RAINGARDEN MAINTENANCE: A GOOD DESIGN STRATEGY

Matthew Punter (HydroVac Ltd)
Bronwyn Rhynd (Stormwater Solutions Consulting Ltd)

ABSTRACT (200 WORDS MAXIMUM)

Raingardens have evolved, with respect to design, within New Zealand over the past 20 years from ones that are just "doing the job" to others that have great features which include aspects of treatment through to aesthetic value.

Including raingardens within the design and development of commercial sites is (or has been) a reality of obtaining consents. Obtaining consent is linked to funding mechanisms therefore there is a straight commercial collaboration between resource consent granting the release of funding.

The on-going reality of raingardens is that there are issues to do with compliance of resource consent conditions, lack of records of drainage and location of raingardens, little knowledge of maintenance requirements by landscaping contractors together with the cost of the maintenance and disposal of waste.

Good raingarden design can be a great asset to future owners of commercial, and residential, development sites. Operation and maintenance of raingardens, and issues such as access, can be built into the design to ensure fully functioning sites that are resource consent compliant.

This paper presents case studies on the operation and maintenance issues that are to be included in the commercial reality of raingarden design.

KEYWORDS

Stormwater, maintenance, raingarden

PRESENTER PROFILE

Matthew Punter is General Manager for HydroVac Ltd, with 15 years' operations management experience in service industries, and 6 years' experience in stormwater filtration maintenance. He has a working knowledge of the operational maintenance advantages and disadvantages of all stormwater filtration systems and types; in residential, commercial and industrial applications.

Bronwyn Rhynd is the managing director of Stormwater Solutions Consulting Ltd with a wide range of experience over the last 15 years of designing and supervising the installation of stormwater management systems, including raingardens. She has experience in resource consenting from the application (to consenting authorities) through to expert witness for hearings on various projects involving stormwater management and best practice issues.

1 INTRODUCTION

With the ever changing landscape of available filtration media's, design strategies and applicable contaminants, best practice raingarden design is in constant flux. What must remain stable is the inclusion of realistic operation and maintenance strategies at the design phase.

It is a reality of the industry that there are currently raingardens in place that either have not been installed correctly due to lack of knowledge around filtration systems, and/or are installed in locations physically difficult to enter.

This paper aims to provide information on design issues and other points of consideration with regard to ongoing operation and maintenance across the lifecycle of a raingarden. It is intended that this paper be used to aid operational reality to current and future design strategies, and does not take the place of legislation, standards and guidelines.

The paper also presents one such case study of a raingarden installed incorrectly in a hard-to-reach location.

2 OPERATION AND MAINTENANCE ISSUES

2.1 GENERAL

While the owner of a raingarden may not understand the difference between an aesthetic garden and a raingarden, and while they may in some cases look similar in appearance, there is a vast variation in design, materials, installation and ongoing maintenance. This paper outlines and defines the following issues around the operation and maintenance of a raingarden:

- Resource / Building Consent requirements
- Client requirements and understanding
- Understanding design needs
- Understanding filtration fundamentals
- Plant / Mulch Selection and needs
- Manpower & Equipment
- Site access
- Disposal and access to contaminated disposal sites

Without taking the maintenance of the garden into account during the initial design process it would be very easy to be ignorant of the above issues. Each issue will be discussed in greater depth in the following pages and, when included in the initial design process, will help to prevent the following detrimental design versus reality obstacles:

- Delays in construction
- Increased installation costs

- Incorrect installation
- Delays in maintenance
- Increased maintenance costs
- Future compliance failures due to lack of maintenance

2.2 RESOURCE / BUILDING CONSENT REQUIREMENTS

Councils will have specific requirements around output water quality, and guidelines around how the components of the raingarden should look and operate, however the design of the system is left to interpretation. Proactive installation contractors need to have access to the applicable resource consent, and an understanding of how to find the information they need, to ensure what they are installing meets the requirements.

Generally the client will provide this resource consent information to the contractor when required, it is then up to the contractor to interpret how to match the requirements of both the design and resource consent to the reality of the site conditions.

The case study to be discussed in section 3 includes an example of a design stipulating a requirement over and above the printed guidelines and resource consent, in this case a grass buffer strip in a location not easily accessible for maintenance via lawnmower. This will be discussed in more detail later, however to summarise; a grass buffer strip was included in the original design and appeared to be excluded from the original 2001 installation, signed off by council at the time, then failed an audit in 2012 for its exclusion.

