Briefing Paper

Comparison of Rolleston Stormwater Runoff Quality with Other Data

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Introduction

Pattle Delamore Partners Limited (PDP) has been commissioned by Selwyn District Council (SDC) to report on the monitoring carried out on the 18th January 2011 at Vasari Grange and Izone during a rainfall event. Four stormwater samples were collected at each site throughout the rainfall event, the samples were analysed at Hill Laboratories for suspended solids, heavy metals - total and dissolved, nitrogen, phosphorous, E. coli and total petroleum hydrocarbons (TPHs). The samples were collected at two hourly intervals after approximately, 0.6 mm, 3.5 mm, 8.0 mm and 16.0 mm of rainfall. SDC also required that the results be compared with generic stormwater data.

Vasari Grange

Vasari Grange is a 27 lot residential subdivision in Rolleston township. Grab samples of stormwater flow in a kerb and channel comprising road and driveway runoff was collected 4 times throughout a rainfall event. The area of the road catchment from which the samples were taken is approximately 1110 m^2. In addition there would have been some runoff from driveways and footpaths at the front of properties. The concentrations of determinands found in the samples are shown in Table 2 (attached) along with stormwater monitoring results from other sites to allow for comparison of values. Reported results for Vasari Grange and Izone are maximum concentrations from the four samples taken during the First Flush (FF). It should be noted that other results are Event Mean Concentrations (EMC) and it is likely that EMC will under estimate the FF concentration.

Figure 1 shows the normalised concentrations for determinands in the Vasari Grange samples. Normalised concentrations were obtained by dividing each of the four concentrations by the maximum respective concentration recorded. Figure 1 shows that the first sample (after 0.6 mm of rainfall) contained the highest concentrations for all determinands. The second highest concentrations were generally recorded in the third sample whilst the third highest concentrations are generally recorded in the second sample. This is slightly unusual, generally the concentration of a determinand would be expected to decrease as cumulative rainfall increases, i.e. the highest concentrations are found

at the start of the event and the lowest at the end of the event with concentrations taken during the event decreasing as the event goes on. One factor that may account for this trend is the intensity of the preceding rainfall. Intuitively, higher rainfall intensity may result in greater determinand concentrations. Figure 2 shows the cumulative rainfall profile and the time each sample was taken. The intensity of the rainfall event before each sample was taken was calculated. These results are shown in Table 1 below.

Table 1: Rainfall Intensity at Time of Each Sample

Sample Number	Intensity (mm/hr)
1	1.3
2	2.7
3	9.2
4	2.5

The higher rainfall intensity before sample 3 was taken may have resulted in a greater dislodgement of material from the impervious services which then resulted in a higher concentration of the determinands. The high concentration after the first sample can be attributed to the initial runoff generally containing higher determinand concentrations, also known as the first flush effect.

