DELIVERING VALUE FOR MONEY WATER QUALITY IMPROVEMENT – EVALUATING THE RETROFIT OF PROPRIETARY TREATMENT DEVICES

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ABSTRACT (500 WORDS MAXIMUM)

Long term environmental monitoring and reporting has indicated that water quality in Omaru Creek, a small heavily urbanised stream system draining to Tāmaki Estuary, Auckland, is impaired. The high level of impervious surfaces and historic infrastructure development practices in the catchment has led to changes to the natural flow regime and increased pollution sourced from stormwater runoff. These contaminants are derived from land use types that are typically regarded as being high contaminant load generating activities. Large-scale regeneration that has already begun across the catchment – driven by over 11,000 new residential homes - offers a once in a life time opportunity to deliver substantial stormwater related benefits to the local community by upgrading the existing stormwater network. Those benefits aim to enhance the existing environment by not only mitigating for the intensification in development, but also by addressing existing stormwater problems. Benefits include improving water quality by upgrading existing infrastructure and incorporating modern water treatment technology into the existing stormwater network.

The main town centre of Glen Innes has been identified as an area of particular concern within the catchment. It is an area that contains a high level of imperviousness, has high vehicle traffic use and supports commercial and light industry business types. The combination of these conditions is generally indicative of an area with high contaminant load generating potential. Available land in the Glen Innes town centre is a significant constraint to infrastructure renewals and retrofitting treatment 'at source', or large space-hungry communal water quality improvement options. 'At source' retention/detention areas, bioretention devices and in-pipe storage tanks or filtration devices have limited potential within the town centre. Devices that require minimal space requirements including start of pipe inlet screens and catchpit inserts, in pipe vortex separators or screens and end of pipe trash racks, baskets or netting devices would be more suited.

This paper focuses on the evaluation and assessment of retrofitting options for a range of different water quality improvement devices within the Glen Innes Town Centre aimed at improving water quality in Omaru Creek. The target contaminant types for this work included the removal of gross pollutants and coarse sediments to complement already existing communal treatment devices located lower down the catchment aimed at treating nutrients, metals and other finer contaminant loadings. The paper outlines the development of an approach to proactively determine the contributing drainage subcatchments, calculate the contaminant loading from each subcatchment, and estimate removal rates for a range of retrofit options to the existing stormwater network informed by literature review.

This paper also outlines the development of a methodology to objectively assess and evaluate the suitability of a range of water quality treatment device types as retrofit opportunities at a subcatchment level, potentially relevant to national discussions on proprietary device evaluation. In collaboration with suppliers, a series of different proprietary devices have been evaluated based on their relative pros and cons and treatment performance. Preferred options were recommended based on a cost benefit assessment for the selected devices.

KEYWORDS

Water quality, Contaminants loading, Sediment transportation, Gros pollutant trap (GPT), Hydraulic analysis, Omaru Creek, Treatment, Proprietary device, Evaluation

PRESENTER PROFILE

Jackie has over 10 years of experience in water resources and stormwater management both in consultancy and local authority. Jackie is a Chartered Professional Engineer (CPEng) and has extensive experience in hydraulic analysis, water quality management, data manipulation and assessment, model development, issue identification, optioneering and conceptual design, as well as project management.

1 INTRODUCTION

Tāmaki is a priority growth area in Auckland region. The Tāmaki Regeneration Company (TRC), is delivering this growth by progressively intensifying development and regenerating the land occupied by the 2,800 state houses currently present in the area. TRC is overseeing the intensification to create a community of over 11,000 homes in the Omaru Catchment. The Tāmaki Regeneration Area sits within the Tāmaki North stormwater catchment, which includes Omaru Creek. Environmental monitoring and reporting for the freshwater resources in the Maungakiekie-Tāmaki's rivers (Omaru Creek and Ann's Creek) indicates that the aquatic health of Omaru Creek is impaired. Urban development has led to a high level of impervious surface in the area, which prevents rainfall from soaking into the ground. With development having taken place in the 1950's to 1980's, very little to no stormwater quality treatment from these impervious surfaces was incorporated into the network. This has follow-on effects for streams in the area leading to high water temperatures, changes to the natural flow patterns and increased concentrations of urban contaminants entrained in stormwater.

Improving the existing stormwater network within the catchment is a necessary action to facilitate the overall growth strategy and support the establishment of a healthy and desirable local community. Auckland Council Healthy Waters Department has prepared a Stormwater Management Plan (SMP) for the region to manage stormwater upgrades and maximise network improvements in a coordinated and cost-effective manner. As part of the SMP development, a variety of options have been considered to upgrade existing stormwater infrastructure to achieve improved water quality treatment from stormwater runoff using a holistic treatment train approach. Water quality treatment options range from construction of large communal stormwater treatment wetlands at strategic locations through the catchment where sufficient space is available for implementation, to the strategic placement of smaller start-of-pipe, in-pipe and end-of-pipe treatment devices to increase the volume of urban contaminant capture. These device types can include Gross Pollutant Traps (GPTs) and other water quality proprietary devices suitable for implementation in more constrained areas of the network, or where particular contaminants of concern have been identified and can be specifically targeted.

The main town centre of Glen Innes (refer Figure 1) has been identified as an area of particular concern within the Tāmaki Regeneration Area. It is an area that contains a high level of imperviousness, has high vehicle traffic use and supports commercial and light industry business types. The combination of conditions described above are generally indicative of high contaminant loading. With land availability and competing uses within Glen Innes town centre itself being a significant constraint to infrastructure renewals, options that require large amounts of space such as start-of-pipe retention/detention devices, or infiltration/bioretention devices, will be less suitable within the town centre. Devices that require minimal space requirements including start-of-pipe inlet screens and catchpit inserts, in-pipe or end-of-pipe vortex separators, screens, trash racks, baskets or netting devices would be more suited.

This paper summarises the approach applied to the Glen Innes Town Centre area used to assess options for retrofitting improved water quality treatment into the existing Glen Innes Town Centre stormwater network to support requirements outlined in the SMP. The target contaminants considered in this paper are gross pollutants, sediment and floatables which are readily removed by devices suitable for retrofitting into existing space constrained networks. Other contaminants including heavy metals, nutrients and finer sediments are anticipated to be treated by communal wetland devices located further downstream in the network as part of the overall catchment treatment train approach.

