

# SAFE WATER: CURRENCY FOR PEACE ACT of 2005

## A Scientific Analysis



Lining up for water in Calcutta, 2003. Source: BBC World Service

## WORKSHOP IN APPLIED EARTH SYSTEMS MANAGEMENT

Columbia University School of International and Public Affairs and  
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# Safe Water Final Report

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## Executive Summary

Over the course of the summer semester, our workshop team has explored the problems related to the lack of safe drinking water and sanitation in developing nations. This final report provides a brief yet comprehensive summary of the science related to improving access to safe water in developing countries. Specifically, we analyze through a scientific lens the problems addressed by the Safe Water: Currency for Peace Act of 2005 and the solutions the act proposes.

Through the Final Report, we address the following major topics related to the science of safe drinking water and the Safe Water: Currency for Peace Act of 2005:

### *Legislative Summary*

Every day thousands of people, mostly children, die because of water-related diseases. In order to address the problem of lack of access to clean water, Senator Bill Frist (R-TN) introduced the Safe Water: Currency for Peace Act of 2005 to the United States Senate in March of 2005. The Act will amend the Foreign Assistance Act of 1961 to further the aims of the United States to promote global economic and social development.

### *Problem being addressed*

Diseases caused by a lack of access to clean water are a major problem in the developing world. The World Health Organization (WHO) estimated in 2003 that 1.1 billion people lacked access to clean water and 2.4 billion people lacked adequate sanitation facilities. While this is a global problem, developing nations in Africa and Asia are most severely affected. The lack of access to safe water hinders development not only due to sickness, but also through limiting opportunities for people to focus their energy elsewhere.

### *Science of the problem*

Water-related disease comes in a number of forms, including water-washed, water-related insect vector diseases, water-borne and water-based diseases. Water sources can become contaminated by the introduction of biological contaminants through human activities. Water can also act as a host surface for contaminants to develop in their life-cycle. Unclean water results from naturally occurring biological microorganisms and from human waste run-off (bathing, toilets, cooking) into available water sources.

### *Description of the proposed solution*

The Safe Water: Currency for Peace Act of 2005 proposes three major solutions to the problem of lack of access to clean water. To stimulate investment, the US government will provide investment insurance up to 75% of the entire cost of a project. This insurance will encourage private investment in the creation of water and sanitation infrastructure in developing nations. In addition, educational programs will be developed to foster understanding about how disease can be combated as well as how the proposed infrastructure actually works.



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### ***Science behind the proposed solution***

Education has been shown to have the most effective and immediate impact on reducing illness from unclean water. Furthermore, construction of basic sanitation facilities can greatly reduce contamination and disease. Development of infrastructure for both urban and rural communities will also produce cleaner water and thereby reduce cases of illness.

### ***Controversies related to the problem or proposed solution***

There are some misconceptions over the underlying causes of disease—malnutrition is perhaps one of the best indicators of whether or not a person is likely to contract a water-related disease. There is also a tendency to overlook urban needs and focus predominantly on rural solutions, when in fact populations in developing countries are rapidly progressing towards urbanization. Finally, there are some doubts as to the effectiveness of a western model of aid.

### ***Measuring program's success***

The goal of the Act is to improve health in developing nations by addressing the lack of access to clean water. In implementation, it will be important to have scientific indicators of success that can objectively determine whether or not solutions are effective. These measures include water quality monitoring, measurements of morbidity and mortality, and surveys to determine improved access and sanitation.

### ***Conclusion***

The Safe Water: Currency for Peace Act of 2005 addresses the needs of billions of people for access to clean water. When progressing with implementation of such an ambitious plan, it will be important to bear in mind the causes of unsafe water, the science behind the proposed solutions, and the indicators that exist for measuring the Act's success.



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## Introduction

Access to safe water and sanitation represents a central hurdle to the development of impoverished nations. A large percentage of the people in developing countries lack these services, particularly in Asia and Sub-Saharan Africa. This creates a significant burden for social and economic stability and, ultimately, for the sustainable development of these countries. The governments of the developing nations in these regions have not been able to cope with the problems of unclean and inaccessible water supplies or sanitation needs and the private sector is hesitant to invest due to the risk that investments will not pay off.

The *Safe Water: Currency for Peace Act of 2005* aims to alleviate these problems and provide US foreign assistance to these developing nations. The Act proposes a pilot program aimed at fostering private sector infrastructure development to provide access to adequate water, sanitation, and improved hygiene in Sub-Saharan Africa and South Asia. Achieving these goals could eventually economic development in these regions. This aid is proposed as a long-run sustainable solution, and accordingly, the Act suggests sustainable financing mechanisms as a key element of achieving this goal.

The objective of this report is to scrutinize the proposed legislation, investigate the extent and context of the environmental problem addressed in the legislation, and analyze the science of the problem, proposed solutions, and associated controversies. Finally, the management of the program requires a measurement of its performance. Therefore, in order to monitor its efficiency and efficacy certain indicators to determine the success of the program are proposed.

