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AHP STORMWATER TREATMENT DEVICE LIFECYCLE COSTING

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Healthy Waters | AHP Stormwater Treatment Device Lifecycle Costing

Dear Jackie,

Thank you for the opportunity for Civix Limited to provide this assessment of the AHP Stormwater Treatment Device Lifecycle Costing for the Healthy Waters.

Please do not hesitate to contact us if you have any questions on this report,

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Contents

Additional Resources:

- Asset Database and Lifecycle Costing Model – https://civixlimited-my.sharepoint.com/:x:/g/personal/adrian_civix_co_nz/Eej0phI6OsBCkcFIVQPX4v0BxbW8efy1AsnzTvgywXW12Q?e=FqB4ol
- GIS Database of Devices – https://arcg.is/0e4Dne

1. Introduction

Civix have been engaged to help Healthy Waters to determine to long term Capital (CAPEX) and maintenance (OPEX) costs for the stormwater treatment systems being installed in some of Aucklands large Land Development projects. This is to help Healthy Waters and Auckland Transport plan for the long term maintenance of these devices and seek lower cost options where possible.

2. Background

Healthy Waters (HW) and Auckland Transport (AT) receive vested stormwater treatment devices when public roads are redeveloped in Brownfields areas or new roads created in Greenfields developments. The treatment devices are required by several legal process (Subdivision Consents, Precent Plans, Network Discharge Consents, Engineering Plan Approval, etc) and the installation costs are met by the initial developer. Once installed and the subdivision is completed, the new stormwater infrastructure and treatment devices are vested to either HW or AT, transferring the ownership and ongoing maintenance burden to these council entities. The maintenance cost of these devices has historically been hard to quantify and could be a significant burden on Council and Aucklands ratepayers over the device's lifetime.

A number of the larger developments in Auckland are lead by Kāinga Ora's Auckland Housing Programme (AHP). This is New Zealand's largest urban regeneration programme and will transform suburbs and communities across Auckland. Kāinga Ora's describes the programme as:

> *Kāinga Ora is the one of the largest landowners in Auckland. Much of this land is underutilised so it makes sense to intensify the use of this land to create more homes for Auckland.*
>
> *The Auckland Housing Programme is not just about numbers of homes. The programme will deliver warm, healthy homes for many Aucklanders – more state housing; more homes for first home buyers; and a greater supply of homes on the market, to house the growing population. It will create improved infrastructure and better amenities for Auckland.*
>
> *The AHP will create more competition and innovation in the home construction market by creating a significant pipeline of work for building companies.*

The Auckland Housing Programme is based around the following eight projects:

- Northcote – 1,500 New homes
- Roskill Development - 11,000 new homes
- Mangere – 10,000 new homes
- Oranga Development - 1,100 new homes
- Hobsonville Point – 4,500 new homes
- Tamaki Development – 10,500 new homes

These developments involve reconstructing whole neighbourhoods, including roads and stormwater infrastructure. Under the Unitary Plan rules, this redevelopment of impervious surfaces triggers the need to include stormwater treatment for the new roads. The stormwater treatment requirements can be achieved by using various methods from Auckland Councils Guidance Document 01 (GD01) or using propriety Stormwater Treatment devices. All these stormwater treatment systems need maintenance over their lifespan and the cost of this maintenance falls to the ratepayer once the system is vested to Auckland Council.

3. Financial Risk to Auckland

With Auckland being a growing city and the Unitary Plan encouraging urban intensification, large parts of Auckland are being redeveloped and these developments are required to install stormwater treatment devices on high traffic roads and parking area. These devices are often constructed by the developer before being vested to Auckland Councils Healthy Waters or Auckland Transport, who are then responsible for the maintenance of these devices for their lifetime. Thousands of these devices are being vested each year and their ongoing maintenance costs could become a significant burden. This study aims to review a sample of these developments, the devices proposed and the long-term costs of these devices to Council.

4. Device Information

With such large areas being redeveloped, this gives the opportunity to compare different methods of stormwater treatment systems and the different costs over their lifetimes. Each development is required to prepare a Stormwater Management Plan (SMP) containing the overall management approach for stormwater and the specific information such as, device type, location, catchment and other information on each device.

The following stormwater management plans were reviewed as part of this study.

- Northcote Development, Northcote: 380 old houses turning into 1,500 new homes.
- Owairaka, Mt Roskill: 200 old houses turning into 1,000 new homes.
- Oranga, Mt Roskill: 400 old houses turning into 1,100 new homes.
- Roskill South Development, Mt Roskill: 280 old houses turning into 1,000 new homes.
- Mangere West, Mangere: 230 old houses turning into 930 new homes.
- Bellgrove: 90 existing houses turning into 230 new homes.
- Redhill, Papakura: 44 existing houses turning into 230 new homes.

All the above are Brownfields developments. A single Greenfields Stormwater Management Plan was also included for comparison:

- Huapai Triangle, Huapai: 140 new homes.

A summary of the different treatment devices in each of the Stormwater Management Plans are:

Stormwater management plan	Devices
Bellgrove	18 x Raingarden 2 x Swale
Kumeu	64 x Raingarden, 4 x Swale
Mangere	5 x Swale
Northcote	80 x Raingarden
Oranga	20 x Stormwater 360 Stormfilter
Owairaka	35 x Stormwater 360 Filterra 1 x Stormwater 360 Cascade Separator
Redhills	10 x Raingarden
Roskill South	1 x Wetland Pond
Total	245

4.1. Device Information Collection Methodology

Each stormwater management plan drawing was imported into ARCGIS and georeferenced into its corresponding position on an Auckland wide base map. Each device was then drawn into GIS by tracing its location and the following information where possible:

- Stormwater management plan
- Asset ID
- Asset type
- Device area - measured of plans
- Device area - from Stormwater Management Plan tables
- Catchment area - measured of plans
- Catchment area - from Stormwater Management Plan tables
- Device length (for swales)
- Device model number (for Stormfilter, Filterra, etc)
- Device location (in road reserve, etc)
- Traffic Control needed to maintain
- Device information source
- Any other relevant device details

This information was recorded in an excel database using the Device ID as the unique identifier. A link to the database and the GIS web portal is provided in the table of contents.

4.2. Raingardens, Swales and Wetlands – Further Information Calculated

Where information was unable to be collected for a device from the information provided, but could be calculated off the other information gathered, the following rules were used to calculation missing information:

Missing Information	Calculation used
Device Area	Raingardens – 2% of measured catchment Raingardens – 2% of stormwater management plan stated catchment Swales - 2m (width) x measured length
Catchment Area	Raingardens – 50 x Measured Device Area Wetlands – Catchment area calculated GD01 calculations based on Device area

4.3. Proprietary Devices – Further Information

The Stormwater Management Plan contained only Device type and location, no sizing or catchment details however all proprietary devices within the Stormwater Management Plan were Stormwater 360 devices, so they were contacted for sizing information. Stormwater 360 provided the device details for the following:

Plan	Details
Oranga stormwater management plan	20 x Stormwater 360 Stormfilter ranging from 2 to 10 Cartridge systems.
Owairaka stormwater management plan	35 x Stormwater 360 Filterra ranging from FT1212 to FT2418 units. 1 x Stormwater 360 Cascade Separator

Stormwater 360 provided their supply price of these systems but as they are sold to a contractor who then installs them with unknown costs, the total acquisition cost (TAC) is not accurately known. Using our knowledge of the construction industry we have estimated the installation costs to provide a reasonable Total Acquisition Cost (TAC) of the devices. The key focus of this study is on operational costs (OPEX) and these TAC is entirely a CAPEX cost met by the developer, so it does not affect the outcome but still can provide guidance to the overall lifecycle cost of these devices.

4.4. Traffic Management

Where a treatment device is close too or on the edge of a road, some form of traffic management will be required for its maintenance, we have recorded this in the asset database and added a cost for this item in the maintenance costings. No differentiation is made for road classification, distances to intersections and different types of traffic control required due to complexity of the information required to do so. Most devices in the study areas are located on quiet residential roads that would likely be classified as "Low Volume" roads by AT.

Where a device is not located near the road, no traffic management costs have been included in its maintenance costs.

5. Life Cycle Costing Source Data

5.1. Overall Methodology

With sizing or specification information recorded for each individual device, we developed a database that allows for an individual lifecycle costing to be prepared for each device. The total acquisition costs (CAPEX), annual maintenance costs (OPEX) and end of life renewal (OPEX) are worked out for each device. The annual maintenance cost is then multiplied by the lifespan, 50 years for all devices, to give a total lifecycle cost for that device.

5.1.1. Net Present Value

The total life cycle cost is not the true representation of the devices cost to the organisation over its 50-year lifetime as over that period due to cashflow requirements involved over suck a long period. The best way to represent this is to use a Net Present Value (NPV) calculation. We have used a standard NPV calculation with a 4% discount.