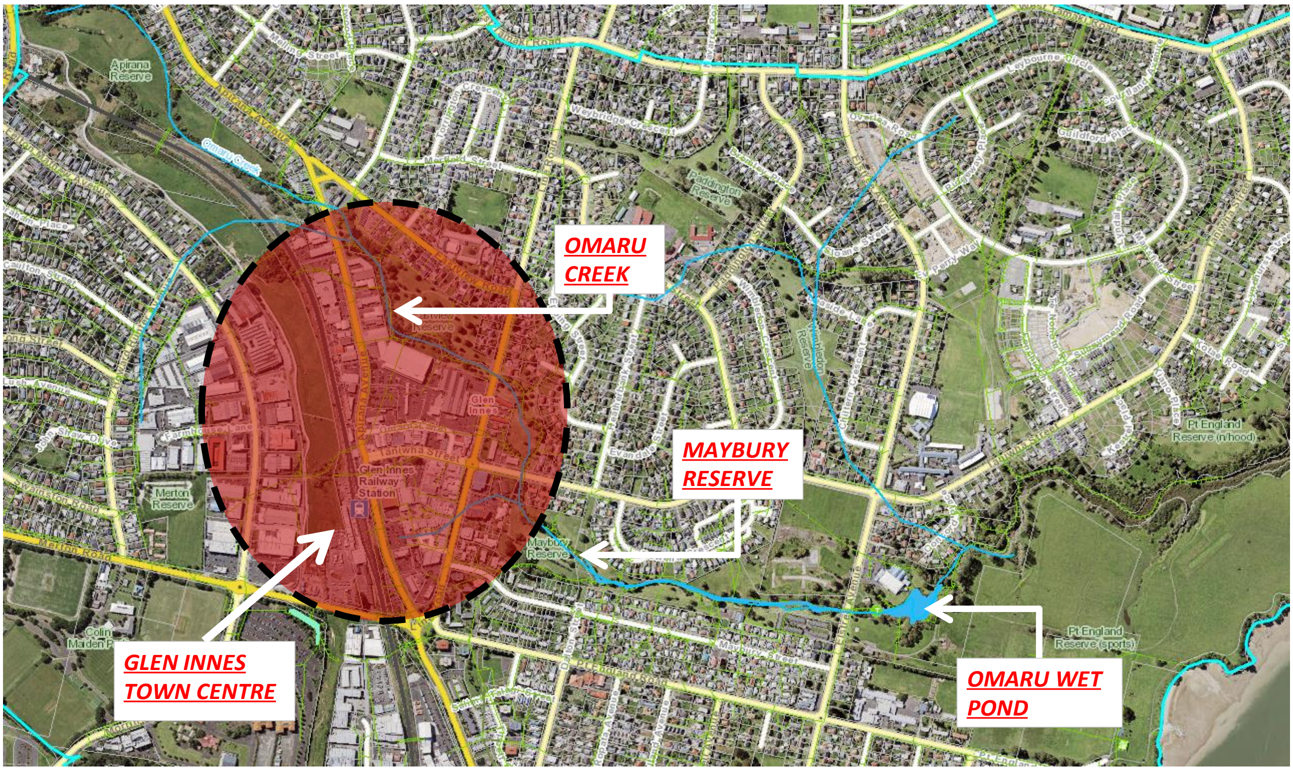

Figure 1: Study area - Glen Innes Town Centre

2 HYDROLOGICAL PARAMETERS AND CONTAMINANT LOADING

A detailed review of the existing stormwater network within the Glen Innes Town Centre, including a review of private drainage plans, indicates that the area is serviced by a series of discrete piped networks which all discharge to Omaru Creek within public reserve areas independently of each other. The town centre was divided into six discrete areas based on these discrete networks, with each area requiring separate controls to manage contaminants (refer Figure 2).

Figure 2: Sub-Catchments based on main stormwater outlets (shown as white dots)

2.1 HYDROLOGICAL ASSESSMENT

Retrofitting of devices into existing piped networks requires careful analysis at the small sub-catchment level to both size devices correctly and ensure the addition of new devices will not adversely affect network conveyance and flood risk. Hydrological assessment of each sub-catchment area was therefore calculated based on the following methodologies and assumptions:

- Catchment area: DEM 2013 and review of private drainage plans
- Impervious area: 90%

- Water Quality Volume: calculated using Technical Publication 108 (1999) methodology
- Water Quality Flow: calculated using Rational Method assuming a constant rainfall intensity of 10 mm/hr (refer comments below)
- Peak Design Flows: calculated using TP108 methodology

Technical Report 2013/035 (2013) notes that use of TP108 methodology is intended for large catchments and that inherent assumptions lead to conservative peak flows when used for smaller catchments. Instead, TR2013/035, recommends that the Rational Method, using a constant rainfall intensity of 10 mm/hr, is more appropriate for sizing smaller catchment areas and their associated smaller stormwater treatment device types. Water Quality Flows (WQF) were therefore calculated using Rational Method in accordance with the TR 2013/035 recommendation. The maximum peak flow rates at each outlet were calculated using TP108 graphical method for the storm events of 2, 5 and 10-year ARI under maximum probability development (MPD) with climate change (CC) and under existing development (ED) (Table 1).

Table 1: Glen Innes Town Centre Hydrological Information

Sub-Catchment	Area (ha)	Pipe Dia. (mm)	Water Quality Flow (L/s)	Peak Flow Rate (L/s)					
				ED			MPD		
				2yr ARI	5yr ARI	10yr ARI	2yr ARI	5yr ARI	10yr ARI
1	2.4	525	56	273	390	469	300	435	532
2	3.6	450	84	408	582	701	448	650	796
3a	1.9	450	44	212	302	364	233	338	413
3b	0.078	150	2	9	13	15	10	14	17
3c	0.25	225	6	29	41	49	31	46	56
3d	0.49	450	11	55	78	94	60	88	107
4a	1.2	450	28	134	191	230	147	213	261
4b1	1.7	900	40	193	275	331	212	307	376
4b2	6.0	300, 375, 375	139	602	867	1049	664	971	1195
4b total	7.7	n/a	179	794	1140	1376	874	1275	1566
Line Road	0.39	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4c	0.2	225	4	18	26	32	20	29	36
5	2.0	375	46	221	315	380	243	352	431
6a	1.6	2x1200	38	185	264	317	203	294	360
6b	0.53	225	12	59	85	102	65	94	116
6c	0.21	225	5	24	34	41	26	38	46

