Community Science Stream Health Monitoring Programme

Results Summary For Kaipātiki Project

Prepared By Environmental Impact Assessments Limited

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Table of Contents

Executive Summary

This report provides a results summary for a school community science stream health monitoring programme for the period August 2017 to May 2019. Schools currently participating in data collation include Verran Primary School, Birkenhead Primary School, Birkdale Intermediate School and Windy Ridge School. Data collated from these schools includes macroinvertebrate communities plus onsite measurements of water temperature, dissolved oxygen, pH and water clarity. At each environmental class, this data collation is further enhanced using technical equipment of Environmental Impact Assessments Limited to include native fish, specific conductivity, turbidity and flow.

Prior to this programme being actioned a GIS desktop and field work validation study was undertaken to provide the overall survey design (Stansfield 2018). This study recommended 5 monitoring sites located in 4 stream catchments for which water quality and ecology results are presented in this report.

Results from this monitoring programme has provided a baseline of knowledge from which future comparisons can be made to determine whether land management practices in these catchments are impacting on surface water quality and ecology. On 14 August 2019 an environmental hui was held to discuss the findings of the project as well as gain feedback from the audience of what aspirational environmental criteria are required to meet the needs of future generations. It was recognised that ecological improvements are needed for all catchments with a strong request for greater fish diversity, reducing pollution, community clean ups, educational signage, continued monitoring, bigger fines for polluting, connecting with more schools, swimmable and drinkable stream water.

Greater community engagement is needed particularly for Kahika Creek that shows the greatest amount of litter of them all. A community clean-up is scheduled for this creek on September 3 2019. Riparian margins of Kahika Creek at Lanagan St and Castleton Creek at Roseberry Ave are not coping with storm events which results in the falling of trees and significant stream bank scour and erosion. Planting of low turf species that can tolerate inundation and high flows is recommended for these stream reaches.

While the Waimanawa Creek shows stable riparian habitat, it has very little water in it. Historical reports from local residents suggest this creek was once 3 times its existing size and that this reduction in flow has been apparent over the past 25 years. Ground water flow augmentation should be investigated to determine whether stream flows of the Waimanawa Creek could be improved to provide a more resilient stream ecosystem. The Waimanawa Creek has shown the highest stream temperatures of the group which is likely to be due to its small volume of water being heated easily during summer low flow periods. There is scope for establishing a large

wetland at the downstream end of Waimanawa Creek prior to discharging to sea. This would filter water contaminants as well as provide an ecological resource to the community.

The control site (Oruamo Creek upstream) represents the best ecological environment that could be achieved if catchment wide mitigations were put in place at the remaining sites. This site also demonstrates the coolest water temperatures and smallest temperature fluctuations of the group.

On site measurements of water clarity, turbidity, dissolved oxygen, electrical conductivity and pH show that the 5 sites have very similar water quality characteristics and no ecologically significant difference in quality is apparent.

Storm event data provides a baseline of flow/ clarity and flow/turbidity relationships for each site. There is difficulty in measuring flow at the Oruamo U/S site, it is recommended that future storm gauging's are taken from the Auckland Council hydrology station further downstream. This will likely improve our understanding of how this creek responds to stormwater inputs during rainfall events.

Abrupt thermal stress events appear to occur at Castleton and Waimanawa Creeks during moderate to high rainfall events in the Winter. The reason for this is unclear but could be related to pollution events.

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Introduction

Globally, volunteers are increasingly engaged in environmental monitoring surveys through community science programmes (Peters et al 2015). The information generated from these programmes continues to enhance our ability to understand, survey and manage natural resources, track at risk species and conserve protected areas (Conrad & Hilchey 2011).

This report provides a results summary of a community science stream health monitoring programme. The survey design for this programme comprises school stream care monitoring that is supported by more rigorous scientific monitoring conducted by Environmental Impact Assessments Limited to provide an overall community science stream health state of the environment monitoring programme.

Schools currently participating in data collation include Verran Primary School, Birkenhead Primary School, Birkdale Intermediate School and Windy Ridge School. Data collated from these schools includes macroinvertebrate communities plus onsite measurements of water temperature, dissolved oxygen, pH and water clarity. At each environmental class, this data collation is further enhanced using technical equipment of Environmental Impact Assessments Limited to include native fish, specific conductivity turbidity and flow.

BACKGROUND

Stansfield et al (2010) clearly demonstrate that urban streams within New Zealand's Regional Council monitoring programmes have the poorest ecological health when compared to rural, forestry and native stream catchments. A key causal driver of this poor ecosystem health has often been cited as total catchment imperviousness (Walsh et al 2005). Beach (2001) demonstrates a marked decline in stream ecosystem health above a threshold of 10% total catchment imperviousness in the stream catchments of the United States of America.

Walsh et al (2005) state that research shows that some of the variance of the total catchment imperviousness to ecological response relationships can be explained by the distance between the stream reach and urban land, or by the hydraulic efficiency of stormwater drainage. Walsh et al further provide a case that the mechanisms behind such patterns require experimentation at the catchment scale to identify the best management approaches to conservation and restoration of streams in urban catchments.

Clearly urban streams are in a poor ecological state in New Zealand and further research into the state and trends of these ecosystems is warranted. This report demonstrates that a community science state of the environment monitoring programme helps improve our understanding of these streams as well as enhance community education and engagement of the importance of maintaining or enhancing these stream ecosystems.

In 2017 Kaipātiki Project made a funding application to the Birkenhead Licensing for stream care education and monitoring for four schools. Funding was approved and a GIS desktop and survey design study recommended 5 sites be monitored in 4 stream catchments. This stream monitoring commenced in August 2017 and has continued on a quarterly basis. To keep the project going, in 2018 a funding application was approved by the Kaipātiki Local Board who are also acknowledged.

PURPOSE

The purpose of this report is to provide a results summary of a community science urban stream state of the environment programme within the Kaipātiki rohe. The report is divided into 5 sections namely:

- Introduction
- Catchment Descriptions
- Water Quality Analyses
- Water Clarity and flow Relationships
- Macroinvertebrate and Fish Communities
- Litter Survey
- Community Hui Feedback
- Conclusion

Catchment Descriptions

Oruamo Creek Upstream

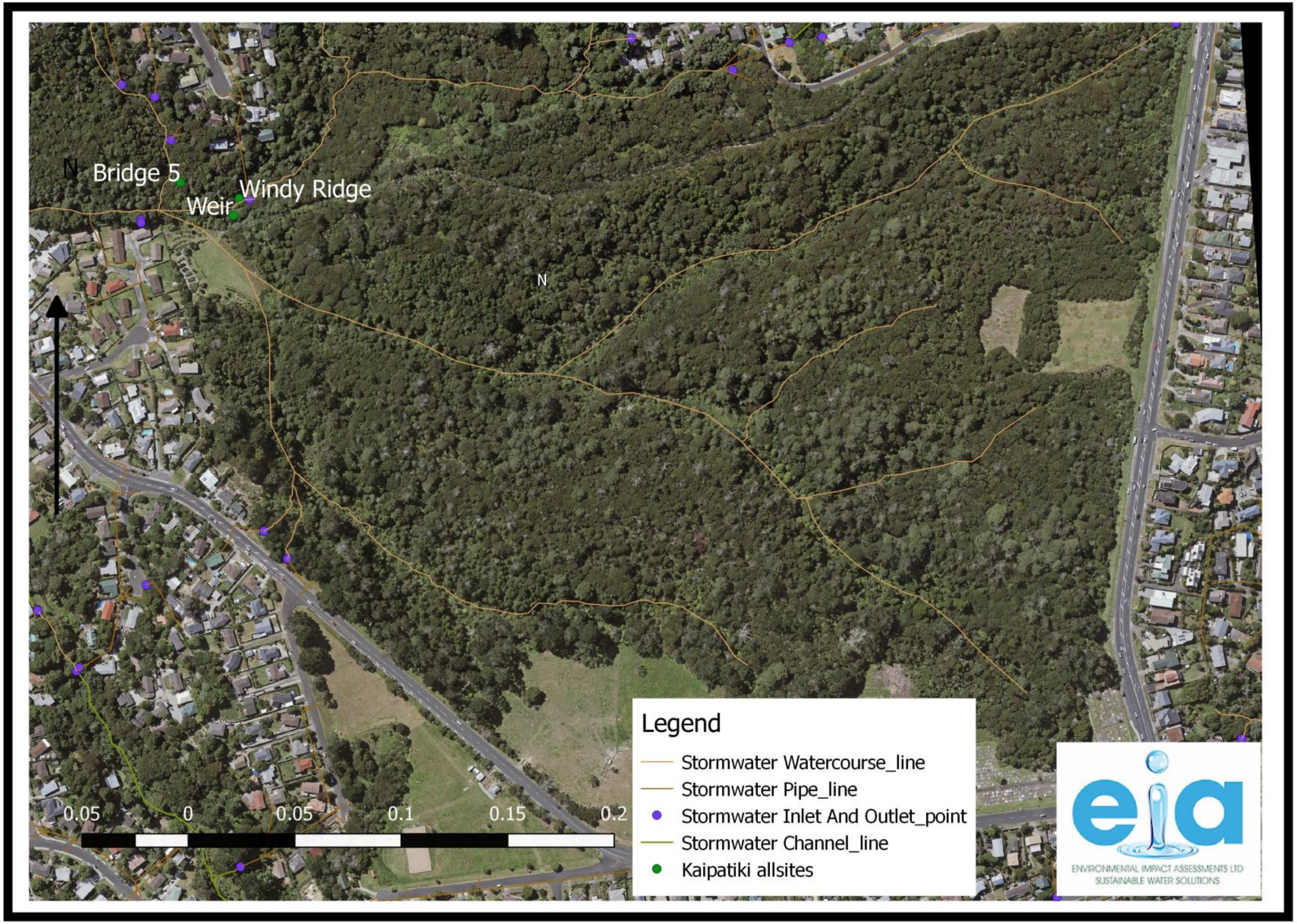
Photo 1: Oruamo U/S Monitoring Site

The Oruamo Creek upstream site is a 3rd order stream that has a catchment area of 0.85km^2 at the Windy Ridge School stream care monitoring site. The stream falls within the Eskdale Scenic Reserve and is surrounded by native broadleaf/podocarp forest. The upper reaches of the eastern tributaries are devoid of any stormwater inputs while the most northeastern tributary has one stormwater input at the headwaters. The total impervious catchment cover at the Windy Ridge School stream care monitoring site is approximately 8%. This low level of imperviousness is unlikely to result in any adverse effect on stream ecosystem health and as such represents a good control site for this study.

Eskdale Rd bound the upper reaches of the stream catchment to the South, Glenfield Road to the east and Domain Rd to the north.

The New Zealand Freshwater Fish Database reveals 105 fish monitoring records for this stream since 1995. The stream has previously been monitored using a variety of techniques (electric fishing, fyke nets, g minnow traps, hand nets) resulting in the capture of 7 native species (red fin bully, common bully, shortfin eel, longfin eel, banded kokopu, crayfish and inanga). The native shrimp (*Paratya curvirostris*) has also been captured as accidental by catch on occasions. No exotic fish have been captured from this stream.

Interrogation of the Auckland Council Database reveals that over 30 species of invertebrates have previously been captured from the Oruamo Creek. The soft bottom macroinvertebrate community index scores recorded by Council reflect good to excellent ecosystem health in the upper reaches (Eskdale Upper Mean SBMCI, 115, max SBMCI 132). This correlates with our own monitoring that shows a composite SBMCI value of 116 for this site (discussed in macroinvertebrates and fish chapter).



Map 1: Oruamo U/S Catchment

Oruamo Creek Downstream

Photo 2: Oruamo D/S Monitoring Site

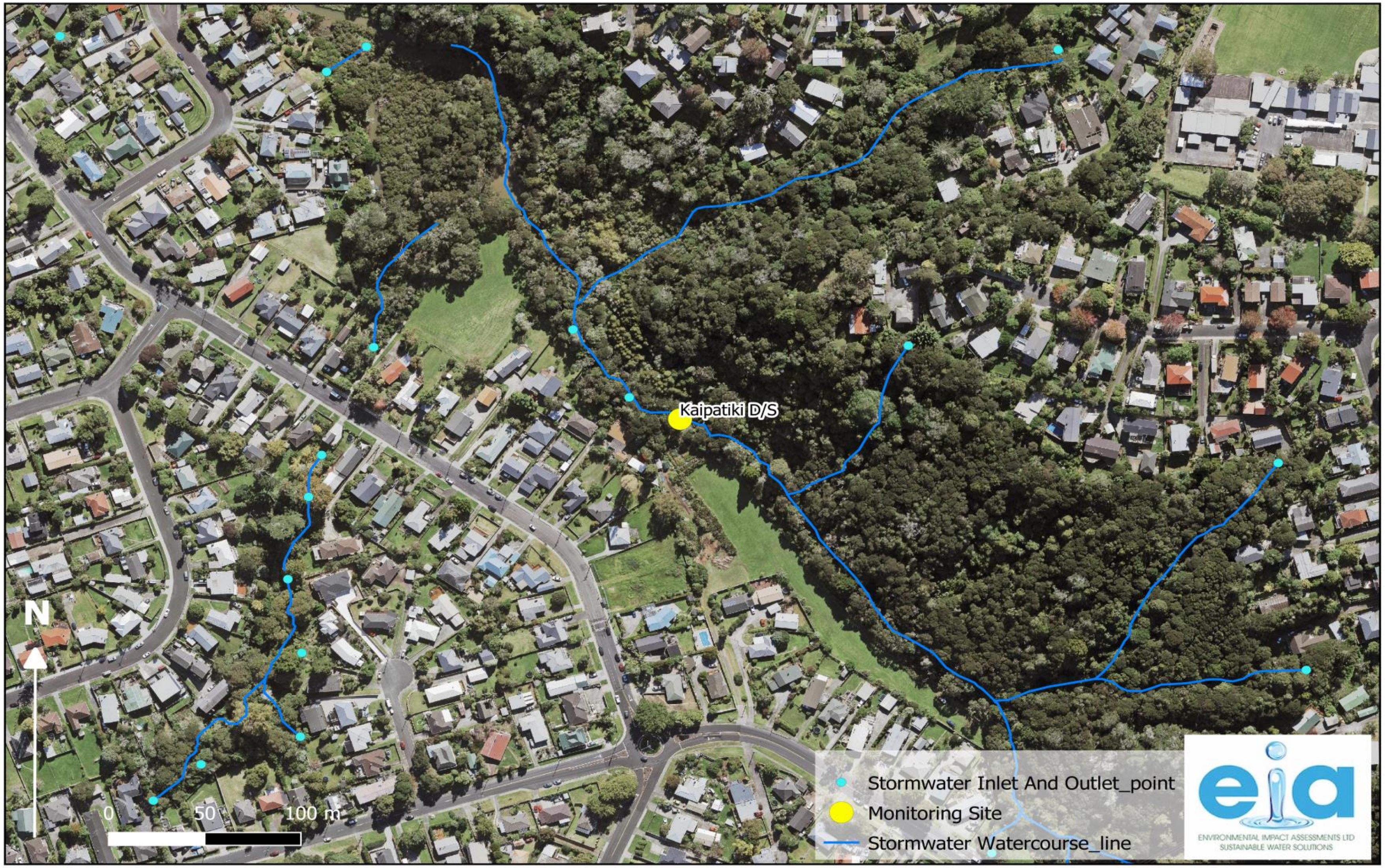
The Oruamo Creek downstream site is a 4th order stream that has a catchment area of 4.77km^2 adjacent to the Kaipātiki Project Environment Centre. The site has an Auckland Council hydrology station that measures stream discharge and water temperature every 5 minutes which is exported to the Auckland Council Environmental Data Portal from which data can be extracted.

