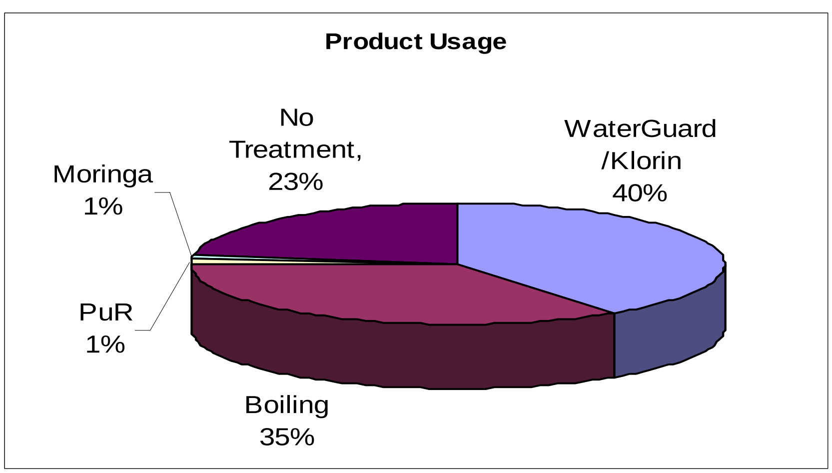

Figure 4.3: SWAK Community Product Usage.

4.5 Safety Factor

Figure 4.4 shows the percentage of WaterGuard® users with detectable free chlorine in their drinking water. About 57% of users were at risk for contamination; however, 100% of users showed detectable levels of total chlorine, meaning they were all treating their water.

Further analysis revealed that the average household used treated water for 3.5 days. This was almost double the amount of time CDC regards treated water to be safe. CDC states that at 1% NaOCl, WaterGuard® lasts as residual in the water for about 24-36 hours. This showed that there was a desperate need to address retreatment in the communities.

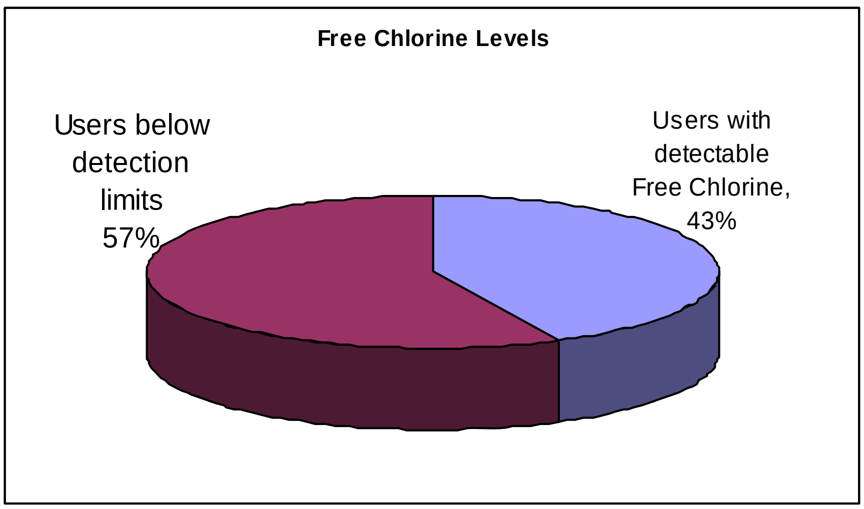

Figure 4.4: Percentage of WaterGuard® Users showing Free Chlorine Levels.

4.6 Field Observations

One of the first observations was the persistent scarcity of health knowledge among community members (including SWAK members). Even basic information like the origins of disease, its relation to water or waterborne diseases, the importance of water treatment, or how untreated rainwater could cause disease, was generally unknown. It isn't a surprise then that water treatment practice is so low in the communities. In addition, over two-thirds of respondents who used WaterGuard® did not know the difference between WaterGuard® and PuR®. Continued use amongst this sector of respondents occurred because they noticed the reduction of illness. But they didn't understand how or why that happened.

The concept of retreatment has not been introduced to any of the communities. Chlorine (at 1% concentration) in WaterGuard® typically lasts as residual for approximately 24-36 hours before evaporating into the atmosphere, leaving water susceptible to recontamination. It was clear that the communities were unaware of this because none of the SWAK members interviewed knew about this, and 44% of households used treated water for 3 or more days before replacing it with freshly treated water. This was also evident in the consistently low levels of free chlorine detected in the field.

The most common reason cited for the lack of water treatment was financial constraints. Many households survived on a day-to-day income. For example, many households preferred to buy firewood (20 Ksh) everyday, instead of investing in a bag of charcoal (300 Ksh) that lasted a month. The charcoal evened out to a savings of 10 Ksh per day, but to the households a lump sum of 300 Ksh was too much. In addition, most people didn't recognize the need to save for water treatment (which they weren't sure would work). Most preferred to save for medication, healthcare (which they knew would work), and funerals. Community members who preferred to boil did not understand the financial or health advantages of using WaterGuard®.

There was a general lack of understanding on correct use of water treatment. For example, users were overdosing WaterGuard® either because of illiteracy or misinformation. Even with boiling, people didn't know how to boil their water properly. Many put the water on the fire only until it became "hot" or steamy, often removing it premature to disinfection.

Tap and borehole water typically cost users 2.5 Ksh /20L. They were preferred in spite of their cost, because they "felt safer" than other sources. This indicates that people value safety. This was also proven by the fact that once households were told about waterborne diseases and how WaterGuard®, PuR® or boiling worked, the adoption rates of WaterGuard® increased. For example, in the Okok widow community, the author encountered a particularly disgruntled and suspicious policeman who thought of WaterGuard® as a big scam. During the survey, many angry questions and accusations were addressed. Two days later, the community leaders informed the author that the policeman had bought three bottles of WaterGuard® – one for use at home and two for the two offices he worked in. This was a common occurrence. SWAK informed the author that in all communities where the author (and the entire team) had visited, WaterGuard® sales increased, sometimes drastically.

Word-of-mouth worked wonders for marketing of the product, as can be gauged from above. Water treatment practices were most prevalent in areas where SWAK members were extremely active in the community. In the Kingpin Youth group for example, all houses in the community were visited by a SWAK representative. A little bit of information went a long way. When health and product information was explained, products tended to sell better within that household. Consequently, communities with higher education levels tended to be healthier, meaning they had much higher levels of water treatment use, safe water and consequently lower disease rates.

4.7 Challenges

There were some challenges in-field that affected the results presented in Section 4.6. These were generally the result of limited availability of the following:

- **PuR®**: PuR® was mostly unavailable. It still was not being marketed in Kenya. SWAK-Nyanza was getting their supply from PSI-Uganda. In January 2005, during the time of this research, the first shipment of PuR® had just arrived from Uganda. Until then, most of the sachets used were produced for Guatemala or the Philippines with instructions in Spanish or Tagalog, which further complicated market penetration. In addition, because of its expense and low demand, most SWAK groups preferred to invest their resources in procuring and promoting WaterGuard® in their communities.
- **WaterGuard®**: In January 2005, WaterGuard® was just being phased into the Kenyan market. Its predecessor, Klorin, was the exact same solution as WaterGuard®, but with a different brand name. During January, Klorin was on its way out of the market. This was a problem because many communities were working hard to exhaust their supply of Klorin. Most Klorin bottles had expired and WaterGuard® had still not permeated into the markets. So it wasn't being used in many homes, even in homes with regular customers. In some other homes where it was still being used, people were underdosing to preserve the length of treatment.
- **Moringa**: Moringa seeds were not distributed anywhere. Only one community harvested them; even they didn't use them claiming the process was too time-consuming.
- **Comprehensive Turbidity Data**: The turbidity data collected was limited in terms of source access. Even though households cited multiple sources, only a few were accessible. For example, communities cited rivers, springs or earthpans that had dried up and therefore could not be measured for turbidity. It was also limited in terms of seasonal variations. Considering that there are short and long rains, it is easy to understand that turbidity levels change over time.

5 RECOMMENDATIONS & CONCLUSIONS

This chapter starts with a summary of the project goals, then outlines the recommendations that were provided to SWAK, CDC and PSI-Nairobi. It ends with the conclusion.

The research presented in this thesis focuses on the technical component of a larger objective to increase the penetration of safe water treatment into the SWAK communities. The purpose of the technical component was to find the most appropriate treatment in the communities. Many of the technical issues like improper or infrequent use of the product, encountered during research, were related to larger socioeconomic issues including poverty and lack of education.

Both components – the technical and business component – can be considered successful based on the implementation of several of the recommendations outlined for SWAK. They are provided in the following section. It is hoped that these recommendations will increase the penetration rates of water treatment in the community, but most importantly will increase the general health and well being of all the people. It will be hard to gauge immediate impact, but the team hopes to check the progress of SWAK in one year.

The technical component sought to find the most appropriate treatment as shown in Table 5.1.

Table 5.1: Aims and Tools Used.

Aim	Tool Used
Gauging consumers': • Treatment preferences • Product knowledge • Current practices	Field Surveys
Gauging water quality	Turbidity Tests on source waters
Gauging if products were being used correctly	Chlorine tests on treated water, to gauge safety levels

5.1 Recommendations

Several recommendations were made based on the research done in the field and beyond. These are presented in subsections 5.1.1–5.1.3.

5.1.1 Treatment Recommendation

Overall the most appropriate treatment for SWAK communities in Nyanza as studied by the author is through gravity sedimentation-cloth filtration-WaterGuard® disinfection method; with double dosage of WaterGuard® administered when water looks "muddy" or has measured turbidities greater than 30 NTUs. This recommendation is based on the following arguments:

- **WaterGuard® is the most utilized product:** 40 percent of the population surveyed used WaterGuard® over PuR®, Moringa, and boiling, making it the most utilized product (Figure 4.3). This can be attributed to its relatively low cost, ease of use, and elimination of disease, as noted by users. Over 80 percent of survey respondents who self-reported being WaterGuard® users continuously used the product, as opposed 28 percent of respondents who continuously boiled their drinking water. The Moringa and PuR® users also preferred WaterGuard®. It is for this reason that the author believes that WaterGuard® is the most appropriate treatment product.

- **WaterGuard® is the most effective treatment option:** WaterGuard® proved to be the most effective water practice against stomach-related illnesses. 100 percent of survey respondents who used WaterGuard® self-reported elimination of stomach-related illnesses during use, as opposed to 54 percent of respondents who continuously boiled their drinking water. In addition, it leaves a residual that keeps water safe even after treatment – unlike boiling where water is prone to contamination even as it cools.

- **WaterGuard® was effective under low turbidities.** CDC sanctions double-dosage WaterGuard® disinfection up to 100 NTU. Turbidity levels during our study had a weighted average of about 11 NTU, with the highest turbidity at approximately 96 ± 3 NTU. In addition, 100 percent of WaterGuard® users, including the respondents who used the most turbid water, reported 100 percent elimination in stomach-related illnesses. All of these statements suggest that the method outlined above works.

The gravity sedimentation-cloth filtration-WaterGuard® disinfection method: The purpose of the gravity sedimentation is to reduce the turbidity through low cost techniques. The water is then decanted and filtered over a clean cotton cloth. This is to remove debris, plankton or other organic particles, some oocysts and microsporidia, and mosquito larva that might be in the water. Finally the water is disinfected with a single dose of WaterGuard® if the water is below 30 NTUs or looks "somewhat muddy"; or double-dosed if the water is between 30 and 100 NTUs or looks "muddy". The dosing standards are in line with CDC recommendations.

For turbidities greater than 100 NTUs (which can be expected based on historical data compiled in Appendix 2, but was not measured during the January field research), CDC recommends the use of PuR®. However, the efficacy of double dosage of WaterGuard® beyond 100 NTUs has not been tested. This should be researched further.

