WAIHEKE STORMWATER REUSE

Mike Hannah & Greg Yeoman Stormwater360 New Zealand

ABSTRACT

Water is quickly becoming one of the world's most valuable resources, yet in New Zealand because of its apparent availability we are very wasteful with its use. So much so that New Zealand is the second largest consumer of water per capita in the world.

An average family home in Auckland pays over $1000 per year in water supply and waste water. Why are we paying for and treating water to a drinking standard only to flush it down the toilet or put it on the garden? Furthermore, industrial sites typically have large impervious areas and often require large amounts of process water to carry out their operation.

In countries such as Australia and the USA, water shortages have driven research and development of technology to make the most out of the stormwater re-use. In these countries stormwater re-use (alternatively called rainwater harvesting), water banking and trading are becoming an intrinsic part of good low impact and sustainable design, however the benefits of stormwater re-use should not be limited to these water scarce places.

This paper talks about an innovative underground water storage system installed on Waiheke Island, New Zealand and subsequent monitoring. The paper will look at the quality of the water, how it was re-used, demand analysis and discuss why designers of stormwater management systems in water plentiful New Zealand should be considering re-use more, and some of the barriers to uptake in New Zealand.

KEYWORDS

Rainwater Harvesting, Stormwater Re-use, Underground tanks, Greenroofs

PRESENTER PROFILE

Mike Hannah is the Managing and Technical Director of Stormwater360 New Zealand. He has 17 years experience in stormwater management and is co-founder of New Zealand's only specialist propriety stormwater management company.

1 INTRODUCTION

'Waiheke water re-use' is a Stormwater360 innovation site on Waiheke Island, Auckland. Waiheke Island is situated in the Hauraki Gulf with approximately 10,000 people. Once only used for holiday batches, the island is now a busy suburb of Auckland. The soils on Waiheke consist mainly of clay, making ground disposal of stormwater not possible.

One of the guiding principles of sustainable water management is onsite management of all three waters: stormwater, wastewater and potable water. Waiheke Island has no reticulated wastewater or water supply system. This makes it ideal for developing and trialing innovative water management systems as on-site management is the only option.

Stormwater re-use has many environmental benefits. From a quantity point of view capture and re-use of the water reduces peak flows, minimizing stream erosion and prevent sewer overflows. From a quality point of view capture and disposal by re-use provides virtually no discharge from the site resulting no discharge of contaminants. Further when stormwater is re-used to irrigation, dissolved metals are absorbed in the vegetative root zone by microbes

Stormwater360 is investigating capture of stormwater and reuse for irrigation. Re-use for irrigation could also be termed disposal of stormwater through irrigation. Another way of looking at this is disposal through evapotranspiration. The project involves installing an underground water reuse tank, solar pumping system, irrigation system, green roof and monitoring equipment.

2 STORMWATER RE-USE AND RAINWATER HARVESTING

While New Zealand is not facing the same water shortages as other part of the world, the cost and demand of water in New Zealand is increasing significantly, particularly in the expanding Auckland region. The price (at present) for water in Auckland is between $1.30 and $2.33 per 1000 litres. On Waiheke Island it costs $300 for a 12,000 litre water truck. ($25 per 1000 litres)

Following the water crisis of 1994, a pipeline from the Waikato River was constructed to reduce Auckland's water supply shortage. Last year however, Auckland was again faced with another shortage as the treatment plant was at capacity after last summer's droughts. Auckland's population is predicted to grow to 1.7 million by 2026; an increase of approx 40% on 2001 levels (Statistics NZ).

To date stormwater re-use has been most widely adopted in areas of infrequent rainfall, such as Australia and California. However as global climate change continues, periods of drought and flood are exacerbated, and so its suitability for New Zealand is growing.

In New Zealand Landcare has researched the benefits of rainwater tanks for residential use. At current water supply prices for larger houses (250m2 >) there is a financial benefit for water tanks to be adopted over mains supply. It is estimated that these tanks would have a 7 year payback period. The same research also estimated that 20% of all domestic water supply is used in the garden. In Australia it is estimated that 40% of domestic supply is used in the garden (Bhakt).

