ITS Malta
In collaboration with

The Emirates Academy

The feasibility of water conservation in the five-star hotel sector in Malta

A Thesis submitted on
August 2022

by:
Mark McBride
Student Number:1901697/1

Submitted to:
Dr. Kevin Gatt

In partial fulfilment for the requirements of the Degree of
Master of Business Administration

The feasibility of water conservation in the five-star hotel sector in Malta

By

Mark McBride

A dissertation submitted to the Institute of Tourism Studies (ITS) in partial fulfilment of the requirements for the Bachelor's Degree in International Hospitality Management (Hons.)

Institute of Tourism Studies, Malta

August 2022

DECLARATION

I, Mark McBride, declare that this is an original study, conducted entirely by me, and that all material referred to has been appropriately referenced. In addition, I attest that no part of his work has been submitted to any other institution or course, and that no other qualification or degree has been supported by his work.

____

Student's signature

Abstract

This study aims to analyse the tourism industry's current and future water demand. It draws on both qualitative and quantitative perspectives to identify potential management issues and improve the industry's sustainability. High water consumption is a significant concern for tourism. This study aims to analyse the virtual water consumption and costs by focusing on daily water use by guests per bed night during their stay and rain catchment at the participating properties. Providing a valuable insight into water use described as direct use within the tourism industry. The study will quantify, and cost water derived from such use and divide it into grey and black water. A comparison of savings against such water use will be presented and analysed, resulting in the best option for a recycling system at each of the five properties. The study aims at diverting such waters to guests' rooms, water closet flushing and irrigation in landscaped areas. Due to the increasing need for water conservation, greywater and rainwater reuse must become a priority for many hotels in Malta. However, regulations and standards for this practice are still not available. This paper aims to evaluate the potential of grey and rainwater reuse to save water. An economic analysis was performed to determine the feasibility of treating grey and rainwater to determine the best possible practices. The study results show that the participating properties reduce water consumption by (total water savings) at the cost of (euro). However, the misuse of reservoirs in the mentioned properties hinders investment due to legislation demands for water use. The payback period for these systems would vary depending on the type of system and the project's cost.

Acknowledgments

I would like to thank Dr Kevin Gatt, for his continuous support and patience throughout the research process. I would like to also thank my wife and daughter for their never-ending support, and for their advice given throughout my studies. Thanks, is also due to all lecturers that helped and guided me throughout my studies at the Institute of Tourism Studies and the participating properties within the Five Star Hotel sector in Malta. My work colleagues and study group members.

Contents

1. Introduction

This study aims to determine if using rainwater from roofs and greywater generated in guest rooms in Malta's five-star hotels is feasible considering Malta's acute water resource shortage. Therefore, only hotels with a significantly high footprint will be considered for this study.

Such a study is significant currently as water scarcity is of global concern, with Malta being no exception. Groundwater resources in Malta are overexploited with a consequent over-reliance on desalinated water to service existing demand (Authority, 2015). Water consumption within the proposed hotels to be studied was estimated at an average of 426 liters per head per night stay (Bureau, M. B., 2012). Of this consumption, it is estimated that a significant component of water is destined for non-potable use. Therefore, it would be wasteful to service such requirements through either potable water or imported groundwater.

Malta only receives an average of five hundred millimeter’s rainfall a year, so such an asset should be conserved and utilised diligently and responsibly (Galdies 2011). Freshwater scarcity in Malta and the overexploitation of freshwater resources motivate this study to determine the viability of turning wastewaters in the form of rain and greywater into circular resources, thereby offsetting the demand for natural freshwater resources. The capital investment and recurrent expenditure required to retrofit the selected hotels will be used to determine the unit cost of water from such sources and compare these against the purchase of potable water from the Water Services Corporation and groundwater from private suppliers.

Harvesting rainwater in Malta dates to the megalithic ages with ground rock-cut cisterns found at Hagar Qim and Mnajdra temples (Sapiano et al., 2006). Supposedly bronze age man could dig a hole in the ground using stone hammers to harvest rainfall. In that case, the possibilities are endless to today's man with all the technology and knowledge available. It must be noted that legal provisions in Malta, namely the former Code of Police Laws and now Technical Guidance F, always stipulated the need for a cistern to accompany every building to collect one year's rainfall. (CAP10 1845) (Office2016)

Up Till the Covid-19 pandemic, Malta registered an ever-growing influx of tourists to the Island, which, amongst others, placed additional demand on the local water supply. As a result, the central Government has had to invest heavily in water production, as evidenced by the desalination plants constructed throughout the past thirty years as well as the new desalination plant proposed for Gozo, which will bring desalinated water to contribute to up to 70% of the total potable mix (Water Services Corporation, 2017).

Malta is a semi-arid country with insufficient freshwater resources. To this effect, Malta has and continues to rely on desalination technology to satisfy its water demand. Nonetheless, its groundwater aquifers continue to be overexploited because of the significant abstraction which occurs to satisfy non-potable needs (Authority, 2015). This places Malta at risk of not meeting the water framework directive's qualitative and quantitative criteria for groundwater bodies (Sapiano et al., 2006). The tourism industry in Malta is one of the main economic sectors with a high visiting population and employment, which impacts the number of water hotels consume. Rainwater harvesting contributes to rebalancing the impermeabilisation effects of physical development by ensuring that surface runoff generated from impermeable areas is harvested and stored for use throughout the year for non-potable activities such as irrigation, toilet flushing, firefighting, and general cleaning activities. This would enable a significant reduction in the demand for both potable and groundwater used for these activities. Five-star hotels have the highest environmental standards in Malta and are also those establishments which have the most substantial financial muscle within which to pilot such harvesting schemes. By looking at the possibility of using storm and grey waters to substitute the use of potable and groundwater for non-potable activities, it will be possible to establish the financial feasibility or otherwise of such installations. If these prove possible, the results can be showcased to other hotels to demonstrate such interventions' economic benefit and payback period. Moreover, the results could also demonstrate the feasibility of such installations in large buildings where the demand for non-potable water is high. If not, it could shed light on what policy and regulatory measures need to be put in place to safeguard this precious resource and internalise the environmental impact of development.

A study conducted by the Malta Business Bureau in 2012 seems to have fallen short of considering bought-in water via tankers as opposed to the potential use of storm and greywater. Thus, the motivation of this study is underpinned by an aim to further build on earlier studies and identify any gaps in the knowledge and data collected by previous studies. Aside from being a vital part of tourism, freshwater use is also essential in developing and operating tourism facilities. People visiting places such as resorts and swimming pools often require water when they use the facilities. Aside from maintaining the gardens and exteriors of hotels, freshwater is also used for food production, cleaning, leisure, and housekeeping.

This study aims to analyses the various impacts of tourism on the sustainable use of freshwater, considering the highest consuming buildings, i.e., 5, star hotels in Malta. It also explores the numerous studies conducted on the use of tourism-related water resources. Although tourism is often overlooked in global discussions about water use, this paper argues that it is still essential to use a review of these studies to estimate the consumption of fresh water in the tourism industry. The study also reviews the diverse types of water use in tourism and the documented use conflicts whilst exploring the management issues related to water use.

Whatever the costs, it is always worth trying to reduce water consumption and waste. However, when the financial feasibility of such retrofits does not yield a positive net present value with a short payback period, the appetite for such investment will be low. Hence, policy and regulatory initiatives will need to be considered to have a development which is truly sustainable in the context of water resources.

2. Literature Review

The scarcity of water in the Maltese islands is well known and documented. The review will investigate scholars' and scientific writings to determine the knowledge available and any literature gaps to support the researcher's questions.

Attempts to combat water scarcity on the islands go back millennia. One finds proof of rain harvesting methods at the megalithic temples of Hagar Qim and Mnajdra. Reitano (2011) writes of a water conservation system in which rock-cut water cisterns served as holding tanks. The site dates to 4500 BC and is recognised by UNESCO as a World Heritage site. However, Malta has always been scarce in water throughout its history, and literature regarding this is not available until The Knights of St John on the Island. Knight Quintinus Haedus (1536) states that during an investigative mission to the Island after King Charles V had offered the Island to the Knights of St John that the water was salty and had a foul smell, springs were present due to winter rainfall, but dilapidated in summer months: potable water is extracted from human-made tanks or ditches.

All potable water was extracted from cisterns purposely built to harvest rainwater throughout the Knights in Malta's early years. It was not until 1615 that the Knights brought fresh water to the capital. Under British rule in 1851, the concept of water conservation took off, with significant projects across the Island, with works continuing up to the late 1960s. During the 70s, excessive extraction from the sea-level aquifer led to a significant drop in quality. As a result, the Island turn to dieselisation plants in the 80s to supply the ever-growing demand for water in domestic and the ever-growing tourist industry.

According to the annual report published by the Water Services Corporation (2017), it produced 33,250,732 cubic meters of potable water, 14,360,651 cubic meters from the water table, and shy of 18,890,081 cubic meters from Reverse osmosis plants. Silvio Attard (2018) reports that the Maltese tourism industry started shaping in the late 1950s because British forces reduced its presence. Inbound tourism has been on the rise ever since, except for a drop between 1982 and 1987. Lockhart (1997) tells how Malta saw an increase in hotels under the Aids to Industry act of 1959 to 1964, paving the way for the birth of the tourism industry on the Island.

The openings of properties are listed below.

1962	Selmun Palace Hotel Corinthia Palace Hotel Comino Hotel
1964	Paradise Bay Hotel Calypso Hotel
1965	The Excelsior Hotel Golden Sands Hotel
1966	Fortina Hotel
1967	Promenade Hotel Neptune Hotel St. Juliens Hotel Hilton Hotel Ramla Bay Hotel Kennedy Hotel Sheraton hotel Metropole Hotel
1968	Marina Hotel Hyperion Hotel Salina bay Hotel The Cavalieri Hotel The Sliema Hotel Dolmen Hotel
1969	Preluna Hotel Halland Hotel Mellieħa Bay Hotel
1970	Verdala Hotel Green Dolphin Hotel Tower Palace Hotel

Bonello (2018) Table 2.1

It is with these hotels, that the birth of hospitality industry on the Island began. Mangion (2013), in his paper Tourism Impact on Water Consumption in Malta, mentions that tourism, although attracting income and generating jobs to the Island, also burdens the natural resource of the country being visited. Being such a small island with natural resources such as water, Malta is limited due to low precipitation. He pinpoints the elements that impact water use within the hospitality industry in his paper. Highlight measures to mitigate the problem by introducing water use management systems.

Grossling (2012) states that tourists use up to three times more water than residents. Calculations per guest per night show that water use per guest in a five-star hotel average around 200 to 1000, according to Grossling (2005), with most of the water used in bathrooms, gardening, and pools. Waggit (2006) says five-star hotels use up to 111% more water than a 3-star hotel; with more luxury comes more water usage. Grossling (2005) further states that the consumption of water by a tourist has not been adequately researched until 2005. The only way to calculate such use is through properties keeping statistics regarding bed nights sold. Grossling (2012) also mentions, amongst other things, that water usage by the tourism industry accounts for 1 % of national water use, with Malta at 7.3% of the total national water use, and Malta is one of a hand full of countries chronically at the risk of water shortage by 2050.

Grossling (2001) debates that guests' direct water use per night varies depending on the property's geographic placing and luxury rating. His studies showed that in hotter countries like Malta, out of the total water needed, 465L, to accommodate guests per night stay at higher rated properties, usually, 50% of the total water goes towards use in irrigation and food production, with 222 L because of direct use in bathrooms. In Cremona's (2012) report, the estimates water uses per head per night at 426 L, breaking down to 62% for fixed use, 26% for showers/baths, 8% for toilets, and 4% for wash-hand basins, giving an average of 161.88 L of water in direct use per head per night, working out to 110.27 L for showers/bath, 34.08 L for toilets and 17.04L for wash-hand basins. Only Cremona (2012) tries to quantify direct water use by guests visiting.

The researcher fully believes it is time to calculate each property's usage, considering bed nights sold by the participating properties, and move on to answer the question asked; are rain catchment and, or greywater systems feasible for the chosen five-star hotels? In his study. Numerous studies have been made covering water use management in hotels, and that water is a vital commodity. Furthermore, the researcher feels he must solidify his beliefs, researching more literature to support his statement.

In a European Union report entitled Best Environmental Management practices in the tourism sector, Styles (2013) writes that rainwater and greywater might reduce properties' demand for mains supplied water. However, not all water used in properties needs to be potable; with gardening irrigation using a large percentage of the water consumed, Grossling (2001) presents a final figure of 50% of his calculated 465 L of water needed per head per night is used for irrigation in the property's gardens.

Styles (2013) defines the two presented systems: rainwater collection systems channel the collected water into storage tanks from roofs and other clean surfaces. Understanding that the water collected is not potable can be used for irrigation, cleaning, and water closet flushing. Greywater, on the other hand, is defined as wastewater deriving from wash hand basins, showering, bathing, which according to Cemona (2012), amounts to 30 % of his calculated 426L, giving a result of 127 L per head per night or reusable greywater, in his two audited five-star properties in 2012. The greywater produced can be collected and used a second time in water closet flushing and garden irrigation. The European Union highly recommends installing such water management measures to save guard the environment and are also cost-effective. Furthermore, the study suggests that an even more cost-saving exercise would be to use all treated wastewater for irrigation of on-site gardens and remove the need for separate holding facilities for rainwater and greywater.

The study will try to fulfil the recommendations made in the report published by The Malta Business Bureau, where Cremona (2012) stresses the importance of hospitality properties to evaluate their water consumption levels and pinpoint measures to reduce water consumption. The report put forward three leading suggestions, for which we will be focusing on two of these recommendations for this study. The other recommendation, to reduce consumption through proficiency, seems to have been taken up by most participating properties. Results were published in 2014 in their final report covering the EU LIFE+ Investing in Water Project, in which Cemona (2012) states that the project had to reach promising results with participating properties making a staggering savings of 96,197,000 litres of water by introducing the suggested implementation of installing flow rate tapes and flushing volume control. For the other two recommendations, rainwater and greywater reuse, a gap exists in the available information, and that future research is needed, as suggested by the research study.

Furthermore, The Ministry for Sustainable Development, the Environment, and Climate Change, in its report Greening Our Economy–achieving a Sustainable Future (2014), strongly suggests following the recommendations made by the Malta Business Bureau's report mentioned above. Stating that ways should be found to have available funds to invest in water use management and the work started by the EU LIFE+ project should continue, entities were being suggested to carry out studies and audits on this specific subject, reducing water consumption within the tourism industry. Suggesting also those touristic properties should urgently implement wastewater recycling and the use of greywater, showing that by 2018 the harvesting and implementation of wastewater treatment were to become mandatory for new properties within the hospitality industry.

In the European Commission, Joint Research Centre Institute for Prospective Technological Studies called Best Environmental Management Practices in the Tourism Sector, Styles (2013) suggests that water recycling should be implemented to reduce water consumption and wastewater levels. Corporate Social responsibility is also to be considered, and in doing so, properties open a new niche market to target. Green travellers are on the rise and always looking for environmentally aware properties to use as their holiday accommodation. The report suggests installing rain catchment and greywater systems as one of their best environmental management practices for irrigation and water closet flushing.

In the report published by the Food and Agriculture Organisation of the United Nations, titled Malta Water Resources Review (2006), the FAO explains how scarce rainfall is in Malta, with just an average of 550mm a year, that no surface water is available to be exploited commercially and that groundwater is being over consumed. Demand for water resources has been elevated through desalination plants that have been in use since the early seventies. Although the mentioned plants have helped the Island in its water shortage, it has unfortunately incited a lesser responsible culture towards water conservation and resource use. Control on water use has only come from the tariffs charged by the local Water Services Corporation, and although the measures have left effect, they have at least urged some of the larger hotels to install in house desalination plants; despite these properties have yet to turn to rainwater harvesting and greywater recycling, as means to reduce water use. In 2012, the Ministry for Resources and Rural Affairs, in its report A Water Policy for the Maltese Islands – sustainable Management of Water Resources (Affairs, 2012), maintained the Governments pledge to make available funds to implement greywater and treatment systems in local hotels.

Grossling (2012) states that although the actual cost of unsustainable water use in the hospitality industry is still to be known, measures to reduce water use are surly economical viable and would safely guard water stocks and further secure the hospitality industry in the future. As with how the industry is analysing the life cycle and its impacts on energy use in its infrastructure and transportation, the industry must look at water consumption—encouraging water conservation management investment.

In the report published in 2018, Malta's Sustainable Development Vision for 2050 from the Minister for the Environment, Sustainable Development and Climate Change (Ministry for the Environment, 2019), the Maltese Government aims to have all buildings as water-friendly and efficient, respectful, and sensitive towards water use and to understand what each building can generate in such resource. Rain catchment and use at the source are encouraged, and greywater systems are implemented, with the water obtained used for non-potable needs. By 2050 the Government foresees that water use would have grown substantially and that the expertise needed to put the measures above should be available. The report divides wastewater into two, greywater and black water; mentioning that systems are available in the market but that due to the cost of instalment and the fact that strict standards are not in place, the relative performance of such systems is still unknown, leaving such a potential resource untapped. The same is said for rainwater catchment from properties as it has been long discussed but has been shouldered for many years. The report encourages the study of rainwater harvesting facilities to determine the potential production and use of water from the mentioned facilities and rehabilitate and upgrade where needed.

The researcher's conviction is that the time has come to update the data available from past writings and finally calculate each property's greywater production and rainwater catchment potential. For example, in Cremona's (2012) report, only two five-star hotels participated. Furthermore, with the researcher's proposed sample being more comprehensive, a clearer picture of the actual situation can emerge in the researcher's sample.

The time has come for the hospitality industry to cut down on water consumption to avoid perils. As developed by Lovins (1976), we have two choices, the hard path forward or the soft path forward, written after the energy crisis in the USA. The concept was then adapted to water by Glieck (2002), which writes that the hard path to water will rely solely on the central Government to harness, store, purify and deliver the resource of water to the end-user. Soft path water will see end-users financing in decentralised facilities, new technologies, and strategies. Soft path options, amongst others, include rainwater harvesting and greywater reuse.

"The soft path seeks to improve the overall productivity of water use and deliver water services matched to the needs of end-users, rather than seeking sources of new supply." Glieck (2002)

This paper aims to synthesise and analyse the various aspects of water management in hospitality Styles et al. (2013), including best practice benchmarks and models, and estimate the magnitude of water savings that can be achieved through implementing these best practices. According to the European Union's statistical agency, Eurostat (2013), in 2011, over 2.439 billion guest nights were spent in tourist accommodations in the European Union Member States. Therefore, implementing process-level best practices in water management could reduce the water consumption of European hotels by 376 million m3 annually. This would be achieved using various measures, such as water-efficient equipment and techniques. Some building applications, such as irrigation and toilet flushing, do not require potable water consumption. However, these activities can contribute to a large portion of the water use in buildings. Using landscaped grounds was identified as an essential factor contributing to hotel water use efficiency. (Bohdanowicz and Martinac, 2007).

To recover grey water, a separate drain system is required to collect water from showers, baths, and wash-hand basins. Therefore, the most basic setup of a greywater recovery system would need to have a separate drain system to separate grey and black water, a filtration system, and a holding tank large enough to hold the properties production of such water. Once water is stored in the holding tank, connections to water closets and irrigation systems need to be placed.

Although a runoff collection system is a simple process that can be easily installed in new buildings, and it is more challenging to install in an existing building due to its complexity. A basic setup of a runoff collection system consists of a roof or surface runoff water collection system designed to divert the collected water under gravity into a storage tank: a water-level detector is ideal for storing rainwater that has been collected from the roof or surface runoff water collection system; a control unit that can send or store rainwater directly to the mains water supply or a header tank. A separate pipe distribution system is commonly used to provide water to various fittings, such as urinals, cisterns, and irrigation systems. In addition, the use of greywater collection systems can help reduce the water consumption of buildings. These systems collect and store rainwater, which can be used for non-potable purposes such as washing machines and irrigation.

In Germany, over 35 percent of new buildings were equipped with rainwater collection systems in 2005 (EC, 2012). In addition, some hotels in the country have also installed recovery tanks to provide car washing and irrigation services. Greywater refers to the water from various activities, such as bathing, washing, and laundry. Greywater can also be reused for non-potable applications by separating the greywater from the water used for toilet flushing and irrigation. Although it is usually impractical to install these systems, they can be efficiently and cost-effectively renovated. Smith et al. (2009) The cost-benefit analysis of greywater recycling and rainwater collection systems should be conducted before the systems are installed. This method should consider the availability and scarcity of water resources in the future. One of the most effective ways to reduce the water consumption of buildings is by installing rainwater collection systems. This method can be done by separating the greywater from the water used for irrigation.

In 2009, the European Commission, EC (2009) estimated that water recycling can reduce water consumption by 10 percent. This figure is based on reducing water consumption, which can be achieved through various water efficiency measures. A rainwater recycling system installed in a 250-room hotel in Birmingham, UK, saved up to 780 million gallons of water annually. This amount is equivalent to about 6 percent of the hotel's annual water consumption. The hotel's other water efficiency measures also helped reduce its consumption. Due to the increasing number of people living in areas with limited water supplies, many companies are now focusing on the use of water reuse. According to the United Nations, the amount of freshwater withdrawn globally has increased by 1% annually since the 1980s (UN,2016) (CAWMA,2017).

Aside from implementing various water-saving measures, such as low flow taps and showerheads, hotels can also help reduce their water consumption. However, even with these measures, many guests still admit to using more water than they would at home. In some water-starved areas, the difference between how much water a hotel guest uses, and the local population can be as high as 20 times. Various initiatives can also help reduce water consumption. For example, rainwater harvesting, and greywater recycling can help reduce the water consumption of a hotel by up to 30%. These can also lower the utility bills of the company. Aside from these, other benefits of these programs include lower storm water flooding rates and lower energy costs.

On World Water Day2017, Waterscan, a leading provider of water reuse solutions, launched its next generation of products and services. These include rainwater harvesting and greywater recycling. However, Claire Yeates, a Waterscan representative, said that many companies are still reluctant to fully adopt water reuse due to the potential issues related to implementing new technologies. These include the payback periods and the operational costs.

Barry Millar, the company's operations director, said that Waterscan's new water reuse systems are now mainly built in the UK and meet each client's exact specifications. This allows Waterscan to provide its clients with the best possible service. Its comprehensive service package also allows it to deliver effective results for its clients. In partnership with Premier Inn, Waterscan recently launched a greywater recycling system in a hotel in Abu Dhabi. The hotel reduced its water consumption by over 735,000 litres a month through this initiative. The system has already saved the hotel over 100,000 baths annually.

2.2. Greywater Recycling

The hotel's greywater recycling system is designed to capture the water used for bathing or showering and then feed it back into the facility for various non-potable uses. The hotel's greywater recycling system is also designed to take advantage of the limited space available in the facility. This method uses less energy and takes longer to process than traditional methods. As a result, the company's on-demand greywater recycling system is ideal for facilities looking to reduce operational costs and maximise space efficiency. In addition, this method eliminates the need for tank storage.

2.3. Rainwater Harvesting

The collected rainwater is then fed back into the facility through a robust treatment system and a well-designed and efficient water harvesting system. This method is ideal for commercial applications that require enough water to meet their needs. In addition, Hoteliers can also learn more about water risk through our Global Water Risk Assessment. The International Hotel Property Federation (ITP) collaborates with its member groups to develop a standard water measurement tool that will help all hotels worldwide measure their water consumption. The tool is currently in its testing phase and will be released during World Water Week in August. (Greenkey2021) Support mechanisms are also being set up to promote greywater recycling systems and rainwater harvesting research and development. The importance of greywaters is acknowledged as a resource that commercial establishments can use for their water-use efficiency. Unfortunately, there is a lack of commercial interest in developing treatment technologies on a small scale. The in-house recycling of greywater can reduce the water consumption of commercial establishments by up to 30%. Greywater is defined as a by-product of various activities such as bathing, washing, and laundry. Unlike other water sources, such as toilets and kitchen sinks, it does not contain harmful microorganisms. Therefore, it can be reused for non-consumption purposes.

One finds mainly two types of Greywater recycling systems:

Diversion

A diversion system is a type of water treatment that uses a drip line to direct greywater from a source, such as a bathroom sink, to a garden. It does not store or purify the water and instead diverts it to the sewer system.

Treatment and filtration system

A complex filtration and treatment system can eliminate bacteria through various mechanisms. It works by taking advantage of the various components of the water supply to purify it. After the purification process, the greywater is stored in a holding tank. The purification process begins with removing particles from the water through a sieve. It can then be conducted using sand beds and other bioreactors through a distillation process and a bio-filtration method.

2.4. The Pros of Grey Water Recycling

Besides reducing the amount of freshwater used, recycling and reusing wastewater can also help minimise the water consumption of a facility. Increasing demand for water has led to higher water bills. Greywater can be used for various purposes, such as irrigation and toilet flushing, helping minimise the amount of water used on a property.

2.4. Minimising Impact on Septic Systems

Proper maintenance of the septic system can quickly add a considerable cost. By recycling greywater, a property reduces the amount of wastewater that enters the sewer system—extending the life span of the building's septic system and lowering the cost of managing wastewater.

2.5. Cutting on Cost of Water Treatment

Compared to other water treatment methods, such as zero liquid discharge, greywater recycling can be relatively cost-effective. It can also offer a 30 per cent return on investment.

The Cons of Grey Water Recycling

Despite the various advantages of greywater recycling, there are still risks associated with it, such as the possibility of contamination and disease. To minimise these risks, the system must be installed with high-efficiency equipment. (Aquatestinc 2018)

https://www.aquatestinc.com/blog/grey-water-recycling-a-guide-for-hotel-managers

Rainwater harvesting is the process of collecting and storing rainwater for future use. This process can be done in various ways, such as in natural reservoirs or tanks. It can also be referred to as collecting the rainwater into subsurface aquifers. The goal of rainwater harvesting is to keep it for reuse instead of letting it runoff. It can be used for various purposes, such as farming and domestic water supplies. People who use a water harvesting system are usually commercial or private individuals. This technology can collect and store rainwater for various purposes, such as washing clothes or irrigation. There are also various types of tanks and structures that can collect and store rainwater.

