Water Conservation in Windhoek Schools

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Water Conservation in Windhoek Schools

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ABSTRACT

The goal of this project was to provide the Windhoek, Namibia Department of Infrastructure, Water and Technical Services with a set of recommendations that would help to reduce water consumption within the City's schools. Through our research we found the following sources of inefficiency: faulty infrastructure, vandalism, insufficient maintenance, inefficient use, and lack of water awareness and conservation education. Our recommendations include infrastructure improvements, maintenance expansion, vandalism prevention methods, water saving devices, and educational programs for both learners and administrators.

AUTHORSHIP PAGE

Richard Gilley, Rebekah Sullivan, Scott Tang and Amanda Tarbet all contributed equally to this project. Amanda and Scott focused on education and awareness, as well as vandalism prevention. Rebekah and Richard focused on the technical side of infrastructure and repairs. The editing and revising of each chapter received equal attention from each team member, but specific sections were drafted by the member who held that area of expertise.

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EXECUTIVE SUMMARY

Namibia's high water distribution costs and history of droughts have encouraged the capital city of Windhoek to develop and maintain supplementary water sources such as its aquifer. Wasteful use of water within the city depletes the aquifer, thus impacting the availability of water in the future. As a result, water conservation and reuse have become important components of the City's management strategy to ensure that there will continue to be a sufficient water supply for its future development.

Many secondary schools in Windhoek have been unable to maintain suitable levels of water usage and some were informed in August 2004 that they would need to reduce their consumption. The Department of Infrastructure, Water and Technical services conducted a study that identified four schools in Windhoek as excessive consumers of water. These four schools- Windhoek High School (WHS), High Technical School (HTS), Centaurus, and Anna Shipena- will be referred to as our **Reference schools**. Each school made repairs to its infrastructure and was able to reduce its monthly water consumption (Brinkman, 2005). These results suggested that other schools could benefit from similar assessments.

The goal of this project was to work with the Department to develop a set of recommendations that, once implemented, would help to reduce water consumption in Windhoek secondary schools. To accomplish this, we completed four major objectives:

1. Assessed the changes and repairs previously made in four Reference schools.
2. Identified inefficient or wasteful uses of water in four **Focus schools**: Augustineum, Concordia College, HTS and Anna Shipena.
3. Assessed the role of water conservation education in the established curriculum.
4. Developed potential recommendations and determined their feasibility.

We chose our Focus schools based on water consumption data and suggestions made by the Department. Augustineum's average daily consumption was the highest with 224 liters per capita per day (Lpcd). HTS was second with 125 Lpcd, followed by 67 Lpcd at Concordia. Data was unavailable for Anna Shipena due to a broken meter. Of the two remaining references schools, WHS had the lowest consumption with 37 Lpcd and Centaurus was the second lowest with 43 Lpcd.

When visiting the schools, we were accompanied by a city inspector which gave us uninhibited access to the bathroom and kitchen areas of the school buildings and hostels. Our infrastructure observations were completed in those locations. Interviews with school administrators provided insight into how the Reference schools reduced their water consumption and the types of challenges that the Focus schools face for improving water efficiency. The interviews, as well as surveys distributed to learners, were intended to help us determine the potential for water conservation education in the schools.

Our research identified six factors that contribute to water inefficiency, including special cases of major wastage, faulty infrastructure, insufficient maintenance, vandalism, an absence of water saving devices and a lack of water conservation awareness and education. For each factor below, we present several recommended solutions.

Major sources of water wastage were present in two of the schools. At Augustineum, a leaking boiler and pipes that have been left unrepaired for months are contributing to an unreasonably high consumption of 224 Lpcd. For types of major faulty infrastructure observed in Augustineum or any other school, we recommend that:

- **The Ministry of Works address major infrastructure problems immediately:** In Fourie's study conducted in 2004, the night flow at Augustineum was around 14 kL/hour. If these levels of wastage persisted, as consumption data has suggested, the amount of water wasted will have cost the school 1000 kL of water and N$93,000 per month. If the MoW cannot complete the repairs, we advise the Department to make the repairs and bill the schools.

We speculate that the high consumption at HTS is due to the fact that they do not use semi-purified water for landscaping. In instances like this we recommend that:

- **Schools investigate the possibility of using semi-purified water:** Semi-purified water is roughly 1/10th the cost of fully purified water. Currently, HTS is using an average of 125 Lpcd. If the school switched to a semi-purified supply, this high consumption of potable water could be greatly reduced.

Aside from these instances of major wastage, **Infrastructure** in need of improvement or repairs proved to be the main cause of wasteful use of water in the Focus schools. Showerheads in the hostels were the most common, with 52% found to be either missing or broken. In the Focus schools, 16% of taps and 19% of toilets were leaking. If not repaired, we estimate that

this faulty infrastructure will waste 1483 kL of water and cost N$14,400 annually per school. We recommend that:

- **The schools themselves, the MoW, or the Department fix all instances of faulty infrastructure.** The savings from making these repairs will begin to exceed the investment after approximately 9 days for taps, 85 days for toilets and 33 days for showerheads.

Water saving devices (WSDs) were a rare occurrence in the Focus schools and could be installed to increase water efficiency. We recommend that:

- **Schools install water saving devices.** The most cost effective WSD is a toilet tank displacement device, such as bricks or rocks which are available at low or no cost. Over the course of a year, a total amount of approximately N$1200 and 137 kL of water could potentially be saved per school by using a displacement device. Other low cost devices or methods include showerhead flow restrictors, faucet aerators and sink pressure reduction. Low-flow showerheads are more expensive, but an investment of N$13,500 will save approximately N$33,000 and 3500 kL of water annually per school.

To complete any infrastructure repairs or improvements, there is a need for free or inexpensive labor. However, the presence of faulty infrastructure suggests that maintenance personnel might not have the knowledge, skills or tools to fix the problems. Furthermore, several school administrators explained to us that the Ministry of Works is often slow to respond or sends personnel that make unsatisfactory repairs. In order to improve the quality of **maintenance** in the schools, we recommend that:

- **The schools form a partnership with the Windhoek Vocational Training Centre (VTC).** Apprentices at the VTC can make repairs or install WSDs as part of their training while educating current maintenance workers. The labor required would be completed at no cost and tools would be provided by the VTC apprentices. Schools can purchase inexpensive tool kits so that future repairs can be made.

It is unlikely that the savings from infrastructure repairs or improvements will be sustained unless some of the underlying causes of the faulty infrastructure are eliminated. In additions to insufficient maintenance, **vandalism** by learners is another known cause of faulty infrastructure. We estimate that preventing vandalism can potentially save each school N$1700

per year in maintenance costs, approximately N$14,500 in annual water costs and any additional costs from repeated acts of vandalism. We recommend that:

- **Schools implement measures to prevent vandalism.** There are several types of measures available from which schools can choose, and each school will have to decide which measures they would like to implement.
    - **Opportunity reduction measures include:** Limiting the hours that school bathrooms are open, locking the bathrooms when supervision is unavailable, having learners or teachers monitor bathroom use and encouraging or requiring learner participation in extramural activities. For Concordia, a school with single block bathrooms, we recommend hiring two bathroom monitors to supervise use. We also recommend that the City construct single block bathrooms in future schools.
    - **School policy reform measures include:** Notifying parents of and requiring them to pay for acts of vandalism committed by their children. Also, schools can reward good behavior.
    - **Learner involvement measures include:** Implementing learner maintenance projects which can provide learners with a practical education and possibly a sense of ownership and pride for their school.

Water Conservation Awareness and Education could be expanded to help administrators and learners more actively reduce their consumption. For instance, learners from rural areas do not always know how to use bathroom facilities or understand the importance of conserving water. At HTS and WHS, such learners have been successfully educated to adapt to their new environment. Based on this evidence, we recommend that:

- **Schools provide incoming 8th graders with hygiene education.** Such a program could be provided at a low cost and will impact both maintenance and vandalism.

Some administrators did not know the location of school water meters or how to read them, or receive a copy of their schools' monthly water bill. We recommend that:

- **Administrators participate in programs to increase their water awareness.** A Department inspector could visit the schools, show administrators the location of the meter and teach them how to read it. The Ministry of Finance can distribute copies of the monthly water bills to administrators.

Of the learners we surveyed, 76% knew that Windhoek gets its water supply from dams and 28% were able to describe the reclamation process. These findings suggest that learners possess a basic level of water awareness, but could benefit from further conservation education. Administrators gave the most support for educational initiatives that did not affect the formal curriculum and were of low cost and short duration. Therefore, we recommend that:

- **Learners participate in water conservation education programs.** Our highest priority recommendation is for an annual Awareness Day, which received support from administrators. Such an event would have to be organized by the Department and the Ministry of Education. We also recommend that the Department publish a newsletter to distribute to secondary learners as a way to study local water conditions.

There is no known incentive for administrators to attempt to reduce water use in their schools. The development of one would provide the momentum for our previous recommendations to be implemented. Finally, we recommend that:

- **The Ministries of Education, Finance, and Works, in conjunction with the Department, cooperate to develop an incentive for administrators to reduce their schools' water consumption.** We suggest allowing a portion of money saved from water use reduction to be given back to the schools to fund other educational initiatives.

Once implemented, these recommendations are intended to reduce the water consumption in our Focus schools, as well as to save significant amounts of money. We estimate that 6,128 kL of water and N$140,500 can potentially be saved annually for all four of our Focus schools combined by repairing the infrastructure, installing water saving devices and maintaining the repairs and improvements that are made. The options we have described also have the added benefit of working to improve the overall conditions in the schools through increased maintenance and vandalism prevention. The educational initiatives also provide schools with the opportunity to foster water awareness in future generations. Schools have the opportunity and capability to significantly reduce their consumption, as well as to foster life long water awareness, but the success of such initiatives will depend on the involvement and cooperation of city leaders, school administrators and, perhaps most importantly, Windhoek's learners.

GLOSSARY AND ABBREVIATIONS

Acre Feet - the amount of water required to cover one acre of ground to a depth of one foot.

AF – *see Acre Feet.*

Aquifer – Source of Underground water.

Borehole – A hole drilled into the earth's surface for access to groundwater.

Department – *see Department of Infrastructure, Water and Technical Services.*

Department of Infrastructure, Water and Technical Services – A branch of the municipality that is in charge of treating all water that is distributed to Windhoek residents, both by NamWater and the city's alternate water supplies.

Department of Water Affairs – This department is within the Ministry of Agriculture, Water, and Rural Development, and is responsible for water resource development projects.

DWA – *see Department of Water Affiars.*

Ephemeral River – Flows for a brief period of time depending on rainfall and season.

Faucet Aerator – Mixes air and water at the end of the spout to reduce the overall flow and save water.

Faulty Infrastructure – Plumbing and/or fixtures that is in disrepair, therefore contributing to water inefficiency.

Focus Schools – The four schools that we chose to study. They were chosen based on past consumption data and recommendations from the department.

Liters per Capita per Day - average amount of water use per person per day.

Lpcd –*see Liters per Capita per Day.*

Flow Restrictors – A device that reduces the overall amount of water being used by limiting the area in which it can flow.

Gammas Water Care Works – Facility where raw sewage is treated to become semi-purified water.

Goreangab Reclamation Plant – Windhoek's water reclamation facility that treats the semi-purified water from Gammas Water Care Works to fully purified water.

Groundwater – Water that is beneath the surface in the aquifer and one of Windhoek's primary sources as well as a backup source.

Infrastructure - The basic facilities, services, and installations that are needed for a city or community to function. In our case we will be looking at the water infrastructure (pipes, plumbing systems, etc).

Learner- In the Namibian public school system, a student is referred to as a Learner.

Low-Flush Toilet – Usually use 6 liters of water per flush, much lower than a conventional toilet.

Low-Flow Showerhead – Restricts the water flow through smaller holes and mixes the water with air so it feels as if the same amount of water is coming out. Typical flow rate is 9.46 l/min. They also come with shut off valves to close when soaping.

Manual Recharge – A process in which un-used water is pumped back into the aquifer for use in the future.

Matrons – Women in charge of supervision, cleaning, and cooking for learners housed within the hostels.

Ministry of Education - Government branch that manages education within the city of Windhoek.

Ministry of Environment and Tourism – They are responsible for protecting Namibia's environmental resources and conserving biological diversity today and in the future.

Ministry of Finance – Government branch that manages the city of Windhoek's finances.

MoW – *See Department of Works.*

Ministry of Works – Government branch that is responsible for repairs or maintenance to any public facilities.

NamWater – The Namibian Water Corporation Ltd. is a company owned and operated by the central government of Namibia which is responsible for supplying water in bulk to communities.

Opportunity Reduction – An approach to preventing vandalism that limits the possibility for learners to vandalize school property

Perennial River – One that flows for an indefinite amount of time.

Point-of-use Reduction – Implementing fixtures that reduce the amount of water used to accomplish a certain task.

Potable Water – Water that is drinkable.

Prefect – A learner who has been recognized as responsible and therefore takes on extra duties within his/her school.

Reclamation Facility – A plant where water that was once considered unfit to drink is made potable. The city of Windhoek is the only place where direct reclamation is practiced.

Reference Schools - Four schools that were previously studied for water consumption by the Department of Infrastructure, Water, and Technical Services.

Semi-Purified Water – Water that can be used for landscaping or uses other than drinking. This water is treated at Gammas Water Care Works and then released to the public for use.

U.S. Energy Policy Act – An attempt to combat the growing energy problem, provides tax cuts and various other incentives for energy saving devices.

VTC – *See Windhoek Vocational Training Center.*

Water Conservation – A reduction of water use. Ways of conservation can include improving current infrastructure and educational programs.

Water Demand Management – It is a management plan that uses economic incentives to accomplish better water saving practices and awareness amongst people and companies.

Water Use Efficiency – Using fewer units of water for any activity that requires water use.

Water Awareness – Acknowledging the sources, uses, and the need for conservation of water.

Water Saving Device – A device that reduces the amount of water normally needed for a given activity.

WSD – *see Water Saving Device.*

Windhoek Vocational Training Center – An institution where people are trained in a variety of trades.

CHAPTER 1: INTRODUCTION

In Namibia, the driest sub-Saharan country, water is a scarce resource. The nation's high water distribution costs and history of droughts have encouraged the capital city of Windhoek to develop and maintain other water sources, such as its aquifer. The aquifer acts as a supplementary source to the dams, but Windhoek primarily relies on it as an "insurance policy" in times of drought. Water conservation, reuse and manual recharge of the aquifer have all become important components of the City's management strategy in order to ensure that there will continue to be a sufficient water supply for its development. Wasteful use of water within the city depletes the aquifer, but it can be manually recharged with water that is not used. Any reduction in the city's overall consumption can lead to greater and faster recharge of the aquifer. Institutions that have been identified as large consumers can play a vital role in reducing the city's consumption by reducing their own.

Many secondary schools in Windhoek have had problems maintaining suitable levels of water usage and, in the summer of 2004, were informed by the Department of Infrastructure, Water and Technical Services that they would need to reduce their consumption. Still, several schools did not reduce their consumption and could not pay their water bills. As a result, the Department shut off the water in an effort to encourage less use. This solution disrupted the learning environment and consequently damaged the relationship between the affected schools and the Department. In response to this, the Waste Water and Bulk Water Division conducted a study that identified four schools in Windhoek as excessive consumers of water. Following recommendations provided by the division, each school had repairs made to its infrastructure and was able to reduce its monthly water consumption by an average of 25% over a period of three months (Brinkman, 2005). These results suggested that other schools could benefit from similar assessments and recommendations.

In addition to reducing water waste, Windhoek schools have the opportunity to encourage water conservation in future generations. As centers of education, schools are a place to foster water awareness. The success of educational programs in similarly arid areas of the world indicates that Windhoek learners could also benefit from learning conservation principles and practices in the classroom. Furthermore, it might be possible for schools that remain under budget to gain access to the additional funds as an incentive to save water.

The goal of this project was to work with the Windhoek Department of Infrastructure, Water and Technical Services to provide it with recommendations that would increase water efficiency and, in turn, reduce water consumption in Windhoek schools. In order to accomplish this goal, we assessed previous infrastructure improvements, identified inefficient or wasteful use of water in the schools, assessed of the role of water conservation in the established curriculum, and analyzed our data in order to develop our recommendations and determine their feasibility. Once implemented, our recommendations are intended to increase water efficiency within schools and thus create an overall reduction in water usage per capita. This will then allow the Department to distribute available water sources elsewhere, as well as to promote better conditions within the schools.

CHAPTER 2: BACKGROUND

This chapter presents the water sources and management in Windhoek in order to explain why schools have been targeted as an opportunity for water savings. We then present methods of evaluating and improving water efficiency in various settings, including schools, in keeping with the City's water management strategy. An analysis of educational conservation programs will familiarize the reader with the potential for water awareness in schools. Lastly, the past and present school systems of Windhoek will be considered in order to provide a basis for understanding the challenges schools may face in improving their water efficiency.

Water Distribution System

Water sources are available for distribution throughout all of Namibia, but high costs and drought preparation have encouraged municipalities such as Windhoek to develop supplementary sources. The distribution of these sources is managed by three main institutions-- NamWater, The Department of Water affairs, and the local water authority-- each of which plays a different and crucial role in supervising, supplying and maintaining water use. A management strategy for distribution within the City, consisting of pricing and maintenance policies, has been implemented in order to secure a sufficient water supply for its continued development.

Water Sources in Namibia and Windhoek

The main sources of water for Namibia are dams on ephemeral rivers, groundwater, and perennial rivers. The combination of these sources provides Namibia with the water needed to meet the basic demands of consumers (Fourie, 2004). Figure 1 shows country wide water source consumption.

The northern and southern borders of Namibia are perennial rivers. A perennial river is one that flows continuously for an indefinite amount of time. The southern border is marked by the Orange River and the northwestern border by the Kunene River. The central north and northeast are marked by the Okavango, Zambesi, and Kwando Rivers. The perennial rivers are

shared by Namibia and its bordering countries (Fourie, 2004). They are the main source of Namibia's surface water, but do not run very close to Windhoek. As a result, Windhoek must rely on other sources to ensure a continuing water supply.

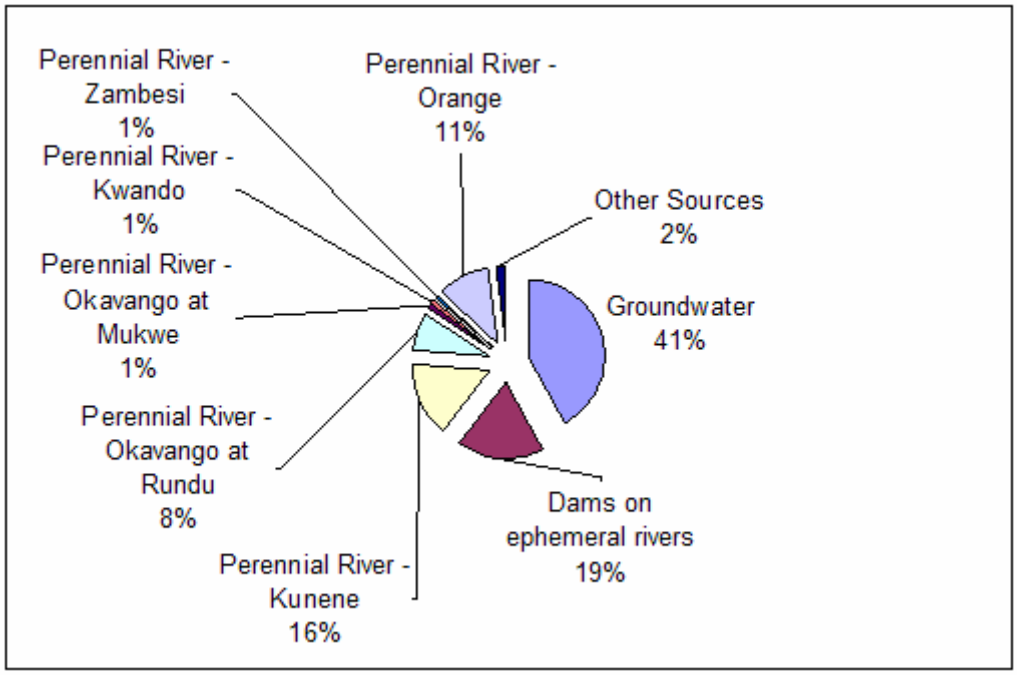

Figure 1 - Yearly Water Consumption in Windhoek by Source (Namibian Resource Consultants)

The three sources of water for Windhoek are ephemeral rivers, groundwater, and reclaimed waste water. NamWater oversees a three dam system which harvests its water from the ephemeral rivers that provide water to all areas in Namibia. The dams are the Von Bach Dam, Swakoppoort Dam, and the Omatako Dam (FAO, 2005). Ephemeral rivers flow for a brief period of time and are primarily fed by rainwater. It is estimated that 1% to 12.5% of the mean annual rainfall ends up in these ephemeral rivers while the rest evaporates. These rivers are effluent, which means they feed the groundwater table rather than being fed by the groundwater (Fourie, 2004). This water source is not very reliable due to the sporadic and unpredictable rainfall in Namibia. However, it is still a main source for Windhoek due to lack of other sources. Therefore city officials wish for it to be used wisely and conserved in case of drought.

Groundwater sources are also available in Windhoek and are accessed through boreholes drilled in the earth (Fourie, 2004). A station from which borehole water is pumped can be seen in Figure 2.

Figure 2 -Borehole Station in Windhoek

However, water from these boreholes is primarily used as an "insurance policy." Windhoek may rely on the aquifer accessed through the boreholes in times of low rainfall, but usually there is still water available in the reservoirs (Brinkman, 2006).

