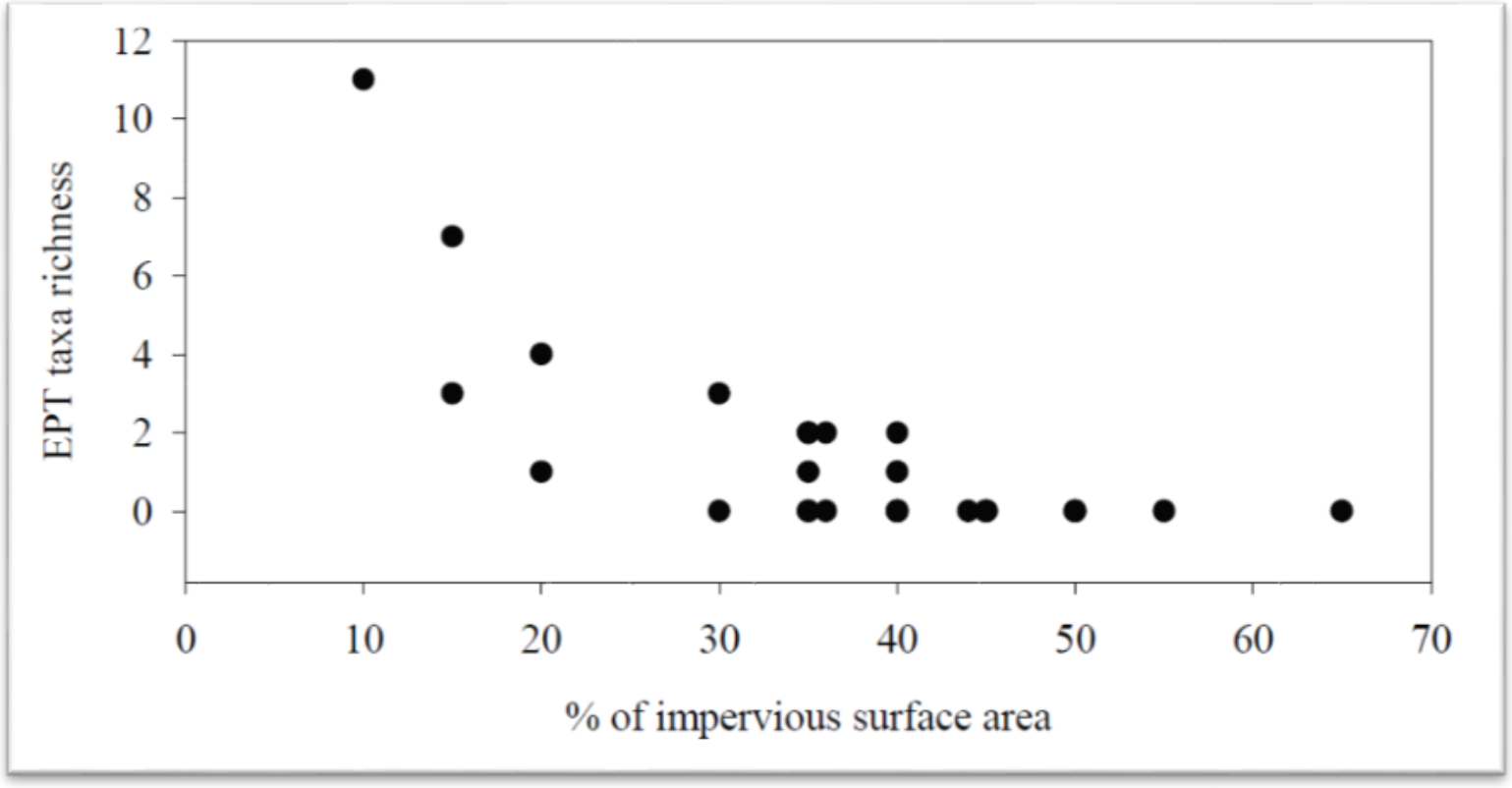
NIWA
Taihoro Nukurangi

Overview of Urban Hydrology & Water Quality

Te Awarua o Porirua Whaitua Committee

16 June, 2016

Better ecological condition



More built-up

The problem(s) with imperviousness

- DIRECT: Impervious surfaces change the hydrology of urban areas and are a key source of contaminants

