THE ROLE OF PROPRIETARY STORMWATER FILTRATION DEVICES IN NEW ZEALAND

Andrew Tipene – Parsons Brinckerhoff - Engineer

ABSTRACT (200 WORDS MAXIMUM)

The role of stormwater filtration devices in New Zealand is to provide a small footprint, "off the shelf" product with minimal engineering costs. Providing the right device for the job requires good product design, specification and installation. Performance objectives are already fairly well acknowledged but require better pragmatic descriptions and local applications. Stormwater filtration devices meet these performances objectives by providing design flow rates and solids holding capacities for defined catchment areas and land use.

The mechanism of pollutant removal is through inert media or sorptive media filtration. Inert media filters function by physically separating particulate contamination from the stormwater flow. Sorptive media filtration removes stormwater constituents by attachment to filter media at the molecular level. Filter media configurations are made to work as either 'surface' or 'depth' filters. The performance of a filtration device depends significantly on how these processes are employed in the prefabricated device.

The proprietary stormwater filtration industry depends on all levels being responsible for device designs and specifications to ensure they meet performance standards and maintenance expectations. Poorly designed, specified or installed devices that disregard the most basic fundamentals of filtration, could possibly undermine the future of proprietary stormwater filtration use in New Zealand

KEYWORDS

Stormwater, Treatment, Proprietary, Device, At source, In line, BMP.

1 INTRODUCTION

The primary role of proprietary devices in New Zealand stormwater treatment is to provide an “off the shelf” solution to stormwater treatment. The benefits of using a proprietary device are best appreciated in urban areas where conventional treatment solutions are not practical due to site constraints such as space availability or land grade.

The configuration and operation of filters used in each device can give different performances under different conditions. Understanding the principles to which the filters are designed is essential to providing a well specified and installed solution.

Before a device can be used in New Zealand, it must obtain approval by local regulatory authorities. Having this work completed upfront allows a device to be easily specified, approved, installed and maintained and in doing so minimises the work required in these areas.

The approval process in New Zealand is still being developed and refined, although overseas regulatory authorities have already established good systems for accreditation, creating a “level playing field” can be a lengthy and contentious process.

2 HOW PROPRIETARY FILTRATION DEVICES WORK

Proprietary devices are characterised by prefabricated structures containing one (or more) systems for filtration. Additional treatment processes such as; screening, settling or absorption/adsorption, may also be incorporated.

Filtration has long been a dependable method for removing contaminates from fluids. For stormwater treatment, filtration provides the best treatment available in the proprietary device market. Although similar filtration mechanisms are employed in raingardens, infiltration basins and even in wetlands, the process is not as easily replicated or predictable across multiple installations as in proprietary devices.

2.1 FILTRATION MECHANISMS

Filtration works by trapping particulate material within the dead ends and pore matrix of the filter media. There are three main physical filtration mechanisms that occur within the media; direct interception, inertial impaction and diffusion. The effectiveness of theses mechanisms is directly related to the velocity of the water passing across the filter media. As the water velocity increases across the media surface, the probability of the filtration mechanisms occurring decreases. At the same the probability of a previously retained particle being released back into the effluent flow increases. It takes very little deduction to appreciate that at higher flows, and with smaller filtration areas, the water velocity across the media surface increases and the filter loses performance.