2.6. Advantages of Rainwater Harvesting

Getting enough water to use for your daily needs can reduce the amount of money paid to the water suppliers. Having enough water can also help keep your home and garden looking great. You can also use the water you harvest for various activities such as washing clothes and watering your outdoor garden. If you have a large-scale water harvesting system, you can cater to the varying needs of your home or business. The process can also help lower the money you pay to the water companies.

2.7. Cost of Maintenance

The cost of maintaining a water harvesting system is relatively low once it has been installed. Even if you do not use the water for drinking, the system does not require much maintenance. When rainwater is collected directly from the ground, it is not contaminated with harmful chemicals. This ensures that the water you get is pure and safe for drinking. Rainwater collected from the ground is also an excellent water source for various purposes, such as watering your small garden or farm. Also, the water that you get is not contaminated with harmful chemicals. The rapid growth of the Earth's population has caused the need for more water to increase. Due to the increasing demand, more drilling is being conducted to find alternative water sources. With the help of rain harvesting, we can conserve the underground water that we currently have. This technology can also help reduce the pressure on the groundwater. Aside from drinking water, rainwater can also be used for other purposes, such as farming and industrial processes. Rainwater is also beneficial to the environment as it allows us to live in an eco-friendly manner. It can be collected in the right way and efficiently used. By harvesting rainwater on a large scale, we can also reduce the amount of water in flood-prone areas. Doing so helps prevent soil erosion and minimises the effects of flooding on low-lying areas. This technology also helps prevent diseases and chemicals from one area to another. It also helps prevent soil contamination.

2.8. Disadvantages of Rainwater Harvesting

Despite the various advantages of rainwater harvesting, it can also come with its own set of disadvantages. This article aims to supply a comprehensive analysis of the process so that we can make an informed decision. One of the most common reasons people choose to use rainwater harvesting is its unpredictable nature. Rainwater collected from the ground may not come as expected. Sometimes, the rainfall level drops low enough to an insufficient water supply. However, if you have enough rainwater, you can still use it for a long time. Although rainwater harvesting can be relatively simple and cost-effective, it can also require regular maintenance. This is because pests and other small animals can infiltrate it, carrying diseases and harmful organisms. Aside from regular check-ups, it is also essential to maintain the system to prevent it from getting infected. Doing so can help minimise the risks associated with rainwater harvesting. Although rainwater harvesting can be relatively cost-effective, its initial setup and maintenance costs can still be high. The cost of a typical rainwater harvesting system can vary depending on the type and model that you choose. In terms of time, it can take around 10 to 15 years to recoup its initial investment.

Despite the advantages of rainwater harvesting, it can still cause water to be contaminated. This is one of the main reasons it is essential to examine the various aspects of the process before deciding thoroughly. Sometimes, rainwater collected from the roofs of buildings can also contact contaminated materials. For instance, some chemicals used in constructing roofs can cause health problems if ingested. Another standard limitation of rainwater harvesting is that it cannot store as much water as possible. This can be caused by various factors, such as insufficient rainfall or the lack of space. In terms of water use, landscaping can significantly reduce the need for irrigation. According to Smith et al., in 2009, reducing the water consumption of landscaping can help conserve up to 50% of water. Some measures to reduce water consumption include installing water meters and installing drip irrigation systems. Given the increasing need to reduce water consumption in tourism, the question of how sustainable is it is to achieve these savings? Various factors can be involved in achieving this, such as implementing policies and programs, technological innovation, and management. Although many factors can be considered to achieve this, only a few indicators are currently used to guide the implementation of water management programs. The increasing number of water-related activities in local communities should be considered when determining the sustainable use of water. For instance, electricity consumption in hotels has increased by up to 30% over the past decade. Higher standards in hotels also contribute to increased water consumption (Hawkins & Bohdanowicz), 2011.

Unless new indicators are developed to measure and monitor the water consumption of hotels, it is unlikely that the global consumption of water will decrease significantly. This is because the various factors that affect the water use of hotels, such as their planning and operational phases, are not always considered in developing effective water management programs. The goal of water management programs is to be optimised based on various indicators designed to address the different types of water use in a hotel. One of the most critical factors that can be considered when developing these indicators is water availability in the area. Ideally, they should be able to establish a baseline for the region's future water use. Peak water use is also considered to determine the level of water consumption. Although many factors can be considered when developing these indicators, such as water availability in the area, general rules for food management can also create more complex assessments. These rules should avoid food purchases made from water-starved areas. According to Zientara and Bohdanowicz-Godfrey, detailed audits are essential to identify potential savings.

Peak season is also considered to determine the pressure on the local water resources during the dry season. This indicator can help determine the appropriate level of water consumption. The increasing number of tourists and the rising popularity of high-standard accommodations are expected to increase water pressure in various destinations. This is especially true in regions where water security is an issue. (Vorosmarty, Green, Salisbury, and Lammers, 2000). Due to the increasing demand and the declining water supply, regional conflicts over water use are expected to become more frequent (ITP, 2013). The effects of climate change and water pollution are also expected to have a significant impact on the world's freshwater resources. (WWAP, 2012) (Hoekstra & Mekonnen,2012). Understanding the various aspects of water consumption is very important to manage the resources effectively. It is also essential to reduce the risks associated with the depletion of water resources. Water consumption is also linked to food production and energy consumption.

The article discussed the various rules that have been established in the literature regarding the use of water in different types of accommodations (Gossling et al., 2012). It also highlighted the importance of distinguishing indirect and direct water use. New research has also been conducted on the various end-use sectors of water consumption. Although the various guidelines have been followed by the industry (Kuoni, 2013), they are not yet comprehensive enough to effectively address the needs of the consumers. Therefore, this article aims to introduce more effective water management indicators.

The paper focused on the use of water in resorts in warm climates. It found that various factors such as the size of gardens, the initial pool filling, and the backwashing can significantly affect the water consumption of these accommodations. It also suggested that water use should be considered in the planning and construction of tourism infrastructure. According to (Bohdanowicz-Godfrey and Zientara 2014; Gossling et al., 2012). Most hotels can reduce their water consumption by 20% per guest night. This can be achieved through various measures such as implementing energy-efficient equipment and reducing the number of water-consuming activities. These, as well as the quantification of renewable water capacities in destinations, require continued research efforts. Non-potable water sources such as treated water can be used for various purposes, such as water closet flushing and irrigation. However, it should be treated to ensure that its quality is not compromised. (Said-Adebitan 2014)

Further to the research available, the writer intends to quantify the cost of water used in five-star properties in Malta. Non-potable water sources, such as treated water, can be used for various purposes, such as water closet flushing and irrigation. However, it should be treated to ensure that it does not compromise its quality. Using water in the hotel for various purposes contributes to the environment's degradation. Untreated wastewater can have detrimental effects on humans and other life forms. Aside from this, the cost of obtaining and maintaining water supply is also a significant issue for hotels. Despite the adverse effects of unrecycled water, it is still considered a renewable resource that can be reused or recycled. The study will show how wastewater from hotels can be reused or recycled. The study aims to provide a comprehensive analysis of the tourism industry's current and future water demands. It also explores the various management challenges that face the industry. The water demands of the tourism industry vary depending on the region, and the type of destination, especially in countries like Malta with limited water resources. As a result, the need for water is more pronounced. However, the exact requirements of the industry are not yet fully understood.

Water is vital to the tourism industry. The study aims to provide an in-depth analysis of the virtual water and costs commonly used in various services and products purchased by tourists, focusing on the tourism industry's direct and indirect consumption of water. The results will provide valuable information for future research projects.

3. Research Method

This study aims to evaluate the feasibility of more sustainable use of second-class water in the form of storm and grey- waters which are generated on-site to service second-class water uses such as toilet flushing, irrigation, and fire safety, intending to offset the current amount of potable and groundwater used for non-potable uses. The study will take a quantitative research approach to assess the feasibility of the use of storm and greywater in 5-star hotels by obtaining as far as possible actual usage figures or, if not possible, to generate accurate data that can be transformed into usable statistics; used to quantify water usage, rain catchment and quantity of greywater discharged by the larger five-star properties. This will enable an assessment of whether an investment in water conservation in the five-star hotel sector in Malta is viable or not.

In doing so, primary data has been obtained from each hotel. However, to estimate climatic and usage patterns, the author has also based his study on findings published in two reports, The first by M. Cremona and co-author G. Saliba for the Malta Business Bureau (Cremona & Saliba 2013), entitled *Water Consumption Benchmarks–a step towards reduced consumption,* and the second being *The Climate of Malta: statistics, trends, and analysis 1951-2010* by C. Galdies (Galdies 2011)

Cremona's study covered water usage in Malta's five-star hotel sector, and Galdies's study covered precipitation over Malta between 1951 to 2011. Therefore, the writer used the information found in the above reports to build the appropriate financial investment appraisal model based on the availability and consumption of water therefrom.

The Covid-19 pandemic hit the hospitality industry in 2020/21, which resulted in Malta having its last full year of trade in the sector in 2019. Therefore, the writer investigated data from 2019 to see how the industry performed during that period to mirror an eventual return to normality.

3.1. Greywater study

The study covering greywater (Cremona & Saliba 2013) within the five-star hotel sector estimates that 162 litres of water are consumed as direct use in hotel rooms by each guest per bed night stay. The study identified direct use: 110.27 litres in showers/baths, 34.08 litres in water closets and 17.04 litres in wash-hand basins. However, the study will only consider water used in wash-hand basins and showers/baths, as these generate the wastewater hereafter known as greywater.

The study aims to take Cremona's study for the Malta Business Bureau further by calculating the amount of potential greywater generated in each participating properties as a fraction of their overall water usage for substituting potable or groundwater use in water closets and irrigation.

3.2. Rain catchment study

The amount of stormwater generated by each property was calculated from the 60-year study Galdies conducted in 2011. It used the average monthly rainfall established in that study as a long-term annual rainfall rather than relying on precipitation recorded in a single year which may be subject to variations.

To optimise volumes required for stormwater, the monthly volume for each property was calculated by multiplying the average monthly rainfall in millimetres by the roof surface area in meters squared and dividing the total by 1000 to give calculations in cubic meters. (Pacey, 1989)

$$\frac{\text{Monthly Rain Fall in mm x Area property in m}^2}{1000} = \text{Stormwater volumes in m}^3$$

This was then complemented by determining the monthly demand for non-potable water, which could be serviced from either storm, greywater, or a mix of both. Finally, the study focused on the total of both waters and the possibility of using them for irrigation, water closet flushing in guest rooms and flushing staff bathrooms.

3.3. Pilot Study

A pilot study was conducted on the property at which the author works, hereafter known as property A. This was the chosen course of action as the author could muster the most accurate and comprehensive data, serving as a benchmark for other properties where similar data was not forthcoming.

The data collected included:

- Bed nights by month to determine the amount of greywater generated and non-potable toilet flushing volumes.
- Potable water volumes from the WSC purchased by month.
- Irrigation volumes utilised from a submetering system by month and the equivalent landscaping area, bought from the water services corporation or private sellers.
- Employee, full-time equivalent of employees for 2019 by month to determine non-potable water consumption and wastewater production.
- The rain catchment area to determine the potential volume of stormwater collected.

- 2nd class water, usually from groundwater sources, purchased, and on-site reservoir sizes

It was only property A that supplied detailed monthly data. Based on this data, the writer formulated the pilot study, using property A as a model to calculate any data not supplied by the participating properties and subsequently use specific parameters to fill in the gap of missing data from other properties.

3.4. Greywater production.

Calculations to quantify greywater produced by property A were done every month, using data from the Malta Business Bureau's report concerning water use and data supplied by the property regarding bed nights. The formula used is as follows-

$$\frac{\text{Bed nights x (bath/shower + wash hand basin water)}}{1000} = \text{greywater volumes in m}^3$$

Thus, for example, the greywater volume for January 2019 was calculated as follows:

$V = 3063 \times 127.8 / 1000 = 391.45\ m^3$

Using the same principlele, the monthly volumes for property A were derived as in Table 3.5.

Table 3.5. Grey water production property A

2019	Bed Nights	Sink, bath/shower ltr	Total grey water m3
January	3063	127.8	391.45
February	3040	127.8	388.51
March	4411	127.8	563.73
April	5815	127.8	743.16
May	5815	127.8	743.16
June	6069	127.8	775.62
July	6225	127.8	795.56
August	6523	127.8	833.64

September	6629	127.8	847.19
October	6460	127.8	825.59
November	4629	127.8	591.59
December	2978	127.8	380.59
Total2019	61,657		7,879.76

Thus, property A is estimated to generate 7,879.76 m^3 of greywater as per 2019 data.

The same methodology was used for deriving the stormwater generated in the other participating properties.

3.6. Rain catchment.

Property A only avails itself of 30% of the available rain catchment area; therefore, 1659.29 m^2 of the effective impermeable area is used for the calculations. Thus, the monthly volume of stormwater would be calculated. The formula used is as follows:

$$\frac{\text{Area of roof } (m^2) \text{ x monthly rain precipitation (mm)}}{1000} = \text{Total runoff in } m^3$$

(Rain Harvesting2020)

Thus, for example, the stormwater volume for January 2019 was calculated as follows:

$V = 1659.29 \text{ x } 87.75 / 1000 = 145.6 \text{ } m^3$.

Using the same principlele, the monthly volumes for property A were derived as in Table 3.7.2

Table 3.7. Calculations for rainwater catchment.

2019	Catchment area	Average monthly precipitation	Total runoff catchment
January	1659.29	87.75	145.60
February	1659.29	60.53	100.44

March	1659.29	42.73	70.90
April	1659.29	22.10	36.67
May	1659.29	9.92	16.46
June	1659.29	3.12	5.18
July	1659.29	0.49	0.81
August	1659.29	7.31	12.13
September	1659.29	42.94	71.25
October	1659.29	86.73	143.91
November	1659.29	87.73	145.57
December	1659.29	102.48	170.04
Total 2019	1659.29	553.83	918.97

Thus, property A is estimated to generate around 918.96 m^3 in 2019, using precipitation averages from Galdies's 50-year study.

The same methodology was used for deriving the stormwater generated in the other participating properties.

3.8. Irrigation water use.

Property A uses 3350 m^3 of water to irrigate its landscaped area, spread over an area totalling 9641 $m^{2.}$ The Property holds accurate monthly readings done via a sub-meter monitored by the maintenance department. As a result, the study determined monthly use and hence the benchmark water requirement per square meter of the landscaped area in any given month.

Thus, the monthly irrigation per square meter by month would be calculated. The formula used is as follows:

$$\underline{\text{Submeter volume used in a specific month } (m^3)} = \text{water used per } m^2$$

Landscaped area (m^2)

Thus, for example, irrigation per square meter of landscaped area for January 2019 at property A was calculated as follows,

$$100 / 9641 = 0.0104 \text{ m}^3 \text{ of water.}$$

The monthly volumes used at property A were derived in Table 3.9. using the same principle.

Table 3.9. Property A irrigation per square meter.

2019	Irrigation cubic meters	Landscaped area	Per square meter
January	100.000	9641.000	0.010
February	140.000	9641.000	0.015
March	230.000	9641.000	0.024
April	310.000	9641.000	0.032
May	340.000	9641.000	0.035
June	510.000	9641.000	0.053
July	850.000	9641.000	0.088
August	590.000	9641.000	0.061
September	300.000	9641.000	0.031
October	0.000	9641.000	0.000
November	0.000	9641.000	0.000
December	180.000	9641.000	0.019
Total 2019	3550.000		0.031

Resulting in an average of 0.0315 m^3 per square meter, at a yearly total of 3350 m^3 for 2019**.**

The same methodology was used for deriving irrigation per square meter in the other participating properties. Furthermore, the study considered what percentage of total use for irrigation was consumed each month in 2019.Thus, for example, the percentage of total used in irrigation for January 2019 at property A was calculated as follows:

$$\frac{\text{Monthly sub-metering irrigation x 100}}{\text{Yearly total irrigation}} = \text{Monthly percentage.}$$

$$100 / 3{,}350 \times 100 = 2.985\%$$

The monthly percentages used at property A were derived using the same principle as in table 3.10.

Table 3.10. Property A calculations of monthly percentage use for irrigation.

2019	Sub-metering Irrigation Property A	Yearly total irrigation	Monthly %
January	100.0	3,350.0	3
February	140.0	3,350.0	4
March	230.0	3,350.0	6
April	310.0	3,350.0	9
May	340.0	3,350.0	10
June	510.0	3,350.0	15
July	850.0	3,350.0	24
August	590.0	3,350.0	17
September	300.0	3,350.0	9
October	0.0	3,350.0	0
November	0.0	3,350.0	0
December	180.0	3,350.0	4
Average			8.3
Total 2019	3,550.00		100

Thus, resulting in an average of 8.3% of the total water used for monthly irrigation at property for 2019.

3.11. Guest rooms water closet flushing.

Property A had a total of 61,657 bed nights sold in 2019 and using data from the Malta Business Bureau's study; flushed water use was taken at 34.08 ltr per bed night. Thus, the monthly use of water in water closets by month would be calculated as follows:

$$\frac{\text{Total month bed nights x 34.08(ltr)}}{1000} = \text{Volume in m}^3$$

(Styles, Schoenberger, Galvez2015)

Thus, for example, water used for flushing water closets for January 2019 was calculated as follows:

$$3060 \times 34.08 / 1000 = 104.39 \text{ m}^3$$

The monthly volumes at property A were derived using the same principle in Table 3.12.

Table 3.12. Guest room flushed water.

2019	Bed Nights	Water Amount ltr	Total flushed water in m3
January	3063	34.08	104.38
February	3040	34.08	103.60
March	4411	34.08	150.32
April	5815	34.08	198.17
May	5815	34.08	198.17
June	6069	34.08	206.83
July	6225	34.08	212.14
August	6523	34.08	222.30
September	6629	34.08	225.91
October	6460	34.08	220.15
November	4629	34.08	157.75
December	2978	34.08	101.49

Total 2019	61657	34.08	2101.27

This resulted in 2,101.27 m^3 of water used in guest rooms' water closet flushing in 2019.

The same methodology was used for deriving total flushed water in the other participating properties.

3.13. Preliminary Findings

Calculations showed that property A consumed 7,879.76 m^3 (basins, showers/bath, and water closet flushing) of water in direct guest use and 3,350 m^3 for irrigation resulting in a total of 11,229.76 m^3. Therefore, 7,879.76 m^3 of direct usage becomes potentially reusable greywater, and 2,101.27 m^3 becomes unusable black water. Therefore, property A potentially produced a total of 8,797.96 m^3 of reusable water through storm and greywater. Calculating supply and demand shows that the property produced 8,797.96 m^3 of reusable water against the 5,451.27 m^3 needed to supply the water used in irrigation and water closet flushing, resulting in a surplus of 3,345.73 m^3. With the surplus, the study sought other solutions to using the said water. The study looked at staff bathroom water closets, where the author believed such water could be consumed.

3.14. Staff Water closet water use

Data related to full-time equivalent for employees was requested from property A.

Calculations for water use in staff bathrooms were based on an interview given by Hydrologist Manuel Sapiano in 2011, in which he stated that "*the average Maltese was consuming 32 litres of water every day to flush water closets"* (Dalli, 2011)

This amount is on par with the guest's use of 34.08 litres in water closets. The study, therefore, used the same amount for staff bathroom use.

To calculate water in staff bathrooms, the study took the staff full-time equivalent for each month is 2019, multiplied by 8 to reach total hours for full-time equivalent, then subtracted leave allowance and divided by 8 to achieve actual working days by the staff at property A.

$$\frac{\text{(FTE x Monthly Hours) – Monthly leave allowance = Actual hours worked by FTE}}{8} = \text{total working day}$$

For example, in January 2019, property A had a full-time equivalent of 191.08 employees, therefore

$$\frac{\text{191.08(full time equivalent) x 153.33(total hours – leave)}}{8} = \text{3675.99(total shifts worked)}$$

Calculations for water used in staff bathroom water were taken using the data taken from Sapiano's 2011 interview and then multiplied by the total number of shifts in each month, therefore

$$34.04 \text{ x total shifts worked = volume in } m^3$$

Thus, for example, water used for flushing water closets in staff bathrooms for January 2019 was calculated as follows:

$$3674.99 \text{ x } 34.08 / 1000 = 125.27 \text{ m}^3$$

Using the sacme principle, the monthly total for staff shifts and water use at property A in staff bathrooms were derived from Table 3.15.

Table 3.15. Property A Staff bathroom water closet flushing's

2019	FTE	Total Shifts (workforce x total hours - leave)	Total Flushed water (total shifts x 34.08 / 1000)
January	191.80	3675.99	125.28
February	174.51	3344.72	113.99
March	171.82	3293.15	112.23

April	183.47	3516.41	119.84
May	184.02	3527.03	120.20
June	210.65	4037.29	137.59
July	227.17	4354.07	148.39
August	222.56	4265.62	145.37
September	216.54	4150.26	141.44
October	216.02	4140.22	141.10
November	198.09	3796.64	129.39
December	193.76	3713.71	126.56
Month average	199.20	45815.12	1561.38

.

The same methodology was used for deriving total shifts worked and water use in staff bathrooms in the other participating properties.

3.16. Participating Hotels

As mentioned above, participating properties will be given a letter as their identifier to protect their privacy in compliance with Maltase laws covering data collection.

Thus, the study covers five properties: A, B, C, D, and E.

Property A already covered above.

Unfortunately, not all properties supplied data at the level property A did. For example, several properties do not account for water used in irrigation, saying it was negligible. Other properties only supplied an annual total for water used in irrigation.

In the case of properties D and E, no data for water used in irrigation was presented, even though having 3515 m^2 and 7940 m^2 of landscaping, respectively.

Where no annual total for irrigation was presented, the study considered that only property A had given monthly readings for water used for irrigation. Therefore, it was decided that an estimate calculation should be done based on the data presented by property A. For this reason, the monthly irrigation readings for property A were divided by its total landscaped area, giving the study litres per meters squared used.

Example of calculation for litres per meter squared of water used in property A in January 2019.

$$\frac{\text{Total irrigation water used in January}}{\text{Area of landscaping.}}$$

100 / 9641 = .0137 cubic meters of water used for irrigation per square meter at property A in January 20219. The same principle used for the rest of the months in 2019 was derived as in Table3.17.

Table 3.17. Property A calculations for irrigation per square meter

2019	Irrigation cubic meters	Landscaped area	Per square meter
January	100.000	9641.000	0.010
February	140.000	9641.000	0.015
March	230.000	9641.000	0.024
April	310.000	9641.000	0.032
May	340.000	9641.000	0.035
June	510.000	9641.000	0.053
July	850.000	9641.000	0.088
August	590.000	9641.000	0.061
September	300.000	9641.000	0.031
October	0.000	9641.000	0.000
November	0.000	9641.000	0.000
December	180.000	9641.000	0.019

Thus, using the above calculations, one can determine that water used by properties E and D for irrigation in 21019 was derived as in Tables 3.18. and 3.19.

Table 3.18. Property E calculation irrigation per square meter.

2019	Irrigation per square meter	Landscape area	Total irrigation per month
January	0.010	7940	82.36
February	0.015	7940	115.30
March	0.024	7940	189.42
April	0.032	7940	255.31
May	0.035	7940	280.01
June	0.053	7940	420.02
July	0.088	7940	700.03
August	0.061	7940	485.90
September	0.031	7940	247.07
October	0.000	7940	0.00
November	0.010	7940	82.36
December	0.019	7940	148.24
Total 2019			3,006

This resulted in property E using an estimated 3,006 m^3 for irrigation in 2019.

Table 3.19- Property D calculation irrigation per square meter.

2019	Irrigation per square meter	Landscape area	Total irrigation per month
January	0.010	3515	36.46

February	0.015	3515	51.04
March	0.024	3515	83.86
April	0.032	3515	113.02
May	0.035	3515	123.96
June	0.053	3515	185.94
July	0.088	3515	309.90
August	0.061	3515	215.11
September	0.031	3515	109.38
October	0.000	3515	0.00
November	0.010	3515	36.46
December	0.019	3515	65.63
Total 2019			1330.75

This resulted in property D using an estimated 1,330 $m^3$of water for irrigation in 2019.

In the case of properties B and C, only an annual total for irrigation was presented. Once again, the study took property A's model to quantify the monthly water needed for irrigation. Example of calculation to determine the percentage of water used for irrigation in a particular month vis a vis the yearly total.

The percentage of water used at Property A in January 2019.

Monthly total x 100 = monthly percentage

Yearly total

This resulted in 100 / 3,350 x 100 = 2.99% of the water used for irrigation in January at property A. The same principle used for the rest of the months in 2019 to convert water use at property A into a percentage of the total was derived as in Table 3.20.

Table 3.20. Property A Calculation of irrigation percentage per month.

2019	Sub-metering Irrigation 2019	Irrigation total	Monthly %
January	100.0	3,350.0	2.99
February	140.0	3,350.0	4.18
March	230.0	3,350.0	6.87
April	310.0	3,350.0	9.25
May	340.0	3,350.0	10.15
June	510.0	3,350.0	15.22
July	850.0	3,350.0	25.37
August	590.0	3,350.0	17.61
September	300.0	3,350.0	8.96
October	0.0	3,350.0	0.00
November	0.0	3,350.0	0.00
December	180.0	3,350.0	5.37

Thus, using the above calculations, one can determine that water used by properties B and C for irrigation in January 21019 was derived as in Tables 3.21 and 3.22.

Table 3.21. Property B calculations monthly irrigation percentages.

2019	Irrigation Total	Monthly % Property A	Monthly %
January	25	2.99	0.75
February	25	4.18	1.04
March	25	6.87	1.72
April	25	9.25	2.31
May	25	10.15	2.54
June	25	15.22	3.81
July	25	25.37	6.34
August	25	17.61	4.40
September	25	8.96	2.24
October	25	0.00	0.00
November	25	0.00	0.00
December	25	5.37	1.34

Table 3.22. Property C calculations monthly irrigation percentages.