Industrial operations use 11% of NZ water consumption, (excluding hydro generation). On-site underground storage tanks or stormwater re-use systems are ideal for these facilities as they typically have large impervious surfaces. Underground stormwater re-use tanks have the potential not only save industry large sums of money for water supply, but also manage the stormwater by reducing runoff volumes and discharged pollutant loads.

In some parts of North America private developments have been able sell excess water harvested on the site back to the local municipality for irrigation of streetscape (Ranna Creek). Rainwater harvesting and re-use schemes will be an integral part of future water supply but greater understanding of how to apply the technology is needed to maximize its potential.

3 REUSE OF IRRIGATION OR GROUND DISPOSAL

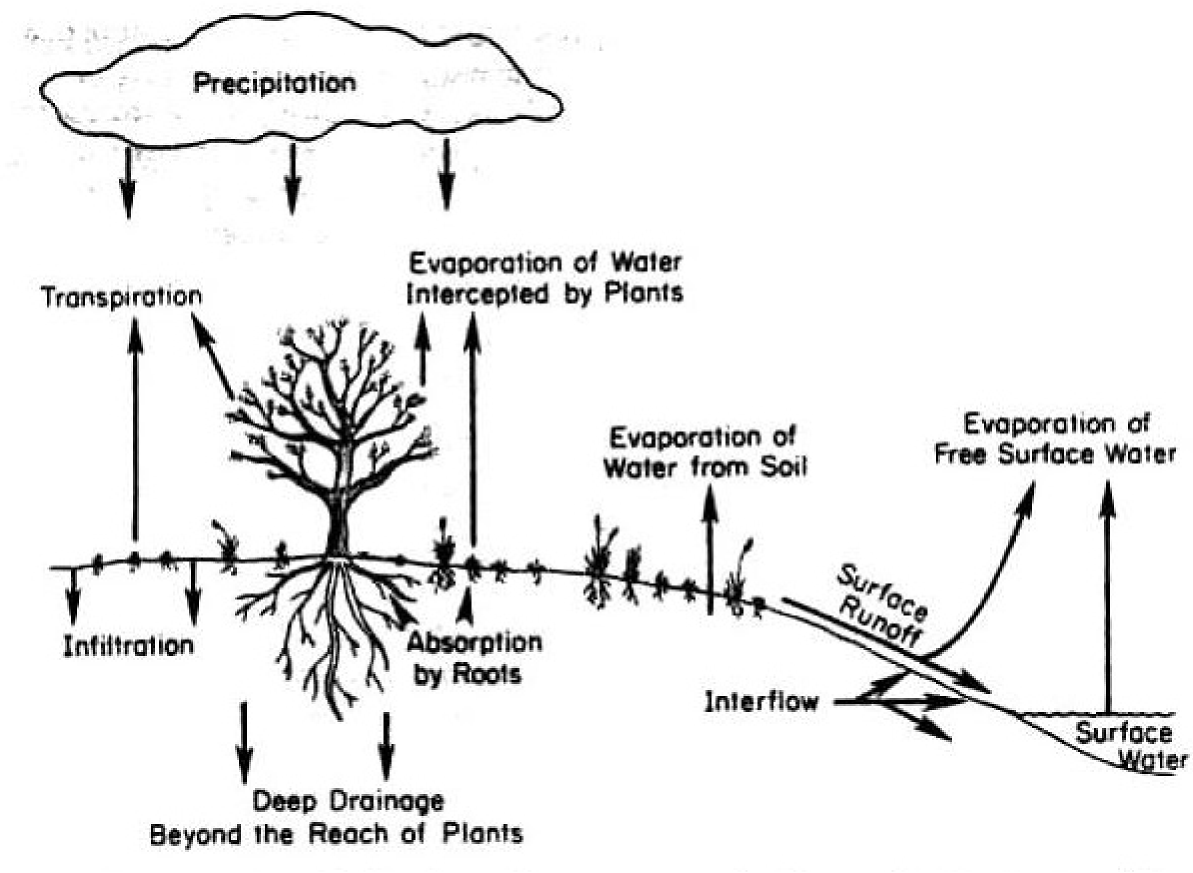

Figure 1: The Water Cycle

With Low Impact Design we are attempting to mimic the natural processes of the water cycle. Traditional stormwater management looked to physically control runoff. In nature, rainfall is disposed through deep drainage, interflow, transpiration and evaporation. In a natural water cycle very little rainfall turns to runoff.