2.2 CONTAMINANT LOADING

2.2.1 STORMWATER POLLUTANTS

Stormwater quality treatment requirements can vary significantly depending on the land use of the contributing catchment, connectivity of the stormwater network and hydrology. In general, contaminants entrained in stormwater draining urban catchments consist of the following types:

- Gross pollutants: Trash, litter and vegetation larger than 5mm;
- Coarse sediments: Contaminant particles between 500μm and 5mm;
- Total Suspended Solids (TSS) smaller than 500μm;
- Floatables: Grease, oil and other floating debris;
- Attached pollutants: Contaminants attached to sediments including nutrients, heavy metals and toxicants;
- Dissolved contaminants: nutrients, heavy metals and other anthropogenic toxicants.

An assessment of long term state of the environment monitoring of Omaru Creek (Auckland Council 2018), additional more detailed monitoring of the creek by Healthy Waters (unpublished data), and long-term operation and maintenance requirements of the existing network was used to guide contaminant treatment retrofitting requirements. Gross pollutants, sediments, and floatables were considered to be the most readily removed contaminants by retrofitting small treatment devices into existing networks. In addition, it was considered that attached and dissolved pollutants will be treated by existing and future larger communal water quality treatment devices including stormwater treatment wetlands in Taniwha and Pt England Reserves, located downstream from the town centre.

2.2.2 PARTICLE SIZE DISTRIBUTION

The contaminant removal rates of devices including catchpit inserts and hydrodynamic separators are typically determined independently for each device type using a combination of laboratory test regimes and trial field tests. The laboratory tests typically use a synthetic sediment particle size distribution. Whereas field tested devices use real stormwater sediment particle size distribution (PSD).

When considering treatment benefits of these devices, it is important to understand the PSD for sediments typically conveyed by stormwater flows within the target treatment area. An indication of representative particle size distribution data for New Zealand road surfaces is summarised in Table 2 (Kingett Mitchell 2003). These values are consistent with those found in a review of road surface PSDs from various international studies undertaken by Kim & Sansalone (2008).

Table 2: Typical NZ road surface particle PSD (Kingett Mitchell 2003)

PSD	<100 μm	100 μm - 500 μm	500 μm – 5 mm
Percent finer (by mass)	10%	60%	100%

The mobility and transport of particles through the stormwater network also requires consideration. Contaminant mobility is related to various factors including the type of contaminant, local weather conditions, catchment topography, surface type, connectivity to receiving network, etc. Although significant literature exists on the topic of the PSD of stormwater borne sediment, at the time of writing, none had been found that directly relates the proportion of generated sediments to sediment transported in "raw" stormwater runoff. Therefore, the values shown in Table 3 have been generated for the purposes of the paperbased on the PSD of stormwater borne sediments found across available literature. (Kingett Mitchell 2003) to account for differences in PSD mobility and transport.

Table 3: Proportion of catchment generated sediment transported in stormwater runoff

Particle Size	<100 µm	100 µm - 500 µm	500 µm – 5 mm
Road (2000-5000 VPD)	100%	60%	10%

It is worth noting that a significant proportion of available literature shows that the PSD of suspended sediments in stormwater is generally shown to be less than 100 µm. This is typically attributed to the fact that a common method of sampling stormwater is within the water column itself and within the piped network or at outlets where some form of pretreatment may already have occurred. The coarse sediment component of the PSD can either settle out of suspension in sumps and catchpits or are transported as bedload within the network. They may therefore not be as readily captured and accounted for using current water quality sampling methods. A study undertaken by Kim & Sansalone (2008) clearly demonstrates this by utilising two methods of sampling stormwater borne sediments, sieve analysis of coarse sediments and laser diffraction analysis of suspended sediments. This study showed that across a number of rainfall events, particles >1000µm accounted for up to 35% of the total mass load of particulate matter.

Catchpit grates and sumps are typically the main start-of-pipe entry point for stormwater inflows to the network. NIWA has previously undertaken a literature review on behalf of Auckland Council[i]to assess the role of catchpits in sediment capture from stormwater runoff (TR2013/017, 2013). Their review indicated that well designed and maintained catchpits typically retain around 35-40% of the total annual sediment load in stormwater and that most of the sediment retained was within the 250-2000µm size range, while only around 10-20% of particles <100µm were retained. Their review also noted that laboratory testing showed that catchpit insert devices were able to remove almost all particles >100µm, further improving start-of pipe water quality treatment capacity.

Data from the reviews outlined above were then incorporated into the Glen Innes investigation to refine contaminant load estimates from the different land uses in the town centre. Contaminant loading rates used in this study are summarized in Table 4.

Table 4: Typical contaminant loading rates

Land Use	Pollutant	Loading Rate	Comments
General Urban (TR2011/006)	Gross pollutant	90 kg/ha/yr 0.4 m^3/ha/yr	Wet density = 250 kg/m^3 Wet to dry mass ratio 3.3:1
Commercial (TP10)	Total Suspended Sediment	242-1369 kg/ha/yr 0.1-0.5 m^3/ha/yr	1000 kg/ha/yr assumed for the purposes of this report Assumed particle density of 2680 kg/m^3
Road (5000-20000 VPD) (TP10)	Total Suspended Sediment	530 kg/ha/yr 0.2 m^3/ha/yr	Assumed particle density of 2680 kg/m^3
General Urban (Williamson, 1993)	Hydrocarbons	4-20 kg/ha/yr 0.02 m^3/ha/yr	15 kg/ha/yr assumed for the purposes of this report Assumed particle density of 850 kg/m^3

Given the site-specific variation in treatment efficiencies, various assumptions were also made to determine the likely benefits offered by installing different treatment device types within the Glen Innes Town Centre catchment.

The final assumed proportion of catchment generated sediment transported in stormwater runoff that would require treatment by network water quality treatment retrofitting is summarised in Table 5.. For the purposes of this study, it is assumed that the majority of hydrocarbons and gross pollutants generated are transported into the stormwater network.