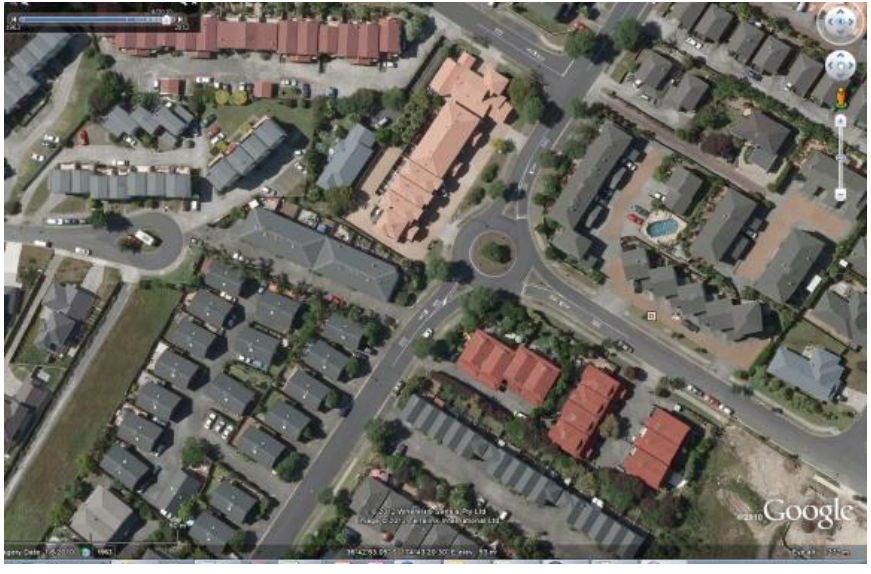
- CLOSELY-RELATED: Infrastructure to deal with imperviousness contributes to these effects – pipe networks speed up the delivery of stormwater to streams

- INDIRECT: Imperviousness is an indicator of urban development, which beings a whole range of other issues: loss of stream habitat, wastewater overflows… etc

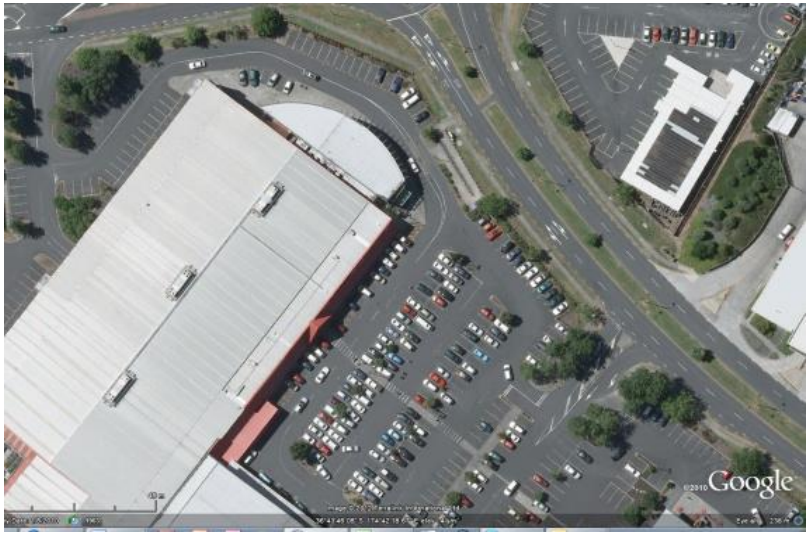
“Not allowing fluid to pass through”