The aquifer is recharged through a combination of natural rainfall and manual recharge. The mean rainfall for Namibia is only 285 mm/year and the evaporation rate can be as high as 83% (FAO, 2005). Hydrological studies conducted in Namibia during the past decade have found that a long-term mean rainfall of 550 mm/year will only result in a recharge rate of the groundwater by 9 mm/year in some locations. Other locations can see as low as 1 mm/year

recharge from the same rainfall (Beekman, *et al*., 2003). The limited natural recharge makes manual recharge an important priority.

Manual recharge of the aquifer happens at specific sites in and around Windhoek. Potable water that isn't consumed within the city is used for this purpose. Unlike the stations that draw water up from the boreholes, the pumps work in reverse, pumping excess water back down into the aquifer. Before being pumped into the aquifer, the water is passed through a bed of granulated activated carbon and a small amount of chlorine is added to ensure that the water is completely clean. This is done even though the water is already of drinking quality. Recharge takes place only with water that is completely clean because pumping in untreated water can lead to contamination.

Reclaimed water is important to Windhoek, not only does it help to recharge the aquifer but it also provides a portion of the city's drinking water. The City has been practicing water reclamation since 1968 and is the only city in the world where direct reclamation takes place. Untreated water enters Gammams Water Care Works, the initial step to the cleaning process. There, raw sewerage is treated to become semi-purified water, still unsuitable for human consumption. It is then sent into retention ponds for four days to settle. After leaving the ponds, some of the water enters the Goreangab Plant where the semi-purified water is treated further to a highly purified state. This highly purified water is of a high enough quality for human consumption. Water that does not enter the Goreangab Plant is used as a semi-purified source for landscaping and irrigation (Esterhuizen, 2006).

The potable water within Windhoek is supplied through mixing stations scattered throughout the city which combine water provided by NamWater, reclaimed water, and water from the boreholes. The majority is provided by NamWater and the maximum amount of reclaimed water allowed in the drinking supply is 34 % (Brinkman, 2006). Reducing the consumption of these sources allows for the excess to be manually recharged into the aquifer and provides the City with the security of a water supply that will sustain it throughout its growth and in possible circumstances of drought.

Water Management in Namibia and Windhoek

The national government institution involved in water management is the Department of Water Affairs (DWA). The main priorities of this department, a component of the Ministry of Agriculture, Water and Rural Development, are to enforce national water policies at the local level and to distribute water to rural communities throughout Namibia. NamWater, the Namibian Water Corporation Ltd., is a company owned and established by the central government. Since it was formed, it has held the position of a national monopoly on water supply (Water Privatization, 2004). NamWater is responsible for bulk water supply to the local authorities and other consumers who have a need for large quantities of water (Van Der Merwe, 1998). According to the NamWater Act of 1997, water distributed by the company is to be of suitable quality and sold at an affordable price to consumers. Furthermore, it must manage the water sources in a sustainable manner (Ministry of Agriculture, Water and Forestry, 2000). Local authorities are then responsible for the water's distribution and billing in their respective areas once they have received their supply from NamWater.

The Department of Infrastructure, Water and Technical Services, Windhoek's local authority in the distribution system, provides water billing services for the City. It collects money from the consumers to cover the water and distribution costs. Payments are based on a rising block tariff system consisting of three blocks. The first block, for small amounts of use, was implemented to make water affordable to all people. Money collected from the second block, the next highest price, funds cost recovery. The highest price is a punitive block meant to encourage people to conserve (Brinkman, 2006). Ultimately, this allows small water consumers to pay less per kilo-liter of water than the larger consumer (IUCN, The World Conservation Union, 2003).

In this system, the city's public schools do not pay the Department directly for their water. Instead, each school sends an annual budget to the Ministry of Education which includes the planned cost of water. A monthly bill for water use is sent to the Ministry of Finance. If the water bills exceed a school's predetermined budget, then the Ministry will not pay and the Department of Infrastructure, Water and Technical Services. This can sometimes lead to the Department shutting off the water supply to the school in order to encourage a reduction in consumption (Esterhuizen, 2006). This suggests that if a school were to remain under budget for

its water use, the excess finances could possibly be directed to fund other needs of the school as an incentive to conserve.

In addition to managing the water supply, Windhoek also takes a very active role in managing and maintaining its water distribution infrastructure. During the 2003/04 fiscal year, the City allocated N$15 million to fund the drilling of new boreholes, as well as to maintain other sources. This was done to secure an adequate water supply for the increasing needs and population of the city (City of Windhoek, 2004). Plans were also put in place to educate the public on water conservation, and policies were implemented to lower consumption. Water audits are being done on a regular basis and a leakage detection program is in progress (Santcross *et al*., 2001). These initiatives are the results of the City's policy to improve water efficiency, an effective way to ensure a sufficient supply of water for the future.

Evaluating and Improving Water Efficiency

In the city of Windhoek, water conservation is an important part of the water management strategy, and improving water efficiency can help the city achieve their usage goals. This section describes in detail ways of evaluating water efficiency and methods for its improvement through water saving devices and educational programs.

Evaluating Water Efficiency

Improving efficiency requires behavioral and technological adjustments which focus on reuse, recycling and point-of-use reduction (Gleick *et al*., 2003). For purposes of this chapter, the focus is on behavioral adjustments and point-of-use reduction.

The United States Environmental Protection Agency provides guidelines for improving the water efficiency of a water system. In these guidelines identifying the source of inefficiency is emphasized including checking meters for accuracy and calibration to eliminate "imagined" water waste. Possible sources of water waste depend on the size and purpose of a water system. Residential areas, for instance, will use water in different ways and amounts than commercial and industrial areas (US EPA, 1998). Furthermore, water use is heavily influenced by cost. One study suggested that when prices are high, people will pay more attention to their water use

(Tate, 1994). Likewise, another study concluded that those of a more affluent economic status who can afford to use water tend to waste more (Vickers, 2001).

Data available for North America can provide insight on sources of water consumption that may be common to homes across the globe. According to Vickers, the average non-conserving household in North America uses about 260 liters per capita per day (Lpcd), while the average conscientiously conserving household uses closer to 170 Lpcd. In comparison, a study conducted in Windhoek in 2004 determined that the average household water consumption ranged from 20 to 180 Lpcd (Fourie, 2004).

Plumbing fixtures as well as behaviors can both be sources of inefficient water use. In general, the greatest opportunity for increased water efficiency is associated with toilets. Our research has shown that non-conserving toilets use 70 Lpcd, while conserving toilets use only 31 Lpcd (Vickers, 2001). This suggests that excess water use can be caused by older or less efficient plumbing fixtures. Water waste in homes may also be occurring through wasteful personal habits, excessive outdoor water use, and leaky fixtures (Vickers, 2001). For instance, a single dripping faucet can waste as much as 380 liters of water a week (NCDENR, 2002). In a state-wide report on the potential for water conservation in California, researchers estimated that simply replacing inefficient water fixtures and repairing leaks could reduce residential consumption by 40% per year. More specifically, replacing inefficient toilets with low-flush models would comprise 57% of those savings (Gleick *et al*., 2003). Furthermore, simple behaviors such as leaving the faucet running while brushing one's teeth or running the dishwasher when it's only half full can waste many liters (MWRA). Lastly, there is outdoor consumption. In the United States, outdoor water consumption can comprise up to 59% of a household's total water consumption. The same trend of large amounts of water being consumed due to outdoor use was identified by Fourie during a study conducted in Windhoek (Fourie, 2004).

Aside from residential use, water is also used in industry, commercial business, and other institutions. Schools are one type of facility in this category. This category tends to be one of largest water consumers (Gleick *et al*., 2003). Gleick's research has shown that office buildings in California were the greatest users of water in America with 339,000 acre feet (AF) per year, with schools coming in second with 251,000 AF per year. In both cases, landscaping was determined to be the main source of water use at 38%, with kitchens acting as one of the smallest

sources at only 6% of the total. Furthermore, toilets were found to be the source of 72% of water use within the schools' restrooms (Gleick *et al*., 2003). Water use is diverse among North American schools, as in other regions of the world, due to differences in facilities, such as the age of heating systems or the presence of swimming pools. Nevertheless, most institutional water waste is caused by outdated and inefficient cooling and/or heating systems, landscaping, and restroom use.

A study conducted within schools in Mesa, Arizona showed that utilities are the second most expensive aspect of schools after salaries. The research discussed thus far suggests that schools have the opportunity to save water by updating their facilities, which in turn will help to save money. According to Peterson, even simple adjustments can save schools in areas of limited resources thousands of US$ per year (Peterson, 2004).

Improving Water Efficiency

Water saving devices such as displacement mechanisms, low-flow shower heads, and faucet aerators are effective in reducing water consumption in schools as well as accomplishing significant savings. With water saving devices in place, the usage in households can be decreased by 30% (Vickers, 2001). The cost of water saving devices is minimal compared to the long term savings, and devices usually pay for themselves in 4-6 months (Hairston, 1995). Many municipalities offer these devices for free to residents, such as in the Contra Costra water district in California (www.ccwater.com, 2006) or in Clearwater, Florida (www.clearwater-fl.com, 2004).

By using a low-flow toilet alone, a family of four can save up to 95 liters of water a day (www.healthgoods.com, 2004). Aside from buying a replacement toilet, which can be quite expensive, there are other methods of decreasing the amount of water consumed when flushing. It is possible to displace water in the tank of an existing toilet by placing a rock, a brick, filled bottle, or a dam made specifically for toilets inside the tank. Using a rock as a displacement device can be seen in Figure 3. However, when using a brick as a displacement device, it is important to first wrap it in plastic to keep the brick from disintegrating in the tank water (www.bae.ncsu.edu, 1996). There are also products specifically made to reduce water used in toilets. A dam can be purchased for N$30 and easily installed (www.healthgoods.com, 2004).

Figure 3 – Water Displacement with Rocks

Another way to save water in terms of toilet use is to check the device for constant running. This can be easily accomplished by putting a few drops of food coloring into the tank and watching to see if the color seeps into the bowl (www.healthgoods.com, 2004).

Research has shown that, after the toilet, the shower uses the second most water in an average household. Using a low-flow showerhead can decrease the amount of water used from 19-38 liters/min down to 9.5 liters/min. It can also decrease the amount of hot water used, which has the additional benefit of decreasing the energy used to heat it (www.clearwater-fl.com, 2004).

Aside from toilets and showers, sinks can also be a source of water inefficiency. An effective way to cut down on water usage and wastage in sinks is by installing faucet aerators. An aerator works by combining air with the water coming out of the faucet and decreasing the overall water flow to as little as 5 liters/min. Aerators are affordable and easy to install (www.bae.ncsu.edu, 1996). In addition to aerators it is possible to install self closing taps, as seen in Figure 4.

Figure 4 - Self -Closing Taps

These self-closing taps work by slowly closing after the tap has been turned on. These can save up to 50% of water consumed while washing hands, but they need to be carefully maintained and inspected on a regular basis because they can sometimes fail in the open position (Department of Educations and Employment, 1993).

One thing to consider, even after water saving devices have been installed, is the existence of any leaks in pipes. Leaking pipes can be a major source of water wastage (www.healthgoods.com, 2004). For example, in 2004, Augustineum High School in Windhoek was monitored at night to determine the extent of avoidable water loss. The school was found to have a median night flow of roughly 14000 liters/hour (Fourie, 2004). This shows that faulty infrastructure, such as leaky pipes, can waste a lot of water and be quite expensive. Another way to check for this without manually inspecting every pipe is by shutting off the water to the building and then watching the flow meter to see if it continues to run. If it is, then there is a leak present (www.ccwater.com, 2006).

In 1992 there was a series of droughts and the city of Windhoek began to practice water demand management. This entails fixing leaks and installing water efficient infrastructure. In doing so, the city reduced its consumption by 30-50% from 1992 onwards (Fakir). Currently in Namibia, the water policy encourages water conservation and water efficient technology, but does not require water saving devices (Schachtschneider, 2001). Our research has shown that such devices are readily available in Namibia and their installation could impact the high usage within institutions.

Water Conservation Education

Installing water saving devices is one way to improve water efficiency. Another way of improving efficiency is to consider the people who are using water and the role they play. This section begins with an analysis of current trends in general water conservation education. The following discussion of water conservation education in Namibia will demonstrate the opportunity for its implementation in Windhoek and the potential challenges to creating a program.

General Water Conservation Education Trends

Communities across the globe are using education as a tool to promote water awareness amongst the public. When a school is considering implementing water conservation into its curriculum, it is important to consider past programs used elsewhere. The content, success rate, and cost of the programs both within and beyond Namibia can serve as models when developing a curriculum.

Organizations and school systems all seem to agree that education is an effective way to instill positive attitudes toward water in future generations (Vickers, 2001). There are materials available that span every discipline and grade. Overviews of several available teachers' guides, discussed below, show that the two most common approaches to water conservation education are the scientific study of water and the use of self-reflection to study one's own behaviors. Conservation education can be taught as a separate unit (USDA, 1992). However, it can also be

fully integrated into the curriculum, included in all subjects from social science to music (Capobianco *et al*., 1993). In South Africa, another country with limited water resources, environmental education is being integrated into all levels of the education system and, to date, millions of learners have participated in water education programs (Asmal, 2000). Often, water conservation units are specific to the sources of a certain geographical area (MWRA, 1983). Such a unit was developed in Southwest Florida and was designed to meet the state's educational standards, another important goal for any educational program (Southwest Florida Water Management District).

Jordan is one place facing environmental problems similar to those of Namibia. The population continues to grow, but all of the country's water sources have been tapped. As a response to the impending crisis, the Jordan Water Conservation Project was formed in 1994. Five units were designed to be taught in middle school eco-clubs. The first three units looked at water scientifically and specifically addressed sources in Jordan while the last two focused on water conservation habits in the home. A formal study was done, showing that it is possible for learners to adopt conservation-friendly behavior changes after participating in an interactive curriculum that recommends and explains these behaviors. This suggests that education advocating environmentally-responsible behaviors is an effective method of improving water efficiency, even among those who have already shown high levels of water awareness (Middlestadt *et al*. 2001). The success of this program is encouraging and suggests that similar results could be obtained with a program in Windhoek.

Another interesting educational tool was Project WATER, which was implemented in East Bay, California in 1974 as a way to change attitudes and behavior toward the use of water (www.awaa.org). The publications, as well as a live theatre performance for elementary schools, were provided at no cost to the 465 participating schools by the sponsoring agency, East Bay Municipal Utility District (www.ebmud.com). Grants may also be available, such as the one that funds the Southwest Florida curriculum (Southwest Florida Water Management District). However, new curricula are not always necessary. For instance, in Mali in the late 1990's, a formal environmental education program was revised and expanded for use in hundreds of schools (Grieser, 1999). Furthermore, it has been concluded that school wide campaigns that incorporate conservation education without disrupting the current curriculum can be incorporated at a very low cost (NCDENR, 2002).

Water Conservation Education in Post-Apartheid Namibia

Post-Apartheid Namibia still struggles with providing equal access to quality education to all schools. Before Apartheid ended, the schools were significantly different in what was available to learners as well as what was taught. The education system was designed to ensure that whites maintained their privileged position (Dunn, 2003). This is still evident in Namibia today when visiting schools that are predominately black or white. Integration has occurred, but it still appears that mostly black or all black schools are not as well maintained or equipped as multi-racial or mostly white schools (Kabivere, 2000).

Since Namibia gained its independence in 1990, the government has been experimenting with new programs in order to provide the best education for its people (Philander, 2006). "Education for all" has become the educational goal in Post-Apartheid Namibia (Diener *et al*. 2001). There is a national curriculum structure to which all the schools adhere, consisting of basic subjects such as mathematics, science, reading, and English as a second language. This curriculum is relatively new due to the massive reconstruction of the education system after Apartheid (Kabivere, 2000). At this point, water conservation is not a mandatory part of this national curriculum (Poolman, 2004). Therefore, its importance may not be as emphasized as much as mandatory subjects.

There are conservation programs in Namibia available to youths in and outside of school, but participation is not required. For example, every year there is a water saving project called the Omeya Schools Water Saving Project. It is a competition between schools to foster water awareness and conservation and allows for the winning school to receive a donation from the Environmental Fund of the Walvis Bay Municipality (Robberts, 2005). However, the program has not been implemented nationwide. Another current program offered to school-aged Namibians is the Youth Conservation Corps (YCC). This program is sponsored by the Ministry of Youth and Sport (MYS) and is intended to provide young Namibians with a wide range of experiences while simultaneously benefiting Namibia. It allows idle youngsters to gain exposure to conservation, environmental education, and outdoor leadership skills (Green Beat, 1998). Furthermore, the Ministry of Environment and Tourism provides a program to promote environmental education. This program targets certain groups in Namibia, one of which is learners and teachers (Ministry of Environment & Tourism, Namibia).

Secondary schools, which consist of grades 8 through 12, are suitable locations for an educational water conservation program to be implemented; however there are still many issues the schools face. According to Philander, there is a lack of capital available to provide for adequate teaching facilities and personnel (Philander, 2006). If no funds are available, schools are unlikely to expand the curriculum to include water conservation. Furthermore, when the learner starts his or her secondary education there is the option of choosing schools. This can, in some cases, lead to crowding in schools and place additional strains on the budget (Brinkman, 2006). Schools might be willing to direct funds towards repairs that will guarantee eventual savings, but not for a program whose long-term savings can only be speculated.

CHAPTER 3: METHODOLOGY

The goal of this project was to work with the Windhoek Department of Infrastructure, Water and Technical Services to provide it with a set of recommendations that would help to reduce water consumption in the City's schools. In order to achieve this goal, the following objectives were established:

1. Assess the repairs/changes previously made in four Reference secondary schools: Windhoek High School, High Technical School, Centaurus, and Anna Shipena.
2. Identify inefficient or wasteful use of water in four Focus secondary schools: High Technical School, Anna Shipena, Augustineum, Concordia.
3. Assess the role of the established curriculum in teaching water conservation principles.
4. Develop potential recommendations and determine their feasibility.

In this chapter we will discuss the use of indirect and direct observations, interviews, and a series of comparison analyses concerning consumption data and water savings potential in order to achieve the above mentioned objectives. Challenges for each of the data collection methods are addressed. The conclusions drawn from the results of Objectives 1, 2 and 3 provided the basis for completing Objective 4.

Objective 1: Assess Repairs/Changes Previously Made in Four Windhoek Secondary Schools

As mentioned earlier, the Department of Infrastructure, Water and Technical Services had previously conducted a study on four Windhoek secondary schools that were identified as large water consumers. The Department made recommendations to the schools to repair faulty infrastructure. Following the repairs, the schools were able to reduce their water consumption by an average of 25% over a period of three months (Brinkman, 2005). The main research questions we sought to answer through this objective were:

- What repairs were made and how successful were they?
- Were the repairs something that could be repeated elsewhere?

- What other changes were made that were responsible for decreases in water consumption?

We visited four Windhoek secondary schools, which we refer to as our Reference schools: Windhoek High School, High Technical School, Centaurus, and Anna Shipena. These schools were the four the Department had previously studied. With the help of a city inspector, we were able to make initial visits to the schools. Our first visits to these schools were unannounced. This allowed us to see what the schools were like with no preparation for inspectors. The city inspector was able to gain access to any room in the schools and hostels with the assistance of a maintenance worker or staff member who had a key. The purpose of this was to get a general idea of the condition of the water infrastructure at the current time and see if we could identify any of the previous repairs or changes that had been made. It also helped us determine what types of inefficiency we should look for in our Focus schools.

The primary methods for the data collection during the initial visit were direct and indirect observations. The data gathered on the previous repairs/changes fell into these categories for assessment:

- Repair/change made at school and date if known
- Cost
- Long-term sustainability
- Water-saving potential

Each specific repair/change made was identified and recorded on a data collection table along with the date, if known. Each repair was rated with respect to each category using a three-point scale. Cost was rated as expensive, moderate, or inexpensive. Long-term sustainability was rated as sustainable, somewhat sustainable, or not sustainable. Water-saving potential was rated as significant savings, moderate/little savings, or no savings. Appendix D gives a detailed description of rubrics for these assessment ratings along with the data collection tables that we used. The feasibility of the repairs/changes was to be determined in Objective 4. At the end of each visit to the Reference schools, we set up appointments to return and hold interviews with the principals. If a date or time could not be set up, a phone number was acquired.

At three of the Reference schools - WHS, Centaurus and Anna Shipena - the principals were interviewed, while at HTS, the hostel superintendent was interviewed. The city inspector did not attend the interviews so he did not have any direct influence on the answers the principals

or maintenance personnel gave. They were conducted in a private and quiet setting with no learners in proximity. The interviews were semi-structured, which meant that some questions could have possibly deviated from the plan. The purpose of the interviews was to answer our original research questions. Topics concerned: school demographics, what things in the school had been repaired or changed, how they had been repaired or changed and whether or not those had been maintained. We also sought to find out if the repairs or changes had any effect on water savings. The complete interview plan can be seen in Appendix B. The summaries of the interviews can be viewed in Appendix K.

Objective 2: Identify Inefficient or Wasteful Use of Water in Windhoek Secondary Schools

In order to complete this objective, we identified four schools as large water consumers through comparison of past consumption data and suggestions from the Department of Infrastructure, Water and Technical Services. The daily consumption of water use per learner was our main criterion for school selection. Large amounts of water being used suggested the presence of water wastage that could possibly be reduced. In addition to being large consumers, those schools recommended by the Department were in poor condition and in need of assessment. Our four chosen schools were Anna Shipena, Augustineum, Concordia and High Technical School (HTS), and will be referred to as our Focus schools. Two of these, HTS and Anna Shipena, had been participants in the earlier improvement program. We chose to work with secondary schools for communication reasons. The learners within the secondary schools were more fluent in English, an aspect that would facilitate our communication with them.