Regulatory authorities can assist the process by having the information easily accessible, and correctly auditing the finished product with the design and consent requirements at code of compliance stage. Conflicts between the installation and the resource consent will usually be easier and cheaper to rectify at the time, with the installation contractor, rather than at a later date.

A relative lack and frequency of compliance checks, together with differing results between compliance officers, has always been a point of contention in the maintenance sector of the industry. The officer performing the audit must have a clear understanding of the design requirements for the site, and the audits must be to a consistent standard. Consistency of information helps to create a level playing field for installation and maintenance contractors, and makes for seamless education of the end user / client.

2.3 CLIENT REQUIREMENTS AND UNDERSTANDING

Understanding the clients' wishes versus what the resource consent requires & intends is a large obstacle to raingarden design, and can distract from the importance of designing with respect to the cost of maintenance over the life of the raingarden. Half the battle is the client gaining the understanding of why they need a raingarden, however the importance of maintenance at this early stage needs to be understood and included in this learning process.

Maintenance is a non-negotiable factor regardless of the type of stormwater filtration system. The importance of maintenance to the required type and cycle must be made clear to the client at the time of design, and during any changes of ownership, and the relevant Operations and Maintenance guide provided. Proactive designers could also

provide contact details for a maintenance contractor they trust to do the right job, to further reinforce the importance that this is not a garden to be ignored.

The act of ensuring the client forms a maintenance contract may seem at first glance to be outside the requirements of the designer or installer. However consider the following points, and how easy it would be to avoid the issue by providing with the completed design a maintenance agreement from a suitable contractor:

- Experience shows the client will most likely remember who designed and installed the system, which is also important for resource consent approval and on-going compliance.
- Poor operation & maintenance of the garden could reflect negatively on the design of the system.
- Going the next step to ensuring the longevity of the garden will have favourable returners with respect to repeat business for the designers.

These highlighted issues are supposition and easily avoidable, yet do happen in some cases based on human nature. Those same points apply to proactive installation contractors as well, assuming they don't maintain the system as part of their service offering.

2.3.1 TRANSFER OF OWNERSHIP

Transfer of information with a change in land ownership occurs at specific times with respect to construction, as follows:

- from a construction company to an end user
- from a construction company to a developer

Treatment systems are predominantly installed at the construction phase and for the construction company. Transfer of information to the owner is hit and miss at best, and it seems only the truly proactive construction companies and developers take stormwater treatment seriously.

When ownership is transferred through a property developer, the same problem of information transfer exists, however a second problem occurs: Change of land use from the intended purpose to something different in occupation phase.

A current example is a treatment device installed at construction phase for general commercial use, then the developer selling the land to a metal scrap yard with high hydrocarbon output. The treatment device currently traps the hydrocarbons as it is designed to do, however with prior knowledge it would have been designed differently to perform as intended and reduce the current high maintenance costs.

2.3.2 COMPLIANCE AUDITS

One positive that has come from the Auckland Council merger is an apparent surge in compliance audits. This has been sadly lacking in the past, and some of the audits performed were questionable, an example of which is highlighted in the case study detailed later in this report.

Irregular or lack of compliance audits has bred a lack of "land owner" understanding as to the importance of maintaining their stormwater treatment device, not only restricted to raingardens but prevalent across the industry. This lack of understanding results in

the asset owners reducing maintenance to cut costs, similar to servicing a motor vehicle; if there isn't a problem, why have it serviced? Only the proactive among us understand the service is to prevent future problems.

It is not the role of maintenance contractors to enforce the conditions of resource consents; theirs is the role of ensuring the maintenance is done correctly, in the correct timeframes, and providing advice on better maintenance or efficiencies.

2.4 UNDERSTANDING DESIGN NEEDS

A maintenance contractor does not need to know how to design a raingarden, however they must be aware of the design elements to correctly identify how each component correlates to the system as a whole.

With an understanding of the design elements comes the ability to problem solve, challenge incorrect designs versus actual site conditions, know when to seek advice and adapt while on site.

Maintenance contractors with an understanding that the installation cannot deviate from the design without the designers knowledge, is an asset to the remediation of failing raingardens, and other treatment devices. To make a change in ignorance of the design parameters is to invite failed audits of a failing system.

2.5 UNDERSTANDING FILTRATION FUNDAMENTALS BY SERVICE PROVIDERS

The raingarden market is predominantly serviced by a combination of civil contractors and landscape gardeners, with each focused on different aspects of the gardens. As a group and in general, the level of knowledge around stormwater filtration varies to a large extent.