The stream falls within the Eskdale Scenic Reserve and is surrounded by native broadleaf/podocarp forest. The total impervious catchment cover at monitoring site is approximately 28.4%. This level of imperviousness is likely to result in some adverse effect on stream ecosystem health and as such represents an impact site of moderate severity for this study. The creek catchment is defined by Stanley Road to the north, Glenfield Rd to the east, Mokoia Rd and Waipa St to the South and Birkdale Rd to the west.

The New Zealand Freshwater Fish Database reveals the same fish species as found at the upstream site, with an additional two species found here namely the Giant Kokopu and inanga. The sighting of Giant Kokopu is an important finding as this species is extremely rare in the Auckland Region (Hackett pers comm.).

The stream does show some degradation where MCI scores decline markedly compared to the upstream site (Eskdale Lower mean SBMCI 79, max SBMCI 87) reflective of severe organic enrichment. This concurs with our own monitoring with a composite SBMCI score of 85, The stream has a high degree of endemicity with no exotic fish or invertebrates previously captured. A recent discovery of kakahi in the lower reaches of the stream is an important finding as this species of bivalve is very rare in the Auckland Region (Henderson pers comm.)

A map of the stream catchment is provided overleaf.



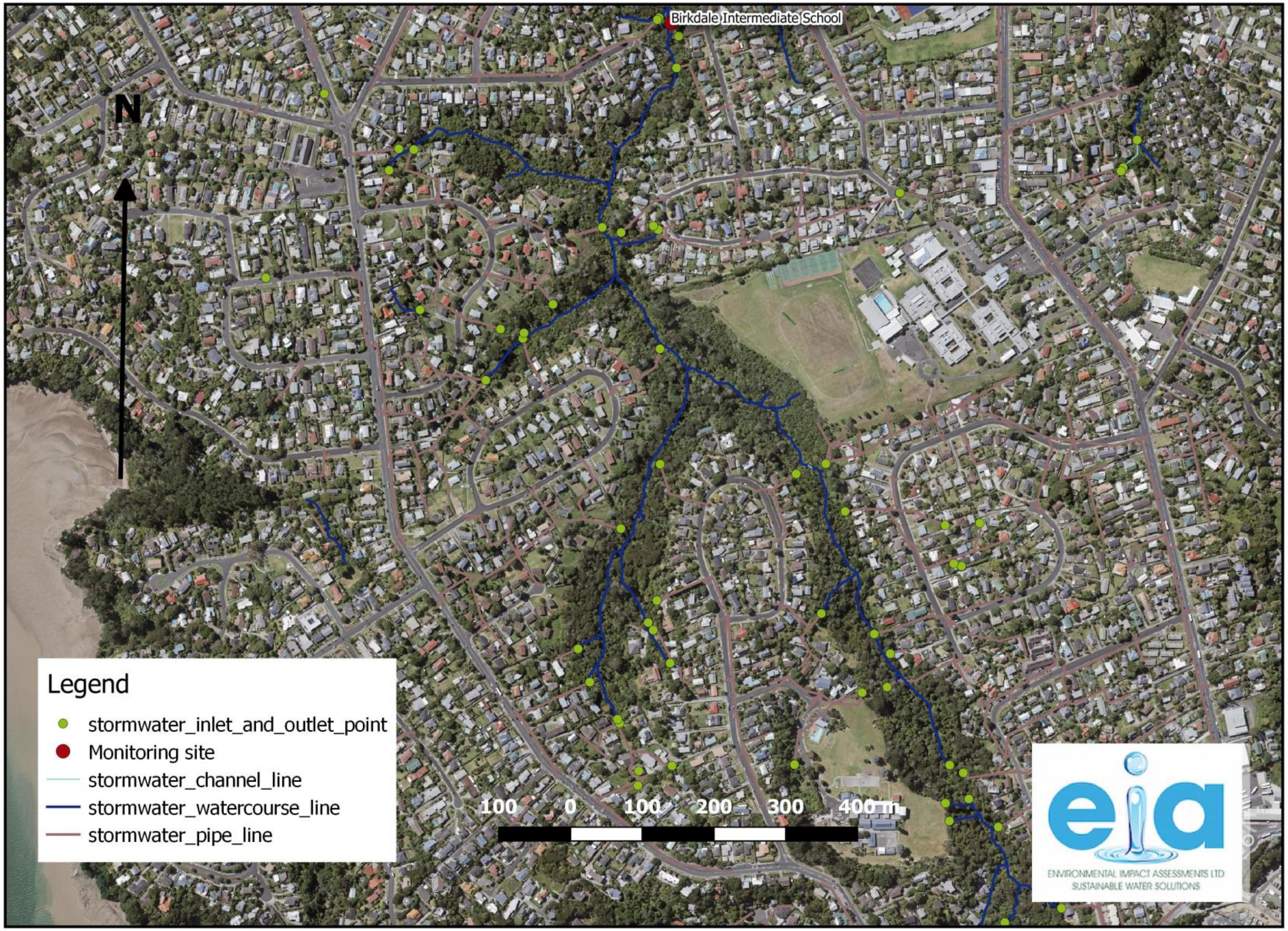
Map 2: Oruamo D/S Catchment

Kahika Creek

Photo 3: Kahika Creek Monitoring Site

The Kahika Creek is a 2nd order tributary that has a catchment area of 2.0 km^2 at the Birkdale Intermediate School stream care monitoring site. The stream falls within an urban area bounded by Rangatira Rd to the south and west and Birkdale Rd to the east. The riparian margin compromises some native broadleaf/podocarp trees interspersed with an equal proportion of exotic trees and pest plant species. The stream has many stormwater inputs and the catchment has a total imperviousness of approximately 33 %. This high level of imperviousness is likely to result in relatively poor ecosystem health owing to the highly altered hydrology created by stormwater inputs form impervious land cover. As such this site represents a highly impacted site for this study.

Until recently the New Zealand Freshwater Fish Database and the Wai Care Database revealed no biological data for this creek. However repeat field surveys undertaken since October 30 2017 revealed that the creek contains a healthy population of longfin eels, **koura** and banded kokopu. Inanga are also present further downstream where tidal influences are present. Invertebrate monitoring since 2017 has shown the presence of beetles (*Rhantus* and *Lancetes* spp), Damselflies and dragon flies (*Xanthocnemis* and *Antipidochlora* spp), free swimming mayflies (*Zephlebia* spp), oligochaete worms and caddisflies (Orthopsyche, *Polyplectropus* and *Triplectedes spp*.). The stream has a SBMCI value of 103 indicative of mild pollution. A map of the Kahika Creek is provided overleaf.



Map 3: Kahika Creek Catchment

Waimanawa Creek of Le Roys Bush

Photo 4: Waimanawa Creek Monitoring Site

The Waimanawa Creek is a 2nd order tributary that has a catchment area of 1.43 km^2 at the Birkenhead Primary School stream care monitoring site. The stream falls within a scenic reserve (Le Roy's Bush) and residential housing bounded by Onewa Rd to the north and Hinemoa St to the south. The creek discharges to sea at little shoal bay. The riparian margin compromises native broadleaf/podocarp trees with an understory of native grasses and ferns. The creek has many stormwater inputs and the catchment has a total imperviousness of approximately 30 % at the Birkenhead Primary School stream care monitoring site. This high level of imperviousness is likely to result in relatively poor ecosystem health owing to the highly altered hydrology created by stormwater inputs form impervious land cover. As such this site represents a moderately impacted site for this study.

The New Zealand Freshwater Fish Database reveals 9 fish monitoring records for this creek since 1998. School stream care monitoring has revealed 3 fish species have previously been captured including longfin eels, shortfin eels and banded kokopu. The Wai Care Database reveals that the aquatic invertebrate fauna comprises flatworms, wood cased caddisflies, dragonflies, damselflies, oligochaete worms, pond skaters, amphipods, snails, backswimmers, leeches, midge fly larvae, free swimming mayflies, amphipods, isopods, mites, and semi aquatic spiders. A composite analysis of all invertebrates captured during school stream care visits reveals an SBMCI value of 94 indicative of moderate pollution. This creek becomes very small during the summer often displayed by a series of stagnant pools in the lower reaches. A map of the Waimanawa Creek is provided overleaf.

Map 4: Waimanawa Creek Catchment

Castleton Creek of Ridgewood Reserve

Photo 5: Castleton Creek Monitoring Site

Castleton Creek is a 3rd order tributary that has a catchment area of 1.6 km^2 and is located 1.34 km from sea when measured at the Verran Primary School stream care monitoring site. The stream falls within a scenic reserve (Ridgewood Reserve) and residential housing bounded by Eskdale Rd to the north, Birkenhead Ave to the east and Waipa St to the south. The creek is a tributary of the Oruamo Creek. The riparian margin compromises native broadleaf/podocarp trees with an understory of flaxes grasses and weeds. The creek has many stormwater inputs and the catchment has a total imperviousness of approximately 25.4 % at the Verran Primary School stream care monitoring site. This moderate level of imperviousness is likely to result in relatively poor ecosystem health owing to the highly altered hydrology created by stormwater inputs form impervious land cover. As such this site represents a moderately impacted site for this study.

The New Zealand Freshwater Fish Database reveals fish monitoring records for this stream since 1998. Three fish species have previously been captured including longfin eels, shortfin eels and banded kokopu The Wai Care Database reveals that the aquatic invertebrate fauna comprises, snails, oligochaete worms, free swimming mayflies, wood cased caddisflies, amphipods, stoneflies, midge fly larvae, damselflies and dragonfly larvae. A composite analysis of all school stream care monitoring reveals that this stream has an SBMCI value of 106 reflective of mild levels of pollution. A map of the Castleton Creek is provided overleaf.

Map 5: Castleton Creek Catchment

Water Quality Analyses

Onsite Measurements

At each school stream care visit on site measurements of flow, water temperature, dissolved oxygen, electrical conductivity, pH, turbidity and water clarity are made. The following box plot charts show a summary of results for these readings which also include readings taken during storm event gaugings.

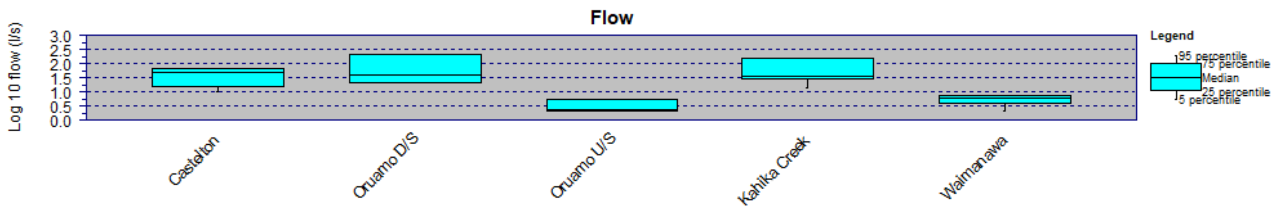


Figure 1: Log 10 Flow by site

Figure 1 shows that the Waimanawa and Oruamo U/S sites have significantly lower flows compared to the remaining sites. Summary statistics of flow show that these two sites have a median flow of 5.2 and 1.4 L/s respectively this is a lot smaller than the median flows of Castleton Creek (49.3 L/s), Kahika (36 L/s) and Oruamo D/S (40 L/s). Smaller creeks tend to be more vulnerable to pollution events owing to them having little water to afford dilution.

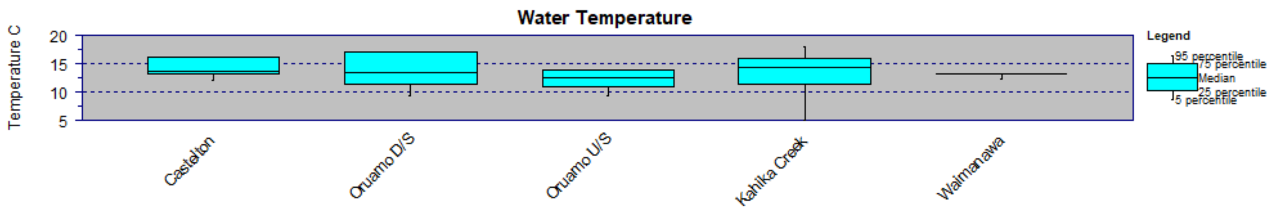


Figure 2: Water temperature by site

Figure 2 shows that the sites have very similar water temperature. Summary statistics reveal that Oruamo U/S site has the coolest median temperature (12.5 °C) while Kahika Creek displays the warmest median temperature (14.4 °C). This is expected as the Oruamo U/S site has the lowest amount of catchment imperviousness (8 %) while the Kahika Creek has the greatest amount of catchment imperviousness (33%). The Waimanawa Creek shows the most stable water temperatures of the group however this could be due to the time of day at which the sampling is undertaken. A more detailed analysis of water temperature is discussed later.