5.1.2 Other Technical Recommendations

1. **Retreatment every 24-48 hours**: It was clear that some families often stored and used water 48 hours after treatment. Water that was tested beyond this period, even though treated, showed free chlorine levels below the detection limit (<1 mg/L). This showed that water had either to be replaced or retreated every 24-48 hours. CDC data suggests that WaterGuard® when administered correctly (4-8mL of 1% solution) keeps water safe for 24 hours.

2. **Promote treatment of rainwater**: Only 52% of the population that used rainwater treated or boiled it before consumption. This is particularly risky because it rainwater is the primary source of water during the rainy season, and the months following it.

3. **Promote use of the entire SWS**: SWS consists of three components – safe storage, treatment and hygiene/health education. Often the educational component seemed to be lacking, because survey respondents and SWAK members did not understand the links between water, hygiene, and health. This caused lower rates of adoption of safe water practices. Conversely, it can be argued that increasing education will result in higher adoption of safe water and water treatment practices.

4. **Research annual turbidity levels across Nyanza**: Turbidity in the region has only been researched in a limited capacity. The author's research was collected from a few community sources over the course of January 2005. CDC's research primarily targeted the most turbid sources in Western Kenya, and was collected over a period of seven months from March through September.

5. **Research double-dosed WaterGuard® with increased turbidity**: Although CDC recommends capping the double-dosage method at turbidities greater than 100 NTU, the exact limit of this procedure has not been researched. What has been proven is that the double dosage of WaterGuard® does indeed maintain safe chlorine residual for turbidities up to 100 NTU.

6. **Research coagulation properties and cost-benefit analysis of *Moringa Stenopetala***: Since so little is known about the coagulation properties of *Moringa Stenopetala* and it is the most locally available species, it could be important to the Kenyan community if this seed could prove a financially viable alternative to PuR®.

5.1.3 Other Recommendations

Since the overall goal of this research is to increase market penetration of water treatment, there are several non-technical recommendations. These are made based on the observations outlined in the "Results" section of Chapter 4.

1. **Increase and improve health and product training programs for SWAK members:** This is because the SWAK member plays the role of the educator in the community. There was a very low level of basic health knowledge amongst the SWAK members. Often, they would market the water treatment products without understanding the implications of what they were doing or why they were doing it. Consequently adoption rates of the products are very low in the communities.

   The training should include material on basic health and marketing/sales principles, and water treatment product knowledge. Health training should start at the very basic level, including how one gets sick, the concept of germs, what the modes of transmission are, how different diseases work and are treated, how clear water is not necessarily safe, etc.

   The MIT-Sloan Business students outlined a separate set of recommendations and a corresponding training curriculum to improve sales/marketing knowledge amongst SWAK members. It has been attached as Appendix 7.

   Product training entails explaining the differences between the different water treatment products, how they work, why they work and when they should be used.

2. **Increase incentives for SWAK members and community interfacing**. This is to encourage knowledge transmission of the products and health information in general from one group to the other. It is hoped that an educated community will become a safer, healthier community. And products will be chosen based on knowledge of the product, rather than its availability. Since a large number of the SWAK members were involved in the organization primarily to help the community, getting them to spread the information should be easy. When asked about information transmission, one SWAK member replied quite simply that she didn't know herself, and when people asked her questions, she couldn't answer. So she stopped marketing the product as much.

3. **Establish an information resource bank for SWAK members to access:** The purpose of this is clearly to improve availability of information that has shown to be severely lacking. Recommendations include a compilation of FAQs (Frequently Asked Questions), a resource library, and a set of resource people such as doctors, pharmacists, and engineers. Also SWAK can consider making a digital database of information as necessary (such as FAQs and the library). FAQs collected over the course of field work in SWAK communities were compiled, answered and submitted to SWAK for future use Appendix 8.

4. **Increase house-to-house informational marketing of the products:** It was very clear that most community members bought water treatment products or other health products after hearing about it from another community member. This circle of trust can be harnessed by SWAK members through house-to-house marketing to transmit information (as describe in point 2 above), improve community relations and increase adoption of water treatment within the community.

5. **Increase flexible payment/savings plans:** As discussed in chapter three, the water treatment products are a strain on household resources. Most families survive on a day-to-day basis, and the concept of saving money "for a rainy day" is non-existent largely because it is an option they cannot afford. A sum of 45 Ksh can be daunting, and many community members cited financial constraints as reasons for intermittent water treatment (boiling or chemical treatment). It would help if SWAK members found a way to create a savings system, where members deposit a shilling a day or they pay a shilling for a cap of WaterGuard® deposited right at the water collection site. Of course, both options are questionable, because most community members are wary of being cheated.

5.2 CONCLUSION

The most appropriate treatment for SWAK communities in Nyanza as studied by the author is through the gravity sedimentation-cloth filtration-WaterGuard® disinfection method with single dosage of WaterGuard® when water looks "clear" to "somewhat muddy" or is lesser than 30 NTUs and double-dosage when higher. Since the author never measured or surveyed a respondent who used a source with turbidity levels higher than 100 NTUs, the author will cite CDC's recommendation to use PuR®.

The most popular treatment option was WaterGuard®, followed by boiling. The most popular source of water was rainwater; however over 52% of the population did not treat or boil it. Note that this was just self-reported boiling. It was not verified by sampling.

The author was saddened by the general lack of knowledge with regards to water, sanitation, and disease. However, the community members seemed very eager to learn and understand the mechanisms of waterborne diseases since had all been affected by it and knew someone who had died from complications.

Already the recommendations from this report and those provided by the Business Team are being implemented. It is fervently hoped that at least some of the research from this project has or will benefit the communities by decreasing the likelihood of water related diseases and improve quality of life.

This project has truly been an amazing experience.

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Appendix 1: History, Economy and Culture in Kenya and Nyanza

This appendix highlights some of the historical, cultural and socio-economic factors that affect poverty, unemployment and health in Kenya and Nyanza. Most of these directly or indirectly affect water safety. Note that a lot of these issues are not just local, but national. They include cultural issues, poverty, rainfall, HIV/AIDS, poor infrastructure, and water resources. For example, poverty and unemployment limit the spending capacity of a family, making access to water treatment products and health facilities more difficult.

A1.1 Kenya: Profile

A1.1.1 Kenya: Brief History

The earliest human settlements have been traced back to 2000 B.C to tribes that migrated from Ethiopia. Since then, nomadic tribes from across Africa settled into Kenya forming the following distinct tribes that today include the Luo, Maasai, Samburu, and Kikuyu tribes among others.

Starting in 700 A.D, Muslims from Persia and the Arabian Peninsula began settling along the east coast of Kenya. They were followed in the 15^{th} C by Portuguese colonists on the lookout for spices and wealth. The 18^{th} C brought with it the brutal seesaw of colonization between the British, the Persians, and the Portuguese. The British finally won in the early 1800s, but the struggle for power resulted in a rapid decline in trade and prosperity. The white settlers were brutal and by the mid 1800s the local peoples began revolting. On December 12, 1963, Kenya was finally declared a Republic, led by its first democratically elected leader Jomo Kenyatta.[31]

A1.1.2 Kenya: Economy

References for this subsection are 32, 33, 34, 35, 36, 37, and 38.

Sustenance farming and hunting supported the majority of the Kenyan population until the British colonialists introduced coffee to Kenya in the middle of the 19^{th} century. The coffee plantations and settlements supported by the British saw the tribes being herded into infertile reserves that were not conducive to farming, and therefore, resulted in a high population of farm laborers, casual workers and squatters among the Kenyan population, still visible today.

Following the independence of Kenya in 1963, Kenya developed into one of the most prosperous countries in Africa under Jomo Kenyatta's rule. However, following his death in 1978, problems among various tribes resulted in a suspension of aid by the International Monetary Fund (IMF).

Since 1993, several economic liberalization steps and reforms initiated by the Government of Kenya led to a turnaround in economic performance. GDP slowed in 2000, but has grown since then.

Although overall GDP has increased since 2000 (Figure A1.1), there are many long-term barriers that the Government of Kenya is working to overcome including high population growth rate of 1.5%[32], and an AIDS epidemic that limits labor productivity as seen in Table A1.1. Table A1.2 shows some key economic indicators for Kenya.

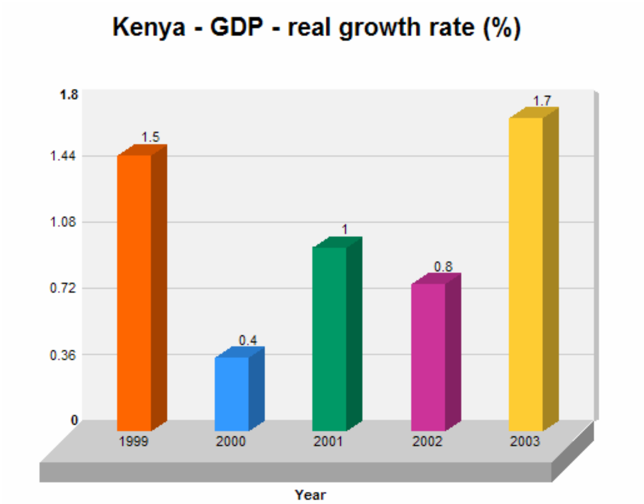

Figure A1.1: Kenya-GDP Real Growth Rate.[33]

Table A1.1: HIV/AIDS statistics in Kenya.[34]

HIV prevalence in pregnant women	**9.4%**
Estimated no. of HIV-infected people	Adults: 1,100,100 children: 100,000
Estimated no. individuals on anti-retroviral therapy	11,000
Estimated no. of AIDS orphans	890,000

Table A1.2: Key economic indicators for Kenya.[35,36,37,38]

GDP	$10.1 billion (2004)
GDP per capita	$322 (2004)
GDP composition by sector	agriculture (19.7%) industry (18.6%) services (61.8%)
Population below poverty line	50%
Unemployment rate	40%

A1.1.3 Kenya: Society & Culture

Kenya consists of seven provinces and one area, populated by about 40 ethnic groups, of which the Kikuyu tribe is the largest constituting 22% of the population, followed by Luhya at 14% and the Luo tribe at 13%. Interestingly, all of these tribes are located in the southwestern sections of Kenya. Table A1.3 shows a percentage breakdown of tribal populations by province.[39]

Table A1.3: Distribution of Ethnic Groups in Kenya by Province.[39]

Province	Total Provincial Population	Dominant Ethnic Group		
		Name	Population Size	Percentage
Nairobi	1,324,570	Kikuyu	428,775	32.4
Central	3,112,053	Kikuyu	2,919,730	93.8
Coast	1,829,191	Mijikenda	994,098	54.4
Eastern	3,768,677	Kamba	2, 031,704	53.9
North-Eastern	371,391	Ogaden	133, 536	36.0
Nyanza	3,507,162	Luo	2,030, 278	57.9
Rift Valley	4,981,613	Kalenjin	2,309, 577	46.4
Western	2,544,329	Luhya	2,192,244	86.2

A1.1.4 Kenya: Health Profile

Table A1.4 highlights some of the health indicators in Kenya.

Table A1.4: Health indicators in Kenya.[40]

Access to potable water	53% of the population has access to potable water
Medical services	6500 persons per doctor
Maternal mortality rate	650/100000
Infant mortality	68.74 deaths/1,000 live births (2000 est.)
Female Genital Mutilation (FGM)	50% of females nationwide suffer FGM

Table A1.5: Estimated HIV infection in adults 15 to 49 by province, June 2000.[41]

Province	Number HIV+	Prevalence (%)
Nairobi	175,000	16
Central	240,000	13
Coast	135,000	10
Eastern	380,000	16
North Eastern	15,000	3
Nyanza	480,000	22
Rift Valley	390,000	11
Western	210,000	12
Total	**2,025,000**	**13.5**

Between its independence in 1963 and 1980, Kenya's child mortality declined rapidly at about 4 percent per annum.[42] The rate first slowed to 2 percent in the early 1980s; and finally reversed. Data from the 1998 Kenya Demographic and Health Survey (KDHS) shows that the child mortality rate (U5MR) increased by about 25 percent from the late 1980s to the mid-1990s. The most important factor was the emergence of an HIV/AIDS epidemic. Table A1.5 gives a clear idea of HIV rates across Kenya.