Raingardens are filter systems that fundamentally allow water to flow into a garden area, then filter through a media in such a way that gross pollutants, sediment and certain other contaminants are removed during the time it takes the water to travel from the top to the bottom. The stormwater then enters subsoil drainage and flows to a receiver such as council drainage, soakholes or waterways.

A couple of the underlying design criteria are; how much water on average will enter the raingarden and how fast does that water flow through the media. The answers will dictate the size of the garden during the design process. Maintenance contractors must understand that poor selection of media will result in a less than desirable result, either for soakage rates or contaminant removal.

2.5.1 CIVIL CONTRACTORS

In general, most civil contractors understand the concept of filtration, and are likely to be involved regularly in large scale projects that install raingardens. Generally their project contracts include retention clauses based on the raingarden (or system) performance over a set period of time, and how well the system is installed may preclude payment of such monies.

Most civil contractors do not focus on maintenance however, due to the relatively small revenue stream involved. Their focus is on installation before moving to the next project

and possibly short periods of maintenance which is associated with the performance clauses of contracts.

2.5.2 LANDSCAPE GARDENERS

Landscape Gardeners are, currently, the most likely to maintain a raingarden, as these devices are (or usually) included with maintenance contract for other aesthetic gardens on the same site. However there seems to be a lack of knowledge and understanding around the fundamentals of filtration and other aspects of the treatment device.

During maintenance, if this is currently being undertaken, incorrect media, soils, mulch and plants are occasionally selected which can cause issues with respect to performance and consent conditions being met for the site. Overflow cesspits, soakholes and drainage all require periodic maintenance to ensure health and safety hazards from blockages and subsequent flood risks do not occur.

It takes an experienced landscaper, or one that has been trained in specific raingarden maintenance aspects, to perform these services, and experience shows they are most often left out of maintenance plans as a result.

2.5.3 DOES THE PERFECT CONTRACTOR EXIST?

Maintaining a raingarden simply requires a maintenance contractor to know what they are looking for as well as the following:

- An understanding in the fundamentals of filtration
- The knowledge of plants that will survive in this environment
- The ability to understand the components of a raingarden and their operation
- Access to the correct plant and equipment

With the correct training raingardens will be maintained at a much higher standard, and therefore have a better chance of protecting our environment as designed.

2.6 PLANT / MULCH SELECTION AND NEEDS

There is a large amount of information in the market pertaining to plant and mulch selection, much of it contradictory making it difficult to make an informed choice for maintenance purposes when the original design data is not available for reference. However by assessing the location, applying the filtration fundamentals and a certain amount of logic, the correct plants and mulch can easily be selected.

2.6.1 PLANTS

In simplistic and general terms, suitable plants for a raingarden are those that can tolerate wetting and drying and sometimes for prolonged periods. Root systems will help to create bio-filtration environments, and enhance infiltration to the media, however large root systems can cause issues with subsoil drainage which can be costly to repair.

Plant selection also needs to consider the size of the garden, and planted to accommodate the intrinsic nature of each plant species to avoid crowding or shadowing.

Consider the need of water supply close to the raingarden for watering the plants during periods of prolonged dryness.

2.6.2 MULCH

Mulch is predominantly included to keep moisture in the media, it also acts as part of the filtration system, whereby larger sediments and gross pollutants will be trapped. The type of mulch available is varied and should be selected logically for the intended use of the raingarden.

Ideally the mulch will be of a type that does not float so is not mobilized and redistributed by water as it flows into the raingarden, and flows towards the outlet during the larger rainfall events. The redistribution (of mulch) during rainfall events is likely to result in sections not covered or, of more concern, being washed into the overflow drainage and blocking outlets. This will cause a safety hazard of water pooling for extended periods of time in areas it normally wouldn't.

Many current raingardens have utilized bark mulch of a chipped variety which is very light and easily redistributed with water. However alternatives are available to enhance the performance of the raingarden in the upper zones, such as the following:

- Shredded bark - is more likely to bind together but will still float
- Wood/Post shavings – a larger mulch suited to larger gardens, can be harder to utilize with smaller gardens due to clumping
- "Forest Floor" mulch – produced by Living Earth, a mix of wood shavings, saw dust and shredded bark, binds together well, however contains a certain amount of dust that may filter through the mulch to combine with the media
- Rock/pebbles – not easily distributed and doesn't float, consideration should be given to replenishing or removal during maintenance of the filter media.

2.7 SITE ACCESS

Any filtration system or type, by virtue of its role in trapping pollutants of any nature, will require maintenance at some stage. Any specific design and installation cannot be called successful unless maintenance has been allowed for and appropriate access to the site included.