Oxford English Dictionary

Low density residential 39%



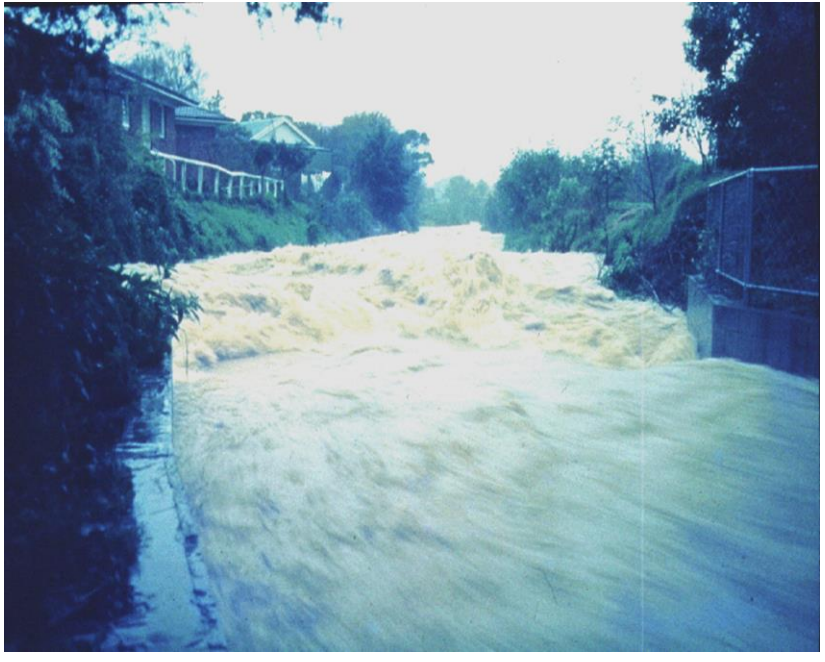
High density residential 55%

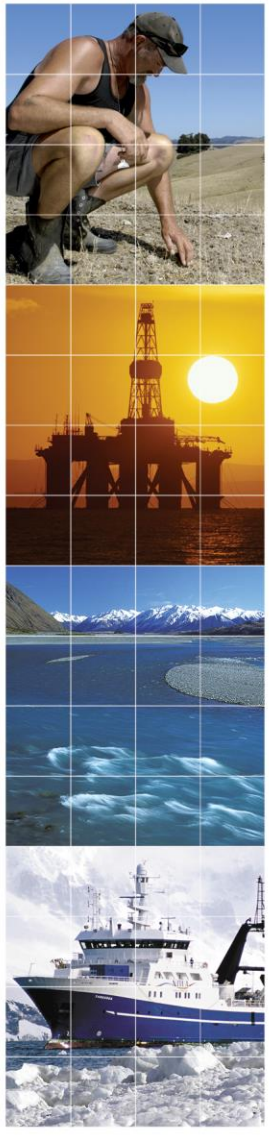


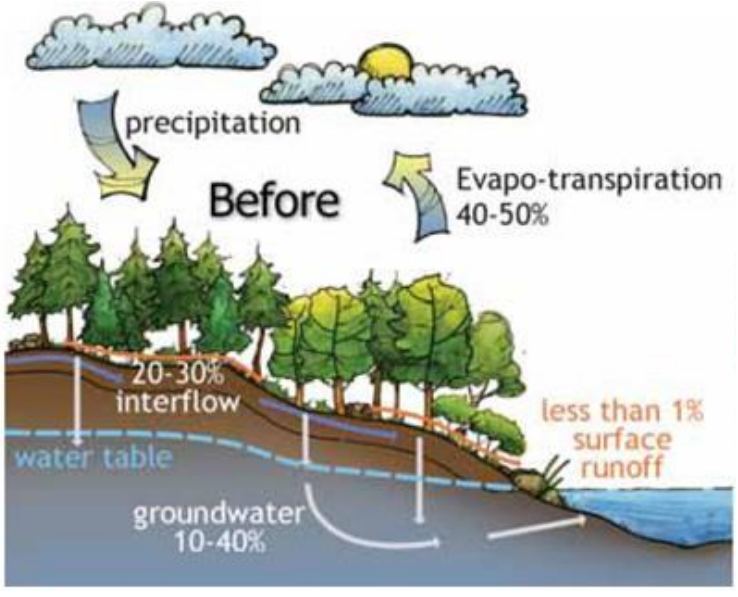
Sub-urban commercial 76%

CBD 85%

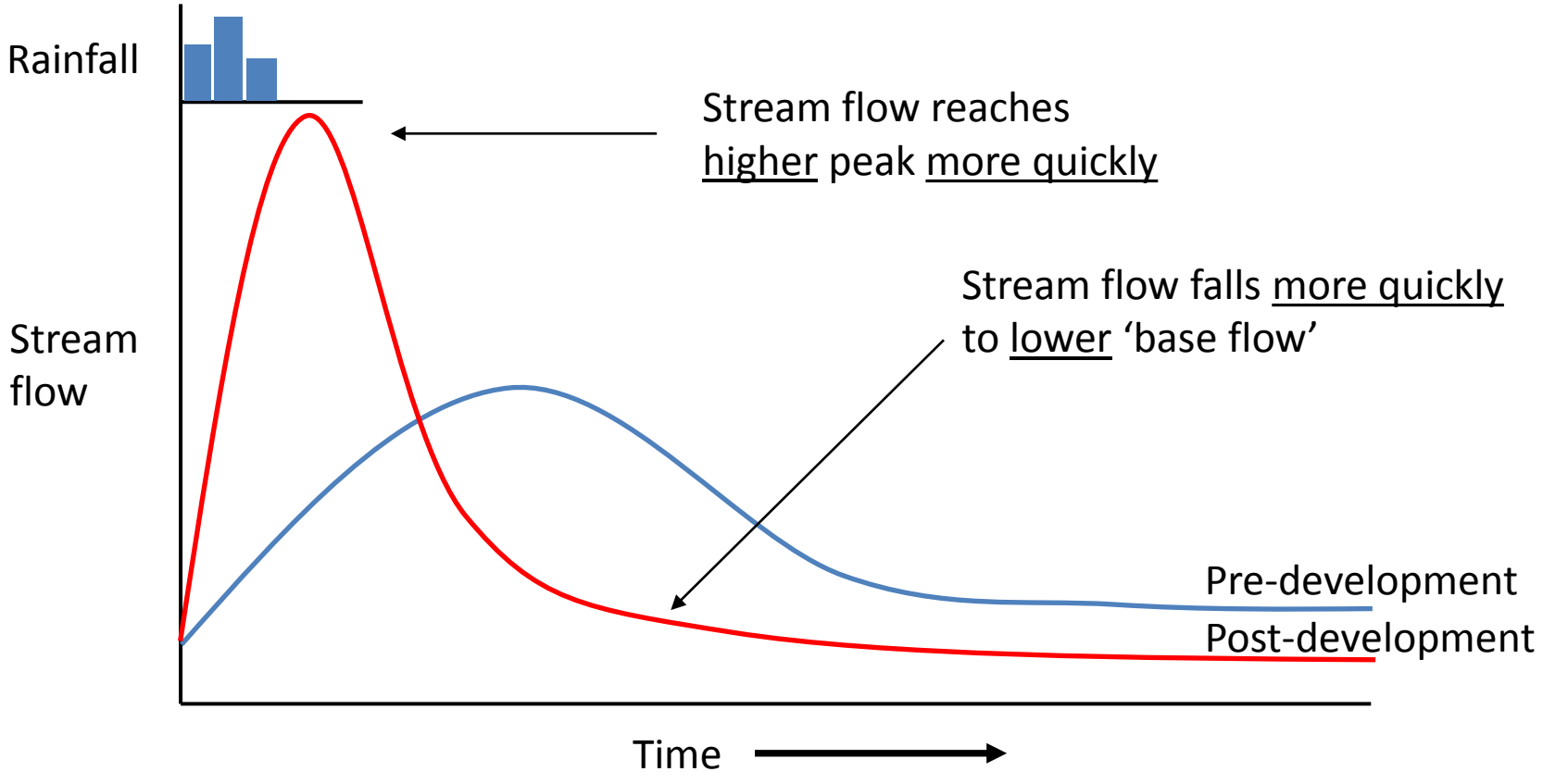
Water Quantity