Table 5: Proportion of catchment generated sediment transported in stormwater runoff

Land Use	Particle Size			Comment
	<100 µm	100 µm - 500 µm	500 µm – 5 mm	
Commercial Roof	100%	n/a	n/a	Sediment generated from roof runoff tends to be deposited by the wind or generated by breakdown of the roofing material. Assumed all sediment particles are <100 µm and fully transportable.
Commercial Pavement	100%	60%	10%	Assumed sediment characteristics the same as for road.
Road (2000-5000 VPD)	100%	60%	10%	Although significant literature exists on the topic of stormwater borne sediment, at the time of writing, none could be found which directly related the proportion of generated sediments to sediment transported in stormwater runoff. The values stated are assumed based on engineering judgement.

The proportion of contaminants transported in stormwater runoff which is assumed to be captured in catchpits is summarised in Table 6 and Table 7.

Table 6: Proportion of stormwater mobilised hydrocarbons and gross pollutants captured in catchpits

Land Use	Hydrocarbons	Gross Pollutants	Comment
Commercial Roof	0%	0%	Assumed catchpits / sumps servicing this land use type are not maintained and offer no capacity for contaminant capture. Or assumed direct connection to public stormwater network bypassing catchpits.
Commercial Pavement	0%	0%	Assumed catchpits / sumps servicing this land use type are not maintained and offer no capacity for contaminant capture.
Road (2000-5000 VPD)	0%	20%	Assumed based on engineering judgement.

Pervious	0%	5%	Assumed based on engineering judgement and proportion of pervious areas serviced by maintained catchpits.

Table 7: Proportion of stormwater mobilised sediment captured in catchpits

Land Use	Particle Size			Comment
	<100 µm	100 µm - 500 µm	500 µm – 5 mm	
Commercial Roof	0%	0%	0%	Assumed catchpits / sumps servicing this land use type are not maintained and offer no capacity for contaminant capture. Or assumed direct connection to public stormwater network bypassing catchpits.
Commercial Pavement	0%	0%	0%	Assumed catchpits / sumps servicing this land use type are not maintained and offer no capacity for contaminant capture.
Road (2000-5000 VPD)	15%	50%	100%	Auckland Council Technical Report 2010/004 p65

The performance of stormwater treatment devices is generally related to the setting of the device and the application of Stokes Law through the device. Performance efficiencies are reported by relevant suppliers based on a variety of testing methods. The proportion of contaminants transported in stormwater runoff which is assumed to be captured in gross pollutant trap (GPT) type devices is summarised in Table 8.

Table 8: Proportion of transported sediment captured in proposed GPTs

Land Use	Particle Size			Comment
	<100 µm	100 µm - 500 µm	500 µm – 5 mm	
All	30%	90%	100%	Assumed based on supplier performance claims for devices capable of treating 80% of particles with an average diameter of 108 µm at WQF.

The total generation and removal of contaminants calculated for each catchment based on the assumptions listed in this section are provided in Table 9.

Table 9: Indicative contaminant generation and removal within Glen Innes Catchment

Sub-Catchment	Total Area (ha)	Contaminant Load Generated (kg/yr)			Contaminant Load Transported[1] (kg/yr)			Contaminant Load Captured in Catchpits (kg/yr)		
		Gross Pollutants	Hydrocarbons	Sediment	Gross Pollutants	Hydrocarbons	Sediment	Gross Pollutants	Hydrocarbons	Sediment
1	2.41	217	36	2210	131	31	1878	4	0	55
2	3.60	324	54	3058	190	46	2600	11	0	158
3a	1.87	168	28	1695	108	24	1441	3	0	36
3b	0.08	7	1	66	4	1	56p	0	0	2
3c	0.25	23	4	233	14	3	198	0	0	3
3d	0.49	44	7	507	36	6	431	0	0	1
4a	1.18	106	18	1177	61	15	1000	0	0	4
4b.1	1.70	153	26	1641	96	22	1395	1	0	10
4b.2	5.96	536	89	5927	392	76	5038	3	0	40
4b total	7.66	689	115	7568	487	98	6433	4	0	50
4c	0.16	15	2	140	8	2	119	0	0	1
5	1.95	176	29	1748	108	25	1486	5	0	69
6a	1.63	147	24	1495	99	21	1271	2	0	30
6b	0.52	47	8	441	27	7	375	1	0	20
6c	0.21	19	3	196	13	3	166	0	0	2
Line Road	0.25	23	4	168	11	3	143	2	0	24

[1] Contaminants transported represent the proportion of the contaminants generated within the catchment which are mobilised by stormwater and enter the network (ie. at the catchpit inlet). This value assumes no treatment of flows has taken place.

3 OPTIONS DISCUSSION

3.1 GROSS POLLUTANT TRAPS SELECTION

Based on the expected contaminant load rates from the subcatchment areas and the overall layout of the existing network, device types selected for further investigation included start-of-pipe catchpit inserts and in-pipe/end-of-pipe proprietary gross pollutant traps (GPT's). Two New Zealand based suppliers were extensively consulted for this study to provide information on proprietary GPT devices they would recommend for servicing the Glen Innes Town Centre stormwater network to achieve the desired treatment outcomes.

A summary of these devices is provided in Table 10. In general, these devices can capture gross pollutants, floating pollutants (oil / grease and debris) and coarse sediments from flows within piped networks. Although these devices are broadly categorised as "GPTs", they employ a range of different treatment mechanisms to remove contaminants from stormwater. Some relative pros and cons of each device associated with treatment efficiency and constructability are provided in Table 11.

Both suppliers provided information regarding devices capable of increased capture rates for finer sediments, nutrients and dissolved metals. However, these device types were not considered further with treatment of these contaminant types already implemented by communal water quality treatment wetlands located lower down the catchment.