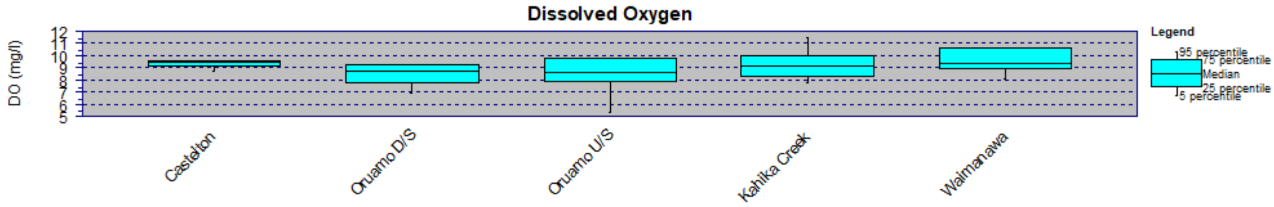


Figure 3 Dissolved oxygen concentrations at the sites

Figure 3 shows that dissolved oxygen concentrations are quite similar at the sites. Summary statistics show that all sites have a median concentration > 8.5 mg/l or > 80% saturation which is adequate to support a healthy aquatic ecosystem. The differences between sites are not considered to be ecologically significant. Diurnal monitoring over a number of successive days would be more useful in determining whether any of the creeks become stressed with low oxygen levels during summer low flow periods

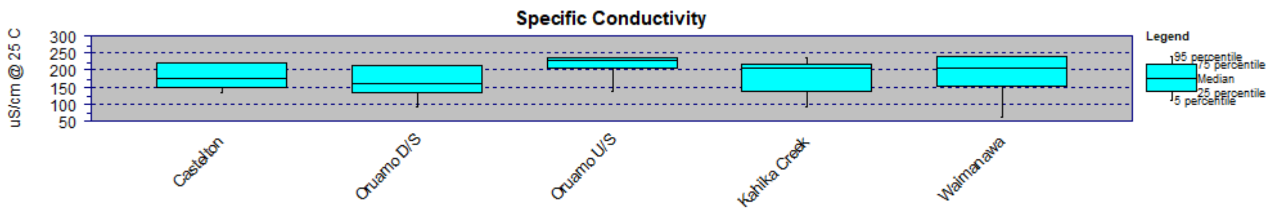


Figure 4: Specific conductivity at the sites

Figure 4 shows that the sites have similar electrical conductivity representing relatively clean streams with low concentrations of dissolved ions in solution. The Oruamo U/S site has slightly higher specific conductivity but this is not considered to be ecologically significant when compared to the remaining sites.

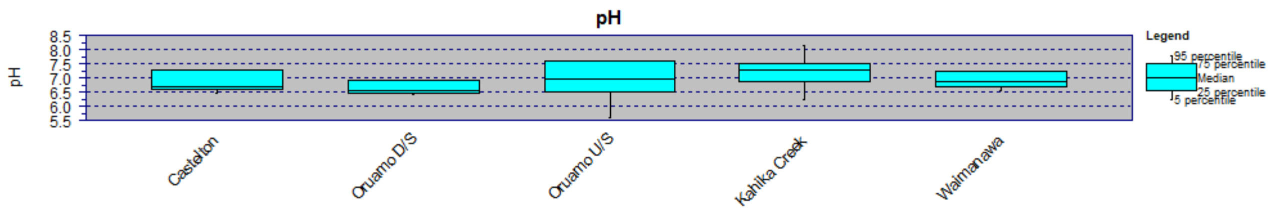


Figure 5: pH at the sites

Figure 5 shows the pH monitored at the sites. Ideally a stream should remain between pH of 6 to 9 which most sites have maintained during the monitoring surveys. The Oruamo U/S site did have a reading of 5.6 on 23 May 2018. The reason for this is unclear. In general, the sites show a pH range that is adequate to support a healthy aquatic ecosystem.

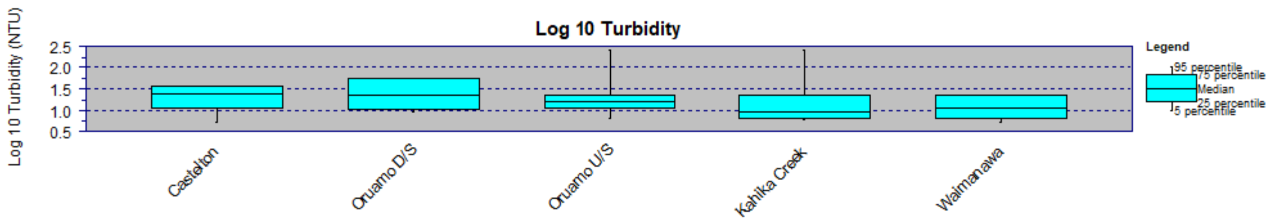


Figure 6: Log10 Turbidity of the sites

Figure 6 shows that all sites have very similar turbidity readings.

During storm events stream sediments are mobilized as storm water enters the stream system resulting in higher sediment loads and lowered clarity. Figure 6 shows that the sites have similar turbidity readings. At base flows the creeks have a typical turbidity reading of 10 - 20 NTU however during storm events the turbidity readings can rise significantly. Summary statistics provide in Appendix 1 show that during storm events turbidity can reach 98 NTU at Castleton, 397 NTU at Oruamo D/S, 52 NTU at Oruamo U/S,339 NTU at Kahika and 212 NTU at Waimanawa.

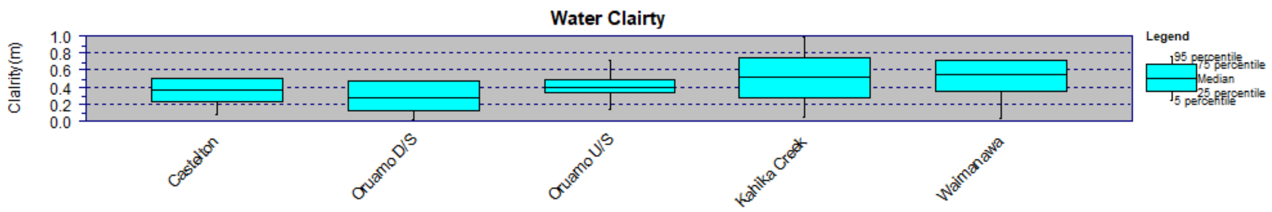


Figure 7: Water Clarity at the sites

Figure 7 shows that the water clarity is quite similar at the sites. Oruamo U/S shows the least amount of variability while Kahika and Waimanawa Creek show the greatest amount of variability. This is expected as the Oruamo U/S site has the least amount of impervious cover (8%) while the other two sites represent high impact sites with catchment imperviousness of 33% and 30% respectively.

Temperature Sonde Analysis

Water temperature is one of the key environmental variables to monitor in urban streams as the delivery of warm water via stormwater inputs during hot days can result in thermal stress to the aquatic ecosystem. During a hot summer day concrete, tar seal and roofing can heat up providing a warm run off surface for rain fall which is then delivered to our streams via stormwater piping. A recent analysis of water temperature of the Oruamo Creek D/S revealed that a rainfall event in summer can result in an abrupt change in water temperature which is likely to thermally stress the aquatic ecosystem.

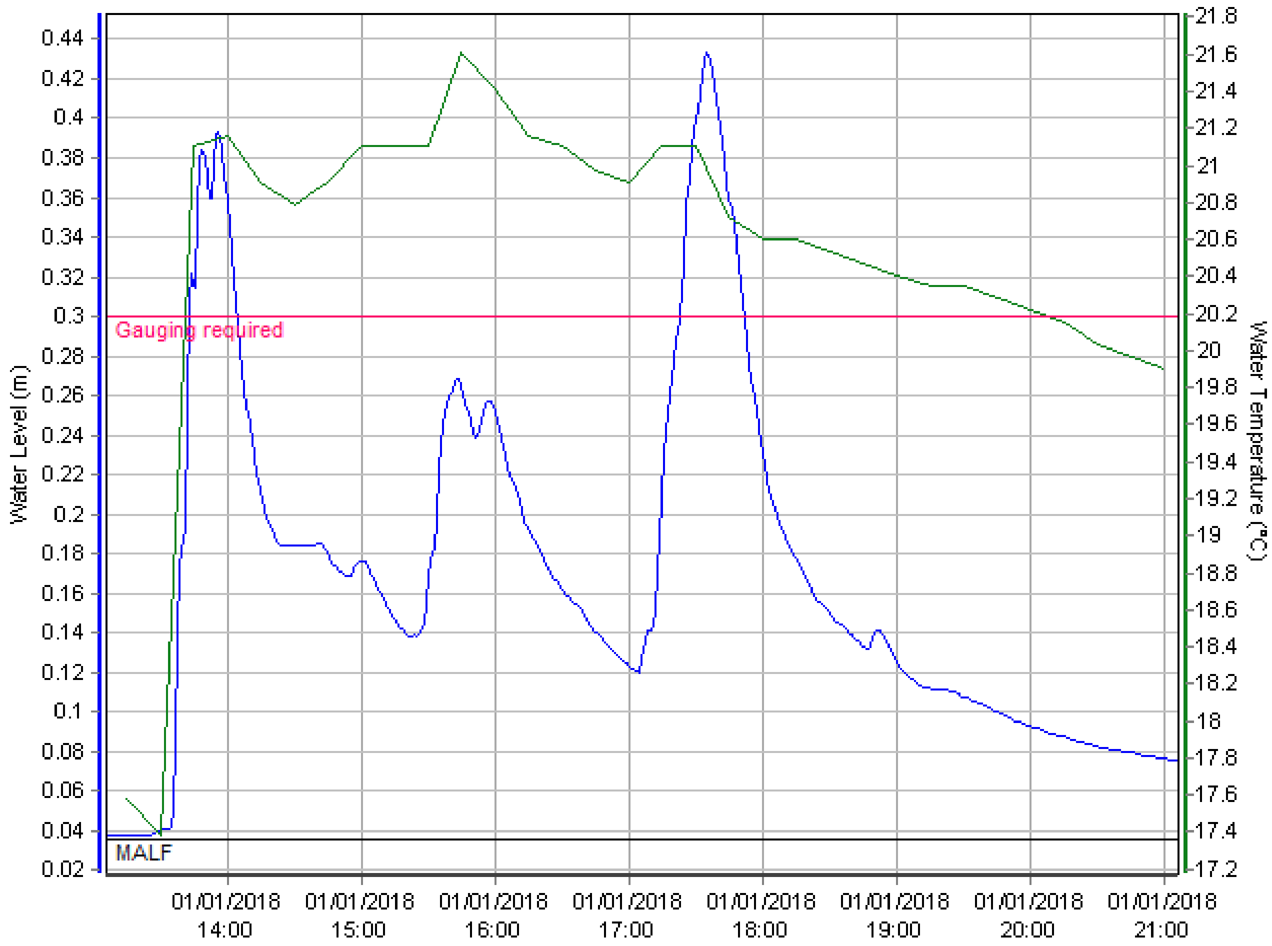


Figure 8: Water Temperature Changes in the lower Oruamo Creek at Eskdale Rd

Figure 8 shows that after a rainfall event the water level of the stream (blue line) quickly rises due to stormwater inputs delivering water to the stream. Water temperature also rises markedly (green line, (3.77 C in the span of 15 minutes) owing to warm rainfall runoff being delivered to the stream. There is every likelihood that this abrupt rise in water temperature is likely to stress temperature sensitive invertebrates such as mayflies and stoneflies.

Sudden rises in water temperature during a rainfall event can also be an indicator that sewage is possibly entering the stream system, via stormwater overflows as house hold water (room to warmer temperature) is generally much warmer than stream temperatures, particularly at night or during winter.

In May 2018 water temperature sensors were installed in the four creeks (Oruamo, Kahika, Castleton and Waimanawa) to see whether the differences in imperviousness of the catchments might result in warmer temperatures at the more impervious catchments. The temperature sensors were set to record every 30 minutes to also examine how quickly temperatures might change after a rainfall event.

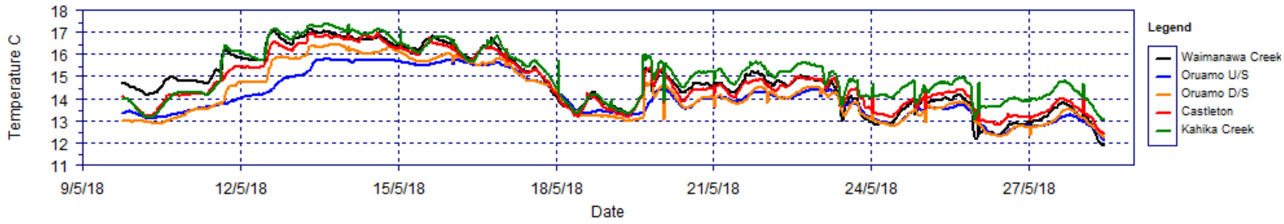


Figure 9: Water temperature profile of the urban creeks

Figure 9 shows that during May 2018 Kahika Creek displayed the warmest water temperatures. This is expected as Kahika Creek has the highest degree of imperviousness of its catchment (33%) furthermore the Oruamo Creek upstream site (monitored by Windy Ridge School) consistently showed the coolest and least variable water temperatures of the sites. This latter trend is also expected as the Oruamo Creek upstream site has the least amount of impervious cover of the catchment (8%) and GIS analysis suggests it is devoid of stormwater inputs. This trend in water temperature supports the notion that the Oruamo upstream site is a good control site for this study.

When viewing the data more closely it was found that a rainfall event in May can result in an abrupt water temperature change of almost 1.8 °C in the span of 30 minutes at Kahika Creek. This temperature increase occurred at 2:53 pm on Saturday 19 May 2018.

Following this initial pilot study, the temperature loggers were placed back in the streams for a period of one year. Unfortunately, a storm event in the Kahika Creek resulted in loss of the logger so no further data extends beyond May 2018 for this site, furthermore the Castleton Creek site also had a major tree collapse during a storm event that resulted in burying of the temperature logger. A new logger was placed in the Castleton Creek site in September 2018 to provide some insight of water temperatures during the spring summer and Autumn periods. The following plot shows the time series results of this monitoring.