Upon selection of our Focus schools, we made visits in order to learn the answers to the following research questions:

- To what extent is faulty infrastructure contributing to high water consumption?
- To what extent might behavioral patterns be contributing to high water consumption?

Our initial visits to the Focus schools were unannounced and we were accompanied by a city inspector. This allowed us unlimited access to the schools and provided us with an idea of what the schools are typically like. We then retrieved contact information for administrators in order to set up interviews for our second visits.

At each appointment, we explained our research to the administrators. We informed them that we were working on a student project that hoped to identify sources of water wastage and possibly reduce consumption within a group of Windhoek secondary schools. Our explanations and time spent with administrators were intended to provide them with an incentive to participate in the study.

Infrastructure and Maintenance

To answer our research question regarding faulty infrastructure, we inspected the current conditions of the infrastructure and plumbing in each school. This was done in order to detect leaks or other forms of inefficiency, such as missing showerheads or missing tap handles. For each incidence of faulty infrastructure, we recorded the type of damage and the number of cases in the school. For any major leaks, we took pictures in order to prevent any challenges to the validity of our data, as well as to supply ourselves with concrete evidence. We used one data sheet which focused on the bathrooms, as well as one that focused on other areas such as kitchens, clothes washing areas, and outdoor spigots. Each sheet also included different types of damages that could be present, and numbers of each type were recorded. The data sheets were designed to be easily read and completed. Below is a list of fixtures we examined:

- Visible/accessible pipes
- Sinks/faucets
- Toilets
- Showerheads
- Dish washing areas
- Clothes washing areas
- Outdoor spigots

Two group members were responsible for touring the schools and observing the infrastructure while the other two conducted the interviews. We decided that this would be the most time-effective method of data collection. The same group members performed the same duty in each school for consistency.

The data collected was mostly quantitative. The numbers of different types of problems were gathered through our observations and used to gain overall insight into the state of the infrastructure within the schools. Some observations, however, were more qualitative, particularly when numbers were not available. The data collection sheets for the numbers of faulty infrastructure can be seen in Appendix E.

Interviews with principals and maintenance personnel were intended to provide us with information on sources of structural water waste and what solutions had been implemented to reduce waste. Furthermore, we asked administrators about their repair process in order to understand why some areas of the infrastructure were in good condition and others were not. We also inquired as to how the administrators might respond if given a set of recommendations by our team. These sessions were designed to be semi-structured and were given by the same two team members every time.

Behavior

Assessing the behavioral habits of the learners and staff within the schools to answer our research questions was challenging. During direct observations there is the risk of behavior change because of the observer's presence, so we did not heavily rely on them. However, if the opportunity to watch the learners or staff interact with water arose, we took careful notice.

Due to the sporadic nature and validity challenges of direct observations, the majority of observations we made were indirect. We recorded instances of running faucets that were not completely turned off when we entered the bathrooms. Every running faucet was checked to see if it was in fact not properly shut off or if it was due to a leak. Also, during formal interviews with administrators, we discussed the level of conservation education the learners receive and whether or not they practice efficient water habits. We asked questions concerning vandalism and level of education in order to identify potential sources of water inefficiency that we were not aware of before the observations took place. We chose to approach our behavior assessment in this manner because it eliminated the possibility of observing false behaviors.

This method faces many validity challenges. For example, what we were told about the learners' behavior may not be completely accurate and observed behaviors may be random occurrences and not be habitual.

Objective 3: Assessing the Role of the Curriculum in Promoting Water Conservation

Previous research has suggested that schools in Windhoek are using education as a way to promote water conservation and have been doing so for several years. Our third objective was to assess the presence, or possible lack thereof, of water conservation in the current curriculum of our Focus schools by interacting with administrators, teachers and learners. The main questions we sought to answer were:

- What and when are learners taught about water conservation?
- In what conservation programs or activities do Windhoek learners participate?
- What are the attitudes of teachers and learners towards water conservation and water conservation education?

This investigation was intended to help determine if the schools could potentially benefit from the development of a new program or the expansion of an existing educational program on water conservation.

In order to learn more about the curriculum and answer our research questions, we asked teachers and administrators about their views on conservation education within their particular school. Questions included whether or not water conservation was a mandatory part of the curriculum, which grades teach water conservation, if education has been successful or not and what other types of education might be necessary to promote conservation habits. The interview questions were pre-tested for clarity before being used within the schools. We chose this specific interview plan because it allowed us to enter the schools with set questions, but also to ask questions based on information received during the interview. By preparing the interview guide beforehand, we had the added benefit of remaining consistent within each of the schools. Following the interviews, the answers to open-ended questions were summarized and coded according to key words, themes or concepts. The complete interview plan can be seen in Appendix B. The interviews summaries can be viewed in Appendix K.

In addition to gathering views of teachers and administrators, we also surveyed the learners. The purpose of the learner survey was to gauge their current knowledge of water conservation, their attitude toward the conditions of their school's bathrooms and their thoughts on the importance of water conservation. A worksheet that consisted of five open-ended questions and one Likert scale question was given to 20 learners at each Focus school. We used

worksheets, as opposed to interviews or class discussions, because the format was preferred by our sponsor. The survey design was structured so that all learners would respond to the same questions and was pre-tested for clarity in word choice. Furthermore, we designed the survey to be completed in less than 30 minutes so that we would not disrupt a full class period and so that the learners would be less likely to lose interest. The worksheet also had the added benefit of allowing us to assess individual learners on their knowledge rather than the combined effort of an entire class where some learners may have chosen not to contribute. The complete survey can be viewed in Appendix C.

We distributed the surveys at a time when the Focus schools were holding exams and we were therefore restricted in controlling the sampling of participants. We surveyed learners that were available, regardless of grade or subject, but the majority of respondents were 10^{th} grade science learners. In some instances, administrators distributed the surveys for us and we made arrangements to retrieve them at a later time. This method did not allow us to monitor the completion of all the surveys. In these cases, the teachers may have aided the learners or the learners may have collaborated while answering some of the questions. Another drawback with the surveys was that learners may have felt like they were being tested and responded to the questions less openly because of fear of being "wrong." Even though we surveyed older learners because they were more proficient in English, the language barrier could have also had an effect on the answers.

Analyzing the data from these classroom sessions was slightly different from the results of the interviews with the adults.

- For questions 1, 3 and 6, we quantified the data by the number of answers a learner gave for each question.
- We analyzed question 2 by determining if the answer given was a reasonable estimate.
- Question 4 was used to help us realize the opinion of learners toward the conditions of their school bathrooms. We also quantified the second half of the question by the number of suggestions they provided.
- Question 5 was used to determine how learners felt about the importance of conserving water.

Our analysis was meant to help us determine the current level of water awareness among learners and if they could benefit from further conservation education.

After completing our data collection we considered different educational programs that may be implemented in the future. A data collection sheet was designed to help with comparison of different programs. The sheet consisted of many categories in which the program could be ranked, including:

- Cost
- Long-term sustainability
- Water-saving potential
- Teacher support

A carefully designed assessment rubric went along with the sheet to ensure consistency of the ratings. Cost was rated as expensive, moderate, or inexpensive. Long-term sustainability was rated as sustainable, somewhat sustainable, or not sustainable. Water-saving potential was rated as significant savings, moderate/little savings, or no savings. Teacher support was rated as supportive, somewhat supportive, or not supportive. Appendix G gives a detailed description of these assessment ratings along with data collection tables used.

Objective 4: Developing and Determining Feasibility of Recommendations for Water Conservation Measures

The final Objective was to develop recommendations for the City of Windhoek that, once implemented, would ideally result in a reduction of water consumption in schools and to determine the feasibility of these potential recommendations. This objective was completed with the results from the previous three objectives, as well as by answering several more research questions. These research questions corresponded to the previous objectives:

- Which repairs/changes made in the Reference schools were most effective and will be the most feasible to recommend?
- What repairs to faulty infrastructure are the most feasible to fix in the Focus schools to reduce water waste, and which water saving devices are the most feasible to recommend to make use more efficient?
- What educational programs are the most feasible to implement in the schools for learners, faculty, and/or maintenance workers?

The levels of feasibility were determined through grading rubrics based on criteria that we developed with help from the Department. These are mentioned below in the following sections of this chapter. The methods used to answer the above research questions are also explained in detail below.

Previous Repairs/Changes

In order to determine which repairs or changes made in the Reference schools might be the most feasible to recommend to the Focus schools, we analyzed the data gathered from completing Objective 1. This included data on each repair/change such as cost, long-term sustainability, and water-saving potential. We developed a four-step qualitative feasibility scale consisting of the ratings very feasible, feasible, somewhat feasible, and not feasible. For each repair/change, we assigned one of these ratings.

The assessment rubric we designed for the data collection table allows for comparisons of repairs/changes and provides for consistency between team members when rating. It should also be noted that a previous repair/change that was effective at one school may not always be effective at another school. The reasons for this, such as different budgets and school construction, were considered in the final recommendations. The data collection table and assessment rubric in detail can be seen in Appendix D.

Faulty Infrastructure Repairs and Water Saving Devices

In order to determine which repairs to faulty infrastructure were the most feasible to recommend, trips were made to four of the major hardware and sanitary supply stores in the city of Windhoek: Pupkewitz Megabuild, ObeCo, Penny Pinchers, and Cashbuild. From our own knowledge of plumbing and speaking with sales clerks at the stores, we were able to determine what the most common plumbing repairs could be at the schools. We then took down the information on the repair parts, as well as took pictures and noted the price of each item. We also determined at which stores the repair parts were the least expensive. Data was then gathered from each of the Focus schools on what faulty infrastructure repairs were needed, as explained in Objective 2. The total cost of the repairs for each school was calculated. Due to the fact that we

were unable to determine the precise extent of all the damage, whether it was the entire flush mechanism or just the gasket, we calculated minimum and maximum possible prices for the repairs at each school. The feasibility of these repairs was based on cost and the affordability for each individual school. A description of each hardware store noted above can be seen in Appendix H.

We also assessed which water saving devices might be the most feasible to recommend for installation at the Focus schools. During our visits to the hardware stores we also noted water saving devices that were available and their price. While we were gathering data on faulty infrastructure repairs in the schools, as described in Objective 2, we made observations on the number of potential water saving devices that could be implemented. The devices were evaluated on these criteria:

- Cost
- Long-term sustainability
- Water-saving potential
- Ease of installation

Cost was rated as expensive, moderate, or inexpensive. Long-term sustainability was rated as sustainable, somewhat sustainable, and not sustainable. Water-saving potential was rated as significant savings, moderate/little savings, and no savings. Finally, installation was listed as easy, moderate, or difficult.

From the above mentioned assessment criteria, feasibility was determined. A four-step qualitative feasibility scale consisting of very feasible, feasible, somewhat feasible, and not feasible ratings were used. This method allows for comparisons of water saving devices and provides for consistency between team members when rating. Appendix F gives a detailed description of these assessment ratings along with data collection tables used.

Educational Programs

In order to determine the feasibility of implementing an educational program, we first developed a list of potential programs. The purposes of the educational programs were to encourage water conservation in the schools or to teach maintenance workers how to repair

plumbing problems. Data was gathered on the possible implementation of educational programs through interviews with administrators and through surveys distributed to learners. Types of programs were rated on the assessment criteria as mentioned in Objective 3.

From the assessment criteria, feasibility was determined. A four-step qualitative feasibility scale consisting of very feasible, feasible, somewhat feasible, and not feasible assessment ratings were used. The rubric and data table for the feasibility of an educational program can be seen in detail in Appendix G.

The methods presented above allowed us to prioritize recommendations to the Department of Infrastructure, Water and Technical Services based on criteria we developed with teachers and school administrators. The recipients will be able to view each recommendation on a clear and concise table to see the potential benefits and effectiveness of each.

CHAPTER 4: FINDINGS

This chapter begins with a set of profiles which familiarize the reader with each participating school. Next, we display our findings according to sources of water inefficiency within the schools. We assess the feasibility of possible recommendations, demonstrating the potential for improvements the schools themselves can complete, as well as improvements that will depend on outside factors. This chapter also includes several cost-saving analyses for certain sources of faulty infrastructure. We conclude with an explanation of how the sources of inefficiency are connected to each other.

School Profiles

This section presents facts on each school that we studied, including the age of the school, the bathroom layout, and the numbers of learners, teachers, and maintenance workers. We also describe some of the conditions of the bathrooms and repairs previously made in the schools. All are multiracial public secondary schools. Of all the schools, Windhoek High School had the best conditions and lowest water consumption. Therefore, it is our benchmark school and received the description of "best." All other descriptions, such as "poor" and "satisfactory" were made relative to the conditions at WHS. The schools are placed in two categories with some overlap. The **Reference** schools are Windhoek High School, Centaurus Secondary School, High Technical School, and Anna Shipena Secondary School. These schools followed recommendations from the Department in 2004 and were able to reduce their water consumption. The **Focus** schools are High Technical, Anna Shipena, Augustineum Secondary School, and Concordia College. We also note solutions previously attempted by some schools to improve water efficiency.

Figure 5 displays monthly water consumption from May 2004 to March 2006 for five of the schools. Data for Anna Shipena was unavailable due to a broken water meter. Usage for all of the schools appears to be erratic at times. This could be due to levels of rainfall or climate changes. Augustineum and HTS both experienced dramatic increases in consumption from Sept-Oct of 2004 and again in June-July of 2005. Concordia's most drastic increase occurred in June

2005, with a recent decrease in consumption from Jan-Mar 2006. We expected to see decreases in late 2004 after schools were notified to reduce their consumption. However, only two schools appear to have experienced decreases in late 2004, Centaurus and HTS, and these savings only lasted until mid to late 2005. In fact, Centaurus's overall usage has been rising over the last few months while other schools have been decreasing. Augustineum has decreased since Sept 2005, but its usage is still unreasonably high. While WHS has experienced some increases, its overall usage has stayed less than or slightly above 2000 kL a month for the entire time span of the data.

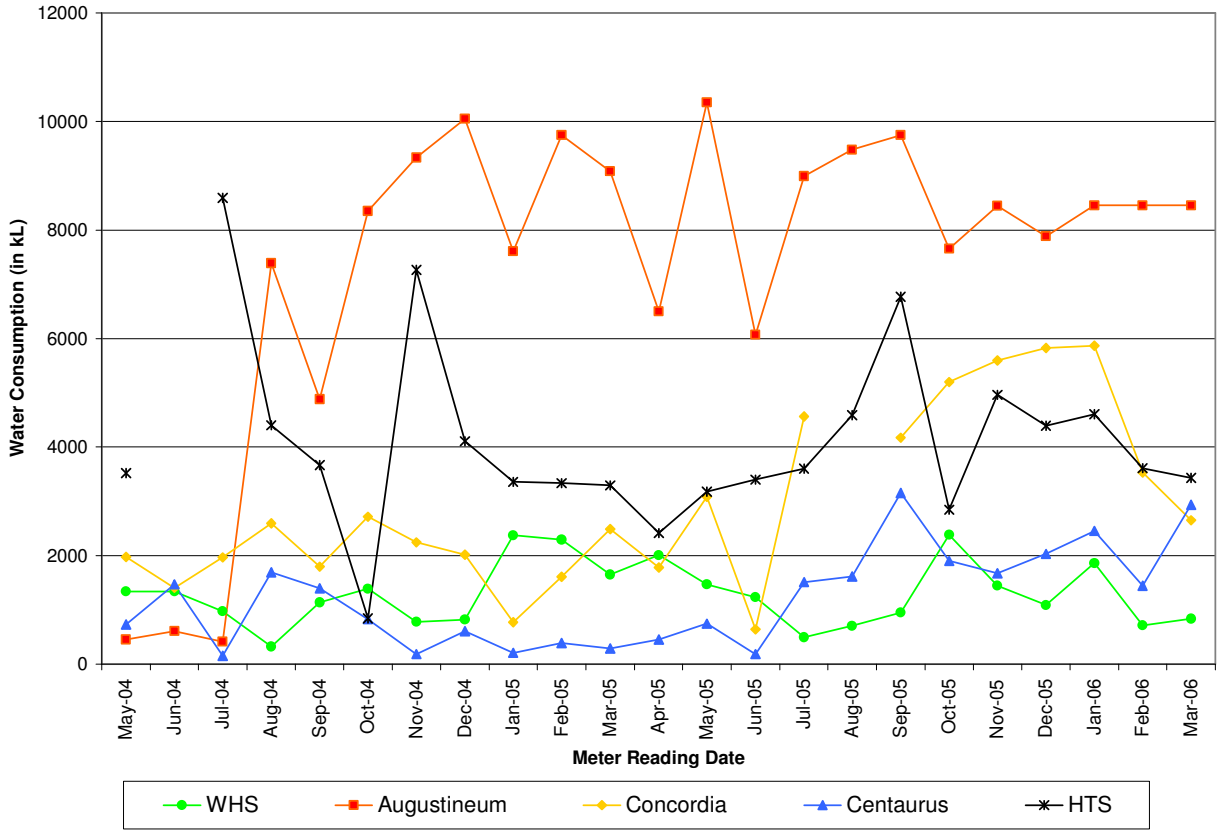

Figure 5 - Monthly Water Consumption (in kL) for Five Reference and Focus Schools

Daily water consumption per capita for each school, displayed in Figure 6, was calculated according to the data presented in Figure 5 and the number of learners attending each school. We have taken into consideration the disparity between the percentages of hostel residents in each school. The varying number of residents per school would influence the daily consumption since it is likely a commuting learner uses less water at the school than one that lives in a hostel.

The two highest consumers, Augustineum and High Technical School, also have the highest percentage of students living in the hostels. However, it is also important to note that WHS has the highest overall student population, with 1230 students, but has the lowest consumption at 37 Lpcd. Furthermore, the number of students attending Concordia is very close to the number at Augustineum, and yet their usages are drastically different. This suggests that Augustineum's high level of usage is due to factors other than student usage. Additionally, by having the highest population but maintaining the lowest consumption, WHS has set a precedent for consumption for which other schools could strive.

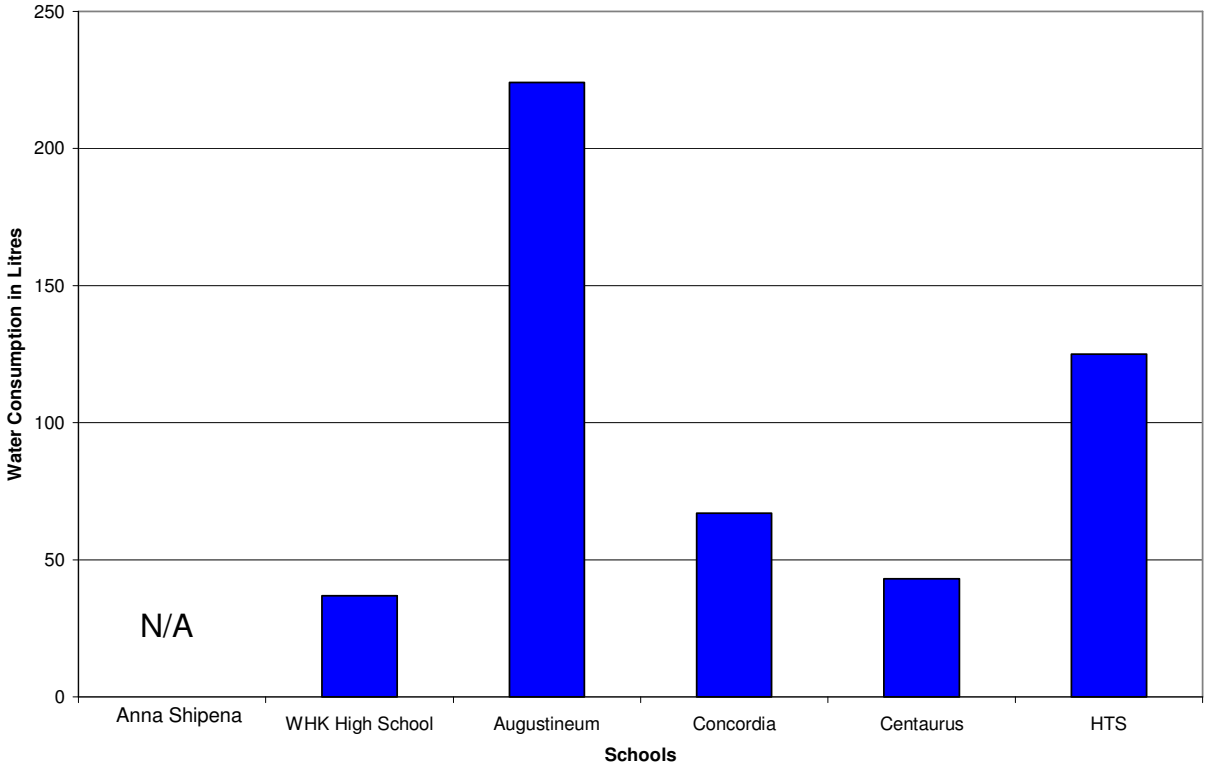

Figure 6 - Average Daily Water Consumption in Liters per Learner per Day in Focus and Reference Schools

Windhoek High School (WHS)

Opened in 1917, WHS currently employs 52 teachers and enrolls 1230 learners coming from all 11 ethnic groups in Namibia. Of the 190 learners residing in the hostels, 100 are girls

and 90 are boys. The average daily consumption at WHS is the lowest of all the schools at 37 L per learner.