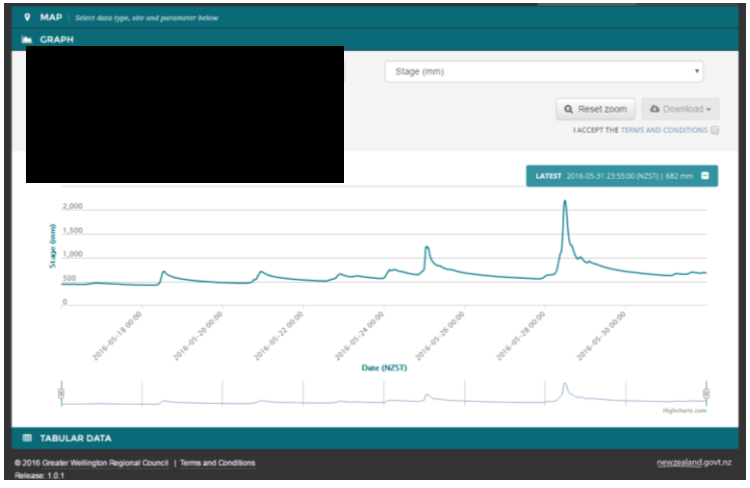




Source: Washington State Dept of Ecology http://www.ecy.wa.gov/washington_waters/images/WaterCycle.jpg


Rainfall
Stream flow
Stream flow reaches higher peak more quickly
Stream flow falls more quickly to lower 'base flow'
Pre-development
Post-development
Time