5.2. Raingardens, Swales and Wetlands

For Raingardens, Swales and Wetlands, the Koru Environmental Lifecycle costings are recognised as the most accurate available now. These models have been evolving since 2012 and cover both acquisition (CAPEX) and operational costs (OPEX). The December 2020 versions were supplied to us by Healthy Waters and were used as the source data. These models are generally based around the device size and catchment area, which was available from the stormwater management plans.

For each item in these models, there is a low cost input and a high cost input to each model parameter. We have formed our costing model to run each device with the low and high costs outputs to give the full range of expected costs.

Our model differs from the Koru Environmental model with the NPV calculation. The Koru model works out the cost over each of the 50 years and adds them up year on year. This allows them to cost in different maintenance items at different intervals, such as significant maintenance of the drainage system for a raingarden on year 15 of the devices life. This calculation is too complex to be done on the hundreds of devices of this study, so our model averages all costs to an annual basis and then multiplied by 50 years. After the Net Present Value calculations, the difference is negligible to the overall numbers but will not be an exact match to the same device individually put through the Koru Environmental Model.

5.3. Proprietary Devices

Stormwater 360 provided guidance on the maintenance costs of their devices however they do not actually provide maintenance services on the devices themselves, so can’t provide firm costs. From the information provided we were able to determine a low and high value maintenance options.

The information is somewhat commercially sensitive so we will not go into detail on the costs and methodology, however we recommend that Healthy Waters Operations review this part of our model to ensure the costs are in line with their records.

6. Results

The results are contained within an excel spreadsheet and the link is provided in the contents table of this report. As the costing models make up over 70,000 cells and calculations, it is impracticable to display the raw data here, or in a printable form.

The results are best displayed in the Box and Wisker graphs below to demonstrate the difference in device costs for different sized catchments. The cost per 100m^2 (\$/100m^2) of catchment treated is the simplest way to demonstrate the relevant values across the whole range of devices. The split for the results is catchments less than 500m^2, 500-1000m^2 and over 1000m^2.

6.1. Small Catchments of less than 500m^2

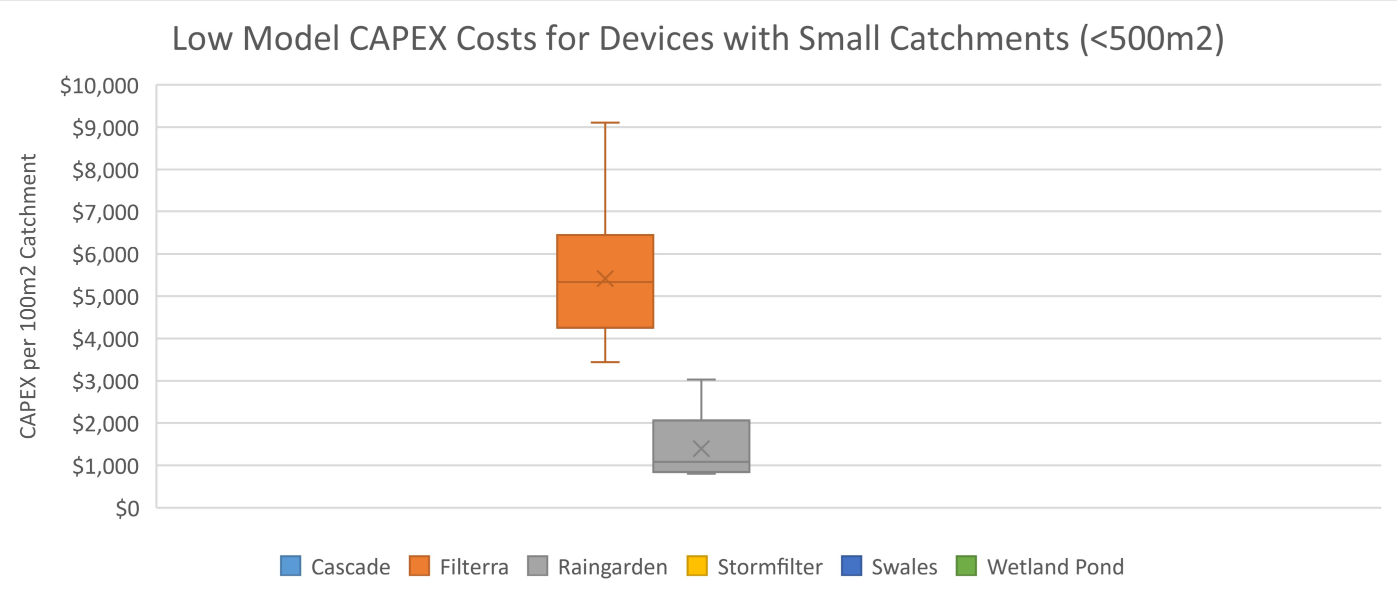
Raingardens and Filterras are the only treatment devices in the smaller catchments of the stormwater management plans in the study. The number of each device type in this sized catchment is:

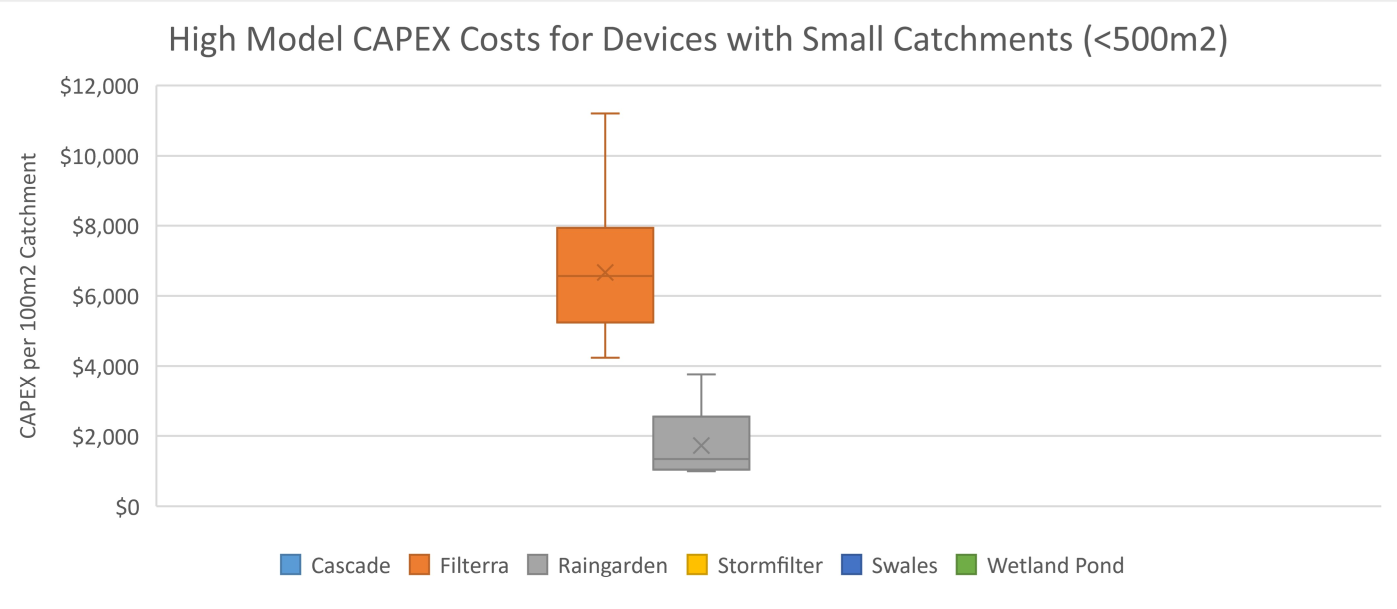
Device	Number
Raingarden	51
Filterra	27

6.1.1. CAPEX Costs - Small Catchments

This is CAPEX costs, or purchase and installation costs that are generally met by the developer and not Council.

Both the Low and High models show that the Filterra is more expensive to purchase and install than a standard raingarden. This ignores any other site constraints that may change the Best Practicable Option assessment outside of the influence of cost, such as the Filterra's smaller footprint. This was cited a major reason for their inclusion in the Owairaka development, where they were being retro fitted into the berm, which had several existing services (power, communications and watermains) that would have had to be relocated to be able to use the larger raingardens in their place.