Access for maintenance is paramount and should be considered at the design phase of the raingarden. Successful operation and maintenance of these devices can only be achieved if you can actually get to the raingarden post construction.

During the design phase consideration must be given to the following:

- Type of equipment required during maintenance– diggers, dump trucks, delivery trailers
- Physical size and weight of equipment – weight limits on access road, overhead hazards, height limits
- Amount of equipment – digger delivery trailers, multiple contractor vehicles
- Room for bulk product storage – scoria, media, mulch and plant deliveries

Whilst the list above is fairly self-explanatory it is easily overlooked during the design. In some cases designers may not appreciate the physical size or weight of this equipment, as shown in the following case study. Examples of maintenance issues that need consideration during design phase are as follows:

- Raingardens located in busy commercial car parks
    - parking spaces will be required to locate machinery and storage of products such as plants, filter media etc
- Multi-story structures
    - considerations around vehicle heights and weight limits must be included.

Poor access design will result in increased maintenance costs and the possibility of asset owners choosing not maintain and run the risk of non-compliance of consents.

2.8 DISPOSAL AND ACCESS TO CONTAMINATED DISPOSAL SITES

A raingarden's purpose is to trap pollutants/contaminants and therefore any media removed during maintenance cycles can be considered contaminated, unless tested otherwise. Contaminated soils should not be disposed of through transfer stations, and alternative disposal receivers will need to be found/located. Therefore several issues will need to be considered during the maintenance period of the raingarden, as follows:

- A contractor may not understand that the media removed is contaminated unless they have a clear understanding of the fundamentals of filtration.
- A contractor may not know about, or have access to, contaminated disposal treatment facilities, unless they have regular dealings with contaminated products.
- A contractor may not have an understanding of the contaminants involved, and therefore may not declare the contaminants correctly, causing issues at the disposal facility, and raises the possibility of increased costs of treatment.

These issues can be overcome by ensuring that the contractors understand filtration, have access to appropriate disposal facilities and can be trusted to accurately declare.

This can also be reinforced by designers taking some responsibility around ensuring an approved maintenance contractor is recommended (or employed) to protect the intention of the design and operation of the stormwater treatment device

3 CASE STUDY – COMMERCIAL RAINGARDEN RENEWAL

Please Note: The project will be referred to as "Site Alpha", at the client's request for the site to remain anonymous

3.1 BACKGROUND

Auckland Council compliance officers attended Site Alpha to audit the stormwater management on site in August 2012. The raingarden failed on the following points:

- No grass buffer between the level spreader and the rain garden as per design
- Overflow cesspit could not be located
- Vegetation is evident but very sparse
- Not clear exactly where the raingarden is located

- No live storage in the raingarden
- A composting bin was located in the rain garden

HydroVac Ltd was called to site in September 2012 to discuss audit findings and provide recommendations. HydroVac maintains the stormwater system on this site for the Property Manager, and was not aware of a raingarden at this site, therefore this raingarden was not included it in their maintenance plans.

The site consists of two office blocks over a multi-story underground car park, and is located on a busy road near a major railway station in Auckland. There are many aesthetic garden beds within the landscaping, and one rain garden in a rear corner of the site. A sign located on the rear driveway entrance denying truck access, however there is no posted weight limit. This was of some concern as part of the driveway is over the underground car park.

The rear driveway is a narrow two lane drive which leads to the underground car park entrance. The driveway is bordered on both sides by buildings, there is no room to park on the driveway without blocking a lane. Parking at the rear of the building is limited to eight visitor car parks, booked out on a timed reservation system and not available to contractor vehicles. There is no available parking on the road in easy reach of the site due to proximity to the railway station.

The raingarden is situated within the landscaping at the rear corner of the site with maintenance access only via through a small overgrown alleyway off the rear driveway, (see Photograph 1)

The raingarden is bordered by sloping banks on 3 sides and a level spreader on the 4th side. A medium sized Pohutakawa tree sits on one bank with several other smaller shrubs surrounding the other sides (see Photograph 2).

Information on the raingarden was not held by the Property Manager or within the property file held at Auckland Council. Copies of the original plans were provided via the stormwater team at Auckland Council, who had these from the time of resource consenting for stormwater discharge (see Appendix A).