2019	Irrigation total	Monthly % Property A	Monthly %
January	1694	2.99	50.57
February	1694	4.18	70.79
March	1694	6.87	116.30
April	1694	9.25	156.76
May	1694	10.15	171.93
June	1694	15.22	257.89
July	1694	25.37	429.82

August	1694	17.61	298.35
September	1694	8.96	151.70
October	1694	0.00	0.00
November	1694	0.00	0.00
December	1694	5.37	91.02

At this stage in the study, one finds that the options on hand in finalising the said study are-

A. If supply exceeds demand, properties will produce a surplus of second-hand water.

B. If supply is greater than demand, can properties do with only using rain catchment and do without using greywater.

C. If demand exceeds supply, calculate cumulative water defecate and cumulative supply.

3.23. Calculating storage volumes

The reservoir analysis method was used to optimise the size of reservoirs required to service the Property's second-class water needs. Technical Guidance F specifies that each building should have a reservoir which is sized at 0.6 times its roof area. However, such a calculation assumes that a year's volume of rainfall will be stored, which is not the case when the water collected is being used regularly. Therefore, the reservoir analysis method's limitation is that it assumes a constant monthly demand. Nonetheless, it provides a better estimation for the optimised size of the reservoir, which will directly impact the cost associated with its construction and hence its investment appraisal.

3.24. Costs related to study implementation.

During the pilot study on property A, the author had the opportunity of having support from the company's Quality project management subsidiary, which provided estimates covering reservoirs building, retrofitting dual drainage systems needed and dual supply where needed. Estimates for greywater treatment plant can be found in Appendix Letter A.

4. Research Findings

The following chapter describes the data analysis and the research findings related to the questions that were asked in the study, data collected during the study were analysed to explore the various aspects of water use in hotels on the island. The information was then analysed and presented to the general managers of the participating properties. This study aims to analyse the various factors that affect the use of water in the hospitality industry in Malta. These include the water used in the rooms, their efficiency, and their potential to be used sustainably. The study will then describe the findings gathered to identify the most significant factors that affect the operations of the hotels in the area. The findings will then be analysed and explained, presenting an appropriate option as the ideal water conservation system for each property.

4.1- Property A

4.1.1. Property Background

Property A has 147 guest rooms for a total bed count of 304, total bed nights occupied in 2019 amounting to 61,657. The property has a total footprint of 17,424 m², of which the Hotel and spa buildings cover 5,530 m², with the remaining 11,894 m², used up the tennis court (749 m²), pools and surrounding deck (763 m²), driveway and small parking (741 m²) with the remaining 9,641 m² being landscaped gardens.

4.1.2. Water Source

The primary water supply for property A is obtained from Main's water supplied by the Water Services Corporation. The property supplemented its water needs by buying (2nd class) water from private water sellers until the end of 2020. As of 2021, the Hotel will no longer be buying 2nd class water from private sellers due to corporate directives from the holding company. The Hotel also has two reservoirs for harvesting rain catchment water, one holding 300 m^3 and a second one able to hold 60 m^3

4.1.3. Monitoring and Consumption

In 2019, property A paid €57,587.5 for the consumption of 23,035 $m^3$of mains water at a commercial rate of €2.50 per cubic meter. In 2019 the property reportedly bought 3350 m^3 from private water sellers, at the rate of €2 for a total cost of €7,100, mainly for irrigation use, totalling €66,462.5. Note should be taken that the property will be migrating to use only mains water during 2021, thus bringing the actual cost of irrigation to €8,375.

Monitoring is done by the Hotels Maintenance department in daily readings to assess water usage in the Hotels. Reference to calculations to be found in Appendix property A Table 1 Water Bought showing water consumption and cost for the year 2019.

4.1.4- Allocation and Sub Metering

Water is used in guests' rooms, kitchens, various pools, Spa, fountains, and housekeeping. Water consumption relevant to the study is shown in Appendix property A Table 2 – Water use – rooms and irrigation. Sub-metering is done covering Irrigation, Spa, Salon, and Rickshaw restaurant. The study will focus mainly on water used in rooms and irrigation for which the property used 9,981 m^3 used by clients as direct use at the cost of €32,052 and 3,350 m^3 of water in irrigation worth € 7,100, Table 1 shows the amount of water consumed in 2019. The total price for water used in irrigation and guests as direct use amounted to €32,052 in 2019 and will rise to €43,080 in 2021 since the Hotel will no longer buy 2nd class water for irrigation from private suppliers, for the reasons explained in 4.1.2.

4.1.5. Segmentation of Direct Use

As shown above, direct use by bed night a consumption of 161.88 litres of water per bed night. To further understand and segment into grey water and black water, in Appendix property A Table 3 – segmentation of direct use, shows the total water used in showers/bath, wash hand basins, and flushing sorting into the two classifications of water. Such workings will determine the study's outcome further along, explaining in detail the segmentation of water used in rooms as direct use by guests. Calculations show that guests rooms produced 7,879 m^3 of greywater and 2,101 m^3 of blackwater and in 2019

4.1.6. Rain catchment

The property has a possible catchment area of 5,530 m^2, but only utilises 1,659 m^2, resulting in 733.34 m^3 of storm water caught. Calculations are shown in Appendix property A Table 4, using precipitation estimates found in Galdies (2012) study.

4.1.7. Monetary value – Rain Catchment at WSC Commercial Rate

In 2019 the property A caught 733.37 m^3 amounting to possible savings of €1,800. A note should be taken that the property does not make any particular use of rain catchment water at present, disposing of it on to public streets. Calculations taken at the rate of €2.5 per m^3 can be found in Appendix property A Table 5.

4.1.8. Hotel Performance in 2019

Property had 61,657 bed nights; below is a Table 6 showing bed nights by month. The average per month was 5,221 bed nights.

4.1.9. Total Bed Nights by Month 2019

2019	Bed nights
January	3063
February	3040
March	4411
April	5815
May	5815
June	6069
July	6225
August	6523

September	6629
October	6460
November	4629
December	2978
Total 2019	61657

4.1.10. Water Usage by Bed Nights by Month

As established earlier in the study, water usage by guests in wash-hand basins was estimated at 17.04 litres, showers/bath at 110.76 litres, and 34.08 in flushing for a total of 161.88 litres per head per day. Therefore, water used in wash hand basins and shower/baths will give the properties greywater production and flushed water resulting in black water produced from guests' rooms. Calculations to be found in Appendix property A Table 7 showing the calculations and the cost of grey and black water for 2019.

The calculation shows the property produced 7879.8 m^3 of greywater and, if taken at the commercial rate of €2.5, at €19,699.41, coming in at 29.39% of the annual water bill. Results show that 2101.27 m^3 of water was used and transformed into black water, coming in at the cost of €5,253, coming in at 7.9% of the total water bill for 2019. The total cost for water in direct use by guests was €24,952, resulting in 37.54% of the total €66,462 paid for water in 2019.

4.1.11. Greywater system Vs Rain catchment.

Property A produces large quantities of wastewater that can be recycled for use. The property also has potential when it comes to stormwater. Calculations covering 2019 clearly show that further investigation is needed to establish the best wastewater system most suitable and economically viable to the Property.

4.1.12. Greywater system study.

Property A produced a total of 7879.8 m^3 of greywater in 2019 with a monetary value of €19,699.41 when calculated at the commercial rate of €2.5. Therefore, potential savings on introducing greywater systems amount to 29.64% of the property's annual water bill.

Calculations show that property A cannot use all greywater produced in guest rooms against water used in guest rooms water closet flushing and irrigation. Therefore, the Property is left with a considerate surplus.

Total greywater – (irrigation + water closet flushing) = surplus in m^3

$$7879 - (3350 + 2101) = 2428 \text{ m}^3$$

The property seems to have no particular use of the resulting surplus of 2,428 m^3, and it is therefore that the study looked at other practical use for the above-mentioned surplus greywater. For example, one option would be to divert the available surplus greywater to staff bathrooms.

4.1.13. Water use in staff bathrooms.

Property A had an equivalent full-time employment of an average of 199.2 workers a month, amounting to 45,815 shifts worked at the property in 2019. To calculate water in staff bathrooms, the study took the staff full-time equivalent for each month in 2019, multiplied by 8 to reach total hours for full-time equivalent, then subtracted leave allowance and divided by 8 to achieve actual working days by the staff at property A.

(FTE x Monthly Hours) – Monthly leave allowance = Actual hours worked by FTE = total working day

For example, for January 2019, property A had a full-time equivalent of 148.46 employees, therefore

$$\frac{191.8(\text{full time equivalent}) \times 153.33(\text{total hours} - \text{leave})}{8} = 3675.99(\text{total shifts worked})$$

Calculations for water used in staff bathroom water were taken using the data taken from Sapiano's 2011 interview then multiplied by the total number of shifts in each month, therefore

$$34.04 \text{ x total shifts worked} = \text{volume in } m^3$$

Thus, for example, water used for flushing water closets in staff bathrooms for January 2019 was calculated as follows:

$$3675.99 \text{ x } 34.08 / 1000 = 125.28 \text{ } m^3$$

Results show that total flushed water in staff bathrooms amounted to 1561.38 m^3, and if taken at a commercial rate of €2.5 per m^3, the total cost of flushed water in staff water closets amounts to €3902.5 in 2019.

Calculations for water used in 2019 by equivalent full-time employees in staff bathrooms can be found in Appendix property A Table 8

Total water used for water closet flushing in staff bathrooms amounts to 1561 m^3 for 2019. The study again calculated greywater production against water use in guests and staff water closet flushing and irrigation.

$$\text{Total greywater} - (\text{guest flushing} - \text{staff flushing} - \text{irrigation}) = \text{surplus in } m^3$$

$$7{,}879 - (2{,}101 + 1561 + 3550) = 667 \text{ } m^3$$

Calculations show that the property will remain with a surplus of 667 m^3, total water needed to supply guests, staff flushing's and irrigation stands at 7,212 m^3 at a commercial cost of €18,030

4.1.14. Rain catchment system study.

The property has a catchment area of 1,659 m^2, with the possibility of harvesting 918 m^3 of water at a commercial cost of €2,295. Calculation shows rain catchment is not enough to supply the water needed to supply guests bathroom flushing and irrigation, let alone staff bathroom flushing's.

$$\text{Rain} – (\text{guest flushing} – \text{staff flushing} – \text{irrigation}) = \text{shortage in } m^3$$

$$918 - (2{,}101 + 1561 + 3550) = - 6{,}294\ m^3$$

4.1.15. Preliminary findings.

The aforementioned calculations clearly shows that stormwater alone is not adequate for property A. However, should the property use all its available impermeable area and not just 30% of it, calculations show that it would not suffice in supplying the water needed as, the Property would harvest 2,445 m^3 which are still not enough to supply the property's needs in guests, staff bathroom flushing and irrigation.

A greywater system would meet these needs in guest, staff bathrooms and irrigation, with savings amounting to 7,212 m^3 of water a year, taken at a rate of €2.5, coming in at a value of €18,030, amounting to 27% of the properties annual water bill of €66,462.

4.2. Property B

4.2.1. Property background

Property B has 433 guest rooms for a total bed count of 866. Total bed nights occupied for 2019 was of 218,166 bed nights. The property has a total footprint of 27,079 m², of which 7,466 m² are taken up by the Hotel, the remaining 19,613 m², are used by pools and surrounding deck 6,877 m², driveway and small parking using 2,622 m², 4,898 m² is landscaped gardens, and the remaining 1,228 m² are public area.

4.2.1. Water Source

The principal water supply for property B is obtained from mains water supplied from the Water Ser-vices Corporation. In addition, the property reported buying water from private sellers. The property has four reservoirs 255 m^3 holding the Hotel's first-class water reserves, 148 m^3 on standby for us in emergency fire sprinklers,120 m^3 for emergency fire hydrants and a smaller holding 25 m^3 for irrigation. At the time of the study, the property had a fully equipped reverse osmosis facility on site but did not use it.

4.2.3. Monitoring and Consumption

In 2019 The Grand Hotel Excelsior paid €331,362.75 for the consumption of 156,006 m^3 of mains water at a commercial rate of €2.375 per cubic meter from January till July and at a rate of €1.82 in the months from August to December. In 2019 property B bought 3,819 m^3 from private water sellers, at the rate of €1.85 for a total cost of €7,065, reported as used for irrigation. Unfortunately, records are not kept monthly, and only the years total was supplied standing at 3,819 m^3. Total expenditure on the water in 2019 amounted to €338,427.

The Hotels Maintenance department does monitoring in the form of daily readings to assess water usage. Reference to calculations to be found in Appendix property B Table 1 Water Bought showing water consumption and cost for the year 2019.

4.2.4. Allocation and Sub Metering

Water is used in guests' rooms, kitchens, various pools, Spa, fountains, housekeeping, and landscaping. Sub-metering to the various needs of the property is not done. The only note regarding irrigation by the Property is that it used a total of 3819 m3. Therefore, the study's first step was to establish water use in irrigation per month, using criteria derived from the pilot study for property A. The equation used to calculate monthly irrigation was determined after the study had calculated the water use percentage per month, used at property A; thus, the below workings were used.

$$\frac{\text{Total water uses in irrigation x percentage per month}}{100} = \text{water use per month.}$$

Reference to the above calculations to be found in Appendix property B Table 2 showing workings to establish monthly use of water in irrigation in property B

As the study will focus on water used in rooms for direct use and irrigation, Table 2 shows the consumption and price of water in 2019 for both. The total price for water used in irrigation and guests as direct use amounted to €7,819 and €75,011 respectively, for a total of € 82,830 in 2019. Reference to the above calculations to be found in Appendix Property B Table 3 showing workings to establish monthly use of water in rooms as direct use and irrigation.

4.2.5. Segmentation of direct use.

As stated above, direct use by guests stands at 161.88 litres of water per bed night. To further under-stand and segment into grey water and black water, Table 4 in Appendix property B – Segmentation of direct use, shows workings for total water used in showers/bath, wash hand basins, and flushing sorting into the two classifications of water, grey and black water. Such workings will determine the study's outcome further along, explaining in detail the segmentation of water used in rooms as direct use by guests. Calculations show the property produced 1,005.23 m^3 of greywater and 7,435.09 m^3 of blackwater and in 2019

4.2.6. Rain catchment

The property has an area for rain catchment of 7,466 m^2. Calculations show the possible rain catchment using Galdies (2012) study of precipitation by month. The property should have harvested 4134 m^3 of runoff in 2019 representing a savings of €10,337 if used. However, the property states it makes no particular use of stormwater runoff. Table 5 in Appendix property B shows calculations for runoff catchment by the property

4.2.7. Hotel Performance in 2019

Property B had 218,166 bed nights; below is Table 6 showing bed nights by month. The average per month was of 18,180.

4.2.8. Bed nights by month

2019	Bed nights
January	7896
February	8765
March	16145
April	20315
May	21889

June	22260
July	24755
August	25831
September	20947
October	21259
November	16263
December	11841
Total 2019	218166

4.2.10- Water Usage by Bed Nights by Month

As established earlier in the study, water usage in wash-hand basins estimated at 17.04 litres, showers/bath at 110.76 litres, and 34.08 litres in flushing for a total of 161.88 litres per head per day. Therefore, water used in wash hand basins and shower/baths will give the properties greywater production and flushed water resulting in black water produced from guests' rooms. Calculations can be found in Table 7 in property B appendix shows calculations and cost of grey and black water for 2019.

The calculation shows the property produced 27,881 m^3 of greywater and, taken at the commercial rate the property buys water at, result in a cost of €59,399. Results show that 7,435 m^3 of water was used and trans-formed into black water, coming in at the cost of €15,839 for 2019. The total cost for water ending as grey and black water was €75,238 in 2019.

4.2.11- Greywater system Vs Rain catchment

Property B produces enormous quantities of wastewater that can be recycled for use. The property also has potential when it comes to stormwater runoff. Calculations covering 2019 clearly show that further investigation is needed to establish the best wastewater system most suitable and economically viable to the property.

4.2.12- Greywater system study

property B produced a total of 27,881 m3 of grey water in 2019 with a monetary value of €59,399. Potential savings on introducing greywater systems amount to 17.53% of the Property's annual water bill of €338,427 for 2019.

Calculations show that property B cannot use all greywater produced in guest rooms against water used in guest rooms water closet flushing and irrigation. Therefore, the property is left with a considerate surplus.

Total greywater – (irrigation + water closet flushing) = surplus in m3

27,811 – (3,819 + 7,435) = 16,557 m3

The property has no particular use of the resulting surplus of 16,557 m3, and hence this study looked at other practical use for the above-mentioned surplus greywater. For example, one option would be to divert the available surplus greywater to staff bathrooms.

4.2.13- Water use in staff bathroom Study

Property B had an equivalent full-time employment of an average of 352.33 workers a month, amounting to 81,034 shifts worked at the property in 2019. To calculate water in staff bathrooms, the study took the staff full-time equivalent for each month in 2019, multiplied by 8 to reach total hours for full-time equivalent, then subtracted leave allowance and divided by 8 to achieve actual working days by the staff at property B.

$$\frac{(\text{FTE x Monthly Hours}) - \text{Monthly leave allowance}}{8} = \text{Actual hours worked by FTE} = \text{total working day}$$

For example, for January 2019, property B had a full-time equivalent of 148.46 employees, therefore

$$\frac{332(\text{full time equivalent}) \times 153.33(\text{total hours} - \text{leave})}{8} = 6{,}363(\text{total shifts worked})$$

Calculations for water used in staff bathroom water were taken using the data taken from Sapiano's (2011) interview then multiplied by the total number of shifts in each month, therefore

$$34.04 \times \text{total shifts worked} = \text{volume in } m^3$$

Thus, for example, water used for flushing water closets in staff bathrooms for January 2019 was calculated as follows:

$$3{,}363 \times 34.08 / 1000 = 216.59 \ m^3$$

Results show that total flushed water in staff bathrooms amounted to 2,761 m^3, and if taken at the commercial rate of which the property bought water in 2019, the total cost of flushed water in staff water closets amounts to €5,905 in 2019. Table 8 – Staff bathroom flushing's, in property B appendix shows calculations for water used in 2019 by equivalent full-time employees in staff bathrooms and the cost of such water.

Calculations show that the cost of water used in Staff bathrooms for water closet flushing amounts to 1.74% of the properties annual water bill. The study again calculated greywater production against water use in guests and staff water closet flushing and irrigation.

$$\text{Total greywater} - (\text{guest flushing} - \text{staff flushing} - \text{irrigation}) = \text{surplus in } m^3$$

$$27{,}881 - (7{,}435 + 2{,}761 + 3819) = 13{,}866 \ m^3$$

Calculations show that the property will remain with a surplus of 13,866 m^3, after deducting water needed to supply guests, staff flushing's and irrigation stands at 14,015 m^3 at a commercial cost of € 28,369. Thus, resulting in a scenario were supplying guest flushing needs, staff bathroom needs, and irrigation will result in surplus.

4.2.14- Rain catchment system study

The property has a catchment area of 1,659 m^2, with the possibility of harvesting 4134 m3 of water at a commercial cost of €10,337. Initial calculations show rain catchment is not enough to supply the water needed to supply guests' bathroom flushing and irrigation.

$$\text{Rain} - (\text{guest flushing} - \text{irrigation}) = \text{shortage in } m^3$$

$$4134 - (7{,}435 + 3819) = - 7120 \ m^3$$

A rain catchment system alone will not suffice in supplying the demands of the property. The study looked at rain catchment in relation to irrigation, and calculations show that the water harvested would be enough to supply irrigation alone, resulting in a surplus.

$$\text{Rain catchment} - \text{irrigation} = \text{surplus in } m^3$$

$$4134 - 3819 = 315 \ m^3$$

At a surplus of only 315 m^3, calculations are somewhat encouraging for the introduction of stormwater harvesting facility.

4.2.15 - Preliminary findings

Calculations show that a greywater system is not economically viable for property B at present, as such a system would generate surplus water compared to the properties current water use. Calculations show that stormwater harvesting would suffice to supply the properties need for water in irrigation, savings on the use of rain catchment against water used for irrigation at the property would amount to € 7,057, 99.8% of the total bill for 2nd Class bought by the property in 2019.

4.3. Property C

4.3.1. Property Background

Property C has 252 guest rooms, for a total bed count of 510. Total bed nights occupied for 2019 was a total of 115,704 bed nights. The property has a total footprint of 26,600 m², of which 6,353 m² are taken up by the Hotel and spa buildings, the remaining 19,245 m², are used up the tennis court 1,163 m², pools and surrounding deck 2090 m², driveway and small parking using 6,440 m² and the remaining 6,250 m² is landscaped gardens.

4.3.2. Water source

The main water supply for property C is obtained primarily through reverse osmosis production, secondly from mains water supplied from the Water Services Corporation and supplemented by buying 2nd class water from private water sellers. In addition, the Hotel has one reservoir holding 250 m^3, and is reported used for rainwater harvesting.

4.3.3. Monitoring and Consumption

In 2019 the property paid €43,886 for the consumption of 39,897 m^3 of reversed osmosis water at a rate of €1.10 per cubic meter. In 2019 the property reportedly bought 8,068 m^3 of mains water from the water services Corporation at a rate of €2.35, amounting to

€18,959, and 1694 m^3 from private water sellers, at the rate of €2 for a total cost of €3,388 mainly used for irrigation. Total expenditure for water consumed by the property in 2019 stands at €66,233.

Monitoring is done by the Hotels Maintenance department in daily readings to assess water usage in the Hotels. Reference to calculations to be found in Appendix property B Table 1 Water Bought, showing water consumption and cost for the year 2019.

4.3.4. Allocation and Sub Metering

Sub-metering is done covering Irrigation, Spa, Salon, and restaurants. As the study will focus mainly on water used in rooms and irrigation, it was established that the total price for water used in irrigation stood at €3,388, whilst that for guests as direct use amounted to €20,603 in 2019 for a total of €23,991. Reference to calculations to be found in Appendix property C Table 2 - Water usage – Rooms and irrigation, showing water consumption and cost in direct use and irrigation for the year 2019.

4.3.5. Segmentation of Direct Use

As already shown above, direct use by bed night gives 161.88 ltr of water per bed night. To further understand and segment into grey water and black water, total water used in showers/bath, wash hand basins, and flushing. Such workings will determine the study's outcome further along. Reference to calculations to be found in Appendix property C Table 3 - Segmentation of direct use, showing water consumption and cost in direct use and irrigation for the year 2019. Such workings will determine the study's outcome further along, explaining in detail the segmentation of water used in rooms as direct use by guests. Calculations show the property produced 14,786.97 m^3 of greywater and 3,943 m^3 of blackwater and in 2019

4.3.6. Rain catchment.

The property has a possible catchment area of 6,353 m^2, resulting in a possible harvesting of 3,518.48 m^3. Reference to calculations to be found in Appendix property C Table 4 – Rain Catchment.

4.3.7. Monetary value – Rain Catchment at WSC Commercial Rate.

In 2019 the property had the potential to harvest 3,518 m^3, which taken at a commercial rate of €2.35; meant the property had the possibility of savings amounting to €8,267. A note should be taken that the property does not report making any particular use of rain catchment water at present.

4.3.8. Hotel Performance in 2019.

Property C had 115,704 bed nights; below is a Table 5 showing bed nights by month. The average per month was 6.332bed. Chart 6 showing a visual of the said bed nights per month in 2019.

4.3.9. Total Bed Nights by Month 2019

2019	Bed Nights
January	6332
February	6004
March	6017
April	8806
May	10163
June	10792
July	13999
August	14603
September	12113
October	12515
November	8031
December	6329

4.3.11- Water Usage by Bed Nights by Month

Calculations of water usage by guests to into account water used in wash-hand basins which was estimated at 17.04 litres and showers/bath at 110.76 litres, and 34.08 in flushing for a total of 161.88 litres per head per day. Therefore, water used in wash hand basins and shower/baths will give the property greywater production and flushed water resulting in black water produced from guests' rooms. Reference to calculations to be found in Appendix property C Table 6 – Water Usage, showing calculations and the cost of grey and black water for 2019, with Chart 7 and 8 showing a visual of the said quantities derived from the calculations in relation to grey and black water.

Calculations shows the property produced 14,786 m^3 of greywater and, if taken at the rate of €1.10, amount to an expense of €16,265. Results show that 3,943 m^3 of water transformed into black water, coming in at the cost of €4,337 for 2019. The total cost for water ending as grey and black water was €20,603 in 2019. Graphs below offer a visual of the calculations mentioned above.

4.3.11- Greywater system Vs Rain catchment

Property C produces significant quantities of wastewater that can be recycled for use. The property also has potential when it comes to stormwater. Calculations covering 2019 clearly show that further investigation is needed to establish the best wastewater system most suitable and economically viable to the property.

4.3.12- Greywater system study

The property produced a total of 14,786 m^3 greywater in 2019, which at a commercial rate of €1.10, costs €16,264. Potential savings on introducing greywater systems amounted to 24.45% of the property's annual water bill of €66,266 for 2019. Calculations show that property C cannot use all greywater produced in guest rooms water closet flushing and irrigation, resulting in a surplus of 9,149 m^3.

$$\text{Total greywater} - (\text{irrigation} + \text{water closet flushing}) = \text{surplus in } m^3$$

$$14{,}786 - (1{,}694 + 3943) = 9{,}149 \ m^3$$

The property seems to have no particular use of the resulting surplus. The study, therefore, looked at other practical use for the above-mentioned surplus greywater. One option would be to divert the available surplus greywater to staff bathrooms.

4.3.13. Water use in staff bathroom Study

Property C had an equivalent full-time employment of an average of 223 workers a month, amounting to 51,472 shifts worked at the property in 2019. To calculate water in staff bathrooms, the study took the staff full-time equivalent for each month in 2019, multiplied by 8 to reach total hours for full-time equivalent, then subtracted leave allowance and divided by 8 to achieve actual working days by the staff at property A.

$$\frac{(\text{FTE x Monthly Hours}) - \text{Monthly leave allowance} = \text{Actual hours worked by FTE}}{8} = \text{total working day}$$

For example, for January 2019, property D had a full-time equivalent of 148.46 employees, therefore -

$$\frac{148.46(\text{full time equivalent}) \text{ x } 153.33(\text{total hours} - \text{leave})}{8} = 2845.42(\text{total shifts worked})$$

Calculations for water used in staff bathroom water were taken using the data taken from Sapiano's 2011 interview then multiplied by the total number of shifts in each month, therefore

$$34.04 \text{ x total shifts worked} = \text{volume in } m^3$$

Thus, for example, water used for flushing water closets in staff bathrooms for January 2019 was calculated as follows:

$$2845.42 \times 34.08 / 1000 = 96.97 \text{ m}^3$$

Reference to calculations to be found in Appendix property C Table 7 – Staff bathroom flushed water, showing calculations for water used in 2019 by equivalent full-time employees in staff bathrooms.