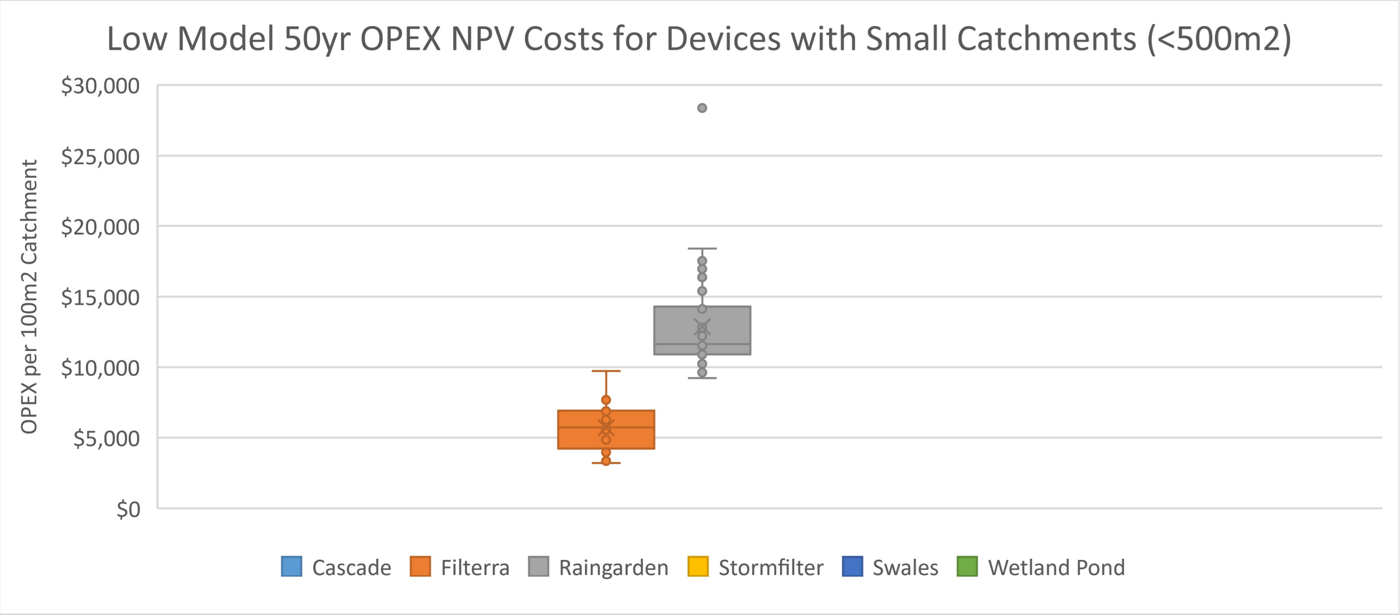


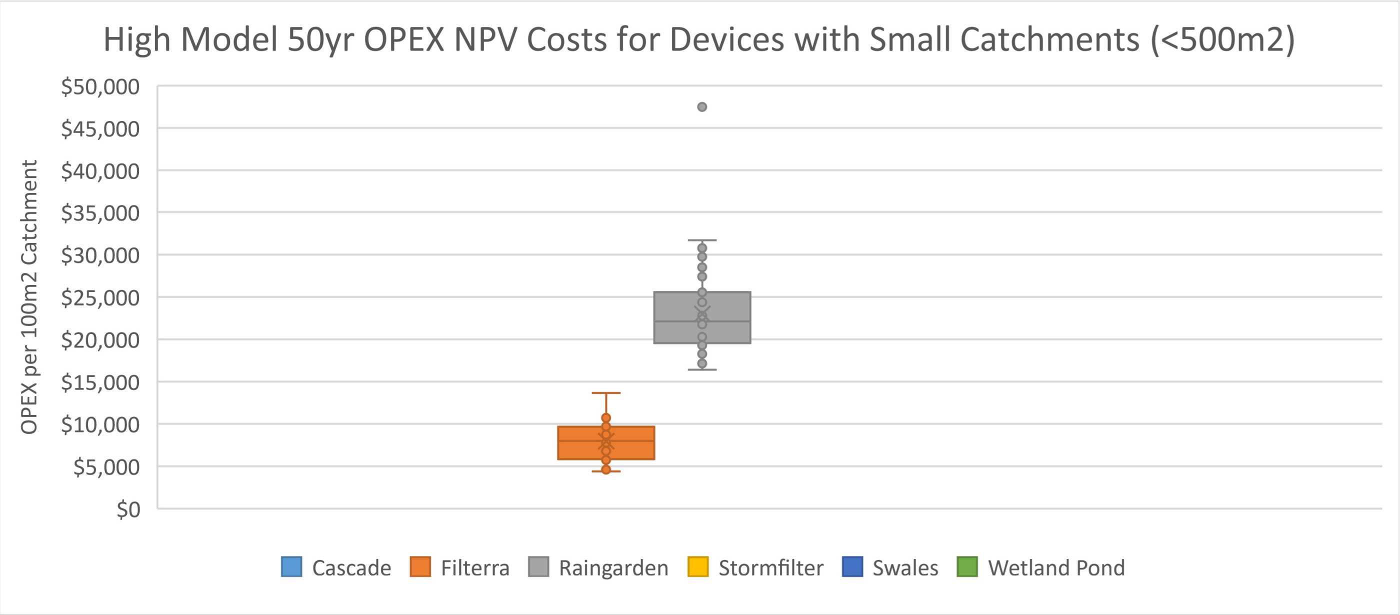


6.1.2. Total Lifecycle OPEX - Small Catchments

This is the total cost of maintenance (OPEX) over the lifespan of the device and includes any renewal costs for the device at the end of its life. This is the information of most interest to HW and AT, as this is the money that needs to be collected from ratepayers to maintain these devices.

The Filterras are more cost effective here, possible due to smaller footprint and lower maintenance schedule. As they are physically smaller than raingardens, they are likely quicker to maintain, saving costs in time onsite for weeding, mulch replacement, traffic control, etc. This is discussed further in section 7 below.