Table 10: Summary of GPT devices considered appropriate for Glen Innes Town Centre

Supplier	Device	Number of Models	Internal Bypass?	Testing Method	Model (min / max)	Max Inlet Dia. (mm)	Dimensions (mm)	Depth to Invert (m)	Sediment Storage (m^3)	Particle Size (µm) / Efficiency (% removal)[1]	Treatment Flow (L/s)	Peak Flow Rate (L/s)
Stormwater 360	Vortechs	9	No	NJCAT[3]	VX1000	varies	2.7L x 1.5W x 2.4H	1.3	0.5	100µm / 80%	17	45
					VX16000	varies	5.8L x 3.9W x 2.6H	1.5	5.4		263	708
	VortCapture	7	Yes	In-house	VC40 (HF)[2]	450 (900)	1.2 dia. x 3.4H (2.7L x 2.4W x 4.3H)	1.4 (2.0)	0.5	110µm / 80%	17	390
					VC120 (HF)[2]	1200 (2100)	3.6 dia. x 6.4H (4.3L x 5.2W x 7.8H)	2.0 (3.2)	4.8		328	5734
	VortSentry HS	6	Yes	NJCAT[3]	HS09	460	0.9 dia. x 2.9H	0.9	0.4	240µm / 80%	16	As required
					HS24	1200	2.4 dia. x 6.4H	2.1	2.8		229	As required
Hynds	First Defence High Capacity	4	Yes	NJCAT[3]	FDHC900	300	0.9 dia. x 2.7 H	1.0	0.3	110µm / 80%	30	424
					FDHC2550	1200	2.8 dia. x 4.7 H	2.0	2.1		212	1415
	Downstream Defender	4	No	NJCAT[3]	DD1200	300	1.2 dia. x 2.1 H	1.3	0.5	100µm / 90%	20	85
					DD3000	750	3.0 dia. x 4.2 H	2.2	6.7		370	700

[1] Performance efficiencies are reported by relevant supplier based on a variety of testing methods which have not been reviewed as part of this report. These values are provided for information purposes only and Opus has not confirmed of their validity.

[2] HF denotes an inline 'High Flow' weir structure included in addition to the standard VortCapture treatment chamber to support higher peak flows.

[3] NJCAT stands for The New Jersey Corporation for Advanced Technology.

Table 11: Performance capability of various proprietary devices

Device	Context	Pros	Cons
Vortechs (VX)	A vault with a shallow profile. As such requires a shallow exaction than other treatment devices of the same treatable flow rate.	• Shallow system • Utilises hydrodynamic separator and baffle system • Relatively good floatable material and hydrocarbon removal • In-situ availability • Removal of average diameter 100μm (can be designed to remove 50μm - 200 μm)	• Relatively large footprint compared to other devices for similar treatment • No internal bypass • No physical screen • Only support one inlet.
VortCapture (VC)	A gross pollutant trap which targets sediments, gross pollutants, floatables and attached pollutants. The device utilises both a swirl chamber and physical screen. High flow by pass can be incorporated.	• Small footprint • Includes internal bypass • Supports high treatment flow rates • Supports high peak flow rates • Designed to remove 80% of particle over 100μm	• Deep sump • Only support one inlet.
VortSentry HS (VS)	A hydrodynamic separator which targets sediments, gross pollutants, floatables and attached pollutants.	• Small footprint • Includes internal bypass • Lower supply cost compared with other devices	• Deep sump • Treatment performance stated at WQF targets 80% removal of particles with average diameter 240μm (compared to 100μm for other devices) • No physical screen (poor removal of neutrally buoyant material) • Only support one inlet.
First Defence High Capacity (FDHC)	A hydrodynamic separator which targets sediments, gross pollutants, floatables and attached pollutants	• Small footprint • Includes internal bypass • Supports high treatment flow rates • Supports high peak flow rates • Supports multiple inlet pipes at various angles (up to 240°)	• Deep sump • No physical screen
Downstream Defender (DD)	A hydrodynamic separator which targets sediments, gross pollutants, floatables and attached pollutants	• Large sediment storage capacity	• Deep sump • No internal bypass • Larger unit for incoming pipe diameter

3.2 TREATMENT OPTIONS ASSESSMENT

Following completion of hydrology and contaminant load rates from each subcatchment, proposed GPTs from two suppliers were evaluated for suitability based on their relative pros and cons and for their ability to treat flows from each catchment.

This involved assessing each device based on the minimum depth to invert, compatible pipe diameters, treatment flow and peak flow capacity, if they required external diversion structures, site access and long term operation and maintenance requirements. Figure 3 shows a workflow for the physical implementation capability used in the project. Option assessments were then carried out for each catchment to determine the most suitable device types and their retrofit locations within the existing network. Sections 3.2.1 and 3.2.2 provide two examples of the option selection process for two typical sub-catchments.