This report has been developed to highlight the relationship between the provisions of the Safe Water Act and the science behind safe water. This report should enable policy makers to understand the problem, the proposed solution, and the environmental science at the center of the issue.

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## Summary of the Safe Water: Currency for Peace Act of 2005

Access to safe water and sanitation and improved hygiene are significant factors in controlling the spread of disease and positively affecting economic development in developing nations. Providing sustainable financing mechanisms, including private sector financing, is critical to the long-term sustainability of improved water supplies, sanitation, and hygiene. With the introduction of the *Safe Water: Currency for Peace Act of 2005*, the United States intends to advance its foreign assistance objectives by improving access to safe water and sanitation and promoting sound water management throughout the developing world. The Safe Water Act will amend the Foreign Assistance Act of 1961 (22 U.S.C. 2151 et seq.), whose main objective was



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to assist developing nations in their long-term economic and social development by means of a non-military agency, the United States Agency for International Development (USAID).

To achieve the ends outlined in the Safe Water Act, the Foreign Assistance Act of 1961 would be amended to promote improved health and economic development by providing assistance to expand access to safe water and sanitation, promote sound water management, and improve hygiene for people in impoverished nations. It would also encourage long-term sustainability in the provision of safe water and sanitation by stimulating private investment in water and sanitation infrastructure and services (USAID, 2005).

These policy objectives include the investment of U.S. assets into foreign infrastructures, equipment, and organizations, as well as human capital and institutional capacity development to carry out and maintain the projects. Assistance would be provided by means of private investments in water and sanitation infrastructure and services.<sup>1</sup> In order to implement the proposed policy, the Act creates a five-year pilot program to be designed by USAID administrators, related Federal Agencies, and the director of the Overseas Private Investment Corporation.<sup>2</sup> This program complements the private sector in managing the risks associated with foreign direct investment in an effort to develop sustainable water infrastructure. Investment risks are mitigated through providing investment insurance, investment or loan guarantees of up to 75 percent, and direct investment or investment encouragement (US Senate 2005).

The policy objectives outlined in the Act will be implemented through a national strategy headed by the Secretary of State and USAID and created in collaboration with other federal agencies, relevant foreign governments, international organizations and US non-governmental organizations.

This strategy will encompass:

- An assessment of planned and implemented program activities
- Methods to achieve long-term sustainability
- Methods to mobilize and leverage the financial, technical, and managerial expertise to achieve the program's goals
- An assessment of how the program effectively supports the goal of combating HIV/AIDS
- An assessment of the resources needed to achieve the objectives and of the individual federal programs that should be involved

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<sup>1</sup> Private investment would be done by eligible investors. An Eligible Investor is a corporation created under the laws of a State of the United States and substantially beneficially owned by United States citizens as defined in Exhibit I, Part D, Key Elements in a Business Plan – Attachment I, Question 3b, Investor Eligibility, in OPIC Form 115 Supplement Guidelines for the OPIC Application for Financing, Overseas Private Investment Corporation. Online. Last accessed on June 11<sup>th</sup>, 2005, <[http://www.opic.gov/forms/finappsupp%20-%20073104ro\\_old.doc](http://www.opic.gov/forms/finappsupp%20-%20073104ro_old.doc)>.

<sup>2</sup> The Overseas Private Investment Corporation (OPIC) is a self-sustaining federal agency that sells investment services to small, medium and large American businesses. OPIC helps U.S. businesses invest overseas, fosters economic development in new and emerging markets, and supports U.S. foreign policy. OPIC's political risk insurance, project finance and investment funds fill a commercial void, create a level playing field for U.S. businesses and support development in emerging economies. On line. Last Accessed July 29<sup>th</sup>, 2005. <<http://www.opic.gov/>>.



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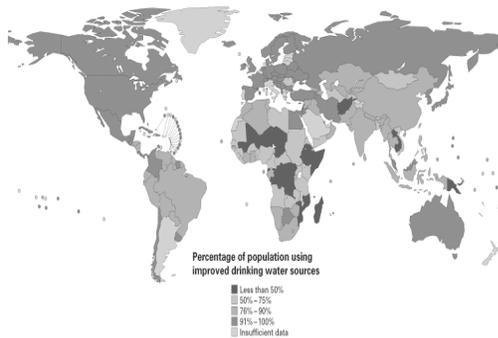
The president will submit to Congress two types of reports: an initial report on program strategy six months after enactment, and then a regular report on the progress of the project every two years. Congress is authorized to appropriate the funds needed to carry out the program, with no specified limits in funding.