Infiltration is a commonly accepted process for stormwater disposal, however the potential for disposal through evapotranspiration has not fully been explored. Controlled irrigation to maximize evapotranspiration could be termed disposal to irrigation.

Disposal to irrigation is ideal on low permeability soils such as clays, as it distributes over a large area allowing lower volumes of runoff to infiltrate through the soil profile and be absorbed and disposed of through evapotranspiration.

In Australia up to 90% of rainfall is lost through Evapotranspiration (ET), and research in the North America (GRIMMOND) indicates that ET in Washington could be up to 40% of the urban water balance. This research also has shows ET can exceed precipitation demonstrating the potential for disposal.

Research by the Auckland University on Evapotranspiration from New Zealand Green Roofs found that that the New Zealand Ice plant (Dsphyma Australia) can Evapotranspire up to 0.29mm/h and that unstressed regally watered plans could ET more.

When re-using stormwater for irrigation the main considerations are public health risks and what level of treatment is required, also surface infiltration rates, the amount of area enquired and slope and soil stability.

4 THE DEMONSTRATION PROJECT

4.1 THE SITE

The trial site is a 950m2 section situated in Oneroa, Waiheke Island. Waiheke soil is predominantly clay and not much opportunity for infiltration. The property is on a septic system for waste water.

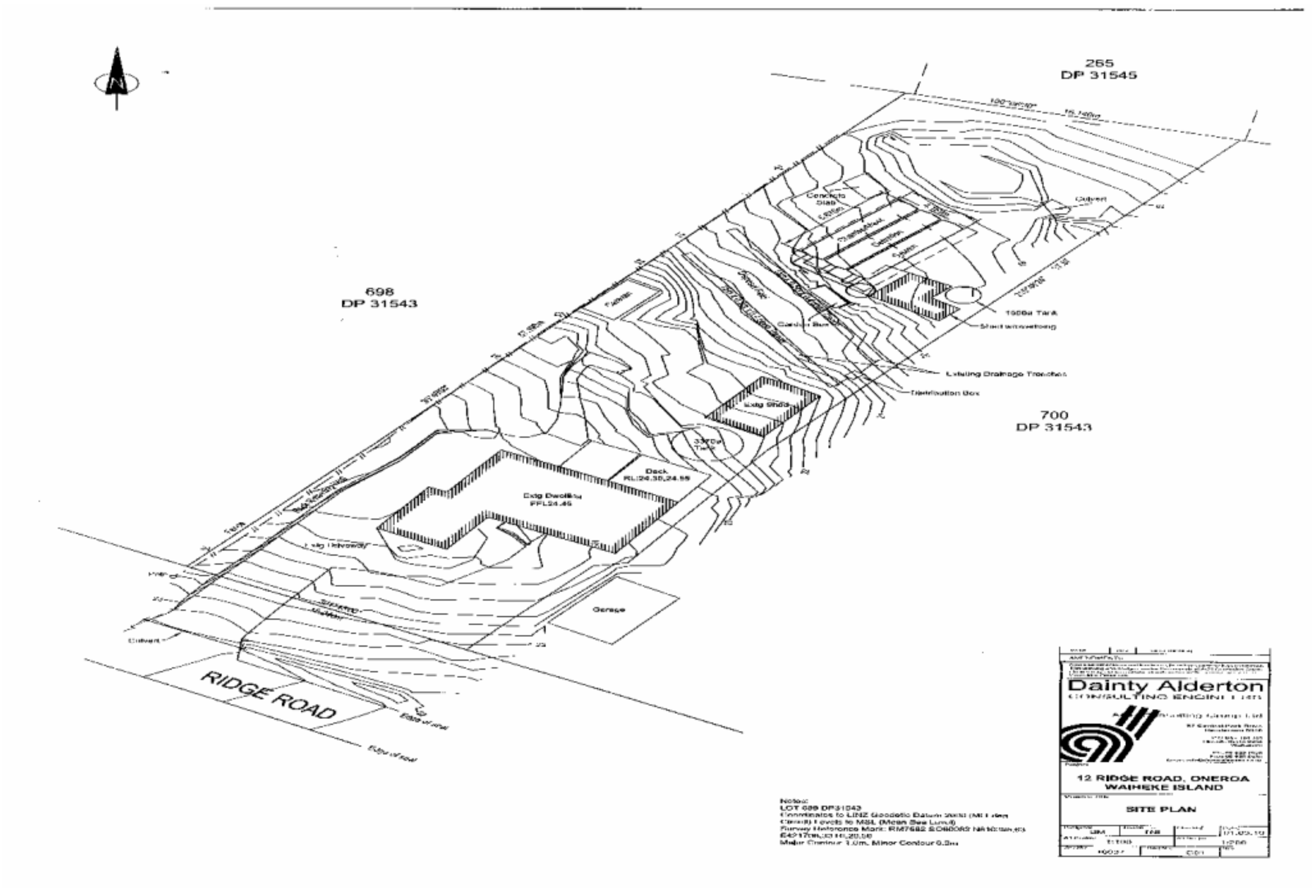

Figure 2: Site Plan

4.2 THE OBJECTIVE