Calculations show that a total of 1,754 m^3 of water was us by staff for flushing in staff bathrooms. Therefore, from the above-calculated surplus of 9,149 m^3 greywater produced, the Property would still be in surplus of 7,935 m^3 should water be diverted to staff bathrooms.

$$\text{Total greywater} – (\text{guest flushing} – \text{staff flushing} – \text{irrigation}) = \text{surplus in m}^3$$
$$14{,}786 – (1{,}694 + 3{,}943 + 1{,}754) = 7395 \text{ m}^3$$

The property does not need such surplus at current standings. The study shows that investment in a greywater system is not the best choice for the property.

4.3.14. Rain catchment system study

The property had a potential stormwater harvest of 3,518 m^3, which calculated at a rate of €1.1 per m^3, results in savings of €3,869.8, amounting to 5.8% of the properties annual water bill. Calculations show the amount of water harvested does not cover the properties needs when it comes to guest, staff bathrooms and irrigation, falling short of 3,873 m^3

$$\text{Rain} – (\text{guest flushing} – \text{staff flushing} – \text{irrigation}) = \text{shortage in m}^3$$
$$3{,}518 – (3{,}943 + 1{,}754 – 1{,}694) = - 3873 \text{ m}^3$$

The property should find a way in which it can utilise this amount of water. Calculations show the only way the property can use its rain catchment is to use in Staff bathrooms and irrigation, leaving a surplus of 70 m^3.

$$\text{Rain} – (\text{staff flushing} – \text{irrigation}) = \text{surplus in m}^3$$
$$3{,}518 – (1{,}754 – 1{,}694) = 70 \text{ m}^3$$

The amount of water needed to supply staff water closet flushing and irrigation, stands at 3,448 m^3 for 2019, taken at a rate of €1.1, stands at a value of €3,792.8 amounting to 5.7 % of the properties annual water bill.

4.3.15- Preliminary findings

Calculations show that a grey water recycling system is not adequate for the property at the time being, due to the high volume of greywater produced against the need in suppling guest, staff bathrooms and irrigation.

Calculation show that a rain catchment recycling system falls short of 3,873 m^3 needed to supply guest, staff bathrooms and irrigation. The water harvested from rain precipitation covers the use of water needed to supply staff bathrooms and irrigation that stands at 3448 m^3 and if taken at a rate of €1.1 amounting to savings €3,792, standing at 5.7 % of the properties annual water bill of €66,266.

4.4. Property D

4.4.1. Property Background

Property D 249 guest rooms, for a total bed count of 500. Total bed-nights occupied for 2019 was a total of 129,043 bed nights. The property has a total footprint of 24,272 m^2, of which the Hotel and spa buildings take up 5,086 m^2, the remaining 16,784 m^2 are used up the beach/lido 4000 m^2, pools and surrounding deck 5,300 m^2, driveway, and small parking using 3,969 m^2 and the remaining 3,515 m^2 is landscaped gardens.

4.4.2-Water Source

The primary water supply for the Corinthia San George's Bay is obtained primarily through reverse osmosis production, secondly from mains water supplied from the Water Services Corporation and supplemented its need for water by buying 2nd class water from private water sellers. The Hotel also has two reservoirs, one holding 50 m^3 of first class and a second one holding 250 m^3 of second-class water.

4.4.3- Monitoring and Consumption

In 2019, the property D paid €36,675 for the consumption of 14,670 $m^3$of mains water at a commercial rate of €2.50 per cubic meter, mainly used in wash-hand basins, baths, and showers. In 2019 property D reportedly bought 9461 m^3 from private water sellers, at the rate of €2 for a total cost of €18,922, mainly used in water closet flushing, and consumed a further 30,386 m^3 of reversed osmosis water, produced at €1.1 per m^3, totalling € 33,424. The total for water consumed in 2019 stands at €89,021.

The Hotels Maintenance department does monitoring in daily readings to assess water usage in the Hotels. Note that no sub-metering of water use is recorded at the property. Reference to the above calculations to be found in Appendix property A Table 1- Water Bought 2019 showing water consumption and price paid by the property in 2019.

4.4.4- Allocation and Sub Metering

Water is used in guests' rooms, kitchens, various pools, Spa, fountains, and housekeeping. Water consumption relevant to the study are shown Appendix property D in Table 2 - Water consumption levels, as the study will focus mainly on water used in rooms and irrigation based on 2019 data collected from property A. As the property does not have sub-meter water for irrigation, the study had to calculate irrigation levels for property D. Such calculations were made according to the properties landscaped and area based on the authors' pilot study at property A, in which exact readings for water consumption for irrigation were given. Reference to the above-mentioned calculations can be found in Appendix property D

Table 3 - Water usage in irrigation, showing calculations made to derive quantities of water used in irrigation.

Calculations show property D used an estimated 1,330.75 m^3 water for irrigation in 2019.

The study also considers water used in guest rooms as direct use, for which the property used 20,889.48 m^3 in 2019. Reference to calculations can be found in Appendix property D Table 4- Direct use in rooms, showing calculations made to derive quantities of water used as direct use.

4.4.5- Segmentation of Direct Use

As shown in the methodology chapter, direct use by bed night gives 161.88 litres of water per bed night, resulting in a total of 20,889.48 m^3. To further understand and segment into grey water and black water, such workings will determine the study's outcome further along. Calculations show the property produced 16,496.7 m^3 of greywater and 4,397.79 m^3 of blackwater and in 2019, reference to calculations can be found in Appendix property D Table 5 - Segmentation and cost of Direct Use, showing segmentation and costs of water used as direct use in rooms by guests.

4.4.6- Rain catchment

The property has a possible area for rain catchment of 5,086 m^2. Below is a table showing rain catchment using average precipitation by month found in Galdies' (2012) study. Reference to calculations can be found in Appendix property D Table 6 – Rain Catchment,

4.4.7- Monetary value – Rain Catchment at WSC Commercial Rate

In 2019 the property had a potential catchment of 2,817 m^3 with a monetary value of €7,041 when taken at the commercial rate of €2.5 per m^3. A note should be taken that the property does not report making any use of rain catchment water at present. Reference to calculations can be found in Appendix property D Table 7 – Rainwater Cost.

4.4.8-Hotel Performance in 2019

Property D 129,403 bed nights; below is a Table 8 showing bed nights by month. The average per month was 10,753.

4.4.9. Total Bed Nights by Month 2019.

2019	Bed nights
January	5246
February	6956
March	8780
April	11455
May	10323
June	12365
July	15591
August	17092
September	12552
October	12746
November	8404
December	7533

4.4.10. Water Usage by Bed Nights by Month

Table 6 shows water usage calculations by guests relevant to the study, taking the amounts of direct use: 17.04 litres and showers/bath at 110.76 litres, and 34.08 litres in flushing for 161.88 litres per head per day. Water used in wash hand basins and shower/baths will give the properties greywater production and flushed water, resulting in black water produced in guests' rooms. Reference to calculations can be found in Appendix property D Table 9 – Water Usage by bed nights, representing the cost of grey and black water for 2019. Calculations show the property produced 16,491 m^3 of greywater and, if taken at the commercial rate of €2.5, amount to €41,229. Results show that 4397 m^3 of water was used and transformed into black water, coming in at the cost of €8,794 for 2019. The total cost for water ending as grey and black was €50,023 in 2019.

4.4.11- Greywater system Vs Rain catchment

Property D produces large quantities of wastewater that can be recycled for use. The property also has potential when it comes to rain catchment. Calculations covering 2019 clearly show that further investigation is needed to establish the best wastewater system most suitable and economically viable to the property.

4.4.12- Greywater system study

Property D produced 16,419 m^3 of grey water in 2019 with a monetary value of €41,229. Therefore, potential savings on introducing greywater systems amount to 46.31% of the Property's annual water bill of €89,021 for 2019.

Calculations show that property D cannot use all greywater produced against water used in guest water closet flushing and irrigation. Therefore, the property is left with a considerate surplus.

Total greywater – (irrigation + water closet flushing) = surplus in m^3

$$16{,}419 - (1{,}330 + 4{,}397) = 10{,}692\ m^3$$

The property seems to have no particular use of the resulting surplus of 10,692m^3, and it is therefore that the study looked at other practical use for the above surplus greywater. For example, one option would be to divert the surplus greywater to staff bathrooms.

4.4.13 Water use in staff bathroom Study

Property D had an equivalent full-time employment of an average of 199.2 workers a month, amounting to 55,729 shifts worked at the property in 2019. To calculate water in staff bathrooms, the study took the staff full-time equivalent for each month in 2019, multiplied by

8 to reach total hours for full-time equivalent, then subtracted leave allowance and divided by 8 to achieve actual working days by the staff at property D.

$$\frac{(\text{FTE x Monthly Hours}) - \text{Monthly leave allowance} = \text{Actual hours worked by FTE}}{8} = \text{total working day}$$

For example, for January 2019, property A had a full-time equivalent of 148.46 employees, therefore

$$\frac{191.8(\text{full time equivalent}) \text{ x } 153.33(\text{total hours} - \text{leave})}{8} = 3675.99(\text{total shifts worked})$$

Calculations for water used in staff bathroom water were taken using the data taken from Sapiano's 2011 interview, then multiplied by the total number of shifts in each month, therefore

$$34.04 \text{ x total shifts worked} = \text{volume in m}^3$$

Thus, for example, water used for flushing water closets in staff bathrooms for January 2019 was calculated as follows:

$$3675.99 \text{ x } 34.08 / 1000 = 125.28 \text{ m}^3$$

Results show that total flushed water in staff bathrooms amounted to 1561.38 m^3, and if taken at a commercial rate of €2.5 per m^3, the total cost of flushed water in staff water closets amounts to €3902.5 in 2019. Reference to calculations can be found in Appendix property D Table 10 – Staff Bathroom Flushing, representing water used in 2019 by equivalent full-time employees in staff bathrooms.

Total water used for water closet flushing in staff bathrooms amounts to 1,899 m^3 for 2019. The study again calculated greywater production against water use in guests and staff water closet flushing and irrigation.

$$\text{Total greywater} - (\text{guest flushing} - \text{staff flushing} - \text{irrigation}) = \text{surplus in m}^3$$

$$16{,}419 – (1{,}330 + 4{,}397 + 1{,}899) = 8{,}793 \text{ m}^3$$

Calculations show that the property will remain with a surplus of 8,793 m^3, of which the property has no particular use at present and should find the best possible way in using it.

4.4.14- Rain catchment system study

The property has a catchment area of 5,086 m^2, with the possibility of harvesting 2816 m^3

of water at a production cost of €7040, when taken at a commercial rate €of 2.5. Calculation shows rain catchment is not enough to supply the water needed to supply guests bathroom flushing and irrigation, let alone staff bathroom flushing's.

$$\text{Rain} – (\text{guest flushing} – \text{staff flushing} – \text{irrigation}) = \text{shortage in m}^3$$

$$2816 - (4{,}397 + 1{,}899 + 1{,}330) = - 5440 \text{ m}^3$$

Calculations show that rain catchment would supply staff bathroom flushing and part of the water needed in irrigation.

$$\text{Rain} – (\text{staff bathroom} + \text{irrigation}) = \text{shortage in m}^3$$

$$2816 – (1{,}899 + 1{,}330) = - 413 \text{ m}^3$$

Introducing such a measure would result in €7,040 in annual savings, amounting to 7.9% of the properties annual water bill of €89,021 in 2019.

4.4.15- Preliminary findings

Calculations show that a greywater system is not the best choice for the property now due to copious quantities of greywater produced by the property for which no particular use was found for such water.

A rain catchment system would supply the properties' need for water used in staff bathroom flushing completely and subsidise in part the need for water used in irrigation. Savings in implementing a rain catchment system would amount to €7,040.

4.5. Property E

4.5.1. Property Background

Property E has 405 guest rooms, for a total bed count of 639. Total bed nights occupied for 2019 were 152,127, with a monthly average of 12,677. The property has a total footprint of 54,909 m^2, of which 10,022 m^2 are taken up by the Hotel and spa buildings, the remaining 44,897 m^2, are used up the tennis court 1,350 m^2, pools and surrounding deck 18,000 m^2, driveway and parking areas using 11,600 m^2, beach using 6,000 m^2, and the remaining 7,940 m^2 is landscaped gardens.

4.5.2. Water source

The primary water supply for the property is obtained from its reverse osmosis plant and stood at 32,000 m^3 produced at the cost of €1.10 per m^3 in 2019. The property reported not buying any water from the Water Services Corporation or private sellers.

The Hotel reported having four reservoirs for harvesting freshwater, 2 holding 70 m^3, another held 130 $m^3$and a fourth was able to hold 160 m^3 reserved for seawater.

4.5.3. Monitoring and Consumption

In 2019 property E paid €35,200 to produce 32,000 m^3 of reversed osmosed water. However, the property reports no water purchase from the water services corporation and private water sellers. In addition, the property did not supply data for submetering for water used in irrigation, nor did the property supply exact data for water produced through RO by month.

4.5.4. Allocation and Sub Metering.

Water is used in guests' rooms, kitchens, various pools, fountains, and housekeeping and irrigation. Water consumption relevant to the study that is mainly used in rooms and irrigation cannot be calculated as the property does not record water use for irrigation; therefore, the study has produced a benchmark for the calculation of water used for irrigation per square meter from its pilot study on the property that supplied detailed data concerning irrigation. On the basis that the property has 7,940 m^2 of landscaping area and calculating the use of 3006 m^3 at the price of €1.10 per, the property spent an approximative €3,306 on irrigation in 2019.

Reference to the above calculations to be found in Appendix property E Table 1- Irrigation per month, showing approximative calculations for irrigation used per square meter per month by the property in 2019. This was done taking data from property A, it being the only property that submeters irrigation.

Calculations show that property E used a total of 24,626 m^3 indirect use by guests in rooms and an approximative 3006 m^3 for irrigation at a combined cost of €30,394.

Reference to the above calculations to be found in Appendix property E Table 2 - Water usage – Rooms and Irrigation, calculations are shown deriving the amount of water used by guests as direct use in rooms and irrigation per month by the property.

4.5.5. Segmentation of Direct Use.

As shown above, direct use by bed night gives 161.88 litres of water per bed night. To further understand and segment into grey water and black water, below are the workings showing total water used in showers/bath, wash hand basins, and flushing sorting into the two classifications of water. Such workings will determine the study's outcome further along. Reference to the above calculations to be found in Appendix property E Table – 3 Segmentation of Direct Use, calculations shown the segmentation of water used by guests as direct use in rooms and irrigation per month by the property in 2019.

Calculations show that guest rooms produced 5,184 m^3 of black water and 19,441 m^3 of greywater in 2019.

4.5.6. Rain catchment

The Property has an area for rain catchment of 10,022m², with an estimated storm runoff catchment of 5,550 m^3. Reference to the above calculations to be found in Appendix property E Table 4 Rain catchment, calculations shown rain catchment quantities per month by the property in 2019.

4.5.7- Monetary value – Rain Catchment

In 2019 the property caught 5,550 m^3, amounting to savings of €6,105 at the rate of €1.1 as the property produces all its water through reverse osmoses plants and does not purchase water from the water services corporation.

4.5.8- Hotel Performance in 2019

The property had 152,127bed nights; below is Table 5 showing bed nights by month. The average per month was 12,677.

4.5.9. Total Bed Nights by Month 2019

2019	Bed nights
January	4987
February	5701
March	7408
April	11239
May	11121
June	13685
July	21271
August	24901
September	16848
October	17156
November	9214
December	8596

4.5.11. Water Usage by Bed Nights by Month

Table 3 shows calculations of water usage by guests as direct use in rooms, considering water used in wash-hand basins estimated at 17.04 litres and showers/bath at 110.76 litres, and

34.08 in flushing for a total of 161.88 litres per head per day. Therefore, water used in wash hand basins and shower/baths will give the properties greywater production and flushed water, resulting in black water produced from guests' rooms. Reference to the above calculations can be found in Appendix property E Table 6 – Water Usage, calculations shown the production and cost of grey and black water for 2019. Chart 3 visualising total greywater produced by month and Chart 4 reflecting the production of black water by month in 2019.

The calculation shows the property produced 19,441 m^3 of greywater and, if taken at the production rate of €1.1, coming in at the cost of €21,386, coming in as 60.75%of total annual water bill. Results show that 5,184 m^3 of water was used and transformed into black water, at the cost of €5,702, resulting in 16.2% of the total annual water bill. The total water used in rooms for direct use and transformed into grey and black water was 24625 m^3, costing €27,085 and resulting in 76.94% of the total annual water bill in 2019

4.5.12. Greywater system Vs Rain catchment

Property E produces large quantities of wastewater that can be recycled for use. The property also has potential when it comes to rain catchment. However, calculations covering 2019 clearly show that further investigation is needed to establish the best wastewater system most suitable and economically viable to the property.

4.5.13. Greywater system study

Property E produced 19,441 m^3 of greywater in 2019 with a monetary value of €21,386. Therefore, potential savings on introducing greywater systems amount to 60.75% of the property's annual water bill of €35200 for 2019.

Calculations show that property E cannot use all greywater produced in guest rooms against water used in guest rooms water closet flushing and irrigation. Therefore, the property is left with a considerate surplus.

Total greywater – (irrigation + water closet flushing) = surplus in m^3

$$19{,}441 - (3306 + 5{,}184) = 10{,}951 \text{ m}^3$$

The property has no particular use of the resulting surplus of 10,951 m^3, and it is therefore that the study looked at other practical use for the above surplus greywater. For example, one option would be to divert the surplus greywater to staff bathrooms.

4.5.14. Water use in staff bathroom Study

Property E had an equivalent full-time employment of an average of 289.87workers a month, amounting to 66,797 shifts worked at the property in 2019. To calculate water in staff bathrooms, the study took the staff full-time equivalent for each month in 2019, multiplied by 8 to reach total hours for full-time equivalent, then subtracted leave allowance and divided by 8 to achieve actual working days by the staff at property A.

$$\frac{\text{(FTE x Monthly Hours) – Monthly leave allowance = Actual hours worked by FTE}}{8} = \text{total working day}$$

For example, for January 2019, property A had a full-time equivalent of 246.62 employees, therefore

$$\frac{\text{246.62(full time equivalent) x 153.33(total hours – leave)}}{8} = \text{4726.78(total shifts worked)}$$

Calculations for water used in staff bathroom water were taken using the data taken from Sapiano's 2011 interview, then multiplied by the total number of shifts in each month, therefore

$$34.04 \text{ x total shifts worked} = \text{volume in m}^3$$

Thus, for example, water used for flushing water closets in staff bathrooms for January 2019 was calculated as follows:

$$4726.78 \times 34.08 / 1000 = 161.08 m^3$$

Results show that total flushed water in staff bathrooms amounted to 2,276 m^3, and if taken at a production rate of €1.1 per m^3, the total cost of flushed water in staff water closets amounts to €2,503 in 2019. Reference to the above calculations can be found in Appendix property E Table 7 – Staff bathrooms water closet flushing's, calculations show for water used in 2019 by equivalent full-time employees in staff bathrooms.

Total water used for water closet flushing in staff bathrooms amounts to 2276 m^3 for 2019. The study again calculated greywater production against water use in guests and staff water closet flushing and irrigation.

$$\text{Total greywater} - (\text{guest flushing} - \text{staff flushing} - \text{irrigation}) = \text{surplus in } m^3$$
$$19{,}441 - (5{,}184 + 2276 + 3{,}006) = 8945 m^3$$

Calculations show that the property will remain with a surplus of 8945 m^3, of which the property has no particular use at present.

4.5.15. Rain catchment system study

The property has a catchment area of 10,022 m^2, with the possibility of harvesting 5,550 m^3

of water at a production cost of €6,105. Calculation shows rain catchment is not enough to supply the water needed to supply guests bathroom flushing and irrigation, let alone staff bathroom flushing's.

$$\text{Rain} - (\text{guest flushing} - \text{staff flushing} - \text{irrigation}) = \text{shortage in } m^3$$
$$5{,}550 - (5{,}184 + 2{,}276 + 3{,}006) = - 4916 m^3$$

Calculations show rain catchment would suffice in supplying either guest rooms flushing alone or supply both staff bathroom flushing and irrigation

$$\text{Rain – guest flushing = surplus in m}^3$$
$$5{,}550 – 5{,}184 = 336 \text{ m}^3$$

Introducing such a measure would result in €5,702 in annual savings, amounting to 16.2% of the properties annual bill for water in 2019.

$$\text{Rain – (staff flushing's + irrigation) = surplus in m}^3$$
$$5{,}550 – (2{,}276 + 3{,}006) = 268 \text{ m}^3$$

Introducing such a measure would result in €5,810 in annual savings, amounting to 16.5% of the properties annual water bill in 2019.

4.5.16- Preliminary findings

Calculations reveal that a greywater recycling system is not adequate for property E due to high levels of water produced; if the property had to make use of the greywater it produces, it would remain with a large percentage of it after use in guests, staff bathroom flushing and irrigation use.

A rain catchment system would supply the properties needs in guestrooms flushing's or staff bathrooms and irrigation combined, with savings amounting to approximately 5,233m^3 of water a year, taken at the production rate of €1.1, comes in at a value of €5,756 amounting to 16.35% of the properties annual water bill of €33,200.

5 Discussion

This chapter aims to discuss potential systems that will help sustainably manage the water five-star hotels. It considers the various properties use of water and identifies the best option in obtaining their sustainability goals.

Although the results are encouraging, one needs to factor in the investment and recurrent cost from adoption of the ideal system. The properties would need to make a considerable investment to implement the best option derived from this study. Results show that a rain catchment system best serves 4 of the properties covered in the study, and a greywater system better serves only one property. A rainwater catchment system would require storage facilities and retrofitting of pipework to supply water closets and irrigation systems, as concluded in the study. A greywater system, on the other hand needs a far higher investment as a dual separation for wastewater system from guestrooms will be needed, together with a treatment plant, a dual supply system to guest rooms and staff water closets and a water storage structure. Due to the need for additional renovations to accommodate the installations of greywater treatment plants and reservoirs for rain catchment where needed, it is unlikely that many hotels will be able to carry out this upgrade. In addition, hotels will unlikely be able to implement greywater treatment in the short term due to the various modifications that need to be made to their plumbing networks. However, this upgrade can be carried out during significant refurbishment projects or new extensions. Rainwater catchment systems are therefore easier to implement, in theory.

The savings the participating hotels can make through the implementation of greywater and storm treatment solutions are computed based on the guest nights per annum. However, since the guest nights per annum vary significantly, total savings will vary throughout the year. Therefore, hotel water-saving measures could help reduce water consumption and improve water resources.

The study has shown how four participating properties can save up to 15,729 m3 per year, at a cost savings of € 23,640, if a rain catchment system was to be introduced, based on the data concerning bed nights sold through 2019. Cost savings differ from one property to another, as not all properties are supplied through the same service provider in the water supply. The fifth property, which would gain more by introducing a grey water system, stands to save

7,212 m3, with savings at €18,030. Total water savings within the five participating properties amounts to 22,941m3, costing € 41,670.

As previously stated, the results seem encouraging, and one hopes that the properties are inclined to invest in such water-saving systems. Rainwater should be collected wherever possible and used as a water source before being used for other purposes. This is because it has the lowest environmental impact and energy consumption. Despite the various advantages of implementing rainwater management systems, the tourism industry's adoption rate has been slow. This is due to the lack of awareness regarding their use and the lack of effective communication regarding their benefits. Aside from using rainwater, the study clearly shows that hotels can reduce their water consumption by recycling grey water, with both systems being an effective way to achieve more sustainable use of resources.

The study also found that the various factors influencing the development and implementation of water-saving measures in hotels were related to the establishment's age and the category. The oldest hotels in the country exhibited a more proactive approach in adopting water-saving measures.

During the early years of the tourism industry's development, it was scarce for hotels to adopt water-saving measures. Various factors prevented these establishments from adopting these measures, such as scarce development, economic factors, and the lack of environmental awareness. These factors and the high-water consumption explain why inefficiency indicators characterised many hotels built during this period.

In response to the increasing concerns about the environment and the rising cost of water, many hotel companies started implementing water-saving measures in their establishments. Although all participating properties have water harvesting facilities, most use such facilities for other use rather than water-saving purposes. Maltese law stipulates in Document F-Conservation of Fuel, Energy, and Natural Resources (Minimum requirements on energy performance of building regulations, 2006), in Table 10F, that hotel buildings should have water harvesting facilities equivalent to 0.6 of the properties rain catchment area within a year. Table 10F Reproduced below-

5.1. Size of well or cistern

Building type	Size of cistern (m^3)
1. Domestic dwellings (inc. Apartment blocks)	Total roof area (m^2) x 0.6m
2. Hotels, Schools, Offices, Factories, industrial buildings, and hospitals	Total roof area (m^2) x 0.6m
3. Shops and showrooms, and places of public gathering and entertainment not integrated in 2 above	Total roof area (m^2) x 0.45m
4. external paved areas (inc. Open terraces and balconies)	Total roof area (m^2) x 0.6m

(Office, 2006)

The study took it upon itself to calculate each of the property's rainwater harvesting capacities. Calculations reveal that the participating properties are not in line with the requisites as asked by regulations. Below Table 5.2 shows the calculations mentioned.

Table 5.2 Use of water harvesting facilities

Property	First Class	Second Class	Rainwater	Sea Water	Fire Sprinklers	Fire Hydrants	Irrigation	Total Harvesting Capacity	Size Requested
Property A					$300m^3$	$60m^3$		360 m^3	1837 m^3
Property B	$255m^3$				$148m^3$	$120m^3$	$25m^3$	548 m^3	2480 m^3
Property C			250 m^3					250 m^3	2034 m^3
Property D	$50m^3$	$250m^3$						300 m^3	1690 m^3
Property E	$70m^3$, $70m^3$, $130m^3$			$160m^3$				430 m^3	3330 m^3

The author reflected on the matter and concluded that reservoirs are either not used properly as requested by law or that other factors have moved properties away from using harvesting facilities for other uses other than rainwater harvesting. The total capacity for water harvesting within the five participating properties stands at 1,858 m³. Falls short of 9,513 m³ from the required total by the law of 11,371 m³, resulting in only 16.34% of the total requested by law. One wonders how it is only one property that reports using its harvesting facilities for rainwater. This could be the lower cost at which 2 nd class water is bought from private sellers and the even cheaper cost at which water produced by reserve osmosis currently cost. Calculations show that water harvesting facilities are used for first-class water standing at 32%, fire sprinklers at 19%, second-class water and rainwater at 14%, fire hydrants at 10%, seawater at 9% and finally, irrigation at 2%, for the properties to introduce water management systems as the study suggests, would mean investing in new water harvesting facilities, which comes at a hefty price.