A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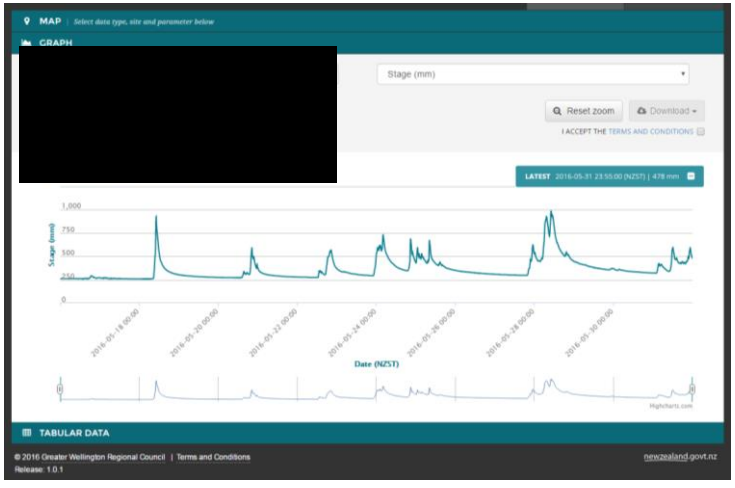
B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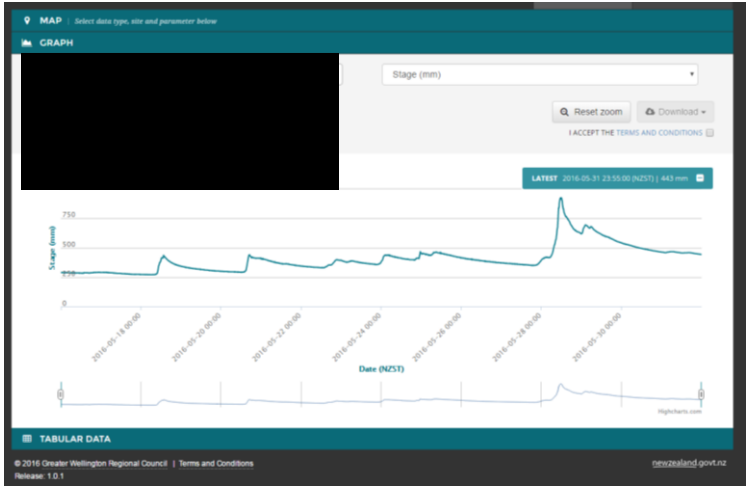
C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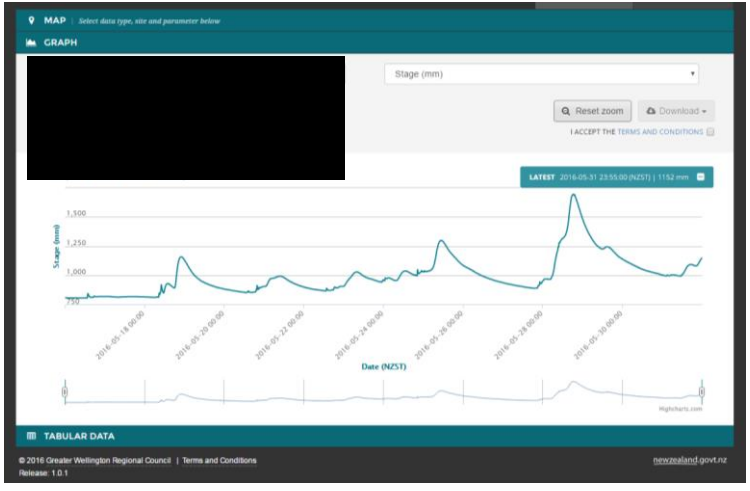
D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Stage (mm)
Date (NZST)
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Flooding

Following urbanisation floods are:

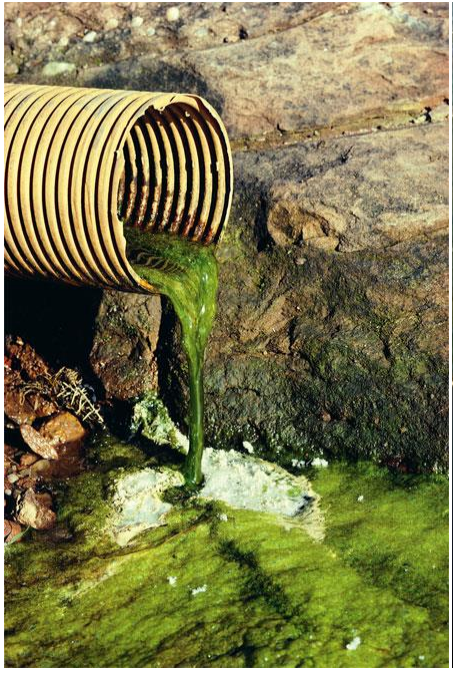
- More frequent
- Larger, for a given frequency

Erosion

More frequent flows capable of causing stream erosion

- Scour and sedimentation
- Habitat loss

Water Quality



Stormwater Contaminants

Although they are discharged at “points” (pipe outlets) stormwater contaminants are a DIFFUSE form of pollution, because they are washed off the land.

In contrast, POINT SOURCE pollution can be tracked to specific sources, such as the wastewater network or industrial activities.