A1.2 Nyanza: Health and Socio-economic Profile

Now the focus of this Appendix shifts towards Nyanza. Table A1.5 shows that the Nyanza Province has the highest prevalence of HIV/AIDS in the country, making both adult and child mortality significant in these areas. Life expectancy is generally believed to be around 37 years of age, the lowest in all of Kenya.[43]

HIV related mortality can be related to opportunistic infections including water related diseases like diarrheal diseases and malaria that routinely plague the area. A 1999 health survey revealed that 66 percent of the population in the rural Nyanza province lacked access to safe drinking water, and 47 percent of children younger than five years had experienced diarrhea in the two weeks preceding the health survey.

The Government of Kenya and many NGOs – including CARE International, World Vision and the Center for Disease Control (CDC), are actively working to bring down the high disease incidence in Nyanza.

Nyanza is also the poorest among all the provinces. It was estimated that 62.9% of households in rural Nyanza are poor as seen in Table A1.6.

Table A1.6: Rural Poverty in Kenya (1997). [44]

Province	Rural Poverty %
Central	31.37
Coast	62.19
Eastern	58.24
Nairobi Area	No Data
North-Eastern	No Data
Nyanza	62.89
Rift Valley	50.17
Western	59.32

People in western Kenya, including the Western and Nyanza provinces, are among the poorest, as seen in the poverty graph in Figure A1.2. Poverty in Nyanza is closely linked to a history of political difficulty. Following the colonization of Kenya, the British began an unequal distribution of land among the various ethnic tribes. The Kikuyu tribe, of which Jomo Kenyatta was a member, was the largest beneficiary of the British policies. By the time of Kenyatta's death, the Kikuyu tribe had more land than the rest of the tribes put together. There was also an unequal distribution of resources that adversely impacted the other tribes in Kenya. The Kikuyu region enjoyed better roads, schools, water, and health services as compared to the other districts.

The reasons for this repression can be partially attributed to rifts between the Kikuyu and the Luo, the dominant tribe in the Nyanza province. A power struggle between Jomo Kenyatta, and the vice president, Oginga Odinga, a Luo leader, led to the former's loss of membership in the ruling party. Following the rift, the Nyanza province was virtually written off of many socio-economic beneficial plans like hydro-electric plants and highways, leading to economic decline in the region.

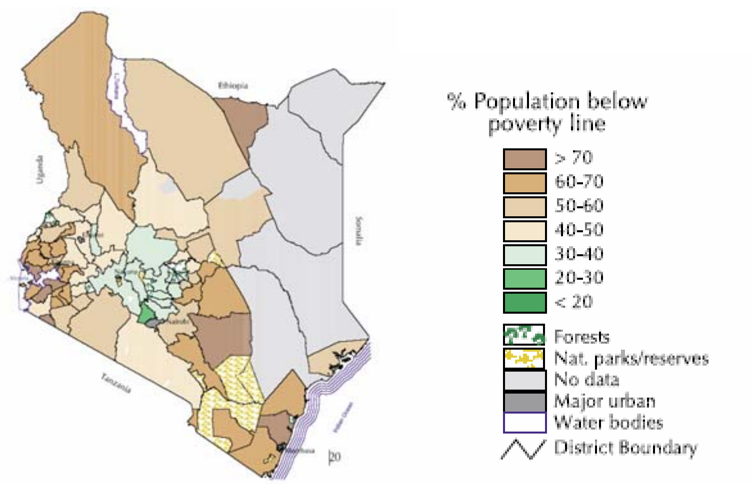

Figure A1.2: Poverty Graph of Kenya.[45]

Appendix 2: Turbidity Data

Surface water turbidities (in NTU) collected by CDC staff between March and September 2003 across Western Kenya. Note that for this study, the most turbid sources of water in the region were deliberately sought out.

CDC Station No.	Date of Test	Turbidity (NTU)
003	7/8/2003	.
	9/16/2003	0054.70
	8/19/2003	0105.00
	7/22/2003	0156.00
	6/25/2003	0190.
	5/29/2003	0353.00
	3/13/2003	**0482.00**
009	7/10/2003	.
	3/13/2003	0041.10
	9/16/2003	0055.50
	8/19/2003	0105.00
	7/23/2003	0106.00
	5/26/2003	**0237.00**
015	7/8/2003	.
	9/15/2003	0027.40
	5/27/2003	0034.40
	8/19/2003	0076.10
	7/22/2003	0079.80
	3/24/2003	**0167.00**
024	7/8/2003	.
	6/23/2003	0199.00
	9/18/2003	0283.00
	6/24/2003	0331.00
	5/26/2003	0386.00
	7/22/2003	0427.00
	8/19/2003	**0802.00**
025	7/7/2003	.
	6/24/2003	0221.00
	5/26/2003	0296.00
	8/18/2003	0425.0
	9/15/2003	0571.00
	3/20/2003	**0767.00**
036	7/7/2003	.
	9/16/2003	0232.00
	9/16/2003	0232.00
	7/22/2003	0348.00
	6/1/2003	0372.00

	3/13/2003	0392.00
	8/19/2003	**0649.00**
041	**6/27/2003**	**0021.70**
042	7/10/2003	.
	7/23/2003	0229.00
	9/17/2003	0452.00
	6/1/2003	0585.00
	8/21/2003	0635.00
	3/24/2003	**0647.00**
043	**9/18/2003**	**2092.00**
044	7/9/2003	.
	7/11/2003	.
	7/11/2003	.
	7/22/2003	0260.00
	5/29/2003	0502.00
	8/19/2003	0527.00
	6/27/2003	0569.00
	7/23/2003	0586.00
	8/20/2003	0594.00
	6/26/2003	0615.00
	7/23/2003	0635.00
	6/26/2003	0976.00
	5/27/2003	1012.00
	3/28/2003	1020.00
	5/29/2003	1052.00
	9/17/2003	1114.00
	9/17/2003	1684.00
	8/20/2003	**1756.00**
045	7/8/2003	.
	3/13/2003	0046.40
	8/19/2003	0117.00
	7/22/2003	0126.30
	7/22/2003	0126.30
	5/30/2003	0146.00
	9/16/2003	**0182.00**
046	7/9/2003	.
	6/26/2003	0048.70
	7/23/2003	0083.90
	8/20/2003	0154.00
	3/25/2003	0410.00
	9/17/2003	**0710.00**
047	**6/26/2003**	**0046.**
050	**6/26/2003**	**0322.00**
102	**9/19/2003**	**0080.50**
103	7/7/2003	.
	6/23/2003	0073.80

	5/26/2003	0085.00
	7/21/2003	**0112.00**
113	**3/13/2003**	**0020.30**
123	7/10/2003	.
	5/29/2003	0034.80
	9/18/2003	0055.30
	6/26/2003	0071.50
	4/8/2003	0074.30
	7/24/2003	0112.20
	8/21/2003	**0127.00**
139	7/7/2003	.
	7/21/2003	0028.70
	9/15/2003	0036.20
	4/7/2003	0053.40
	6/23/2003	0063.40
	8/18/2003	0077.60
	5/26/2003	**0131.00**
140	7/9/2003	.
	4/11/2003	0009.34
	9/17/2003	0061.80
	5/28/2003	0064.80
	7/23/2003	0068.30
	6/25/2003	0121.60
	8/20/2003	**0142.00**
141	7/9/2003	.
	7/10/2003	.
	4/11/2003	0004.89
	8/20/2003	0034.10
	9/18/2003	0039.60
	6/26/2003	0054.70
	9/17/2003	0081.50
	5/29/2003	0090.40
	5/28/2003	0096.00
	6/26/2003	0122.50
	7/24/2003	0123.70
	7/24/2003	0138.40
	8/21/2003	0171.00
	4/11/2003	**0492.00**
142	7/9/2003	.
	7/23/2003	0065.80
	6/24/2003	0068.20
	4/11/2003	0073.00
	8/19/2003	0079.50
	9/16/2003	0105.00
	5/26/2003	**0142.00**
144	7/9/2003	.

	9/18/2003	0032.40
	5/28/2003	0090.50
	8/20/2003	0126.00
	6/25/2003	0130.30
	7/24/2003	**0135.10**
146	7/11/2003	.
	9/19/2003	0053.40
	4/11/2003	0055.20
	5/13/2003	0059.20
	8/23/2003	0076.60
	5/30/2003	0082.00
	6/27/2003	0130.30
	7/25/2003	**0138.70**
147	7/7/2003	.
	7/8/2003	.
	7/8/2003	.
	8/19/2003	0018.60
	9/16/2003	0029.90
	8/18/2003	0032.50
	7/21/2003	0066.00
	4/11/2003	0067.40
	9/16/2003	0068.70
	8/18/2003	0069.00
	5/26/2003	0070.40
	7/22/2003	0070.60
	6/24/2003	0081.80
	6/23/2003	0085.60
	4/11/2003	0098.10
	9/15/2003	0111.00
	5/27/2003	0116.00
	7/21/2003	0117.30
	5/26/2003	0154.00
	6/23/2003	**0226.80**
156	7/8/2003	.
	7/8/2003	.
	8/19/2003	0026.30
	7/22/2003	0033.70
	6/27/2003	0046.70
	5/30/2003	0096.90
	7/25/2003	0125.20
	9/18/2003	0132.00
	6/24/2003	0197.00
	5/13/2003	0205.00
	9/15/2003	0257.00
	5/27/2003	0267.00
	8/18/2003	0274.00

	5/13/2003	**0331.00**
157	7/10/2003	.
	8/18/2003	0044.20
	6/25/2003	**0080.70**
158	7/8/2003	.
	4/11/2003	0037.20
	7/22/2003	0038.80
	9/16/2003	0053.90
	6/24/2003	0084.50
	5/27/2003	0142.00
	8/19/2003	**0213.00**
221	**4/11/2003**	**0067.80**
222	4/11/2003	0012.30
	4/11/2003	**0017.30**
223	7/10/2003	.
	7/10/2003	.
	5/28/2003	0008.13
	4/8/2003	0012.40
	4/8/2003	0013.00
	5/28/2003	0017.60
	9/17/2003	0030.40
	6/25/2003	0077.70
	8/20/2003	0079.50
	7/23/2003	0100.00
	8/20/2003	0112.00
	9/17/2003	0112.00
	6/25/2003	0125.00
	7/23/2003	**0192.00**
224	**4/11/2003**	**0008.05**
226	7/8/2003	.
	8/19/2003	0068.70
	7/22/2003	0073.30
	9/16/2003	0091.60
	5/26/2003	0124.00
	6/24/2003	**0128.70**
228	7/11/2003	.
	4/11/2003	0016.70
	5/29/2003	0053.80
	9/18/2003	0077.20
	8/21/2003	0088.00
	6/26/2003	0112.90
	7/24/2003	**0121.00**
238	7/7/2003	.
	7/7/2003	.
	7/11/2003	.
	4/11/2003	0032.90

	6/27/2003	0040.90
	8/18/2003	0045.60
	9/15/2003	0049.80
	9/20/2003	0066.20
	8/18/2003	0067.10
	7/21/2003	0069.40
	6/23/2003	0079.00
	4/8/2003	0079.30
	9/15/2003	0082.30
	4/8/2003	0093.60
	5/26/2003	0096.20
	5/30/2003	0097.10
	8/18/2003	0098.80
	5/26/2003	0104.00
	7/21/2003	0114.00
	7/21/2003	0115.90
	6/23/2003	**0143.00**

Appendix 3: Rainfall Data

Rainfall Data from across Kenya in a study done between 1903 and 1973.[46]

TABLE 1. A list of rainfall stations and the lengths of available records.