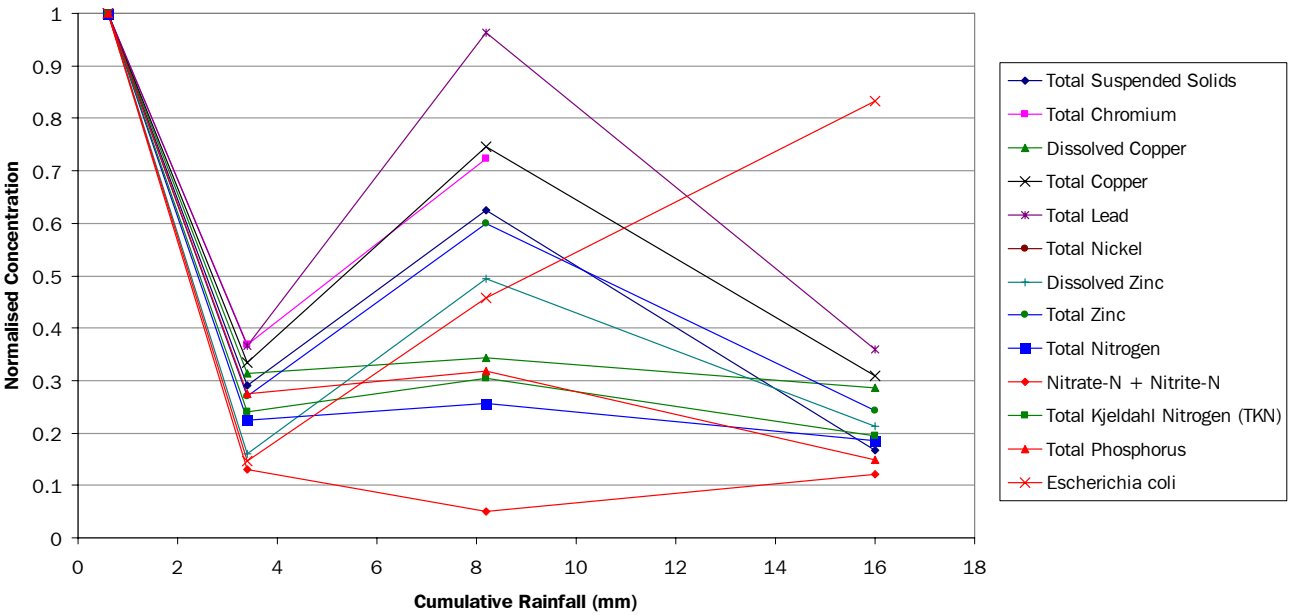

Figure 1: Plot of Normalised Determinand Concentrations for Vasari Grange

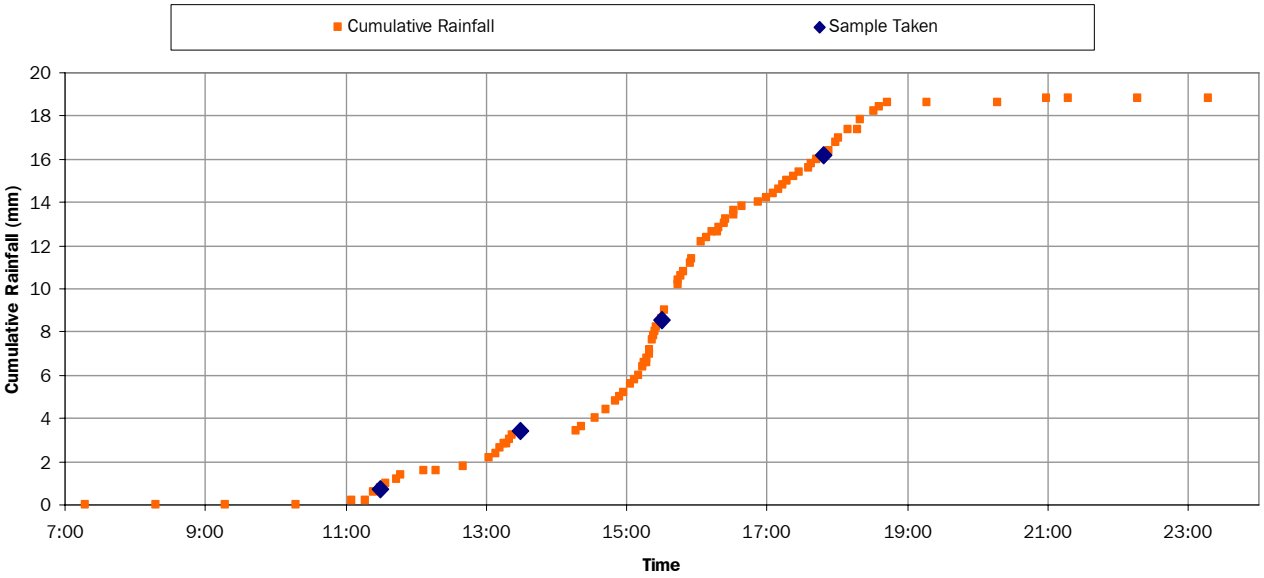

Figure 2: Plot of Cumulative Rainfall and Sampling Time

Note that in addition to the determinands plotted in Figure 1 the samples were also analysed for total petroleum hydrocarbons (TPH). All the TPH results were below the level of detection. The only determinand which has concentrations that exceed the Maximum Acceptable Value (MAV) or Guideline Value (GV) in the Drinking Water Standards for New Zealand (DWSNZ) is E. coli where the concentration of all samples was greater than the MAV of less than 1 per 100 mL sample. E. coli values did not follow the same trend as other determinands throughout the storm. From the data we have it appears E. coli values are random and do not follow any observable trend. High concentrations of E. coli are not unusual in stormwater.

Figure 3 shows the concentrations of the recent round of monitoring at Vasari Grange in comparison to historical monitoring carried out in other residential subdivisions. Data for the plot (with the exception of Vasari Grange) was obtained from the Christchurch City Council's (CCC's) Waterways Wetlands and Drainage Guide (WWDG) which provides EMC values not FF concentration values. Results from Vasari Grange are FF concentration values. Not all samples had recordings for all concentrations and therefore they are not displayed in Figure 3. Figure 3 shows that Vasari Grange has the lowest recorded concentrations of total copper and zinc. Figure 3 also shows a lower metal concentration for samples taken more recently. This may imply that stormwater is becoming "cleaner". This could be that more roofs use colour steel which is factory bonded paint on zinc-alum corrugated iron. Additionally modern vehicles do not leak as much as older vehicles, and lead has been removed from petrol. It should be noted that roofwater in the Vasari Grange subdivision is discharged directly to ground via separate sealed systems and does not contribute to the runoff sampled.