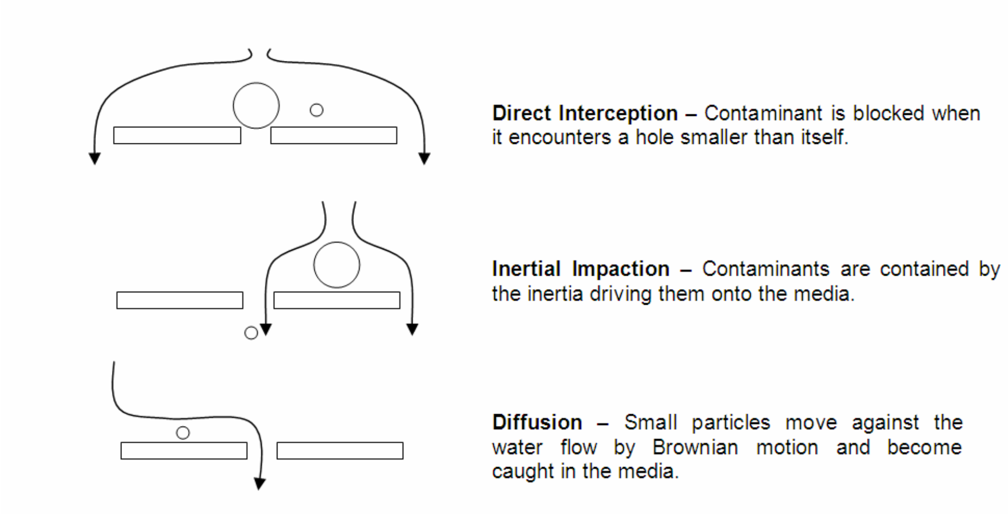

Figure 1: Main types of inert filtration mechanisms

2.2 FILTER MEDIA CONFIGURATION

Filtration performance is also largely dependant on the media used and the way the media is arranged as a filter. There are numerous types of media available for filtration; traditionally sand has been used as this has been conventional practice in the potable water industry. In stormwater treatment, sand is still used, but medias that provide larger surface areas and have less specific gravity are preferred. The larger surface area provides increased points for particle retention and the lighter weights means cheaper disposal costs.

The two main media arrangements are as a surface filter or depth filter. Surface filters work by building a layer of accumulated contaminants on the media surface known as the filter cake. Further contaminant removal then occurs within and above the filter cake. When the filter becomes blocked the filter cake can be removed and the throughput capacity of the filter partially restored. In comparison Depth filters remove contaminants throughout the entire media bed and do not rely on building a filter cake. In depth filtration, the media is completely contaminated and must be replaced once the solids holding capacity is reached. By using the entire media for filtration, the effective surface area is increased and the particulate retention capacity is also increased.

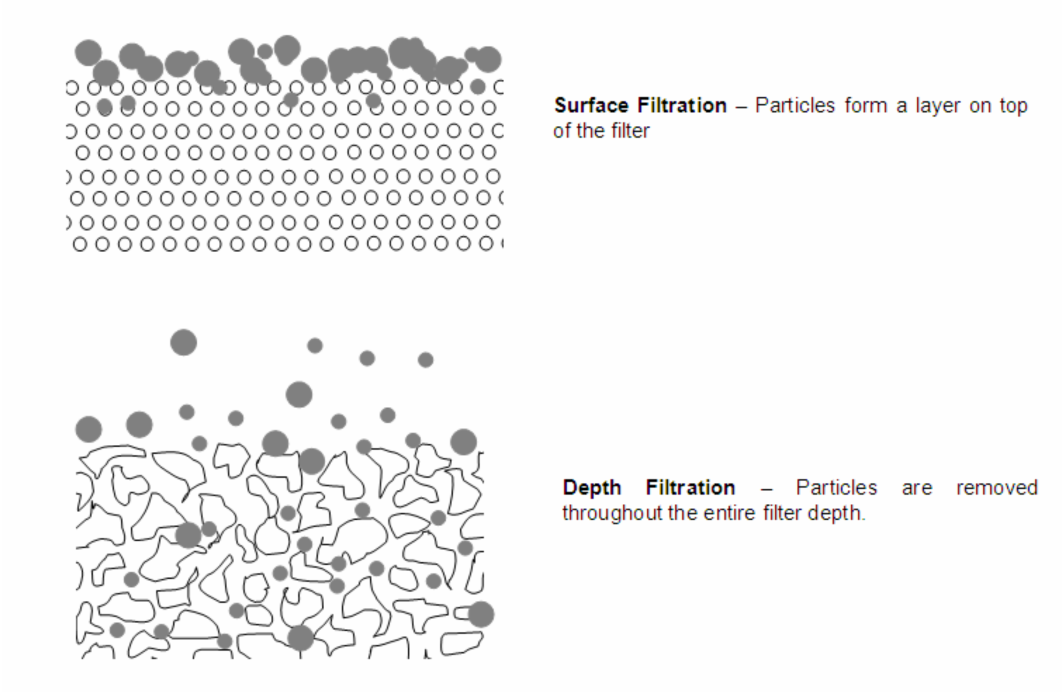

Figure 2: Filter media arrangement

2.3 SORPTIVE MEDIA FILTRATION

In addition to physical filtration some products on the market also use sorptive media to remove contamination through adsorption and ion exchange processes. The media currently approved and available in New Zealand is so far limited to activated carbon and zeolite which target hydrocarbons and heavy metals respectively. Other media is used elsewhere in the world and it is only a matter of time before they are used in New Zealand.

2.4 DEVICES AVAILABLE IN NEW ZEALAND

The most common proprietary filtration devices available in New Zealand are the StormFilter, UpFlo, and Filternator. To this list the conventional SandFilter could also be added as a proprietary device. In some unregulated parts of the country, other devices can also be found.