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## The Problem of Lack of Access to Safe Water and Basic Sanitation

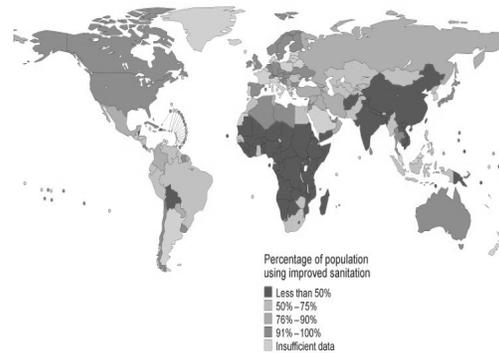
Access to clean water and basic sanitation facilities is a universal human right that is unequally distributed worldwide. According to the World Water Development Report of 2003, 1.1 billion people globally lack access to safe drinking water and an additional 2.4 billion people are without adequate sanitation facilities (UN World Water Assessment Program, 2003). The vast majority of people lacking access to safe water and sanitation reside in developing nations. The incidence of water-borne illness that results from the contaminated water in these nations exacerbates problems of poverty. Approximately 80% of all diseases and over one-third of deaths in developing countries can be attributed to the consumption of contaminated water (Water Can/Eau Vive, 2003). Children are the most vulnerable population, as more than 6,000 children die every day from diseases associated with unsafe water and inadequate sanitation (Water Can/Eau Vive, 2003).

Good water coverage attained in most regions  
Figure 1 Coverage with improved drinking water sources in 2002



(A) Coverage with improved drinking water sources in 2002. Source: Unicef

Half the developing world are still without improved sanitation  
Figure 7 Sanitation coverage in 2002



(B) Half the world still without improved sanitation. Source: Unicef

On a national scale, water-borne diseases and their consequences hinder economic activity. In some cases, debilitating illnesses like malaria slow the economic growth rate by 1.3% a year (World Bank Group, 2005).

The problem of safe water and sanitation is a great burden to economic development. Individual productivity is greatly reduced by illness, and families experience diminished disposable income due to payments for medical treatment and valuable time and energy diverted to efforts to secure



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their water supply. Women and children may spend several hours fetching the household's water from far away sources, forcing many to forego basic education and more productive, income-generating activities.

Governments in developing nations are frequently unable to provide sufficient management or access to clean water due to a lack of natural and financial resources, a lack of expertise, government corruption, and civil wars. Thus, conditions of illness and poverty are further aggravated by the lack of proper water resource management (World Bank Group, 2005).

There is little dispute that access to safe water and sanitation is a critical problem in developing countries. In fact, water has been recognized as a human right in the World Health Organization's constitution and the International Covenant on Economic, Social and Cultural Rights (World Health Organization, 2005). The recent creation of the Millennium Development Goals commits participating United Nations members to reduce by half the proportion of people without sustainable access to safe drinking water in the world. Further consensus measures led by the United Nations and its member nations are directed by World Water Assessment Program, which was implemented to address issues of global water management. This program aims to identify the tools and skills needed to achieve a better understanding of the basic processes, management practices, and policies that will help improve the supply and quality of global freshwater resources (World Water Assessment Program, 2005).

There is a consensus regarding the solution to the problems of water and sanitation and their impacts. The World Water Assessment program estimates that if improved water and basic sanitation were extended to currently un-served populations, the burden from diarrhoeal diseases could be reduced by 17 % annually. Furthermore, adverse health effects of contaminated water could be reduced by 70 % if full sanitation and well-regulated piped water were supplied. Since many water-related diseases can be prevented by sanitation initiatives such as hand-washing and boiling water, education plays a key factor in reducing the prevalence of disease (UN World Water Assessment Programme, 2003).

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### The Science of the Problem

The acquisition of a water-related disease is determined by socioeconomic factors associated with poverty, including education and access to potable water and hygiene facilities (MacPherson, 2005). Thus, the potential for mismanaged water to cause illness results from water acting as a medium for the transmission of biological pathogens. Ultimately, consumption of contaminated water leads to deteriorated health conditions (Gleick, 1998).



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The Safe Water: Currency for Peace Act of 2005 highlights some major diseases of concern, including diarrhoeal diseases, trachoma, intestinal helminth infections, and schistosomiasis. These can be further subdivided into four categories:

- Waterborne diseases: Water acts as the medium of transmission of biological pathogens and microorganisms that are capable of causing disease. Examples include cholera, typhoid fever and jaundice.
- Water-washed diseases: Caused by the lack of water for washing. Examples include diarrhoeal diseases, helminthes, and skin and eye infections such as Trachoma.
- Water-based diseases: Arise from hosts that either live in water or need it for a phase in their life cycles such as the larval stage. Examples include Schistosomiasis and guinea worm.
- Water-related insect vectored diseases: Dirty water provides a habitat for disease transmitting insects like mosquitoes, for example, which breed in water. The adult mosquitoes may later transmit parasites, such as malaria, river blindness, and sleeping sickness (Gleick, 1998).

Diarrhoeal diseases comprise viral and bacterial gastroenteritis. Diarrhea is caused primarily by the ingestion of contaminated water with viral or bacterial agents or food washed in this water. About 1.8 million people die of diarrhoeal diseases each year (Cohen & Powderly, 2004).

Trachoma is a disease that primarily infects children and results in a severe eye infection that gradually and painfully leads to blindness by the productive years of early adulthood (Cohen & Powderly, 2004).