5.3 Property A scenario

Looking at Properties, A scenario would mean refitting pipes and installing a dual drains system in all 147 rooms costing an estimated €25,000, at €170 for each room and having identified that the Property does not have the holding capacity for the greywater produced. Therefore, a harvesting facility would have to be built. Calculations covering supply and demand show that the facility needs to be large enough to hold 600m3 at €425.5 per m3, totalling €255,240. The calculation for supply and demand and reservoir building costs can be found in Property A Appendix Tables 9 and 10. Furthermore, the recycling plant needed would amount to approximately €110,00. Supplier estimate found in property A Appendix Letter A

Total investment at this stage stands at €365,230. Therefore, although the property will be saving €19,699.41 a year with the introduction of such a system, the introduction of a greywater system would only give a return on investment well after 30 years, as shown in the Investment Appraisal found in property A Appendix in Table 11. The study concludes that such a project is not feasible, and that property A should continue purchasing its water needs from the Water Services Corporation unless existing regulatory measures are enforced, or a new water policy would make" imported water" less attractive.

Property–A

Deficit – June to August 600 m3

Surplus – September to May 2,813 m3

Reservoir size – 600 m3

Reservoir cost – 600 x 425.5 = € 255,240

Plant cost - € 110,000

Retrofitting cost – 147 x 170 = €24,990

NVP – € -328,387

Rolling value – payback after 30-year simulation = €-314,724

5.4 Property B scenario

Looking at property B, one notices that once again, it does not report harvesting rainwater for any particular use, seeing all its water harvesting facilities are assigned to other users, and only reports having a harvesting capacity of 25 m3 for irrigation. A scenario arises where the Property will need to build a harvesting facility should it opt to introduce its best option of using rainwater to service its needs for irrigation. Calculations covering supply and demand show that the facility must be large enough to hold 2,472m3 at €425.5 per m3, totalling €1,051,588. The calculation for supply and demand and reservoir building costs can be found in Property B Appendix Tables 9 and 10. Not retrofitting costs needed at Property B

Total investment at this stage stands at €1,051,588. Although the Property will be saving €7,057 a year with the introduction of such a system, the introduction of a rainwater system would only give a return on investment well over 30 years, as shown in the Investment Appraisal found in Property B Appendix in Table 11. The study concludes that such a project is not feasible, and that Property B should continue purchasing its water needs from the Water Services Corporation

Property – B

Deficit – April to August 2,472 m3

Surplus – September to March 2,843 m3

Reservoir size – 2,472 m3

Reservoir cost – 2,472 x 425.4 = €1,051,588

Plant cost- Nil

Retrofitting cost – Nil

NVP = € - 1,051,588

Rolling value – payback after 30-year simulation = € -1,804,076.53

5.5 Property C scenario

Property C differs from our previous scenarios, as the property's best option is to implement a rainwater system to supply its needs for water needed in staff water closet flushing and irrigation. The property will still be meet with difficulty to implement such a system, as it only reports having a harvesting capacity of 250 m3 used for rainwater harvesting. The property would need additional water storage capacity; calculations covering supply and demand show that the facility needs to be large enough to hold 1,194m3 at €425.5 per m3, totalling €508,047. The calculation for supply and demand and reservoir building costs can be found in property C Appendix Tables 8 and 9. Not retrofitting costs needed at property C

Total investment at this stage stands at €508,047. Therefore, although the property will be saving €3,792 a year with the introduction of such a system, the introduction of a rainwater system would only give a return on investment well over 30 years, as shown in the Investment Appraisal found in property B Appendix in Table 10. Therefore, the study concludes that such a project is not feasible, and that property C should continue producing its water needs through Reserve Osmosis.

Property – C

Deficit – March to September 1,194 m3

Surplus – October to February 1,265 m3

Reservoir size – 1,194 m3

Reservoir cost – 1,194 x 425.5 = € 508,047

Plant cost- Nil

Retrofitting cost – Nil

NVP = € -508,047

Rolling value – payback after 30-year simulation = € - 881,797

5.6 Property D scenario

Properties D best option would be to implement a rainwater system that would supply its needs in staff water closet flushing in full and irrigation subsidise in part the need for water used in irrigation. The Property reports water harvesting facilities of 300 m3, 50 m3 for first-class water and 250 m3 for second-class water but does not define second-class water. Calculations show that the Property will need to build a harvesting facility should it opt to introduce its best option of using rainwater to service its needs. Calculations covering supply and demand show that the facility needs to be large enough to hold 1,035m3 at €425.5 per m3, totalling €440,392. The calculation for supply and demand and reservoir building costs can be found in property D Appendix Tables 11 and 12. No retrofitting costs are needed at property D.

Total investment at this stage stands at €440,392. Therefore, although the property will save €7,040 a year by introducing such a system, introducing a rainwater system would only give a return on investment well over 30 years, as shown in the Investment Appraisal found in property D Appendix in Table 13. Therefore, the study concludes that such a project is not feasible, and that property D should continue producing its water needs through Reserve Osmosis.

Property – D

Deficit – March to September 1,035 m3

Surplus - October to February 956 m3

Reservoir size – 1,035 m3

Reservoir cost = 1,035 x 425.5 = €440,392.5

Plant cost - Nil

Retrofitting cost – Nil

NVP = € -440,393

Rolling value – payback after 30-year simulation = € -766,147

5.7 Property E scenario

In the scenario for property E, the study is faced by, is of a property that reports a water harvesting capacity of 430 m3, using 270 m3 for first-class water and 160 m3 for seawater. Therefore, for property E to implement its best option, a water harvesting facility will need to be built.

Calculations covering supply and demand show that the facility needs to be large enough to hold 1,800 m3 at €425.5 per m3, totalling €765,720. Specifications for supply and demand and reservoir building costs can be found in property E Appendix Tables 8 and 9. No retrofitting costs are needed at property E.

Total investment at this stage stands at €765,720. Therefore, although the property will save €5,756 a year by introducing such a system, introducing a rainwater system would only give a return on investment well over 30 years, as shown in the Investment Appraisal found in property E Appendix in Table 10. Therefore, the study concludes that such a project is not feasible, and that property E should continue producing its water needs through Reserve Osmosis.

Property – E

Deficit – March to September 1,802 m3

Surplus – October to February 2,034 m3

Reservoir size – 1,800 m3

Reservoir cost – 1,800 x 425.4 = €765,720

Plant cost- Nil

Retrofitting cost – Nil

NVP– € -765,720

Rolling value – payback after 30-year simulation = €-1,131,576

5.8 Closing thought's

A water system's viability is linked to its services' affordability and the rate it should charge. If the service cost is too high, it will affect the system's long-term viability. In addition to the affordability of its services, a sustainable rate also needs to meet the revenue sufficiency of the system. Water systems can also use economic theory to develop pricing strategies. In this concept, marginal-cost pricing assumes that economic efficiency is a fundamental goal and that a system should be able to provide its services at an affordable price. The importance of water sustainability in the hospitality industry is acknowledged due to the significant environmental impact of hotels on the environment. However, implementing a sustainable approach can be challenging due to the connection between the customer experience and water consumption. Water is becoming more prevalent as a global environmental issue. Consumers also acknowledge it as a vital issue they should discuss. Despite the advantages of sustainability in the hospitality industry, professionals still need to overcome the challenges of implementing a sustainable strategy. One of the most common factors that hotel professionals face when implementing a sustainable strategy is the perception that it costs more. However, becoming more energy-efficient can help reduce the hotel's overall energy consumption.

The study also revealed that the hotel industry is a significant contributor to developing and implementing water-saving measures. It has been found that higher-end hotels use more water due to their higher standards and the services they provide. Unsustainable tourism is incompatible with the principles of sustainable development, as it could lead to the degradation of water resources and harm the health and well-being of the industry. Therefore, policymakers and the tourism industry should take this issue seriously

In Malta, tourism is a significant source of income and employment, but low precipitation levels have made it difficult for the country to produce and use water efficiently. This could result in a high cost to the country.

6 Conclusion

The goal of this study was to determine if it is feasible to use greywater and rainwater collected from the roofs and greywater generated by guest rooms in a sample of Malta's five-star hotels. Only those establishments with a high environmental footprint were considered for the study.

This study is important due to the increasing scarcity of water resources on the Island. In Malta, the over-exploitation of the groundwater resources has resulted in the over-reliance on desalinated water.

Through data collection, analyses, and investment appraisals, the study has concluded that introducing water conservation systems in the form of grey and rainwater in the Maltase five-star hotel sector is not economically viable although environmentally desirable. Although results demonstrate the possibility of enhanced water management in these establishments, the investment needed to adopt such systems, its payback period and net present value hinders participating properties from introducing them from an investment perspective. This issue highlights the importance of conducting comprehensive studies on the water consumption of tourism within the reality we face ourselves with, that being of water shortage. Furthermore, instead of relying on annual assessments, studies should be conducted on a case-by-case basis.

Economic sustainability is a concept that aims to create long-term value by conserving resources. This means that we must use, safeguard, and sustain the resources that are available to us. To meet the needs of the future, we must conserve natural resources not least water resources which demonstrates the abstraction they are subjected to (Authority, E. a. R., 2015). Getting the most out of water efficiency is not easy, especially when compared to energy-saving measures such as energy efficiency improvements and the installation of renewable energy sources. Although water is a valuable resource, its actual value is not fully reflected in the price. Commercial establishments are charged a rate which is inferior to the unsubsidised rate for domestic dwellings whilst there is no groundwater pricing policy. Moreover, Malta does not have any stormwater discharge charges or a sewerage fee which is proportional to the actual amounts of wastewater discharged. As a result, water becomes an undervalued commodity, and the hospitality sector therefore takes advantage of the resultant artificially low prices to ensure that they have enough water at lowest cost possible.

The study was based on the perception that the average tourist uses 162 litres of water per bed night. On the other hand, indirect water use is more prevalent. This suggests that the use of indirect water, normally used for the hotel’s daily needs in kitchens, pools, housekeeping and pools is contributing more to the overall water consumption. The increasing number of tourists and the need for more water-intensive activities are expected to contribute to the increasing pressure on water resources in various regions. This could cause the development of tourism to become less sustainable. Furthermore, due to global climate change, the effects of the tourism industry on the water supply are expected to increase.

To adapt to the changes, the tourism industry should take on a more integrated role in managing water resources. This can be achieved through the development of policies and research programs by Government in conjunction with sector representatives. Despite the many advantages of sustainability in the hospitality industry, professionals still face challenges in developing effective strategies and implementing such projects due to the financial feasibility of such interventions. Despite the wide range of technical solutions available for water reuse, the potential contribution of this technology to the management of water resources remains unquantified. This is because the economic considerations involved in choosing an appropriate reuse application usually influence the decision-making process.

The low return on investment and llengthy payback period are some of the factors that prevent the implementation of water reuse systems. These systems are designed to provide comprehensive management of water resources. The pricing of water is a sensitive issue that affects the development of projects in the countries. The generation of financial revenues also influences it. Setting too low a price for water works against the intended water savings. Without incentives to conserve water, participating Properties will not be able to implement more efficient technology.

However, it is still not feasible for the tourism industry to prioritise water use. Due to the low cost of water, it is not feasible for the industry to make water use a significant priority. The pricing of wastewater reuse projects is determined by the political decision made by the authorities. This is different from the cost and economic value of the resource.

It is clear from the questionnaire responses that the participating properties are aware of the amount of second-class water that can be reused. Properties are knowledgeable in the fact that storm runoff and grey water if collected, can be used to service non-potable supplies, with one specific Property reporting that "*Whilst rainwater from the roof can be collected in reservoirs, the building was not designed and built in a way to separate grey from black water. Grey and black water are connected to the same risers."* Meaning that there is no conformity to building regulations, the property was either planned wrongly or waived its responsibility towards such legislation when it was built.

When asked if the properties would consider adopting a water conservation plan, the answers show the participating properties are willing to move toward such plans, with three properties answering in the affirmative, one of which stated the property could not finance such a project. One property said they would need a more detailed investigation to move forward, and finally, one property stated outright that it had no plans in the pipeline for such projects. These results show a mixed reaction towards adopting water conservation plans.

When asked if the properties would consider moving towards adapting a water conservation plan in the form of a rain catchment system, the responding properties showed interest in such projects, with one property declaring in the affirmative, claiming the reason for not implementing such a system, as the need for reservoirs' to be built on the Property.

When asked if the properties would consider investing in a grey water system, the majority of respondent's answered yes, with only one property showing no interest whatsoever in grey water reuse. Furthermore, when presented with the question of to what extent would the property be ready to invest in rain/grey water harvesting the answers were mixed. One property stated the importance of understanding the investment needed, however claiming it was the properties aim to move towards a more sustainable way of operating.

Further comments related to the project costs would need to be discussed at a corporate level and some went even as far as stating that no such projects are in the pipeline. When asked if such investments depend on that investment yielding an appreciable rate of return or are it a regulatory obligation which should be respected, all responding properties feel it is their moral obligation to operate sustainably and in line with local legislation, citing that return on investment is most important.

A pattern emerges that shows that the responding properties are conscious of their properties' potential in water reuse systems and wish to move towards a more sustainable operation. It is the cost of implementing the suggested systems that keep the participating properties from investing in such sustainable projects. It seems it all boils down to return on investment. In the hospitality sector, recycling can be very cost-effective, but in other areas, it can be more valuable. This is because government financial incentives can help develop a recycling system. The initial investment in establishing a recycling facility can be high, and this is where the government can step in. Therefore, the government and the private sectors must work together to develop effective wastewater treatment practices. All new developments should have sustainable practices as a matter of principle, obtained by establishing a comprehensive system that includes both traditional and sustainable systems.

One of the critical factors that can be considered when implementing water management systems is the potential for operational savings. However, the industry's lack of experience hinders the implementation of these systems. In addition, the lack of capital investment is a significant issue that prevents the implementation of sustainable practices. Before implementing sustainable practices, numerous factors that affect the tourism industry's expectations and requirements will have to be considered. Currently, the ecotourist is in the minority, and the legislative requirements for sustainability are only being implemented. Most of the surveyed hotels were familiar with some of the various water conservation measures commonly used in the tourism industry. A study on Malta's tourism industry's water footprint would benefit the government. This will help develop a better strategy for the industry and its water treatment facilities.

Despite the positive effects of tourism on the local economy, its adverse effects on the environment can still be significant. For instance, it has been known that the water consumption of the tourism industry is higher than the consumption of the local population per capita. The multiple factors that affect the industry can also contribute to the high-water consumption. In addition, the lack of resources in an area can also cause the demand for treatment facilities. Aside from the number of tourists, other factors such as the weather and the development of the tourism industry can also affect the country's water consumption.

Despite a range of factors that affect the hotel industry, there are still many issues that it can still face. One of these is the low water tariffs. This issue can be exacerbated by the lack of awareness about the water management policies in the country. Therefore, the government should work with the hospitality industry in Malta to address this issue and to introduce meaningful tariffs for groundwater abstraction as well as abstraction quotas based on the sustainable yield of Malta’s aquifers. This will valorize groundwater and trim the excessive exploitation that is being witnessed and which makes its use financially attractive.

.

In line with the UN's recommendations, governments should also consider forming partnership agreements with the tourism industry to address the water issues affecting the country. These can be done through programs that promote the use of innovative technologies and the development of effective management policies. Besides addressing the issue of water supplies, the partnership should also help educate the industry about the global water situation. (United Nations 2006)

Further studies into the financing of such projects are the next step in the search for the way forward in which hospitality finds a way in which it helps to reduce its burden on the Island's water resources. Despite the various initiatives implemented to address the water scarcity issue in Malta, the country is still far from achieving its goal of sustainable water consumption. There are still many sacrifices that will need to be made for the country to reach this goal. Therefore, the development of a national water policy is also necessary to implement the various changes that will be implemented. The lack of sustainable policies and governance for various sectors has contributed to the country's water crisis. In addition, this issue has led to a general lack of awareness about the seriousness of the situation. Although various environmental programs have been implemented to address the issue, the national policy is needs to focus on the main points and to work with stakeholders to see how incentives for retrofitting can be mainstreamed. Moreover, building regulations should be revised to reflect these issues and expanded to address buildings with high water consumption such as hotels. Other factors such as establishing effective strategies designed to prevent water wastage during a drought are also considered. Despite the current situation, it is still essential that the private sector and the government work together to address the water shortage. One of the most crucial factors that the country can consider when addressing its water scarcity issue is the proper implementation of groundwater abstractions.

Despite the various measures that the government has been implementing to improve the country's infrastructure, future policies and measures are still needed to address the country's water scarcity issue. A comprehensive national water policy is also needed to help limit the country's water consumption. In addition, other factors such as establishing adequate infrastructure are also considered. A comprehensive national water policy can also help improve the guidance and technology available to the country's water users

The findings presented in the study are in line with the various studies presented in the literature review, showing that the hospitality sector in Malta deserves immediate attention of the stakeholders in the industry. It has been the local authorities plan to invest in wastewater management in the Maltase hospitality sector from as far as 2012 in its report by the Ministry for Resources and Rural Affairs - A Water Policy for the Maltese Islands – sustainable Management of Water Resources. In 2104, The Ministry for Sustainable Development, the Environment, and Climate Change, in its report Greening Our Economy– achieving a Sustainable Future, suggested having available funds to invest in water use management and the work started by the EU LIFE+ project by the Malta Business Bureau's should continue, suggesting also those touristic properties should urgently implement wastewater recycling and the use of greywater, showing that by 2018 the harvesting and implementation of wastewater treatment were to become mandatory for new properties within the hospitality industry. In the report published in 2018, Malta's Sustainable Development Vision for 2050 from the Minister for the Environment, Sustainable Development and Climate Change (Ministry for the Environment, 2019), the Maltese Government aims to have all buildings as water-friendly and efficient, respectful, and sensitive towards water use and to understand what each building can generate in such resource. Rain catchment and use at the source are encouraged, and greywater systems are implemented, with the water obtained used for non-potable needs. The author strongly suggests further studies into the financing of such projects with the involvement of the local authorities.

Bibliography

Authority, E. a. R., 2015. The 2nd water catchment management plan, Malta: Environment and Resources Authority.

Bureau, M. B., 2014. e EU LIFE+ Investing in Water Project, Malta: Malta Business Bureau.

Cremona, M., & Saliba, G. (2013). Recommendations - grey water treatment as a green economy initiative. Malta: Malta Business Bureau.

Dalli, M. (2011, October 7). Maltatoday. Retrieved from https://www.maltatoday.com.mt/: https://www.maltatoday.com.mt/news/national/13221/down-the-drain-each-one-of-us-is-flushing-32-litres-of-water-every-day#.Ysazb3ZBzIU

Environment, T. M. f. t., 2018. Malta's Sustainable Development Vision for 2050, Malta: The Ministry for the Environment.

FAO, 2006. Malta water resources review, Rome: FOOD AND AGRICULTURE ORGANISATION OF THE UNITED NATIONS.

Galdies, C., 2011. The Climate of Malta: Statistics, trends, and analysis 1951-2010, s.l.: NSO.

Health, I. f. W. &., 2015. Institute for Work & Health. [Online]

Available at: https://www.iwh.on.ca/what-researchers-mean-by/primary-data-and-secondary-data

[Accessed 09 09 2020].

Malta, G. o., 2014. eufunds.gov.mt. [Online]

Available at:
https://eufunds.gov.mt/en/EU%20Funds%20Programmes/EU%20Territorial%20Programmes/Pages/Public-Consultation---EU-Funds-for-Malta-2014-2020.aspx
[Accessed 09 09 2020].

(n.d.).

Cremona, M., & Saliba, G. (2013). Recomandations - grey water treatment as a green economy initiative. Malta: Malta Business Bureau.

Dalli, M. (2011, October 7). Maltatoday. Retrieved from https://www.maltatoday.com.mt/: https://www.maltatoday.com.mt/news/national/13221/down-the-drain-each-one-of-us-is-flushing-32-litres-of-water-every-day#.Ysazb3ZBzIU

Marco Cremona, G. S. (2013). water Consumption Benchmarks - a step towards reduced consumption. Malta: Malta Business Bureau.

matlaweather.com, 2020. Maltaweather.com. [Online]
Available at:
https://web.archive.org/web/20150809124857/http://www.maltaweather.com/rainfall
[Accessed 09 09 2020].

Office, S. D. B. R., 2006. Document F- Conservation of fuel, energy, and natural resources., Malta: Building regulation office.

Pacey, A. a. C., 1989. Rainwater Harvesting. [Online]
Available at: http://www.rainwaterharvesting.org/urban/ThePotential.htm
[Accessed 08 09 2020].

Project, M. B. B. E. L. I. i. W., 2014. Recommendations – National Water Management Plan, Malta: Malta Business Bureau.

Travel, C. t., 2020. Climates to travel - World climate guide. [Online]
Available at: https://www.climatestotravel.com/climate/malta

[Accessed 12 11 2020].

Affairs, M. f. R. a. R., 2012. A WATER POLICY FOR THE MALTESE ISLANDS, SUSTAINABLE MANAGE-MENT OF WATER RESOURCES, Malta: Government of Malta.

Airport, M., 2020. Malta Airport. [Online]

Available at: https://www.maltairport.com/weather/

[Accessed 12 09 2020].

Attard, 2018. The Evolution of Malta's tourism product over the years, Malta: Central Bank of Malta.

Bonello, G., 2018. Downs and ups of tourism to Malta in the 50's. Malta: The Times of Malta.

Corporation, W. S., 2017. Annual report, Malta: water Services Corporation.

Cremona, M. S. G., 2012. EU LIFE+ Investing in Water Project, Water Consumption Benchmarks, Malta: Malta Business Bureau's EU LIFE+ Investing in Water Project.

D. Styles, H. S. J. G. M., 2013. JRC Scientific and Policy Report on Best Environmental Management Practice in the Tourism Sector, Luxembourg: Publications Office of the European Union.

Galdies, C., 2011. The Climate of Malta: Statistics, trends, and analysis 1951-2010, s.l.: NSO.

Gleick, P., 2002. Water management: soft water paths. Nature, 25 July, Volume 418, p. 373.

Google, 2020. Google Maps. [Online] Available at: https://www.google.com.mt/maps/place/Grand+Hotel+Excelsior+Malta/@35.8972219,14.5045567,18.46z/data=!4m8!3m7!1s0x130e4532e720622b:0x2cd91a35694872ce!5m2!4m1!1i2!8m2!3d35.8971876!4d14.5053709

[Accessed 13 09 2020].

Google, 2020. Google Maps. [Online] Available at: https://www.google.com.mt/maps/place/Corinthia+Palace+Hotel+%26+Spa,+Malta/@35.894

2903,14.447501,18.08z/data=!4m8!3m7!1s0x130e5018779b7fd9:0xc21910c5b32d7a88!5m2!4m1!1i2!8m2!3d35.8942043!4d14.4491988
[Accessed 13 09 2020].

Grossling, 2001. The consequences of tourism for sustainable water use on a tropical island. Zanzi-bar, Tanzania. Journal of Environmental management, 61(2), pp. 179-191.

Grossling, 2005. Tourism's contribution to global environmental change: space, energy, disease, and water. In: C. H. a. J. Higham, ed. Tourism, Recreation and Climate Change: International Perspec-tives. United Kingdom: Channel View Publications, pp. 286-300.

Haedus, Q., 1536. Insulae Melitae description. 1536 ed. Lyon: s.n.

Health, I. f. W. &., 2015. Institute for Work & Health. [Online]
Available at: https://www.iwh.on.ca/what-researchers-mean-by/primary-data-and-secondary-data [Accessed 09 09 2020].

Lockhart, D., 1997. 'We promise you a warm welcome': tourism in Malta since the 1960's. Geojurnal, 41(2), pp. 145-152.

Lovens, A., 1976. Energy Strategy: The Road Not Taken? Foreign Affairs, Issue October.

Malta, G. o., 2014. eufunds.gov.mt. [Online]
Available at: https://eufunds.gov.mt/en/EU%20Funds%20Programmes/EU%20Territorial%20Programmes/Pages/Public-Consultation---EU-Funds-for-Malta-2014-2020.aspx
[Accessed 09 09 2020].

Mangion, E., 2013. Tourism Impact on Water Consumption in Malta, Malta: Islands and Small States Institute, University of Malta.

MINISTRY FOR SUSTAINABLE DEVELOPMENT, T. E. A. C. C., 2014. GREENING OUR ECONOMY – ACHIEVING A SUSTAINABLE FUTUR, Malta: Government of Malta.

Ministry for the Environment, S. D., 2019. Sustainable Development Strategy for Malta for 2050, Malta: Government of Malta.

Organisation, F. a. A., 2006. Malta water resources review, Rome: Food and Agriculture Organisation.

Pacey, A. a. C., 1989. Rainwater Harvesting. [Online]
Available at: http://www.rainwaterharvesting.org/urban/ThePotential.htm
[Accessed 08 09 2020].

Qualtrics, 2020. Qualtrics. [Online]
Available at: https://www.qualtrics.com/uk/experience-management/research/cross-tabulation/?rid=ip&prevsite=en&newsite=uk&geo=MT&geomatch=uk
[Accessed 12 09 2020].

Stefan Grossling, P. P. C. M. H. J.-P. C. G. D. L. V. L. D. S., 2012. Tourism and water use: Supply, demand, and security. An international review. Tourism Management, 33(1), pp. 1-15.

Sapiano, M., Mangion, J. & Batchelor, C., 2006. Malta water resources review, Rome: Food and Agriculture Organization of the United Nations.

Travel, C. t., 2020. Climates to travel - World climate guide. [Online]
Available at: https://www.climatestotravel.com/climate/malta
[Accessed 12 11 2020].

ServicesCorporation, W., 2017. *Annual Report*, Malta: Water Services Corporation Public Relations Office.

Styles, D., Schoenberger, H., & Galvez-Martos, J. L. (2013). Best Environmental Management Practice in the Tourism Sector: Learning from frontrunners. JRC Scientific Report. Seville: IPTS, ISBN 978-92-79-30895-6. Available at http://

susproc.jrc.ec.europa.eu/activities/emas/documents/TourismBEMP.pdf. Testa, F., Rizzi, F., Daddi,

Wagget, R., 2006. Water key performances for offices and hotels, United Kingdom: CIRIA.