Regions and stations	Latitude	Longitude	Altitude (m)	Length of record	Regions and stations	Latitude	Longitude	Altitude (m)	Length of record
Coastal Kenya:					*Central Kenya:*				
Kilifi	3°40′S	39°51′E	3	1918–1974	Embu	0°31′S	37°27′E	1433	1908–1973
Lamu	2°16′S	40°54′E	9	1906–1973	Kabete	1°15′S	36°44′E	1891	1910–1973
Malindi	3°14′S	40°07′E	3	1892–1973	Kiambu	1°11′S	36°50′E	1767	1908–1973
Mombasa	4°03′S	39°39′E	19	1891–1973	Machakos	1°31′S	37°16′E	1646	1894–1973
					Meru	0°30′N	37°39′E	1570	1910–1973
Coastal Tanzania:					Muranga	0°43′S	37°10′E	1281	1901–1973
					Nakuru	0°17′S	36°04′E	1851	1904–1973
Bagamoyo	6°25′S	38°55′E	9	1922–1973	Ngong	1°20′S	36°40′E	2043	1910–1973
Dar es Salaam	6°53′S	39°12′E	9	1922–1973	Nyeri	0°26′S	36°57′E	1829	1904–1973
Kilwa Kivinje	8°45′S	39°25′E	9	1922–1973					
Tanga	5°05′S	39°04′E	9	1922–1973	*Kilimanjaro:*				
					Arusha	3°20′S	36°37′E	1387	1922–1973
Northern Kenya:					Moshi	3°21′S	37°20′E	831	1922–1973
Marsabit	2°19′N	37°59′E	1345	1919–1963	*Lake Victoria:*				
Moyale	3°32′N	39°03′E	1113	1915–1973					
Lodwar	3° N	35°37′E	506	1920–1973	Bukoba	1°20′S	31°49′E	1144	1922–1970
Wajir	1°45′N	40°04′E	244	1918–1973	Entebbe	0°03′N	32°27′E	1155	1901–1973
					Kalangala	0°20′S	32°19′E	1159	1922–1973
Central Tanzania					Kisumu	0°06′S	34°45′E	1146	1903–1970
					Musoma	1°30′S	33°48′E	1147	1922–1973
Dodoma	6°10′S	35°46′E	1120	1922–1973	Mwanza	2°28′S	32°55′E	1140	1922–1970
Kurio Mission	5°13′S	35°23′E	1372	1922–1973					
Mbulu	3°52′S	35°33′E	1738	1922–1973	*Voi:*	3°24′S	38°34′E	560	1905–1973
Singida	4°48′S	34°45′E	1498	1922–1973					
Tabora	5°05′S	32°50′E	1190	1922–1973					

TABLE 2. Basic statistical parameters of the data sets.

Regions and stations	Mean rainfall (mm)	Highest rainfall (mm)	Percent of mean (%)	Year of occurrence	Lowest rainfall (mm)	Percent of mean (%)	Year of occurrence	Standard deviation σ(mm)	Coefficient of variation (%)	Mean deviation $\|e\|$ (mm)	$\frac{\|e\|}{\sigma}$
Lake Victoria:											
Bukoba	2047	2705	132.1	1968	1639	80.1	1943	302.5	14.8	230.8	0.76
Entebbe	1551	2262	145.8	1923	982	63.3	1971	256.2	16.5	195.6	0.76
Kalangala	2237	3552	158.8	1936	1372	61.3	1946	541.6	24.2	411.2	0.76
Kisumu	1108	1562	140.9	1951	698	62.9	1971	229.9	20.7	188.1	0.82
Musoma	818	1400	171.1	1961	442	54.0	1934	235.3	23.0	150.8	0.80
Mwanza	1053	1900	180.4	1961	623	59.2	1960	206.9	22.3	179.9	0.76
Voi:	549	1201	218.8	1927	184	33.5	1921	206.9	37.7	164.4	0.79

Appendix 4: PuR® Test Results

The following are PuR® test results published by the Proctor & Gamble Health Sciences Institute in rural Guatemalan households. [21]

Effective in Removing Bacteria

Bacteria	Initial (org/liter)	Post-Treatment
E. coli	2.0×10^8	ND
10 common fecal bacteria	9.2×10^9	ND
Salmonella typhi	1.6×10^8	ND
Vibrio cholerae	1.2×10^8	ND
Shigella sonnei	2.2×10^8	ND
Klebsiella terrigena	2.8×10^8	ND
Campylobacter jejuni	2.0×10^8	ND

ND = None Detected

Effective in Removing Viruses

Virus	Initial Viral Count/ml (log 10)	Mean Log Reduction
Poliovirus	7.1	>5.0
Rotavirus	7.9	>5.0

Effective in Removing Cysts

Cyst	Mean Initial (org/liter)	Mean Log Reduction
Cryptosporidium parvum	1.76×10^6	4.0
Giardia lamblia	1.84×10^6	3.6

Reduction of Heavy Metals

Heavy Metal	Initial (ppb)	Post-Treatment (ppb)
Arsenic	229	1.2*
Chromium (III)	1300	3.1*
Lead	270	<10*

* Below WHO Guideline

Removes Organics and Some Pesticides

Test Material	Initial	Post-Treatment
Humic acid (ppm)	24-30	<1
DDT (ppb)	6	0.34

WHO Guideline for DDT = 2 ppb

Effective* in a Wide Variety of Field Samples

Country	Initial NTU	Treated NTU
Guatemala	0 - 501	0.0 - 2.6
Kenya	0.7 - 1850	0.4 - 3.2
Morocco	0 - 244	0.0 - 1.1
Philippines	0 - 550	0.0 - 1.2
Bangladesh	10 - 35	0.0 - 1.1
South Africa	<0.2 - 54	0.2 - 0.4

* Effective microbiologically as well as improving clarity

Appendix 5: Household Field Survey

This Appendix contains the author's survey conducted in the SWAK communities in Nyanza Province in January 2005. Its purpose was to gauge household drinking water practices. A quantitative tabulation of results is presented in Appendix 6.

Group Name:
Date:
Location:
Community Leader Name (first name only):

All surveys began with an introduction of team members and the goal of "understanding current water practices." The respondent was asked if she had any questions. These were answered and then the survey began. At the end of the survey, the team again answered any questions that the respondent had.

1. First name (solely for reference and only first names were taken for privacy)

2. No. of members who drink regularly out of your "pot":

3. Where do you get your drinking water from (source water)?

4. How much do you pay for it?

5. How long does 20 L of drinking water last in your home?

6. Do you treat or boil your water?

7. (If they use rainwater) do you treat or boil your rainwater?

8. Method used:

9. Why do you use this method?

10. (If WaterGuard®/PuR®) Where do you get this product from?

11. How did you learn about this method?

12. How do you treat or boil your water?

13. How long have you been using this method?

14. Is it convenient to use?

15. Do you have any complaints about your method?

16. How often do you use this method?

17. What do you use your treated water for?

18. Do you think your water is safe to drink?

19. Has anyone in this home had stomach pains or illnesses in the past few months?

If they are not using WaterGuard® or PuR®:

20. Have you heard of Klorin/WaterGuard®/PuR®? Do you know what it is for?

21. Why do you not use it?

Appendix 6: Survey Results

Tabulated results of select questions from the survey. Other results are qualitatively discussed in Chapter 5.

Key: “W” = WaterGuard®
“P” = PuR®
“B” = Boiling
“+” = and, for example, “W+B”= WaterGuard® and Boiling
“/” = or, for example, “P/W” = PuR® or WaterGuard®,
“Y” = Yes,
“N” = No,
“>” = Respondent uses this source, but source water was either unavailable or inaccessible for turbidity test

Survey Question #	Questions #6 & #8	Question #7	Question #2	Question #5	Question #13	Question #16	Question #3 & Turbidity levels							
Community	**Treatment Procedure**	**Treat Rainwater?**	**# Family (people)**	**20 L lasts? (days)**	**Length of Use (months)**	**Con-tinuous?**	**Source Turbidity (NTU)**							
							Tap	**Lake**	**Borehole**	**Spring**	**River**	**Tank**	**Pond/ earthpan**	**Rainwater**
KAZ PTC	W	n/a	8	2	24	Y	1.06							
KAZ PTC	W	n/a	5	2	3	Y							7.67	
KAZ PTC	B	n/a	5	1		Y	1.96							
KAZ PTC	W	n/a	12	1	24	Y			4.82					
KAZ PTC	W	n/a	8	1	24	Y			3.68					
KAZ PTC	W	n/a	3	10	12	Y							4.51	
KAZ PTC	B	n/a	20	0.5		N							6.47	
Menyatta	B	N	5	1			0.76		0.78					>
Menyatta	B	N	5	4			0.76		0.78					
Menyatta	W	Y	5	4	12	Y	0.76		0.78					>
Menyatta	N	N	3	5			0.76		0.78					
Menyatta	N	N	7	5			0.76		0.78					

Okok Widow	P/W	Y	7	1	12	Y	1.08				7.53			>
Okok Widow	W	Y	6	2	3	N	1.08				7.53			>
Okok Widow	W	Y	6	1	12	Y	1.08				3.46			>
Okok Widow	N	N	3	3			1.08							>
Okok Widow	N	N	3	4			1.08							
Mambo	W	N	4	2	36		1.15		95.7					1.31
Mambo	B	Y	4	5	36		1.15		95.7					1.31
Mambo	W+B	Y	4	2	3		1.15							1.31
Mambo	B	N	3	7			1.15							1.31
Mambo	W	N	13	2	12		1.15							1.31
Mambo	B	Y	6	4			1.15							1.31
Kingpin	W	Y	3	1	60	Y					13.6			2.94
Kingpin	W+B	N	4	7	12	Y					14.1			2.94
Kingpin	N	N	4	7							14.1			2.94
Kingpin	N	N	3	10							14.1			2.94
Kingpin	N	N	5	2							14.1			2.94
Kingpin	B	N	6	1		N					14.1			2.94
Kingpin	W+B	Y	9	1	12	Y					14.1	25.4		2.94
Hawi	B	N	5	5		N							42	>
Hawi	B	N	8	1		N							42	>
Hawi	B	N	6	2		N							42	>
Hawi	N	N	6	2									42	>
Hawi	B	N	3	3		N							42	>
Hawi	B	Y	8	1		Y							42	>
Kasiri	W	Y	10	1	36	Y		22.4					>	>
Kasiri	W	Y	6	1	36	Y		22.4					>	>
Kasiri	B	Y	4	4		Y		22.4					>	>
Kasiri	B	Y	1	7	12	Y		22.4					>	>

St Mary's	B	N	4	3		N							28.3	>
St Mary's	W	Y	5	2	24	Y							28.3	>
St Mary's	B	Y	7	1		N							28.3	>
St Mary's	N	N	2	2									28.3	>
St Mary's	B	N	3	7		N							28.3	>
St Mary's	B	N	1	7		N							28.3	>
Bar Chando	N	N	4	4					0.45					1.59
Bar Chando	N	N	8	4					0.45					
Bar Chando	K	Y	10	2	12	Y			0.45					1.59
Bar Chando	N	n/a	6	4					0.45					
Bar Chando	K	Y	8	1	12	Y			0.5					1.59
Rufaa	K	Y	5	2	12	Y			1.3					1.37
Rufaa	B	n/a	2	3		Y			1.3					
Rufaa	K	Y	2	4	6	Y			1.3					1.18
Rufaa	W	Y	4	6	6	Y			1.3					1.4
Rufaa	N	N	6	7					1.3					>
Aluor Moye	B	Y	5	4		Y			1.96					3.3
Aluor Moye	K	Y	7	6	6	Y			1.96	4.78				3.3
Aluor Moye	K	Y	6	4	24	Y			1.96		6.47			3.3
Aluor Moye	N	N	3	2					1.96					3.3
Dienya CBD	B	Y	2	4		Y					59.6			5.2
Dienya CBD	N	N	4	2							59.6			5.2
Dienya CBD	B	N	4	7		N					59.6			5.2
Dienya CBD	B	N	5	2		N					59.6			5.2
Saloo	B	Y	8	4		N				2.5				1.2
Saloo	N	n/a	2	2						2.5				
Saloo	W	Y	8	7	24	Y				2.5				5

Saloo	W	Y	6	3	2	Y				2.5				0.35
Saloo	W	Y	6	2	18	Y				2.5				6
Rise&Shine	N	N	500								3.7		4.1	0.3
Rise&Shine	N	N	6	4							3.7		4.1	0.3
Rise&Shine	K	Y	9	7	6	Y					3.7		4.1	0.3
Rise&Shine	K	Y	5	5	1	Y					3.7		4.1	0.33
Rise&Shine	W	Y	9	2	0.5	Y					3.7		4.1	0.1

Appendix 7: Business Research Team Paper

The MIT-Sloan Business Team Report done on the Business Component described in Chapter 1.[24] This project report was submitted as part of the coursework for 15.389 – Global Entrepreneurship Lab, taught by Professor Richard Locke at the MIT-Sloan School of Business.