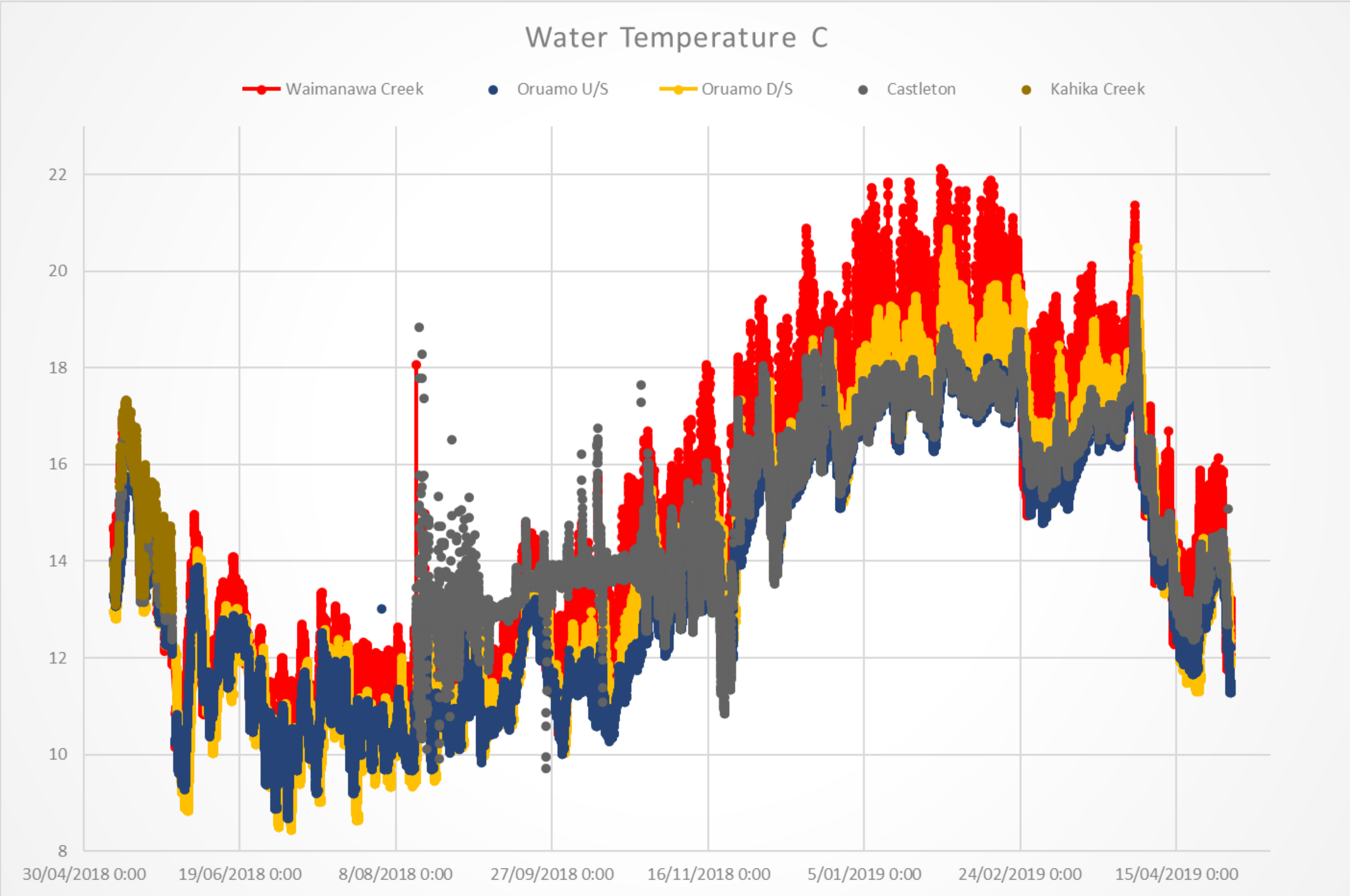


Figure 10: Water temperature sonde analysis

Figure 10 shows the water temperature sonde results for the period May 2018 to May 2019. Kahika Creek displays the warmest temperatures for May 2018 after which the logger was lost to a flood. Waimanawa tends to show the warmest temperatures for June 2018 to 14 August 2018 after which Castleton shows the warmest temperatures through to 17 October 2018 after which Waimanawa shows the warmest temperatures for the remainder of the plot. These two sites have the highest impervious cover so it is expected that these sites would demonstrate higher water temperatures. Conversely Oruamo U/S site tends to show the lowest water temperatures which is also expected as the site has the lowest catchment imperviousness.

Castleton Creek tends to show warmer temperatures than Oruamo D/S site for the Autumn, Winter and Spring seasons however it displays cooler temperatures than Oruamo D/S in summer. The reason for this could be due to the relative contributions of groundwater to these creeks however this would require further investigation. The following table shows some seasonal median water temperatures for each site.

Table 1: Seasonal median water temperatures

Season	Waimanawa	Oruamo U/S	Oruamo D/S	Castleton
Autumn	15.89	15.22	15.58	15.91
Winter	11.66	10.91	10.83	12.79*
Spring	13.28	12.07	12.67	13.71
Summer	18.13	16.98	17.86	17.29

Key: blue shading = coolest median water temperature, pink shading = warmest water temperature.

Table 1 shows that on average Waimanawa Creek tends to be the warmest tributary during Summer while Castleton Creek is the warmest tributary for the remainder of the year. Table 1 also shows that the Oruamo U/S site is usually the coolest tributary for most seasons with the exception of Winter for which Oruamo D/S is the coolest site of the group. Note there was insufficient data to present for Kahika Creek owing to the temperature sonde at this site having been flushed away during a storm event.

Thermal tolerances of aquatic ecosystems have been tested for selected species (Quinn et al 1994) for which Cox and Rutherford (2000) recommend the tolerance values apply to the midway temperature of a diurnally variable temperature profile. The midway temperature is the value between the daily mean and daily maximum temperature on any given day.

Data generated from the temperature sondes suggest that all stream sites have midway temperature regimes that will sustain aquatic invertebrates and long-term thermal stress is not envisioned for those species previously tested in New Zealand.

The site to display the highest summer temperature was Waimanawa (22.15 C) followed by Oruamo D/S (20.9 C), these temperature extremes are below the LT50 of the 12 species tested by Quinn et all 1994 which showed significant mortality at temperatures ranging from 22.6 C to 32.4 C. A future community aspirational goal could be that all of our awa exhibit a summer time maximum water temperature below 23 C.

Urban creeks are often subject to sudden changes in water temperature owing to heated impervious surfaces warming the rainfall water prior to being discharged to the creek via stormwater pipes. This form of abrupt heat stress to aquatic ecosystems has not been researched in New Zealand, however it is worthy to investigate differences of our sites to see which sites experience the greatest changes in temperature over a short interval. The following results focus on all thermal shocks of >2.5 C within a 15-minute interval that could stress the aquatic biota of a stream.

Table 2: Temperature changes at selected sites

Date	*Site*	*Delta Temperature °C*	*Flow*
15/8/2018 12:45	*Waimanawa*	*5.88*	*High*
15/8/2018 13:00	*Castleton*	*3.96*	*High*
15/8/2018 13:30	*Castleton*	*3.69*	*High*
16/8/2018 10:15	*Castleton*	*2.61*	*Medium*
16/8/2018 13:00	*Castleton*	*2.5*	*Medium*
17/8/2018 12:15	*Castleton*	*2.96*	*Medium*

Key: Low Flow = < median

*Medium Flow = > median < 3*median*

*High Flow = > 3*median*

Very High Flow = >90th percentile

Table 2 shows that the only sites to show temperature changes greater than 2.5 °C in a 15 minute interval are Waimanawa and Castleton Creeks. These temperature changes tend to occur during medium to high flow events (as measured at Oruamo D/S continuous logger) in the afternoon. There are no significant temperature changes at low flow or very high flows.

One result (Castleton 16/8/2018 10:15) is possibly due to a pollution event as the temperature increase is occurring at 10:15 am. It is likely that surface temperatures are cooler during this time of the day so any rainfall runoff is not expected to give to such an increase in temperature.

Water Clarity and Flow

High rainfall events have been targeted for stream flow gauging and water clarity monitoring to gain a better understanding of water clarity and flow relationships of the four catchments. During each storm event water clarity using the water clarity tube and turbidity (a meter measurement of light attenuation) is measured prior to taking a stream gauging. At this stage the data set is quite small (n≥6) however it is expected that over time more comprehensive relationships will be attained

The following plots show the flow / clarity/ turbidity relationships for each catchment.

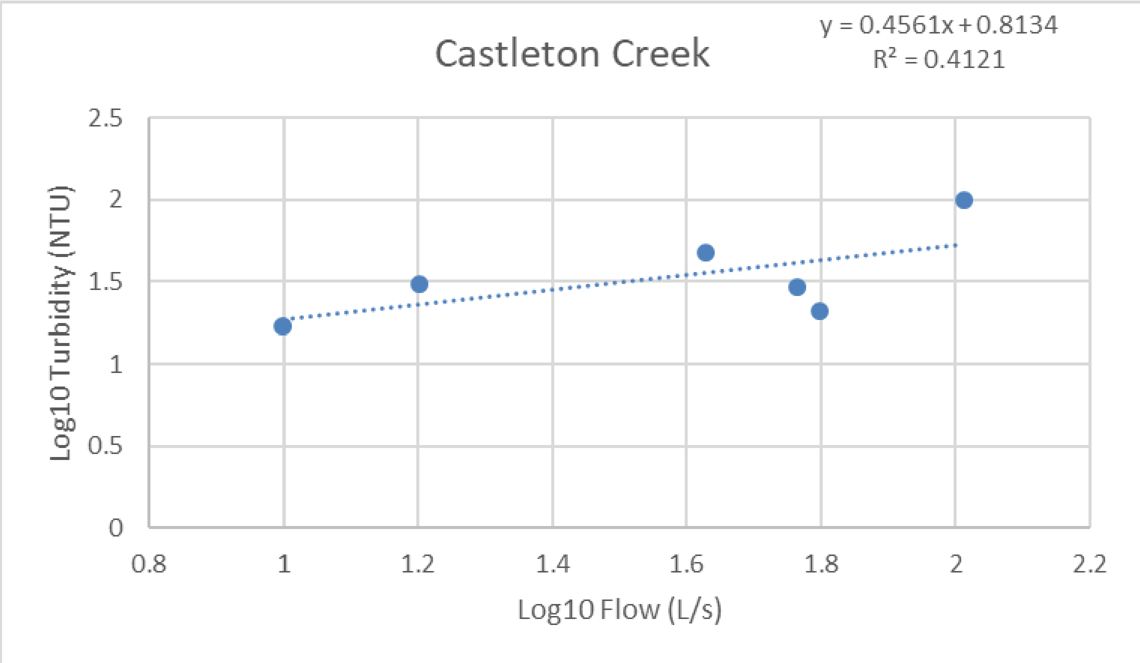


Figure 11: Log 10 Flow / Turbidity Relationship for Castleton

Figure 11 shows the flow / turbidity relationship for Castleton Creek. The regression model is unreliable (R^2 = 0.41) explaining only 41% of the variability of the data. Developing good flow /clarity relationships is difficult in an urban catchment because often road or parks and reserves works may be happening within the catchment which creates more turbidity than would normally occur. This was particularly so for Castleton Creek which had road works, stream and path works occurring on 2 of the 6 storm event stream gaugings.

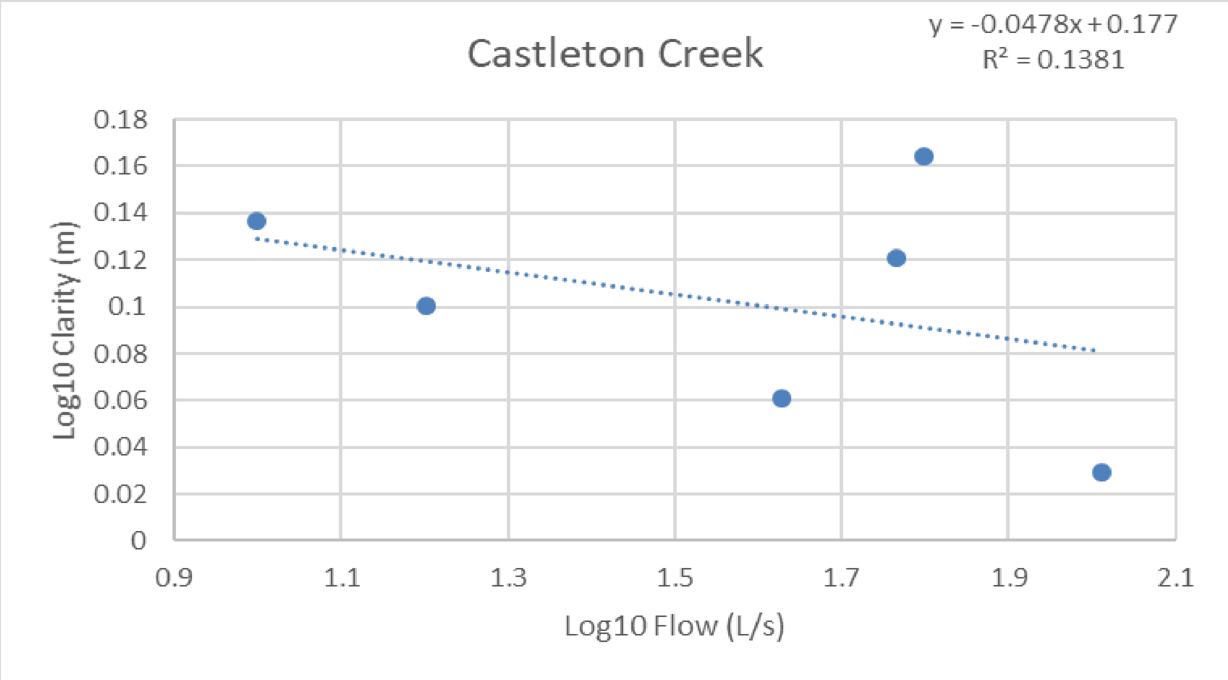


Figure 12: Log 10 Flow / Clarity Relationship of Castleton Creek

Figure 12 shows the flow / clarity relationship at Castleton Creek. As expected, as flows increase water clarity declines. There is a lot of scatter outside the line of best fit indicating that model is unreliable in its predictions explaining only 13% of the variability of the data (R^2 = 0.138).

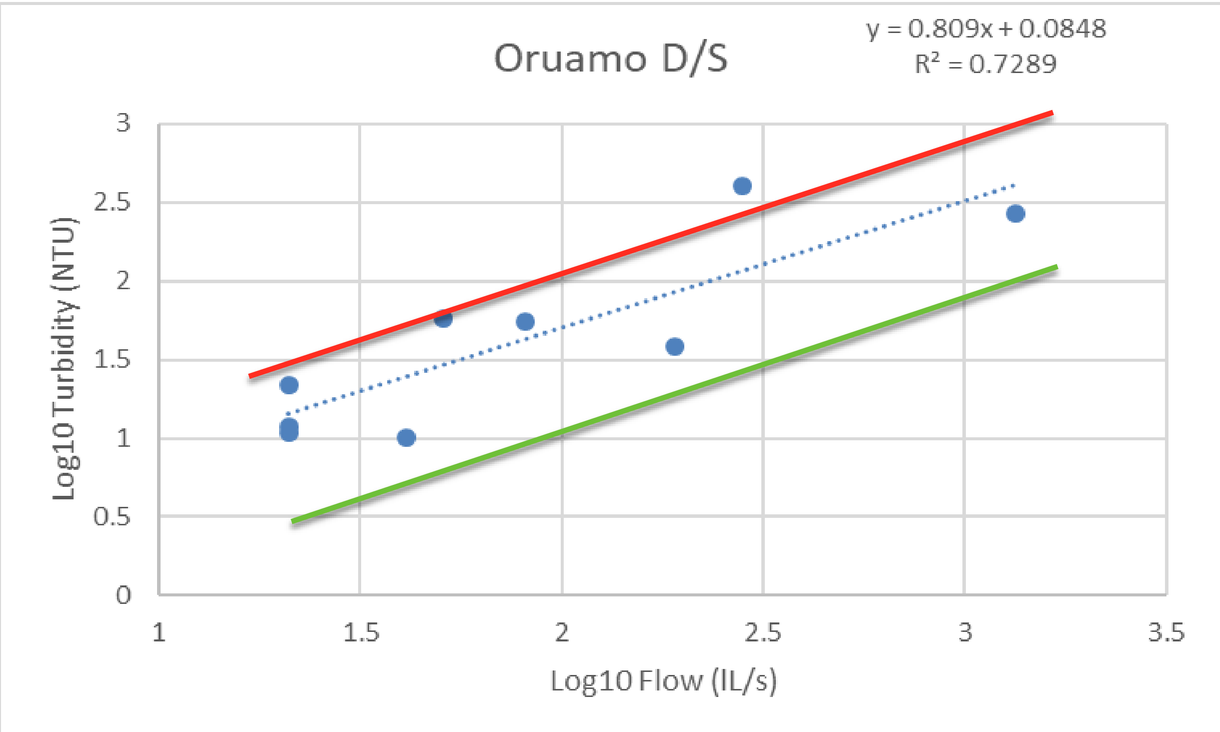


Figure 13: Log 10 Flow / Turbidity Relationship for Oruamo D/S

Figure 13 shows the turbidity / flow relationship for Oruamo D/S. As flow increases, light attenuation (turbidity) increases. This is an expected trend as during storms, silty stormwater is discharged into the stream and stream sediments are mobilized creating silty water. The regression model is good explaining 73% of the variability of the data. A future community aspiration goal could be to improve lower turbidity of the creek (green line) conversely if catchment management practices were negligent then turbidity would increase (red line).