Weather, M., 2020. maltaweather.com. [Online]

Available at: http://maltaweather.com/

[Accessed 12 09 2020].

https://www.aquatestinc.com/blog/grey-water-recycling-a-guide-for-hotel-managers

Appendices

Tables relative study

Study Appendices

Property A - Appendices.

Table 1 Water Bought 2019

Property A	Water bought cost 2019			
2019	Mains m^3	Mains @ 2.35€	2nd Class m^3	2nd class @2€
January	1243	3107.5	100	200
February	1595	3987.5	140	280
march	1820	4550	230	460
April	2059	5147.5	310	620
May	1867	4667.5	340	680
June	2034	5085	510	1020
July	2115	5287.5	850	1700
August	2011	5027.5	590	1180
September	3142	7855	300	600

October	2080	5200	0	0
November	1590	3975	0	0
December	1479	3697.5	180	360
Total 2019	*23035*	57587.5	3550	7100

Table 2- Water usage – Rooms and Irrigation

2019	Bed Nights	Irrigation 2019 €	Irrigation 2021 €	Direct use €	Total Price irrigation and direct use 2019	Total price irrigation and direct use 2021
January	3063	200	250	1239.60	1439.60	1985.43
February	3040	280	350	1230.29	1510.29	2072.40
March	4411	460	575	1785.13	2245.13	3074.18
April	5815	620	775	2353.33	2973.33	4069.66
May	5815	680	850	2353.33	3033.33	4144.66
June	6069	1020	1275	2456.12	3476.12	4713.57
July	6225	1700	2125	2519.26	4219.26	5651.96
August	6523	1180	1475	2639.86	3819.86	5170.80
September	6629	600	750	2682.76	3282.76	4505.86
October	6460	0	0	2614.36	2614.36	3660.11
November	4629	0	0	1873.36	1873.36	2622.70
December	2978	360	450	1205.20	1565.20	2137.28
Total 2019	61657	7100	8875	24952.59	32052.59	43808.62

Table 3 Segmentation of Direct Use

2019	Bed Nights	Direct Use m^3	Flushed water m^3	Hand Basin m^3	Total Shower/Bath m^3
January	3063	495.84	104.39	52.19	339.26
February	3040	492.12	103.60	51.80	336.71
March	4411	714.05	150.33	75.16	488.56
April	5815	941.33	198.18	99.09	644.07
May	5815	941.33	198.18	99.09	644.07
June	6069	982.45	206.83	103.42	672.20
July	6225	1007.70	212.15	106.07	689.48
August	6523	1055.94	222.30	111.15	722.49
September	6629	1073.10	225.92	112.96	734.23
October	6460	1045.74	220.16	110.08	715.51
November	4629	749.34	157.76	78.88	512.71
December	2978	482.08	101.49	50.75	329.84
Total 2019	61657	9981.04	2101.27	1050.64	6829.13

Table 4- Rain catchment

2019	Catchment area	Galdies Study	Catchment in mm	Catchment in m3
January	1,659.29	87.75	145,602.79	145.60
February	1,659.29	60.53	100,436.88	100.44
March	1,659.29	42.73	70,901.50	70.90
April	1,659.29	22.10	36,670.33	36.67
May	1,659.29	9.92	16,460.17	16.46
June	1,659.29	3.12	5,176.99	5.18
July	1,659.29	0.49	813.05	0.81
August	1,659.29	7.31	12,129.42	12.13
September	1,659.29	42.94	71,249.96	71.25
October	1,659.29	86.73	143,910.31	143.91
November	1,659.29	87.73	145,569.60	145.57
December	1,659.29	102.48	170,044.14	170.04
Total 2019	1,659.29	553.83	918,965.13	918.96

Table 5- Rain catchment value

2019	Catchment	Price per m3	Cost
January	145.60	2.50	364.01
February	100.44	2.50	251.09
march	70.90	2.50	177.25
April	36.67	2.50	91.68
May	16.46	2.50	41.15
June	5.18	2.50	12.94
July	0.81	2.50	2.03

August	12.13	2.50	30.32
September	71.25	2.50	178.12
October	143.91	2.50	359.78
November	145.57	2.50	363.92
December	170.04	2.50	425.11
Total 2019	918.96		2297.41

Table 7 – Water Usage by bed nights

2019	Bed Nights	Blackwater m^3	Blackwater cost	Greywater m^3	Greywater cost
January	3063	104.39	260.97	391.45	978.63
February	3040	103.60	259.01	388.51	971.28
March	4411	150.33	375.82	563.73	1409.31
April	5815	198.18	495.44	743.16	1857.89
May	5815	198.18	495.44	743.16	1857.89
June	6069	206.83	517.08	775.62	1939.05
July	6225	212.15	530.37	795.56	1988.89
August	6523	222.30	555.76	833.64	2084.10
September	6629	225.92	564.79	847.19	2117.97
October	6460	220.16	550.39	825.59	2063.97
November	4629	157.76	394.39	591.59	1478.97
December	2978	101.49	253.73	380.59	951.47
Total 2019	61657	2101.27	5253.18	7879.76	19699.41

Table 8 – Staff bathrooms water closet flushing.

2019	EFTE	Total shifts	Total flushed
January	191.80	3675.99	125.28
February	174.51	3344.72	113.99
March	171.82	3293.15	112.23
April	183.47	3516.41	119.84

May	184.02	3527.03	120.20
June	210.65	4037.29	137.59
July	227.17	4354.07	148.39
August	222.56	4265.62	145.37
September	216.54	4150.26	141.44
October	216.02	4140.22	141.10
November	198.09	3796.64	129.39
December	193.76	3713.71	126.56

Table 9- Consumption levels

Area												
2019	30% Rain Catchment in cubic meters	Total use in wash hand basins and showers/baths in cubic meters	Irrigation cubic meters	Staff rooms flushed in cubic meters		Total In	Total Out	S(in)	S(out)			
January	108	391	100	125		499	740	499	740		-241	
Febuary	65	389	140	114		453	740	953	1480		-287	
march	94	564	230	112		658	740	1611	2220		-82	
April	46	743	310	120		789	740	2399	2960		49	49
May	35	743	340	120		778	740	3177	3700		38	87
June	0	776	510	138		776	740	3953	4440		36	123
July	2	796	850	148		798	740	4751	5180		58	180
August	0	834	590	145		834	740	5585	5920		94	274
September	130	847	300	141		977	740	6562	6660		237	512
October	176	826	0	141		1001	740	7564	7400		261	773
November	20	592	0	129		612	740	8176	8140		-128	645
December	57	381	180	129		438	740	8614	8880		-302	343
Monthly Average	61	657	296	130		499	740	9113	9620			102
Daily Average	2	2	1	5		453	740	9566	10360		-266	-184
Total 2019	734	7880	3550	1691		658	740	10224	11100			-266
						789	740	11013	11840			
January	499	426		73		778	740	11791	12580			
Febuary	453	426		27		776	740	12567	13320			
march	658	426		232		798	740	13364	14060			
April	789	426		363		834	740	14198	14800			
May	778	426		352		977	740	15176	15540			
June	776	426		350		1001	740	16177	16280			
July	798	426		372		612	740	16789	17020			
August	834	426		408		438	740	17227	17760			
September	977	426		551								
October	1001	426		576								
November	612	426		186								
December	438	426		12								

Table- 10 Supply and Demand

Area	1659						Need to input		Fixed		Formulae								
Month	Rainfall	Runoff	Greywater	Total 2nd class supply		Irrigation	Guest rooms	Staff rooms	Total demand	Average demand	Greywater - Total Demand		Supply	Demand	Supply Cumulative	Demand Cumulative	Grey - total demand	total 2nd class - total demand	rain - total demand
January	87.75	146	391	537		100	104	125	330	601	207		537	601	537	601	62	207	-184
February	60.53	100	389	489		140	104	114	358	601	131		489	601	1026	1203	31	131	-257
March	42.73	71	564	635		230	150	112	493	601	142		635	601	1661	1804	71	142	-422
April	22.1	37	743	780		310	198	120	628	601	152		780	601	2440	2405	115	152	-591
May	9.92	16	743	760		340	198	120	658	601	101		760	601	3200	3006	85	101	-642
June	3.12	5	776	781		510	207	138	854	601	-74		781	601	3981	3608	-79	-74	-849
July	0.49	1	796	796		850	212	148	1211	601	-414		796	601	4777	4209	-415	-414	-1210
August	7.31	12	834	846		590	222	145	958	601	-112		846	601	5623	4810	-124	-112	-946
September	42.94	71	847	918		300	226	141	667	601	251		918	601	6541	5412	180	251	-596
October	86.73	144	826	969		0	220	141	361	601	608		969	601	7511	6013	464	608	-217
November	87.73	146	592	737		0	158	129	287	601	450		737	601	8248	6614	304	450	-142
December	102.48	170	381	551		180	101	129	411	601	140		551	601	8799	7216	-30	140	-241
January	87.75	146	391	537		100	104	125	330	601	207		537	601	9336	7817	664	1583	-6297
February	60.53	100	389	489		140	104	114	358	601	131		489	601	9825	8418			
March	42.73	71	564	635		230	150	112	493	601	142		635	601	10459	9019			
April	22.1	37	743	780		310	198	120	628	601	152		780	601	11239	9621			
May	9.92	16	743	760		340	198	120	658	601	101		760	601	11999	10222			
June	3.12	5	776	781		510	207	138	854	601	-74		781	601	12779	10823			
July	0.49	1	796	796		850	212	148	1211	601	-414		796	601	13576	11425			
August	7.31	12	834	846		590	222	145	958	601	-112		846	601	14422	12026			
September	42.94	71	847	918		300	226	141	667	601	251		918	601	15340	12627			
October	86.73	144	826	969		0	220	141	361	601	608		969	601	16309	13228			
November	87.73	146	592	737		0	158	129	287	601	450		737	601	17047	13830			
December	102.48	170	381	551		180	101	129	411	601	140		551	601	17597	14431	3166 total surplus 2nd class over 2 years		

Table 11- Investment Appraisal

INVESTMENT APPRAISAL																															
Discount rate	0.04																														
Item	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Cost of reservoir	255240																														
Greywater system	110000																														
Cost of retrofitting piping (M&E works)	24990																														
Operations & Maintenance		12762	12762	12762	12762	12762	12762	12762	12762	12762	12762	12762	12762	12762	12762	12762	12762	12762	12762	12762	12762	12762	12762	12762	12762	12762	12762	12762	12762	12762	12762
Value of water		17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129
Net Saving		4367	4367	4367	4367	4367	4367	4367	4367	4367	4367	4367	4367	4367	4367	4367	4367	4367	4367	4367	4367	4367	4367	4367	4367	4367	4367	4367	4367	4367	4367
Discount rate		0.96154	0.92456	0.889	0.8548	0.82193	0.79031	0.75992	0.73069	0.70259	0.67556	0.64958	0.6246	0.60057	0.577475	0.555265	0.533908	0.513373	0.493628	0.474642	0.456387	0.438834	0.421955	0.405726	0.390121	0.375117	0.360689	0.346817	0.333477	0.320651	0.308319
Net Present Value	-390230	4198.56	4037.07	3881.8	3732.5	3588.94	3450.91	3318.18	3190.56	3067.84	2949.85	2836.4	2727.3	2622.41	2521.545	2424.562	2331.31	2241.644	2155.427	2072.526	1992.814	1916.167	1842.468	1771.604	1703.465	1637.948	1574.95	1514.375	1456.129	1400.124	1346.273
Rolling value - payback		-386031	-381994	-378113	-374380	-370791	-367340	-364022	-360831	-357764	-354814	-351977	-349250	-346628	-344106	-341682	-339350	-337109	-334953	-332881	-330888	-328972	-327129	-325358	-323654	-322016	-320441	-318927	-317471	-316071	-314724

Letter A

Hi Mark,
As to the report, the water usage is ~34l/p/night and shower/bath 110l/p/night.

62,500 bed/nights =
2,125m3 WC / 365 = 5.8m3/d
6,875m3 shower / 365 = 19m3/d

You see that you have much more yield than demand. Therefore, the system would be sized to demand.
As I have not irrigation demand figure, I would allow for an ARC 280 MB.

Budget cost: £40,000 without distribution pump ex VAT

216,000 bed/nights =
7,344m3 WC / 365 = 20m3/d
23,760m3 shower / 365 = 65m3

For this above we could use 2x ARC 400 to allow for 30m3/d treatment.

Budget cost: 2x £52,000 = £104,000 without distribution pump ex VAT

I hope this helps.

Kind regards
Lutz

Aquality Trading & Consulting Ltd.
6 Wadsworth Road
London UB6 7JJ
Phone +44 (0)20 8991 3725
Mobile : 07843 563970
johnen@aqua-lity.co.uk
www.aqua-lity.co.uk

Property B - Appendices.

Table 1- Water Bought 2019

2019	Mains Water bought m^3.	2nd Class Bought m^3.	Total Price Mains Water	Total Price 2nd Class 2019
January	8,931.00	0.00	21,211.13	
February	8,002.00	0.00	19,004.75	
March	11,076.00	0.00	26,305.50	
April	12,238.00	0.00	29,065.25	
May	13,496.00	0.00	32,053.00	
June	15,671.00	0.00	37,218.63	
July	16,052.00	0.00	38,123.50	
August	15,032.00	0.00	27,358.24	
September	16,417.00	0.00	29,878.94	
October	16,119.00	0.00	29,336.58	
November	11,748.00	0.00	21,381.36	
December	11,223.00	0.00	20,425.86	
Total 2019	156,005.00	3,819.00	331,362.73	7,065.15

Table – 2 Irrigation per month

2019	Irrigation total m^3.	Monthly %	Monthly irrigation m^3.
January	3819	2.82	107.58

February	3819	3.94	150.61
March	3819	6.48	247.43
April	3819	8.73	333.49
May	3819	9.58	365.76
June	3819	14.37	548.65
July	3819	23.94	914.41
August	3819	16.62	634.71
September	3819	8.45	322.73
October	3819	0	0.00
November	3819	0	0.00
December	3819	5.070422535	193.64
Total 2019		100	3819.00

Table 3- Water usage – Rooms and Irrigation.

Total Direct Use in Rooms m^3	Total Cost Direct Use in Rooms	Irrigation m^3	Total Cost Irrigation
1274.34	3026.55	107.58	199.02
1414.58	3359.64	150.61	278.63
2605.64	6188.40	247.43	457.74
3278.64	7786.76	333.49	616.96
3532.67	8390.08	365.76	676.66
3592.54	8532.29	548.65	1014.99
3995.21	9488.62	914.41	1691.66
4168.87	7587.33	634.71	1174.21
3380.64	6152.76	322.73	597.05
3430.99	6244.40	0.00	0.00
2624.69	4776.93	0.00	0.00
1911.02	3478.05	193.64	358.23
Total 35209.81	75011.81	3819	7065.15

Table 4 - Segmentation of Direct Use

2019	Total Direct Use m^3	Flushed m^3	Wash Hand Basin m^3	Shower/Bath m^3
January	1278.20	269.10	134.55	874.56
February	1418.88	298.71	149.36	970.81

March	2613.55	550.22	275.11	1788.22
April	3288.59	692.34	346.17	2250.09
May	3543.39	745.98	372.99	2424.43
June	3603.45	758.62	379.31	2465.52
July	4007.34	843.65	421.83	2741.86
August	4181.52	880.32	440.16	2861.04
September	3390.90	713.87	356.94	2320.09
October	3441.41	724.51	362.25	2354.65
November	2632.65	554.24	277.12	1801.29
December	1916.82	403.54	201.77	1311.51
Total 2019	35316.71	7435.10	3717.55	24164.07

Table 5 - Rain catchment

2019	Rain Fall Galdies study	Available catchment area	Catchment m^3	Price of Rain Catchment
January	87.75	7,466	655.14	1637.85
February	60.53	7,466	451.92	1129.79
March	42.73	7,466	319.02	797.56
April	22.1	7,466	165.00	412.50
May	9.92	7,466	74.06	185.16
June	3.12	7,466	23.29	58.23
July	0.49	7,466	3.66	9.15
August	7.31	7,466	54.58	136.44
September	42.94	7,466	320.59	801.48
October	86.73	7,466	647.53	1618.82
November	87.73	7,466	654.99	1637.48
December	102.48	7,466	765.12	1912.79
2019 Total	553.83		4134.89	10337.24

Table 7 – Water Usage

2019	Greywater m^3	Greywater cost	Blackwater m^3	Blackwater cost
January	1009.11	2396.63	269.10	639.10
February	1120.17	2660.40	298.71	709.44
March	2063.33	4900.41	550.22	1306.78
April	2596.26	6166.11	692.34	1644.30
May	2797.41	6643.86	745.98	1771.70
June	2844.83	6756.47	758.62	1801.72
July	3163.69	7513.76	843.65	2003.67
August	3301.20	6008.19	880.32	1602.18
September	2677.03	4872.19	713.87	1299.25
October	2716.90	4944.76	724.51	1318.60
November	2078.41	3782.71	554.24	1008.72
December	1513.28	2754.17	403.54	734.45
Total 2019	27881.61	59399.65	7435.10	15839.91

Table 8 - Staff bathroom flushing's

2019	EFTE	Total Shifts	Total Flushed m^3	Price €	Cost €
January	332	6363.20	216.86	2.375	515.04
February	306	5864.87	199.87	2.375	474.70
March	337	6459.03	220.12	2.375	522.79
April	337	6459.03	220.12	2.375	522.79
May	353	6765.69	230.57	2.375	547.61
June	377	7225.68	246.25	2.375	584.85
July	383	7340.67	250.17	2.375	594.15
August	407	7800.66	265.85	1.82	483.84
September	365	6995.68	238.41	1.82	433.91
October	345	6612.36	225.35	1.82	410.14
November	340	6516.53	222.08	1.82	404.19
December	346	6631.52	226.00	1.82	411.32

Year total		81034.91	2761.67		5905.35

Table 9 Consumptions levels

Area													
2019	Rain Catchment in cubic meters	Total use in wash hand basins and showers/baths in cubic meters	Irrigation cubic meters	Staff rooms flushed in cubic meters		Total In	Total Out	S(in)	S(out)				
January	655	2387	0.70	217		3043	5100	3043	5100		-2057		
Febuary	452	2650	0.99	120		3102	5100	6145	10200		-1998		
march	319	4882	1.62	220		5201	5100	11345	15300		101		
April	165	6142	2.18	220		6307	5100	17653	20400		1207	1207	
May	74	6618	2.39	231		6692	5100	24345	25500		1592	2800	
June	23	6731	3.59	246		6754	5100	31099	30600		1654	4454	
July	4	7485	5.99	250		7489	5100	38588	35700		2389	6842	
August	55	5985	4.15	266		6040	5100	44627	40800		940	7782	
September	321	4854	2.11	238		5174	5100	49802	45900		74	7856	
October	648	4926	0.00	225		5573	5100	55375	51000		473	8330	
November	655	3768	0.00	222		4423	5100	59798	56100		-677	7653	
December	765	2744	1.27	226		3509	5100	63307	61200		-1591	6061	
Monthly Average	345	4931	2	223		499	5100	63806	66300			4004	
Daily Average	11	162	0	7		453	5100	64259	71400		2107	2006	
Total 2019	4135	59172	25	2707		658	5100	64917	76500			2107	
						789	5100	65706	81600				
January	3043	226	0.70	2817		778	5100	66484	86700				
Febuary	3102	226	0.99	2877		776	5100	67260	91800				
march	5201	226	1.62	4975		798	5100	68058	96900				
April	6307	226	2.18	6082		834	5100	68892	102000				
May	6692	226	2.39	6467		977	5100	69869	107100				
June	6754	226	3.59	6528		1001	5100	70870	112200				
July	7489	226	5.99	7263		612	5100	71482	117300				
August	6040	226	4.15	5814		438	5100	71920	122400				
September	5174	226	2.11	4949									
October	5573	226	0.00	5348									
November	4423	226	0.00	4198									
December	3509	226	1.27	3283									

Table 10 Supply and demand

January	87.75	664	1005	1669		107.58	269	217	594	318	556		1669	318	1669	318	412	1076	70
February	60.53	458	1116	1574		150.61	299	120	569	318	307		1574	318	3243	636	547	1005	-111
March	42.73	323	2055	2379		247.43	550	220	1018	318	76		2379	318	5622	955	1038	1361	-694
April	22.1	167	2586	2754		333.49	692	220	1246	318	-166		2754	318	8375	1273	1340	1508	-1079
May	9.92	75	2787	2862		365.76	746	231	1342	318	-291		2862	318	11237	1591	1444	1519	-1267
June	3.12	24	2834	2858		548.65	759	246	1554	318	-525		2858	318	14094	1909	1280	1304	-1530
July	0.49	4	3152	3155		914.41	844	250	2008	318	-911		3155	318	17250	2228	1143	1147	-2005
August	7.31	55	3289	3344		634.71	880	266	1781	318	-579		3344	318	20594	2546	1508	1563	-1726
September	42.94	325	2667	2992		322.73	714	238	1275	318	2		2992	318	23585	2864	1392	1717	-950
October	86.73	656	2706	3363		0.00	725	225	950	318	656		3363	318	26948	3182	1757	2413	-294
November	87.73	664	2070	2734		0.00	554	222	776	318	664		2734	318	29682	3501	1294	1958	-113
December	102.48	775	1507	2283		193.64	404	226	823	318	582		2283	318	31965	3819	684	1460	-48
January	87.75	664	1005	1669		107.58	269	217	594	318	556		1669	318	33634	4137	13839	18029	-9745
February	60.53	458	1116	1574		150.61	299	120	569	318	307		1574	318	35208	4455			
March	42.73	323	2055	2379		247.43	550	220	1018	318	76		2379	318	37587	4774			
April	22.1	167	2586	2754		333.49	692	220	1246	318	-166		2754	318	40340	5092			
May	9.92	75	2787	2862		365.76	746	231	1342	318	-291		2862	318	43202	5410			
June	3.12	24	2834	2858		548.65	759	246	1554	318	-525		2858	318	46059	5728			
July	0.49	4	3152	3155		914.41	844	250	2008	318	-911		3155	318	49215	6047			
August	7.31	55	3289	3344		634.71	880	266	1781	318	-579		3344	318	52559	6365			
September	42.94	325	2667	2992		322.73	714	238	1275	318	2		2992	318	55550	6683			
October	86.73	656	2706	3363		0.00	725	225	950	318	656		3363	318	58913	7001			
November	87.73	664	2070	2734		0.00	554	222	776	318	664		2734	318	61647	7320			
December	102.48	775	1507	2283		193.64	404	226	823	318	582		2283	318	63930	7638			

Table 11 Investment appraisal

INVESTMENT APPRAISAL																															
Discount rate	0.04																														
Item	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Cost of reservoir	1051589																														
Greywater system																															
Cost of retrofitting piping (M&E works)																															
Operations & Maintenance		52579.44	52579.44	52579.44	52579.44	52579.44	52579.44	52579.44	52579.44	52579.44	52579.44	52579.44	52579.44	52579.44	52579.44	52579.44	52579.44	52579.44	52579.44	52579.44	52579.44	52579.44	52579.44	52579.44	52579.44	52579.44	52579.44	52579.44	52579.44	52579.44	52579.44
Value of water		9063	9063	9063	9063	9063	9063	9063	9063	9063	9063	9063	9063	9063	9063	9063	9063	9063	9063	9063	9063	9063	9063	9063	9063	9063	9063	9063	9063	9063	9063
Net Saving		-43516	-43516	-43516	-43516	-43516	-43516	-43516	-43516	-43516	-43516	-43516	-43516	-43516	-43516	-43516	-43516	-43516	-43516	-43516	-43516	-43516	-43516	-43516	-43516	-43516	-43516	-43516	-43516	-43516	-43516
Discount rate		0.961538	0.924556	0.888996	0.854804	0.821927	0.790315	0.759918	0.73069	0.702587	0.675564	0.649581	0.624597	0.600574	0.577475	0.555265	0.533908	0.513373	0.493628	0.474642	0.456387	0.438834	0.421955	0.405726	0.390121	0.375117	0.360689	0.346817	0.333477	0.320651	0.308319
Net Present Value	-1051589	-41842.7	-40233.4	-38686	-37198	-35767.3	-34391.7	-33068.9	-31797	-30574.1	-29398.1	-28267.4	-27180.2	-26134.8	-25129.7	-24163.1	-23233.8	-22340.2	-21480.9	-20654.7	-19860.3	-19096.5	-18362	-17655.8	-16976.7	-16323.7	-15695.9	-15092.2	-14511.8	-13953.6	-13416.9
Rolling value - payback		-1093432	-1133665	-1172351	-1209549	-1245316	-1279708	-1312777	-1344574	-1375148	-1404546	-1432814	-1459994	-1486129	-1511258	-1535421	-1558655	-1580995	-1602476	-1623131	-1642991	-1662088	-1680450	-1698106	-1715082	-1731406	-1747102	-1762194	-1776706	-1790660	-1804077

Property C- Appendices

Table 1 Water Bought 2019

Property C	Water Consumption Cost 2019				
Mains consumptionn @2.354	Mains	RO @ 1.10	RO Cost 2019	2nd class @ 2	2nd Class Cost 2019
325	765.05	3122	3434.2	0	0
413	972.202	2644	2908.4	0	0
14	32.956	3649	4013.9	0	0
217	510.818	3284	3612.4	132	264
960	2259.84	2710	2981	88	176
610	1435.94	3745	4119.5	0	0
807	1899.678	3727	4099.7	506	1012
1508	3549.832	3511	3862.1	396	792
1691	3980.614	3428	3770.8	176	352
628	1478.312	3808	4188.8	88	176
788	1854.952	3086	3394.6	0	0
107	251.878	3183	3501.3	0	0
8,068	18,992.072	39,897	43,886.7	1,386	2,772

Table 2 - Water usage – Rooms and Irrigation

Property C		Direct use and irrigation	
2019	Bed Nights	Total Direct Use 2019 m^3	Monthly irrigation m^3
January	6332	1025.02	47.72
February	6004	971.93	66.81
March	6017	974.03	109.75
April	8806	1425.52	147.93
May	10163	1645.19	162.24
June	10792	1747.01	243.36
July	13999	2266.16	405.61
August	14603	2363.93	281.54
September	12113	1960.85	143.15
October	12515	2025.93	0.00
November	8031	1300.06	0.00
December	6329	1024.54	85.89
Total 2019	115,704	18,730.16	1,694.00