3 HOW DEVICES ARE SIZED AND SPECIFIED

The correct sizing and application of a proprietary filtration device requires consideration of the following factors:

3.1 HYDROLOGY

Reliable hydrological information is required to calculate the runoff volumes and peak flow rates for sizing an appropriate proprietary device. The selected device must be capable of treating the runoff volume and the peak flow without re-suspending or releasing settled or filtered contaminants. Suppliers are able to provide flowrate capacities for different models or configurations of their devices. Considerations to either internally or externally bypass storm events larger than the design storm also need to be made. The figure below shows a typical hydrograph in blue. The peak of the hydrograph is buffered by detention volume within the device so that the peak treatment flowrate is minimised and the performance of the filtration is maintained.

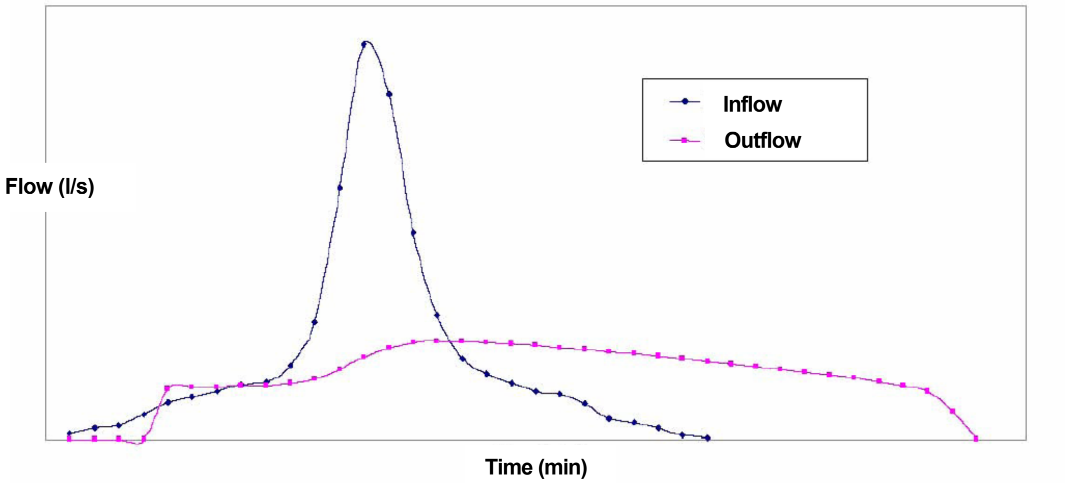

Figure 3: Filtration inflow/outflow hydrograph

3.2 POLLUTANT LOADS

Pollutant loads affect not only what type of device should be used but also how it will perform. All filtration devices have varying particle size removal efficiencies and solids loading capacities so these variables in the stormwater influent must be considered. High loadings of large particles or gross pollutants may require pre-treatment using screens or extended settling bays. High concentrations of fine particulate matter may require a reduction in the treatment flowrate by increasing the size or number of the filters.

Estimates of particle size distributions and solids loading may be available through local authorities or even suppliers. A typical stormwater particle size distribution is shown below to which most devices performances are evaluated. If this is found in the field, the end user or council can be assured the device will work effectively.