Intestinal helminthes infections are caused by worms that live in human hosts. Helminthes eggs enter the body through orifices such as the mouth, nose, and anus. Once in the body, the eggs will lodge in the intestines where they develop into worms, which then migrate to infest various organs of the body. Symptoms vary from malnutrition and noticeable weight loss as in roundworm and pinworm infection; to fever, diarrhea, and muscle pain, as in trichinosis (MedicineNet, 2005).

Finally, *Schistosomiasis* caused by the infection of one of several species of parasites, is a major source of morbidity and mortality worldwide. Transmission occurs via skin contact when a person baths, fishes, or wades in freshwater containing the pathogen. Within several weeks of penetrating the host's skin, the parasites develop into worms in the blood vessels. From there, they can travel to different organs of the body (Centers for Disease Control, 2005).



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### The Proposed Solutions

In order to improve sanitation and provide safe water in developing countries, the Safe Water Act proposes a number of possible solutions. The Act recognizes the importance of educating and informing communities about health, sanitation, and hygiene, along with expanding infrastructure and teaching local community members water system operation management skills. The Act promotes the use of private investment as a method of funding improved water and sanitation.

The Act identifies a set of responsibilities of the United States' government in promoting safe water in developing world. The Secretary of State is charged with overseeing the development and implementation of a strategy for the U.S. to implement the Act. The Secretary is responsible for proposing methods to achieve long-term sustainability and underlying hygiene improvement programs in developing nations. These methods should include appropriate financial, municipal, health, and water management systems. In addition, the U.S. government should provide investment insurance and investment or loan guarantees; provide for direct investment or investment encouragement; and carry out special projects and programs for eligible investors to assist developing nations in the establishment of safe drinking water and sanitation infrastructure programs (US Senate 2005). The Act limits the amount of loan insurance the government can provide to, at most, 75 percent of the total loan cost. In choosing which foreign development projects to support, preferential consideration is to be given to projects sponsored by U.S. small businesses or cooperatives. Furthermore, U.S. agencies must be directly involved in the assistance of foreign programs, particularly by establishing effective indicators to measure and evaluate the progress of all projects. Finally, the U.S. must also promote a community-based approach to programs by including citizens of the native country in which programs are being implemented.

The Act also proposes the creation of a legal and regulatory environment conducive to private sector investment and participation in the delivery of water and sanitation services, to make investment in the developing nations more attractive. The use of revolving funds or pooled funds, which has been proposed by the G8 Plan to provide local currency for capital-intensive water infrastructure projects, is offered as a complementary method of obtaining capital to carry out development programs. The Act suggests that any funds going to the developing nations should be made in local currencies.

There are both costs and benefits associated with the privatization of water services. Using private investment to establish capital in developing countries where government budgets are minimal is one viable way to obtain funding to provide communities with safe water. Privatization of the water industries will allow federal governments to apply the money that was formerly spent on the management and distribution of water to other important projects. It could also generate greater efficiency in water system operations. However, with the introduction of



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foreign private investment, communities will face the risk of losing local control of the water industry. The private company will have greater influence on water-related decision making, including the pricing of water. Government subsidies may no longer be applicable to water, thus increasing its cost and rendering it unaffordable for many people. Also, a profit-driven agenda could lead a company to ignore the needs of the people as well as the environmental and ecosystem impacts for which they are responsible. This may require developing nations to establish methods for regulating the practices of these private water and sanitation suppliers. In addition, communities face the risk that a private investor will pull out, leaving projects unfinished.

Education initiatives are another solution to the problem of inadequate sanitation. Education can increase people's awareness of how to maintain proper hygiene and how to dispose of waste. Increased awareness and improved hygiene can greatly reduce the number of people afflicted with water-related diseases. The major obstacle to this solution is adequate funding to produce and distribute educational resources and pay for teachers to go into communities where they will provide training.

Fostering the growth of infrastructure within developing countries has a great potential to improve the accessibility of safe water. The construction of water storage facilities, ranging from sanitation treatment and processing plants near urban centers to covered wells and spigots in rural communities, can prevent water from becoming contaminated. Such facilities could eliminate open water sources that function as the breeding grounds of malaria-infected mosquitoes. Other infrastructure developments, such as pipelines that transport water from clean sources to communities, can prevent people from using polluted and unsanitary streams and puddles. The easy and convenient access to water these pipes can provide will also increase the economic welfare of local populations because it will decrease the amount of time women and children spend traveling to water sources. Nonetheless, infrastructure development is costly and requires resources that many countries do not have. In addition, operations and maintenance costs continue even after the infrastructure is constructed. There are environmental concerns that must also be addressed, as construction of a pipeline can fragment habitats and disrupt ecosystems. Finally, many African and Asian nations have naturally limited supplies of water. Diverting water from a source may deprive the environment around that source of adequate supplies of water, causing degradation.

Teaching local community members how to manage water and waste system operations requires finding and paying skilled personnel to teach the necessary management and business skills. The payoff, however, if local people are successful at learning these skills, is the potential for a community to establish and run their own sanitation and water department and, consequently, keep the profits within their community.