The conditions of the school bathrooms were very good. This can be attributed to the school having two bathroom blocks, one for boys and one for girls. This layout makes it easier for each bathroom to be supervised by one monitor who is paid by the school. This monitor's sole job is to clean the facility and supervise its use until the end of the school day when it is then locked. The hostel bathrooms are supervised and cleaned by four matrons. When we visited, every sink and toilet was in good condition and worked properly. The floors were clean and no rubbish was found outside of the trash cans. The principal's best suggestion for other schools, in order to keep the bathrooms in good condition, was to hire private monitors to keep an eye on the learners. After doing so, he has not experienced any major problems regarding the bathrooms in his school.

When a small problem like a leak is discovered, it is fixed immediately by maintenance workers. Outside contractors are hired for larger repairs that require large investments. WHS does not need to rely on the Ministry of Works to make such repairs since it has the funds to pay for them. In June of 2005, complete renovations were made to both bathroom blocks. Everything was replaced, including the floors, walls, sinks and toilets. The total cost of the renovations was N$160,000, or N$80,000 for each block. The funds were provided by an outside investor in return for guaranteed advertising space on the athletic fields. According to the principal, the reason renovations were made was to improve the image of the school because it receives many outside visitors.

Centaurus Secondary School

Centaurus enrolls 896 learners of which 106 girls reside in their hostel. The boys' hostel was shut down in late 2005 due to "collapsed" plumbing. The average daily consumption at Centaurus is 43 L per learner. This relatively low rate may be related to the closing of the boys' hostel and the fact that not all bathrooms were made available to the learners.

The overall conditions of the bathrooms were very poor. The school has four boys' and three girls' bathrooms which are maintained by one worker. There were other bathroom blocks that we were unable to access. Many of the sinks did not work, ceiling panels were falling off, a

urinal trough was broken causing water to overflow onto the bathroom floor, and rubbish was swept into the corner and left on the floor next to a garbage can. Each of the two girls' hostels has one bathroom block that is maintained by three workers. At the time of our visit, one of the blocks was undergoing government paid renovations by which the floors, walls, and plumbing were being fixed.

According to the principal, Centaurus has used a chemical deterrent to discourage learners from staying in the bathrooms for long periods of time. The school board is in the process of purchasing an N$19,000 steam cleaner that can be used to clean the bathroom, as well as other areas of the school, and will reapply the chemical on a regular basis.

High Technical School (HTS)

HTS enrolls 886 learners of which 234 reside in the hostels, 139 girls and 95 boys. The average daily consumption at HTS is 125 L per learner.

The conditions of the school bathrooms were good. However, the average daily consumption was relatively high compared to the other schools. This may be related to the use of fully purified water supply for landscaping instead of a less expensive semi-purified source. There were few leaking faucets, running toilets, or missing tap handles. Additionally, there was no rubbish on the floors. The school bathrooms are locked during the day and only the prefects have keys so that learners do not have unlimited access. The six boys' and seven girls' bathroom blocks are maintained by three workers. The hostels each have two bathroom blocks that are supervised by a hostel superintendent. He employs six matrons to clean and two workers to oversee infrastructure inspection and repair.

Since 2003, when the new hostel superintendent was hired, much work has been done to the hostels. Since his hiring, he has raised the annual hostel fees from N$150 to N$300 to N$1500 in order to finance the repairs he has made. Rewiring the entire hostels cost N$100,000 alone and in 2005, he spent N$ 363,000 on infrastructure repairs and painting. He was able to raise the money from the parents and created a five-year plan that explains how all the money was going to be spent. He also holds annual dinners for the hostel residents and presents them with rewards for their good behavior.

Augustineum Secondary School

Augustineum currently employs forty-four teachers and enrolls 1080 learners. Of the 280 pupils that reside in the hostels, 190 are girls and 90 are boys. The average daily consumption per learner at Augustineum is 224 L, the highest of all the schools.

The conditions of the school bathrooms were poor. One of the bathrooms could not be fully observed due to the flooded floors. Many toilets were not flushed or were clogged, sink basins were broken, and faucets were leaking. The school has four bathroom blocks, two for the boys and two for the girls that are maintained by six workers whose responsibility is to inspect and fix leaks and other small scale problems. The hostels each have two bathroom blocks that are supervised by a hostel superintendent who employs four matrons to clean.

In 2005, the school was notified by the Ministry of Education that the monthly water consumption was too high. According to Augustineum's principal, the school tried to contact the Ministry of Works to fix a broken pipe that was causing significant damage to the walls. The Ministry of Works did not fix the pipe until the wall collapsed. Aside from the collapsed wall, there were other problems that led to significant amounts of water wastage. Water damage to other walls was evident in the school and hostels. Furthermore, there was a leaking water boiler with extensive damage. The boiler had been in these conditions for months. All these factors played a fundamental role in leading Augustineum to be the highest consumer of water in our Focus schools.

Concordia College

Concordia was opened in 1983. It currently employs 44 teachers and enrolls 1020 learners, some of which live in the schools hostels. The average daily consumption at Concordia is 67 L per learner. The interview with the school principal was cut short due to an unexpected meeting, so we were unable to attain further demographic information. We were unable to schedule another interview date or talk to an administrator over the phone because all of the secondary schools went on a month-long break in April.

The hostel bathrooms, maintained by four matrons, were in very poor condition. Many showerheads were missing, bathtubs were leaking, floors were flooded, wires from missing light

fixtures were hanging from the ceiling, and toilets were not flushed. There was also a hole in the ceiling due to pipes that were leaking. There is one school bathroom block for each the boys and girls. The conditions of the school bathrooms were satisfactory. Half of the toilet stalls were locked due to faulty infrastructure, tap handles were missing, and some taps did not work. The relatively low daily water consumption compared to the condition of the school may be a result of the lack of facilities available to the learners. Within the one boys' bathroom block there were ten toilet stalls, five of which were locked and unusable.

Concordia spent N$48,000 last year on maintenance, most of which went into the hostels. They have not made any major renovations since the school was opened, but they are waiting for a budget approval by the Ministry of Works to make them in 2007.

Anna Shipena

We were unable to set up a meeting time with Anna Shipena due to miscommunication with the administration and the month-long vacation that all secondary schools take in April. However, we were still able to make infrastructure observations. The conditions of the bathrooms were poor. One of the bathrooms was flooded due to a leaking toilet and another had a door that was half missing. We concluded that the broken door was an act of vandalism. It appeared that the bottom of the door was kicked in and after further inspection on our second visit, more than half the door was missing. There were also broken sink basins, leaking taps and missing handles.

The following table summarizes basic information from each of the schools to facilitate comparison. Water consumption data drawn from Figure 5 is included so that one can associate the differences with the number of learners and residents.

			# of Maintenance Workers			
School	# of learners	% of Learners Residing in Hostels	School	Hostel	Daily Water Consumption Per Capita	School Bathroom Condition
WHS	1230	15.4	2	4	37	Best
Centaurus	896	11.8	1	3	43	Very Poor
HTS	886	26.4	3	6	125	Good
Augustineum	1080	25.9	6	4	224	Poor
Concordia	1020	N/A	N/A	4	67	Satisfactory
Anna Shipena	N/A	N/A	N/A	4	N/A	Poor

Table 1 - Logistical Data on Reference and Focus Schools

The information made available to us suggests certain trends. First, having a large number of learners will not necessarily create poor bathroom conditions. WHS has the most learners and the best conditions, while Centaurus has a much smaller student body and very poor bathroom conditions. Secondly, a large percentage of learners residing in hostels may cause higher daily water consumption. As previously mentioned, HTS and Augustineum have the highest percentage of hostel residents and the highest water consumption. This does not necessarily mean there is a direct relationship. Augustineum has about two times the percentage of hostel residents as Centaurus, but has a water consumption level more than five times as high. Thirdly, having more maintenance workers does not mean there will be lower water usage. WHS and Centaurus have the fewest workers and the lowest consumption meanwhile HTS and Augustineum are the largest consumers and have the most maintenance workers. The reasons why these scenarios arise will be explained later in the chapter.

Factors Affecting Water Efficiency

Our research identified several sources of water inefficiency within the schools:

- **Special cases** of major water wastage.
- **Faulty infrastructure** such as broken taps and missing showerheads.

- **Insufficient maintenance** in the form of faulty infrastructure not being repaired.
- **Vandalism** by learners as a source of faulty infrastructure.
- **Inefficient use** caused by an absence of water saving devices.
- **Lack of water awareness and education** among administrators, maintenance workers and learners.

For each of these sources, we use both qualitative and quantitative data to describe trends such as frequency of occurrence and past solutions employed by the Reference schools.

Special Cases

We identified certain conditions of some of the schools that led to significantly high water consumption. As mentioned in the school profiles, Augustineum had a number of broken water pipes that were evident through the extensive damage seen on the walls. Furthermore, there was broken water boiler that was leaking water onto the school courtyard. According to the principal, the damages have been problematic for months and when she tried to contact the Ministry of Works to fix the damages it took them a long time to respond. When the Ministry finally came, the damages were not fixed because the workers did not know how to make the necessary repairs. This suggests that these problems have led Augustineum to be the highest consumer of water out of our Focus schools.

HTS had an unusually high rate of water consumption compared to the good conditions of its school and hostel bathrooms. We believe this is directly caused by its landscaping. The city provides institutions with semi-purified water at a less expensive rate for purposes such as landscaping but according to the superintendent of hostels, HTS does not use the semi-purified water for its landscaping. All the water the school uses is drawn from the same source and is recorded on the same meter resulting in high consumption.

Faulty Infrastructure

Of the four Focus schools, all had some type of faulty infrastructure in the hostel bathrooms. The most common type of faulty infrastructure found in the Focus schools was

missing showerheads. All of the hostels we visited had a problem with the learners removing the showerheads and keeping them for themselves. After showerheads, worn-out washers resulting in leaking taps was the second most common type of faulty infrastructure. Leaking showers, bath tubs and urinals can also be attributed to worn-out washers or valves. Missing handles in either the showers or the sinks can also lead to leaks. The water may not be easily turned off if there are missing handles. Broken or faulty toilet mechanisms can be a large source of water waste as well. In some cases the entire mechanism was missing or completely broken, resulting in continuous running.

Figure 7 displays the percentage of faulty infrastructure in each of the four Focus schools compared to the percentage of working infrastructure.

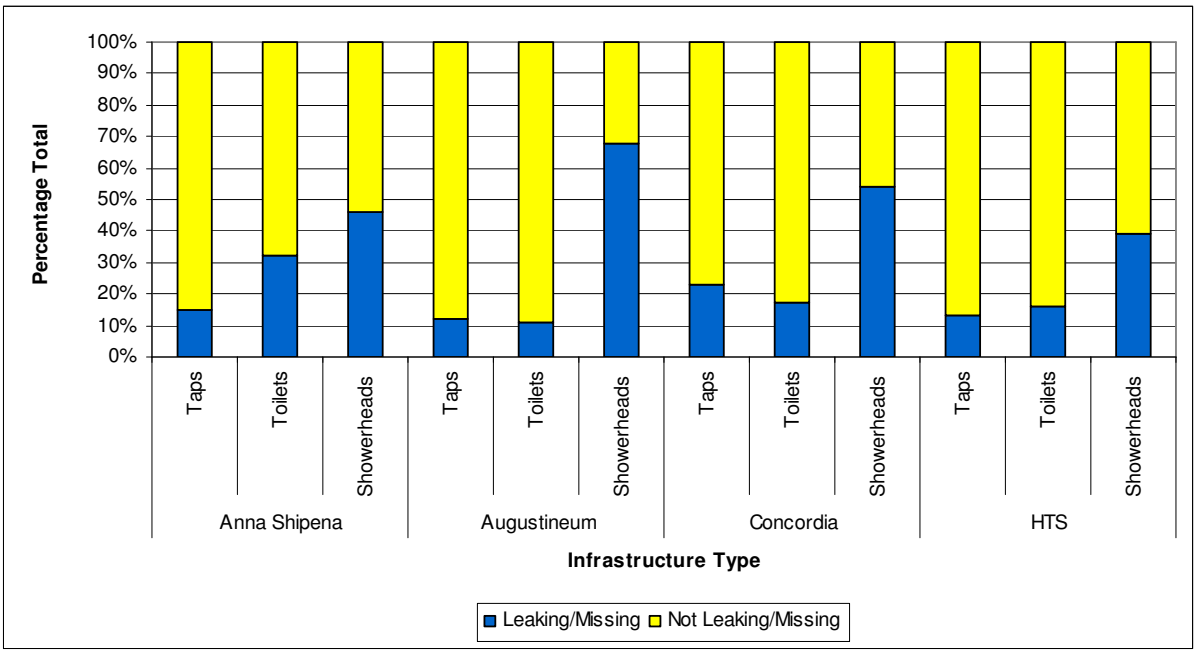

Figure 7 - Percentages of Faulty Infrastructure in the Reference and Focus Schools

A response to faulty infrastructure in the past has been to complete repairs. It was difficult for us to determine exactly which parts of the infrastructure in the Reference schools underwent repairs. The hostels at HTS underwent extensive renovations beginning in 2003 that included repairs to the plumbing infrastructure. This school experienced a significant decrease in consumption between late 2004 and early 2005, as can be viewed in Figure 5. Recently the consumption levels have increased, which may be due to more landscaping.

Another response to faulty infrastructure, though less common, was to shut down school bathrooms that were too damaged to be used. At Augustineum and Anna Shipena, entire bathroom blocks have been closed. As mentioned in the profile, Centaurus went as far as shutting down the entire boys' hostel.

Methods of improving water efficiency will require an initial investment that will eventually be re-paid which would lead to financial gain through the benefit of water savings and maintenance. A cost analysis was done for the three main occurrences of faulty infrastructure, those being leaking faucet taps, leaking toilets, and missing showerheads. The analysis on leaking sink taps is shown in Table 2.

Considering that all of the schools have maintenance workers that should be able to make these repairs, we have not included labor costs in the analysis. However, as the next section will describe, it appeared from our observations that not all of the maintenance personnel have the necessary skills or knowledge to make the repairs.

Water Waste Cost Analysis

		Day (L)	Week (L)	Month (L)	3 Months (L)	6 Months (L)	1 year (L)
Leaking Sink Tap		15	105	420	1350	2,738	5,475
Anna Shepina (14 cases)		210	1470	6300	18900	38325	76650
Cost of Wasted Water (N$9.24/kL):		N$2	N$14	N$58	N$175	N$354	N$708
Cost of Repair Parts (N$1.24/ea):	N$17.36						
Days to pay-off:	9						
Augustineum (12 cases)		180	1260	5400	16200	32850	65700
Cost of Wasted Water (N$9.24/kL):		N$2	N$12	N$50	N$150	N$304	N$607
Cost of Repair Parts (N$1.24/ea):	N$14.88						
Days to pay-off:	9						
Concordia (21 cases)		315	2205	9450	28350	57487.5	114975
Cost of Wasted Water (N$9.24/kL):		N$3	N$20	N$87	N$262	N$531	N$1,062
Cost of Repair Parts (N$1.24/ea):	N$26.04						
Days to pay-off:	9						
HTS (21 cases)		315	2205	9450	28350	57487.5	114975
Cost of Wasted Water (N$9.24/kL):		N$3	N$20	N$87	N$262	N$531	N$1,062
Cost of Repair Parts (N$1.24/ea):	N$26.04						
Days to pay-off:	9						

***Leakages rates are estimates based on averages from experiments and online research

Table 2 - Waste Water Cost Analysis for Leaking Taps

There are other sources of free, skilled labor available and, as long as they are made available to the schools, these repairs will be possible. Furthermore, if current maintenance personnel are trained for no cost, it will be possible to sustain the repairs.

We estimated that a single leaking faucet tap could waste an average of 15 liters of water a day. Taking the cost of the repair parts, and the number of leaking faucets at each school, we were able to calculate the payback period. Based on these estimates and calculations, it will take nine days for the water savings to exceed the initial costs at any individual school. There is some potential for savings, as can be seen in the table.

The next common occurrence of faulty infrastructure we found in the schools was leaking toilets. A leaking toilet has the potential to waste a significant amount of water if the problem is not addressed. The data for the cost analysis of leaking toilets is shown in Table 3.

Water Waste Cost Analysis

		Day (L)	Week (L)	Month (L)	3 Months (L)	6 Months (L)	1 year (L)
Leaking Toilet		100	700	2800	9000	18,250	36,500
Anna Shepina (15 cases)		1500	10500	45000	135000	273750	547500
Cost of Wasted Water (N$9.24/kL):		N$14	N$97	N$416	N$1,247	N$2,529	N$5,059
Cost of Repair Parts (N$78.95/ea):	N$1,184.25						
Days to pay-off:	85						
Augustineum (7 cases)		700	4900	21000	63000	127750	255500
Cost of Wasted Water (N$9.24/kL):		N$6	N$45	N$194	N$582	N$1,180	N$2,361
Cost of Repair Parts (N$78.95/ea):	N$552.65						
Days to pay-off:	85						
Concordia (11 cases)		1100	7700	33000	99000	200750	401500
Cost of Wasted Water (N$9.24/kL):		N$10	N$71	N$305	N$915	N$1,855	N$3,710
Cost of Repair Parts (N$78.95/ea):	N$868.45						
Days to pay-off:	85						
HTS (10 cases)		1000	7000	30000	90000	182500	365000
Cost of Wasted Water (N$9.24/kL):		N$9	N$65	N$277	N$832	N$1,686	N$3,373
Cost of Repair Parts (N$78.95/ea):	N$789.50						
Days to pay-off:	85						

***Leakages rates are estimates based on averages from online research and Dept. of Inf.
Cost of repairs is for partial flush mechanism

Table 3 - Waste Water Cost Analysis for Leaking Toilets

We found resources that gave estimates on how much water could be wasted from a single leaking toilet. Taking averages, we calculated it to be about 100 liters per day. Based on the cost of the repair parts and the number of leaking toilets at each school, we were able to calculate the payback period, which was 85 days for an individual school. At one school, approximately 400 kL of water and N$3500 can be saved annually by repairing toilets.

The final commonly occurring source of faulty infrastructure we found in the schools was missing showerheads. A missing showerhead has the potential to waste a significant amount of water, and was the most common case of faulty infrastructure found in the four schools. The data for the cost analysis of missing showerheads is shown in Table 4.

Water Waste Cost Analysis

		Day (L)	Week (L)	Month (L)	3 Months (L)	6 Months (L)	1 year (L)
Missing Showerhead		120	840	3360	10800	21,900	43,800
Anna Shepina (17 cases)		2040	14280	61200	183600	372300	744600
Cost of Wasted Water (N$9.24/kL):		N$19	N$132	N$565	N$1,696	N$3,440	N$6,880
Cost of Repair Parts (N$36.48/ea):	N$620.16						
Days to pay-off:	33						
Augustineum (28 cases)		3360	23520	100800	302400	613200	1226400
Cost of Wasted Water (N$9.24/kL):		N$31	N$217	N$931	N$2,794	N$5,666	N$11,332
Cost of Repair Parts (N$36.48/ea):	N$1,021.44						
Days to pay-off:	33						
Concordia (24 cases)		2880	20160	86400	259200	525600	1051200
Cost of Wasted Water (N$9.24/kL):		N$27	N$186	N$798	N$2,395	N$4,857	N$9,713
Cost of Repair Parts (N$36.48/ea):	N$875.52						
Days to pay-off:	33						
HTS (29 cases)		3480	24360	104400	313200	635100	1270200
Cost of Wasted Water (N$9.24/kL):		N$32	N$225	N$965	N$2,894	N$5,868	N$11,737
Cost of Repair Parts (N$36.48/ea):	N$1,057.92						
Days to pay-off:	33						

***Leakages rates are estimates based on averages of experiments.
Showerhead price is for standard showerhead

Table 4 - Waste Water Cost Analysis for Missing Showerheads

Through experimentation, we estimated that a single missing showerhead could waste an average of 120 liters of water a day. A shower without a showerhead uses 4.8 liters/min more

than a shower with a standard showerhead. Assuming there are 200 learners living in the hostels at a school, and around 35 showers at each school, we estimated that each shower is used five times a day for five minute shower periods. Therefore, if a shower is used for 25 minutes, and does not have a showerhead, it will waste 120 liters a day. Taking the cost of the repair parts and the number of missing showerheads at each school, we were able to calculate a payback period of 33 days. Throughout a year, a school could potentially save up to 1000 kL of water and up to N$10,000. There is potential for savings, as can be seen in the table.

Insufficient Maintenance

Insufficient maintenance was another source of water inefficiency found in all of the schools. For instance, the large number of leaking taps that do not get repaired suggests that maintenance personnel do not have the knowledge, skills or tools to fix the problem, or even that there are not enough maintenance personnel available at the school. Although every school has maintenance personnel, the school does not always have the money or the capability to fix large infrastructure problems. In these cases, administrators contact the Ministry of Works to send repairmen. Many administrators told us that the Ministry's response time is not as quick as they would like and there often is no government money available to pay for major repairs. One principal anticipated that the schools would soon be required to pay for all of their own maintenance, not just the smaller scale problems, as well as the cost of utilities including water.