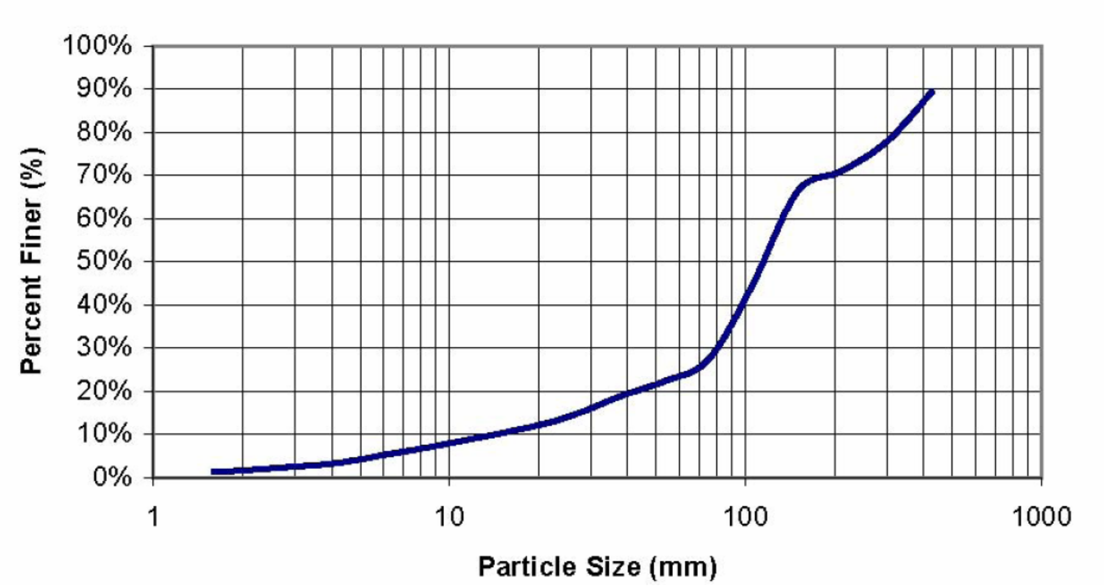

Figure 4: Typical Stormwater sediment particle distribution

3.3 TREATMENT GOALS

Regulatory authorities are responsible for setting treatment goals and in New Zealand the Auckland regional council has set precedence. Historically this has been to remove 75% TSS. Two problems exist with this requirement. Firstly TSS is a poor representation of stormwater quality as its measurement and quantification was taken from wastewater quality which is inherently different to the properties of stormwater. Secondly, a % reduction requirement is ambiguous to the influent concentrations and receiving water treatment requirements.

There is continual debate about what the best methods for setting goals and monitoring are. Ideally a particle size distribution and associated removal efficiencies need to be set. Further adjustments could also be made for sensitive receiving environments. This treatment and monitoring requirement has been difficult in the potatable water industry, and it is not expected it will be viable in stormwater due to the complications of measurement. It could however be used to establish baselines and benchmarks to which other similar installations can be compared.

3.4 SITE CONSTRAINTS

Proprietary treatment devices are closed systems so prefabrications can be installed below ground level. In most cases the land use or aesthetic value of the site can then be preserved. Reinforcing can be used in the prefabrications for heavy traffic loading so devices can also be installed in irregular places such as under roads, or suspended from bridges and viaducts.

In urban areas, proprietary devices are regularly installed in car parks. In Auckland a device treating an area of 25 car parks and providing just one extra car park by being below ground has a pay back period of around 3 years. On a larger scale a proprietary device capable of replacing land required for a pond or swale in a new development, can potentially provide an additional section. This has obvious benefits for a land owner or developer depending on the land cost.

3.5 TREATMENT SELECTION

As mentioned previously, different filter systems have different particle size removal efficiencies and solids loading capacities. When treating common low intensity impervious areas <1000m^2 there may be little performance difference notable between different devices. However when treating areas >1000m^2 with high solids loading and pollutants other than sediment, performance and suitability can vary drastically.

Good treatment devices that perform well under different conditions will provide the following as either standard or optional:

- Modular and customisable designs to accommodate large sites in one easy to access system.
- Floatable and Neutral buoyant material separation or screening to prevent gross pollutants from blinding the filter surface and causing premature filter fouling.
- High flow bypasses to avoid re-suspension of contaminants
- Hydrocarbon and Heavy Metal removal media for heavy trafficked sites.

3.6 INSTALLATION

Designs need to consider the upstream and downstream Network. Ideally a device will be installed at a common point in the network to reduce the number of installations required.

External bypassing may be required depending on the pipe and overland bypass designs. The internal bypass weir height should always be used for the upstream hydraulic gradeline. A common mistake is to incorrectly take the inlet pipe as the hydraulic high point regardless of the fact that it is installed below the overflow weir height. As with all filtration devices a driving head is required to force water through the filter, so water will always builds up height above the filter. When the filter becomes blocked or a storm event greater than the design storm of the filter occurs, water always builds up to the overflow weir height.