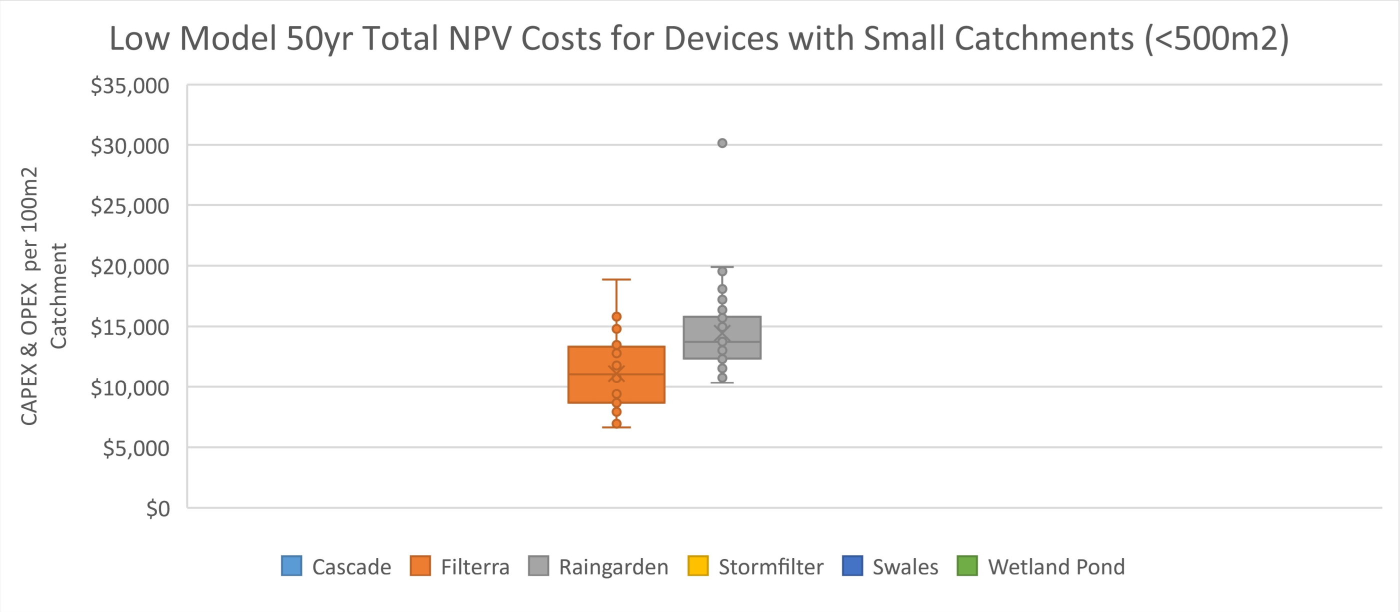


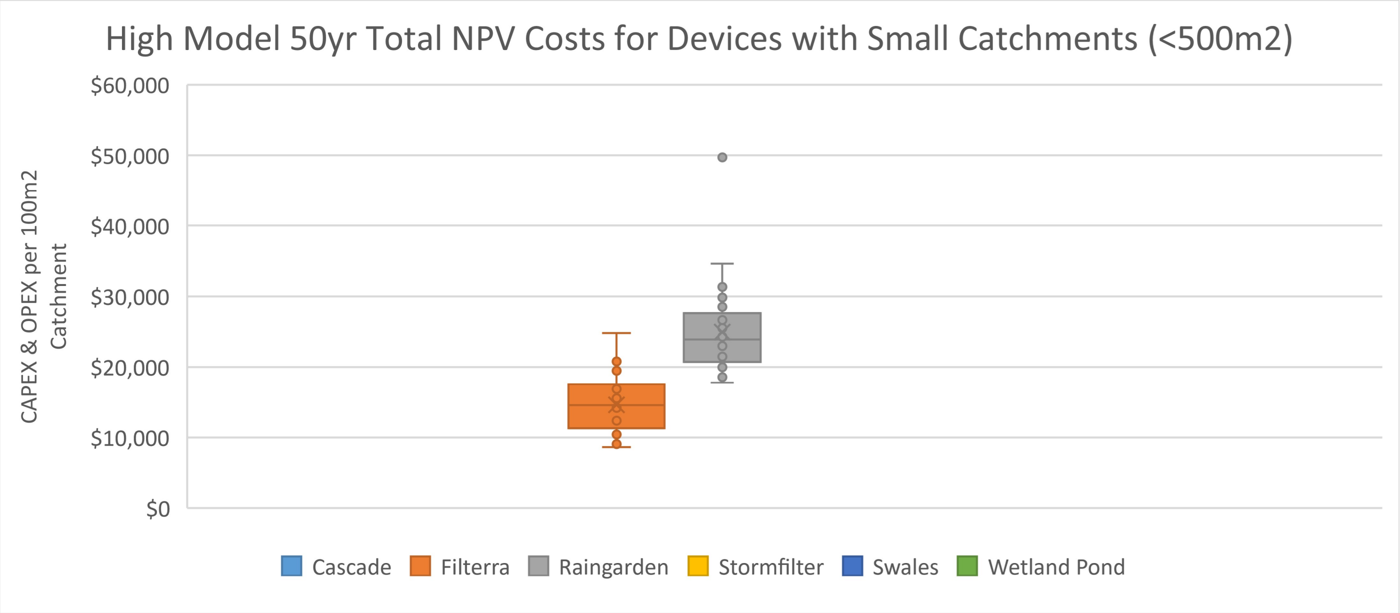


6.1.3. Total Lifecycle Cost – CAPEX AND OPEX - Small Catchments

This is the total lifetime cost of the device, with the CAPEX being funded by the developer and the OPEX being funded by Council.

Over the total lifespan (50 Years) the device costs are not that different overall, however the Filterras are relatively more cost effective. The higher initial purchase and install cost is offset by the lower maintenance costs, making them cheaper over their entire life.





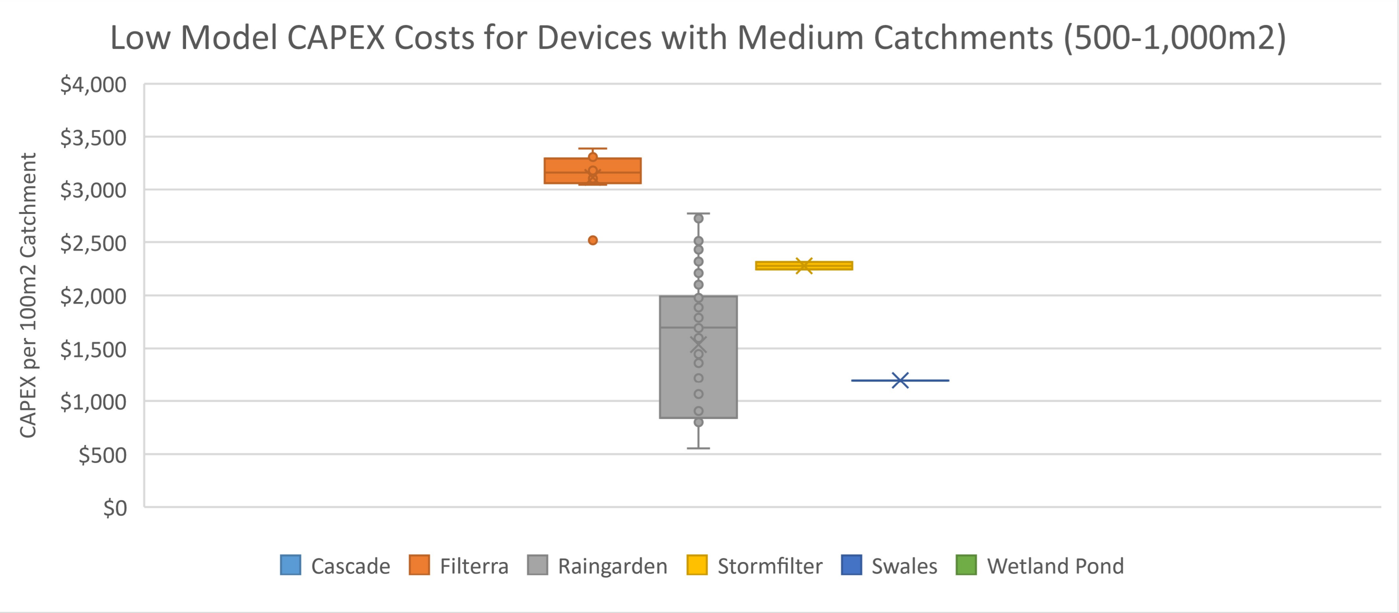
6.2. Medium Catchments – 500-1,000m^2

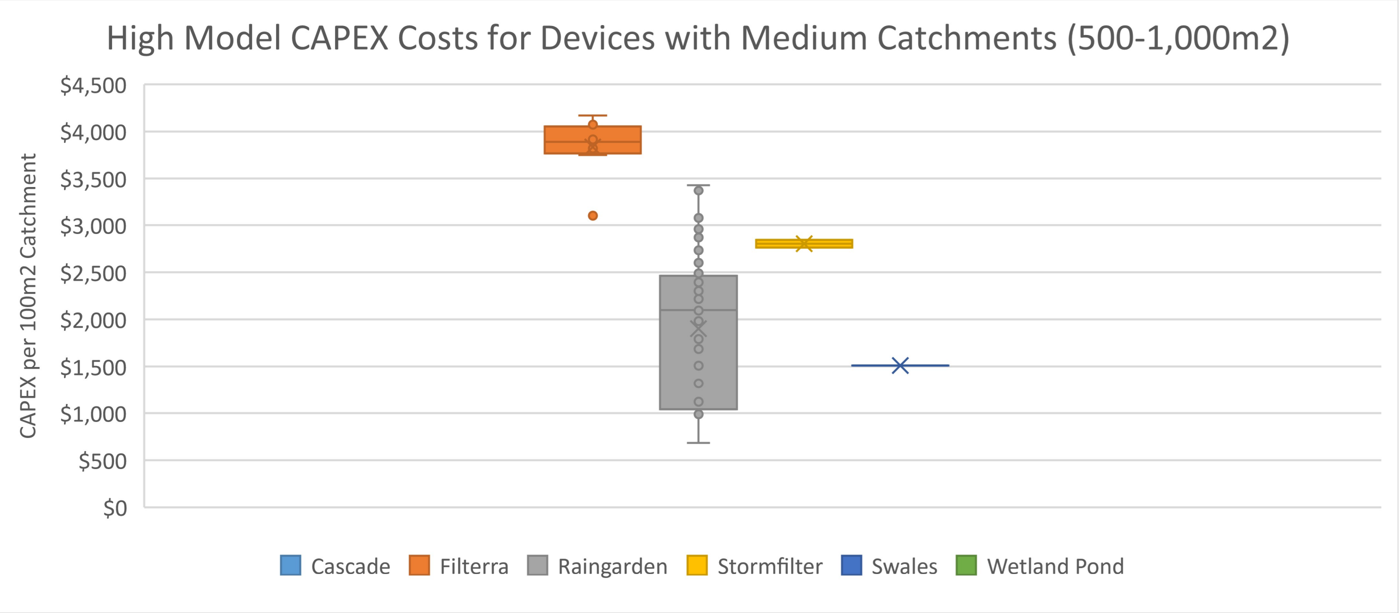
In the medium catchments, we have a wider range of devices, with Filterras, Raingardens, Swales and Stormfilters. The number of each device in this sized catchment is:

Device	Number
Raingarden	72
Filterra	8
Swale	1
Stormfilter	2

6.2.1. CAPEX Costs - Medium Catchments

The propriety devices again show a higher purchase and install cost over the lower raingardens and swales.