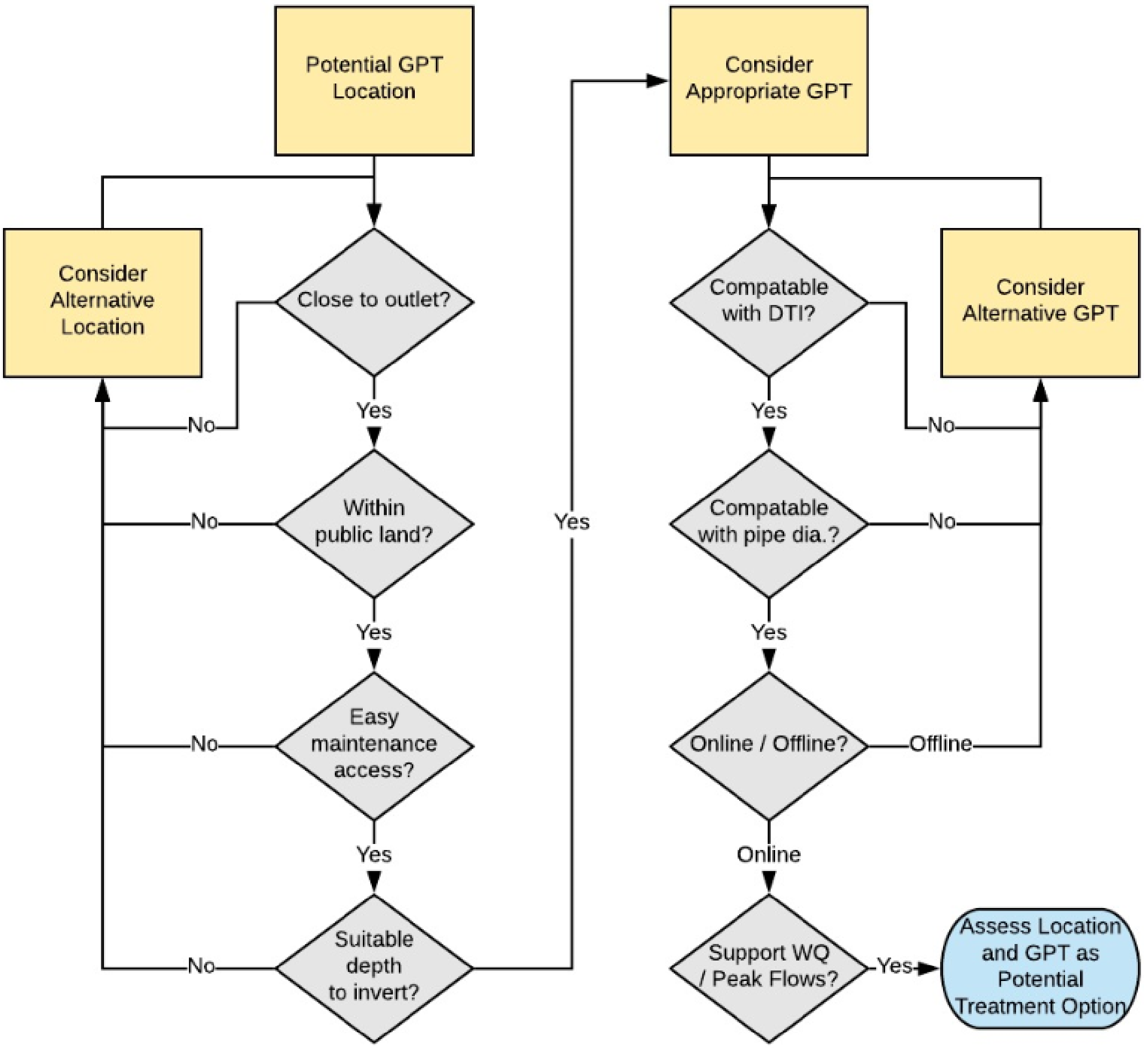

Figure 3: Stormwater treatment location and GPT device selection workflow

3.2.1 SUB-CATCHMENT 1

A 525mm dia. line services the 2.3-hectare catchment from the township and discharges via a 1500mm dia. line to Omaru Creek within Maybury Reserve at the rear of 14D Maybury Street. Only locations upstream of the 1500 mm dia. line connection have been considered practicable for installation of a GPT due to site specific constraints identified during the site visit.

Three existing manholes were assessed as potential GPT locations for Sub-Catchment 1 (refer Figure 4). Of the three, the existing manhole (SAP ID:2000447895) within the berm adjacent 4B Maybury Street was considered the most appropriate location. This location maximised upstream catchment area treated, was located on public land and provided suitable access for long term operation and maintenance. However, the shallow depth to invert (DTI) restricted the number of compatible GPT devices available.

Both the FDHC 1800 and VX 5000 can be custom configured to accommodate the shallow DTI at the proposed location (based on consultation with suppliers). The FDHC 1800 was capable of supporting the water quality and peak flows from the catchment without an external diversion. The VX 5000 would require an external diversion structure to bypass peak flows. Both devices specify that they are capable of providing a minimum removal efficiency of 80% of particles with an average diameter of 108µm (~100µm). The proposed options for Sub-Catchment 1 are summarised in Table 12.

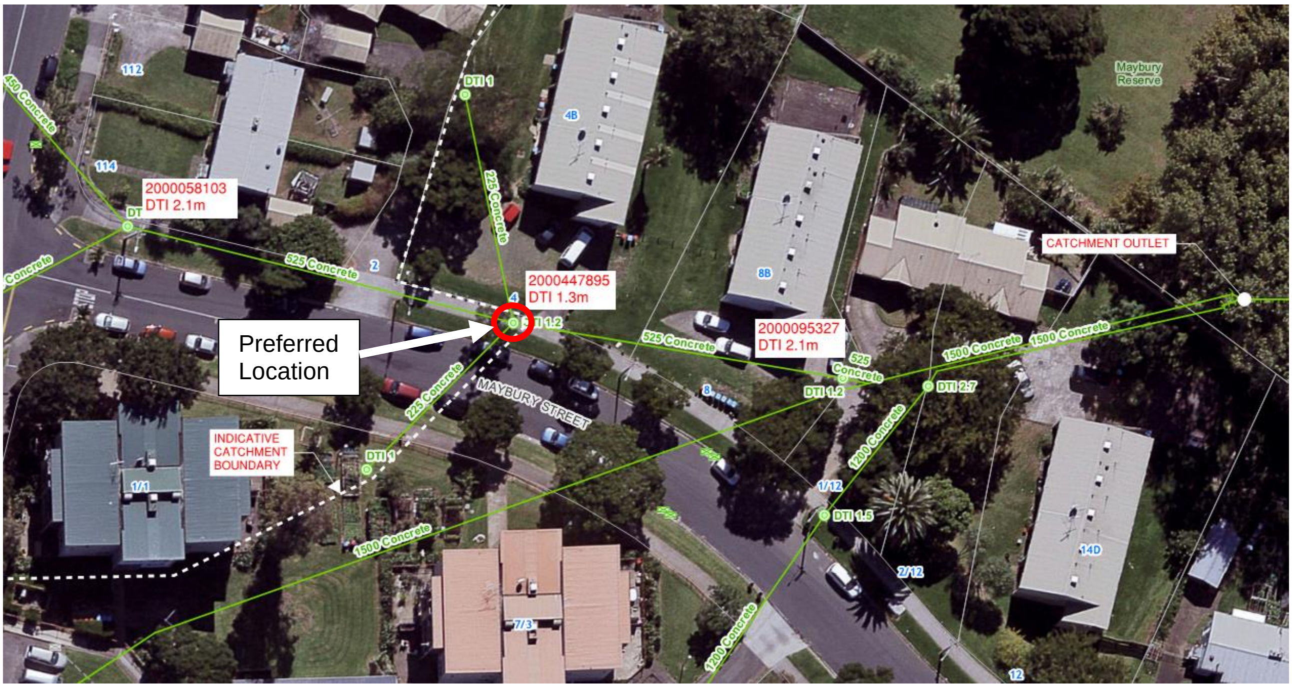

Figure 4: Potential GPT locations (Sub-Catchment 1)

Table 12: Glen Innes Town Centre stormwater treatment options (Sub-Catchment 1)

Option	Description	Particle Size (µm) / Efficiency (% removal)[1]
0	Do nothing	n/a
1	Replace existing manhole SAP ID:2000447895 with FDHC 1800	108µm / 95%
2	Install VX 5000 immediately downstream of existing manhole SAP ID:2000447895	108µm / >80%

[1] Performance efficiencies at WQF are reported by relevant supplier based on a variety of testing methods which have not been reviewed as part of this report. These values are provided for information purposes only and Opus has not confirmed of their validity.