Concerns were raised by HydroVac Ltd and property manager at this time due to the following elements:

- How to gain access to the raingarden site
- How to remove the excavated soil from site
- Where to store plant and equipment on site while not in use
- Where to store new media, mulch and replacement plants until required

Photograph 1: Maintenance access to raingarden is restricted

Photograph 2: Raingarden prior to maintenance

3.2 INITIAL FINDINGS

HydroVac and Auckland Council, after locating the original resource consent, completed a site visit to ascertain what Site Alpha was providing with respect to consent compliance. The initial findings are as follows:

- The original design did not match the actual site, also no clear definition as to the raingarden extents
    - The design dimensions were not possible in the area available.
    - The location of the Pohutakawa tree and the level spreader made two clear boundaries, however these were too close to allow the required dimensions.
- The as-built location of the level spreader was different to the design
- Sampling of the filter media was undertaken by digging multiple holes
    - Results were inconclusive as to consistency of sand/clay mix
- The overflow cesspit was found, buried under approx. 50mm of soil and covered by a piece of weed mat.
    - The location is shown in *Photograph 2* marked by a pile of rocks.
- One corner of the garden was very wet, suggesting ponding occurs and surface not level.
    - Low point at the opposite corner of the garden from the overflow cesspit.
- Mulch was a chipped bark type, very sparse and mostly consolidated in the wet area, suggesting redistribution during rain events.
- Inspection of the soakhole was undertaken however unclear whether subsoil drainage was discharging to this
    - Doubts as to whether any subsoil drainage existed

Due to the above findings there were doubts raised over whether a rain garden had been installed. Approval was granted by the client to remove all soils to a depth of 150mm (in a line out from the level spreader) in an attempt to find the raingarden boundaries.

During the investigation stage HydroVac found bricks, rock, concrete spoil and pieces of steel at a depth of only 100mm, directly opposite the level spreader. All works were halted until further advice could be sought on the design intentions and construction of the raingarden.

Stormwater Solutions Consulting Ltd were engaged at this point to provide expertise and to design a new raingarden that would meet the standards of today. With new media technologies and efficient design techniques the required size was reduced from the original consented 26.36m^2 to a much more space efficient 8.2m^2 (see Appendix B). This new design was approved by Auckland Council, without the need to amend the resource consent.

3.3 INSTALLATION OF NEW RAINGARDEN – FIXING THE PROBLEM

The replacement raingarden was installed to the specifications of the new design. This was undertaken in an efficient and effective way. The methodology undertaken together with problems encountered and their solutions are presented as follows:

- The top layer was scraped and more rocks and debris was encountered.
    - Approx. 150mm of sediment was found before the top layer of original sand/clay media was exposed.
- In forming the "entry slope" as per design, HydroVac observed that this was a very steep slope and may impede access from one side to the other for maintenance.
    - HydroVac made the decision to lengthen the slope by 200mm horizontally, thereby creating a slightly gentler slope.
    - Installers and maintenance crews can access from one side to the other without walking on the media
        - ongoing operation of the raingarden will not be affected
    - Location of the raingarden shifted a further 200mm away from the level spreader.
- The edge of a large boulder was struck immediately after beginning the excavation for the rain garden, directly in front of the level spreader, at a depth of approx. 300mm. This boulder was essentially inside the borders of the original raingarden design dimensions, and would have been a large component of the media bed (see Photograph 3). HydroVac did not want to attempt removal this boulder as it would likely have undermined the entry slope and walls of the raingarden.
    - The location of the raingarden shifted a further 400mm away from the level spreader, now a total of 600mm horizontal movement.
    - This movement bought the edges of the raingarden very close to the drip line of the Pohutakawa tree, and given restrictions of ground works inside the drip line
        - The shape of the raingarden was changed without altering the total area to accommodate the tree's drip line
- Further excavations unearthed several large rocks, a paint bucket lid, tin cans and what appeared to be a BBQ flat plate (see Photographs 4 & 5), all within the original boundaries of the raingarden.
- A total of approximately 1500kg of media was excavated and removed off site to a treatment facility for disposal, the rest of the soil/clay mix (approximately 6m^3) was spread across the areas surrounding the raingarden to build up levels and reduce disposal costs.
- The original scoria bed was uncovered and replaced, and a new section of drainage installed to the soakhole (see Photograph 6)

- The entry slope, scoria bed and walls were covered with Geocloth, then filled with Living Earth soil media (Living Earth, 2012)(see Photographs 7 & 8)
- Carex Virgata and Oi Oi plants were selected for their suitability to the conditions and raingarden size. Large scoria rocks were installed both to demarcate the raingarden boundaries and to prevent any mulch on the surrounding areas from being washed into the filtration area (see Photograph 9)

Photograph 3: Large boulder in original media bed

Photograph 4: Paint lid and tin can in media bed

Photograph 5: Appears to be a BBQ hot plate in the original media bed

Photograph 6: Scoria Bed

Photograph 7: Geocloth Install

Photograph 8: Soil Media Install

Photograph 9: Finished Rain Garden

4 CONCLUSION

Raingardens provide treatment for stormwater runoff through fundamentally filtering the contaminated water through the soil media. They can also provide the site with an added aesthetic benefit and, in some instances, are conditions of a consent held by the site owner.