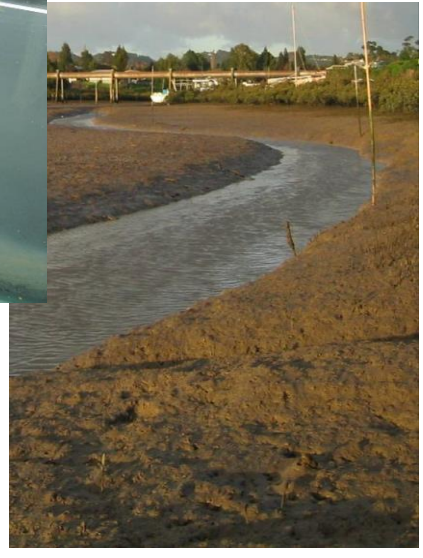
Sediment

Principal sources:

- Earthworks sites
- Areas of soil and vegetation
- Roads and paved areas

Principal effects:

- Build up in streams and harbours
- Increased muddiness
- Smothering of aquatic life
- Reduced water clarity



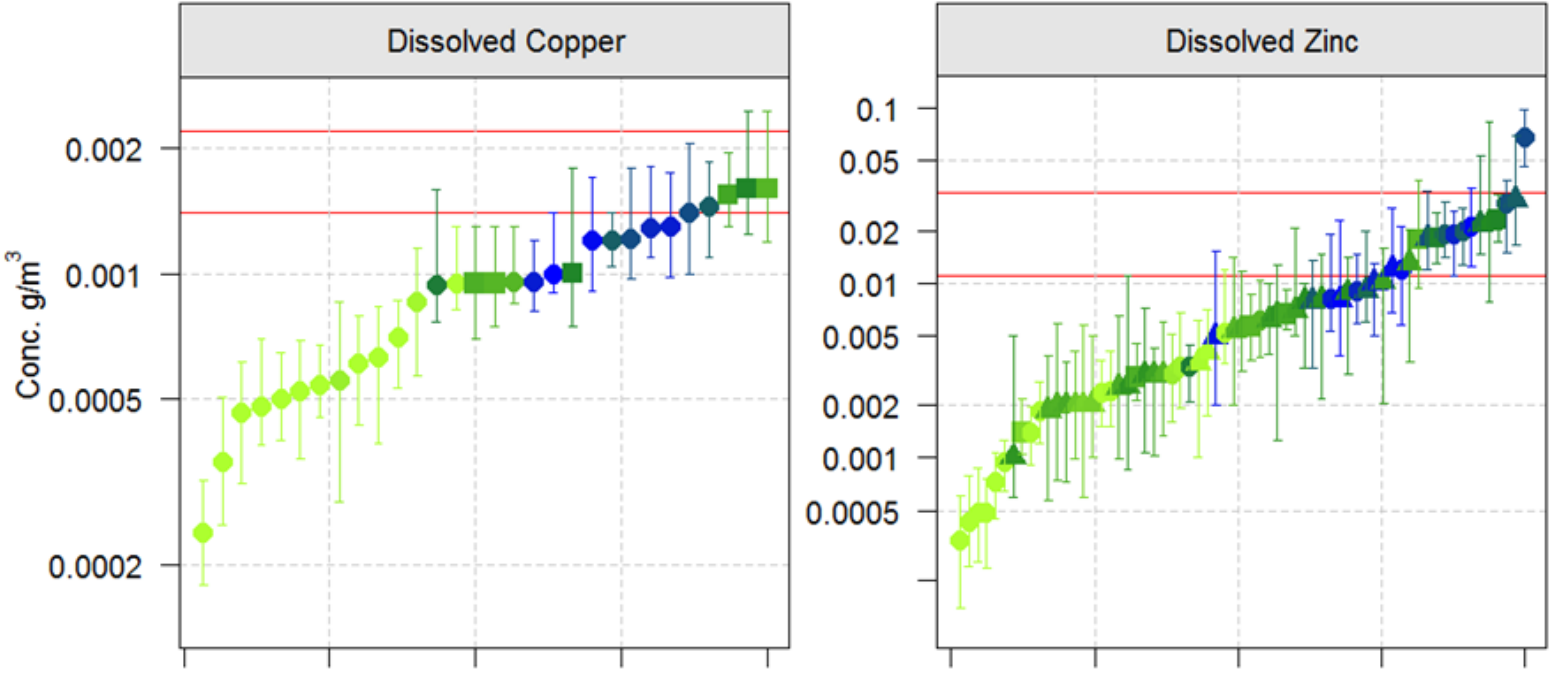
Metals: Zn, Cu and Pb

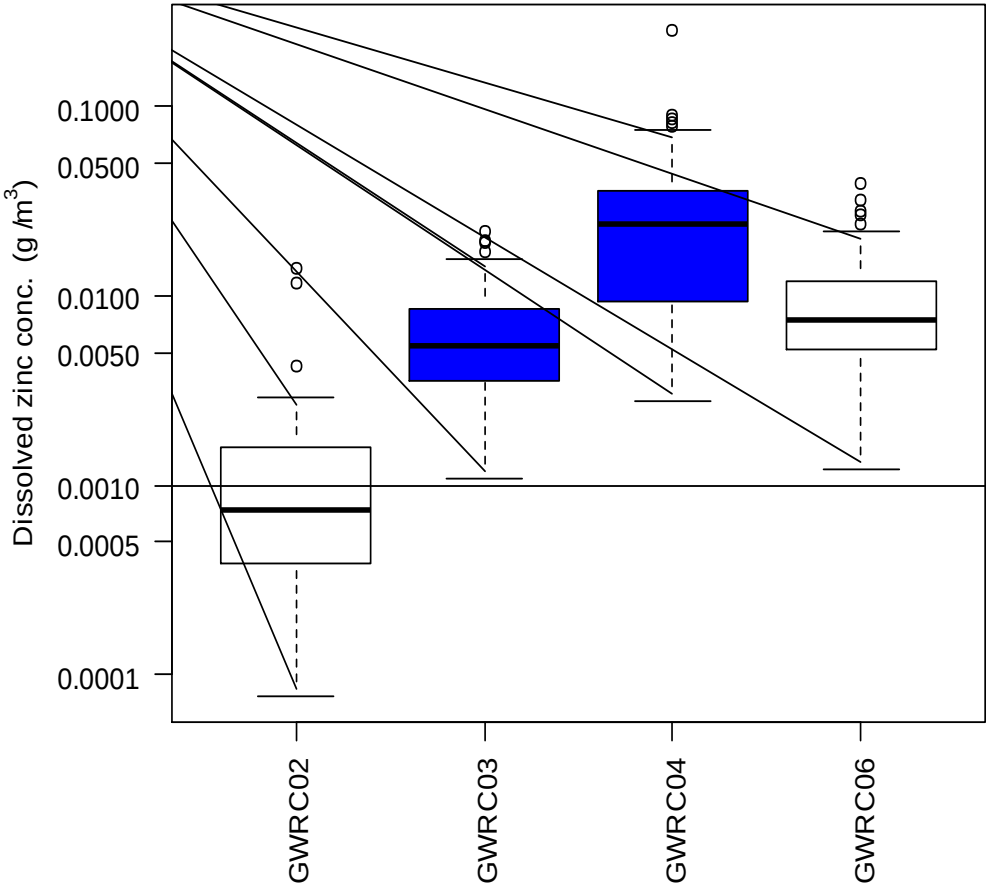
Principal sources:

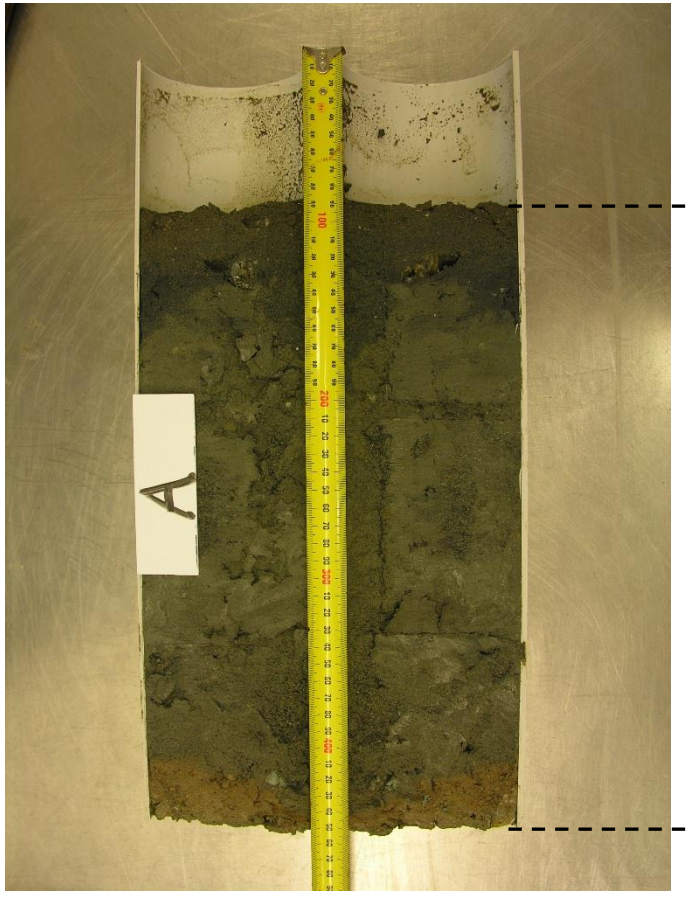
- Galvanised roofs
- Vehicle components: tyres and breakpads
- Highest yields from industrial areas, highways
- Legacy sources: e.g. lead paint in soil