Install an underground water reuse tank; the MaxxTank, which provides maximized storage. Connect this to ancillary building and the overflow from the main tank resulting in 100% capture of roof runoff.

Use a solar pumping system to pump captured runoff from the MaxxTank to a holding tank where it can carry to the irrigation system and then to the existing vegetation of the site.

Construct a carport with a green roof system to examine the disposal potential through evapotranspiration. Install moisture probes, rain gauges and monitoring equipment to collect data and monitor the volume ET properties of the site.

4.3 THE DESIGN

4.3.1 MAXXTANK.

The MaxxTank is a flexible underground storage tank constructed from ChamberMaxx arches, a polypropylene liner and 20/50 drainage rock. The ChamberMaxx is a corrugated arch, injected mold using structurally efficient and corrosion resistant polypropylene resin. The light weight chambers allow for placement without heavy equipment.

The ChamberMaxx has undergone a thorough structural analysis by engineers and in ground burial tests. The chambers are deigned to exceed New Zealand's HN-H0 72 highway heavy loading standards.

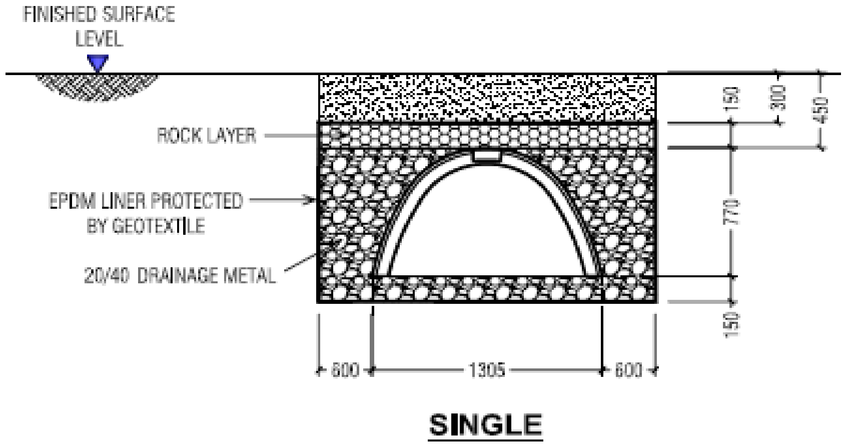

Figure 3: MaxxTank Elevation

4.3.2 SOLAR PUMPING SYSTEM AND HEADER TANK

The use of a solar pumping system gravitational system is logical. When there is no sun it is unlikely that irrigation is required. During period of high sunshine more water is pumped to the header tank. Pumping only occurs during dry sunny periods. A **Helical Rotor** submersible pump and the **Lorentz PS200** solar water pump were chosen for the project.