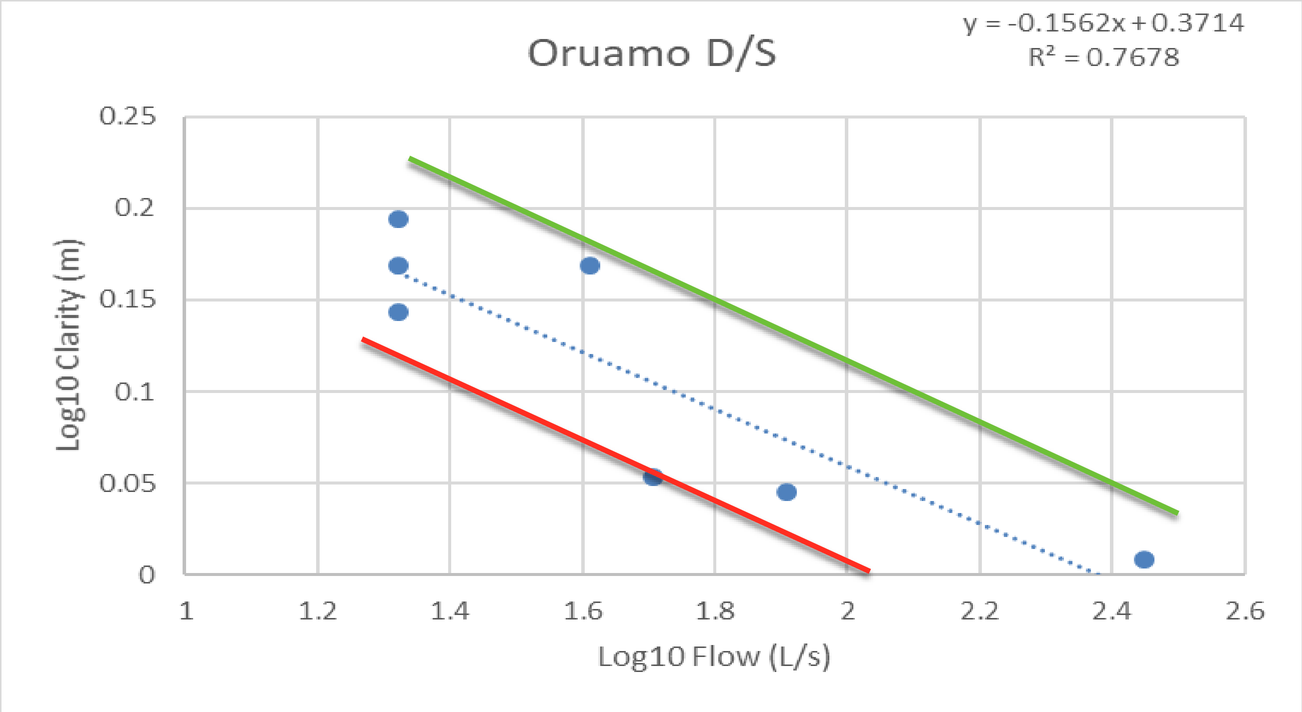


Figure 14: Log 10 Flow / Clarity Relationship for Oruamo D/S

Figure 14 shows the flow / clarity relationship for Oruamo D/S. there is some scatter around the line of best fit however the model is still good for predicting values. As flow increases, water clarity decreases. This is an expected trend as silty stormwater enters a stream and increased flows mobilise stream sediments. A future community aspirational goal could be to improve water clarity of the creek (green line) conversely if catchment land management practices were negligent then water clarity for a given flow would decline (red line).

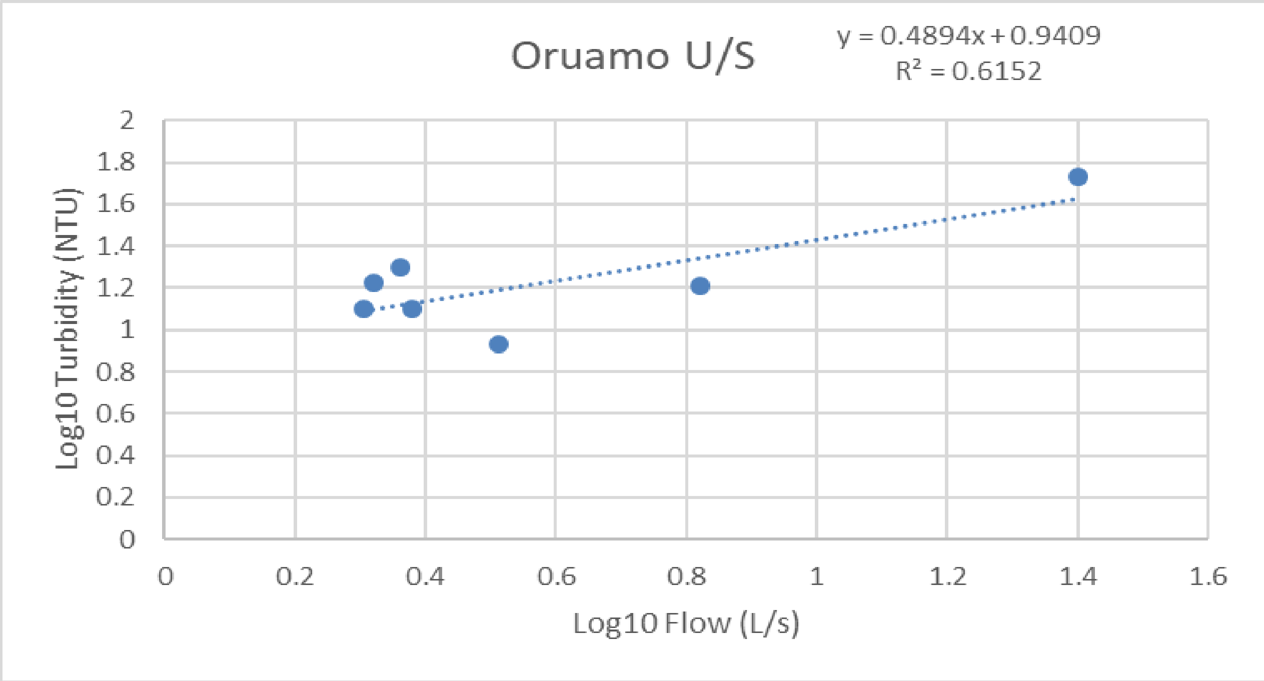


Figure 15: Log10 Flow / Turbidity Relationship at Oruamo U/S

Figure 15 shows the flow / turbidity relationship at Oruamo U/S. In this instance I have used flow values generated from Auckland Council's hydrology station located by the Kaipātiki Project Environment Centre as flow values measured on site were erroneous. The plot shows a lot of scatter around the line of best fit and the model is generally unreliable for predicting values R^2 = 0.61). The error in the model could be due to a host of reasons, potentially the largest of which could be not knowing the travel time from the U/S to the D/S site during a storm event to gain an accurate determination of flow at the time the water testing is done.

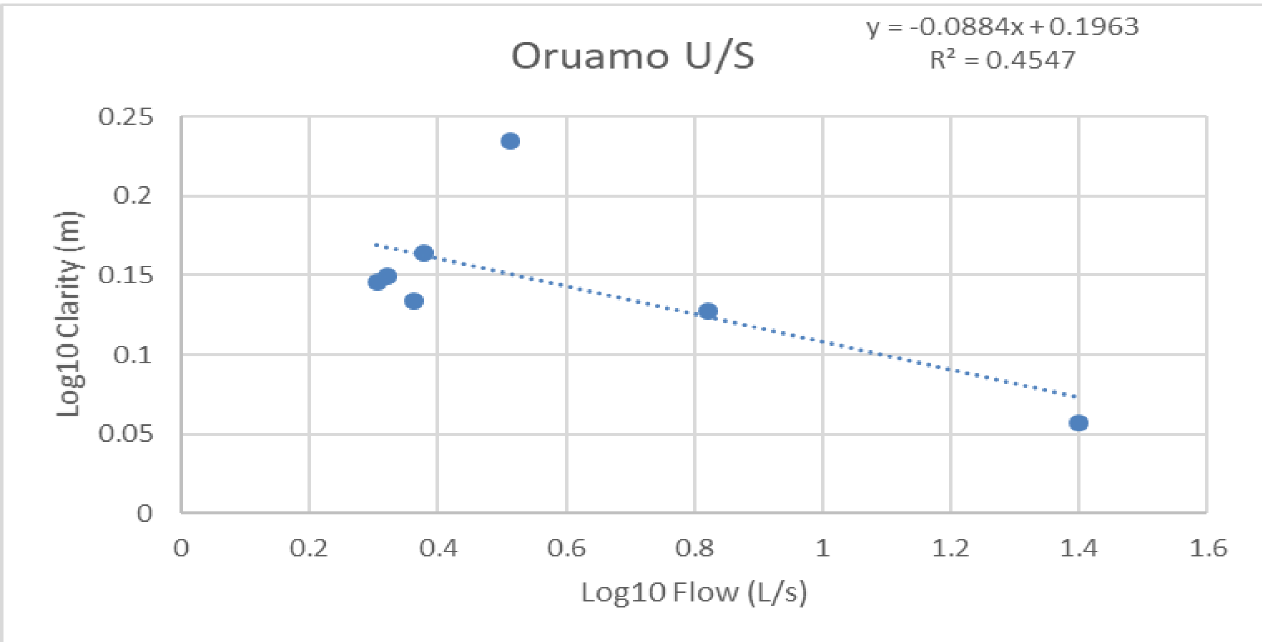


Figure 16: log10 Flow / Clarity Relationship at Oruamo U/S

Figure 16 shows the flow / clarity relationship at Oruamo U/S. There is a lot of scatter around the line of best fit and the model is unreliable at predicting values (R^2 = 0.45). Water clarity declines at increasing flows which is an expected trend.

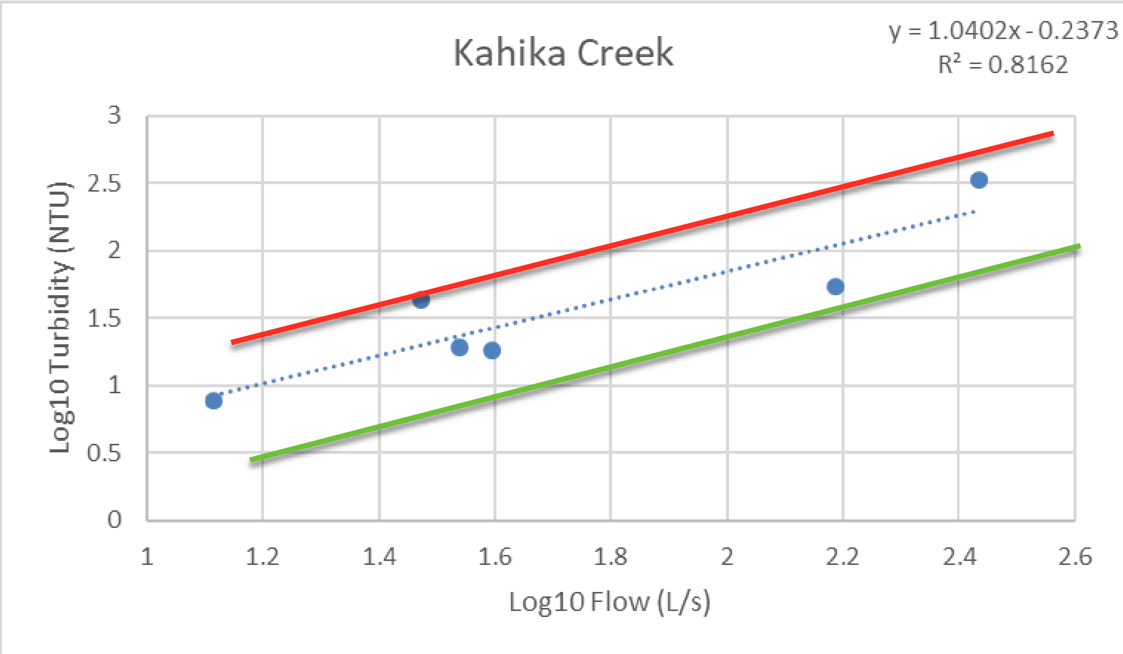


Figure 17: Log10 Flow/Turbidity Relationship at Kahika Creek

Figure 17 shows the flow / turbidity relationship at Kahika Creek, in general light attenuation (turbidity) increases as flow increases which is an expected trend owing to the sediment inputs and stream mobilization of sediments during a storm. The future community aspirational goal could be to reduce turbidity (green line) conversely if land management practices were negligent in the catchment then turbidity would increase (red line).