KENYA G-LAB TEAM FINAL PROJECT

DEVELOPING A SALES AND TRAINING PLAN IN NYANZA PROVINCE, KENYA

March 11, 2005

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Executive Summary:

This paper provides a summary of our Global Entrepreneur Lab (G-Lab) project in Nyanza province and Kisumu, Kenya during January 2005. The first section of this paper provides background on Kenya in general and Nyanza province in particular. We also discuss waterborne illnesses, point-of-use water treatment, and the Society of Women and AIDS in Kenya (SWAK), the organization that was the focus of our project. The second section outlines our project goals and describes our deliverables. We gave a presentation to SWAK which included business recommendations, as well as a suggested training curriculum for the SWAK groups who are selling WaterGuard. The third section of this paper delves into the details of the deliverables, and the fourth section describes where we see the Safe Water System project in Nyanza Province going in the future. The final section provides a conclusion and summary of the project.

Section I: Background

Kenya

Kenya is a country roughly twice the size of Nevada located on the equator in eastern Africa. Agriculture and wildlife safaris are two of Kenya's largest industries, and the country is rich in natural resources. Unfortunately, these resources and industries are not equally distributed throughout the country and some provinces are poorer than others. Nyanza province, where our project was located, is one of Kenya's poorest provinces.

Nyanza

Nyanza (Swahili for "Lake") Province has a population of approximately 4.5[1] million and is situated in western Kenya around the shores of Lake Victoria[2]. (Figure 2) Lake Victoria is the world's second largest fresh water lake, and its shores reach Uganda and Tanzania. Trade was the main industry in the region for many years. Unfortunately due to the demise of the "East African Community" trading agreement in 1977, the introduction of an exotic, fresh water weed which clogged the shipping lanes, and the subsequent collapse of the trading industry, the economy of the area has suffered. In fact, in Nyanza's capital Kisumu (pop. 400,000[3]) the 2002 the annual per capita income of the area was only KSh. 14,160[4] (approx. $177[5])This is more than 50% below the "dollar a day" poverty line set by the World Bank[6].

[1] http://www.cbs.go.ke/census1999.html
[2] See Figure 1
[3] http://www.rvsci.us/html/kisumu.html
[4] http://www.nationaudio.com/News/DailyNation/12052002/Comment/Sp_Report43.html

This poverty is compounded by the HIV/AIDS epidemic that is sweeping Africa. Due to a number of local customs, the Nyanza province is suffering particularly hard from HIV/AIDS with approximately a 20%[7] infection rate, although some estimate this rate may be higher.

The poverty in the region, as well as Kenya's corrupt national and local governments[8], means that little infrastructure exists. This has resulted in only 0.6% of the population in the province having access to piped water[9]. The majority of the people in the province collect water from natural sources (e.g. rivers, rain, and wells). This water is often not disinfected to prevent microbiological contamination and is therefore highly susceptible to one or more disease-causing agents.

Waterborne Diseases and Nutrition

A variety of waterborne diseases and disease-causing microorganisms can be contracted by drinking untreated water. Among the worst diseases are cholera, dysentery, typhoid, and chronic diarrhea. These diseases cause massive dehydration by diarrhea in infected persons and can be fatal if left untreated. In fact, the Centers for Disease Control (CDC) estimates that annually one million people (mostly children) die from diarrhea each year[10]. In addition to these major diseases, drinking untreated water can also lead to less serious forms of diarrhea and can lead to increased susceptibility to infection and malnutrition. Malnutrition is already a major issue in Nyanza due to the poverty and drinking untreated water compounds the problem.

Point of Use Water Treatment

Drinking water can be easily treated and many non-governmental organizations (NGOs) are working on water treatment programs. A very popular focus of these programs is the treatment of water at the point of use (POU). This differs from the centralized treatment common found in developed countries, where the water is treated in a central treatment facility and then delivered via a piped infrastructure. Since Nyanza lacks a piped infrastructure, water is collected by individuals from their local source. This water is then transported in five gallon containers ("jerry

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[5] KSh 80 equals approximately $1

[6] http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTPOVERTY/EXTPA/0,,contentMDK:20153855~menuPK:435040~pagePK:148956~piPK:216618~theSitePK:430367,00.html

[7] http://www.pathfind.org/site/PageServer?pagename=Programs_Africa_Kenya_Country_Profile

[8] http://www.transparency.org/cpi/2002/cpi2002.en.html

[9] http://www.irc.nl/page/14671

[10] http://www.cdc.gov/ncidod/dbmd/diseaseinfo/waterbornediseases_t.htm

can") to their homes where the water is ultimately stored in a wide mouth, open-topped clay jar. Cups are then used to scoop the water from the jar for drinking. Point of use treatment in Nyanza focuses on treating the water that goes into the clay jar.

A common form of water treatment in Nyanza is the addition of small amounts of sodium hypochlorite at the point of use. Sodium hypochlorite is cost effective, easy to use, and easily made. The focus of our project is a sodium hypochlorite product developed in conjunction with the CDC and branded in Kenya under the name "WaterGuard". We also looked at a combination flocculent/sodium hypochlorite powder manufactured by Proctor & Gamble and marketed under the name PUR®. Because the findings and recommendations are similar between PUR® and WaterGuard, for the purposes of this paper, we will focus on WaterGuard specifically.

WaterGuard

Waterguard[11] is a liquid sodium hypochlorite solution sold in 250ml bottles at a retail price of KSh. 45 (approximately $0.56) (Figure 2). For use, one capful of the solution is added to 25 liters of water and allowed to sit for thirty minutes. Waterguard's per use cost is very low, and one bottle can treat up to 2500 liters. However, due to the high rate of poverty in the province, the absolute cost is very high for consumers in the region. While much is being done to keep down the cost, rising manufacturing cost and an increase in Kenya's value added tax (VAT) added an additional KSh 10 to the price in the beginning of 2005.

In order to keep the costs of the product as low as possible, the CDC is working with a NGO, Population Services International (PSI), to distribute and sell WaterGuard. PSI coordinates the manufacture of WaterGuard, and PSI also sets the margins and spearheads all marketing efforts. WaterGuard is distributed wholesale in crates of 24 bottles, at a price of KSh 40 per bottle, leaving KSh 5 margin to the retailers.

Society of Women and AIDS in Kenya (SWAK)

SWAK is a loosely connected group of support and care groups whose main purpose is the emotional support and care those affected by HIV/AIDS. SWAK Nyanza is headquartered in Kisumu, and the groups are scattered throughout the region. The SWAK coordinating office in Kisumu identifies active community groups such as youth groups, widows and orphans groups

[11] WaterGuard was branded Klorin until May 2003

and womens groups. SWAK then supports these groups in their efforts to address the affects of HIV/AIDS in their area.

In addition to activities (Appendix 9), one way that SWAK contributes to the groups is through the provision of basic business training and relevant health-related products at wholesale prices. SWAK group members then go out into the community and sell these products, thereby filling two valuable needs. First, the community gets access to goods that might not be readily available, and the individuals in the groups can earn much needed income.

One of the newest products added to the SWAK "basket of goods" is the WaterGuard product. Unfortunately, the WaterGuard product was not selling as well as had been hoped, so SWAK and the CDC reached out to us as business school students to investigate the causes and potential solutions.

Section II: The Project---Scope, Methodology, and Final Product

Initial Project Scope

The scope of our initial project was determined after several conversations with Dr. Robert Quick, a medical epidemiologist with the CDC (who started The Safe Water System (SWS) program in Kenya along with CARE International and PSI), and Susan Murcott, Lecturer in the Department of Civil and Environmental Engineering at MIT. In the first draft of our letter of agreement, we indicated that our deliverables would include "a business plan for water purification products, including best practices and microfinance indicators." Our second deliverable was "a marketing plan for water purification products, including training and scaling." (Appendix 1). After discussion with various stakeholders, we decided that we would provide an outline for a training curriculum for the SWAK groups as a third deliverable.

Final Project Scope

Once we arrived in Kisumu and had spent some time with our key stakeholders, we changed the scope of our deliverables to best meet their needs. Because information transfer was limited between groups, we realized that while it was important that we understand the best business practices for the sale of the WaterGuard, it was more important that this information be shared between groups. In the end, we created a presentation for SWAK Nyanza that outlined:

1) Current best practices among SWAK groups for the sale of WaterGuard
2) The attributes of an “ideal group”
3) A business model, including marketing strategy, bookkeeping suggestions, and ways to deal with capital constraints
4) A five-day training curriculum for the SWAK groups on the business practices associated with POU water treatment products
5) Recommendations for addressing common challenges that SWAK groups faced

In addition, when we gave a presentation to PSI Nairobi, we included suggestions for inexpensive ways to market WaterGuard in rural Kenya. Due to the needs that we observed while in Kenya, the final deliverables focused more on the training curriculum, and less on microfinance (which was extremely limited) and less on tips for expanding WaterGuard globally.

Stakeholders

See Appendix 3.

Methodology

Our research consisted of three major components:

1) Preliminary research while in the United States
2) Interviews with stakeholders in Nairobi
3) Interviews with stakeholders in Kisumu

Prior to our arrival in Kisumu, our team prepared for our trip through extensive research and planning. We:

1) Created a Gant chart outlining our research plan prior to departing for Kenya (Appendix 2)
2) Conducted preliminary “book” research on Kenya, Kenyan culture, Kisumu, household water treatment, clean water, travel in Africa, and microfinance (Appendix 5)
3) Held phone or in-person interviews with key stakeholders as well as other individuals with relevant knowledge (Appendix 4)

During the day we spent working in Nairobi, we met with:

1) Leaders from PSI Kenya in Nairobi
2) The head of SWAK Kenya

After our arrival in Kisumu, we learned about SWAK and the sale of WaterGuard through:

1) **Interviews with Alie Eleveld, Technical Support Officer for SWAK Nyanza.** Alie arranged all of our transportation, lodging, and visits to our community groups. In addition to providing us with support, through our extensive conversations with Alie, we gained insight into the cultural and business climate of the region.
2) **Focus groups (interviews) with 14 local SWAK community groups.** Best practices and the needs of the community were determined through 2-3 hour focus groups with sellers of the SWS products. The bulk of our research was done through these interviews. See Appendix 4 for a list of groups.
3) **Individual, house-to-house visits to understand actual use and perception of safe water system products.** These visits were conducted by Pragnya Alekal, a MIT Civil Engineering masters student, who also served as our technical advisor. Each member of our team took turns shadowing Pragnya and learning more about the buyers of WaterGuard.