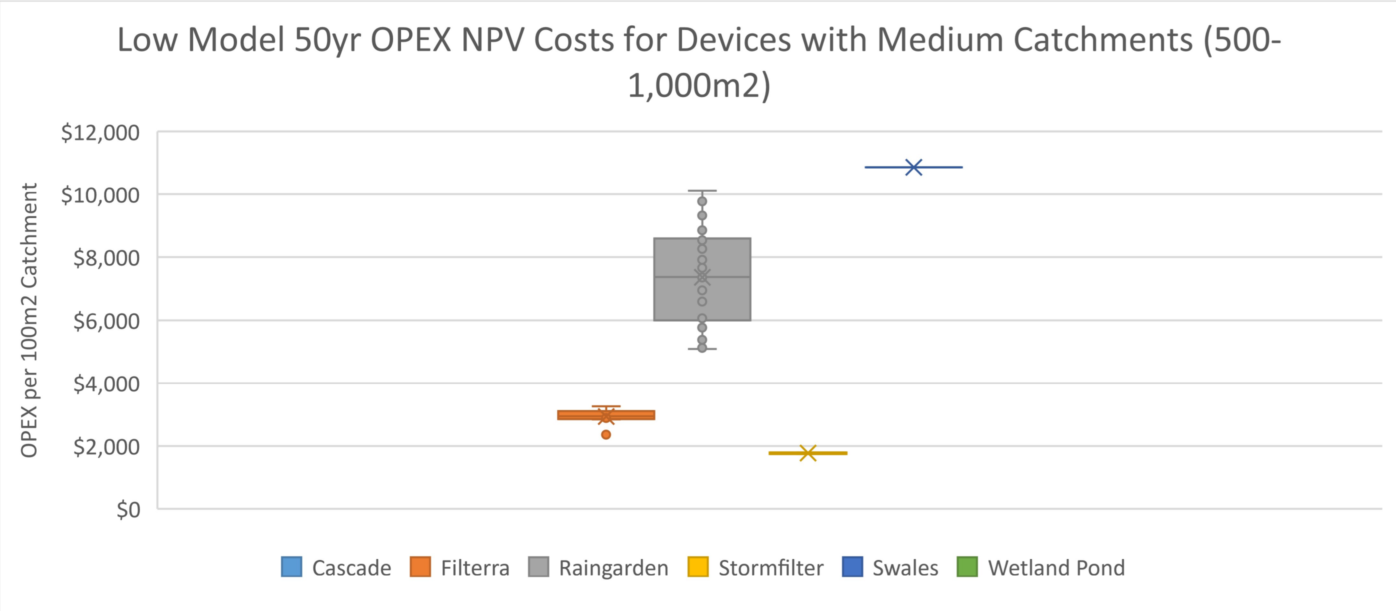


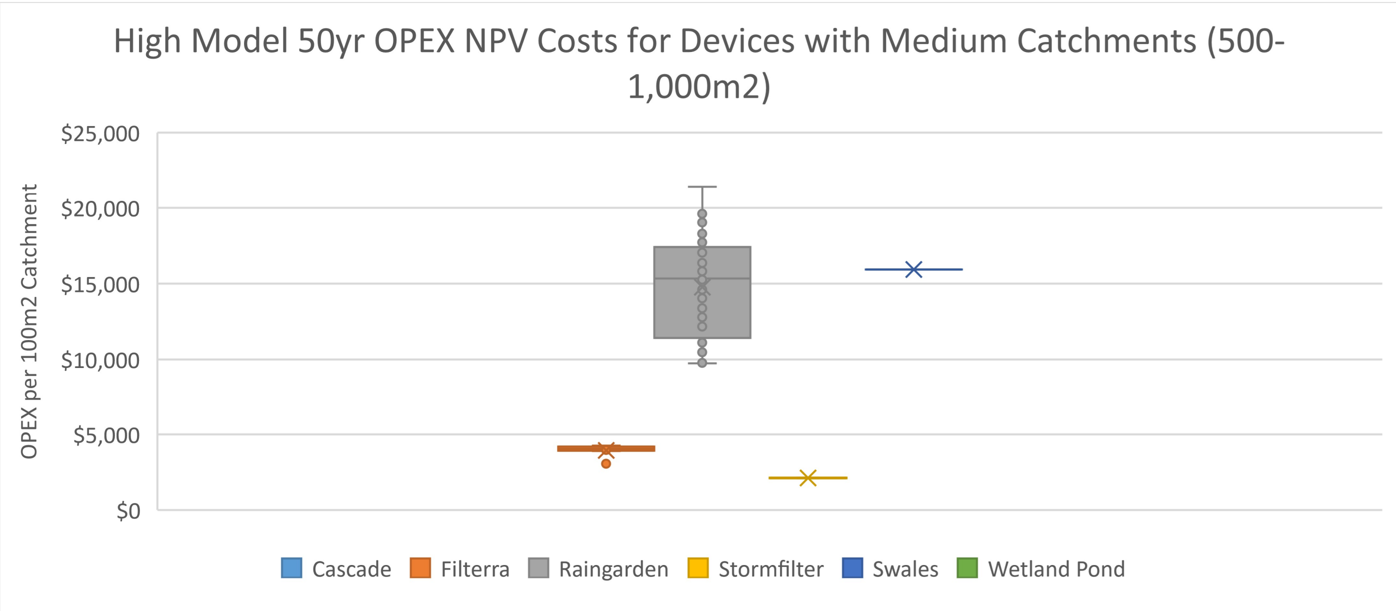


6.2.2. Total Lifecycle OPEX - Medium Catchments

Like in the smaller catchments, we see that raingardens and swales have higher maintenance costs over the proprietary devices. As discussed in Section 7, this is likely to be due to a number of reasons such as frequency of maintenance, cosmetic maintenance, etc.

In comparison to the small catchments, the medium catchment Raingardens and Filterras lifecycle OPEX costs are about 40-50% lower. This is a significant cost difference and represents a significant saving for Council.