Table 3 Segmentation of Direct Use

Property C	Segmentation of direct use				
2019	Bed Nights	Wash Hand Basin m^3	Total Shower/Bath m^3	Total Flushed m^3	Total direct use m^3
January	6332	107.90	701.33	215.79	1025.02
February	6004	102.31	665.00	204.62	971.93
March	6017	102.53	666.44	205.06	974.03
April	8806	150.05	975.35	300.11	1425.52
May	10163	173.18	1125.65	346.36	1645.19
June	10792	183.90	1195.32	367.79	1747.01
July	13999	238.54	1550.53	477.09	2266.16
August	14603	248.84	1617.43	497.67	2363.93
September	12113	206.41	1341.64	412.81	1960.85
October	12515	213.26	1386.16	426.51	2025.93
November	8031	136.85	889.51	273.70	1300.06
December	6329	107.85	701.00	215.69	1024.54
Total 2019		1,971.60	12,815.38	3,943.19	18,730.16

Table 4- Rain catchment

Property C	Rain Catchment 2019		
2019	Galdies study	Area	Catchment m3
January	87.75	6353	557.48
February	60.53	6353	384.55
March	42.73	6353	271.46
April	22.1	6353	140.40
May	9.92	6353	63.02
June	3.12	6353	19.82
July	0.49	6353	3.11
August	7.31	6353	46.44

September	42.94	6353	272.80
October	86.73	6353	551.00
November	87.73	6353	557.35
December	102.48	6353	651.06
Total 2019	553.83		3518.48

Chart 4 - Rain catchment

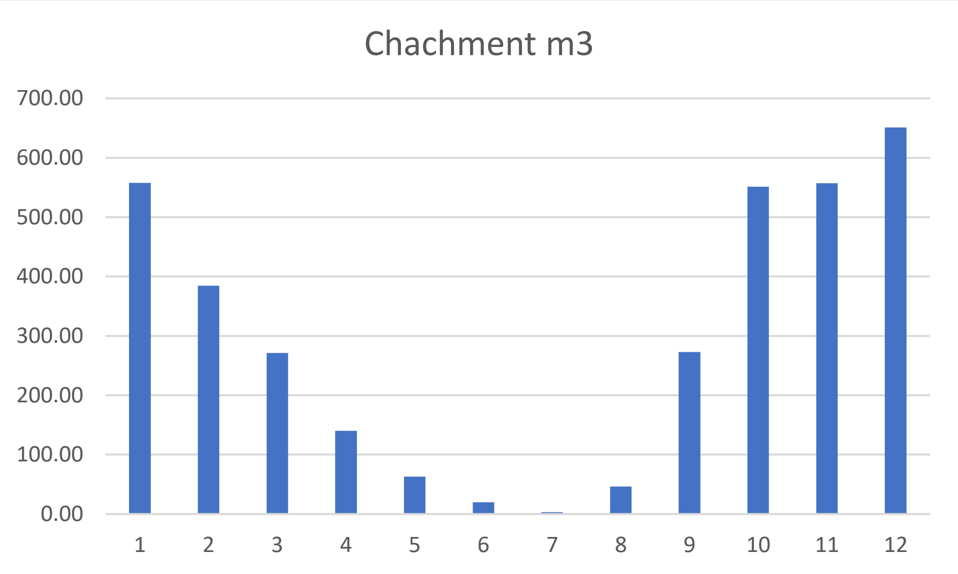


Table 6 – Water Usage

Property C	Black and grey water cost				
2019	Bed Nights	Black Water m3	Blackwater cost	Greywater m3	Greywater cost
January	6332	215.79	237.37	809.23	890.15
February	6004	204.62	225.08	767.31	844.04
March	6017	205.06	225.57	768.97	845.87
April	8806	300.11	330.12	1125.41	1237.95
May	10163	346.36	380.99	1298.83	1428.71
June	10792	367.79	404.57	1379.22	1517.14
July	13999	477.09	524.79	1789.07	1967.98
August	14603	497.67	547.44	1866.26	2052.89
September	12113	412.81	454.09	1548.04	1702.85
October	12515	426.51	469.16	1599.42	1759.36
November	8031	273.70	301.07	1026.36	1129.00
December	6329	215.69	237.26	808.85	889.73
Total 2019	115704	3943.19	4337.51	14786.97	16265.67

Chart 7- Total greywater produced by month.

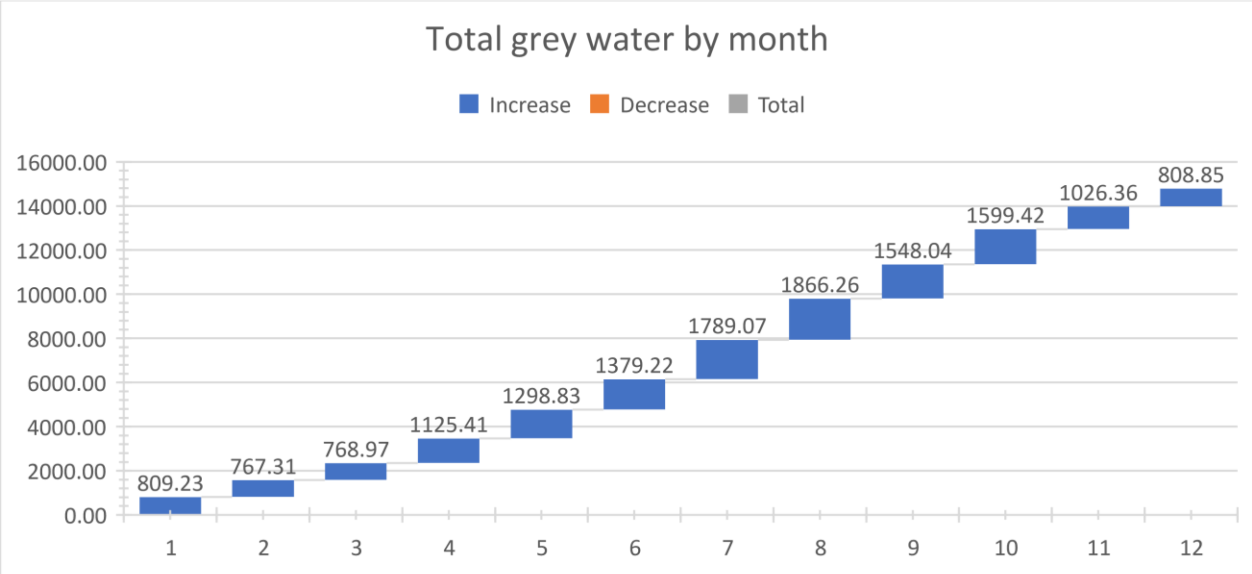
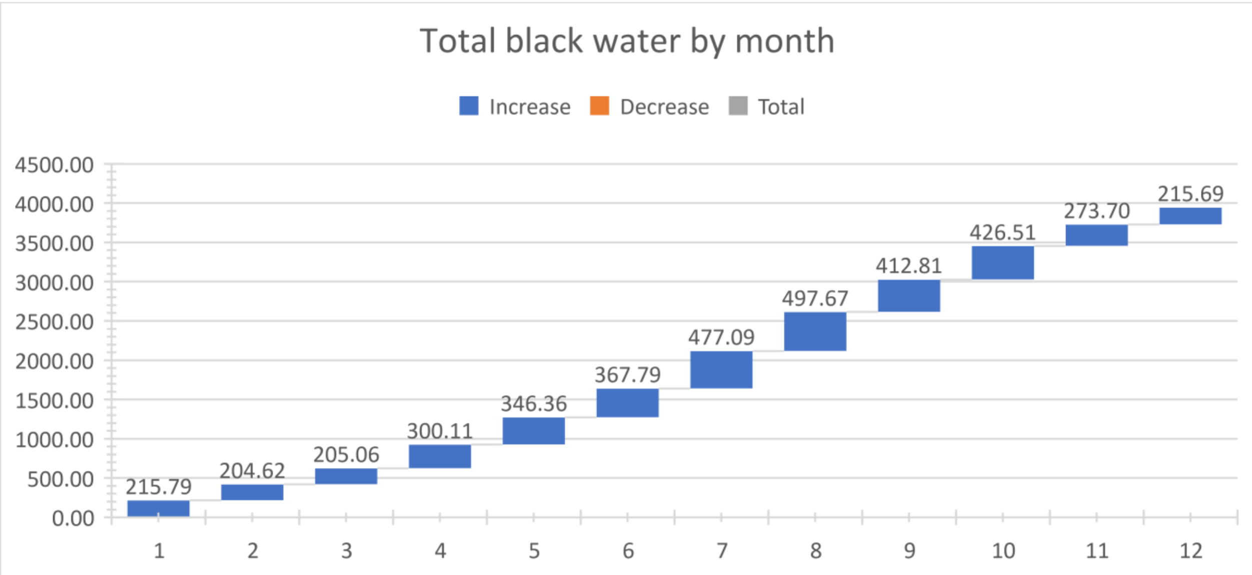


Chart 8 – Total black water produced by month



Charts 9 - Grey Water value.

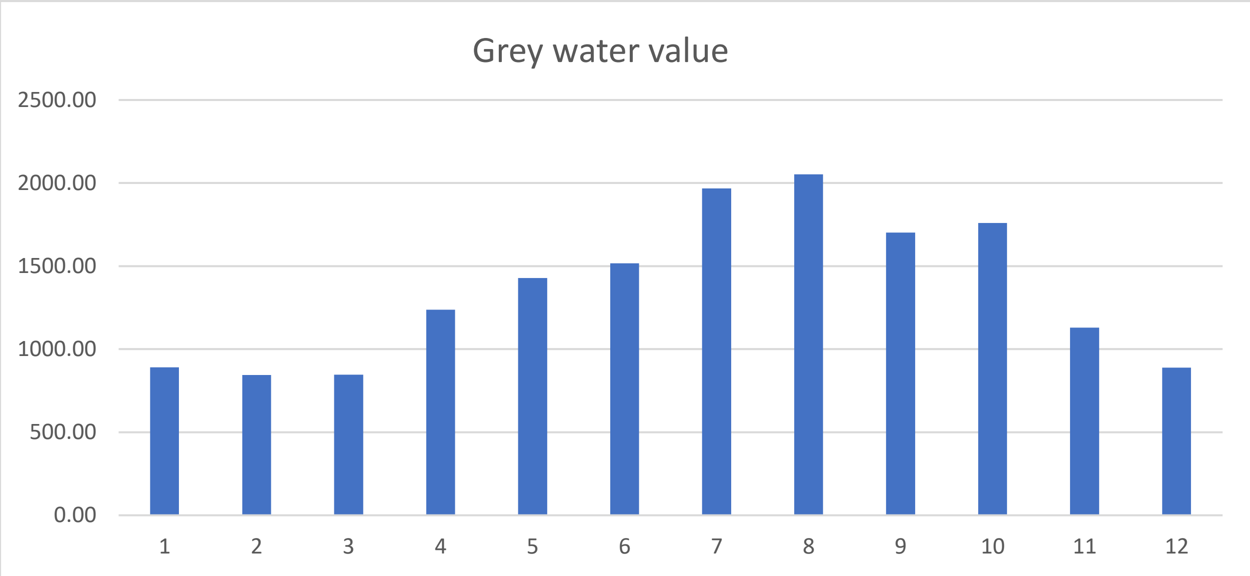


Chart 10 - Black water value

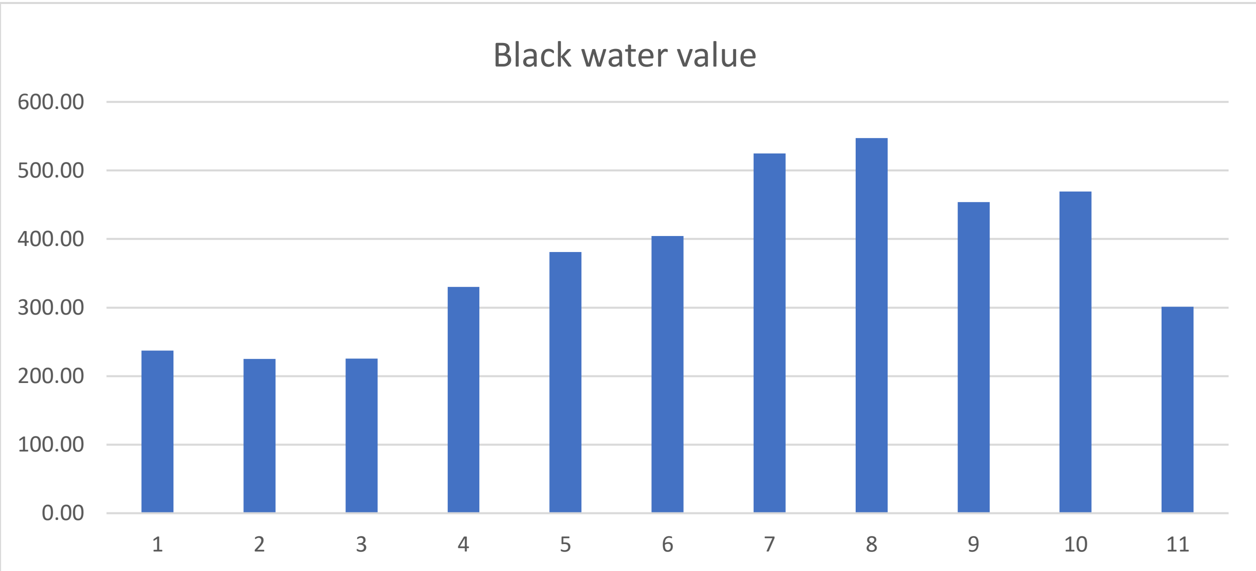


Table 7 – Staff bathroom flushed water

2019	EFTE	Total Shifts	Total Flushed
January	148.46	2845.42	96.97
February	189.18	3625.87	123.57
March	200.14	3835.93	130.73
April	204.59	3921.22	133.64
May	219.47	4206.42	143.35
June	249.25	4777.19	162.81
July	273.33	5238.71	178.54
August	262.61	5033.25	171.53
September	245.54	4706.08	160.38
October	239.50	4590.32	156.44
November	220.74	4230.76	144.18
December	232.79	4461.71	152.06
Total 2019		51472.88	1754.20
Monthly average		4289.41	146.18
Daily average		141.02	4.81

Table 8- Consumption levels

Area									
2019	Rain Catchment in cubic meters	Total use in wash hand basins and showers/baths in cubic meters	Irrigation cubic meters	Staff rooms flushed in cubic meters		Total In	Total Out	S(in)	S(out)
January	557.47575	701.33232	48	97		1259	740	1259	740
Febuary	384.54709	665.00304	67	123		1050	740	2308	1480
march	271.46369	666.44292	110	131		938	740	3246	2220
April	140.4013	975.35256	148	134		1116	740	4362	2960
May	63.02176	1125.65388	162	143		1189	740	5551	3700
June	19.82136	1195.32192	243	163		1215	740	6766	4440
July	3.11297	1550.52924	406	179		1554	740	8319	5180
August	46.44043	1617.42828	282	172		1664	740	9983	5920
September	272.79782	1341.63588	143	160		1614	740	11598	6660
October	550.99569	1386.1614	0	156		1937	740	13535	7400
November	557.34869	889.51356	0	144		1447	740	14982	8140
December	651.05544	701.00004	86	152		1352	740	16334	8880
Monthly Average	293	1068	141	146		499	740	16833	9620
Daily Average	10	35	5	5		453	740	17286	10360
Total 2019	3518	12815	1694	1754		658	740	17944	11100
						789	740	18733	11840
January	1259	287		972		778	740	19511	12580
Febuary	1050	287		762		776	740	20287	13320
march	938	287		651		798	740	21085	14060
April	1116	287		828		834	740	21919	14800
May	1189	287		901		977	740	22896	15540
June	1215	287		928		1001	740	23897	16280
July	1554	287		1266		612	740	24509	17020
August	1664	287		1377		438	740	24947	17760
September	1614	287		1327					
October	1937	287		1650					
November	1447	287		1160					
December	1352	287		1065					

Table 9- Supply and demand

Month	Rainfall	Runoff	Greywater	Total 2nd class supply		Irrigation	Guest rooms	Staff rooms	Total demand	Average demand	Deficit = Supply - Demand	Runoff - av demand (staff + irrigation	Supply	Demand	Supply Cumulative	Demand Cumulative
January	87.75	557	701	1259		48	216	97	145	287	1114	270	1259	287	1259	287
February	60.53	385	665	1050		67	205	123	190	287	860	97	1050	287	2308	575
March	42.73	271	666	938		110	205	131	240	287	697	-16	938	287	3246	862
April	22.1	140	975	1116		148	300	134	282	287	834	-147	1116	287	4362	1149
May	9.92	63	1126	1189		162	346	143	306	287	883	-224	1189	287	5551	1436
June	3.12	20	1195	1215		243	368	163	406	287	809	-267	1215	287	6766	1724
July	0.49	3	1551	1554		406	477	179	584	287	970	-284	1554	287	8319	2011
August	7.31	46	1617	1664		282	498	172	453	287	1211	-241	1664	287	9983	2298
September	42.94	273	1342	1614		143	413	160	304	287	1311	-15	1614	287	11598	2586
October	86.73	551	1386	1937		0	427	156	156	287	1781	264	1937	287	13535	2873
November	87.73	557	890	1447		0	274	144	144	287	1303	270	1447	287	14982	3160
December	102.48	651	701	1352		86	216	152	238	287	1114	364	1352	287	16334	3448
January	87.75	557	701	1259		48	216	97	145	287	1114	270	1259	287	17593	3735
February	60.53	385	665	1050		67	205	123	190	287	860	97	1050	287	18642	4022
March	42.73	271	666	938		110	205	131	241	287	697	-16	938	287	19580	4309
April	22.1	140	975	1116		148	300	134	282	287	834	-147	1116	287	20696	4597
May	9.92	63	1126	1189		162	346	143	305	287	883	-224	1189	287	21885	4884
June	3.12	20	1195	1215		243	368	163	406	287	809	-267	1215	287	23100	5171
July	0.49	3	1551	1554		406	477	179	585	287	969	-284	1554	287	24653	5459
August	7.31	46	1617	1664		282	498	172	454	287	1210	-241	1664	287	26317	5746
September	42.94	273	1342	1614		143	413	160	303	287	1311	-15	1614	287	27932	6033
October	86.73	551	1386	1937		0	427	156	156	287	1781	264	1937	287	29869	6321
November	87.73	557	890	1447		0	274	144	144	287	1303	270	1447	287	31316	6608
December	102.48	651	701	1352		86	216	152	238	287	1114	364	1352	287	32668	6895

Table 10 – Investment appraisal

INVESTMENT APPRAISAL																
Discount rate	0.04															
Item	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Cost of reservoir	508047.5															
Greywater system																
Cost of retrofitting piping (M&E works)																
Operations & Maintenance		25402.38	25402.38	25402.38	25402.38	25402.38	25402.38	25402.38	25402.38	25402.38	25402.38	25402.38	25402.38	25402.38	25402.38	25402.38
Value of water		3788	3788	3788	3788	3788	3788	3788	3788	3788	3788	3788	3788	3788	3788	3788
Net Saving		-21614	-21614	-21614	-21614	-21614	-21614	-21614	-21614	-21614	-21614	-21614	-21614	-21614	-21614	-21614
Discount rate		0.961538	0.924556	0.888996	0.854804	0.821927	0.790315	0.759918	0.73069	0.702587	0.675564	0.649581	0.624597	0.600574	0.577475	0.555265
Net Present Value	-508048	-20782.7	-19983.3	-19214.7	-18475.7	-17765.1	-17081.8	-16424.8	-15793.1	-15185.7	-14601.6	-14040	-13500	-12980.8	-12481.5	-12001.5
Rolling value - payback		-528830	-548814	-568028	-586504	-604269	-621351	-637776	-653569	-668755	-683356	-697396	-710896	-723877	-736359	-748360

INVESTMENT APPRAISAL															
Discount rate															
Item	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Cost of reservoir															
Greywater system															
Cost of retrofitting piping (M&E works)															
Operations & Maintenance	25402.38	25402.38	25402.38	25402.38	25402.38	25402.38	25402.38	25402.38	25402.38	25402.38	25402.38	25402.38	25402.38	25402.38	25402.38
Value of water	3788	3788	3788	3788	3788	3788	3788	3788	3788	3788	3788	3788	3788	3788	3788
Net Saving	-21614	-21614	-21614	-21614	-21614	-21614	-21614	-21614	-21614	-21614	-21614	-21614	-21614	-21614	-21614
Discount rate	0.533908	0.513373	0.493628	0.474642	0.456387	0.438834	0.421955	0.405726	0.390121	0.375117	0.360689	0.346817	0.333477	0.320651	0.308319
Net Present Value	-11539.9	-11096	-10669.3	-10258.9	-9864.34	-9484.94	-9120.13	-8769.36	-8432.08	-8107.77	-7795.93	-7496.08	-7207.77	-6930.55	-6663.99
Rolling value - payback	-759900	-770996	-781665	-791924	-801788	-811273	-820394	-829163	-837595	-845703	-853499	-860995	-868203	-875133	-881797

Property D - Appendices.

Table 1 Water Bought 2019

Property D		Water consumption cost				
2019	Mains @ 2.5	RO @1.10	2nd Class @ 2.00	Cost Mains 2019	Cost RO 2019	Cost 2nd Class 2019
January	166	2,996	0	415	3,295.6	0
February	0	3,146	0	0	3,460.6	0
March	90	3,833	0	225	4,216.3	0
April	523	2,764	513	1,307.5	3,040.4	1,026
May	327	2,537	1,172	817.5	2,790.7	2,344
June	737	2,818	1,593	1,842.5	3,099.8	3,186
July	1,952	1,730	1,775	4,880	1,903	3,550
August	1,879	2,857	1,960	4,697.5	3,142.7	3,920
September	6,679	189	1,385	16,697.5	207.9	2,770
October	7	2,463	938	17.5	2,709.3	1,876
November	0	28,90	125	0	3,179	250
December	2,310	2,163	0	5,775	2,379.3	0
Total 2019	14,670	30,386	9,461	36,675	33,424.6	18,922

Table 2 – Water consumption Levels

2019	Mains @ 2.5	RO @1.10	2nd Class @ 2.00	Cost Mains 2019	Cost RO 2019	Cost 2nd Class 2019
January	166	2996	0	415	3295.6	0
February	0	3146	0	0	3460.6	0
March	90	3833	0	225	4216.3	0
April	523	2764	513	1307.5	3040.4	1026
May	327	2537	1172	817.5	2790.7	2344
June	737	2818	1593	1842.5	3099.8	3186
July	1952	1730	1775	4880	1903	3550
August	1879	2857	1960	4697.5	3142.7	3920
September	6679	189	1385	16697.5	207.9	2770
October	7	2463	938	17.5	2709.3	1876
November	0	2890	125	0	3179	250
December	2310	2163	0	5775	2379.3	0
Total 2019	14670	30386	9461	36675	33424.6	18922

Table 3- Water usage in irrigation

Property D	Irrigation per square meter per month		
2019	Irrigation per square meter	Landscape area	Total irrigation per month m^3
January	0.010	3515	36.46
February	0.015	3515	51.04
March	0.024	3515	83.86
April	0.032	3515	113.02
May	0.035	3515	123.96
June	0.053	3515	185.94
July	0.088	3515	309.90
August	0.061	3515	215.11

September	0.031	3515	109.38
October	0.000	3515	0.00
November	0.010	3515	36.46
December	0.019	3515	65.63
Total 2019			1330.75

Table 4 – Direct use in rooms

January	Bed Nights	Direct use m^3
February	5,246	849.22
March	6,956	1,126.04
April	8,780	1,421.31
May	11,455	1,854.34
June	10,323	1,671.09
July	12,365	2,001.65
August	15,591	2,523.87
September	17,092	2,766.85
October	12,552	2,031.92
November	12,746	2,063.32
December	8,404	1,360.44
Total 2019	7,533	1,219.44
	129,043	20,889.48

Table 5 Segmentation and cost of Direct Use

Direct Use m^3	flushed m^3	cost @ 2	Basin m^3	Cost @ 2.5	Shower/Bath m^3	Cost shower/bath 2.5
849.22	178.78	357.57	89.39	223.48	581.05	1,452.62
1,126.04	237.06	474.12	118.53	296.33	770.45	1,926.12
1,421.31	299.22	598.44	149.61	374.03	972.47	2,431.18
1,854.34	390.39	780.77	195.19	487.98	1,268.76	3,171.89

1,671.09	351.81	703.62	175.90	439.76	1,143.38	2,858.44
2,001.65	421.40	842.80	210.70	526.75	1,369.55	3,423.87
2,523.87	531.34	1,062.68	265.67	664.18	1,726.86	4,317.15
2,766.85	582.50	1,164.99	291.25	728.12	1,893.11	4,732.77
2,031.92	427.77	855.54	213.89	534.72	1,390.26	3,475.65
2,063.32	434.38	868.77	217.19	542.98	1,411.75	3,529.37
1,360.44	286.41	572.82	143.20	358.01	930.83	2,327.07
1,219.44	256.72	513.45	128.36	320.91	834.36	2,085.89
				-		-
20,889.48	4,397.79	8,795.57	2,198.89	5,497.23	14,292.80	35,732.01

Table 6 - Rain Catchment

2019	Monthly average Galdies study	Catchment area	Catchment in m^3
January	87.75	5086	446.29
February	60.53	5086	307.85
March	42.73	5086	217.32
April	22.1	5086	112.40
May	9.92	5086	50.45
June	3.12	5086	15.86
July	0.49	5086	2.49
August	7.31	5086	37.17
September	42.94	5086	218.39
October	86.73	5086	441.10
November	87.73	5086	446.19
December	102.48	5086	521.21

Table 7- Rainwater cost

Property D	Rainwater cost	
2019	Catchment m^3	Rainwater cost @ 2.5
January	446.30	1115.74
February	307.86	769.64
March	217.32	543.31
April	112.40	281.00
May	50.45	126.13
June	15.87	39.67
July	2.49	6.23
August	37.18	92.95
September	218.39	545.98
October	441.11	1102.77
November	446.19	1115.49
December	521.21	1303.03
Total 2019	2816.78	7041.95