Helical Rotor submersible water pumps have lift capabilities of up to 240 metres and have a high tolerance to silt, making them well suited to deep well bores, home header tanks or farm stock water tanks. The Lorentz PS series pumps can be driven directly from solar panels making them a very versatile complete pumping package.

The **Lorentz PS200** solar water pump used at the Waiheke site is run by a maintenance free brushless DC motor and is driven directly from a 24 Volt, 175W PV (photovoltaic) panel through the controller unit. The water is pumped from the underground ChamberMaxx tank along a horizontal distance of 60m and vertical lift of 8m to a 1000 litre header tank located adjacent to the residential home. Modelling of the annual output estimates between 4m3 and 6.6m3 per day pumping capability across the annual period at a flow rate of 0.3m3/h to 0.84m3/h.

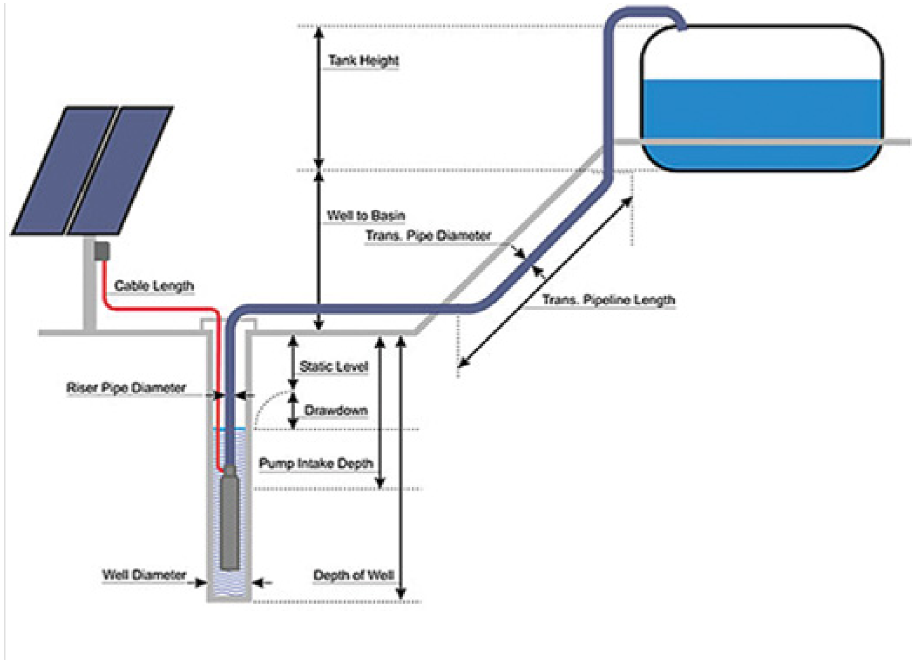

Figure 4: Solar Pumping System Schematic

4.3.3 IRRIGATION SYSTEM

The irrigation system uses TORO components from Parklands irrigation specialists, including a computerized controller, moisture sensor, solenoid valves, and above and below surface drip irrigation lines.

Water from the 1000 litre header tank is pumped to the irrigation system using a 0.75 kw pump split into two TORO drip irrigation beds. Irrigation for the lawn above the ChamberMaxx system is a subsoil drip line configuration and irrigation to the greenroof bed is by surface drip line.

The two irrigation zones are directed independently by solenoid valves connected to a four stage digital controller. The controller can be either activated manually or connected to a moisture probe to activate only when the soil moisture drops below a set level in any given zone.