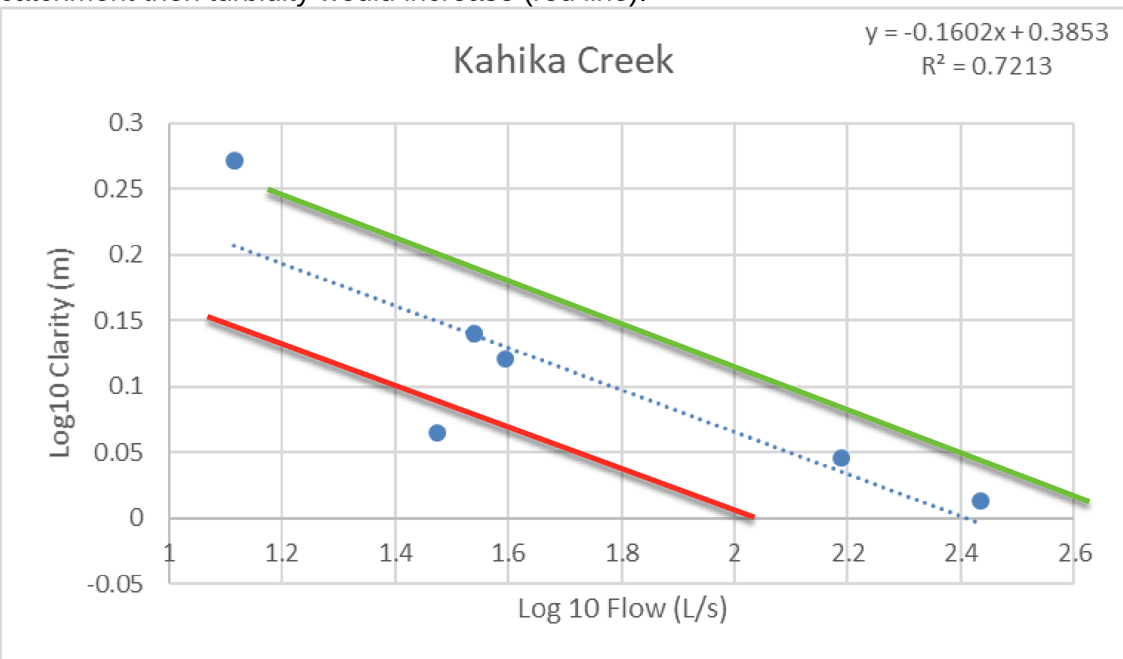


Figure 18: Log 10Flow / Clarity Relationship at Kahika Creek

Figure 18 shows the flow / clarity relationship at Kahika Creek. As flows increase, water clarity declines. The regression model is good at predicting values. A future community aspirational goal could be to improve water clarity of this creek (green line) conversely if catchment management practices were negligent, water clarity of the creek would decline (red line).

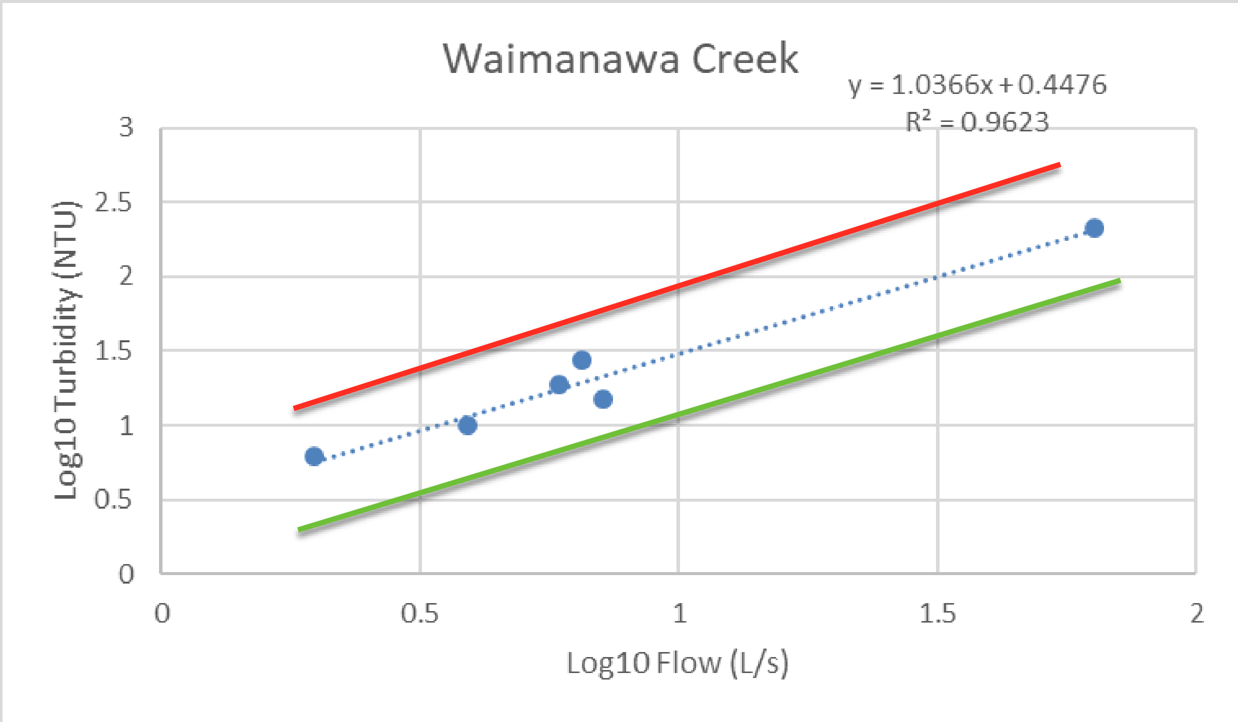


Figure 19: Log 10 Flow/Turbidity Relationship for Waimanawa

Figure 19 shows the Log 10 flow / turbidity relationship for Waimanawa Creek. The model is very strong (R^2=0.96) explaining 96% of the variation of the data. As expected, higher flows create more turbid water so light attenuation in the water column increases. A future aspirational goal could be that as a community we want clearer water (green line). Alternatively, if land development in the catchment was not well practiced the stream could become siltier (red line).

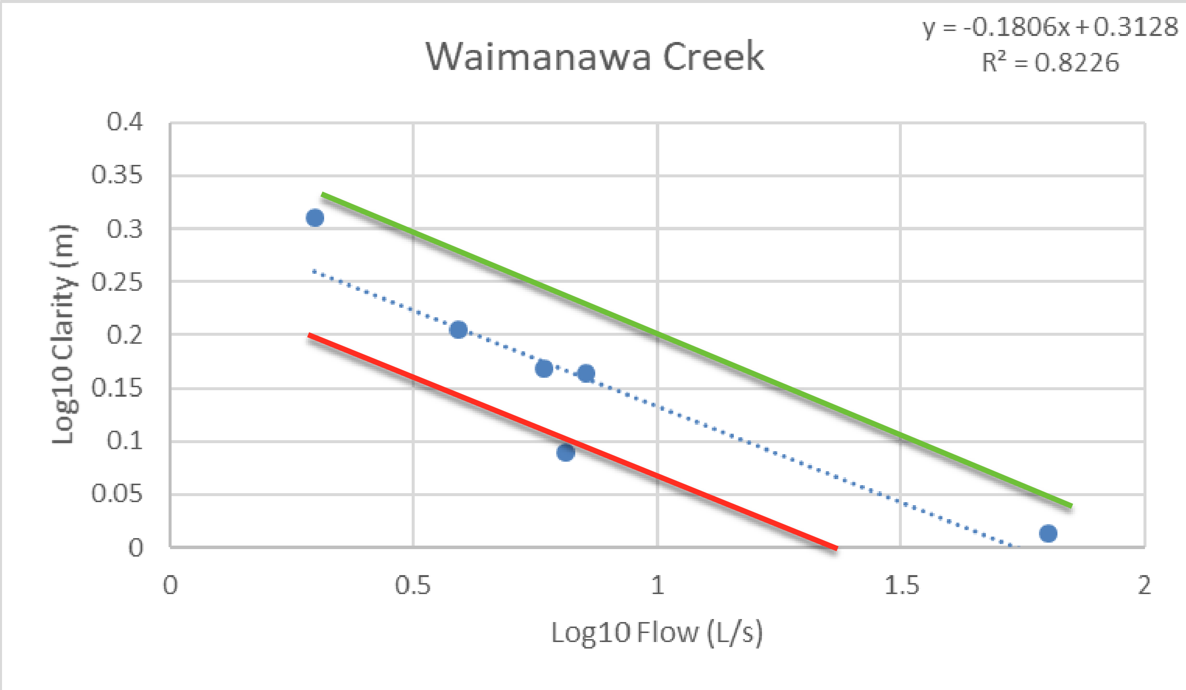


Figure 20: Log 10 Flow / Clarity Relationship for Waimanawa

Figure 12 shows that as flows increase water clarity decreases. This is expected as silty stormwater enters the stream and higher flows mobilise sediments of the stream bed. The flow/clarity regression model is strong (R^2 = 0.83) explaining 83% of the variability of the data. A future community aspirational goal could be to reduce sediment inputs to the stream thereby improving water clarity (green line). Alternatively, if land management practices within the catchment were negligent the flow clarity relationship would be worse (red line).

Macroinvertebrates and Fish

Ecosystem Health MCI

With the exception of Oruamo D/S for each site a kick net macroinvertebrate sample was taken in the summer and winter of 2018. Data for Oruamo D/S was provided by Auckland Council as this is a state of the environment site monitored by them. Macroinvertebrate sampling was undertaken to gain an understanding of ecosystem health which can vary depending upon the season.

In winter aquatic macroinvertebrates tend to be less stressed owing to cooler water temperatures and more flow being available to colonise preferential habitat. Regular freshes are scouring the stream bed in winter too keep the substrate clean and free of algal growths. Conversely in summer water temperatures can get quite high which can lead to lower dissolve oxygen concentrations both during the day and night. Algae can proliferate in summer owing to high sun light levels reaching the stream and provided adequate nutrient is in the water columns these growths can blanket preferential habitat as well as consume large amounts of oxygen at night when plant life is respiring.

The following plots show the ecosystem health of each site as measured by the macroinvertebrate community index. The macroinvertebrate community index (MCI) is a biological index of water quality that is based on known pollution tolerances of aquatic macroinvertebrates. In any creek each macroinvertebrate has a known pollution tolerance score e.g. 1 = very tolerant, 10 = very sensitive to pollution. These pollution tolerance scores are totaled for each site and multiplied by a scaling factor to give the MCI value. Any site that has an MCI <80 is considered severely polluted, 80-100 moderately polluted, 100-120 mildly polluted and > 120 excellent water quality.

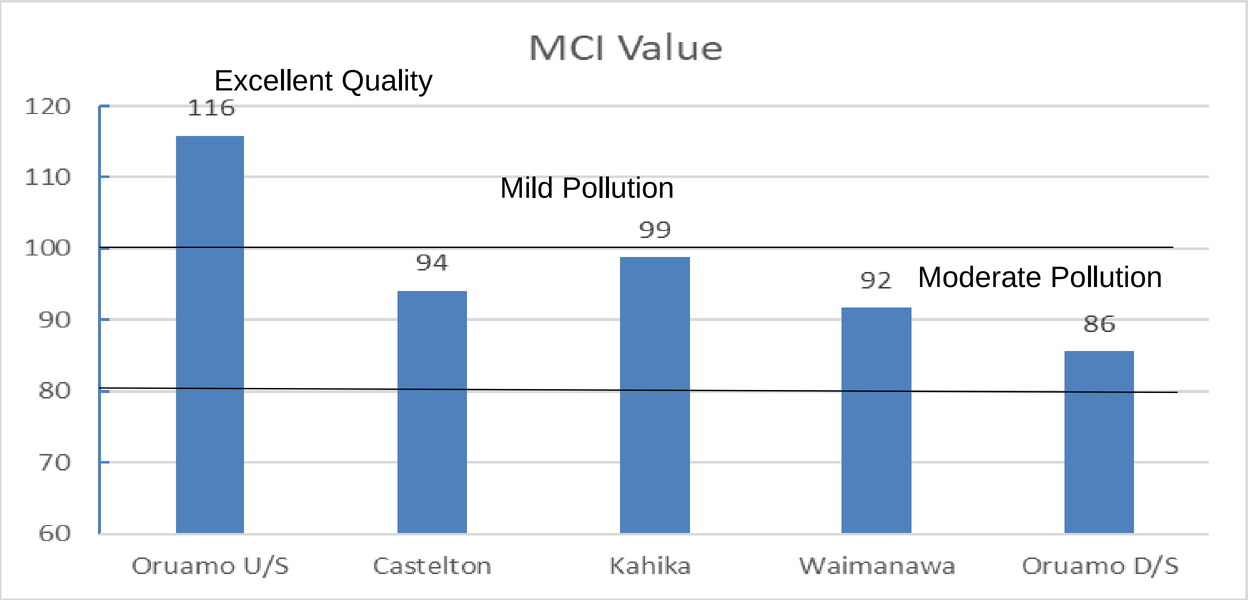


Figure 21: Mean SBMCI Values for The Sites

Figure 21 shows the mean soft bottom macroinvertebrate community index (SBMCI) scores for the sites. Oruamo U/S has the highest ecosystem health very close to excellent water quality while Castleton Creek and Kahika Creek show mild pollution followed by Waimanawa and Oruamo D/S which show moderate pollution. A future community aspirational goal could be to see Oruamo U/S remain above 120 and the remaining sites to remain above 110.

An interesting trend is evident when analyzing the increase in the number of macroinvertebrate types (taxa) by undertaking Kaipātiki school stream care visits.

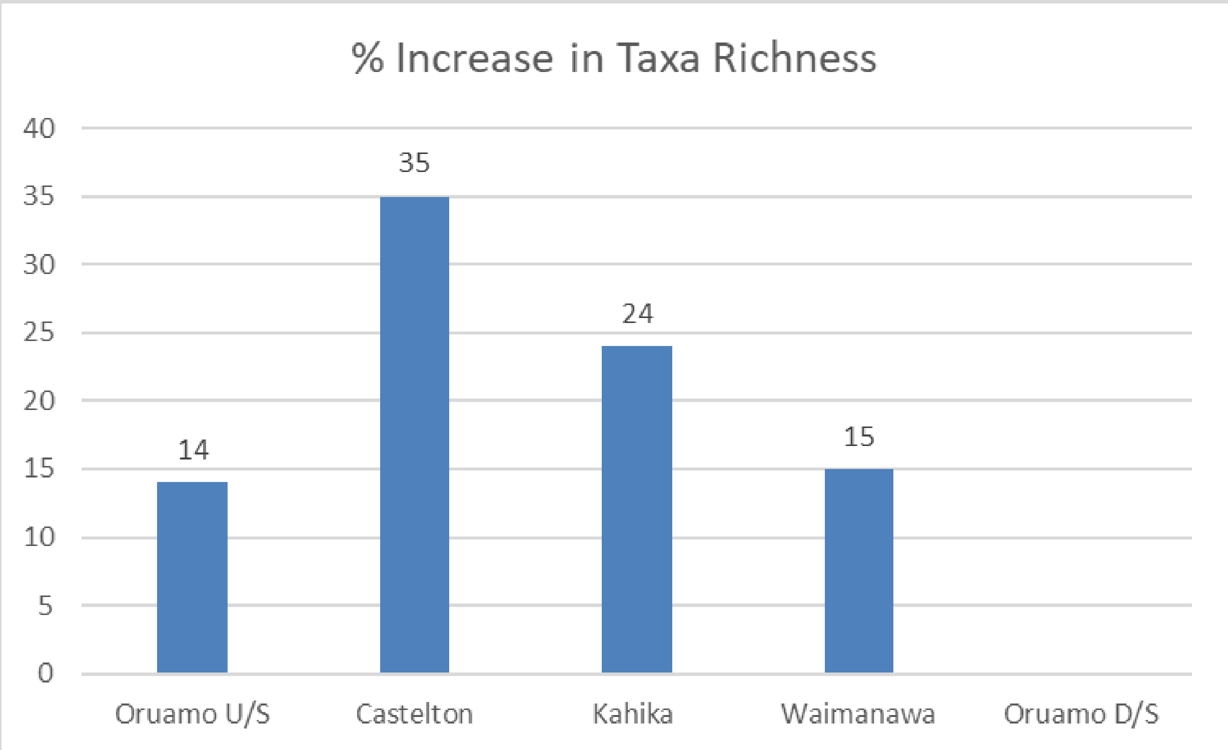


Figure 22: Increase in taxa richness by undertaking school workshops

Figure 22 shows that by undertaking Kaipātiki school stream monitoring that our knowledge of macroinvertebrate taxa richness increases between 14 – 35% compared to a once off survey undertaken in winter and summer. This trend is expected as once off surveys often miss rare macroinvertebrate taxa, furthermore macroinvertebrates have patchy distributions across a stream transect therefore some taxa are easily missed with a once off survey. Note the Oruamo D/S is not visited by any school so we are unable to report on this aspect for this site.