Some schools have turned to private contractors for the larger problems, but this is not a feasible solution for schools which do not have the funds to pay for the repairs. To alleviate the costs of their renovations, the principal at WHS solicited outside investors, offering advertising space in exchange for money to maintain the school. At HTS, the superintendent raised hostel fees to fund the renovations and hired alumni of the school who did the work at a discounted price. WHS receives alumni donations of about N$50,000/month, some of which goes to maintenance

Vandalism

Vandalism was a frequent source of water inefficiency, especially in relation to the broken infrastructure. All of the administrators that we interviewed reported instances of vandalism in their bathrooms, both in the schools and in the hostels. For example, at HTS, the superintendent informed us that learners steal the showerheads from hostel bathrooms. It was suggested by a hostel matron that they take the showerheads and keep them in their room in order to ensure that they will have one when they go to use the shower. Measures to secure the showerheads, such as gluing them to the pipes, have failed, and the superintendent is still looking for a solution to this problem. According to him, learners also steal toilet paper, which leads others using newspaper instead, clogging the toilets. Some bathrooms were completely without toilet paper.

Possible causes of the vandalism were suggested by the principals during our interviews. Several believed that for some learners, it's a matter of not being able to express anger except through destructive means. "They have a lack of respect for themselves and other people," explained one principal. This administrator also pointed out that those learners involved with extramural activities are rarely the causes of vandalism. All of the schools encourage extramural activities to build "a sense of self-worth" in the learners, as one administrator said, while keeping them occupied.

Administrators suggested that a lack of supervision may also contribute to the problem. In response to bathroom vandalism, WHS hired private supervisors for N$1000/month whose sole job is to monitor and clean the bathrooms throughout the day. The bathrooms at WHS also have monitored community toilet paper dispensers so that the paper cannot be stolen or used for vandalism. Furthermore, the bathrooms are closed immediately after school to keep learners from spending time in them. Similarly, HTS and Augustineum keep the bathrooms closed during classes and Augustineum's teachers monitor the bathrooms in between classes. At HTS, the keys to the bathrooms and individual stalls are given to prefects and learners must ask them to use the bathroom. Both WHS and HTS reported decreases in vandalism since they began increasing supervision and limiting access to the bathrooms. Augustineum's supervision attempt is still new and has yet to undergo any type of evaluation.

We observed that at Anna Shipena the learners had access to school bathrooms after hours and there was no supervision during school hours. This school had some of the worst instances of vandalism in the bathrooms and has also had its water meter vandalized.

One solution to prevent learners from spending unnecessary time in the bathrooms to commit acts of vandalism was employed by Centaurus. The bathrooms were cleaned with a chemical called *Jay's Fluid*, the smell of which acts as a deterrent to keep learners out of the bathrooms. The first time the chemical was used, the school rented a steam cleaner. Steam cleaners are the method for applying the chemical. Results, according to the principal, were initially successful, but the chemical has since faded. The school board has recently purchased their own cleaner that can be used on a weekly basis to clean the bathrooms and other areas of the school.

Some schools have also changed their discipline policy. At HTS and Augustineum, parents are notified immediately when their child has vandalized school property and must pay for the damage. Administrators see this to be very effective because the learners have been more likely to listen to their parents in these situations. When parents are already paying hostel fees, further charges give them an incentive to encourage positive behavior in their children.

The solutions used by some schools could also be employed by others, but the feasibility of each depends on several factors, one being funds. First, extra supervision costs money that some schools do not have. According to one principal, the schools do not have an incentive to make changes because they do not benefit from any savings. For schools with several bathroom blocks, it would not be as feasible to hire more than two supervisors, which can cost up to N$24,000/year. Likewise, the deterrent chemical can only be used if a school can afford to rent or buy a steam cleaning machine. A machine can be bought for N$19,000 or rented for N$300/hour. The less expensive or no cost solutions used by HTS and Augustineum are the most feasible for all of the schools.

Inefficient Use

There were very few instances of water saving devices in the Focus schools. The most common type of water saving device that we encountered was a faucet aerator. Concordia's school bathrooms, as well as the majority of kitchens we visited, had aerators in place. In

Augustineum, there were self-closing taps within the hostel bathrooms. There were no low-flow showerheads or toilets that we observed in any of the schools. Additionally, there were no toilet dams or other displacement devices within the toilet tanks. These devices are readily available and inexpensive in Windhoek. A cost analysis was done with the water saving devices for which we had flow rates to determine the feasibility of their installation. The data is shown in Table 5.

Water-Saving Device Cost Analysis

		Day (L)	Week (L)	Month (L)	3 Months (L)	6 Months (L)	1 year (L)
Toilet Displacement Device		0.5	3.5	14	45	91	183
Water Saved ***		375	2625	11250	33750	68437.5	136875
Money Saved (N$9.24/kL):		N$3	N$24	N$104	N$312	N$632	N$1,265
Cost of Device:	Free						
Days to pay-off:	Zero						
***(750 Flushes/Day at 1 School):							
Low-Flow Showerhead		250	1750	7000	22500	45,625	91,250
Water Saved (35 Showers at single school):		8750	61250	262500	787500	1596875	3193750
Money Saved (N$9.24/kL):		N$81	N$566	N$2,426	N$7,277	N$14,755	N$29,510
Cost of Device (N$388.00):	N$13,580						
Days to pay-off:	168						

Table 5 - Water Saving Device Cost Analysis

Through experimentation, it was determined that a toilet displacement device, such as a rock or brick, can displace up to 0.5 liters per flush. We assumed that there were approximately 750 flushes per day at an individual school. From this, we found that a school could save up to 140 kL of water and N$1200 annually by installing this free water saving device. We also found that a low-flow showerhead saves approximately 10 liters/min of water when compared to a standard showerhead. If 35 of these devices were installed in a single school, and each was used for 25 minutes a day, the payback period would be approximately 170 days. It should also be noted that, in a single school, up to 3200 kL of water and N$30,000 could be saved annually with installation of these devices. It appears that installation of these devices would be very cost-effective.

Vandalism within the bathrooms and hostels may additionally decrease the feasibility of water saving devices. The sources and results of vandalism (discussed in detail above) may prove to be an obstacle to both infrastructure repairs and improvements.

Lack of Awareness and Water Conservation Education

Many administrators expressed interest in taking a more active role in reducing their school's water consumption. However, some also informed us that they do not see their monthly water bill and do not know the location of their school's meters or how to read them. Some of the schools had been told by the Ministry of Education that their water consumption was too high, but they have no data with which to compare and confirm this. This was true with the majority of the schools. Many administrators have asked to see their water bills but their requests have gone unanswered. This demonstrates a lack of awareness among the administration partly due to the Ministry.

Aside from the lack of administration awareness, many learners have a lack of proper bathroom education. All of the schools host learners who are originally from the rural areas of Namibia and neighboring countries. When these learners arrive, many of them do not know how to use bathroom facilities. This results in inefficiency. For instance, as one teacher informed us, the learners will forget to shut off taps or the showers because they have never used such amenities before and have not been taught the importance of conserving water. This behavior can also have an effect on maintenance, for administrators told us that their workers may neglect bathrooms that have been seriously soiled. HTS and WHS have approached this problem by educating new learners on how to properly use the bathrooms. Administrators from both schools informed us that these brief educational programs, held at the beginning of each school year, have been very successful. Others, however, suggested that this education needs to be given at a much younger age and that secondary school is too late.

Although water conservation is not a mandatory part of the curriculum in any of the schools, many still make an effort to teach it. In our four Focus schools, water conservation is taught in Life Science classes between grades 8 and 10, with topics covering the water cycle, the water situation in Namibia and the government dams. The data collected from learner surveys supports this information. For instance, 76% of learners surveyed knew that Windhoek gets it

water supply from various dams and 28% were able to describe the water reclamation process. Furthermore, 76% of learners were able to give at least one example of a water conserving behavior. Responses included such things as reusing water, shutting off taps when not being used, and educating people on the importance of conserving for the future. Total numbers of answers for this question can be seen in Figure 8.

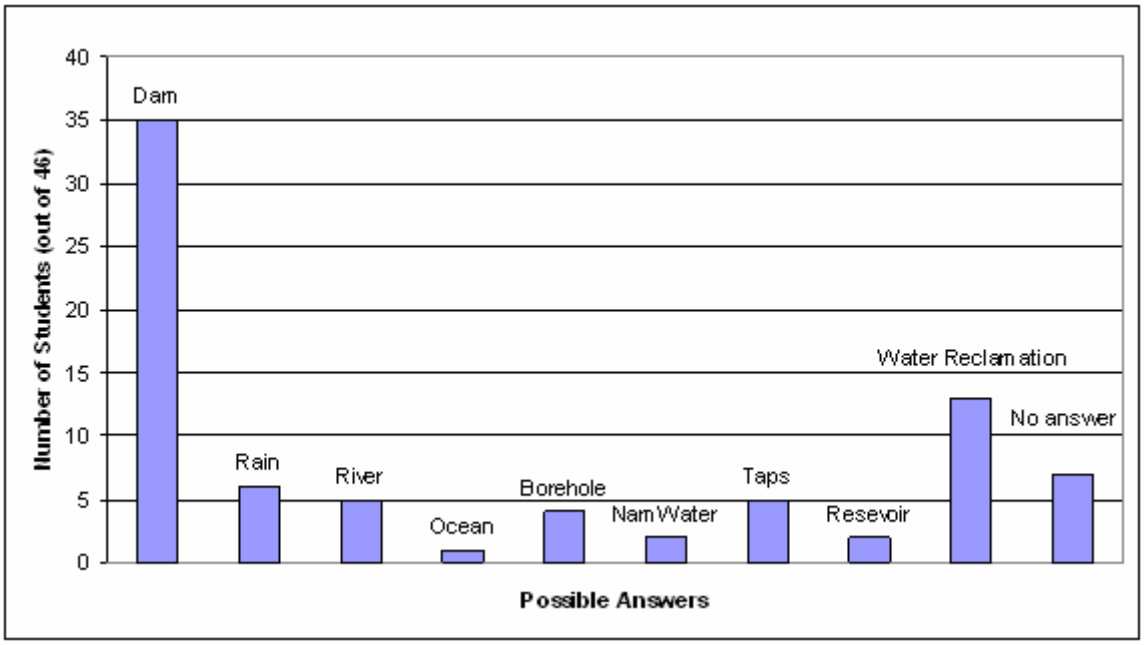

Figure 8 - Answers to Survey Question 6: Do you know what Windhoek's sources of water are? Describe them below.

Our surveys also suggest that learners will be receptive to water conservation education. When asked about their opinion on water conservation, 100% of learners said that people should make some effort to conserve water either all the time or whenever possible. The types of answers are shown in Figure 9. We also asked the learners to describe the conditions of their school's bathrooms and suggest ways of conserving water within them. Some who reported poor conditions gave helpful suggestions for improving efficiency, such as fixing leaking taps and limiting the bathroom hours throughout the day. For learners at schools where conditions were relatively good, they suggested encouraging conservation behaviors, such as reminding everyone to close the taps.

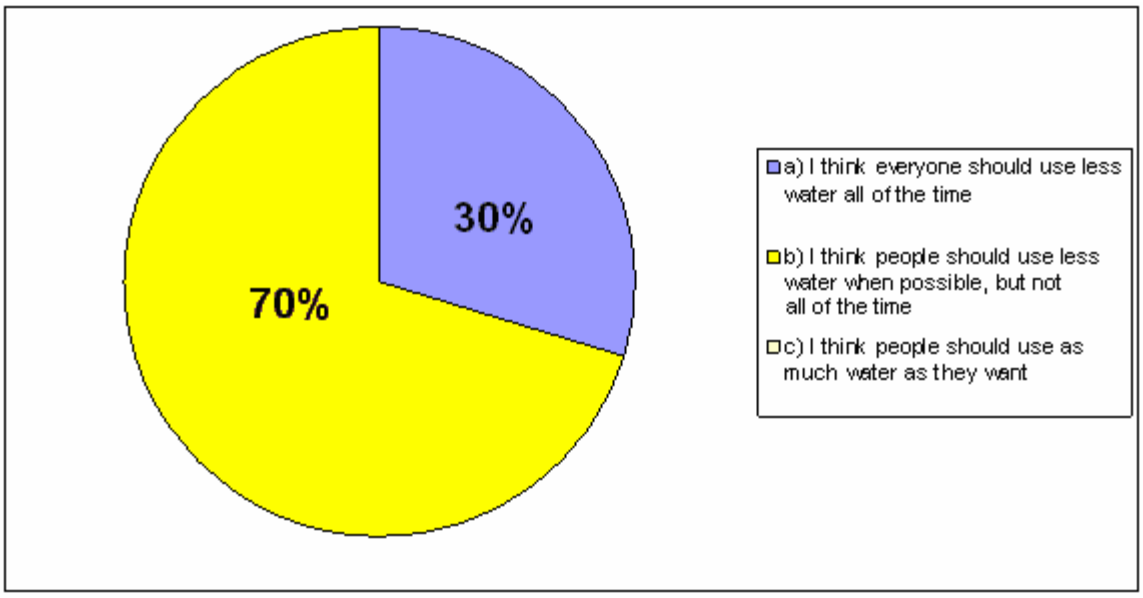

Figure 9 - Answers to Survey Question 5: Do you think people should use less water? Pick the statement that best describes your thoughts.

We received inconclusive answers when learners were asked about the amount of water they used for their daily activities. We wanted to gain a general idea of their awareness towards the amount of water they used for each of these activities. The question was interpreted differently by the learners and the answers were inconsistent. Some gave amounts for their overall daily water consumption and some gave amounts per activity they listed.

Collectively, the data from the learner surveys suggest that most learners possess basic knowledge of water awareness and conservation measures. However, the presence of incorrect answers and misconceptions in responses suggest that learners could benefit from further conservation education.

According to the principal at Augustineum, the newly written 2007 national curriculum frameworks include water conservation as a subtopic under pollution and environmental conservation. This will make it mandatory for all 11th grade biology learners to learn about water conservation. However, some learners may never study conservation if they do not take biology. It was the opinion of some administrators that learners should study conservation at least once a year. This suggests that administrators would be open to expanding the role of conservation in the curriculum.

When asked about expanding the role of water conservation in the curriculum, many administrators said that the frameworks are "tight" and leave little room for extension of any one topic. Despite these findings, there may be a place for water conservation outside of the formal curriculum. For instance, several administrators reported participating in a water awareness day in 2004. The event was designed to act as a competition where learners answered questions about water use and conservation. The event was sponsored by the Department of Infrastructure, Water and Technical Services and all of the administrators said that it was very successful and well received. There was no follow up in succeeding years, though administrators had been expecting one. On a smaller scale, select learners from each school are able to participate in conservation projects, but these initiatives do not reach all of the learners. Those that do participate are able to visit the Gammas Water Care Works and learn about the reclamation process. There is also the opportunity for schools to continue to talk about water awareness through science projects, maintenance projects and awareness competitions. For most schools, there are no funds available for extra programs, so inexpensive or externally funded initiatives should be considered to be the most feasible.

Making Connections

All of our observations and interviews revealed that the causes of inefficiency within the schools are interrelated. For instance, vandalism creates faulty infrastructure which then leads to water inefficiency. Insufficient or delayed maintenance may foster faulty infrastructure. The subsequent poor conditions of the bathrooms may lead to a lack of respect for the school which, in turn, may foster more vandalism. Vandalism is also likely caused in part by a lack of awareness, as well as by an absence of supervision. Figure 10 shows a visual diagram of the relationships between the causes of inefficiency. Ignoring one source of inefficiency can diminish the benefits of improving the others.

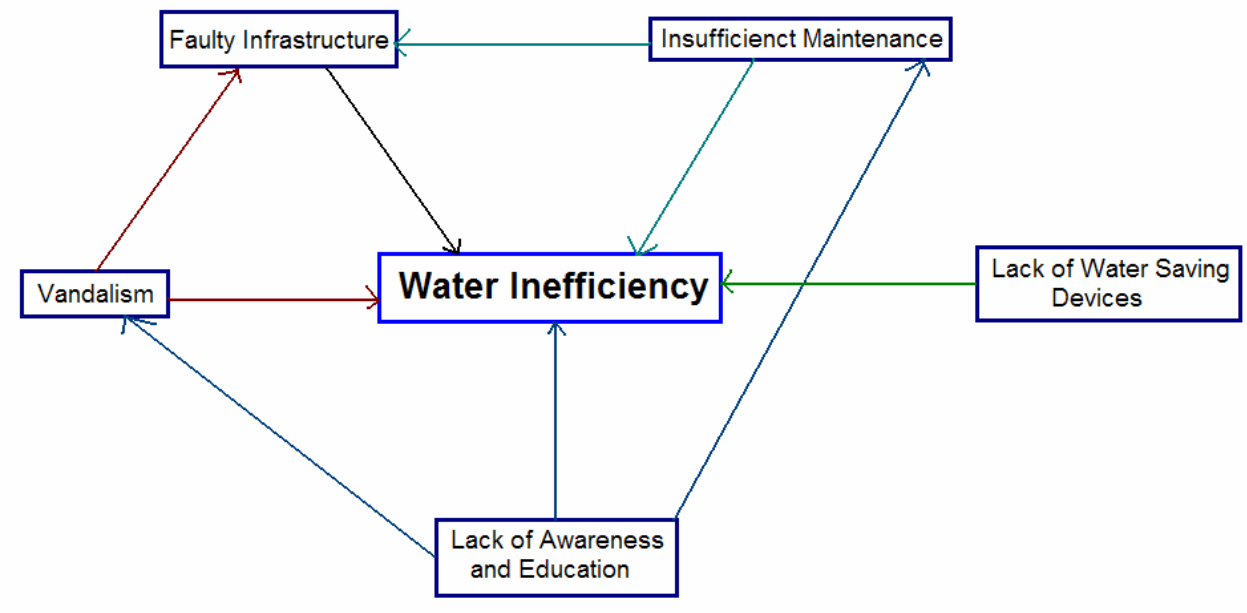

Figure 10 - Concept Diagram

CHAPTER 5: RECOMMENDATIONS

The sources of water inefficiency that we found in the schools consist of special cases of major wastage, faulty infrastructure, lack of maintenance, inefficient use, vandalism and lack of education and awareness. They each have several potential solutions. For each source, we present recommendations for improving efficiency and, ultimately, reducing consumption of water. This would also have the added benefit of reducing water bills. We include the feasibility of each possible option and specify which recommendations are of a higher priority. Our conservation measures were designed with our specific Focus schools in consideration, but could possibly be implemented in other Windhoek schools or even elsewhere where there are similar problems with consumption.

Infrastructure Improvements

Faulty infrastructure was present in every school that we visited. However, we observed that large scale issues like burst pipes and heavily leaking boilers, such as at Augustineum, caused the most water wastage. Augustineum's consumption was 224 Lpcd which is much higher than a reasonable amount of 80 Lpcd. For types of severe faulty infrastructure observed in Augustineum or any school with similar issues we recommend that:

- **The Ministry of Works or the Department of Infrastructure, Water and Technical Services address major infrastructure problems immediately:** These problems are sources of a significant amount of water waste within Augustineum. In Fourie's study, conducted in 2004, the night flow at Augustineum was around 14 kL/hour. If these levels of wastage persisted, as consumption data has suggested, the amount of water wastage will cost the school 1000 kL of water and N$93,000 per month. The Ministry of Works should address these issues immediately. If this is not possible then the Department should take responsibility for the completion of the repairs and bill the school. This would at least alleviate the high consumption. In the past, the Department has made repairs in Windhoek schools when the Ministry did not, therefore this recommendation is highly feasible and also of great importance because of the significant savings it can achieve.

We also noticed that the consumption for HTS was unusually high. This is most likely due to the fact that the school uses fully purified water for landscaping purposes. Generally, semi-purified water is used for landscaping and is recorded on a different meter. In the case of HTS and any other schools that use fully purified water for landscaping we recommend the following:

- **Investigate the possibility of using semi-purified water for landscaping:** Semi-purified water is roughly $1/10^{th}$ the cost of fully purified water. Currently, HTS is using an average of 125 Lpcd, which is much higher than the suggested amount of 80 Lpcd. If the school switched to semi-purified this high consumption of potable water could be reduced by about a quarter to a half of the schools current consumption. We understand that switching to a semi-purified water source may also have the added burden of paying for the installation of a new piping system. However, the monetary savings the school could gain would be in great excess of the initial investment and we highly recommend that HTS explore this option.

Aside from specific wastage problems at HTS and Augustineum, we noticed that all four of our Focus schools had instances of faulty infrastructure in the bathrooms. Leaking taps, leaking toilets, and missing showerheads were all present. In this case we recommend that:

- **Either the schools themselves, the Ministry of Works, or the Department of Infrastructure, Water and Technical Services fix the instances of smaller faulty infrastructure such as leaking taps, leaking toilets, and missing showerheads as soon as possible:** If the problems were to be addressed the amount of water wastage would be significantly reduced. Included below are the estimated cost, payback period, and potential average water savings for each plumbing fixture for one individual school. The numbers were obtained through research and experiments and were analyzed using a cost analysis as mentioned in the previous chapter. Our cost analysis showed that:
    - Repair parts for leaking taps would cost approximately N$20, and the payback period for that investment would be approximately 9 days. Over the course of a year, a total of approximately N$900 and 93 kL of water could potentially be saved per school.

- Repair parts for leaking toilets would cost approximately N$850, and the payback period for the investment would be approximately 85 days. Over the course of a year, a total of approximately N$3500 and 390 kL of water could potentially be saved per school.
- By adding a standard showerhead to a shower that is missing one, the cost of parts would be approximately N$900 and the payback period would be approximately 33 days. Over the course of a year, a total of approximately N$10,000 and 1000 kL of water could potentially be saved per school.