Raingardens that are part of a functioning site can have the following issues that are sometimes over looked:

- Knowledge that they are to comply with resource consent conditions
- lack of records with respect to drainage catchments and location
- Contractors that maintain the raingardens lack design and maintenance knowledge
- The asset owner has very little knowledge or understanding of the device
- an understanding of the full cost of maintenance
- access for maintenance purposes
- need to dispose of waste during periods of rejuvenation or maintenance

Good raingarden design can be a great asset to future owners of commercial and residential development sites. Operation and maintenance of raingardens, and issues such as access, can be built into the design to ensure fully functioning sites that:

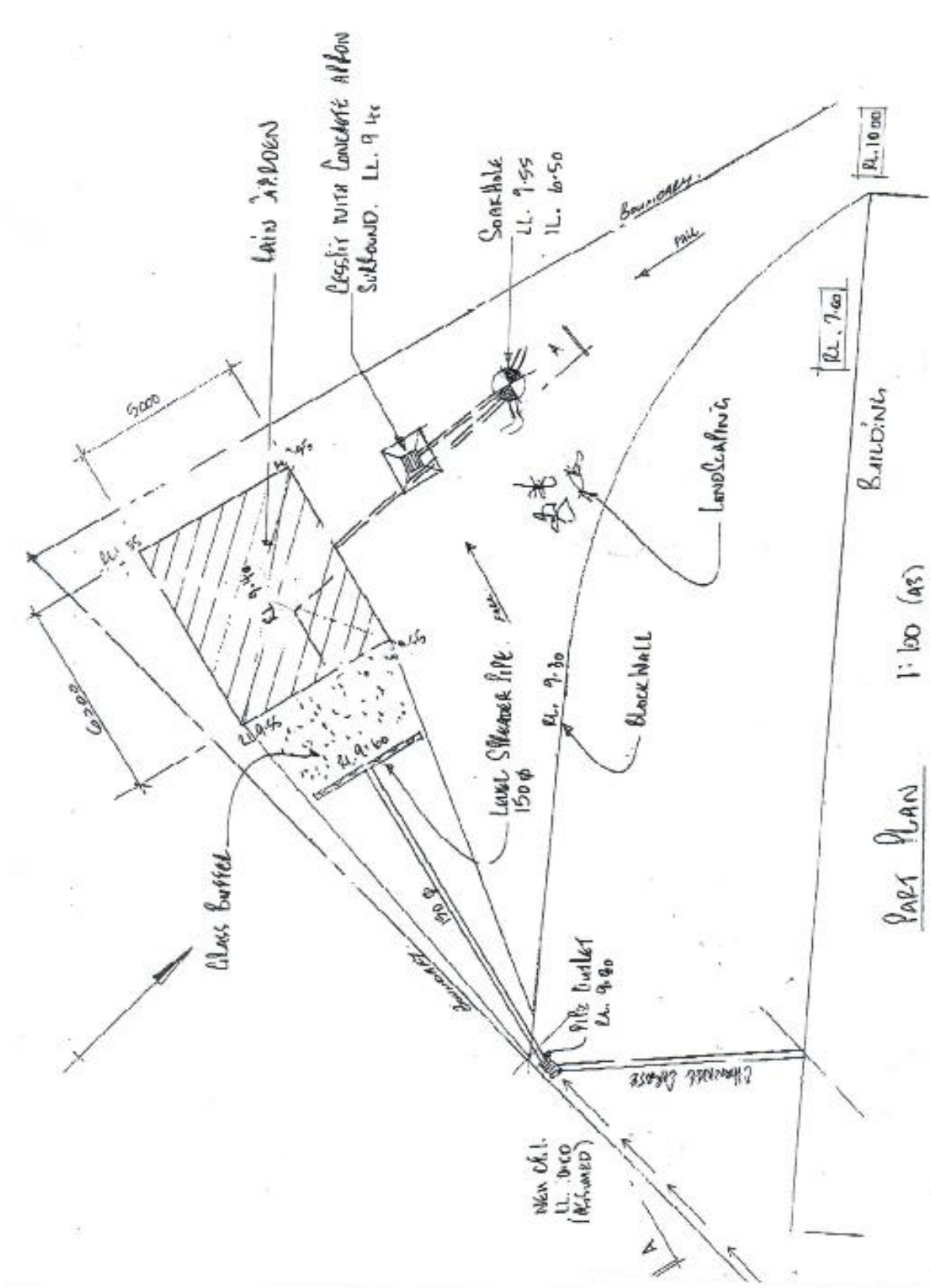
- comply with resource consent conditions; and
- cost less to maintain