Subsurface drip irrigation was used below the lawn area as it is an efficient low volume method of irrigating and is also hidden below the ground surface so as to not create any obstruction.

Surface drip irrigation is to be used on the greenroof as it was installed after the roof was installed. Again drip line irrigation is a low water volume method of irrigation, if irrigation is to be used to disperse excess water, the system can be substituted for spray sprinkler irrigation.

It is intended to examine both spray and drip irrigation during the monitoring process as one may be more effective as spray may be more effective for disposal and drip for conservation.

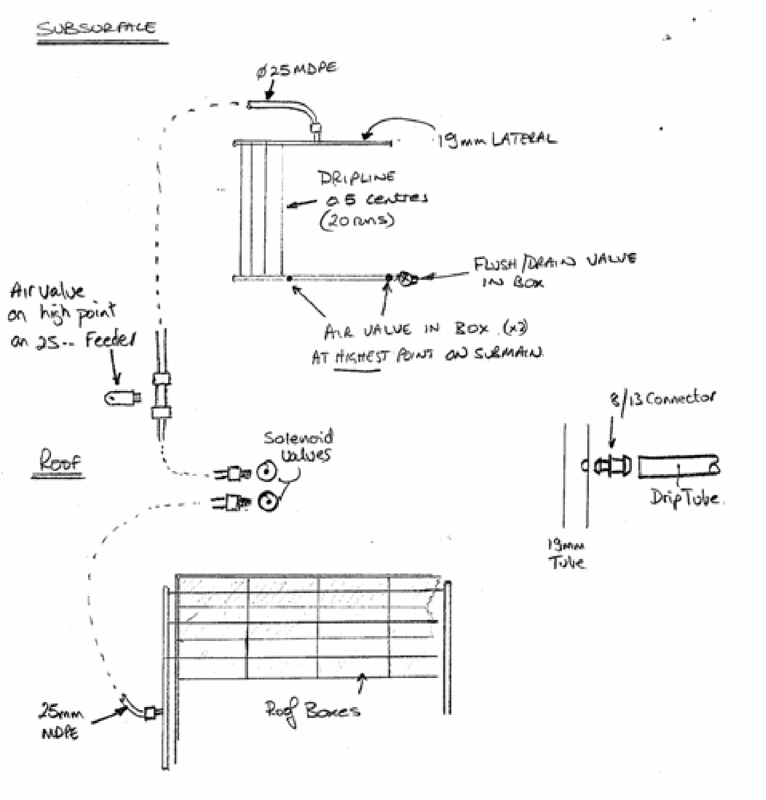

Figure 5: Irrigation Schematic

4.3.4 LIVE ROOF MODULAR GREEN ROOF

A new carport is to be constructed with a green roof to examine the ET potential of two varying depths of substrate. The deeper the substrate the larger the plants that can be grown. Larger plants have greater ET potential.

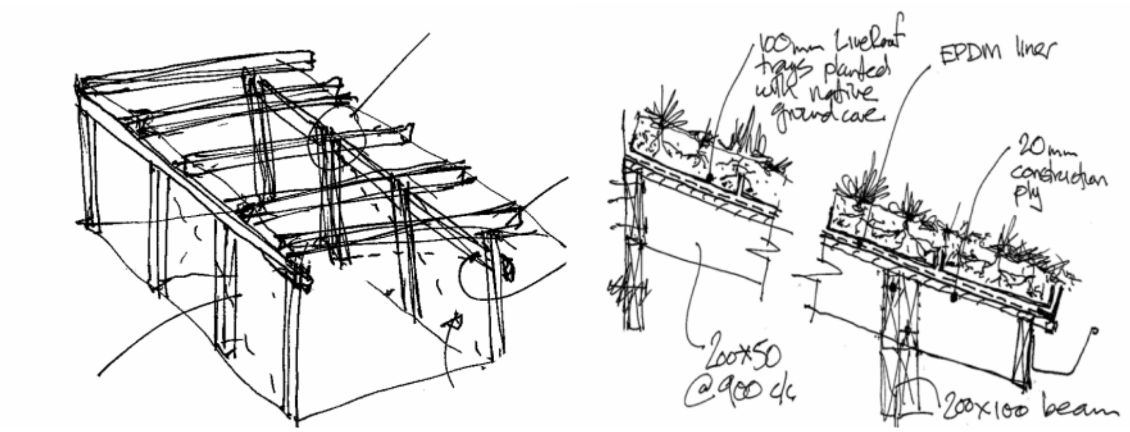

Figure 6: Carport and Live Roof Detail.