Final Product

1) Presentation to SWAK Nyanza as well as to SWAK community group leaders
2) Presentation in Nairobi to PSI with suggestions for rural marketing

<u>Section III: Findings and Recommendations</u>

General Findings and Recommendations

The current SWS business model is not conducive to high success. The top-selling groups sell only 96 bottles of WaterGuard a month, which represents almost a 0% penetration rate. Most groups sell 48 or fewer bottles per month. Margins are pegged at a very low rate, incentives to sell are extremely low, access to training on products and basic business tactics is severely limited, and a lack of resources affects all aspects of selling, from distribution to marketing.

Nonetheless, trends did emerge in our research that shed light on opportunities for improvement within all groups, as well as at the SWAK administrative level. At the end of our on-site stay, we reported on the ideal business model, a marketing plan, a training curriculum, and solutions to common challenges.

Business Model Recommendation:

The most successful groups were ones who had spent time planning and thinking about the selling of WaterGuard. We recommend the implementation of formal business planning, from conception to implementation to maintenance. Our business model is subdivided into nine sequential sections:

1. Establish goals
2. Raise capital
3. Educate sales people on products
4. Create organizational structure
5. Create territory structure
6. Create customer segmentation to aid in sales planning
7. Implement plan
8. Keep records
9. Conduct follow-up appointments

Finding	Recommendation	Detail
• The most successful groups had discussed the reasons why they wanted to sell the Safe Water products and what they intended to do with the profits o Examples included: raising money to support widows and orphans, helping improve the health of the community, and complementing their services as community health workers	1. Establish Goals	• Each group should discuss what is important to that group's particular purpose, and should make sure all group members agree on the overall goals. • Additionally, setting sales targets and revenue goals will help with motivation and creating a common ambition.
• Groups used a variety of means to save enough money for an initial capital investment to build an inventory of products. o Examples included: group member donation (merry-go-round saving), income from other income generating activities (IGAs), microfinance loans and donations • Some groups would not set aside the portion of revenues which was needed to sustain the business selling Safe Water products. o These groups were unable to maintain original levels of inventory, and they had long gaps in supply.	2. Raise Capital	• **First Time Capital**: The amount needed to purchase the first round of inventory 1. Identify amount needed i. Start small (e.g.: one crate) 2. Think about possible sources of money and choose the mix that best suits the group 3. Arrange purchase of inventory with SWAK • **Continuing Capital**: The amount needed to either sustain or grow inventory 1. Maintain Original Capital- set this money aside, only spend profits. 2. Identify additional amount of money needed a. Sustainability: only original capital amount needed b. Expansion: estimate how many products can be sold based on past data

Finding	Recommendation	Detail
		3. Think about possible sources of money, as in first time capital

• The level of knowledge about the products and waterborne illness was often limited within groups
• Only a few members in each group had attended the SWAK organized Safe Water System (SWS) training.
• The intra-group teaching of untrained group members was often informal and abbreviated.
• Questions raised by community members went unanswered if the salesperson did not have the answers.
• Training on products only occurred once within each group, and new members were not formally trained.
	3. Educate salespeople on Safe Water Products	• Each group should create formal training procedures
		• A representative should go to SWS training and then be in charge of teaching the rest of the group
		  o Create group training plan
		  o Schedule time in advance to share knowledge with group
		• Don't let questions go unanswered
		  o Write down questions from community and group
		  o Arrange systematic way to get answers. (e.g.: have specific person in group responsible to get answers from SWAK or CDC)
		• Hold regular training review
		  o Hold periodic and new member review sessions
		  o Ensure all members understand all product benefits

• The most successful groups had assigned specific roles and positions to facilitate the sales of Safe Water products
• One reason often cited for not being motivated to sell was difficulty in dealing with rejection or bad sales days, and the isolation of walking door to door by yourself.
• Some groups reported difficulty in retrieving a consistent supply of inventory because they live far away from a central region and may not be able to make it to the appropriate contact in a timely manner to purchase more
	4. Create Organizational Structure	Each group should have the following positions, and all positions should work closely with the record keeper:
		• Sales Manager
		  o Dedicated to managing and increasing product sales
		  o Makes sure everyone in group is familiar with products
		  o Coordinates sales teams
		  o Responsible for communication with other groups
		• Distribution Manager
		  o Gets products from distributor (e.g. SWAK, CDC)
		  o Responsible for getting questions answered
		• Record Keeper
		• Sales teams
		  o Pairs for door-to-door
		  o Teams for events

• Many salespeople focused only on houses close to their own. • In some communities, one person might be familiar with the product, but a neighbor - or even someone within the same compound – might not be aware of the product • Coverage of communities was generally sporadic	5. Create Territory Structure	• Review community area and establish sales territory • Create systematic plan to reach each person in territory • If one person does not buy the first time, continue to return to that house on a periodic basis

Finding	Recommendation	Detail
• Only a few groups actually planned out which houses and areas they would travel to each day that they were door-to-door selling. • No group had a defined sales territory		
• All groups indicated that female heads of households were by far their most common customers • Some groups sold to men, but only at specific times (eg: at *community meetings*) • No group had examined opportunities in trying to segment the market	6. Create Customer Segmentation to Aid in Sales Planning	• Identify types of customers • Identify influential people in community who might help you sell • Identify events and activities which will reach these people. • See attached example in Appendix 6
• There was a severe lack of marketing materials • The most successful groups relied on each other for support and encouragement	7. Implement	• Use the information in steps 1-6 and go out and sell o Use customer segmentation plan o Create and use marketing materials o Use knowledge from training o Use group for support
• Inventory control is extremely important because of the low margins o Groups would have to sell 7 bottles to be able to repurchase one lost bottle • Some groups were using their capital replenishment revenue to purchase non-SWS products (such as goats) and were unable to sustain the businesses	8. Keep Records	• Keep sales ledger o Keep capital money separate from profit o If you want to expand inventory, put profit in capital account • Keep pending sales ledger o Helps track inventory and ensures capital recovery o Give out more product only when salesperson has returned money for previous products • See attached example in Appendix 7
• Many community members were not using the proper dosing of the Safe Water products. Underdosing, overdosing and inconsistent use were the most popular misuses. • Boiling and no treatment are the most common competitors to Safe Water Products • When a potential client does not buy the product the first time he or she is approached, most groups did not return to that person to try to sell again • Because trust levels have to be high before someone will try something new, word of mouth is a very popular means of sales expansion	9. Conduct follow-up appointments with customers	• After sale, visit customer at home o Make sure she is using product properly o Answer any questions o Add customer house to territory plan o Schedule next meeting with customer • Even if you were turned down once, try visiting potential customer again • Ask for referrals to find new customers o Ask if there is someone else in the area you can visit o Ask for testimonials o Ask customer to tell friends about product

Training Curriculum Recommendations

A new training curriculum is needed to promote the sale of WaterGuard. The existing training schedule inadequately prepares the SWAK groups to successfully sell the products.

Currently, the training consists of a three day “Income Generating Activities” (IGA) training and a one day seminar on waterborne illness and safe water products. The IGA training focuses more on assessing market need than addressing planning, and the IGA training does not help the group members to think about the variety of tactics they can use to sell their products. Furthermore, there are barriers to the dissemination of information to the entire group or to new members. These barriers include centralized trainings that only one or two people from each group can attend, lack of materials, and lack of guidance on how to teach non-trained members.

A new training curriculum should be more rigorous, covering each section of the business model, field training, and a train-the-trainer section. Ideally this training would be done regionally, so all group members could attend. After training is complete, refresher training should be undertaken after six months to address any troubles or issues the community groups have encountered.

A five day training curriculum should look similar to this:

Day One
- Familiarize with product (SWS Training)

Day Two
- Establishing Goals
- Raising Capital

Day Three
- Organizational Structure
- Territory Structure
- How to Create Sales Plan (customer segmentation)
- Record Keeping

Day 4
- Implementation
- Familiarization with marketing materials
- Learn how to follow-up with customers
- Practice skits

Day 5
- Field-Training (mentoring, shadowing)
- Train-the-Trainer

6-Months after Training
- Regional refresher course

Marketing Plan

Current rural marketing for WaterGuard is minimal, and there is opportunity for effective and inexpensive marketing programs. The customer segmentation plan outlined in the business model and exhibited in Appendix 6 is the first step in creating effective marketing. Each group needs to recognize the unique needs of different members of the community population, in order to create a customized sales approach. Additionally, there are a variety of marketing materials which would add incentives for salespeople and ensure the proper use of products.

- Instructional Materials such as brochures, hand-outs and calendars
  - Customers who used the products properly reported a reduction in diarrheal diseases and were more likely to want to purchase the products again
  - Many customers were not dosing properly or were not updated on changes in dosing schedules
  - Rural citizens have an extreme lack of resources and desire decorations of any kind. Offering free calendars with instructions for the products would be highly welcomed
- Rural Event Sponsorships such as football and athletic tournaments, local dramas and plays
  - Market penetration is highest at community events where large numbers of the rural population gather together
  - Public events allow for an educational opportunity to teach about why use of the products is necessary
- Low-Cost Sales Incentives such as badges and certificates for salespeople, or free pens with purchase
  - Group members are proud to be SWAK members, and uniforms solicit respect and trust from community members—two characteristics vital in the sale of health care items
  - Badges help to formalize the selling process, and highlight the importance of the work these SWAK members undertake.
  - Especially with door-to-door sales, morale can be low with long walks between houses and heavy products to carry. Any kind of reward to motivate salespeople and to encourage high sales is helpful.
- Sales Contests and Rewards, for example, award a bicycle to the group with the highest sales in region
  - Most groups lack sufficient access to transportation which limits their ability to have full territory coverage.
  - Contests and rewards will motivate salespeople to be more aggressive and intelligent about selling products.

Common challenges

Many groups experience similar frustrations in day to day operations. These are some suggestions to help address these issues.

Type of Problem	**Problem**	**Recommendation**

Demand Issues	Lack of Customer funds	• Suggest creative ways to gather funds
		  o Example: buy 1 bottle for each compound
		• Sell in small quantities
		  o Example: go door to door and sell one capful at a time.

	Low Awareness	• Do more events: refer to sales plan/customer segmentation • Perform demonstrations • Be a role-model: Group should use product • Make product suggestion at point of sale o If someone buys a related product, suggest WaterGuard to them • Use marketing materials (e.g. posters, handouts, brochures)
	Lack of Customer Incentive to Buy	• For challenging sales, offer first time purchase at cost • Offer free gift with large or bulk purchases
Supply Issues	Irregular Supply	• Schedule regular delivery of product to central location
	Lack of group funds to repurchase Safe Water Products	• Don't spend original capital on anything but product
Incorrect Usage of Product	Overdosing, underdosing, inconsistent use, no retreatment, using for purposes other than drinking water	• Use picture-based instructional material • Leave instructions for customers at house • Include information on product choice and dosage • Use follow-up meeting to check if product is being used correctly
Low Incentive to Sell	Margins are too low to have profit be a strong incentive	• Give badges to all salespeople to wear while selling • Give certificates to top-selling groups • Create prizes for successful sales: in group, in greater community, regionally, nationally • Set sales goals • Give group recognition of top salespeople • Give regular pep-talks to remind group of the great things they are doing to help the community

The Ideal Group

Although a more formalized approach to selling products will help increase sales, the main driver of success appears to be group members who are extremely motivated to help their community. These people have a passion to help and are motivated by the idea of improving lives within their communities. These groups create strategies to structure their activities and are continually brainstorming to come up with unique ways to improve market penetration. The salience of their energy and enthusiasm inspires respect from the community. They are highly regarded because they are helping and educating the community as well as because they are trained, skilled and have exhibited success. Ultimately, these qualities are the foundation upon which a successful business model and marketing plan can be implemented. We outlined the qualities that we believe go into the "ideal group" and presented this to SWAK Nyanza (Appendix 8).