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### The Science of Solutions Proposed in the Act

Of the solutions proposed by the Safe Water Act, education and infrastructure development have the most direct impact on communities at high risk of contracting water-related diseases. Education of local communities about hygiene and waste management is an inexpensive yet effective solution that can be integrated into a variety of cultural value systems. Infrastructure development represents a complex but direct solution that will require different types of infrastructure in rural and urban areas.

#### *Education*

Accessible, clean water is most effective in reducing water-related diseases when coupled with education about improved sanitation. Simple hygiene behavioral changes, such as hand washing or using toilet tissue, reduces incidence of diarrhoeal disease by 45% ,whereas improvements to and/or treatments of drinking water reduce incidence of the disease by 39% (Fewtrell, 2005). There is a need to focus on sanitation a root cause of water-related health issues; recent improvements that have been made in safe water in the developing world have reflected a trend towards a focus on access at the expense of sanitation. While access to safe drinking water continues to increase, with a 61% improvement seen in the early 1990s alone, the number of people without adequate sanitation continues to rise (Nelson, 1997).

Sanitation education initiatives developed over the past few years by organizations including the UN, the International Rescue Committee, and the World Bank focused primarily on hand washing. The primary issue of concern revolves around particulates of fecal matter. “One gram of fecal mater can contain 10 million viruses, one million bacteria, 1,000 parasite cysts, and 100 worm eggs” (India Resource Center, 2005). There are two means of disease prevention regarding particulates of fecal matter: interruption of the feces-fluid-food route and interruption of the feces-flies-food route (IRC IWSC, 2005). The first is addressed through behavior changes regarding cleaning the hands and body after defecation and the latter is addressed through defecation location and/or disposal. As such, education campaigns aim at interrupting human interaction with the disease vector for these particulates, particularly regarding hands and flies. In Africa, the UN has incorporated values into their education campaigns, aiming to bring about “positive attitude changes” (UN-HABITAT, 2005). Similarly, a model program instituted by the IRC at Kakuma Camp, Kenya credits latrine installation and hand washing after defecation with a reduction of cases of diarrhea within the camp from 101 to 41 per week (IRC, 2005).

#### *Urban Solutions*

By 2020, 50% of the population in Africa will be in cities, making Africa the most rapidly urbanizing region in the world (World Health Organization, 2000). Rapid population growth has resulted in 40-70% of the urban population in African cities living in slums (Mara and Veron, 2004). Since slums are not built around the typical city grid of streets and blocks that allow for access of utilities and egress of traditional sewer systems, urban sewage systems have become inadequate. Without sewers, people are forced to dump their solid waste on the outskirts of the community or in open drainage channels along dirt roads where it can contaminate surface and groundwater.



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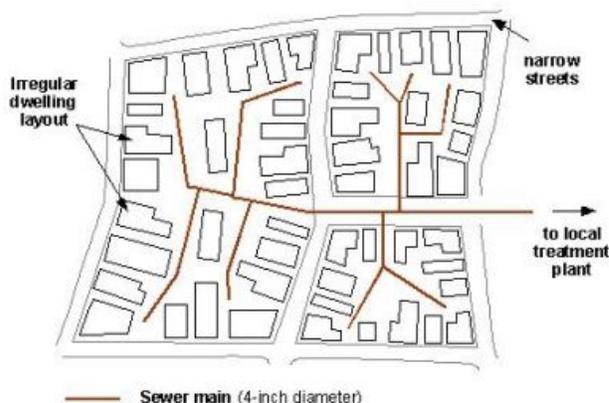
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Shallow sewer systems, which use smaller pipes made of light plastic and are placed at shallow depths allowing communities to install and manage them independently, can be used in slums. The pipe used is small-bore plastic with a diameter of 100 mm minimum (USAID, 2005). The pipe attaches to the main pipeline, which then leads to a treatment plant or to a water stabilization pond. The pipes are placed at a depth adequate for water to flow between connections via gravity. Their plastic composition allows these pipes to be raised or lowered between connections and configured to follow the haphazard layout of a slum area.

Another urban water treatment option is installing and upgrading treatment plants, which use a three-stage layered system to remove contaminants from water. The purpose of primary treatment is to settle out solids and reduce oils, sand, and grit. Secondary treatment focuses on the biological composition of the resulting sewage liquid. This microbial action of biodegradation is the process of converting the organic contaminants into carbon dioxide and water. Tertiary treatment is the final step, in which further elements such as nitrogen, phosphorus, and nutrients from the water are removed to bring the water to required discharge standards. Currently, not all of these three steps are being performed at treatment plants in developing countries. When improving existing facilities or constructing new ones, increased standards would have to be in place to ensure adequate sanitation.

Waste stabilization ponds are the most common form of water treatment in developing countries. The sewer system funnels into two human-made ponds; the first uses anaerobic processes to convert waste to methane. The second, called a facultative pond, is larger and uses aerobic processes to treat waste. The resulting effluent can be used for agricultural processes.

Types of water access points in developing areas are household taps, public and private standpipes, and water vendors. Urban slums have difficulty understanding and paying water tariffs, which makes utility companies leery of installing access. People sometimes resort to illegal pipeline tapping of surface water for their drinking water.