Considering these issues early in the design process will also remove the likelihood of design costs and will help to ensure a smooth process for all parties concerned.

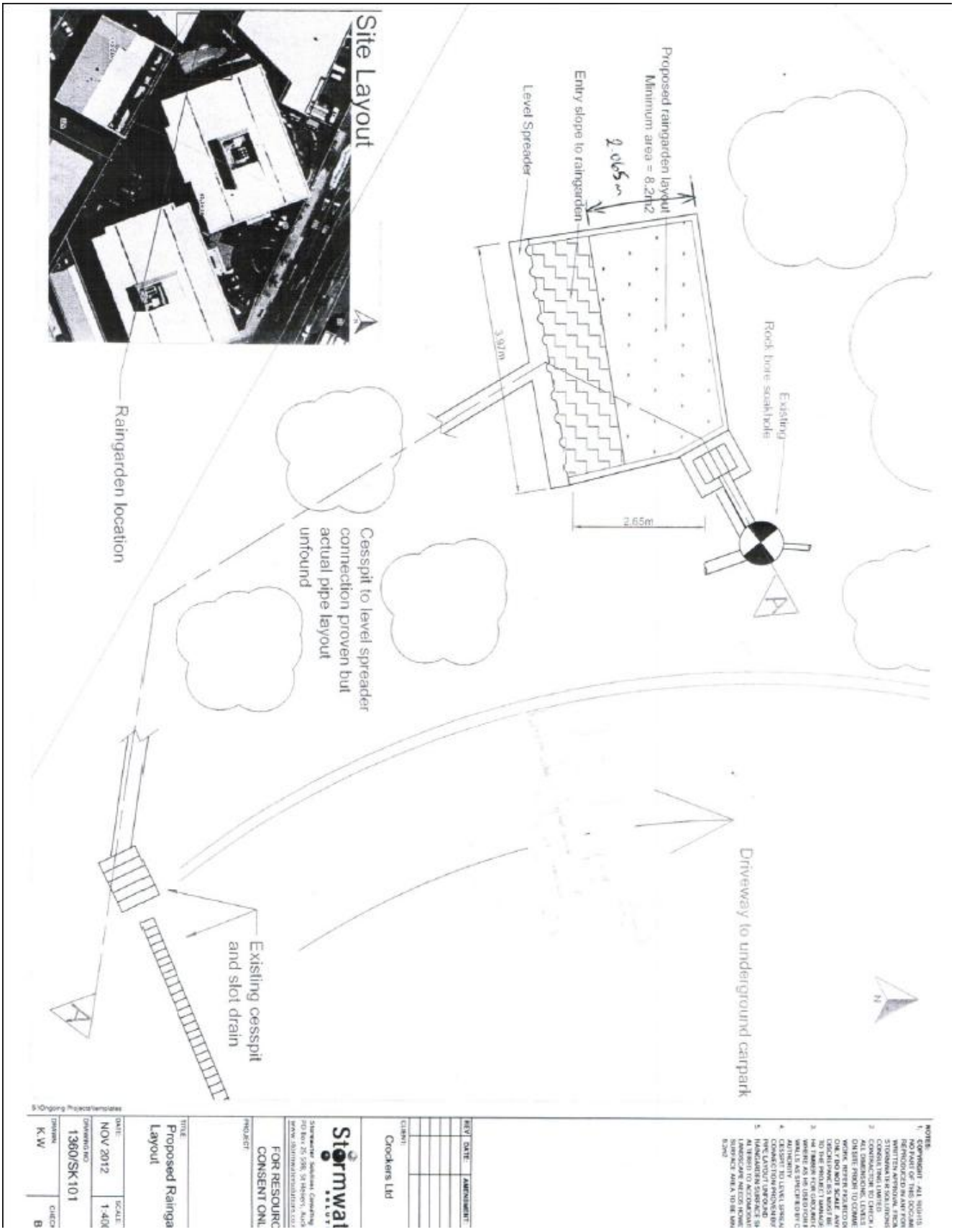
REFERENCES

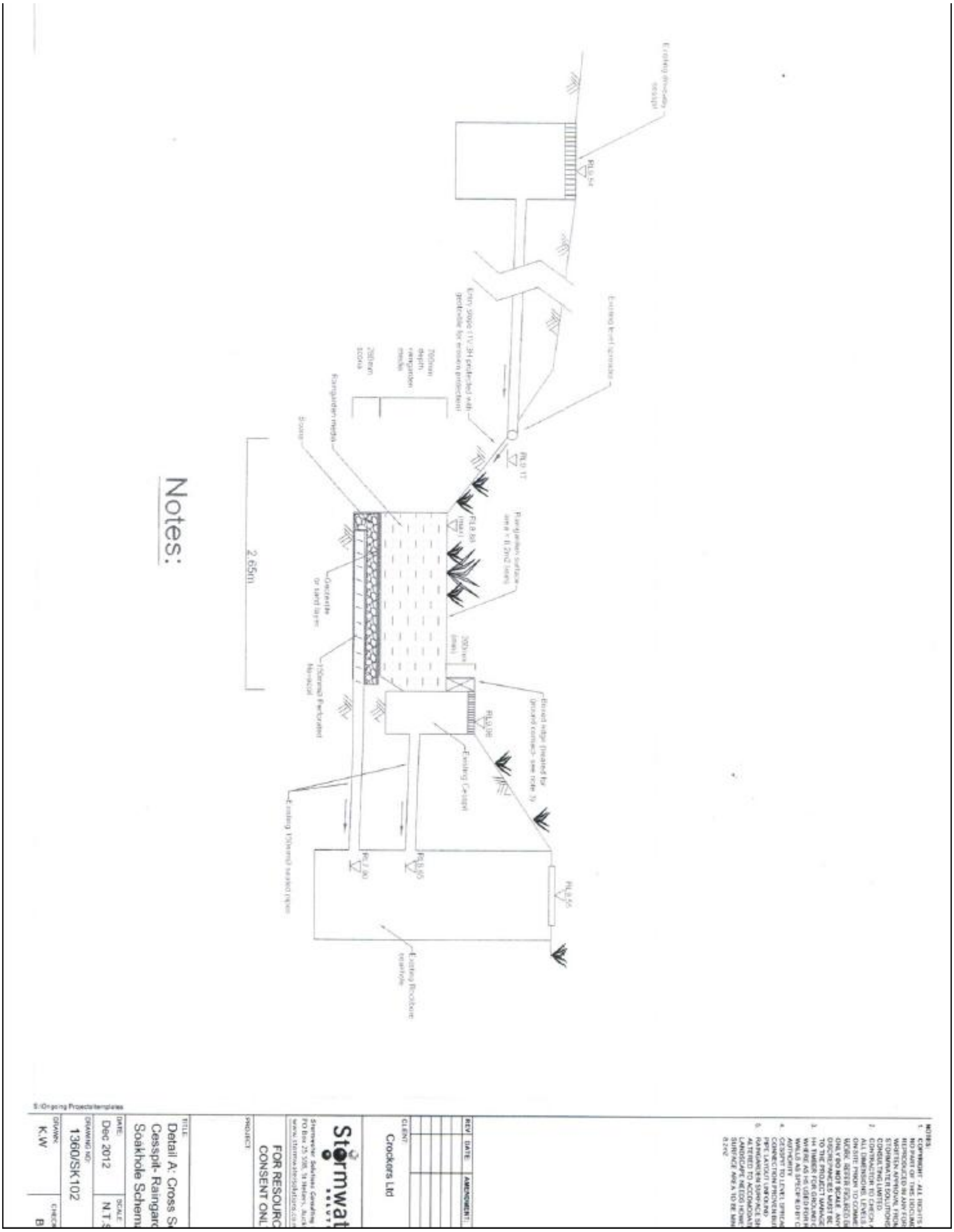
Living Earth, 2012, Living earth soil media, www.livingearth.co.nz

APPENDIX A – ORIGINAL RAINGARDEN DESIGN (DECEMBER 2001)



APPENDIX B – NEW RAINGARDEN DESIGN (JANUARY 2013)




Notes:
2.65m
Crockers Ltd
FOR RESOURC
CONSENT ONL
Detail A: Cross S
Cesspit- Raingarc
Soakhole Schem
Dec 2012
1360/SK102
K.W