Section IV: Going Forward

In this section, we summarize the challenges presented by the SWAK business model, introduce options for future growth, and review the value that our team's involvement added to the Safe Water initiative in Nyanza.

SWAK Business Model: Initiatives in Progress

As discussed above, the structure of the rural WaterGuard sales model poses significant challenges for growth in Nyanza Province. However, several key initiatives that were outside the scope of our project are in progress, and may address some of the most problematic features of the business model:

- *VAT Tax Exemption:* PSI submitted a petition to exempt WaterGuard from the 16% VAT tax to the Kenyan Government in late 2004, just after the product lost its tax-exempt status. The petition will be pursued in 2005, and it is entirely possible that the product will receive exemption (many other PSI products are VAT-exempt).
- *New Bottles:* PSI plans to introduce smaller bottles in 2005 to address both a) the high absolute cost of a KSh 45 product b) the rural purchasing patterns that encourage packaging in the smallest quantities available. The new bottles will initially cost KSh 25 (including VAT), but will include a more concentrated chlorine solution that will last almost as long as the existing, larger bottle. The reduction in price – particularly if combined with VAT tax exemption, which would lower the total price to KSh 21 – would help rural sales considerably: not only would the end-user purchase become more affordable, but individual groups would have lower capital requirements to buy and expand stock.
- *PSI Rural Marketing Efforts:* PSI currently does not fund any rural marketing. If PSI receives funding from its national office for the WaterGuard product, then PSI will support SWAK's efforts with rural marketing resources.

In addition, SWAK's efforts in rural areas have pushed the proportion of rural WaterGuard sales relative to total provincial sales well above the national average: to 13%, vs. the national average of 5.6% rural sales. If the various initiatives described above are successful, then it is likely that the rural community groups selling this product could benefit considerably from increased product demand. In particular, if PSI launches a rural marketing campaign, the rural community groups will not have to shoulder the burden of conducting all marketing efforts on their own. With the introduction of the KSh 25 bottle, the community group margins will rise from 11% (KSh 5 per KSh 45 bottle) to 20% (KSh 5 per KSh 25 bottle). This will make the product more attractive, and easier to sell and re-stock.

Our Contribution to SWAK

The value that our team added to SWAK's point-of-use water sales project was really found in our introduction of a business focus to their rural sales initiatives. Most of the stakeholders involved in rural WaterGuard and PUR® sales view their activities from an education and health perspective. While SWAK focuses on AIDS-related activities, and the CDC is concerned about incidences of diarrhea, both groups are now involved with a considerable business initiative. Although the goal of selling point-of-use water products is to mitigate health- and AIDS-related problems, in practice SWAK is running a small business. The most important value that we brought to the project was the integration of a business perspective into their sales and training efforts:

- *Customer Segmentation:* Introducing customer segmentation and targeting to rural groups, to help them to create strategies to gain new customers and recruit influential community members to boost sales
- *Business-Focused Training Plan:* SWAK's existing "Safe Water" training did not include any business content, even though water product sales requires the management of a small business. We created a new training structure and content outline that emphasized accounting, inventory management, marketing, and sales.

Section V: Conclusion

Although SWAK's business model for the sale of water purification products does face a number of structural and environmental challenges, our team was impressed by the commitment and motivation of the grass-roots community groups who were selling the products. Despite incredibly low margins, inadequate training, and little bookkeeping or sales experience, groups continue to reach out to the community and spread awareness about water safety through the sale of the Safe Water products.

There is hope for future sales in Nyanza province: SWAK has recently received funding for an enhanced training program, and the new bottles have been designed and are ready to ship. If this is accompanied by the elimination of the VAT tax, and, most importantly, rural marketing support from PSI, it is likely that product sales in the region will take off. The Safe Water products could become a real income-generator for rural community groups.

Finally, this project was an incredible learning experience for the whole group. Not only were we faced with an entirely new culture and environment, but we were also presented with the opportunity to work with an incredibly diverse cross-functional team. During the project we worked with environmental engineers, P&G managers, CDC specialists, NGOs, and – most importantly – the community members who sold the water products. The project brought home to us the challenges facing communities devastated by HIV/AIDS, in a way that reading about the problem just cannot do. It was amazing to see so many dedicated people overcoming the challenges that this kind of environment presents, and this experience puts the challenges of our own daily lives in perspective.

Glossary of Acronyms:

CDC: Center for Disease Control

G-Lab: Global Entrepreneurship Lab, a MIT Sloan class

IGA: Income Generating Activity

MIT: Massachusetts Institute of Technology

NGO: Non-Governmental Organization

POU: Point-of-Use

PSI: Population Services International

SWAK: Society for Woman and AIDS in Kenya

SWS: Safe Water System (which includes: 1.disinfection 2.storage 3. education)

Figure 1

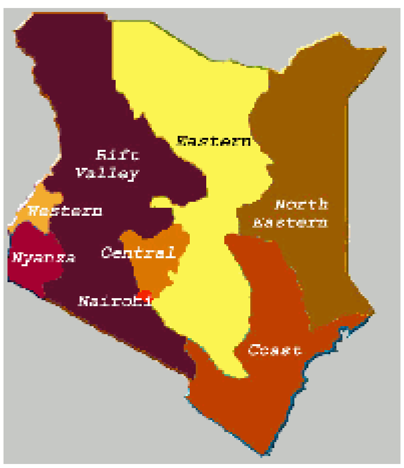


Figure 2

App 1

Scope/Deliverables

During this project, we will focus on clean water distribution practices in Nyanza Provence, Kenya. In particular, we will concentrate on developing a sustainable business and marketing strategy for two "point of use" water purification products: Pur & Water Guard.

Our final deliverables for this project will be:

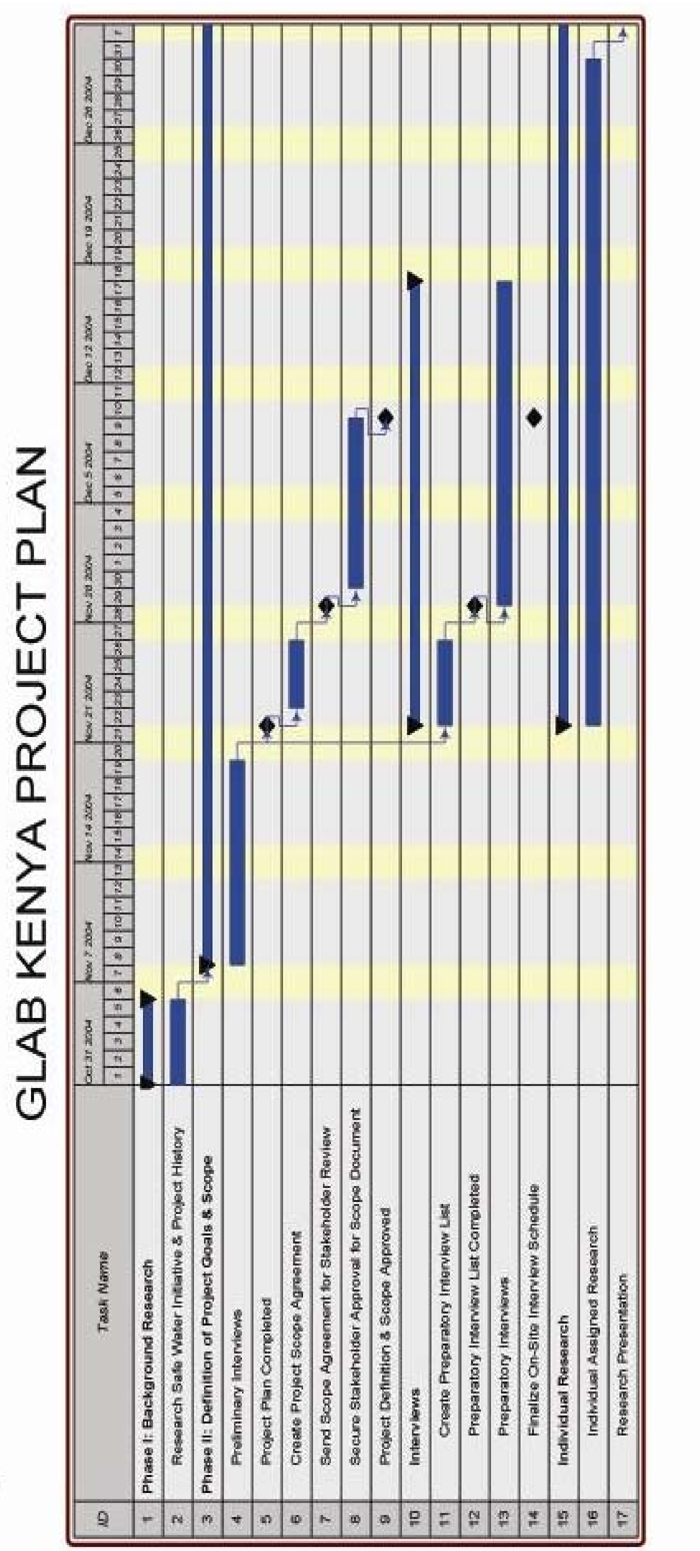
1. A Business plan for water purification products, including best practices and microfinance indicators
    - Includes summary of best practices based on interviews with Nyanza Province SWAK groups
    - Will provide targeted advice to individual SWAK groups as needed
2. A Marketing plan for water purification products, including scaling and training recommendations
    - Will review existing training curriculum and update based on best practices from primary research & marketing strategy
3. Recommendations for Global Scaling
    - List of recommendations for further research in order to create a review of global safe water system implementations from a business perspective

Approach

In order to complete these deliverables, we plan to interview and survey a wide sample of stakeholders (e.g. Buyers, Sellers, Influencers, etc)

To accomplish this, we have developed tentative work plan: (see attached exhibit)

App 2


GLAB KENYA PROJECT PLAN
ID
Task Name
Oct 31 2004
Nov 7 2004
Nov 14 2004
Nov 21 2004
Nov 28 2004
Dec 5 2004
Dec 12 2004
Dec 19 2004
Dec 26 2004
1 Phase I: Background Research
2 Research Safe Water Initiative & Project History
3 Phase II: Definition of Project Goals & Scope
4 Preliminary Interviews
5 Project Plan Completed
6 Create Project Scope Agreement
7 Send Scope Agreement for Stakeholder Review
8 Secure Stakeholder Approval for Scope Document
9 Project Definition & Scope Approved
10 Interviews
11 Create Preparatory Interview List
12 Preparatory Interview List Completed
13 Preparatory Interviews
14 Finalize On-Site Interview Schedule
15 Individual Research
16 Individual Assigned Research
17 Research Presentation

App 3: Stakeholders

Name	Title	Organization
Rick Locke	Professor	MIT, Sloan School of Management
Susan Murcott	Lecturer	MIT, Dept of Civil and Environmental Engineering
Daniele Lantagne	PE	Center for Disease Control
Alie Eleveld	Technical Support Officer	SWAK Nyanza Province
Robert Quick	Medical Epidemiologist	Center for Disease Control
Pamela Ogoi	Chairperson	SWAK Nyanza Province
Pragnya Alekal	Masters Student	MIT, Dept of Civil and Environmental Engineering
Rachel Greenblatt	MBA Student	MIT, Sloan School of Management
Ellen Sluder	MBA Student	MIT, Sloan School of Management
Jody Gibney	MBA Student	MIT, Sloan School of Management
Mark Chasse	MBA Student	MIT, Sloan School of Management
SWAK Nyanza group members	Community Members	SWAK