(A) Simplified sewerage approach. Source: World Bank



(B) Secondary sedimentation tank. Source: Wikipedia.



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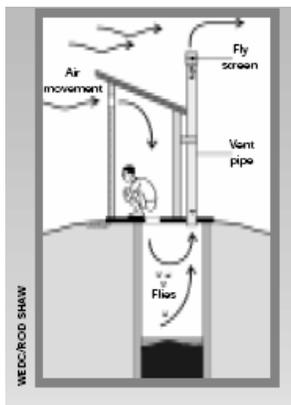
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### *Rural Solutions*

Most rural communities obtain their water from surface water sources such as ponds, rivers, and streams. Due largely to the lack of proper sanitation and waste storage, these sources are highly contaminated and result in the contraction of water-borne diseases. These contaminants can be reduced through using wells and boreholes as water sources. These are dug to reach the water table, where it only takes 2 meters of fine-grained soil to filter out nearly all contaminants. However, it is extremely important to know the hydrogeological conditions where wells and boreholes are to be sited, since contamination can occur if they are placed too close to or in the wrong direction from point sources such as pit latrines or livestock pens. If parameters such as water table level are incorrectly assessed, a dry borehole or well can be dug, resulting in a waste of money and effort.

Pipelines provide a way to bring water from large, uncontaminated sources across both short and long distances to communities lacking clean water sources. However, there are environmental dangers to their construction. Because they are built above ground, their presence can cause habitat fragmentation. Also, water being taken away from the source can cause sinkholes and damage to aquatic biota.

Another important infrastructure development necessary to resolving the problem of sanitation is building latrines. If open-air defecation is near a water supply, it is easy for that source to become contaminated both bacterially and by nitrates, through groundwater flow that carries the contaminants of the feces into the source. Simple pit latrines, which can be merely holes dug in the ground with covers placed on top, are a form of an infiltration system whereby the excreta is absorbed into the soil. Composting latrines can effectively breakdown waste under high temperatures. Fifty litres of feces produced by one individual per year can thereby be reduced to a bucketful, which after undergoing composting can be used safely as a fertilizer. (Farley and Kilbey, 1999). Removal systems, such as the sewage systems previously discussed, are much better options than simple latrines because the waste is actually transported to a central facility where it can be treated. Unfortunately, rural areas may not have the option to employ this type of system due to the impracticality of constructing pipelines through the vast areas rural communities can extend.





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(A) VIP latrine. Source: Water and Sanitation Program

(B) Pipeline in desert. Source: Mono Lake Committee

There are many initiatives that could be funded through the *Safe Water Currency for Peace Act of 2005*. We have simply identified some of the most important ones here. Education is vital to ensuring people in developing countries practice personal cleansing and proper defecation disposal. Urban problems are best addressed by assessing infrastructure and expansion of utilities, particularly to urban slums. Rural challenges can be mitigated by constructing wells, latrines, and pipelines. These are but a few of the issues to address in improving access to clean water and sanitation in developing countries.

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### Scientific Controversies of the Problem and Proposed Solutions

The main controversies behind the science of the Act are misconceptions about the root causes of disease, a need for increased focus in aid for dense urban settlements, the toxic nature of chlorination byproducts, and a western ethnocentric approach to water-based aid.

#### *Biological and Cultural Protectors from Disease*

The intuitive approach to solving the international crisis of individuals burdened by water-borne disease is to address the presence of disease vectors within the water supply. However, whether a water supply is contaminated with microorganisms is actually not the best indicator of disease in a community. Sanitation improvements, for example, are more closely related to improved disease rates than improved water quality (Fewtrell, 2005).

Biological adaptations have protected humans against waterborne disease for all of human history. The immune system's primary line of defense against most waterborne diseases, the intestinal tract, is also among the most affected by malnutrition (Thapar et al, 2004).

Consequently, malnutrition has been identified as the best indicator of whether a human succumbs to disease or provides an adequate immune response (Thapar et al, 2004). The primary household indicators of malnutrition in the developing world are food security, adequate care for mothers and children, and adequate health infrastructure (Smith and Haddad, 2000). Monetary support, then, is better spent on these root causes of malnutrition so that illnesses are more easily survived, than on the more improbable efforts to prevent illness from occurring altogether.

Cultural adaptations are another form of protection against waterborne disease. Scientists in recent years have proven the validity of several important longstanding anecdotal cultural traditions regarding water treatment in developing countries, especially in India. Earlier this year the journal *Science* reported on the discovery that the copper in brass pitchers traditionally used in India for water storage effectively kills harmful bacteria (*Science*, 2005). Similarly, filtering water with cotton cloth, such as that used in *saris*, and then drying that cloth in the sun, has exhibited effective cholera prevention (Powell, 2003). Many protective taboos are already lost



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from cultural diffusion, but these recent discoveries serve to fuel growing momentum among scientists to investigate low-cost, traditional mechanisms for disease reduction (Tjossem, 2005).