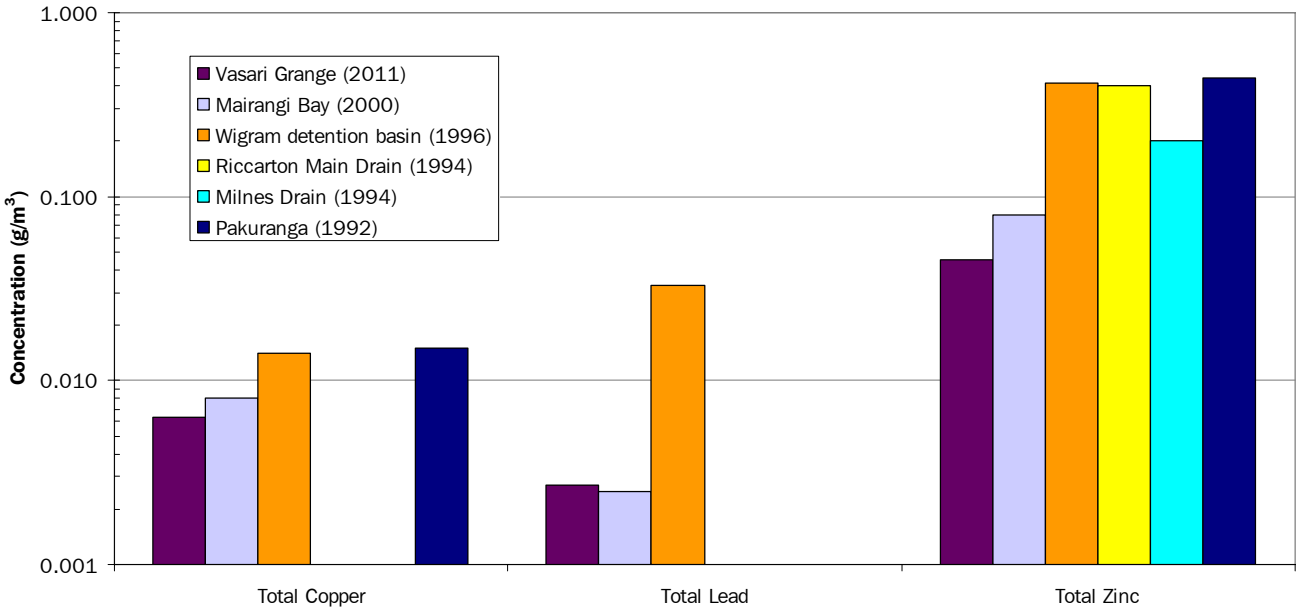

Figure 3: Recorded Determinand Concentrations of Stormwater for Various Residential Areas

Izone

Izone is a commercial/industrial subdivision adjacent to Rolleston township. Once again 4 grab samples were taken of kerb and channel flow. The contributing area of the road catchment was 1200 m^2. In addition there would have been some runoff from driveways and footpaths.

The concentrations of determinands found in the samples from Izone are shown in Table 2 (attached) along with other stormwater monitoring results to allow for comparison of values. Reported results for Izone and Vasari Grange are maximum concentrations from the four samples taken during the First Flush (FF). It should be noted that other results are Event Mean Concentrations (EMC). It is likely that EMC will under estimate the FF concentration.

Figure 4 shows the normalised concentrations for determinands in Izone. Normalised concentrations were obtained by dividing each of the four concentrations by the maximum respective concentration recorded. Figure 4 shows that the first sample (after 0.6 mm of rainfall) contained the highest concentrations for almost all determinands. Once again the second highest concentrations were generally recorded in the third sample whilst the third highest concentrations are generally recorded in the second sample. As discussed with the Vasari Grange site, one factor that may account for this trend is the intensity of the preceding rainfall. Intuitively, higher rainfall intensity may result in greater dislodgement of determinands and therefore higher determinand concentrations.