Two Oruamo Creek sites have been monitored by Auckland Council since 2005. The following plots show time series analysis of how SBMCI values have tracked since this time.

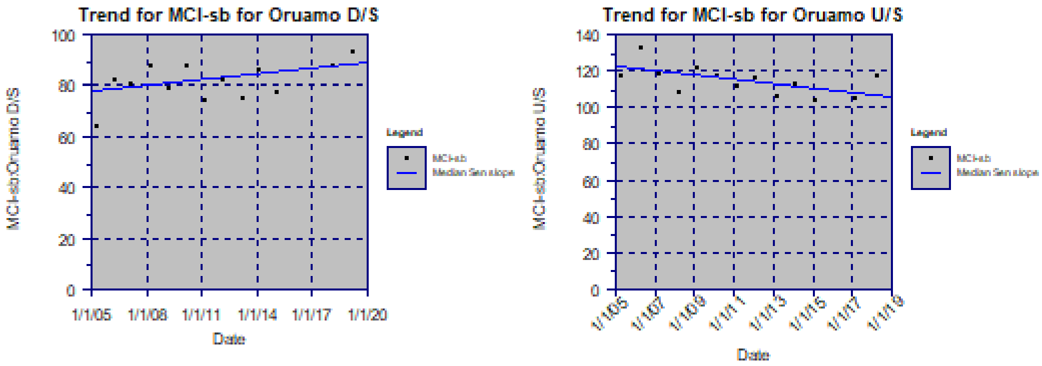


Figure 23: Time Series Analysis of Oruamo Creek Sites

Figure 23 shows that the Oruamo D/S is showing improvement over time while the Oruamo U/S site is showing a decline over time. This is an unexpected result as the Oruamo U/S site is largely devoid of stormwater inputs. Statistical testing reveals that the time series trend for Oruamo Creek D/S is likely (probability 90%) and for Oruamo Creek U/S is extremely likely (probability 99%). The reason for these trends is unclear and warrants further investigation (see Appendix 3).

Signature Macroinvertebrate Species

The following photos show some sensitive macroinvertebrate species that inhabit our local awa. I refer to these as signature species as they are sensitive to pollution and have specific habitat requirements to ensure their continued survival. Any increase in the abundance of these species would indicate improved ecosystem health, conversely any decline in these species would indicate declining ecosystem health.

Photo 6: Sensitive macroinvertebrates unique to Oruamo U/S site. Photos taken from the Landcare Research Identification Guide.

Photo 6 shows the sensitive macroinvertebrates unique to the Oruamo U/S site. The three mayflies (Arachnocolus top left, Ameletopsis top right and Austroclima mid left) are particularly sensitive to pollution and have tolerance scores of 10,8.1 and 6.5 respectively. They require a thin film of periphyton (algae) to graze upon with cool clear water as sediment laden water can irritate their gills. Typically, these species are found in bush covered catchments with well oxygenated cool water with a gravel base to the stream. Ameletopsis is a predator feeding off other macroinvertebrates

The uncased caddisfly Edpercivalia (mid right) is also a predator feeding off other macroinvertebrates and has a tolerance score of 6.3. The cased caddisfly Pycnocentria (bottom left) is also commonly found in bush covered catchments with cool clear water and has a tolerance score of 6.8. They are collector gatherers feeding on a variety of periphyton and detritus. The Dobson fly Edpercivalia (bottom right) is also common in bush covered catchments with cool clear water. They are also predators feeding off other macroinvertebrates and have a tolerance score of 7.3.

Photo 7: The Koura

The koura (Paranephrops planifrons) is unique to the Oruamo creek (U/S and D/S) and Kahika creek. This species of invertebrate is often referred to as a keystone species because it feeds off biofilms growing on wood. In doing so it breaks down organic matter to a size that other animals and bacteria can feed off. Any decline in koura could result in a decline of other species of macroinvertebrates. Koura are also culturally significant to Maori as a mahinga kai species that is taonga. The Koura has a pollution tolerance value of 8.4 meaning it is particularly sensitive to pollutants in water. Its' presence in the Kahika Creek is surprising as this creek is moderately polluted.

Photo 8: Freshwater Mussel – Kakahi taken from NZ stuff website

Freshwater mussels are under threat and are declining, both in New Zealand and worldwide. This decline has been attributed to the loss of habitat associated with river regulation, eutrophication, and other types of pollution, and possibly through loss of the host fish on which completion of the life cycle depends.

Kākahi (freshwater mussels) are common and widespread throughout New Zealand, in habitats ranging from small, fast-flowing streams to lakes. Kākahi are unique to the Oruamo D/S site and were recently discovered by Neil Henderson during some volunteer monitoring of the creek. Kākahi are also of cultural significance to Maori as a mahinga kai species. This species of Kākahi (Hyridella menziesii) has a pollution tolerance value of 6.7 being relatively sensitive to pollution in streams.

Photo 9: Orthopsyche Caddisfly

The caddisfly Othropsyche is an omnivore feeding on any detritus or other invertebrates that it captures by making an underwater web. These caddisflies are characteristically in cool clear bush covered catchments. They are unique to the Oruamo U/S and Kahika creek sites. The Orthopsyche caddisfly has a pollution tolerance value of 7.5 so their presence in the Kahika creek is surprising as this creek is moderately polluted.

Photo 10: The Ptilodactylidae Beetle

The Ptilodactylidae beetle is unique to the Oruamo U/S and Waimanawa Creek sites. These beetles are common in bush covered catchments with cool clean water. They have a pollution tolerance value of 7.1 meaning they are quite sensitive to pollution.

Fish Monitoring

Fish have also been monitored by setting G minnow and fine mesh fyke nets the night before each Kaipātiki school stream care monitoring survey. All fish captured are identified measured and returned to the water. The data is then entered into the New Zealand Freshwater Fish Database.

The database contains 169 records for Oruamo Creek since 1996. Of these records 76 are from Kaipātiki school stream care monitoring (45%). The creek hosts a variety of native fish including longfin eel (Anguilla dieffenbacchii), shortfin eel (Anguilla australis), redfin bullies (Gobiomorphus huttoni), common bullies (Gobiomorphus cotidianus), Koura (Paranephrops, planifrons), and banded kokopu (Galaxias fasciatus). More recently a sighting of giant kokopu (Galaxias argentus) was recorded by white bait connection. This is a particularly important finding as this species of whitebait is very rare in Auckland. Inanga (Galaxias maculatus) have also been sighted in the lower reaches of this creek.

A white bait spawning survey is currently underway and hay bales have been positioned in the lower reaches of the Oruamo creek to improve the white bait population spawning success in this creek.

There are no exotic pest fish species in this creek which is very encouraging.

There are 14 records for Castleton Creek in the NZFFDB since 2017 all of which are from Kaipātiki school stream care monitoring. The creek contains longfin eels and banded kokopu. Prior to the commencement of this school stream care programme, nothing was known about its biota. No exotic pest fish species have been found in this creek.

There are 19 records for Kahika Creek in the NZFFDB since 2017 all of which are from Kaipātiki school stream care monitoring. The creek contains longfin eels, banded kokopu and inanga. Prior to the commencement of this school stream care programme, nothing was known about the biota of Kahika Creek. No exotic pest fish species have been found in this creek.

There are 31 records for Waimanawa Creek in the NZFFDB since 1998 of which 18 (58%) are from Kaipātiki school stream care monitoring. The creek contains banded kokopu, shortfin eels, longfin eels and inanga. No exotic pest fish have been found in this creek.

The following photos show the fish we have found in our awa to date.

Photo 11: Native fish captured during school stream care surveys

Photo 11 shows some of the native fish captured during Kaipātiki school stream care surveys. The red markings of the redfin bully (top left) is prominent in the male fish, another bully commonly found in Auckland Streams is the common bully (top right). Inanga (mid left) are common in the lower reaches of the Oruamo Waimanawa and Kahika Creeks. Banded kokopu (mid right) are common at all sites. Shortfin eels (bottom) are common in the lower reaches of most creeks in New Zealand and have been recorded in the Waimanawa and Oruamo Creeks.


Photo 12: Giant kokopu (left) photo taken by Helen McCaughan DOC, longfin eel (right) photo taken by EIA Ltd.

Photo 12 shows the giant kokopu and longfin eel. Many of the eels found in our awa are of a good size, occasionally exceeding. 1m in length. This indicates a healthy fishery with a good supply of adults to ensure continued sustainability of the fishery.

Some key characteristics of our native fish described by McQueen (2013) are described below.

Table 3: Fish characteristics

Name	Diadromy	Habitat Requirements	Threat Status
Redfin Bully (*Gobiomorphus huttoni*)	Amphidromous- adults spawn in freshwater with larvae going to sea for a short period before returning to freshwater to mature	Deep water and larger substrate during the day then moves to finer substrate shallower water during the evening	At risk declining
Common Bully (*Gobiomorphus cotidianus*)	Facultatively amphidromous. Readily forms non diadromous populations	Prefers slower flowing water, generally widespread	Not threatened
Inanga (*Galaxias maculatus*)	Amphidromous	Backwaters or slack water of lowland rivers lakes and streams.	At risk declining
Banded kokopu (*Galaxias fasciatus*)	Amphidromous	Small overgrown tannin stained streams, often in lowland wetlands or swampy forest. Often inhabiting pools of slow	Not threatened

		flowing streams	
Giant Kokopu	Amphidromous	Gently flowing swampy pools, stream and lake edges with thick riparian vegetation. Lurks around bank cover log jams and boulders in pools waiting to prey on invertebrates. Strong social hierarchy	At risk declining (partial decline)
Shortfin eel (*Anguilla australis*)	Catadromous – adults migrate to the sea to spawn; larvae spend a short time at sea before migrating back to freshwater to mature	Lowland swamps lakes and streams	Not threatened
Longfin eel	Catadromous	Common where stream cover exists, a generalist of rivers and lakes. Prevalent in undercut bank areas.	At risk declining

Table 3 shows that all of the native fish in our awa are diadromous meaning they require fish passage to the sea to complete their lifecycle. If a barrier to migration like an elevated culvert or weir was in our awa it would limit the natural fish distribution. This could be the case for Castleton Creek as it only has two fish taxa (longfin eel and banded kokopu) both of which are particularly good climbers. It could be that a partial barrier exists somewhere down this creek that is limiting upstream migration for other species of fish.

The index of biotic integrity for fish was developed by Joy and Death (2004) providing an overall index of river condition based on the fish fauna identified at a stream site. The inputs to the model are altitude and distance to sea for which the model grades the stream according to poor (<10), fair (10-30), good (30-45) or excellent (>45) based on the fish recorded for the site. The following table shows the fish IBI outputs for the 5 monitoring sites.

Table 4: Fish IBI Scores

Site	Altitude (metres above sea level)	Distance from sea (km)	Fish IBI score	Descriptor
Oruamo U/S	31.3	1.9	58	Excellent
Oruamo D/S	28.3	1.1	58	Excellent
Castleton	53.3	1.3	38	Good
Kahika	23.5	1.0	38	Good
Waimanawa	5	0.4	40	Good

Table 4 shows that the Oruamo Creek sites have an excellent grade for river condition. This awa is largely devoid of any fish barriers along its length so this result is expected. The remaining sites have a good grade for river condition.

A community future aspirational goal could be to see the fish IBI scores improve for the Castleton, Kahika and Waimanawa Creeks.

Litter Survey

On 19 May 2019 a litter survey was conducted at all monitoring sites except Waimanawa which was closed for track maintenance so access was not possible. The Waimanawa site was later surveyed on 2 June 2019. For each survey a 100m reach was walked and any debris recorded. The following table shows the amount of debris found in each creek. Recorded debris includes that which is found in the creek and immediately adjacent to it to streambank height.

Table 5: Litter Survey Results

Castleton Creek	Oruamo U/S	Oruamo D/S	Kahika Creek	Waimanawa Creek
Steel Waratah 1		Aluminium Can 2	Aluminium Can 6	Aluminium Can 2
Fence Post 1				Rubber Glove 1
44 Gallon Drum 1				Wheelie Bin Ticket 1
Plastic Pipe 2		Plastic Pipe 1	Plastic Pipe 1	
Yoghurt Container 1			Yoghurt Container 1	
Glass Bottle 1	Glass Bottle 1	Glass Bottle 1	Glass Bottle 1	
Fibrolite Board 1		Broken Jar 1		Piece of Fibrolite Board
Sealant Tube 1				
Polystyrene 1				
Plastic Ribbon 1				
	Plastic Bag 4	Plastic Bag 6	Plastic Bag 1	
			Corflute Real Estate Sign 6	
	Metal Grate 1	Car Tyre 2	Car Tyre 3	
	Fishing Float 1	Steering Wheel 1	Plastic Ring 1	
	Cake Grill 1	Roofing Iron 1	Plastic Stool Footing 1	
	Plastic Spoon 1	Plastic Spoon 1	Plastic Seat 1	
	Bottle Cap 1	Computer Wiring 1	Plastic Baby Bath 1	Bottle Cap 1
	Piece of iron 1	Bed Sheet 1	Plastic Straw 1	
	Small wheel		Plastic Pot 1	
	Plastic Bottle 2		Plastic Bottle 4	
			Hair Spray Can 1	
			Plastic Gun 1	
Plastic Wrappers 2		Plastic Wrappers 2	Plastic Wrapers 5	Plastic Wrappers 2
			Plastic 25l Vat 1	
			Plastic Road Marker Pipe 1	
		Plastic Corrugating 1	Plastic Corrugating 1	Plastic Fragment
	Cloth 1	Sweat Shirt 2	Golf Caddy 1	
		Shorts 1	Plastic Bucket 1	
	Packaging tape 1	Packaging Tape 1	Desk Fan 1	Packaging Tape 1
		Vest 1	Sports shoe 2	
	Scooter 1	Bike Crank 1	Plastic Umbrella Base 1	
		Pram Wheel 1		

Table 3 shows that the Kahika Creek has the most amount of debris (48) followed by Oruamo D/S (31), Oruamo U/S (17), Castleton (13) and Waimanawa (12).