### *Urban Aid Scenarios*

Asia and Africa are experiencing unprecedented urbanization. The existing paradigm of aid for rural settings must now shift to accommodate the majority of the world's population that now lives in cities. Aid for the future needs to create models of sustainable development in dense, urban settings with little or no infrastructure for sanitation and access to clean water. An aid plan for densely populated urban areas must consider the unique properties of slums, their poverty, and the transient nature of their inhabitants. Community stakeholders' involvement is difficult to mobilize in a community defined by its transient nature.

### *Chlorination Controversies*

The most common means of disinfecting contaminated water supplies is through the addition of chlorine to water. Policy-level support of the chlorine industry through further chlorine-based infrastructure development in the developing world is controversial because the production of chlorine is harmful to the environment; chlorine, in combination with organic materials, produces byproducts that have demonstrated carcinogenicity in lab animals; and the reintroduction of chlorinated water into the environment has unexamined but theoretically detrimental effects on ecosystems.

### *Culturally Specific Aid*

Historically, models of humanitarian aid have been based on the values of those providing the aid. Increasingly, this trend is changing after follow-up observation revealed high rates of rejection of introduced aid, especially regarding latrines. Considering the high US\$1/week cost of soap for a household, research is needed to develop means of washing hands without soap and water (Pittet, 2005).

The resolution of each of these controversies is unlikely precisely because the nature of this crisis is spread across the entire globe, spanning cultures, countries, and continents. The controversies identified here have largely been addressed in the Millennium Development Goals issued by the United Nations earlier this year in an effort to build consensus and unify international efforts to improving living conditions in the developing world.

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## The Indicators of Success

The Safe Water Act proposes to use private investment to reduce the toll of illness and death associated with water-related disease and sanitation in developing countries. However, in order to ensure effectiveness it is important to establish certain criteria that assess the success of these programs. These criteria should include available measures to monitor water quality and determine whether the monitoring techniques are effective in identifying harmful biological



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pathogens in the water. Ideally, these criteria must be evaluated regularly to ensure the program's overall success.

### *Water Quality*

A key indicator in assessing water quality is whether the water contamination in these regions has improved. Another equally important indicator related to water quality is determining whether mortality and morbidity associated with unsafe water have decreased (CDC, 2005).

### *Water Quality Monitoring Techniques*

In order to assess the effectiveness of a newly implemented water management project or treatment plant, a monitoring system must be able to determine whether a facility is effectively treating pathogens in the water supply. There are specific measuring techniques in place that can monitor water quality. The most commonly used methods are microbial analysis and physical testing. Microbial analyses includes testing for coliforms and enterococci while physical tests include examining pH, residual chlorine, and turbidity (EPA Groundwater, 2005). Microbial analysis is undertaken to determine whether the presence of pathogens are in waterways, using indicator bacteria such as coliforms and enterococci. Though there are many testing mechanisms, which vary regionally and with diseases, the four most all-encompassing microbial and physical analyses for pathogens in water are total coliforms, enterococci, residual chlorine, and turbidity (EPA Groundwater, 2005).

Although most coliforms are harmless to human health, the presence of *Escherichia coli* (*E. coli*), which comprises 90% of coliform bacteria found in the intestines of animals and feces, is an indicator that more harmful pathogens are present in the waterway (EPA Groundwater, 2005). These pathogens can include viruses, protozoa or bacteria that cause diarrhoeal and other water-related diseases such as hepatitis, cholera, shigella and dysentery (CDC, 2005). As per EPA guidelines, the presence of zero mg of *e.coli* per liter of water is ideal (CDC, 2005).

Enterococci are a subgroup of fecal streptococci, which are bacteria primarily found in the gut of warm-blooded animals. They are unrelated to coliform bacteria, but have the ability to survive in salt water and closely mimic survival of pathogens in waterways. The presence of this microorganism in water is an indication of fecal contamination and the possible presence of harmful pathogens (CDC, 2005). According to EPA guidelines, allowable levels of enterococci bacteria in waterways is zero mg per liter of water (EPA Groundwater, 2005).

With advanced water treatment systems, chlorine is used to disinfect drinking water by killing off all of the pathogens and then leaving a small amount of active chlorine in the water. This remaining chlorine is called the residual chlorine, which can further disinfect unclean water once it has been collected.

Turbidity is a measure of the cloudiness of water. It is used to indicate water quality and filtration effectiveness. Higher turbidity levels are often associated with higher levels of disease-causing microorganisms such as viruses, parasites, and some bacteria in the water. These organisms can cause symptoms such as nausea, cramps, diarrhea, and associated headaches. Turbidity also adversely affects the efficiency of disinfection (EPA Groundwater, 2005).



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Though microbial analysis and physical testing are useful in assessing whether or not water is safe to drink, they are not perfect. We cannot really know that water is safe until we see that people are not getting sick from drinking the water in a particular location (WHO, 2005). Of course, this is difficult to quantitatively measure. Therefore, more qualitative indexes such as the Disability Adjusted Life Years (DALY) are effective tools that measure the combined effects of “illness, disability, and mortality on population health,” for various risk factors present in a community (WHO Regional Office For Europe, 2005). The importance of this tool is that it measures both the burden of disease and the efficiency of health policies and interventions.