Note that in addition to the determinands plotted in Figure 4 the samples were also analysed for TPH. All the TPH results were below the level of detection. The only determinand which has concentrations which exceed the MAV or GV in the DWSNZ is E. coli. The concentrations of all samples were greater than the MAV of less than 1 per 100 mL sample. Once again E. coli results showed no observable trend. High concentrations of E. coli are not unusual in stormwater.

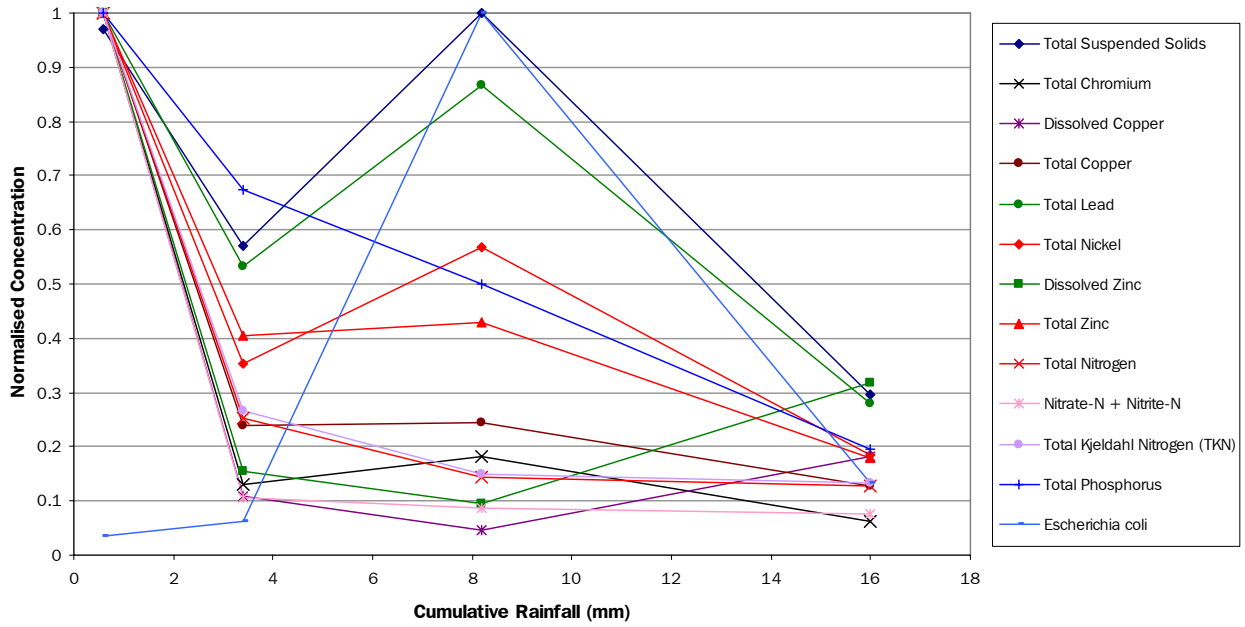

Figure 4: Plot of Normalised Determinand Concentrations for Izone

Figure 5 shows the concentrations of the recent round of monitoring at Izone in comparison to historical monitoring carried out in other commercial/industrial areas. Data for the plot (with the exception of Izone) was obtained from the CCC's WWDG which provides values for EMC not FF concentrations. Results from Izone are FF concentrations. Not all samples had recordings for all concentrations and therefore they are not displayed in Figure 5. Figure 5 shows that Izone has the lowest recorded concentrations of total lead and zinc.