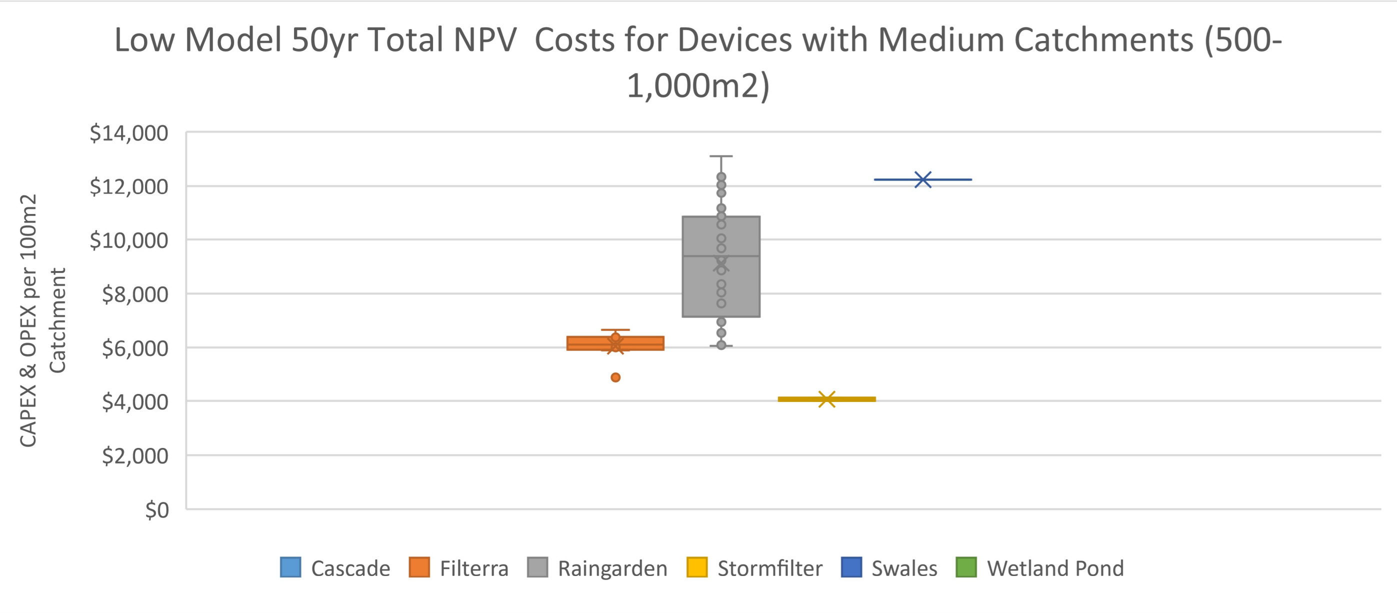


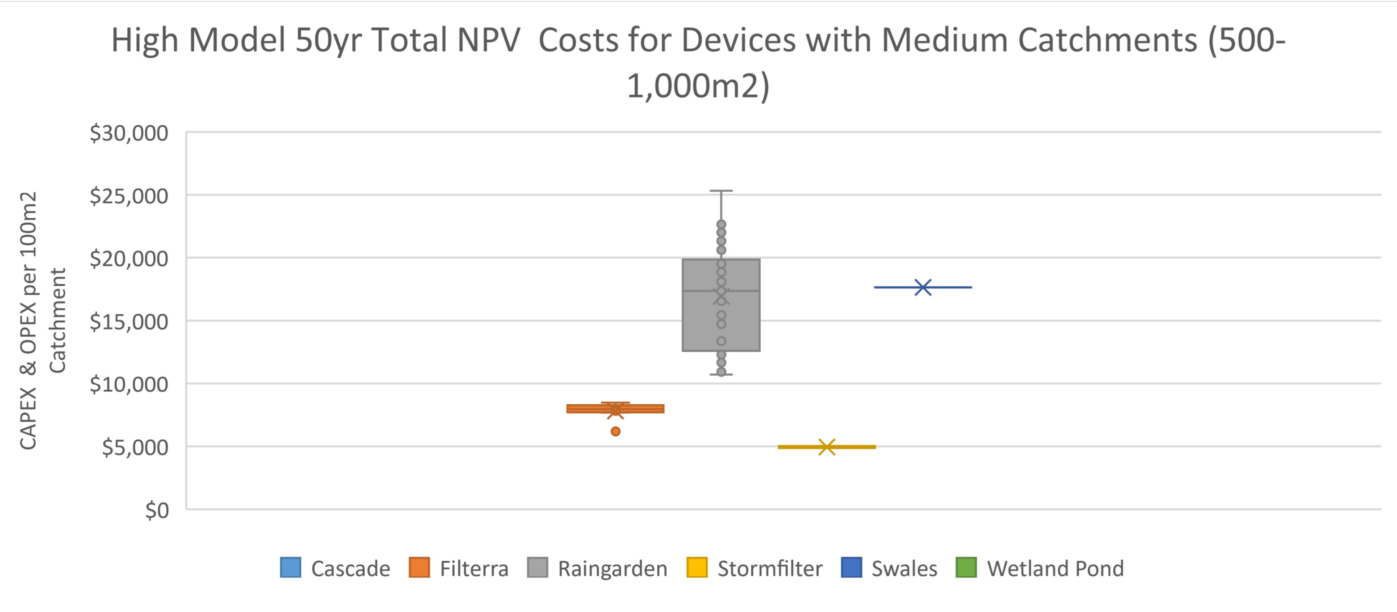


6.2.3. Total Lifecycle Cost – CAPEX AND OPEX - Medium Catchments

The total lifecycle cost of the proprietary devices is still lower even after the higher purchase price is factored in. This also ignores that the proprietary devices are likely to be easier and cheaper to install in most retrofit applications as they have a smaller footprint and more flexibility.

Compared to the smaller catchments, the overall lifecycle costs of these devices is 30-40% lower.





6.3. Large Catchments – 1,000m^2 and larger

In these larger catchments, the Raingardens, Stormfilters and Swales still make up a large number of the devices but there is also Wetland Pond and a Cascade Separator. The Cascade Separator does not treat stormwater to GD01 levels and is not a direct comparison to the other devices as it targets Gross Pollutants and larger sediment particles, however it can be useful in a catchment wide approach as a best practical option in tricky install situations where other devices will not fit.

The wetland is substantially different to the other devices in the study as it treats a much larger area of 42ha, which is larger than the combined catchments of all the other devices. This wetland also serves a flooding and attenuation purpose. It is estimated that the treatment portion of the wetland has capacity to treat approximately 10ha of the upstream catchment to GD01 levels, therefore this area was included for calculating the Wetland rates.

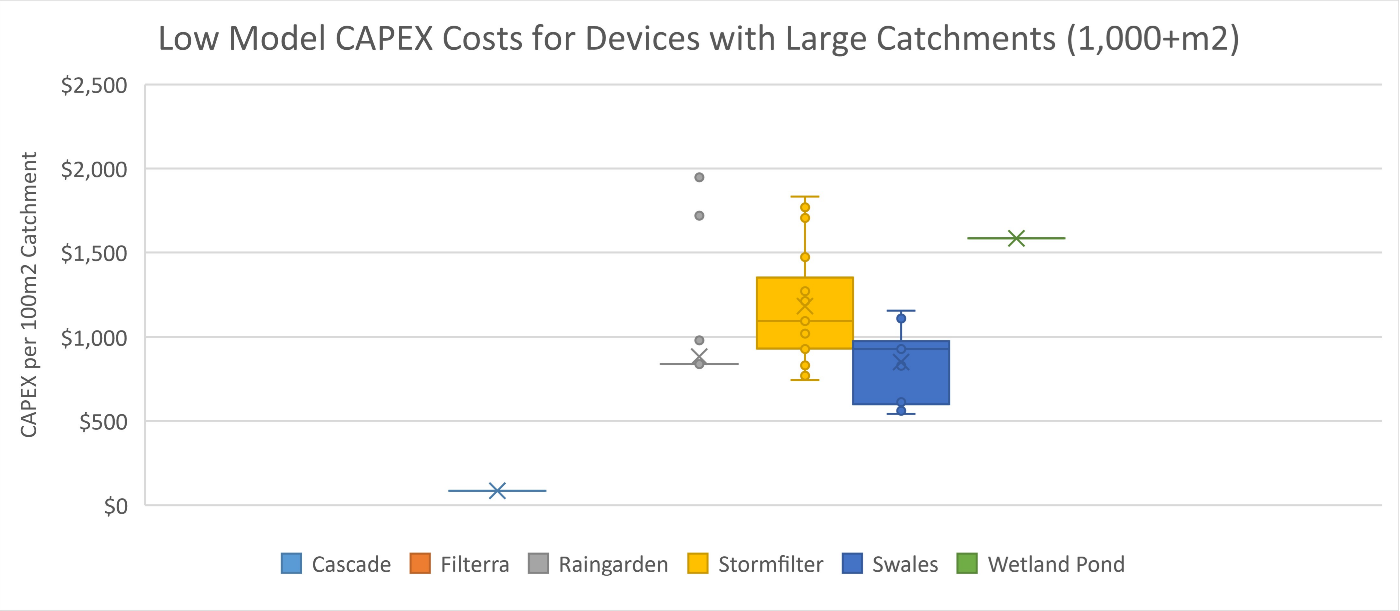
The number of each devices in this sized catchment is:

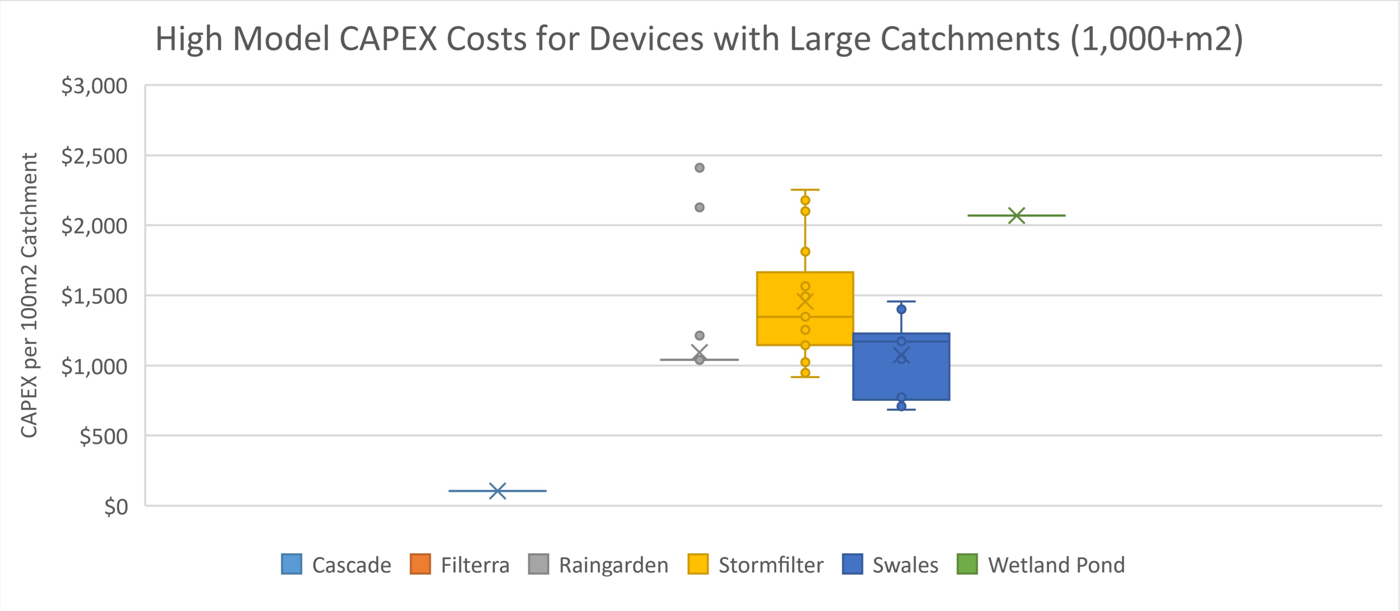
Device	Number
Raingarden	49
Swale	10
Stormfilter	18
Wetland	1
Cascade Separator	1

6.3.1. CAPEX Costs - Large Catchment

Once the catchments get larger, the devices initial costs look to become similar. This is likely down to economies of scale on the larger devices. The Cascade filter is an outlier but it does not provide the same level of treatment as the others, so should not be directly compared. As Stormfilters get larger, they need larger diameter manholes and external diversions that may increase their transport and installation cost, bring them in line with other devices. The single wetland in the study is one of the more expensive devices.