Appendix 4: Interviews

Pre-Kenya Interviews

Name	Title	Organization
Stephen Perrault	G-Lab alumni	MIT, Sloan School of Management alumni
Daniele Lantagne	PE	Center for Disease Control
Susan Murcott	Lecturer	MIT, Dept of Civil and Environmental Engineering
Rick Locke	Professor	MIT, Sloan School of Management
Robert Quick	MD	Center for Disease Control
Keith Zook	Spokesperson	Proctor and Gamble, PUR
Matt Freeman	MPH Student	Emory, Masters in Public Health Program
Shelley Bratton	MPH Student	Emory, Masters in Public Health Program
Robert Dies	G-Lab alumni	MIT, Dept of Civil and Environmental Engineering
Rachel Glennerster	Executive Director	MIT, Poverty Action Lab
Mark Bean	Chair	Amesbury for Africa
Sue Crawford	Member	Newburyport-Bura Alliance
Marcia Odell	Executive Director	WORTH (Microfinance Organization)
Diane Dorazio	Director	Roanoke-Kisumu Alliance

App 4 Continued

Nairobi Interviews

Name	Title	Organization
Carol Wamatu	Marketing Director	PSI
	WaterGuard Brand	
Grace Kiraguri	Manager	PSI
Mercy Wahome	Executive Director	SWAK Kenya

Nyanza Interviews

SWAK Group Focus Groups

Okok Widows
King Pin Youth
Mambo Youth
Kazi Ngumu Women's Group
Manyatta B Widows
Hawi Project
Barchando HIV AIDS and Poverty Eradication
St. Mary's Widows and Orphans
Kasiri Youth Group
Saloo Women's Group

Aluor Moyie Post-Test Club
Dienya CBD
Rise and Shine Youth Group
Rufah Program

We would like to thank all of our stakeholders, sponsors and participants for their help and guidance. This project was truly a collaborative effort and we really appreciate everyone's generosity. Sincerely, Rachel Greenblatt, Mark Chasse, Ellen Sluder, Jody Gibney

App 5: Written Sources

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Lonely Planet
Rough Guide
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App 6: Customer Segmentation "How to Reach Your Customers (Example of Sales Plan)"

Type of Customer	**Influencer**	**Events and Methods**
General population	• Chiefs • Pastors • Friends • Neighbors • Influential community members	• Kiosk • Church Events • Chief Baraza • Market • Funeral • Wedding • Big Gatherings • Dramas • Door-to-Door
People who are sick	• Doctors • Community Health Workers • Clinics • Nurses • PTC/Support Groups	• Home Visits • Hospitals & Clinics • Pharmacies • Group Visits
Mothers	• Schools • Doctors • Community Health Workers	• Home Visits
Expectant Mothers	• Traditional Birth Assistant • Doctors • Clinics • Community Health Workers • Other Expectant Mothers	• PMTC • Door-to-Door • Kiosk
Men	• Wives	• Chief Baraza
Kids/Youths	• Youth Groups • Teachers • Peers • Parents	• Schools • Parent-Teacher Meetings • Tournaments • Dramas
Hospitals	• Chiefs • Doctors • Nurses • Administrators • Patients	• Hospital Visits
Schools	• Parents • Teachers	• Parent-Teacher Meetings
Restaurants/Hotels	• Owners	Door-to-Door

App 7: Record Keeping

Example of Pending Sale Ledger

Date Given	**Sales Person**	**Product**	**Quantity Taken**	**Unit Cost**	**Total Owed**	**Amount Repaid**	**Date Repaid**	**Entered in Sales Ledger?**

Example of Sales Ledger

Date	**Sales Person**	**Product**	**Quantity**	**Unit Cost**	**Total Cost (-)**	**Price (+)**	**Profit (=)**

App 8: THE IDEAL GROUP

1. **Motivated to Help Community**
2. **Sustained High Sales**
3. **Extensive Group Reach**
    a. A strategy to ensure full coverage of community
    b. Defined territory
    c. Selling beyond individual home area
    d. High number of customers
    e. High percentage of repeat customers
    f. Continual addition of new customers
4. **Clearly Defined Goals**
5. **Financial Records**
6. **Group Highly Respected**
    a. Helping community
    b. Educating community
    c. Highly trained group members
    d. Variety of skills in group
    e. Successful IGAs
7. **Actively Promotes Product**
    a. Contact with leaders & community influencers
    b. Contact with community health workers
    c. Frequent and varied promotions and events
    d. Group members use products and act as role models
    e. Knowledgeable about products
    f. Encourages word-of-mouth and testimonials
8. **Shares Training Information with Group**
9. **Well Organized**
    a. Individual roles and responsibilities
    b. Cross-training and extensive member participation
    c. Sales updates at meetings
    d. Track against goals
    e. Shares successes and failures
    f. Sales targets and selling incentives
10. **Works together as a group**
    a. Selling in teams
    b. General selling support
    c. Practice selling
    d. Mentorships for new salespeople
11. **Works with other groups**
    a. Joint events
    b. Shares resources
    c. Reaches all potential customers
    d. Follow-up training events

APP 9: SWAK NYANZA

The following is a description of the activities that SWAK Nyanza performed in the last year, as listed in their 2004 Annual Report:

SERVICES OFFERED

SWAK Nyanza offers the following services:

- Pre and post test counseling for HIV
- Child Counseling
- Bereavement Counseling
- Paralegal Counseling
- Typesetting and printing
- Photocopying
- Sale of healthy products
- Capacity Building of registered SWAK groups and individual members
- Male initiative activities
- Children’s club activities
- Community Mobilization

TRAINING PROGRAM

SWAK offers the following training for registered groups and members:

- Community Counseling Training
- Systemic Child Counseling Training
- Paralegal Training
- Advocacy Workshops
- Memory Project Training
- Prevention of Mother to Child Transmission Training
- Home Base Care Training
- Safe Water System
- IGA Training
- Nutrition Training
- Malaria Training
- Behavioral Change Workshop

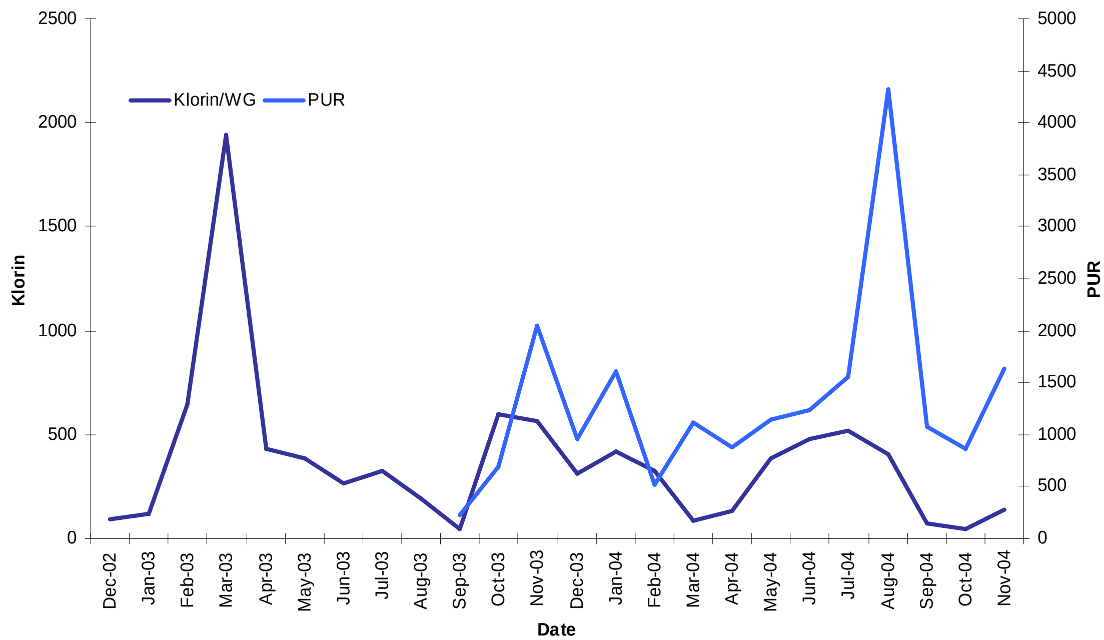
SWAK PRODUCTS

To promote positive living SWAK has been selling throughout 2004 the following products:

Product	**Retail Price**
Round Mosquitonet	Ksh 320
Rectangular Mosquitonet	Ksh 100
Powertab	Ksh 30
Mosqbar	Ksh 50
High Protein Flour	Ksh 100
Immune Booster Kemri	Ksh 1,000
Moducare Adults	Ksh 1,300
Moducare Children	Ksh 800
Sprinkles (Immune Booster Children)	Ksh 5
Klorin	Ksh 25
Waterguard	Ksh 35
Pur (treatment of turbid water)	Ksh 5
Modified Safe Storage Water Pot 20 L	Ksh 350
Modified Safe Storage Water Pot 40 L	Ksh 500
Savlon Ointment	Ksh 100
Benzyl Konium	Ksh 100
Mouth Gargle	Ksh 100
Red Ribbons	Ksh 100
Tshirts (SWAK)	Ksh 350
Tshirts (Womens AIDS Run)	Ksh 150
Condoms 3/pack	Ksh 10

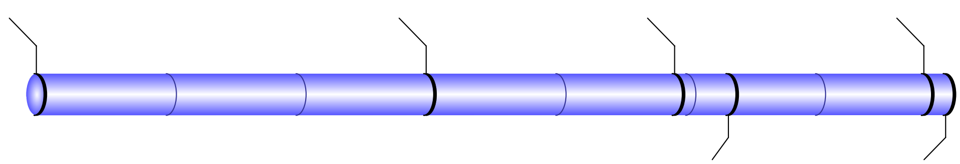
Around 20 registered SWAK groups within Kisumu, Bondo and Siaya are vendors of the above products and are buying them from SWAK at wholesale price. The profit of the sales remains with the groups, so it becomes an income generating activity.

App 10: SWAK Klorin/WaterGuard and PUR Sales Data



Source: SWAK Nyanza Central Office Sales Data (Alie Eleveld)

App 11: Safe Water System Timeline in Kenya 1998-2005



Appendix 8: Frequently Asked Questions (FAQs)

Set of questions compiled by the author during field surveys in SWAK communities in Nyanza during January 2005. Answers are being researched and compiled by CDC doctors and engineers, and the FAQs will be distributed and displayed within SWAK communities.

1. Why and how do I get sick?

2. What are waterborne diseases? How do I get them?

3. How does my water get contaminated?

4. Why should I treat or boil my water? What is the difference between them?

5. Why should I treat instead of boiling?

6. Does WaterGuard® cure Malaria, TB, and HIV?

7. What is WaterGuard®? How does it clean my water?

8. What is PuR®? How does it clean my water?

9. What is the difference between PuR® and WaterGuard®? How do I know which one to use?
10. Why does my treated water taste so bitter, and why does it smell like “Jik”?

11. What is the correct dosing for WaterGuard®?

12. What is the difference between WaterGuard® and Klorin?

13. When I put WaterGuard® near the snakes, they die. When I put it near the frogs, they die. How do I know that this isn’t going to kill me?

14. What happens if I overdose on Klorin/WaterGuard®?

15. Does treated water kill the germs and worms in my stomach?

16. Does treated water kill mosquito larvae in my water?

17. I don’t want to treat my water. What else can I do to make sure it is safe?

18. What should I do if I overdose my water or someone drinks WaterGuard® just like that?

19. How long is my water safe after treatment? What should I do after that point?
20. Which is the safest water source (pond, borehole, lake, stream, spring, tap, rainwater, etc.)?
21. I have heard that borehole water is very safe since it comes from the ground. Do I still need to treat my water? Why?
22. My children keep putting their dirty hands in my drinking water pot. Therefore I do not see any point in adding WaterGuard®. Is there anything I can do?
23. What does it mean if my bottle is expired?
24. Where can I get WaterGuard® from?
25. I have heard that they are making a new WaterGuard®. Why are they making a new one? What is the difference? When is it coming out? How do I dose for this one?

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