3.2.2 SUB-CATCHMENT 4B

A 900mm dia. line services both Sub-Catchments 4b.1 (1.7 hectares) and 4b.2 (6.0 hectares) as shown in Figure 2. The catchment outlet is located at the northern boundary (rear) of the PAK'nSAVE site and discharges directly into Omaru Creek within Eastview Reserve. The outlet was not considered an appropriate location for a GPT due to potential hydraulic impacts on an adjacent 1500mm dia. culvert and difficult access for long term operation and maintenance.

Three existing manholes were assessed as potential GPT locations for Sub-Catchment 4b (refer Figure 5). Of the three, the existing manhole (SAP ID:2000970941) located in the traffic island adjacent to the southern (front) side of the PAK'nSAVE building was considered the most appropriate. This location maximises upstream catchment area receiving treatment, and although located in private land, it would provide suitable access for maintenance with appropriate easements in place.

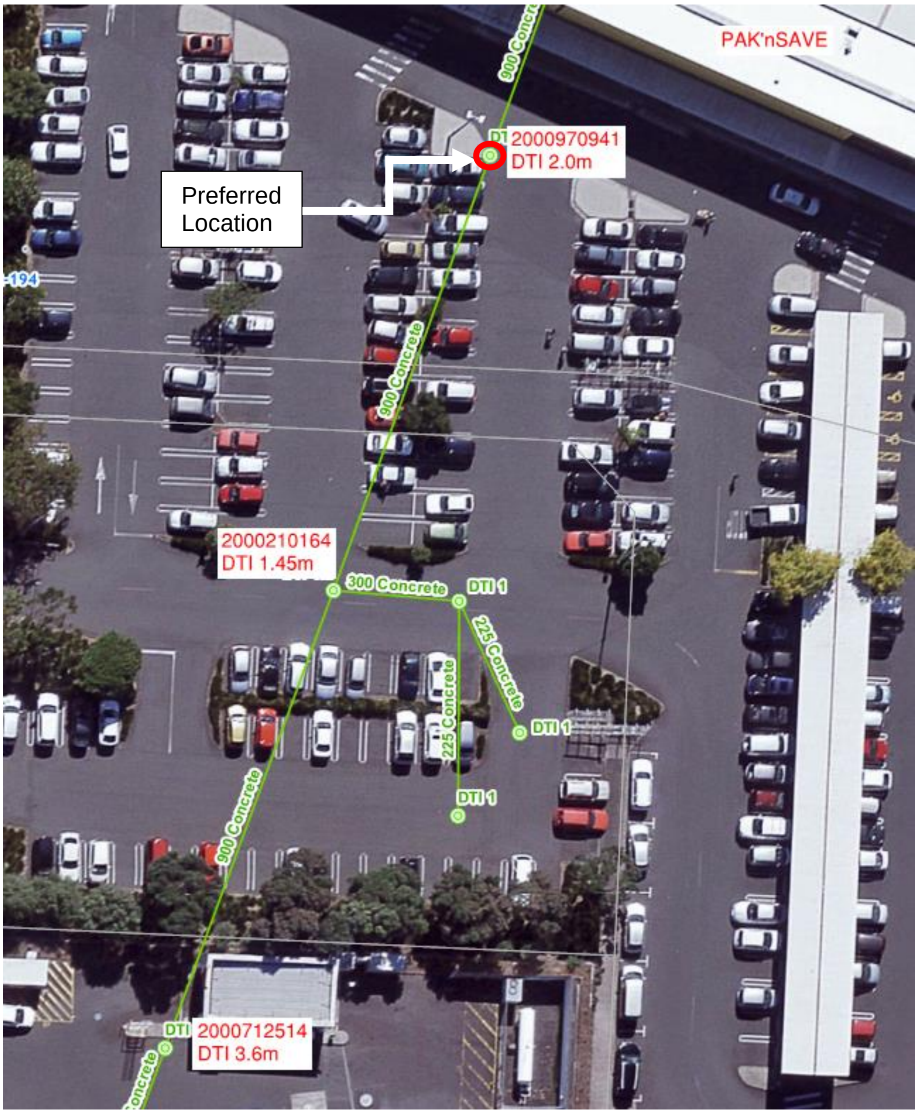

Figure 5: Potential GPT locations (Sub-Catchment 4b)

Both the VX 11000 and VC100 HF were compatible with the proposed location (based on consultation with suppliers). FDHC units were not considered for this catchment as a minimum of two devices would be necessary to support treatment flow and peak flow requirements. Both the VX 11000 and VC100 HF require high flow diversion structures due to the estimated peak flows received from the piped network. The VC100 HF and VX 11000 are reported to provide 80% removal of particles greater than 108 µm. The proposed options for Sub-Catchment 4b are summarised in Table 13.

Table 13: Glen Innes Town Centre stormwater treatment options (Sub-Catchment 4b)

Option	Description	Particle Size (µm) / Efficiency (% removal)
0	Do nothing	n/a
1	Install low flow diversion and VX 11000 adjacent to existing manhole (SAP ID: 2000970941).	108µm / 80%
2	Install VC100 HF immediately downstream of existing manhole (SAP ID: 2000970941).	108µm / 80%

3.3 WHOLE OF LIFE IMPLICATIONS/SCREENING

As indicated in Section 3.2.1 and 3.2.2, three water quality treatment options were developed for each sub-catchment consisting of a “do nothing” option, a recommended option and an alternative option.

For the recommended and alternative options, the proposed location and device type were determined using the workflow as shown in Figure 3 and their capital cost including design and consenting cost, project management, construction and 20% contingency. In general, the devices with internal bypass structures built into the device had lower construction risk (e.g., disturbance footprint) and capital cost. The GPT locations were chosen to maximise treated catchment area, utilise public land, provide ease of access for operation and maintenance, and have a suitably deep invert to be compatible with device types assessed.