In comparing these costs to the smaller and medium catchments the overall costs are about 70% and 40% lower respectively per 100 m^2 of treated catchment.

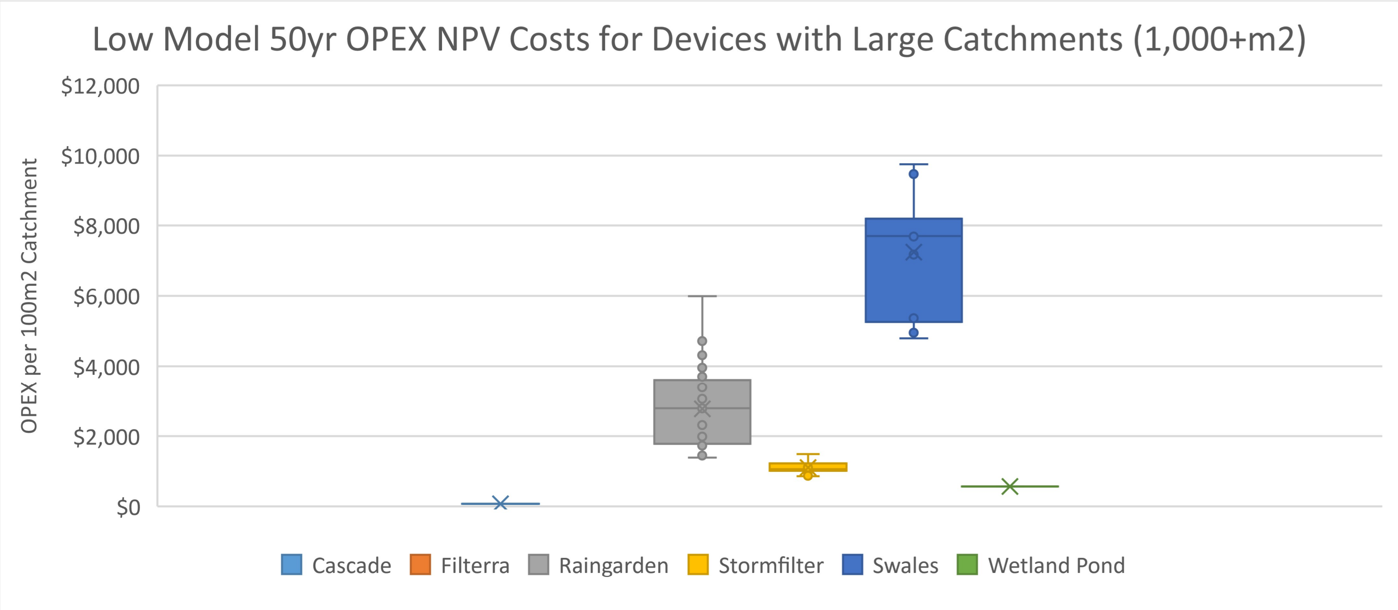


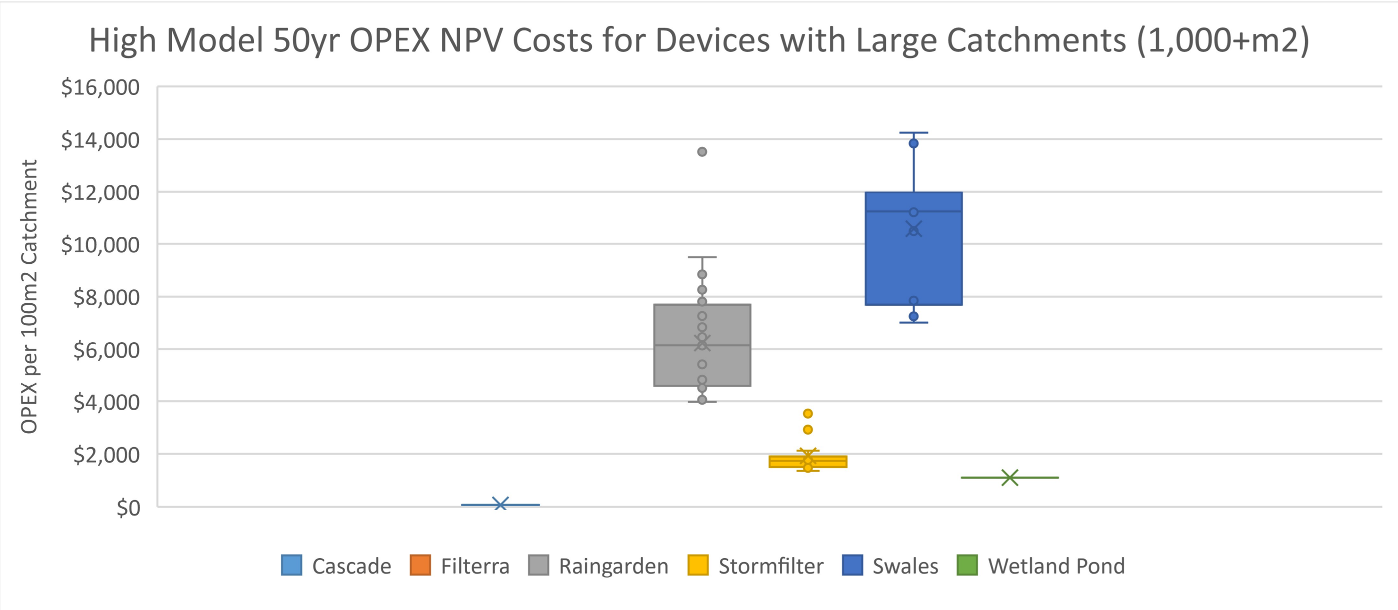


6.3.2. Total Lifecycle OPEX - Large Catchment

Following the common trend of the smaller catchments, the proprietary devices have a lower operating cost than the raingardens and swales. For these size catchments, the swales have a higher cost compared to the other devices. This could be due to their larger size and length, making them time consuming to maintain and driving up the costs. The large wetland looks very cost effective.

Overall these OPEX costs are significantly lower compared to the same devices in smaller and medium catchments. The large Raingardens OPEX for example are 25% of the cost compared to small catchment raingarden OPEX, and 42% of the medium catchment costs.