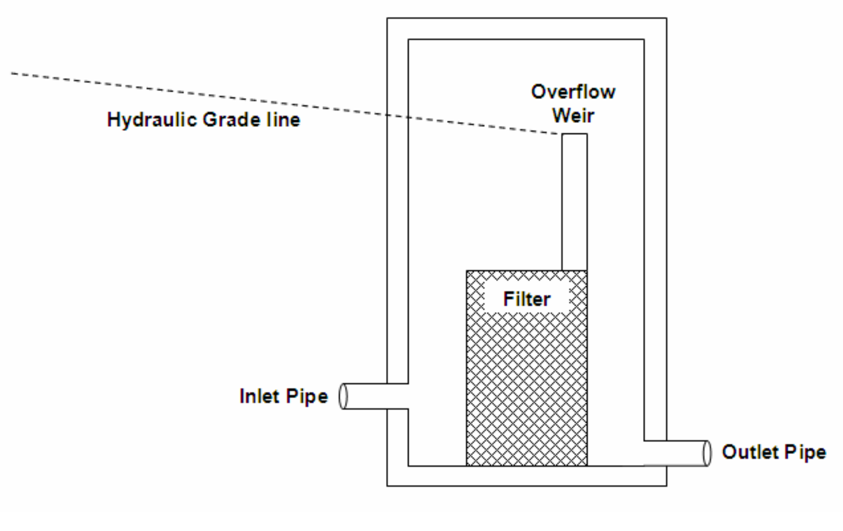

Figure 5: overflow heights and the hydraulic gradeline

When used in conjunction with detention, proprietary devices can be installed either upstream or downstream. When installed upstream the filter will reduce the volume of solids entering the detention device and reduce the frequency (and cost) of detention maintenance. When installed downstream the detention will buffer peak flows so smaller filtration devices can be used. The detention tank however will only remove a small percentage of sediment so the solids loading will still be an important factor in the sizing of the filter. Some suppliers can also incorporate detention volume in their filter prefabrications.

Most good contractors are familiar with installing proprietary devices so installation is generally straight forward. The standard practice is to dig and shore up a suitable excavation, lift the device into place, connect inlet and outlet pipes then pack and rise access and inspection holes to ground level. Due to the simple installation requirements of proprietary devices they are regularly used in retrofit or with design variation situations, where the cost of retrofitting a traditional stormwater treatment system is not feasible.

3.7 MAINTENANCE

Maintenance plays an important factor in the role of proprietary devices in New Zealand. Because proprietary devices are analogous in basic operation, maintenance procedures are standardised. This can be a major benefit to those responsible for device maintenance in that internal maintenance schedules and procedures for different installations are not required. In addition to this maintenance can also be provided or at least administered by the supplier and in doing so this again reduces the inconvenience to those responsible for maintenance.

The normal procedure for proprietary device maintenance is to simply remove the pollutants captured in the filter with a suction truck and then replace the filters and/or media.

The frequency of maintenance depends on the solids loading of the catchment and the solids retention capacity of the device. Larger filters with greater solids holding capacities last longer. This is where careful selection and sizing of the appropriate device is required. It may be very easy to select a small device that meets performance requirements on paper, but it may end up requiring maintenance every other month which will significantly offset any capital cost savings.

3.8 MONITORING OF DEVICES

Without educated monitoring of devices in the field, it is easy for inappropriately designed, sized or installed devices to become accepted by the industry. This is especially true where regulatory controls of devices are not in place or where an installation circumvents the consent at the installation stage. It may not be viable to obtain representative water samples (this is both extremely difficult and expensive) but simple visual inspections can tell a lot about the performance of the device.

A current practice which could at least give some idea of a devices performance is to monitor the overflow occurrence by either inspection during a measured storm event or by using a static head test similar to that used in soakage hole testing.

4 COMMERCIAL ENVIRONMENT

4.1 COSTS

There are varying perceptions regarding the costs of proprietary stormwater devices in New Zealand. The fact is that prices are dropping due to recently increasing competition and reduced technology costs due to global economics. In light of this proprietary devices have always been marketed competitively against conventional stormwater treatment solutions.

4.2 MANUFACTURER AND SUPPLIER

Performance claims are often made based on theoretical or laboratory test data and at best a claim may be backed up by field trial data or third party reports. The actual performance under local conditions can be very different from these theoretical claims. For this reason it is important for councils and suppliers to work together to achieve sensible local interpretations of these claims.

4.3 CONTRACTORS

Contractors are in a competitive market where more often than not the cheapest price wins the job. If they are able to supply an equivalent product for a lower price they will likely put this in their tender as a variation. The problem is that no two devices are alike and in a lot of cases special design alterations are made after considerable work at the design phase. By allowing the swap out of one accredited device for another the industry undermines a lot of its work already achieved in accreditation and resource consenting and the market becomes cost driven. In this environment good design and specification practice is near worthless.

5 CONCLUSIONS

Proprietary stormwater treatment devices provide a simple cost effective solution in urban areas or where conventional systems are not practical. Their performance reproducibility relies on a good understanding the devices basic filtration design. Once this can be reliably transposed onto other applications the benefits of minimising the engineering requirement are seen.

Underlying the integrity of a devices performance is a level accreditation and monitoring system from regulatory authorities. To date this is still a work in progress in most areas.

Manufactures and suppliers have an obligation to protect their industry by providing honest and verified claims about there products. There assistance with the design and installation of devices is vital to achieving good practice and performance in the field.

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7 PRESENTER PROFILE

Andrew Tipene is a B.Tech. Environmental Engineering graduate who has spent ten years specifying engineering products to the industrial, commercial and regulatory sectors in New Zealand. His technical involvement has been with Water, Wastewater, and Stormwater Treatment, Process Control and Optimisation, and Facilities Energy Management.