The green roof is to be constructed of a modular green roof system called LiveRoof. The LiveRoof system comprises of pre-grown tray's that are easily installed over a waterproof membrane. One feature of the LiveRoof system is the Moisture Portal between the trays. The moisture portal allows for the natural sharing of water, nutrients and beneficial organisms across the entire rooftop strata maximizing ET potential.

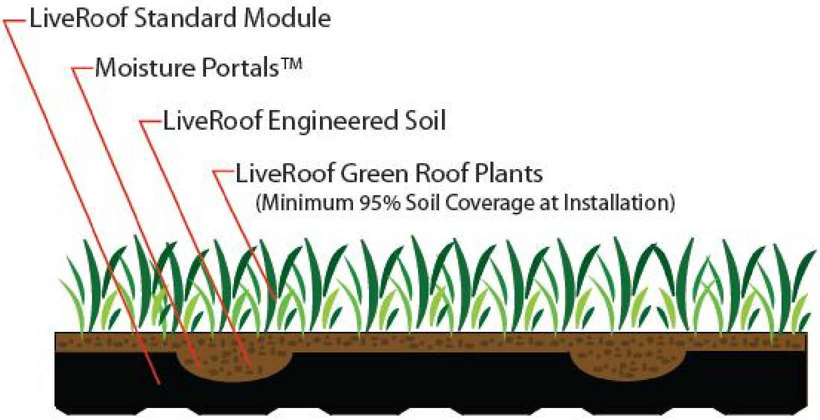

Figure 7: LiveRoof Module.

4.4 THE CONSTRUCTION

Stage one of the project was to construct the MaxxTank.

A total of 9 ChamberMaxx sections were used to construct the MaxxTank on the site, with a total storage volume of 23,600 litres. Installation of the chambers was carried out over a 2 day period in April 2010 and has collected approx. 18,000 litres of water over the winter period. A subsoil drain was placed at the base of the excavation to intercept any ground water and overcome any possible flotation issues. A layer of protective geotextile is in place below and above the liner.

Photographs 1,2,3,4: Construction of MaxxTank

Weighing less than 40kg each, the plastic arch sections can easily be man-handled into position, whatever the site constraints.

Photographs 5,6,7,8: Construction of MaxxTank

Washed 20/50 drainage rock is placed under and around chambers. When buried with crushed rock, the plastic arches are capable of withstanding high traffic loads. Marcmac couplers are used to create a quick water tight connection between the header pipe sections.

Photographs 9,10: Construction of MaxxTank

5 CONCLUSIONS

This paper has described the establishment of the Stormwater360 innovation site focused on water re-use and disposal to irrigation.

Evapotranspiration is a natural part of the water cycle, as vegetation naturally disposes of rainfall and runoff back into the atmosphere. Disposing of stormwater for re-use and irrigation in order to maximize evapotranspiration is an interesting concept which scientific research has demonstrated is possible. The Waiheke re-use site is the first working research site of its type in New Zealand. The opportunity for this project was provided by the fact that Waiheke Island does not have main supply water and in order to have a well irrigated garden an alternative water supply source is needed.

The paper described a number of innovative proprietary low impact design technologies installed at the site and how they were constructed. No monitoring data had been obtained at the time of writing this paper, the future monitoring and data gained from this site will provide Stormwater360 valuable information for design and implementation for on-site stormwater disposal and re-use systems.

REFERENCES

For References please contact author on michaelh@stormwater360.co.nz