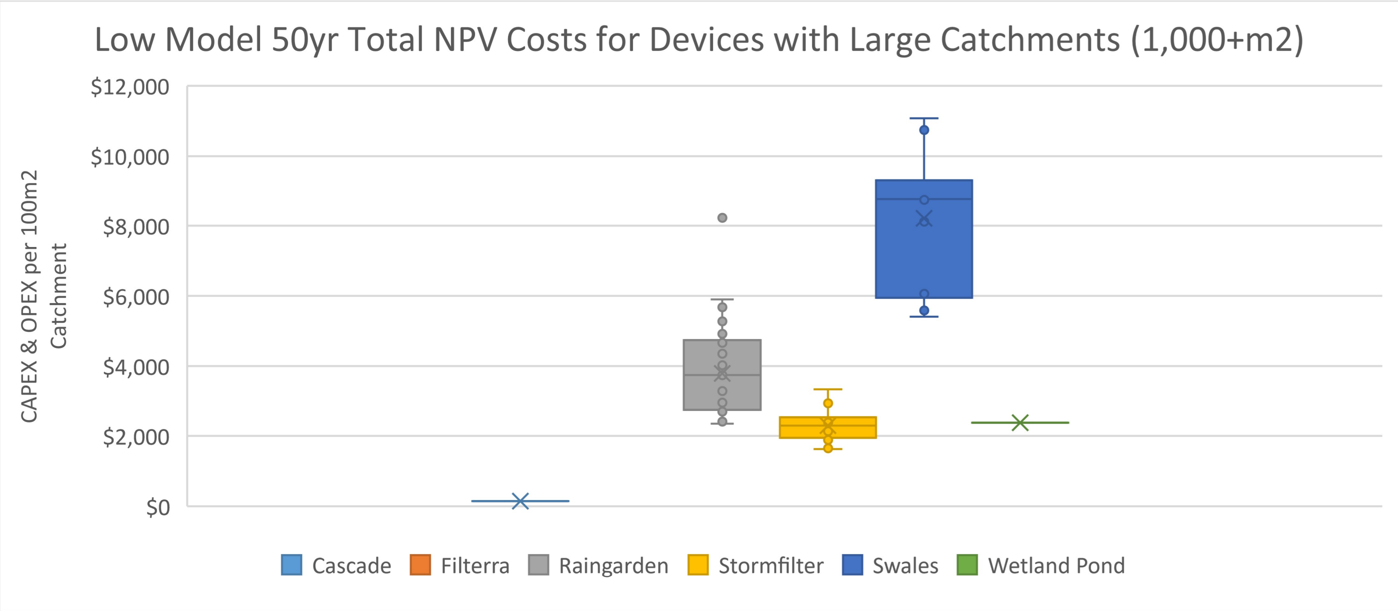


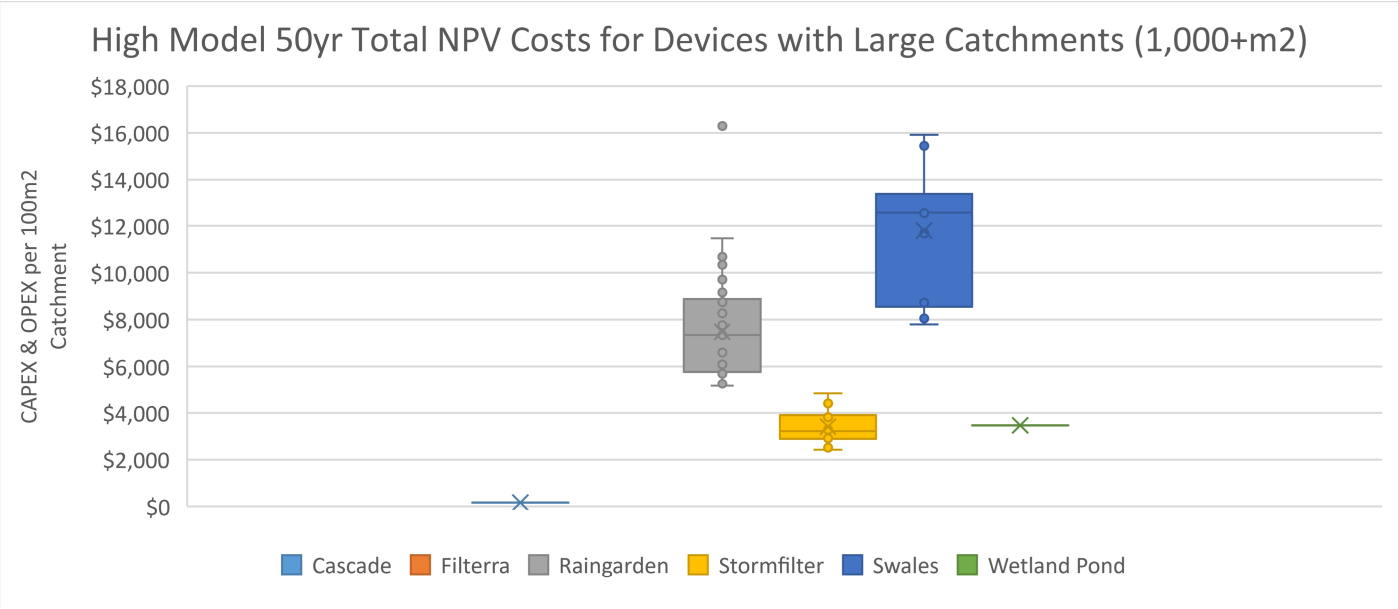


6.3.3. Total Lifecycle Cost – CAPEX AND OPEX - Large Catchment

As expected, with lower overall CAPEX AND OPEX costs for the devices in larger catchments, the overall lifecycle costs of these devices is significantly lower than the same devices in smaller catchments.

Whilst only having one data point to assess, the Wetlands look like a good mitigation option when considering their ability to also provide flooding control for larger catchments as well as their treatment function.





7. Discussion

There are two common themes through the results, being:

- Devices in larger catchments have significantly lower overall costs, especially maintenance costs.
- Proprietary Devices have lower maintenance costs than typical GD01 devices.

These, and other observations are further explored in this section.

7.1. Large Devices are more Cost Effective.

There is an overall reduction in costs as the device catchments increase in size. This is true for both CAPEX and OPEX costs, however the difference seems to be largest in OPEX costs. For example, the average OPEX lifecycle costs per 100m^2 of catchment for raingardens over the different catchments are:

Catchment Size	Low Cost Model	High Cost Model
Small (Less than 500m^2)	$12,853	$22,986
Medium (500m^2-1000m^2)	$7,357	$14,757
Large (More than 1,000m^2)	$2,776	$6,225

Reviewing the cost model, most of the savings in larger devices comes from fixed fee per device maintenance items, so the costs don't significantly increase with the size of each device.

AT has recently introduced a minimum of 20m^2 (approx. 1000m^2 catchment) surface area for raingardens for this purpose. Based on the numbers above, this looks like a sensible cost saving measure however for brownfields developments, this minimum size can be hard to achieve due to the existing topography. For the catchments in this study, 65% for the devices were in the small or medium catchments, suggesting this is the natural size that designers end up working towards in brownfields catchments in residential streets. GD01 does contain guidance on how to perform a Lifecycle Costing on a device, however this section may need updating with some more direct guidance that larger devices are preferred.

The single Wetland performed very well in the Lifecycle costings and is further discussed below.

7.2. Proprietary Devices Maintenance costs.

The costing model suggests the proprietary devices are cheaper to maintain and the possible reasons for this could be:

- Smaller Footprint – In the examples where Filterras are used in similar catchments to raingardens, the Filterras are generally about half the size of the raingarden. This likely results in:
    - Half the Mulch to replace.
    - Half the weeds to remove.
    - Longer periods before the weeds require removal.
    - Half the plants to maintain.
    - Half the time to maintain the device overall.
    - Half the maintenance costs for all these tasks.
- Underground system – As the Stormfilters are entirely underground, they do not require the regular checks

that all the other above ground systems do for:

- Weeds – this appears to be a major driver for regular (possibly monthly) maintenance on above ground systems
- Graffiti – only the lids can be graffitied, so no difference to normal underground infrastructure which is not a significant target.
- Damage – as most devices are in the road reserve, they can get damaged and need repair, but this is not an issue for underground infrastructure.
- Cosmetic issues – only the lids are visible on underground systems, so no maintenance required on these.
- Safety issues – above ground devices can represent a danger to the public and this can sometimes require barriers, which then need maintaining.

- Maintenance Period – the recommended maintenance periods for the proprietary devices are generally much longer than those recommended for raingardens and swales. For the Stormfilter it is generally 18 months that the system needs to be inspected and the cartridges maintained. This is compared to monthly visual inspections for raingardens. There is a cost associated with each of these inspections that mount up over time.

Overall the proprietary devices seem like most cost effective option however historically there has been resistance from local government bodies to accept them due to the future uncertainty of having only a single supplier for proprietary materials that often make these devices more efficient that other options. Public entities usually have procurement rules preventing them using a single supplier in case they become trapped with that technology and are forced to pay a premium to that supplier. With the potential savings being significant for the ratepayers, we recommend Councils procurement teams investigate ways to find multiple suppliers for these devices to reduce the risk associated with single suppliers.

7.3. Cosmetic Maintenance of Raingardens and Swales

With these devices forming part of the streetscape for generally dense housing suburbs, they add to the amenity of the streetscape too. This brings requirement of maintaining these devices for a cosmetic purpose rather than just a functional stormwater treatment perspective. This generally involves removing litter and preventing weed growth however these costs mount up over a 50 year lifespan of a device. There needs to be some recognition that these devices perform more than just stormwater functions and that some of the maintenance funding should come from other parts of Council to reflect the increased amenity these devices provide.

7.4. Large Scale Catchment Devices

One development contained within the study had a single large scale treatment device, being the Wetland Pond in the Roskill South SMP. This device appears to perform very well in the costing model but being a single data point, more data is required to demonstrate statistically significant benefits over other devices. It does follow the trend of larger devices are cheaper and is likely a cost effective option for of stormwater treatment for this catchment. Further investigations on this topic should include more large scale treatment devices to provide more reliable data that may influence further discussions about “at source” vs “end of pipe” treatment options.

8. Recommendations

- Healthy Waters and Auckland Transport need to encourage designers to designing fewer, larger devices rather than lots of smaller devices.

- More proprietary devices should be installed as they have lower maintenance costs.
- Council Procurement Department should look at how to avoid the risk of a single supplier for proprietary devices.
- Further studies should be undertaken to review larger, end of pipe treatment solutions.

9. Conclusion.

This study has reviewed the stormwater treatment devices installed in eight different large scale house developments in Auckland. Over 240 devices were recorded into the asset database, along with device and sizing information. The lifecycle costs for these devices have been modelled for each individual device over a 50 year lifecycle.

The results show there are some trends in the data that suggest Council should be favouring larger devices and accepting more proprietary devices. The larger devices have substantially lower maintenance costs, as much as 75% lower over the lifetime of the device. The proprietary devices do have a higher initial cost, which is usually met by the developer, but have significantly lower maintenance costs across most of the catchment ranges.