The litter is predominantly plastic (63%) followed by steel (14%) and clothing (8%).
A community clean up is scheduled for Kahika Creek on September 3 2019.

Future annual surveys of litter will be conducted at each stream site as part of this monitoring programme to gauge whether litter levels are increasing or declining over time.

Community Stream Hui

On Wednesday August 14 2019 a community hui was held to discuss the findings of the current Kaipātiki Stream Care programme. Students from each school presented their findings to the audience and attendees were separated into catchment groups to set aspirational goals for each awa. The following bullet points summarise the aspirational goals that had been mind mapped.

Waimanawa Creek – Birkenhead Primary

- Lobby Parliament for better environmental change
- More Native Fish
- More Koura in the Streams
- Beat Kaipātiki's record/Stream
- More Plants
- Make a Sign to Stop Plastic

- Community Clean-Up
- More Invertebrates
- More People Looking After It
- Ask Auckland Council to Ban Plastic
- Make a Treaty About not Littering and get Everyone to Sign it
- Make it Clean Enough to Drink
- Create a Non-Fiction Story About Eels
- Educate Adults
- More Varieties of Fish
- Help the Stream in the Future
- Getting More People to Help Other Streams and Improve Water Clarity
- Signs About the Importance of Water Clarity PH
- Add Signs that Say what is in the Stream
- When we see Rubbish Actually Pick it up
- Consequences for Littering
- Remove Pollution
- Come back in 10 Years and Find we are still Helping the Stream
- Ask Jacinda Ardern to make Stronger Laws to Look After our Creeks
- To Save All the Creeks

Castleton Creek –Verran Primary

- A Fish Food Stand
- Get Rid of Pollution
- More Species of Fish
- Set up Community Events to Plant Plants and Stop Erosion
- Get Rid of all the Metal, Plastic etc.
- Encourage Future Generations to be Enviro Leaders
- Wai Care Sessions During School
- Signs about the Journey of the Longfin Eel to Tonga and Back
- Make a Video and Share it on Facebook, YouTube etc.
- Link to a Longfin Eel Website to Convince People
- More Bins
- Whitebait Breeding Center
- Educate with Interesting Stories and Pictures
- Keep Testing the Creek and Make Sure it Improves
- More Fresh Water Life
- Cleanup Events Once a Month
- Big Fines for Polluters e.g. A $100 Fine or More
- For Developments Ensure Sediment Controls are Always in Place
- Add Hidden Cameras to Catch Vandals and Polluters
- Posters and Articles of Facts about Endangered Fish and why we need to Save them
- Join Clean-Up Events
- Add small Pumps to keep the Water Flowing Fast
- Teach Wai-Care to more Schools

Kahika Creek –Birkdale Intermediate

- Less Litter
- Decrease the Amount of Stormwater
- More Fish Species
- Add Signs Showing what's in the Creek
- Use Less Detergent at Home
- Put up Signs Made by Kids
- Make the Path to the Stream Bank more Accessible
- More Invertebrates
- Less Stream Bank Erosion
- Get Rid of Chairs from the Creek
- Connect with Other Schools
- Make Features
- Clean up the Environment around the Stream to Prevent Anything Falling in
- Show People how they're Harming Stream Life
- Make Sure our Stream can be the Best it Can be
- Go to the Creek for Testing/Picking up Litter more Often
- Repaint the Bridge
- Spread the Word of how People are Littering and what Happens when it Reaches the Creek
- When we See Litter Actually Clean it
- What can we do About the Stormwater Drains that feed into our Creek and Overflow it Bringing Rubbish with it?
- Show People our Rare Fish and get them to Care More
- Put up Signs with Facts about Kahika
- Expand Wai-Care to more Primary Schools and Colleges
- Make the Bank Less Slippery
- Stormwater Systems need Sorting out
- Bridge Sign Needs to say the Creek's Name Rather than Bridge
- A Mix of Baby and Adult Longfin Eels

Oruamo Creek –Windy Ridge Primary

- More Varieties of Fish
- More Boardwalks Across the Creek
- Seeing more Endangered Fish
- Protection of Native Trees on Private Property so they Don't get Cut Down
- Be Able to Swim in Kaipātiki
- Support a School to Start testing Downstream once a term
- No Plastic Bags
- Penalties for People who pollute the Creek
- Higher Water Levels
- More Native Bush
- More reserves Around the Creek
- More Shore Disinfectant Stations
- Less Stinky
- Rubbish bins
- Educate the Community

- A Native Gardening/Planting Group
- Signs with Information about the Creek
- Make a Tidy-Up Group
- To be able to See Longfin Eels in the Creek
- More Wetlands
- Less Litter and Plastic
- To have Advertising about the creek
- Safe Creek App
- More Accessible
- Protect it from Storm Weather
- Ask Jacinda Ardern to make Stronger Laws Around the Environment
- More Koura
- School Trips to the Creek so more Kids can Learn About them
- More Kind of Fish
- More Bush/Wetland
- To Still be Testing in 10 years

It was recognised that ecological improvements are needed for all catchments with a strong request for greater fish diversity, reducing pollution, community clean ups, educational signage, continued monitoring, bigger fines for polluting, connecting with more schools, and a drive for swimmable and drinkable stream water.

These bullet points were sent to members of the Kaipātiki Local Board who attended the hui. Our intention is to work with as many agencies as possible to ensure that we are realising these goals in the next 10 years.

Conclusion

The Kaipātiki School stream care monitoring programme has provided our community with a robust and scientifically defensible data set from which future comparisons can be made. It has engaged our young people and prepared them as environmental champions, scientists and advocates for the awa of the Kaipātiki Rohe. It has created a ground swell of support from our local community and the goal setting has set a precedent which we must achieve for our future generations in the next 10 years.

We have sought funding from the Ministry of Business Innovation and Employment for a further 1 years monitoring and intend to include two high schools (Birkenhead College and Northcote College) for additional stream surveys of E. coli bacteria and suspended solids monitoring. This monitoring will strengthen our current data set and enable our community to track changes in environmental quality of our streams further.

Stormwater mitigation measures are required to lift the ecosystem health of our awa. We are fortunate to be dealing with fairly short steep catchments that have comparatively small catchment areas, making mitigation works less exhaustive than larger stream catchments.

We encourage adaptive management in our restoration measures at a small scale to begin with to see what measures work best for our awa. We would like our aspirational goals tabled with key decision makers of water management of our rohe. This monitoring has highlighted where the targeted rate for our stream catchments could be channelled to help us achieve the stated aspirational goals for our awa.

Teachers and students participating in the stream care monitoring have provided positive feedback for the continuation of this monitoring programme (see Appendix 1) and we are excited to be expanding this to high schools dependent on funding.

AKNOWLEDGEMENTS

I would like to thank the Birkenhead Licensing Trust and the Kaipātiki Local Board for funding the first 2 years of this programme. Without this funding it would have been difficult to have proceeded with the stream surveys. I would like to thank Janet Cole and Sam Tu'itahi from Kaipātiki Project for helping with organising the hui and organising funding applications for the project to continue. I would finally like to thank the highly enthusiastic teachers I have worked with, Maureen Robertson (Verran Primary School), Heather Nicholson (Verran Primary School), Jocelyn Sanders (Birkenhead Primary School), Inge Millard (Windy Ridge School) and Craig Watson (Birkdale Intermediate School). The dedication and support offered by these teachers for this stream care monitoring programme has been overwhelming.

Auckland Council Wai Care have assisted with updating existing stream care kits for each school. We look forward to working with you in the foreseeable future.

Funding to date has been provided by the Birkenhead Licensing Trust (year 1) and Kaipatiki Local Board (year 2), we are very grateful you have provided us with financial support to make this project come to fruition.

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APPENDIX 1: TEACHER REFERRALS

TO WHOM IT MAY CONCERN

Verran Primary School in Birkenhead has been involved in testing their local stream over the past few years with the help of the Wai Care Team at the North Shore Council.

When they first got involved we had in class sessions prior to going out into the field to carry out the standard observations and tests. On one or two special occasions we were able to sample the macroinvertebrates that inhabit the stream and once or twice the children have been lucky enough to discover a koura or kokopu.

Most recently funding for this programme has been dramatically reduced and so the school has had far less support from the Wai Care specialists. This has been most unfortunate as the children learn best when the learning is out in the field, community based and experiential.

Brett Stansfield is a local Freshwater scientist who has offered to help us continue and extend our work in this area. He has volunteered his time and expertise over the past two years and has been able to continue the children’s education around freshwater stream health and habitat protection.

Brett has gone to extra trouble to engage the children’s interest by setting his fish traps the evening prior to a session with the children. On several occasions they have been the luckiest students alive to help Brett discover long fin eels in the trap and study and learn more about them up close.

We know how much these experiences mean to the children and therefore speak very highly in favour of a programme for schools developed and delivered by Brett Stansfield around freshwater ecology.

This programme would be special and relevant to all schools; primary, intermediate and secondary as it is aligned with the Science curriculum, largely experiential and delivered by a qualified scientist who is understanding and respectful of the students and their needs.

Verran Primary are very keen to continue our involvement with Brett and his teaching and hope he gets all the support he needs to offer it to many other schools in the area.

Yours faithfully,

Maureen Robertson, T.I.C. Education for Sustainability
Verran Primary School

Jeanette Dunning
Principal
Verran Primary School
Birkenhead
Auckland

Windy Ridge School,
54 Seaview Rd,
Glenfield, 0629
2nd July, 2019

To whom it may concern,

For the last couple of years Brett Stansfield has been working with me and the Windy Ridge Enviro team to monitor the health of the Eskdale Stream and to provide regular data to the Council through their website.

He meets with us every term at the stream so that the students can measure the clarity of the water, get the ph balance, measure the temperature and the flow of the stream. They also collect a sample from the stream and identify the stream life found in it. These are all recorded.

Brett sets traps the night before and these are collected with much enthusiasm from the students to see the various stream inhabitants that might be inside. These are all carefully measured then put back into the stream.

Brett has a great manner with the students and shows patience while allowing the students to learn from him. He brings all the equipment with him which is really helpful as then we just have to turn up. He inspires us to keep monitoring the stream with his regular meeting times and we look forward to the visits.

I feel the information and data we provide the council by doing this and the encouragement Brett gives our students to participate are really valuable and I hope to be able to continue the work with him. We are looking forward to presenting our findings to the local community next term at the Hui Brett is organising.

Kind regards,
Inge Millard - Deputy Principal
28 July 2019

28 July 2019

To whom it may concern

200 Birkdale Road Birkdale Auckland 0626 P: 094839168
E: office@bis.school.nz www.bis.school.nz

This is a referral for Brett Stansfield who has been supporting Birkdale Intermediate School with Wai Care. He is also an active member of our school community and member of our Board of Trustees.

The children who are involved in the stream care programme are developing a keen interest on how best to improve the health of our local eco systems. The visits to our local stream are informative, practical and eye opening to our students.

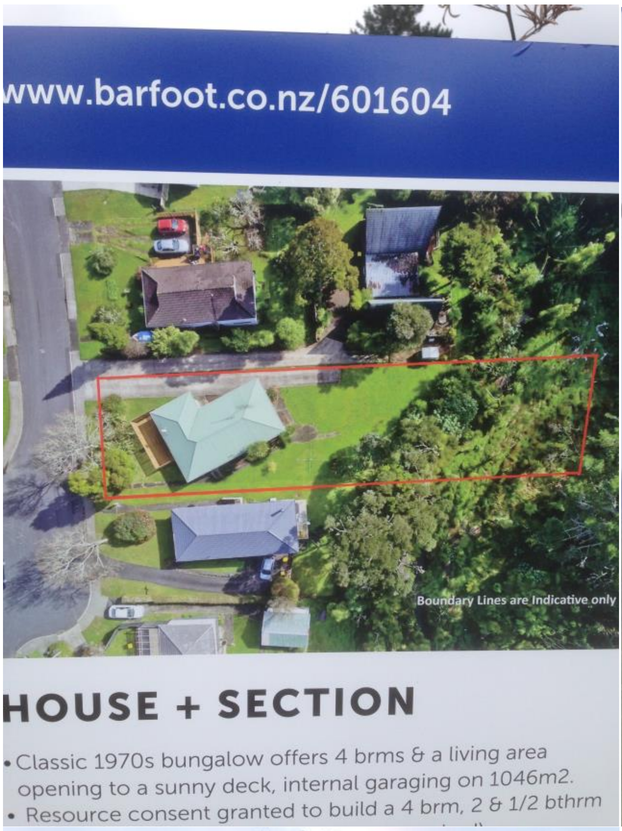
Brett is always well prepared with these sessions so that children can experience as much as possible, in the short amount of time available. They are involved in recording and validating the data and are quite often amazed by the nature of the findings.

Brett's passion about the environment comes through in his teaching and this is appreciated by the children who attend. These sessions inspire our young adults that they can make difference in caring for our local eco systems.

Regards

Craig Watson
Deputy Principal
Birkdale Intermediate School

APPENDIX 2: URBAN DEVELOPMENT PRESSURES IN THE CASTLETON CREEK CATCHMENT



Community Science Results Summary

Appendix 3:Time Series Results for Oruamo Creek.

Assessment of trend using Mann-Kendall test and slope analysis with median values in each time period of 1 month

Time periods used in analysis are: January February March April May June July August September October November December

If the sample size is less than 10 small sample size probabilities are used otherwise a normal approximation is used to determine P value

Site	Variable	Samples used	Sampling period	Mean	Maximum	Minimum	Median value	Kendall statistic	Variance	Z	P	Median Sen slope (annual)	Percent annual change	95% confidence limits for slope	Trend direction and confidence	Probability
Oruamo D/S	MCI-sb	13	30/3/05 - 19/2/19	81.023	92.700	63.400	82.060	22	268.667	1.281	0.20	0.73	0.89	-0.523 to 1.869	Increasing trend likely	0.906
Oruamo U/S	MCI-sb	13	30/3/05 - 25/2/18	113.974	132.750	103.470	115.390	-36	268.667	-2.135	0.033	-1.19	-1.03	-2.54 to -0.11	Decreasing trend extremely likely	0.989