Table 9 – Water Usage

Property D	Grey and black water cost				
	Bed Nights	Blackwater in m^3	Blackwater cost @ 2	Greywater in m^3	Grey Water cost @ 2.5
January	5246	178.78	357.57	581.05	1676.10
February	6956	237.06	474.12	770.45	2222.44
March	8780	299.22	598.44	972.47	2805.21
April	11455	390.39	780.77	1268.76	3659.87
May	10323	351.81	703.62	1143.38	3298.20
June	12365	421.40	842.80	1369.55	3950.62
July	15591	531.34	1062.68	1726.86	4981.32
August	17092	582.50	1164.99	1893.11	5460.89
September	12552	427.77	855.54	1390.26	4010.36
October	12746	434.38	868.77	1411.75	4072.35
November	8404	286.41	572.82	930.83	2685.08
December	7533	256.72	513.45	834.36	2406.79

Total 2019	129043	4397.79	8795.57	14292.80	41229.24

Table 10 - Staff Bathroom Flushing

2019	Equivalent full time employment	Total Shifts	Total Flushed water m^3
January	226.45	4,340.20	147.91
February	221.34	4,242.26	144.58
March	236.33	4,529.56	154.37
April	238.75	4,575.94	155.95
May	252.24	4,834.49	164.76
June	265.86	5,095.54	173.66
July	279.55	5,357.93	182.60
August	283.94	5,442.07	185.47
September	215.73	4,134.74	140.91
October	195.55	3,747.96	127.73
November	247.33	4,740.39	161.55
December	244.60	4,688.06	159.77
Year total	2,907.67	55,729.13	1,899.25

Table 11- Consumption levels

Area 6353									
2019	Rain Catchment in cubic meters	Total use in wash hand basins and showers/baths in cubic meters	Irrigation cubic meters	Staff rooms flushed in cubic meters		Total In	Total Out	S(in)	S(out)
January	446	89	36	226		536	740	536	740
Febuary	308	119	51	221		426	740	962	1480
march	217	150	84	236		367	740	1329	2220
April	112	195	113	239		308	740	1637	2960
May	50	176	124	252		226	740	1863	3700
June	16	211	186	266		227	740	2090	4440
July	2	266	310	280		268	740	2358	5180
August	37	291	215	284		328	740	2686	5920
September	218	214	109	216		432	740	3118	6660
October	441	217	0	196		658	740	3777	7400
November	446	143	36	247		589	740	4366	8140
December	521	128	66	245		650	740	5016	8880
Monthly Average	235	183	111	242		499	740	5515	9620
Daily Average	8	6	4	8		453	740	5968	10360
Total 2019	2817	2199	1331	2908		658	740	6626	11100
						789	740	7415	11840
January	536	353		182		778	740	8193	12580
Febuary	426	353		73		776	740	8969	13320
march	367	353		14		798	740	9766	14060
April	308	353		-46		834	740	10600	14800
May	226	353		-127		977	740	11578	15540
June	227	353		-127		1001	740	12579	16280
July	268	353		-85		612	740	13191	17020
August	328	353		-25		438	740	13629	17760
September	432	353		79					
October	658	353		305					
November	589	353		236					
December	650	353		296					

Table 12- Supply and demand

Area	5086						Need to input		Fixed		Formulae					
Month	Rainfall	Runoff	Greywater	Total 2nd class supply		Irrigation	Guest rooms	Staff rooms	Total demand	Average demand	Deficit = Supply - Demand	Runoff - av demand (staff + irrigation	Supply	Demand	Supply Cumulative	Demand Cumulative
January	87.75	446	670	1117		36	104	125	162	241	955	205	1117	241	1117	241
February	60.53	308	889	1197		51	104	114	165	241	1032	67	1197	241	2314	483
March	42.73	217	1122	1339		84	150	112	196	241	1143	-24	1339	241	3653	724
April	22.1	112	1464	1576		113	198	120	233	241	1343	-129	1576	241	5229	965
May	9.92	50	1319	1370		124	198	120	244	241	1126	-191	1370	241	6599	1206
June	3.12	16	1580	1596		186	207	138	324	241	1273	-225	1596	241	8195	1448
July	0.49	2	1993	1995		310	212	148	458	241	1537	-239	1995	241	10190	1689
August	7.31	37	2184	2222		215	222	145	360	241	1861	-204	2222	241	12412	1930
September	42.94	218	1604	1823		109	226	141	251	241	1572	-23	1823	241	14234	2171
October	86.73	441	1629	2070		0	220	141	141	241	1929	200	2070	241	16304	2413
November	87.73	446	1074	1520		36	158	129	166	241	1354	205	1520	241	17825	2654
December	102.48	521	963	1484		66	101	129	195	241	1289	280	1484	241	19308	2895
January	87.75	446	670	1117		36	104	125		241	1117	205	1117	241	20425	3136
February	60.53	308	889	1197		51	104	114	269	241	928	67	1197	241	21622	3378
March	42.73	217	1122	1339		84	150	112	347	241	993	-24	1339	241	22961	3619
April	22.1	112	1464	1576		113	198	120	431	241	1145	-129	1576	241	24538	3860
May	9.92	50	1319	1370		124	198	120	442	241	927	-191	1370	241	25908	4101
June	3.12	16	1580	1596		186	207	138	530	241	1066	-225	1596	241	27504	4343
July	0.49	2	1993	1995		310	212	148	671	241	1325	-239	1995	241	29499	4584
August	7.31	37	2184	2222		215	222	145	583	241	1639	-204	2222	241	31720	4825
September	42.94	218	1604	1823		109	226	141	476	241	1346	-23	1823	241	33543	5066
October	86.73	441	1629	2070		0	220	141	361	241	1709	200	2070	241	35613	5308
November	87.73	446	1074	1520		36	158	129	323	241	1197	205	1520	241	37133	5549
December	102.48	521	963	1484		66	101	129	297	241	1187	280	1484	241	38617	5790

Table 13 – Investment appraisal

INVESTMENT APPRAISAL													
Discount rate	0.04												
Item	0	1	2	3	4	5	6	7	8	9	10	11	12
Cost of reservoir	440392.5												
Greywater system													
Cost of retrofitting piping (M&E works)													
Operations & Maintenance		22019.63	22019.63	22019.63	22019.63	22019.63	22019.63	22019.63	22019.63	22019.63	22019.63	22019.63	22019.63
Value of water		3181	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181
Net Saving		-18838	-18838	-18838	-18838	-18838	-18838	-18838	-18838	-18838	-18838	-18838	-18838
Discount rate		0.961538	0.924556	0.888996	0.854804	0.821927	0.790315	0.759918	0.73069	0.702587	0.675564	0.649581	0.624597
Net Present Value	-440393	-18113.9	-17417.2	-16747.3	-16103.2	-15483.8	-14888.3	-14315.7	-13765.1	-13235.6	-12726.6	-12237.1	-11766.4
Rolling value - payback		-458506	-475924	-492671	-508774	-524258	-539146	-553462	-567227	-580462	-593189	-605426	-617193

INVESTMENT APPRAISAL													
Discount rate													
Item	13	14	15	16	17	18	19	20	21	22	23	24	25
Cost of reservoir													
Greywater system													
Cost of retrofitting piping (M&E works)													
Operations & Maintenance	22019.63	22019.63	22019.63	22019.63	22019.63	22019.63	22019.63	22019.63	22019.63	22019.63	22019.63	22019.63	22019.63
Value of water	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181	3181
Net Saving	-18838	-18838	-18838	-18838	-18838	-18838	-18838	-18838	-18838	-18838	-18838	-18838	-18838
Discount rate	0.600574	0.577475	0.555265	0.533908	0.513373	0.493628	0.474642	0.456387	0.438834	0.421955	0.405726	0.390121	0.375117
Net Present Value	-11313.9	-10878.7	-10460.3	-10058	-9671.14	-9299.18	-8941.52	-8597.61	-8266.93	-7948.97	-7643.25	-7349.27	-7066.61
Rolling value - payback	-628506	-639385	-649845	-659903	-669575	-678874	-687815	-696413	-704680	-712629	-720272	-727621	-734688

Property E - Appendices.

Table 1 – Irrigation per month

Property E	Irrigation per m² using Property A Study		
2019	Irrigation per m²	Landscape m²	Irrigation per month m^3
January	0.010	7940	82.36
February	0.015	7940	115.30
March	0.024	7940	189.42
April	0.032	7940	255.31

May	0.035	7940	280.01
June	0.053	7940	420.02
July	0.088	7940	700.03
August	0.061	7940	485.90
September	0.031	7940	247.07
October	0.000	7940	0.00
November	0.010	7940	82.36
December	0.019	7940	148.24
Total 2019			3006.015973

Table 2- Water usage – Rooms and Irrigation

Property E	Direct use and irrigation Cost			
2019	Total Direct Use m^3	Price €	Total Irrigation m^3	Price €
January	807.30	888.03	82.36	90.59
February	922.88	1,015.17	115.30	126.83
March	1,199.21	1,319.13	189.42	208.36
April	1,819.37	2,001.31	255.31	280.84
May	1,800.27	1,980.29	280.01	308.01
June	2,215.33	2,436.86	420.02	462.02
July	3,443.35	3,787.68	700.03	770.03
August	4,030.97	4,434.07	485.90	534.49
September	2,727.35	3,000.09	247.07	271.78
October	2,777.21	3,054.93	0.00	0.00

November	1,491.56	1,640.72	82.36	90.59
December	1,391.52	1,530.67	148.24	163.07
Total 2019	24,626.32	27,088.95	3,006.02	3,306.62

Table 3 Segmentation of Direct Use

2019	Bed Nights	Direct Use m^3	Flushed m^3	Washbasin m^3	Shower/Bath m^3
January	4987	807.30	169.96	84.98	552.36
February	5701	922.88	194.29	97.15	631.44
March	7408	1,199.21	252.46	126.23	820.51
April	11,239	1,819.37	383.03	191.51	1,244.83
May	11,121	1,800.27	379.00	189.50	1,231.76
June	13,685	2,215.33	466.38	233.19	1,515.75
July	21,271	3,443.35	724.92	362.46	2,355.98
August	24,901	4,030.97	848.63	424.31	2,758.03
September	16,848	2,727.35	574.18	287.09	1,866.08
October	17,156	2,777.21	584.68	292.34	1,900.20
November	9,214	1,491.56	314.01	157.01	1,020.54
December	8,596	1,391.52	292.95	146.48	952.09
Total 2019	152,127	24,626.32	5,184.49	2,592.24	16,849.59

Table 4- Rain catchment

2019.00	Goldies study	Catchment area	Catchment in mm	Catchment in m3
January	87.75	10022	879430.50	879.43
February	60.53	10022	606631.66	606.63
March	42.73	10022	428240.06	428.24
April	22.10	10022	221486.20	221.49
May	9.92	10022	99418.24	99.42
June	3.12	10022	31268.64	31.27
July	0.49	10022	4910.78	4.91
August	7.31	10022	73260.82	73.26
September	42.94	10022	430344.68	430.34
October	86.73	10022	869208.06	869.21
November	87.73	10022	879230.06	879.23
December	102.48	10022	1027054.56	1,027.05
Total 2019	553.83	10022	5550484.26	5,550.48

Table 6 – Water Usage

2019	Bed Nights	Blackwater m^3	Blackwater cost	Greywater m^3	Greywater cost
January	4,987	169.96	186.95	637.34	701.07
February	5,701	194.29	213.72	728.59	801.45
March	7,408	252.46	277.71	946.74	1,041.42
April	11,239	383.03	421.33	1,436.34	1,579.98
May	11,121	379.00	416.90	1,421.26	1,563.39
June	13,685	466.38	513.02	1,748.94	1,923.84
July	21,271	724.92	797.41	2,718.43	2,990.28
August	24,901	848.63	933.49	3,182.35	3,500.58
September	16,848	574.18	631.60	2,153.17	2,368.49
October	17,156	584.68	643.14	2,192.54	2,411.79
November	9,214	314.01	345.41	1,177.55	1,295.30
December	8,596	292.95	322.25	1,098.57	1,208.43
					-
Total 2019	152,127	5,184.49	5,702.94	19,441.83	21,386.01

Table 7 – Staff bathrooms water closet flushing's

2019	Full time equivalent	Total shifts	Total flushed
January	246.62	4726.78	161.09
February	214.62	4113.46	140.19
March	218.05	4179.20	142.43
April	218.56	4188.98	142.76
May	241.70	4632.48	157.88
June	300.75	5764.25	196.45
July	327.84	6283.46	214.14
August	381.71	7315.95	249.33
September	393.31	7538.28	256.90
October	343.56	6584.76	224.41
November	319.61	6125.73	208.76
December	278.85	5344.51	182.14
Year total		66797.83	2276.47

Table 8- Consumption levels

Area									
2019	Rain Catchment in cubic meters	Total use in wash hand basins and showers/baths in cubic meters	Irrigation cubic meters	Staff rooms flushed in cubic meters		Total In	Total Out	S(in)	S(out)
January	879	637	82	161		1517	740	1517	740
Febuary	607	729	115	140		1335	740	2852	1480
march	428	947	189	142		1375	740	4227	2220
April	221	1436	255	143		1658	740	5885	2960
May	99	1421	280	158		1521	740	7405	3700
June	31	1749	420	196		1780	740	9186	4440
July	5	2718	700	214		2723	740	11909	5180
August	73	3182	486	249		3256	740	15165	5920
September	430	2153	247	257		2584	740	17748	6660
October	869	2193	0	244		3062	740	20810	7400
November	879	1178	82	209		2057	740	22867	8140
December	1027	1099	148	182		2126	740	24992	8880
Monthly Average	463	1620	251	191		499	740	25491	9620
Daily Average	15	53	8	6		453	740	25945	10360
Total 2019	5550	19442	3006	2295		658	740	26603	11100
						789	740	27392	11840
January	1517	442		1075		778	740	28170	12580
Febuary	1335	442		893		776	740	28945	13320
march	1375	442		933		798	740	29743	14060
April	1658	442		1216		834	740	30577	14800
May	1521	442		1079		977	740	31554	15540
June	1780	442		1338		1001	740	32556	16280
July	2723	442		2282		612	740	33168	17020
August	3256	442		2814		438	740	33606	
September	2584	442		2142					
October	3062	442		2620					
November	2057	442		1615					
December	2126	442		1684					

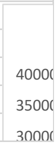


Table 9- Supply and demand

Month	Rainfall	Runoff	Greywater	Total 2nd class supply		Irrigation	Guest rooms	Staff rooms	Total demand2nd class	Average demand	Deficit = Rain - av Demand		Supply	Demand	Supply Cumulative	Demand Cumulative	Supply - demand
January	87.75	879	637	1517		82		161	243	442	438		1517	442	1517	442	1075
February	60.53	607	729	1335		115		140	255	442	165		1335	442	2852	884	1968
March	42.73	428	947	1375		189		142	331	442	-14		1375	442	4227	1325	2902
April	22.1	221	1436	1658		255		143	398	442	-220		1658	442	5885	1767	4118
May	9.92	99	1421	1521		280		158	438	442	-342		1521	442	7405	2209	5197
June	3.12	31	1749	1780		420		196	616	442	-410		1780	442	9186	2651	6535
July	0.49	5	2718	2723		700		214	914	442	-437		2723	442	11909	3092	8817
August	7.31	73	3182	3256		486		249	735	442	-368		3256	442	15165	3534	11631
September	42.94	430	2153	2584		247		257	504	442	-11		2584	442	17748	3976	13772
October	86.73	869	2193	3062		0		244	244	442	427		3062	442	20810	4418	16392
November	87.73	879	1178	2057		82		209	291	442	437		2057	442	22867	4859	18007
December	102.48	1027	1099	2126		148		182	330	442	585		2126	442	24992	5301	19691
January	87.75	879	637	1517		82		161	243	442	438		1517	442	26509	5743	20766
February	60.53	607	729	1335		115		140	255	442	165		1335	442	27844	6185	21660
March	42.73	428	947	1375		189		142	331	442	-14		1375	442	29219	6626	22593
April	22.1	221	1436	1658		255		143	398	442	-220		1658	442	30877	7068	23809
May	9.92	99	1421	1521		280		158	438	442	-342		1521	442	32398	7510	24888
June	3.12	31	1749	1780		420		196	616	442	-410		1780	442	34178	7952	26226
July	0.49	5	2718	2723		700		214	914	442	-437		2723	442	36901	8393	28508
August	7.31	73	3182	3256		486		249	735	442	-368		3256	442	40157	8835	31322
September	42.94	430	2153	2584		247		257	504	442	-11		2584	442	42740	9277	33464
October	86.73	869	2193	3062		0		244	244	442	427		3062	442	45802	9719	36084
November	87.73	879	1178	2057		82		209	291	442	437		2057	442	47859	10160	37699
December	102.48	1027	1099	2126		148		182	330	442	585		2126	442	49985	10602	39383

Table 10- Investment appraisal

INVESTMENT APPRAISAL																
Discount rate	0.04															
Item	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Cost of reservoir	765720															
Greywater system																
Cost of retrofitting piping (M&E works)																
Operations & Maintenance		38286	38286	38286	38286	38286	38286	38286	38286	38286	38286	38286	38286	38286	38286	38286
Value of water		17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129
Net Saving		-21158	-21158	-21158	-21158	-21158	-21158	-21158	-21158	-21158	-21158	-21158	-21158	-21158	-21158	-21158
Discount rate		0.961538	0.924556	0.888996	0.854804	0.821927	0.790315	0.759918	0.73069	0.702587	0.675564	0.649581	0.624597	0.600574	0.577475	0.555265
Net Present Value	-765720	-20343.8	-19561.3	-18808.9	-18085.5	-17389.9	-16721.1	-16078	-15459.6	-14865	-14293.2	-13743.5	-13214.9	-12706.6	-12217.9	-11748
Rolling value - payback		-786064	-805625	-824434	-842520	-859909	-876631	-892708	-908168	-923033	-937326	-951070	-964285	-976991	-989209	-1000957

INVESTMENT APPRAISAL															
Discount rate															
Item	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Cost of reservoir															
Greywater system															
Cost of retrofitting piping (M&E works)															
Operations & Maintenance	38286	38286	38286	38286	38286	38286	38286	38286	38286	38286	38286	38286	38286	38286	38286
Value of water	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129	17129
Net Saving	-21158	-21158	-21158	-21158	-21158	-21158	-21158	-21158	-21158	-21158	-21158	-21158	-21158	-21158	-21158
Discount rate	0.533908	0.513373	0.493628	0.474642	0.456387	0.438834	0.421955	0.405726	0.390121	0.375117	0.360689	0.346817	0.333477	0.320651	0.308319
Net Present Value	-11296.2	-10861.7	-10443.9	-10042.2	-9656.01	-9284.62	-8927.52	-8584.15	-8254	-7936.53	-7631.28	-7337.77	-7055.55	-6784.18	-6523.25
Rolling value - payback	-1012253	-1023115	-1033559	-1043601	-1053257	-1062542	-1071469	-1080054	-1088308	-1096244	-1103875	-1111213	-1118269	-1125053	-1131576

Questionnaires

Property A

ITS MALTA
THE EMIRATES ACADEMY OF HOSPITALITY MANAGEMENT
Mark McBride
MBA THESIS STUDY
Property A

All information gathered is used for statistical proposes only within the studies context, your help and support in this study is greatly appreciated.

Are you aware that the property uses a certain amount of water which can be serviced through second class water supplies?
Yes
Are you aware that runoff from the property if collected in a reservoir and grey water can be used to service non-potable supplies?
Yes
Would the property consider moving towards adapting a water conservation plan?
Yes
Would your property be interested in exploring further rain catchment systems?
Yes – we are interested in exploring this idea further
Would your property be interested in exploring further grey water recycling systems?
Yes- we are interested in exploring this idea further
To what extent would your property be ready to invest in rainwater/ greywater harvesting?
It is beneficial to understand the investment needed. However, our aim for the property is to move towards a more sustainable way of operating.

Would such investments depend on that investment yielding an appreciable rate of return or a short payback period or is it a regulatory obligation which should be respected?
I believe that it is a regulatory obligation

What incentives could be put in place to attract investment in reservoirs to collect and reuse stormwater and/or grey water systems to further service non-potable water uses?

1) **Separation of effluent lines**

We would need to separate the drains of the showers and sinks from that of the toilets, ergo pass an independent drain network parallel to the current one. **(Roughly 25 m3 a day – based on av. 100 guests a night, 250ltr/guest-night from shower and sink)**

Challenges:

- Installation of vertical pipework in shaft
- Installation of horizontal pipework (would cross corridors – typically between odd and even sides, requiring excavation of ground floor or basement (depending on wing).

2) **Treatment System**

Install a treatment system (a reverse osmosis of sorts) to purify this water. This would need a minimum of three storage tanks (or reservoirs) to hold the influx grey water, the product water, as well as a third storage connected to the sewer (for discharge purposes).

Challenges:

- An area large enough to host the treatment system (est. 25m2 footprint)
- An area large enough to host the cascade of tanks (est. 50m2 footprint)
- Adequate ventilation
- Permitting and maintenance costs

3) **Product Use**

We identify a potential use for the grey water. Our best bet would be:

a) Re circulate to toilets – i.e., we would need a further parallel network of pipes **(Roughly 11m3 a day – based on av. 100guests a day, 15 flushes per guest, 7ltr per flush)**
b) Use for irrigation of landscaping. **(Roughly 8m3 a day)**

ITS MALTA
THE EMIRATES ACADEMY OF HOSPITALITY MANAGEMENT
Mark McBride
MBA THESIS STUDY
Property B

All information gathered is used for statistical proposes only within the studies context, your help and support in this study is greatly appreciated.

Are you aware that the property uses a certain amount of water which can be serviced through second class water supplies?
Yes
Are you aware that runoff from the property if collected in a reservoir and grey water can be used to service non-potable supplies?
Whilst rainwater from the roof can be collected in reservoirs, the building was not designed and built in a way to separate grey from black water. Grey and black water is connected to the same risers.
Would the property consider moving towards adapting a water conservation plan?
Not in the pipeline.
Would your property be interested in exploring further rain catchment systems?
The main issue is that reservoirs need to be constructed.
Would your property be interested in exploring further grey water recycling systems?
No
To what extent would your property be ready to invest in rainwater/ greywater harvesting?
Not in the pipeline

Would such investments depend on that investment yielding an appreciable rate of return or a short payback period or is it a regulatory obligation which should be respected?
A bit of both

What incentives could be put in place to attract investment in reservoirs to collect and reuse stormwater and/or grey water systems to further service non-potable water uses? **N/A**

ITS MALTA
THE EMIRATES ACADEMY OF HOSPITALITY MANAGEMENT
Mark McBride
MBA THESIS STUDY
Property C

All information gathered is used for statistical proposes only within the studies context, your help and support in this study is greatly appreciated.

Are you aware that the property uses a certain amount of water which can be serviced through second class water supplies?

Yes

Are you aware that runoff from the property if collected in a reservoir and grey water can be used to service non-potable supplies?

Yes

Would the property consider moving towards adapting a water conservation plan?

Yes, however we are not able to finance such projects at the moment

Would your property be interested in exploring further rain catchment systems?

Yes

Would your property be interested in exploring further grey water recycling systems?

Yes

To what extent would your property be ready to invest in rainwater/ greywater harvesting?

These needs to be discussed and agreed at corporate level

Would such investments depend on that investment yielding an appreciable rate of return or a short payback period or is it a regulatory obligation which should be respected?

Partially yes. Of course, we have the moral obligation to operate sustainably

What incentives could be put in place to attract investment in reservoirs to collect and reuse stormwater and/or grey water systems to further service non-potable water uses?

N/A

Property D

ITS MALTA
THE EMIRATES ACADEMY OF HOSPITALITY MANAGEMENT
Mark McBride
MBA THESIS STUDY
Property D

All information gathered is used for statistical proposes only within the studies context, your help and support in this study is greatly appreciated.

Are you aware that the property uses a certain amount of water which can be serviced through second class water supplies?

Yes, and it is done already.

Are you aware that runoff from the property if collected in a reservoir and grey water can be used to service non-potable supplies?

Runoff water is already collected in a reservoir and utilised for non-potable supply.

Would the property consider moving towards adapting a water conservation plan?

To be investigated in more detail

Would your property be interested in exploring further rain catchment systems?

Further rain catchment would require major infrastructural changes, that is it depends on the cost of such changes.

Would your property be interested in exploring further grey water recycling systems?

To be investigated upon having a detailed study.

To what extent would your property be ready to invest in rainwater/ greywater harvesting?

Depends on the investment.

Would such investments depend on that investment yielding an appreciable rate of return or a short payback period or is it a regulatory obligation which should be respected?

Highly dependent on the ROI.

What incentives could be put in place to attract investment in reservoirs to collect and reuse stormwater and/or grey water systems to further service non-potable water uses?

Reduction in costs.

ITS MALTA
THE EMIRATES ACADEMY OF HOSPITALITY MANAGEMENT
Mark McBride
MBA THESIS STUDY
Property E

All information gathered is used for statistical proposes only within the studies context, your

help and support in this study is greatly appreciated.

Are you aware that the property uses a certain amount of water which can be serviced through second class water supplies?
Yes
Are you aware that runoff from the property if collected in a reservoir and grey water can be used to service non-potable supplies?
Yes
Would the property consider moving towards adapting a water conservation plan?
Yes, already doing so and improving as we go on.
Would your property be interested in exploring further rain catchment systems?
Yes, we already have them in place
Would your property be interested in exploring further grey water recycling systems?
Yes
To what extent would your property be ready to invest in rainwater/ greywater harvesting?
Depends on ROI

Would such investments depend on that investment yielding an appreciable rate of return or a short payback period or is it a regulatory obligation which should be respected?
If there is a regulatory obligation we have no choice, but otherwise it would be decided on an ROI basis.

What incentives could be put in place to attract investment in reservoirs to collect and reuse stormwater and/or grey water systems to further service non-potable water uses?
An incentive to monitor the reservoir for leaks.

Property A draft Calculations

DECLARATION

I, *Mark McBride*, declare that this is an original study, conducted entirely by me, and that all source material has been appropriately referenced. In addition, I attest that no portion of the work referred to in this thesis has been submitted in support of any other course, degree, or qualification at this or any other university or institute of learning.

Student’s signature