Based on the possibility for water and financial savings, this recommendation is of a high priority. However, the savings from this recommendation will not be sustained unless some of the underlying causes of the faulty infrastructure are eliminated. Some of these causes, such as insufficient general maintenance and vandalism, are discussed below in detail. There is also a need for inexpensive skilled labor to complete these repairs to alleviate the cost. Our following recommendations address this issue and should be considered before encouraging the schools to make repairs themselves.

Maintenance Expansion

General maintenance is something that all four of our Focus schools could improve. In many cases, faulty infrastructure remains unfixed for extended periods of time. This could be due to several factors, including the irregular response time from the Ministry, a lack of funds within the schools to complete the repairs themselves, or a lack of maintenance knowledge among the workers. Schools that do have the funding generally make repairs on their own, as we learned at WHS and HTS. In order to improve the quality of maintenance within the schools, we recommend the following solution:

- **Train current maintenance workers to do repairs:** The formation of a partnership between the schools and the Windhoek Vocational Training Center (VTC) would be an effective way to complete repairs as well as educate the current maintenance personnel. The Department of Infrastructure, Water and Technical Services should encourage the formation of this partnership, and the Ministry of Works should help to organize it.

Apprentices at the VTC are required to practice their skills while completing their training. The apprentices can simultaneously make repairs themselves as well as supervise the current maintenance workers' repair process. The labor required for completing these repairs would be available at no cost, and the tools to complete them would be provided while the VTC apprentices were present. For these reasons, we have concluded that this solution is very feasible and we highly recommend that this partnership be formed.

After the maintenance personnel at the schools have been sufficiently trained, they will need tools of their own to complete repairs. For this reason we recommend that:

- **Schools invest in the tools needed to complete basic repairs:** Investing in a set of tools to be shared amongst all the maintenance personnel at a school would alleviate the dependency of the schools on the VTC, assuming a partnership is formed. Tools vary widely in cost but a basic tool set can be acquired for under N$200.

Property Damage Prevention

Vandalism was common in all four of our Focus schools. If this underlying cause of water inefficiency is not addressed, it is unlikely that any infrastructure improvements will be sustained. If a school spends an average of approximately N$1700 per year (the price to repair faulty infrastructure as determined in the previous chapter) to repair vandalism committed within the bathrooms, then there is no long-term financial gain or consumption reduction achieved. Also, we have found that preventing vandalism in the bathrooms at one school has the potential to save that school approximately N$14,500 per year in water costs from the same cost analysis. It is also important to note that the cost of maintaining the infrastructure rises with repeated acts of vandalism. We will discuss three ways to possibly reduce the amount of vandalism in any school. All three approaches are possible in any school and we encourage administrators to implement as many as possible.

Opportunity Reduction

The opportunity reduction approach, which attempts to make vandalism more difficult or impossible to commit, has been shown by researchers to have the potential to be more effective in prevention and have a more immediate impact than therapeutic approaches (Hope, 1980). Increasing supervision is one method of opportunity reduction, and was found to be effective when implemented at WHS. A second method of opportunity reduction, decreasing access to bathrooms, was also effective at WHS and HTS. We recommend this method for all schools due to its low cost. Possible solutions include:

- **Limit bathroom hours:** Bathrooms can be locked during after-school hours. If they are opened for extramural activities, then monitors should be present. In the hostels, where it is impractical to have monitors throughout the day, the bathrooms should be closed during school hours and opened only during hours when learners can be supervised. This was done at both HTS and WHS, and was found to be highly successful.
- **Lock the bathrooms:** This method is essentially free due to the fact that no one will be paid and nothing needs to be purchased assuming that all bathrooms already have locks on them. Prices to attach a locking mechanism to existing bathroom doors would be minimal. Therefore, this recommendation is of a high priority and is applicable to all schools regardless of their current condition or financial status. Outlined below are two options for keeping the school bathrooms locked.
    - **Monitored by a prefect:** Those learners in the school that the administration feel they can trust can be given keys to the bathrooms. They will then be responsible for opening and closing the bathrooms between classes or at other times specified by the administration. Those learners will also be asked to report instances of vandalism to the administration. This method was employed at HTS and was found to be highly successful.
    - **Monitored by a teacher:** Between class times or at other specified times of the day, teachers can act as bathroom monitors, such as was done in Augustineum. When there is no teacher to monitor, the bathrooms remain locked. Also it is important to realize the overall demand for teacher attention, meaning that the teacher may not always be able to monitor as well as is needed.

- **Hire bathroom monitors:** There are more costly options, which can be more effective, for preventing vandalism. Where funds are available, schools can hire men and women to monitor learners and be responsible for maintenance within the bathrooms. Our research has shown that learners will be less likely to commit acts of vandalism if they know they will be caught by the monitor. This method was employed at WHS and was found to be highly successful. WHS had the least amount of vandalism out of all the schools we visited. Furthermore, regular maintenance will prevent the conditions from becoming unmanageable or unhygienic. We estimate the cost to be about N$1000/month per monitor, as was in WHS. For schools with multiple bathroom blocks, this option will not be feasible, for the cost will be greater than the potential benefit if more than three monitors are hired. However, for a school with single block bathrooms, hiring two monitors for the year would cost only N$24,000.

  Concordia was our only Focus school with single block bathrooms. Roughly, the school spends N$48,000 on maintenance per year, most of which is to repair vandalized infrastructure. A bathroom monitor would reduce this cost by providing general maintenance and preventing vandalism. Therefore, hiring bathroom monitors in Concordia could save the school approximately N$24,000 per year.
- **Build single block bathrooms:** Construction of future schools within the city should include single block bathrooms like those found at WHS and Concordia. We found that schools with single block bathrooms were in better condition than schools with multiple blocks. As noted before, WHS had the best conditions and this can be partially attributed to the fact that the school has single block bathrooms.
- **Encourage or require extramural activities:** If schools do not wish to lock or monitor their bathrooms after school hours, there is another alternative. They can continue to encourage, or require, learner involvement in extramural activities. Such involvement limits the free time that learners may have to commit vandalism after hours and may foster a sense of pride in the learners for their school, making them less likely to damage school property.

School Policy Reform

Another preventative tactic discussed by Hope is the school reform approach in which schools readjust their policies on discipline and positive reinforcement (Hope, 1980). Both HTS and Augustineum reported decreased vandalism when parents were notified of the offense and required to pay for the damage. Furthermore, the superintendent at HTS informed us that rewards for good behavior among hostel learners, such as movie nights and special dinners, also helped to decrease vandalism within the hostels. In light of these findings, we also recommend that schools:

- **Increase discipline:** Schools should contact parents immediately following an act of vandalism. Having monitors in the bathrooms will make it easier to determine which learners are causing the property damage. However, this method will not be feasible unless there is a way to identify the culprit.
- **Implement positive reinforcement:** Learners who do not vandalize can be rewarded for their good behavior. Depending on the reward, there may be some cost to the school.

Learner Involvement

Our research has shown that learners are less likely to vandalize property for which they feel a sense of ownership or pride. Learners can gain these feelings by performing some of their school's maintenance themselves. Furthermore, the study by Pablant and Baxter goes on to conclude that poorly maintained schools experienced more vandalism than those that were well kept (Hope, 1980). We therefore recommend that schools consider:

- **Implementing learner maintenance projects:** Taking part in the maintenance of their school can provide learners with a practical education and possibly a sense of ownership and pride for their school. Schools would need to finance the materials, but they would not need to pay for labor. This could possibly be done in conjunction with volunteers from the VTC as was mentioned earlier. In addition to fixing taps and toilets, the schools could take the opportunity to paint over graffiti or remedy other forms of vandalism in the school.

Installation of Water Saving Devices

Another method of improving water efficiency would be to install water saving devices (WSDs). Currently, there are very few WSDs within the schools. There are some steps that every school can take regardless of financial situation. To increase water efficiency within any school we recommend the following:

- **Install flow restrictors in the showers:** These restrictors can be easily installed between the shower neck and the showerhead and eliminate the need for expensive low-flow showerheads while providing a similar amount of savings. This method is only recommended if the schools can prevent the removal of showerheads.
- **Install displacement devices inside toilet tanks:** Displacement devices can range from a dam made specifically for a toilet tank to rocks or bricks. This is highly feasible because it provides for a significant amount of water savings, up to a half liter with every flush. Our cost analysis showed that parts would be available at a minimal charge or free, and the payback period for that investment would be almost instantaneous if rocks were used. Over the course of a year, a total of amount of approximately N$1200 and 137 kL of water could potentially be saved per individual school. For these reasons we highly recommend this method of improving water efficiency in toilets. However, learners may remove rocks or bricks that have been placed in the toilets and use them in inappropriate ways.
- **Install faucet aerators:** The sinks in most of the kitchens within our Focus schools as well as some sinks in Concordia's school bathrooms had aerators. This is an effective way to improve water efficiency because aerators are inexpensive and easy to install. They create water savings by using up to 40% less than the tap would use without it. Kitchens experienced the least vandalism within the schools, meaning that the aerators will most likely remain in place. Therefore we recommend that aerators be installed in all school kitchens.
- **Reduce water pressure below sinks:** In most schools that we visited, we observed shut-off valves below the sinks. In order to reduce water consumption, one can shut the valve slightly, which in turn reduces the flow. This can be done by a school prefect or an

administrator once or twice a month. This is very feasible and highly recommended because it can be done at no cost and will reduce water consumption.

The aforementioned recommendations are possible within any school. However, some schools may have access to more funds and can install more WSDs. For schools that have an effective vandalism prevention technique, as well as available funds, we recommend that they complete the following:

- **Install low-flow showerheads:** Schools such as WHS can benefit from low-flow showerheads because they already have a successful anti-vandalism program in place, as well as the funds to install them. Our cost analysis showed that low-flow showerheads would cost approximately N$13,500 for a single school, and the payback period for that investment would be approximately 150 days. Over the course of a year, a single school can save a total of approximately N$33,000 and 3500 kL of water. This recommendation is of a high priority within schools that can afford the installation and ensure that the showerheads will not be vandalized or removed.

Awareness through Education

Water inefficiency is indirectly and directly caused by a lack of awareness and education in the learners, administrators and other school employees. There are several options available to schools that can foster awareness. Some of the following recommendations will require assistance from other organizations. Even though the benefits of an educational program are difficult to measure and the payback periods for such investments will not be as immediate as those for other recommendations, the benefits of educational programs can stay with the learners for years. We recommend the implementation of the following programs as long term investments.

Hygiene Education

A recurring problem that we found within the schools was lack of water awareness and hygiene education amongst rural learners who have grown up without modern plumbing. As a result, they often don't shut off taps or showers when they are finished because they were never taught the importance of doing so. Furthermore, when the toilets are improperly used, they contribute to the overall poor conditions of the bathrooms. At WHS, all eighth graders go through an orientation program where they are taught how to use the bathrooms regardless of the area from which they came. Similarly, at HTS, learners are peer educated on bathroom use and water awareness. Administrators at both schools claimed that their initiatives were successful. Considering that lack of water awareness and hygiene education is a common problem, we recommend that:

- **Schools implement hygiene education programs:** Proper bathroom use and water awareness should be taught at a young age, in primary school whenever possible. However, in cases where this is not possible, an effort should be made to educate older learners on proper bathroom use and water awareness. Such an educational program may last a maximum of a few hours and would be inexpensive to implement. In addition to decreasing consumption, preventing improper use will stop hygiene conditions from becoming poor and fostering vandalism or insufficient maintenance.

Information for Administrators

Several administrators expressed an interest in taking a more active role in lowering their school's water consumption. However, some did not know the location of their school's meters or how to read them. Furthermore, not all of the principals saw their monthly water bill before it was sent to the Ministry of Education. We believe that, with cooperation between the Department and the Ministry, the administrators could begin to take an active role in reducing their schools' consumption. In order to accomplish this we recommend:

- **Providing administrator awareness:** With the assistance of the Department of Infrastructure, Water and Technical Services, an inspector from the Department could show the administrators the location of and how to read their meters. An educational

pamphlet can be designed for the schools detailing how to read the meters in case the Department cannot afford the time to teach them in person. Also, copies of the schools' monthly water bills can be sent to administrators either by the Department or the Ministry of Education.

Learner Education

Data collected from our learner surveys revealed that most learners possess a basic level of water awareness, but that they could benefit from further education in water conserving behaviors and their water sources. After speaking with administrators, we determined that expansion of the new national curriculum is not feasible. However, there was great support for programs that were of a short duration or occurred outside of the regular school day and were low cost. From this we have concluded that there is a place for water conservation education in the schools. With cooperation between the Ministry of Education and the Department of Infrastructure, Water and Technical Services, we recommend:

- **Implementation of an Annual Awareness Day:** The enthusiasm that administrators expressed for the 2004 Awareness Day indicates that it should be repeated. This will most likely require cooperation between the Ministry of Education and the Department. The previously used materials could be updated and reused, eliminating the cost of producing brand new materials.

There are also many other initiatives that can be taken to help educate learners about their schools water consumption. Some ideas for additional initiatives include:

- **Encouraging a school competition:** A competition between all of the secondary schools would provide schools with an incentive to reduce their consumption while simultaneously giving learners something to be proud of. Furthermore, it could be used as an opportunity to educate learners on their water use. If learners are constantly reminded to save water in order to win an award, they may form good water use habits while in school.
- **Host field trips:** The Department of Infrastructure, Water and Technical Services could host field trips to the Goreangab Reclamation facility so that learners could see for

themselves the process that they hear about in class. If they see the effort and technology put into making their water exceptionally clean, then they may put more effort into conserving it. We recommend that the trips be offered to science classes so that it will be relevant to their formal education.

- **Distribute newsletters:** The Department can publish a newsletter to give out to learners once a term. The newsletter would contain information on water conservation, current conditions in Namibia, school water consumption and other relevant topics. These too can be distributed in science classes or as part of an Awareness event.
- **Implement meter monitoring:** Groups of learners could be taught how to read meters as part of a science or mathematics class or other extramural activity. In addition to being educational, this activity will give the learners a sense of ownership over the meters and may keep them from being vandalized. The same pamphlet that will be distributed to administrators could be utilized by teachers for this initiative.
- **Encourage science projects:** Several schools hold science fairs. Water Conservation can be encouraged as a topic of research for learners with which to experiment.

Preparing for Implementation

There is no known incentive for administrators to attempt to reduce water use in their schools. The development of one would provide the momentum for our previous recommendations to be implemented. Finally, we recommend that:

- **The Ministries of Education, Finance, and Works, in conjunction with the Department, cooperate to develop an incentive for administrators to reduce their schools' water consumption.** We suggest allowing a portion of money saved from water use reduction to be given back to the schools to fund other educational initiatives. Any solution should benefit all of the involved parties.

Closing Remarks

Though we have reached the end of our project, the findings and recommendations raise some questions about the nature of water wastage in schools. For instance, if the schools were

required to pay their own water bill, would they be more likely to make the effort to reduce their consumption? Currently, the billing account lies with the Ministry of Education, for the Department has told us that they are more likely to get paid for the water by the Ministry than individual schools. However, as one administrator mentioned, schools may eventually be required to pay for their utilities themselves. We anticipate that such an arrangement would encourage schools to prevent water wastage, but what can encourage them in the meanwhile? There is no known incentive for administrators to attempt to reduce water use in their schools. The development of one would provide the momentum for our recommendations to be implemented.

How does behavior affect water inefficiency in the schools? Unfortunately, we were unable to thoroughly explore the aspect of behaviors, such as shower length. Future studies of water inefficiency would benefit from a closer investigation of behavior, the results of which may reinforce our conclusion that conservation education will be a worthwhile investment. Furthermore, if schools or other sponsoring organizations choose to implement educational programs, the effectiveness of such initiatives will need to be measured. Evaluation will provide a basis for improvement, a process that is important to the development of new educational tools and programs.

We anticipate that other schools in Windhoek may benefit from these methods of improving water efficiency, as well. Any educational programs that are developed could be extended to schools that we did not study. Schools in other areas of the world that may be facing similar problems, such as vandalism in the bathrooms, may also find these recommendations useful. Furthermore, now that the Department is aware of the major cases of water wastage, such as Augustineum's leaking boiler, they may find it worthwhile to search for severely damaged infrastructure in other large consuming institutions.

Once implemented, these recommendations are intended to reduce the water consumption in our Focus schools as well as save significant amounts of money. We estimate that 6,128 kL of water and N$140,500 can potentially be saved annually for all four of our Focus schools combined by repairing the infrastructure, installing water saving devices and maintaining the repairs and improvements that are made. The options we have described also have the added benefit of working to improve the overall conditions in the schools through increased maintenance and vandalism prevention. The maintenance and educational initiatives may

encourage more cooperation between the schools and the Department of Infrastructure, Water and Technical Services, as well as between the schools and the Ministries of Education, Finance and Works. The educational initiatives also provide schools with the opportunity to foster water awareness in future generations. Lastly, the money saved by reducing consumption can be directed elsewhere in the government, perhaps back to the schools themselves.

This project can benefit Windhoek Schools, the Department of Infrastructure, Water and Technical Services and the city of Windhoek as a whole. Decreasing consumption within the schools, or any institution that has been identified as a large consumer, can lead to faster recharge of the aquifer and, therefore, ensure that the City will continue to have enough water to sustain its development. Schools have the opportunity and capability to significantly reduce their consumption, as well as to foster life long water awareness. However, the success of such initiatives will depend on the involvement and cooperation of city leaders, school administrators and, perhaps most importantly, Windhoek's learners.

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APPENDIX A: DEPARTMENT OF INFRASTRUCTURE, WATER AND TECHNICAL SERVICES

The Department of Infrastructure, Water and Technical Services is in charge of treating all water that is distributed to Windhoek residents, both by NamWater and the cities alternate water supplies.

Information released by the City of Windhoek indicated that water consumption is steadily rising. Therefore there is an increasing demand on the Department to manage and meet the demands of Windhoek residents and institutions.

The Department consists of six divisions:

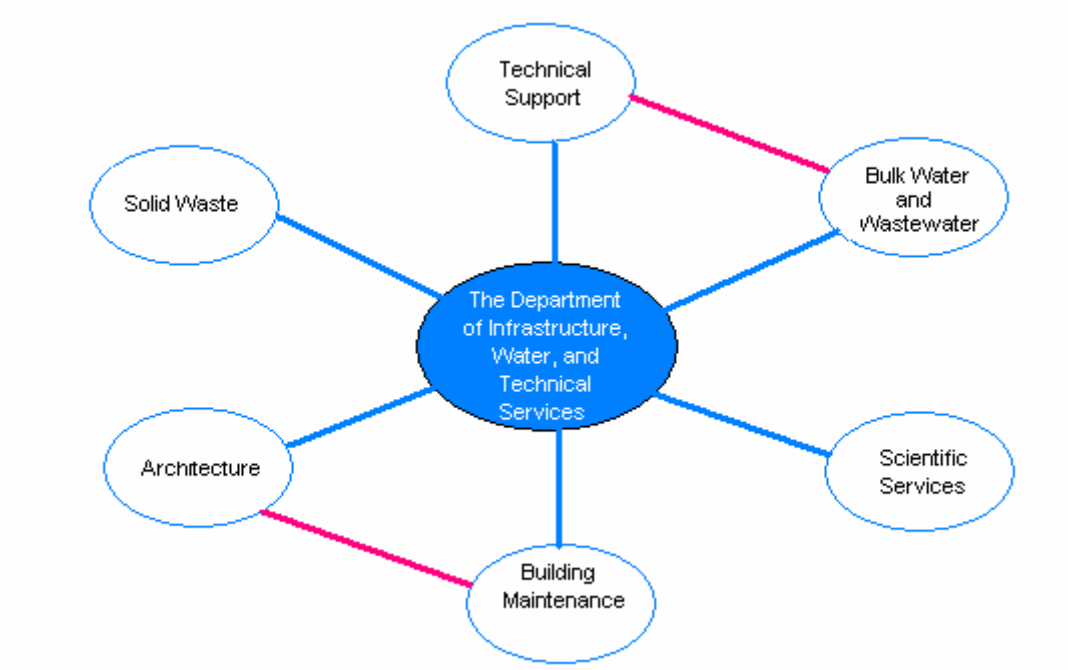

Figure 11 - The Department of Infrastructure, Water and Technical Services

The Department of Technical Support is responsible for water and sewer related infrastructure. This is in cooperation with the Bulk Water and Wastewater division which supplies water to the city and collects and treats the wastewater. Likewise, the Department of Solid Waste manages the waste collection systems and provides for environmentally friendly disposal. The Architecture and Building Maintenance divisions oversee and maintain the structural needs of the existing and future buildings. The Department of Scientific Services controls the quality of water and waste water within the city.

APPENDIX B: DETAILED INTERVIEW PLAN AND GUIDES

IQP: Water Conservation in Windhoek Schools

Interview Packet

March 30 – April 6, 2006

Contents:

- Interview Guide: Reference Schools
  - High Technical, Centaurus, Windhoek High, Anna Shipena
- Interview Guide: Focus Schools, Parts I and II
  - High Technical, Anna Shipena, Augustineum, Concordia
- Project Summary Sheet
  - Print 1 for each principal at Focus Schools
- Learner Survey
  - Print 20 for each Focus School

Interview Guide: Reference Schools

High Technical School, Thursday March 30, 2006, 9 a.m.

Windhoek High School, Monday April 3, 2006, 7:30 a.m.

Centaurus, Monday April 3, 2006, 9:30 a.m.

Anna Shipena, April 7, 2006, 3:00 p.m.

Target Respondents: Principals and/or maintenance personnel

Concepts: School Demographics, Repairs, and Savings

Demographics:

a) How many learners? Teachers? Staff (maintenance personnel)? Non-staff?

b) Do your learners live in a school hostel? How many?

c) Do other staff/non-staff live in the hostel? How many?