The recommended treatment options and an estimate of the improved contaminant capture rate offered by each of the preferred options for each sub-catchment have been summarised in Table 14. Table 14 lists contaminant capture of each sub-catchment expressed as an indicative percentage increase of stormwater borne contaminants captured by the proposed devices in each sub-catchment based on the assessment and assumptions outlined in Section 2.2. An indicative proportion of the Glen Innes Town Centre Catchment stormwater borne contaminants captured by the proposed device by the area was also estimated.

Maintenance costs for each device provided by the Healthy Waters Operation team are listed in Table 14 assuming three maintenance visits per year and their experience with managing similar devices types. The capital costs and the life cycle costing for implementing the devices in the selected location were also calculated. However, due to the commercial sensitivity these figures are not presented in the paper.

The percentage of contaminants removed and the cost analysis from the NPV provide decision makers with guidance for determining the most cost effective and beneficial investment regime for improved water quality. For an estimated financial outlay of $2 million (both CAPEX and OPEX) on targeted water quality improvement device retrofits for 30 ha (which is 15.2% of total catchment) of high contaminant load land use, a reduction in the contaminant loading of 25% for suspended sediment loading in the Glen Innes town centre can be achieved. Alternatively, the recommended option can be also prioritised and staged to consider the relative cost and benefit, constructability, upstream impacts, and overall capacity for capture of contaminants from the total Glen Innes Town Centre Catchment.

Table 14: Recommended options in Glen Innes Town Centre with estimated cost

Option	Sub-Catchment	Recommended Device	Increased Contaminant Capture		Operating Cost ($/yr)[3]
			Sub-catchment[1]	Glen Innes Catchment[2]	
Do Nothing	All	Do nothing	n/a	n/a	$787
Recommended	1	Install First Defence High Capacity (FDHC) 1800	35%	2.7%	$3,500
	2	Install FDHC 1800	31%	3.4%	$3,500
	3a	FDHC 1800 and low flow diversion	34%	2.1%	3,500
	3b	Do nothing	n/a	n/a	$98
	3c	Do nothing	n/a	n/a	$98
	3d	Install FDHC 1200	41%	0.74%	$3,000
	Line Road	Install 4x catchpit inserts	23%	0.14%	$60

	4a	Install FDHC 1200	37%	1.5%	$2,000
	4b	Install Vortech (VX) 11000	38%	10%	$3,000
	4c	Do nothing	n/a	n/a	$98
	5	Install VX 3000 and diversion structure	34%	2.1%	$4,500
	6	Install catchpit inserts and 2x FDHC 900	20%	2.5%	$2,000
	Total		n/a	25%	$25,400

[1] Contaminant capture is expressed as an indicative percentage increase of stormwater borne contaminants captured by the proposed stormwater treatment option. Values are based on assumptions described in Section 2.2.

[2] These values show the indicative proportion of the total Glen Innes Town Centre Catchment stormwater borne contaminants captured by the proposed device.

[3] Maintenance of GPT devices assume three maintenance visits per year. Cost per maintenance visit provided by Healthy Waters.

4 CONCLUSION AND RECOMMENDATION

Tamaki is a priority growth area in Auckland, with redevelopment and intensification of urban land forms resulting in the creation of a new community of over 11,000 homes. Improving the existing stormwater network within the catchment is a necessary action to facilitate the overall growth strategy, support the establishment of a healthy and desirable local community and improve the quality of associated receiving environments. This paper presents an assessment approach for retrofitting increased water quality treatment into the existing Glen Innes Town Centre stormwater network. The approach taken involved use of small footprint proprietary devices installed at strategic locations within the existing network to reduce the volume of gross pollutants and coarse sediments entering the degraded Omaru Creek receiving environment. These devices are intended to complement larger communal treatment devices located lower down the catchment aimed at capturing and treating finer sediments and other contaminant types.

An approach was developed to proactively determine the contributing drainage subcatchments, calculate contaminant loading from each subcatchment, and estimate removal rates for a range of retrofit options to the existing stormwater network informed by literature review.

Proposed water quality treatment devices from two suppliers within Auckland were evaluated based on their relative pros and cons including performance capability, their ability to treat flows from each catchment, their overall suitability for implementation and long-term operation and maintenance requirements. This involved assessing each device based on the minimum depth to invert, compatible pipe diameters, whether they support necessary treatment flows and peak flows, overall treatment efficiency and if they required external diversion structures.

A recommended solution was developed in each of the defined subcatchments ranging from “Do Nothing”, addition of catchpit inserts and/or addition of proprietary gross pollutant trap devices. A life cycle assessment was undertaken to support the decision makers with determining the return on investment achieved and associated water quality benefits for each option assessed.

The outcome of the investigation recommended investing up to $2 million on targeted water quality improvement for the Glen Innes town centre high contaminant load generating area. This investment would result in an estimated reduction in sediment discharged from each subcatchment ranging between 21 – 41%, which equates to an overall sediment contaminant reduction rate of 25% from the entire catchment area. The device types selected would also achieve 100% capture of gross pollutants (litter) from the catchment, a key outcome of the project given the high volume of gross pollutants currently discharged to Omaru Creek. Implementation of water quality retrofits can be prioritised and staged to maximise the benefit return.

If implemented, this will become one of the first large-scale public retrofit installations of GPTs in the Auckland region. Therefore, it is recommended undertaking a comprehensive pre- and post-installation treatment effectiveness monitoring study and evaluation of hybrid treatment train including the downstream wetlands, carried out by a competent research agency using scientifically rigorous methods. Collected information can then be used for assessing the effectiveness of the devices at achieving the desired outcomes, and for informing future treatment options within East Tāmaki and the wider area.

It is also recommended further investigation is needed during subsequent design to confirm the likely impact of the proposed treatment options on water levels within the upstream network, the loading rate of contaminants reaching the proposed devices and the performance efficiency of the devices.

In addition, it is recommended having a national discussion on the GPTs and their performance from more suppliers, local councils and consultants to create a more transparent selection screening covering environmental risks, construction risks, operational risks, maintenance risks, and asset disposal (or renewal) risks.

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