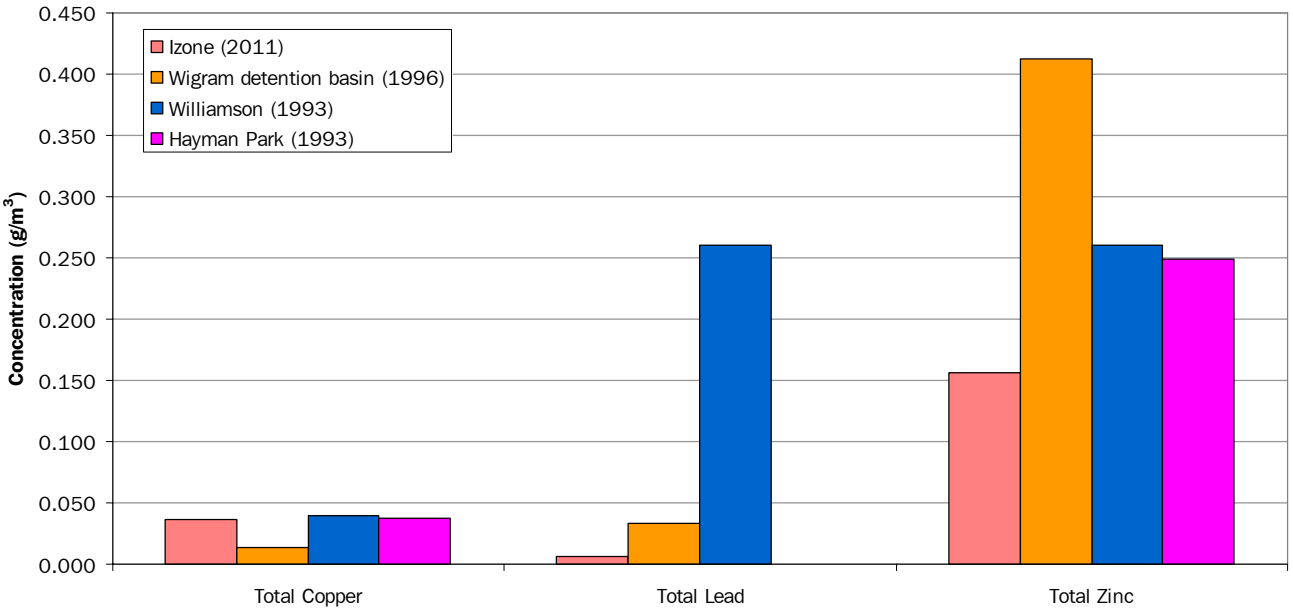

Figure 5: Recorded Determinand Concentrations of Stormwater for Various Commercial/industrial Areas

Discussion and Conclusion

In general, the concentrations of determinands were greater at the Izone site than Vasari Grange site. This is expected as generally concentrations of determinands in stormwater runoff from industrial areas are higher than stormwater runoff from residential areas. All values were well below the relevant DWSNZ MAV or GV, with the exception of E. coli. No TPHs were recorded, above the level of detection, at either site. Results from the first samples from both sites contained the highest concentrations for almost all determinands. The second highest concentrations were generally recorded in the third sample whilst the third highest concentrations were generally recorded in the second sample. A possibility for this trend is the intensity of the preceding rainfall since higher rainfall intensities may result in greater amounts of material being washed off the land surface.

Concentrations of determinands recorded at both Vasari Grange and Izone are similar to other samples taken from modern developments. These concentrations are generally lower than historic literature values. It is suggested that this is because of three main factors:

- Better roofing materials
- Less leakages from modern vehicles
- Removal of lead from petrol

The lower determinand concentrations observed in recent stormwater samples indicates that these should form the basis for environmental assessments from modern residential subdivisions rather than historic data which has been used to date. The data also indicates that different catchment types result in different concentrations of contaminants. Therefore the type and scale of treatment required for stormwater runoff should reflect the concentrations of contaminants in the stormwater and the receiving environment and there should not be a generic approach for all stormwater.

Table 2: Analyses of Stormwater Samples

Determinand	Units	Mairangi Bay[1] (2000)	Pakuranga[1] (1992)	Hayman Park[1] (1993)	Wigram Detention Basin[1] (1996)	Vasari Grange (2011)	Izone (2011)	Williamson[1] (1993)
		Residential	Residential	Commercial	Mixed	Residential	Commercial	Urban
Total Suspended Solids	g/m^3			30	101	48	97	170
Dissolved Copper	g/m^3					0.0035	0.022	
Total Copper	g/m^3	0.008	0.015	0.0380	0.0140	0.0063	0.036	0.04
Dissolved Lead	g/m^3					0.00005	0.00115	
Total Lead	g/m^3	0.0025			0.0330	0.0027	0.006	0.26
Dissolved Zinc	g/m^3					0.0075	0.066	
Total Zinc	g/m^3	0.08	0.444	0.2490	0.4120	0.045	0.156	0.26
Total Nitrogen	g/m^3					2.1	4.2	2.5
Nitrate-N + Nitrite-N	g/m^3					0.36	0.42	
Total Kjeldahl Nitrogen (TKN)	g/m^3					1.74	3.8	1.9
Escherichia coli	cfu / 100mL					240	4,100	
Total Petroleum Hydrocarbons in Water								
C7 – C9	g/m^3					< 0.10	< 0.10	
C10 – C14	g/m^3					< 0.2	< 0.2	
C15 – C36	g/m^3					< 0.4	< 0.4	
Total hydrocarbons (C7 – C36)	g/m^3					< 0.7	< 0.7	1 – 5

1 – Results are Event Mean Concentrations not First Flush concentrations which are likely to underestimate First Flush concentrations.