Repairs:

1) What types of repairs were made to your school's infrastructure?
2) When were the repairs completed?
3) How were the repairs paid for?
4) Who made the repairs?
5) Who monitors the repairs/infrastructure now?
6) Were the repairs durable or are they in need of further maintenance?
7) How successful do you feel the repairs were in reducing the school's consumption?
8) **How much money does your school spend on maintenance each year?**
9) **When a leak or other problem is detected, in what period of time do you usually have it repaired?**
10) **Do you feel that your school is in need of plumbing repairs?**
11) **If so, what areas of your school need them the most?**

Savings:

I. What were your initial savings?

II. Have you maintained those savings since the repairs?

III. Do you think that your school is capable of further savings?

Interview Guide: Focus Schools, Part I

Augustineum, Friday March 31, 2006, 9 a.m.

Concordia, Friday March 31, 2006, 1:30 p. m.

Target Informants: Principals and/or maintenance personnel

Concepts: School Demographics and Repairs

Demographics:

a) How many learners? Teachers? Staff? Non-staff?
b) Do you learners live in a school hostel? How many?
c) Do other staff/non-staff live in the hostel? How many?

Repairs:

1) Who monitors the plumbing in your school?
2) When a leak or other problem is detected, in what period of time do you usually have it repaired?
3) Do you feel that your school is in need of plumbing repairs?
4) If so, what areas of your school need them the most?
5) Are you aware of the repairs made in 4 other schools that resulted in significant savings in water consumption?
6) How much money does your school spend on maintenance each year?

Interview Guide: Focus Schools, Part II

High Technical School

Augustineum Friday March 31, 2006, 9 a.m.

Concordia, Friday March 31, 2006, 1:30 p. m.

Anna Shipena, April 7, 2006, 3:00 p.m.

Target Informants: Principals and Classroom Teachers

Concepts: Water Conservation Education

1) Does water conservation get frequent attention in the classroom, or is it a topic that is discussed occasionally during the year?
2) In what grade do learners begin learning about water conservation?
3) Is water conservation taught as a separate unit or integrated throughout the curriculum?
4) Is water conservation the focus in one particular grade or does it receive equal attention in all grades?
5) Which subjects might include activities on water conservation?
6) Do you have any specific examples of activities teachers have used to teach learners about water conservation?
7) Do you sponsor a school-wide campaign or competition that specifically promotes water conservation? Energy conservation?
    i. If yes, what is the goal of the campaign? What is the level of participation in the campaign? How is it publicized?
8) Do learners seem enthusiastic when learning about water conservation? Is it the activities or delivery/presentation that makes them excited/disinterested?
9) Have you noticed the learners practicing what they have learned?
10) Do you think there is space in the current curriculum to expand the presence of water conservation? What subject areas could include more activities on water conservation?
11) What constraints do you anticipate preventing expansion of water conservation in the curriculum?

Windhoek Schools Water Use Research Study

Researchers: Richard Gilley, Rebekah Sullivan, Scott Tang, Amanda Tarbet
Worcester Polytechnic Institute, USA
Polytechnic of Namibia
The Dept. of Infrastructure, Water and Technical Services

Goals:

- Determine sources of water inefficiency in Windhoek Schools
- Learn from teachers and learners about the potential for water conservation education

Tasks:

Observations

- Inspect plumbing/infrastructure
- Indirectly observe water use behavior (hand washing)
- Directly observe water use behavior (dish and clothes washing)

Interviews

- Individually interview an administrator or maintenance personnel concerning school's demographics and infrastructure
- Interview one administrator and a few teachers in a group about water conservation education

Survey

- Survey learners (at least one class in each grade) on their water knowledge and water use behavior

We estimate needing 2-3 hours in your school to complete the observations and interviews.

Thank you!

APPENDIX C: WATER KNOWLEDGE SURVEY

Water Survey

School: Grade:

Please answer the following questions. Leave blank any questions you cannot answer. If you run out of space, please continue your answers on the back of this sheet.

1) What are the ways in which you use water at home or in school each day?

2) Thinking about your answer above, how much water (in litres) do you think you use each day for those activities?

3) What are some things you can do to use less water at home or in school?

4) What do you think of the bathrooms at your school? Is there something that your school can do to use less water in the bathrooms?

5) Do you think people should use less water? Pick the statement that best describes your thoughts.

- o I think everyone should use less water all of the time.
- o I think people should use less water when possible, but not all of the time.
- o I think people should use as much water as they want.

6) Do you know what Windhoek's sources of water are? Describe them below.

APPENDIX D: DATA COLLECTION RUBRIC AND TABLE FOR REFERENCE SCHOOLS

Data Collection for Schools With Previous Improvements (Reference Schools)

Rubric for Data Collection Table:

Repair/Change Made as School and Date if Known

- The specific repair/change will be noted from interviews and observations. The date will also be noted to aid in seeing how the repair/change is progressing

Cost

- **Expensive** – A rating of Expensive signifies: The repair/change made cost a significant amount of money for materials and man hours involved.
- **Moderate** – A rating of Moderate signifies: The repair/change made cost some moderate amount for materials and man hours involved.
- **Inexpensive** – A rating of Inexpensive signifies: The repair/change made did not cost anything for materials and man hours involved.

Long-term Sustainability

- **Sustainable** - A rating of Sustainable signifies: The repair/change lasted for many years after implementation.
- **Somewhat Sustainable** - A rating of Somewhat Sustainable signifies: The repair/change lasted for some time. Implementation in the future may be likely.
- **Not Sustainable** - A rating of Not Sustainable signifies: The repair/change will not last very long and should not be implemented.

Water-Saving Potential

- **Significant Savings** – A rating of Significant Savings signifies: A significant reduction in the amount of water used.
- **Moderate/Little Savings** – A rating of Moderate/Little Savings signifies: Some water saved.
- **No Savings** - A rating of No Savings signifies: The same amount of water or more will be used as before.

Feasibility of Future Implementation

- **Very Feasible** – A rating Very Feasible signifies: The repair/change is still in good condition at the present time and was effective.
- **Feasible** - A rating of Feasible signifies: The repair/change is in good condition at the present time and was effective to somewhat effective.
- **Somewhat Feasible** - A rating of Somewhat Feasible signifies: The repair/change is in acceptable condition at the present time and was somewhat effective.

- **Not Feasible** - A rating of Not Feasible signifies: The repair/change is faulty at the present time and was not effective at all.

School Name:

Repair/Change Made at School and Date if Known	Cost	Long-Term Sustainability	Water-Saving Potential	Feasibility of Implementation

APPENDIX E: DATA COLLECTION RUBRIC AND TABLE FOR FAULTY INFRASTRUCTURE IN FOCUS SCHOOLS

Explanation of Faulty Infrastructure Data Collection Sheet

This data collection sheet will be used for identifying the total number of sources of faulty infrastructure in the Focus schools. Those schools are Augustineum, Concordia, Windhoek Technical School, and Anna Shipena. A separate data collection sheet will be used for each school. The sheet is divided into different locations of the school where water wastage can occur.

- Bathroom – The total number of all the plumbing fixtures in each bathroom is first noted (sinks, toilets, showers, etc.). Then, the number of cases is tallied for the faulty infrastructure by each type of problem that is present for each fixture (leaking, missing handle, missing aerator) within each bathroom.
- Kitchen – Same as above.
- Laundry – Same as above.
- Outside – Same as above.

This data will allow us to get a total count of all the leaking plumbing fixtures in the bathrooms, kitchens and laundry rooms of each school.

Data Collection Table For Focus Schools Faulty Infrastructure

School Name: _____

			Different Bathrooms								
Location	**Fixture**	**Faulty Infrastructure**	**#**	**#**	**#**	**#**	**#**	**#**	**#**	**#**	**Total**
Bathroom	**Sinks**	Total (Working and Broken)									
		Missing Aerator									
		Leaking Faucet (packing)									
		Missing Handle									
		Broken Basin									
		Other									
	Shower	Total (Working and Broken)									
		Missing Showerhead									
		Missing Handles									
		Leaking (packing)									
		Broken Pipe									
		Other									
	Urinal	Total (Working and Broken)									
		Leaking									
		Clogged Drain									
		Other									
	Toilets	Total (Working and Broken)									
		Leaking (flush mechanism)									
		Cracked									
		Clogged									
		Other									
	Bath Tub	Total (Working and Broken)									
		Leaking Faucet (packing)									
		Clogged									
		Other									

Data Collection Table For Focus School Faulty Infrastructure

School Name: _____

Location	Fixture	Faulty Infrastructure	#	#	#	#	#	#	#	Total
Kitchen	**Sinks**	Total (Working and Broken)								
		Missing Aerator								
		Leaking Faucet (packing)								
		Missing Handle								
		Broken Basin								
		Other								
	Dishwasher	Total (Working and Broken)								
		Leaking								
		Other								
Laundry	**Wash Basin**	Total (Working and Broken)								
		Leaking Faucet (packing)								
		Other								
Outside	**Outdoor Spigot**	Total (Working and Broken)								
		Leaking (packing)								
		Missing Handle								
		Other								

APPENDIX F: DATA COLLECTION RUBRIC AND TABLE FOR WATER SAVING DEVICES

Data Collection for New Infrastructure Improvements of Schools

Rubric for Data Collection Table:

Water Saving Device

- The generic name of the water saving device.

Cost

- **Expensive** – A rating of Expensive signifies: School is not able to afford this type of device.
- **Moderate** – A rating of Moderate signifies: There is a possibility the school will be able to afford this water saving device.
- **Inexpensive**– A rating of a Inexpensive signifies: School is able to afford this water saving device.

Long-Term Sustainability

- **Sustainable** - A rating of Sustainable signifies: The device is made of strong materials and needs to extra maintenance.
- **Somewhat Sustainable** - A rating of Somewhat Sustainable signifies: The device is made of materials that are semi-strong and may not be able to take the abuse of a sustainable device. The device may also require some maintenance for repairs and cleaning.
- **Not Sustainable** - A rating of Not Sustainable signifies: The device is made of materials that are not very strong and needs a lot of maintenance attention, either for repairs or cleaning.

Water-Saving Potential

- **Significant Savings** – A rating of Significant Savings signifies: A significant reduction in the amount of water used.
- **Moderate/Little Savings** – A rating of Moderate/Little Savings signifies: Some water saved.
- **No Savings** - A rating of No Savings signifies: The same amount of water or more will be used as before.

Ease of Installation

- **Easy Installation** – A rating of Easy Installation signifies: Little or no tools are required, a small number of man hours, and a non - professional may be able to do installation.
- **Moderate Difficulty** – A rating of Moderately Difficult signifies: Some of the steps may require professional instruction, while others may be easily completed. Some tools may be required.

- **Difficult Installation** - A rating of Difficult Installation signifies: Tools are required, complicated instructions, many man hours, and professionals needed to do installation.

Feasibility of Implementation

- **Very Feasible** – A rating of Very Feasible signifies: The water saving device will be within the schools budget, is sustainable, has potential for water savings, and is easy to install.
- **Feasible** – A rating of Feasible signifies: The educational program has many of the above criteria, but there are some criteria lacking that do not make it the first choice.
- **Somewhat Feasible** – A rating of Somewhat Feasible signifies: The educational program is lacking several of the above criteria and may not be the best option for the schools. The idea should still be considered.
- **Not Feasible** - A rating of Not Feasible signifies: The educational program should not be used due to the fact it is lacking too many of the above criteria. Further research should not be done.

Water Saving Device	Cost	Long-Term Sustainability	Water-Saving Potential	Ease of Installation	Feasibility of Implementation

APPENDIX G: DATA COLLECTION RUBRIC AND TABLE FOR EDUCATIONAL PROGRAM

Data Collection for Possible Educational Programs

Rubric for Data Collection Table:

Type of Educational Program

- This section is for listing the different types of educational programs that could potentially be recommended.

Cost

- **Expensive** – A rating of Expensive signifies: The program requires a significant amount of materials at a large cost to the school. This would most likely not fall into the schools budget. Requires teacher training.
- **Moderate** – A rating of Moderate signifies: The program requires some teaching materials that are of cost. Some of the materials may be free of charge. May require some teacher training.
- **Inexpensive** – A rating of Inexpensive signifies: The teaching materials are free for use and the program requires few extra teaching aids. Requires little or no teacher training.

Long-term Sustainability

- **Sustainable** - A rating of Sustainable signifies: The program is likely to last for many years after implementation.
- **Somewhat Sustainable** - A rating of Somewhat Sustainable signifies: The program is likely to work for at least one time, maybe more, but implementation in the future does not seem likely.
- **Not Sustainable** - A rating of Not Sustainable signifies: The program will not last more than one time, or may never be implemented.

Water-Saving Potential

- **Significant Savings** – A rating of Significant Savings signifies: A significant reduction in the amount of water used.
- **Moderate/Little Savings** – A rating of Moderate/Little Savings signifies: Some water saved.
- **No Savings** - A rating of No Savings signifies: The same amount of water or more will be used as before.

Teacher Support

- **Supportive** – A rating of Supportive signifies: Many, if not all of the faculty and administration support the implementation of the educational program.

- **Somewhat Supportive** – A rating of Somewhat Supportive signifies: Some of the faculty and administration supports the implementation of the educational program.
- **Not Supportive** – A rating of Not Supportive signifies: Very few or none of the faculty and administration supports the implementation of the educational program.

Feasibility of Implementation

- **Very Feasible** – A rating of Very Feasible signifies: The educational program will be within the schools budget, is sustainable, has potential for water savings, and has support from the teachers.
- **Feasible** – A rating of Feasible signifies: The educational program has many of the above criteria, but there are some criteria lacking that do not make it the first choice.
- **Somewhat Feasible** – A rating of Somewhat Feasible signifies: The educational program is lacking several of the above criteria and may not be the best option for the schools. The idea should still be considered.
- **Not Feasible** - A rating of Not Feasible signifies: The educational program should not be used due to the fact it is lacking too many of the above criteria. Further research should not be done.

Type of Educational Program	Cost	Long-Term Sustainability	Water-Saving Potential	Teacher Support	Feasibility of Implementation

APPENDIX H: SANITARY WARE SUPPLIERS

Pupkewitz Megabuild – This supplier provides all materials for inside and outside the home. They sell most of the supplies the schools need for basic water infrastructure repairs, those being leaky pipes, faulty toilet flush mechanisms, and faucet stem repair parts. They do supply some water saving devices in the form of aerators and low-flow shower heads, but do not have much of a selection. One can go into this store and pick out what individual parts they want from the sales floor. Most items are unpackaged and sold from bins. Bulk discounts are applicable for certain purchases.

OBeCo – Known as O. Beherens & Co. They are a supplier who is specialized in sanitary ware supplies. They have a large inventory of new plumbing fixtures as well as repair supplies. They do not stock very many water saving devices. All of their parts are stored behind a counter so one has to know exactly what they want prior to coming to the store. Bulk discounts are applicable for certain purchases.

Penny Pinchers – This hardware store supplies all materials for inside and outside the home. They have a very small plumbing section and prices are not much cheaper than Pupkewitz Megabuild. They did not have any water saving devices for sale. One can go into this store and pick out what individual parts they want from the sales floor.

Cashbuild – This supplier provides all materials for inside and outside the home. They sell most of the supplies the schools need for basic water infrastructure repairs, those being leaky pipes, faulty toilet flush mechanisms, and faucet stem repair parts. Their parts are located on sales floor and are neatly packaged and displayed for easy viewing and purchasing with all information on sizes present.

APPENDIX I: INTERVIEW PLAN FOR MINISTRY OF WORKS

Interview Guide: Ministry of Works
Conducted on:
By: Richard Gilley, Rebekah Sullivan, Scott Tang, and Amanda Tarbet

Concept: Examine relationship between Ministry and Schools

-Introductions

-Explanation of project

1. Can you please explain your relationship with Windhoek Secondary Schools?
2. What types of infrastructure repairs do the schools depend on you for?
3. What types of funds are available for repairs made within the schools?
4. Are these funds enough to complete repairs within schools?
5. How do you think the situation can be improved?
6. Some of our recommendations include your participation; do you think you will be able to help implement them?

APPENDIX J: FAULTY INFRASTRUCTURE DATA

School Name: Anna Shipena, Hostels

Location	Fixture	Faulty Infrastructure	Boys Hostel (ground) #	Boys Hostel (top) #	Girls Hostel (ground) #	Girls Hostel (top) #	#	#	#	#	Total
Bathroom	**Sinks**	Total (Working and Broken)	13	13	12	12					50
		Missing Aerator									
		Leaking Faucet (packing)	3	3	3	5					14
		Missing Handle	2	2	2	1					7
		Broken Basin	0	0	0	0					0
		Other	0	1	2	1					4
	Shower	Total (Working and Broken)	7	7	3	3					20
		Missing Shower Head	7	7	0	3					17
		Missing Handles	0	0	0	1					1
		Leaking (packing)	0	0	0	0					0
		Broken Pipe	0	0	0	0					0
		Other	0	1	0	0					1
	Urinal	Total (Working and Broken)	1	1							2
		Leaking	0	0							0
		Clogged Drain	0	0							0
		Other	0	0							0
	Toilets	Total (Working and Broken)	4	4	6	6					20
		Leaking (flush mechanism)	2	2	3	2					9
		Cracked	0	0	0	1					1
		Clogged	0	0	0	0					0
		Other	0	0	0	0					0
	Bath Tub	Total (Working and Broken)	3	3	5	5					16
		Leaking Faucet (packing)	0	0	0	1					1
		Clogged	1	0	0	0					1
		Other	0	0	2 handle	0					2

School Name: Anna Shipena, Non-Hostels

Location	Fixture	Faulty Infrastructure	B4 #	C block bottom #	F girls #	B block top #	C block top #	F 107 #	#	#	Total
Bathroom	**Sinks**	Total (Working and Broken)	5	5	5	4	4	4			27
		Missing Aerator									
		Leaking Faucet (packing)	0	0	0	0	0	0			0
		Missing Handle	0	0	1	0	0	0			1
		Broken Basin	0	0	0	0	0	0			0
		Other	2	0	0	0	1 drain	0			3
	Shower	Total (Working and Broken)									
		Missing Shower Head									
		Missing Handles									
		Leaking (packing)									
		Broken Pipe									
		Other									
	Urinal	Total (Working and Broken)				1	1	1			3
		Leaking				0	0	0			0
		Clogged Drain				0	0	0			0
		Other				0	0	0			0
	Toilets	Total (Working and Broken)	5	6	6	4	3	3			27
		Leaking (flush mechanism)	1	2	1	0	1	1			6
		Cracked	0	0	0	0	0	0			0
		Clogged	2	1	1	1	1	0			6
		Other	0	0	1	1	0	0			2
	Bath Tub	Total (Working and Broken)									
		Leaking Faucet (packing)									
		Clogged									
		Other									

*** block top, E block bottom, and D11 locked and not in use

School Name: Augustineum, Hostels

Location	Fixture	Faulty Infrastructure	Boys Hostel (ground) #	Boys Hostel (top) #	Girls Hostel (ground) #	Girls Hostel (top) #	Maintenance quarters #	#	#	#	Total
Bathroom	**Sinks**	Total (Working and Broken)	12	12	12	12	2				50
		Missing Aerator									
		Leaking Faucet (packing)	1	1	2	0	3				7
		Missing Handle	0	0	0	0	0				0
		Broken Basin	0	0	0	0	0				0
		Other	0	0	1 drain	0	0				1
	Shower	Total (Working and Broken)	14	14	5	6	2				41
		Missing Shower Head	14	14	0	0	0				28
		Missing Handles	0	0	0	0	0				0
		Leaking (packing)	0	1	0	0	0				1
		Broken Pipe	0	0	0	0	0				0
		Other	0	0	0	0	0				0
	Urinal	Total (Working and Broken)	1	1			1				3
		Leaking	1	0			0				1
		Clogged Drain	0	0			0				0
		Other	0	0			0				0
	Toilets	Total (Working and Broken)	5	5	5	5	1				21
		Leaking (flush mechanism)	0	1	0	0	0				1
		Cracked	0	0	0	1	0				1
		Clogged	0	2	0	0	0				2
		Other	0	0	2	1	0				3
	Bath Tub	Total (Working and Broken)			5	5					10
		Leaking Faucet (packing)			2	1					3
		Clogged			0	0					0
		Other			0	1 pipe					1

School Name: Augustineum, Hostels

Location	Fixture	Faulty Infrastructure	Boys Hostel (ground) #	Girls Hostel (ground) #	Cafeteria 1 #	Cafeteria 2 #	Kitchen #	outside #	#	Total
Kitchen	**Sinks**	Total (Working and Broken)			8	7	11			26
		Missing Aerator			0	0	0			0
		Leaking Faucet (packing)			0	0	0			0
		Missing Handle			8	6	4			18
		Broken Basin			0	0	1			1
		Other			0	0	0			0
	Dishwasher	Total (Working and Broken)								
		Leaking								
		Other								
Laundry Room	**Wash Basin**	Total (Working and Broken)	16	12						28
		Leaking Faucet (packing)	2	3						5
		Other	8 handles	4 don't work						12
Outside	**Outdoor Spigot**	Total (Working and Broken)						1 gate valve		1
		Leaking (packing)						1		1
		Missing Handle						0		0
		Other						0		0