Principal effects:

- Toxic to aquatic life
- ‘Acute’ effects during storms
- ‘Chronic’ effects from build up over time in sediments


Dissolved Copper
Conc. g/m3
0.002
0.001
0.0005
0.0002
Dissolved Zinc
0.1
0.05
0.02
0.01
0.005
0.002
0.001
0.0005


Dissolved zinc conc. (g /m3)
0.1000
0.0500
0.0100
0.0050
0.0010
0.0005
0.0001
GWRC02
GWRC03
GWRC04
GWRC06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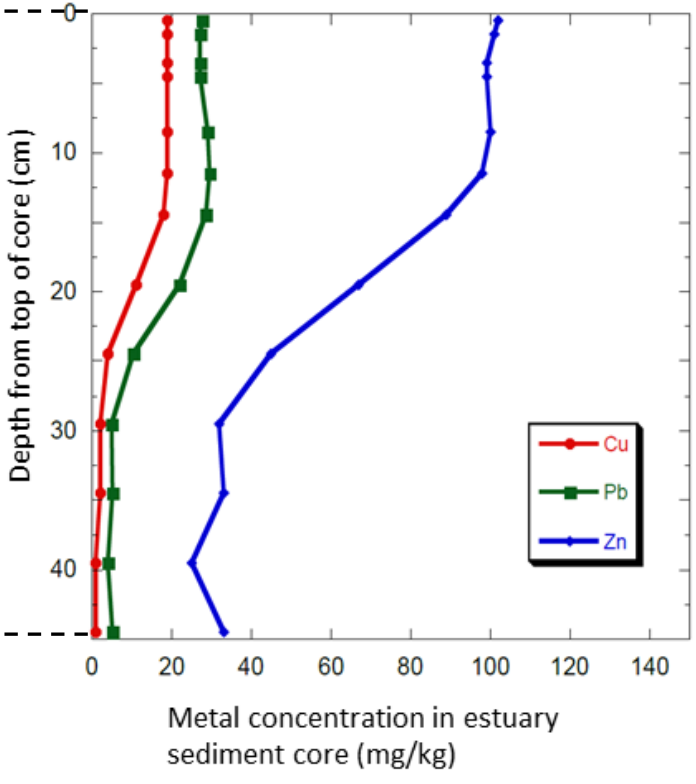
Depth from top of core (cm)
0
10
20
30
40
0
20
40
60
80
100
120
140
Cu
Pb
Zn
Metal concentration in estuary sediment core (mg/kg)

Other Contaminants in Stormwater

Nutrients – Nitrogen & Phosphorus:

- Organic matter
- Fertilisers used in parks etc
- Industrial activities and spills
- Can result in eutrophication

Microbial

- Pathogens (e.g. viruses)
- Presence shown by indicator bacteria, e.g. *E. coli*
- Animal droppings, soil

… but where there are frequent wastewater overflows these can be the principal source of these contaminants

Stormwater and Wastewater

How does UNTREATED wastewater end up in stormwater and/or the environment?

- Dry weather overflows, e.g. due to pipe blockages
- Combined sewer systems in older parts of cities (not Porirua)
- Illegal / cross-connections between the s/w and w/w network
- Infiltration into (end exfiltration out of) joints and breaks in wastewater pipes

Leading to wet weather overflows from the w/w network in heavy rain:

- As part of the network design, from engineered discharge points and
- When network capacity is exceeded, elsewhere…

Managing Stormwater Quantity and Quality

‘Traditional’ Approach

- Focus on drainage function
- Pipes and channel modification
- Less emphasis on stormwater treatment
- Catchpits for gross pollutant removal
- End-of-pipe ponds provide attenuation and some treatment

Water Sensitive Design - source control

- Reduce runoff by limiting imperviousness and using permeable paving

- Reduce contaminants by using low-metal yielding materials

Water Sensitive Design – green technologies

Use or mimic natural processes

- Bio-filtration - raingardens and swales
- Wetlands – more effective than ponds

Summary

- Urban hydrology features more runoff, higher and quicker peak flows, and lower baseflows
- This results in more frequent flooding and stream erosion
- Stormwater carries sediments, metals, nutrients and microbial contaminants
- Sediment effects include poor water clarity and sediment accumulation
- Metal effects include exceedance of toxic levels in water (acute) and in sediment (chronic)
- Wastewater is also source of nutrients and microbial contaminants
- Wet weather wastewater discharges occur when stormwater gets into the wastewater system and *vice versa*
- Traditionally, stormwater management has focused on drainage
- Water Sensitive Design aims to manage runoff and contaminants at source and through using green technologies