### *Sanitation and Access*

The primary social indicator used to determine if the Act is successful in improving access is a guideline established by the World Health Organization. This guideline defines physical access to a water source as 200 meters or less from a household while defining sanitation as 20 liters of water per individual per day (WHO, 2003).

### *Access and Sanitation Monitoring Techniques*

Use of assessment questionnaires is most effective in assessing improvements in access and sanitation. The assessment questionnaire defines access to water supply and sanitation in terms of the types of technology and levels of service that are afforded. For water, this includes public standpipes, house connections, boreholes, protected dug wells protected springs and rainwater collection. Sanitation is defined to include connection to a sewer or septic tank system, simple pit, pour-flush latrine or ventilated pit latrine.

In completing the survey, data are collected a survey of a random sample of households. The survey should be carried out at the time of year when the water quantity is lowest or most sources have run dry. The surveyor should visit each house or compound and verify access to water supply as defined above. In some cases, the distance to the water supply may actually have to be measured to be sure it is within the 200 meters.

Access to water sources are additionally qualified through measuring the permanent skeletal damage caused to women from carrying heavy loads of water over long distances day after day (EPA Groundwater, 2005).

The Core Welfare Indicators Questionnaire (CWIQ) Survey looks at the provision of services in Water, Sanitation and the Environment. The survey’s findings provides indicators of living standards for the households and household members, including such areas as land assets, home ownership, type of home construction, fuel for cooking, ownership of selected household goods, literacy levels, employment, health and nutrition.

The primary limitation associated with the more qualitative measurement techniques of access and sanitation is that data collection is reliant on participant cooperation and compilation is a very lengthy and expensive process.



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### *Measuring Success*

As discussed earlier, there are many techniques in place to measure water quality, access and sanitation that have already been established by the US Environmental Protection Agency and the World Health Organization. The effectiveness of these techniques is highly dependent on behavioral changes among citizens of developing countries. Therefore, educational programs must accompany the implementation of these water projects. It is also important that the newly implemented programs do not introduce new problems, such as chemical contamination of waterways associated with new infrastructure development.

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## Conclusion

The lack of access to clean water and basic sanitation is the cause of widespread disease and high morbidity rates in Africa and Asia. The *Safe Water Currency for Peace Act of 2005* seeks to address these issues as an extension of the Foreign Assistance Act of 1961. The Act proposes that sanitation infrastructure and access points to clean water be expanded and that hygiene practices be improved. It proposes to fund these initiatives through private investment that will ensure the sustainability of the proposed solutions by offering investment insurance of up to 75 percent on private investments.

Unclean water causes disease in three ways: water-borne, water-washed, and water-based. Of these, diarrhoeal disease is the largest contributor to morbidity in developing countries. Trachoma, intestinal helminthes infections, and Schistosomiasis also are contracted through unclean water. Of primary importance to addressing this problem is personal hygiene. Washing your hands or using toilet paper can reduce the incidence of disease by 45 percent. Thus, education initiatives must be part of the solution.

The Act also proposes infrastructure improvements to address sanitation and access deficiencies. The solutions are different for rural and urban centers. In rural settings, wells, boreholes, or pipelines can be used to improve access to clean water. Latrines can be installed to ensure proper feces disposal and develop sanitation. In urban areas, some infrastructure is already in place. However, the nature of urbanization has created densely populated slums with no sanitation. Shallow sewer systems have flexible pipes that can follow the ungridded nature of slums to provide sanitation. Additionally, waste stabilization ponds can be built and managed by the community to process waste.

In order to know whether or not the Act is successful, monitoring programs must be in place to evaluate the progress of the Act in improving access to safe water and reducing water-related diseases. Many such measurements already exist: water quality can be monitored through measuring levels of micro-organisms present in the water, access and sanitation can be assessed through questionnaires, and indexes exist to determine a community's level of mortality and morbidity. It will be important for a program to develop standards for improvement in each of these areas.



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Although the issues concerning unclean drinking water are generally recognized as a problem by the international community, controversies exist in the Act concerning its implementation. One of these concerns is the Act's focus on infrastructure development even though improving hygiene education has been shown to best mitigate disease. Additionally, the solutions are based on western models of aid and may not be culturally acceptable to communities in developing countries. Lastly, the Act's focus on rural solutions ignores the fact that Africa and Asia are two of the most rapidly urbanizing continents in the world, and thus more focus needs to be placed on solutions in urban settings.

The *Safe Water Currency for Peace Act of 2005* provides a starting point to address the enormously complex issues surrounding unsafe water and the lack of sanitation in developing countries in Africa and Asia. Studying the science behind this problem has allowed for identification of the major causes of water-related diseases and unsafe water and development of solutions to these problems. While the Act does have some controversy surrounding implementation of these solutions, it is an important primary step to aiding the people of developing nations.



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