*** Leaking Boilers on girls side

School Name: Augustineum, Non-Hostels

Location	Fixture	Faulty Infrastructure	J12 #	W1 #	J11 #	J19 #	W19, not used #	#	#	#	Total
Bathroom	**Sinks**	Total (Working and Broken)	7	12	7	14	12				52
		Missing Aerator									
		Leaking Faucet (packing)	1	2	1	0	1				5
		Missing Handle	0	1	0	0	0				1
		Broken Basin	1	2	0	2 minor	0				5
		Other	0	1 clogged	0	0	0				1
	Shower	Total (Working and Broken)									
		Missing Shower Head									
		Missing Handles									
		Leaking (packing)									
		Broken Pipe									
		Other									
	Urinal	Total (Working and Broken)			1	1	1				3
		Leaking			0	1	0				1
		Clogged Drain			0	0	0				0
		Other			1 not work	0	0				1
	Toilets	Total (Working and Broken)	7	14	5	9	8				43
		Leaking (flush mechanism)	1	1	1	1 not work	2				6
		Cracked	0	0	0	1	0				1
		Clogged	0	0	0	0	0				2
		Other	3	0	0	1	2 tops				6
	Bath Tub	Total (Working and Broken)									
		Leaking Faucet (packing)									
		Clogged									
		Other									

School Name: Concordia, Boys Hostels

Location	Fixture	Faulty Infrastructure	Boys Hostel (ground) #	Boys Hostel (ground) #	Boys Hostel (top) #	Boys Hostel (top) #	Boys Hostel (ground) #	Boys Hostel (ground) #	Boys Hostel (top) #	Boys Hostel (top) #	Total
Bathroom	**Sinks**	Total (Working and Broken)	4	4	4	4	4	4	4	4	32
		Missing Aerator									
		Leaking Faucet (packing)	0	0	3	8	2	0	0	0	13
		Missing Handle	7	7	7	0	6	2	3	0	32
		Broken Basin	1	0	1	1	0	0	0	0	3
		Other	0	0	0	0	0	0	0	2	2
	Shower	Total (Working and Broken)	4	4	4	4	4	4	4	4	32
		Missing Shower Head	0	0	4	4	4	4	4	4	24
		Missing Handles	4	6	4	0	2	0	0	1	17
		Leaking (packing)	0	0	0	1	0	0	2	0	3
		Broken Pipe	0	0	0	0	0	0	0	0	0
		Other	0	0	0	0	0	0	0	0	0
	Urinal	Total (Working and Broken)	2	2	2	2	2	2	2	2	16
		Leaking	0	0	0	0	0	0	0	0	0
		Clogged Drain	0	0	0	0	0	0	0	0	0
		Other	0	1 knob	0	2	2 handles	0	0	0	5
	Toilets	Total (Working and Broken)	2	2	2	2	2	2	2	2	16
		Leaking (flush mechanism)	0	0	1	0	0	0	1	0	2
		Cracked	0	0	0	0	0	0	0	0	0
		Clogged	0	0	0	0	0	0	0	1	1
		Other	0	0	0	0	0	0	0	0	0
	Bath Tub	Total (Working and Broken)	1	1	1	1	1	1	1	1	8
		Leaking Faucet (packing)	0	0	0	1	1	0	0	0	2
		Clogged	0	0	1	0	0	0	0	0	1
		Other	2 handles	2 handles	0	0	0	0	1 running	1	6

School Name: Concordia, Girls Hostels

Location	Fixture	Faulty Infrastructure	Girls Hostel (ground) #	Girls Hostel (ground) #	Girls Hostel (top) #	Girls Hostel (top) #	Girls Hostel (ground) #	Girls Hostel (ground) #	Girls Hostel (top) #	Girls Hostel (top) #	Total
Bathroom	**Sinks**	Total (Working and Broken)	4	4	4	4	4	4	4	4	32
		Missing Aerator									
		Leaking Faucet (packing)	1	0	0	1	1	0	0	1	4
		Missing Handle	3	4	3	1	0	0	0	0	11
		Broken Basin	0	1	1	0	1 major	0	0	0	3
		Other	0	0	0	0	0	0	0	0	0
	Shower	Total (Working and Broken)	4	4	4	4	2	2	2	2	24
		Missing Shower Head	0	0	0	0	0	0	0	0	0
		Missing Handles	2	4	0	0	0	0	0	0	6
		Leaking (packing)	2	0	0	1	0	0	0	0	3
		Broken Pipe	0	0	0	0	0	0	0	0	0
		Other	0	0	0	0	0	0	0	0	0
	Urinal	Total (Working and Broken)									
		Leaking									
		Clogged Drain									
		Other									
	Toilets	Total (Working and Broken)	2	2	2	2	3	3	3	3	20
		Leaking (flush mechanism)	2	1	2	1	1	0	1	1	9
		Cracked	0	0	0	0	0	0	0	0	0
		Clogged	0	0	0	0	0	0	0	0	0
		Other	0	0	0	0	0	0	0	0	0
	Bath Tub	Total (Working and Broken)	1	1	1	1	2	2	2	2	12
		Leaking Faucet (packing)	0	0	0	0	0	0	1	0	1
		Clogged	0	0	1	0	0	0	0	0	1
		Other	0	0	0	0	0	0	0	0	0

School Name: Concordia, Girls Hostels

Fixture	Faulty Infrastructure	Girls Hostel (ground) #	Kitchen #	#	#	#	#	#	Total
Sinks	Total (Working and Broken)		10						10
	Missing Aerator		0						0
	Leaking Faucet (packing)		5						5
	Missing Handle		0						0
	Broken Basin		0						0
	Other		0						0
Dishwasher	Total (Working and Broken)								
	Leaking								
	Other								
Wash Basin	Total (Working and Broken)	1							1
	Leaking Faucet (packing)	1							1
	Other	0							0
Outdoor Spigot	Total (Working and Broken)								
	Leaking (packing)								
	Missing Handle								
	Other								

School Name: Concordia, Non-Hostels

Location	Fixture	Faulty Infrastructure	N11 #	Boys Bathroom #	Girls Bathroom #	#	#	#	#	#	Total
Bathroom	**Sinks**	Total (Working and Broken)	1	8	7						16
		Missing Aerator	0	1	0						1
		Leaking Faucet (packing)	1	2	1						4
		Missing Handle	0	1	1						2
		Broken Basin	0	0	0						0
		Other	0	0	1 clogged						1
	Shower	Total (Working and Broken)									
		Missing Shower Head									
		Missing Handles									
		Leaking (packing)									
		Broken Pipe									
		Other									
	Urinal	Total (Working and Broken)		6							6
		Leaking		1							1
		Clogged Drain		0							0
		Other		0							0
	Toilets	Total (Working and Broken)		10	18						28
		Leaking (flush mechanism)		0	0						0
		Cracked		0	0						0
		Clogged		0	0						0
		Other		5 locked	4 locked						9
	Bath Tub	Total (Working and Broken)									
		Leaking Faucet (packing)									
		Clogged									
		Other									

School Name: High Technical School, Hostels

Fixture	Faulty Infrastructure	Boys Hostel (ground) #	Boys Hostel (top) #	Girls Hostel (ground) #	Girls Hostel (top) #	Guest Hostel (ground) #	Guest Hostel (top) #	Guest Hostel (ground) #	Guest Hostel (top) #	Total
Sinks	Total (Working and Broken)	12	12	12	12	12	12	12	12	96
	Missing Aerator									
	Leaking Faucet (packing)	2	0	1	0	3	0	0	0	6
	Missing Handle	1	0	0	0	0	0	0	0	1
	Broken Basin	2 minor	1 minor	0	1 minor	4 minor	2 minor	1 minor	2 minor	13
	Other	1	0	2	0	0	0	0	1	4
Shower	Total (Working and Broken)	5	6	5	6	5	6	5	6	44
	Missing Shower Head	5	6	1	1	5	6	1	4	29
	Missing Handles	0	0	0	0	0	2	1	1	4
	Leaking (packing)	0	0	1	0	0	0	0	0	1
	Broken Pipe	0	0	0	0	0	0	0	0	0
	Other	0	0	0	0	0	0	0	0	0
Urinal	Total (Working and Broken)	1	1			1	3	3	3	12
	Leaking	0	0			0	1	0	0	1
	Clogged Drain	0	0			0	0	0	0	0
	Other	0	0			0	0	0	1	1
Toilets	Total (Working and Broken)	4	4	4	4	4	4	4	4	32
	Leaking (flush mechanism)	0	0	1	2	2	1	0	0	6
	Cracked	0	0	0	0	0	0	0	0	0
	Clogged	0	0	0	0	0	0	0	0	0
	Other	1	2 seats	0	0	0	0	0	1	4
Bath Tub	Total (Working and Broken)	4	4	4	4	4	4	4	4	32
	Leaking Faucet (packing)	0	0	1	0	0	0	0	0	1
	Clogged	0	1	0	0	0	0	0	0	1
	Other	0	0	0	0	1	0	0	0	1

School Name: High Technical School, Girls Hostels

Location	Fixture	Faulty Infrastructure	Boys Hostel (ground) #	Girls Hostel (ground) #	Guest Hostel (ground) #	Guest Hostel (ground) #	Kitchen #	#	#	Total
Kitchen	**Sinks**	Total (Working and Broken)					18			18
		Missing Aerator					1			1
		Leaking Faucet (packing)					2			2
		Missing Handle					3			3
		Broken Basin					0			0
		Other					0			0
	Dishwasher	Total (Working and Broken)		2		2				4
		Leaking		0		0				0
		Other		1 Drain		0				1
Laundry Room	**Wash Basin**	Total (Working and Broken)	2	2	2	2				8
		Leaking Faucet (packing)	2	0	0	1				3
		Other	0	1	0	0				1
Outside	**Outdoor Spigot**	Total (Working and Broken)								
		Leaking (packing)								
		Missing Handle								
		Other								

School Name: High Technical School, Non-Hostel

Location	Fixture	Faulty Infrastructure	63 **#**	89 **#**	30 **#**	16 **#**	119 **#**	Gym girls **#**	Gym guys **#**	**#**	**Total**
Bathroom	**Sinks**	Total (Working and Broken)	3	2	5	16	1	7	8		42
		Missing Aerator									
		Leaking Faucet (packing)	0	0	0	5	1	0	2		8
		Missing Handle	0	0	1	1	0	0	0		2
		Broken Basin	0	0	0	0	0	0	0		0
		Other	0	0	0	0	0	0	0		0
	Shower	Total (Working and Broken)		7					7		14
		Missing Shower Head		0					7		7
		Missing Handles		0					1		1
		Leaking (packing)		0					1		1
		Broken Pipe		0					0		0
		Other		0					0		0
	Urinal	Total (Working and Broken)			5				1		6
		Leaking			0				0		0
		Clogged Drain			0				0		0
		Other			0				0		0
	Toilets	Total (Working and Broken)	3	3	5			2	2		15
		Leaking (flush mechanism)	0	0	0			0	0		0
		Cracked	0	0	0			0	0		0
		Clogged	0	0	0			0	0		0
		Other	0	0	0			0	0		0
	Bath Tub	Total (Working and Broken)									
		Leaking Faucet (packing)									
		Clogged									
		Other									

School Name: High Technical School, Non-Hostel

Location	Fixture	Faulty Infrastructure	28 #	64 #	87 #	37 #	115 #	114 #	Motor Shop #	#	Total
Bathroom	**Sinks**	Total (Working and Broken)	1	2	2	2	6	1	6		20
		Missing Aerator									
		Leaking Faucet (packing)	1	0	0	1	0	0	5		7
		Missing Handle	0	0	0	0	0	0	0		0
		Broken Basin	0	0	0	0	0	0	0		0
		Other	0	0	0	0	0	0	0		0
	Shower	Total (Working and Broken)	1								1
		Missing Shower Head	1								1
		Missing Handles	0								0
		Leaking (packing)	0								0
		Broken Pipe	0								0
		Other	0								0
	Urinal	Total (Working and Broken)	1		1	1	1				4
		Leaking	1		0	0	0				1
		Clogged Drain	0		0	0	0				0
		Other	0		0	0	0				0
	Toilets	Total (Working and Broken)	2	2	3	1	7	1			16
		Leaking (flush mechanism)	1	1	1	0	1	0			4
		Cracked	0	0	0	0	0	0			0
		Clogged	0	0	0	0	0	0			0
		Other	0	0	0	0	0	0			0
	Bath Tub	Total (Working and Broken)									
		Leaking Faucet (packing)									
		Clogged									
		Other									

APPENDIX K: ADMINISTRATOR INTERVIEW SUMMARY SHEETS

Windhoek Technical High
Abe Van Wyk, Superintendent of Hostels and teacher

Maintenance

- Two people over seeing maintenance, one inspects and one makes the simple repairs.
- If the problem is too big then they hire private contractors to do the job which is about 50% of the time. They do that because the ministry does not respond or pay for the repairs.
- Some contractors are alumni and make repairs at discounted rates.
- Repairs are made immediately when a problem comes up.
- When the first major repairs were made, there were significant savings, "there was a dramatic decrease in payments."

Budget

- Each hostel resident pays and annual hostel fee of N$1500. It was increased from N$150 in 2003 to N$300 then to N$1500.
- that money goes into the 5 year program
    - put in place so that parents know where their money is going
    - Helps maintain everything from windows to walls to bathrooms and showers.
- spent N$363,000 last year on maintenance on hostel
    - Hostel fee: N$825/yr/learner paid to ministry. Pays salaries of staff, food, electric and water. Should be increased according to Van Wyk to keep up with the rising cost of living.
- The ministry pays for their water bills and was asked to compare the bills to the water meters but they don't know where they are. The hostel never sees any of the bills
- The ministry told the hostel that they were consuming too much water (20 in the country) and they needed to use less.
- They have no incentive to decrease their water bill because the money saved would not be directed towards other costs. He does it for his personal interest. He does the entire fundraising to keep the hostels open and to have a place for the kids to live.

Vandalism

- Very bad when he got there.
- Instead of communicating anger, kids break things.
- Parents are notified if their child breaks stuff so the have to for the vandalism in addition to the high hostel funds so the kids stop in fear of getting in trouble by parents.
- The hostel discipline policy changed to get the parents more involved. Parents are called right away if a problem occurs
- The traditional beliefs of some kids make them afraid to go to the bathrooms at night so they urinate in their rooms or their beds. They are scared of a little monster named Tokolos. They tried to educate the kids that he wasn't real. 2 kids were still scared so

they assigned a prefect that would wake the kids up at night and escort them to the bathroom with a "torch."

- He gives out toilet paper so they don't use newspaper, which clogs the toilets.
- Some students from the rural areas don't have bathrooms or showers so they don't know how to use them. They splash themselves in the sink and get water everywhere
- The prefect helps him teach the kids about hygiene. He teaches a group of kids about leadership and they in turn teach the younger ones
- Hire private supervisors that would keep an eye on the kids. Government supervisors don't do their jobs.
- keep the kids busy to give the kids a sense of self worth
    - bought a basketball court, soccer, 3 pool tables, TV's and video for the hostels, projector to watch movies
    - activities every term like beauty contests that also gets the teachers involved as judges
    - try to force them to play sports
    - try to support them and make them more positive and give them pride for their school so they won't damage things
- rewards for good behavior
    - end of the year dinner and presents to say thanks for being good

Education

- By 10th grade the students have heard about water conservation several times in their school career.
- Water conservation is part of the curriculum (a chapter in the textbook). They are taught to protect the environment.
- Taught about the water cycle, country's conditions, and government dams. Also teaches the kids how and why to fix taps and pipes.
- Students should hear about water conservation at least once a year.
- Their program doesn't need any expansion.
- Three years ago the ministry held a water day. The kids learned about how much water they used. It was in the form of a competition.
- He thought it was really successful and should be held again.

Recommendations

- he would respond positively to our recommendations
- hire private supervisors to keep an eye on students

School Maintenance

- things do not get fixed because of a lack of funds
- teachers maintain their own sinks in their classroom
- possible recommendation would be to have the kids fix the taps etc

Augustineum
Mrs. Losper, principal and teacher
1080 learners, hostel 190 girls, 90 boys
44 teachers

Maintenance

- Superintendent in charge of hostels.
- Six workers in charge of reporting leaks and broken pipes.
- Ministry of works supposed to fix problems but don't respond in time and workers are not trained to do work (sent girls to fix.)
- Ministry finally repaired a collapsed wall after it was damaged by a broken pipe.
    - meter was installed
    - repairs decreased water from N$196,000 to N$53,000
- Cleaners were sent into one set of bathrooms but refused to clean because of the condition. Students were forced to clean up their mess and did.

Budget

- Spent N$30,000 last year on maintenance, already surpassed that so far this year.
- There's no money for private plumbers, they respond but can't afford.
- Hostel fee: 900/yr/learner of 300/trimester
- Get less money from new government (since 1990) and she expects that the school will have to pay for everything in the future.
- "The schools were in a much better state with the old government."
- School does not see their water bill.

Vandalism

- The students use the floor instead of toilets because they don't work.
- There is a bathroom monitor in technical block.
    - not enough man power to have monitors all day
- Kids turn on taps and leave the bathroom.
- Kids walk past garbage cans and throw garbage on floor.
- "They have a lack of respect for themselves and other people."
- Parents are used as a discipline measure.
    - the students are afraid to have their parents called
- Extracurricular (extramural) activities keep the students busy.
    - school choir, sports, debating team, drama society, etc
    - students that participate in these activities are less likely to vandalize
    - the school tries to encourage all students to get involved but they do not

Education

- Not part of current curriculum but is in new syllabus that will be implemented next year for grade 11 and 12.
- Water conservation is part of two broader topics of pollution and environmental conservation in biology for grades 11 and 12.

- Shell Namibian and Tourism sponsor a water conservation project for five learners to come up with ideas for the government to save water every year.
    - Visited the Goreangab Facility
- Awareness day by municipality held in 2004.
    - Very effective and well organized good posters
    - There was nothing done to follow it up but she thought it should have been
    - Her reasoning for the lack of follow up was because she thought the ministry was supposed to take over the efforts and did not
    - Students taught other students what they learned
- Competition with DRFN
- The learners need proper bathroom education that needs to begin in primary school; it is too late to teach them in secondary.

Concordia
Mr. Ishola, principal and teacher
1020 learners
34 staff

Maintenance

- No major renovation since school was built in 1983.
- Spent N$48,000 last year on maintenance.
- They fix their minor problems but call ministry for bigger problems.
    - They take "quite" a long time to come.
- Difficult to get parts that fit old infrastructure, parts are becoming modernized.
- Waiting for budget approval from ministry to start renovations next year.

Budget

- School development fund
- They see their water bills but do not pay them.

Education

- Water conservation not mandatory in curriculum.
- Learn water conservation in life sciences in grades 8-10.
- Project held in 2004.
    - Learners learned how to read meters, report leakages, and organized repairs.
- Don't teach practical practices like fixing taps in classes.
- They learn about conditions specific to Namibia.
- They have an awareness competition every year where prizes are given out.
    - They are enthusiastic about it
    - It is an extension of project held by municipality
- They should do what they can to promote water conservation but the curriculum is very tight.

Our interview was cut short due to an unexpected meeting that came up with Mr. Ishola. A second interview time was unable to be set up because all secondary schools went on a month long vacation.

Windhoek High School
School principal
1250 learners, hostel 90 boys 100 girls 4 teachers
52 teachers

Maintenance

- School was built in 1917.
- Two maintenance employees.
- Leaks are fixed immediately themselves.
- Expensive repairs go to the ministry, very slow response.
- Complete bathroom renovations done in June 2005, previous conditions weren't bad.
    - Made repairs to improve school image.
    - Funded by outside company, N$160,000 from one company.
- No significant decrease in water bill sees water bill.
- One monitor per bathroom (1 girl and boy) not in hostels.
    - Cleans and watches over learners, watches community toilet paper rolls.
    - Paid N$1,000/month.
    - Very effective in preventing vandalism.
- Closes bathrooms right when school get out, monitors get paid extra if they are brought in for functions.
- Toilet paper needs to be available so they don't use newspapers etc.

Education

- Not part of curriculum but it is a science project theme.
- He trains all 8th grade male learners how to use bathrooms properly.
- Extracurricular activities have a good impact on students to prevent vandalism.

Apartheid

- Does not pose a problem at all.
- The school had a quick integration among students.
- All eleven ethics represented in school.
- Apartheid not part of their vocabulary.

Centaurus High
Mr. Treurnicht, principal
896 learners, hostel, 106 girls
31 teachers

Maintenance

- One caretaker paid through school to make simple repairs.
- 2004: N$100,000 spent
- 2005: N$110,000 spent
- 2006: N$90,000 budgeted
- Boys hostel closed to collapsed plumbing.
- August 3, 2004, meeting with all the principles.
    - They were told that their water bills were too high and had to lower them
    - Schools were promised that they would start seeing the bills but never saw them
    - He made no changes or repairs.
- Going to purchase a N$19,000 steam cleaner paid by school board.
    - Disinfectant used to keep kids out of bathroom.
    - Clean on a weekly basis.

Vandalism

- Does not make an issue about it because it just makes it worse, gives them attention.
- Allocated toilets according to grades to spread out the use.
- Kids use toilets as hang out place.
- Can't hire monitors because they're are too many of them and it is not practical to assign teachers to bathrooms
- Will consider building a single bathroom for boys and girls but doesn't know where to put them or how to pay for them.

Education

- Water conservation not part of curriculum.
- Water conservation is taught part of life sciences in grade 10.
- Learners aware of water problem in Namibia but do not necessarily conserve it.

Apartheid

- Learners from informal settlements that lack proper bathroom skills and hygiene are direct results of apartheid.
- It will take a long time for the country to get the previously disadvantaged up to the same level as the advantage