Fish Passage Design for Ecological Connectivity to a Stormwater Facility

By Marcia Ho
Civil Engineer at Aurecon Ltd

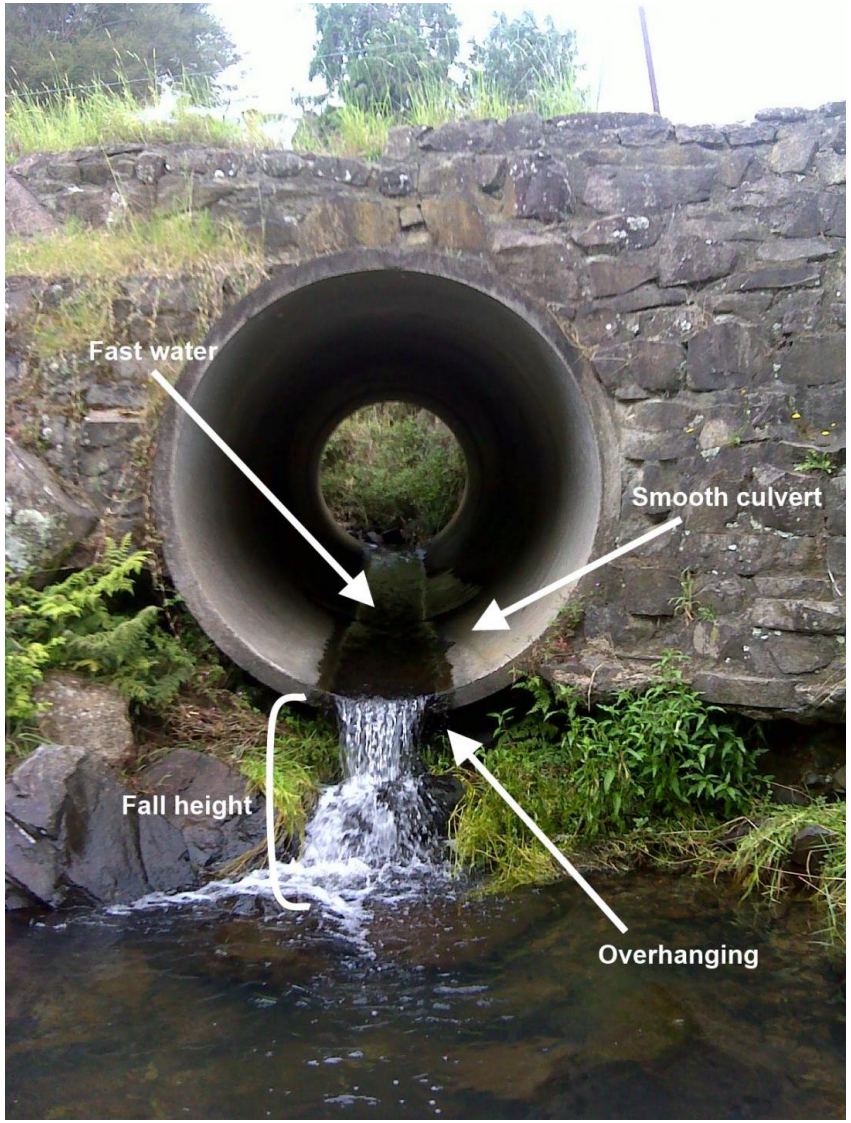


Image from niwa.co.nz

Introduction

1. Fish Passage - Why It's Important
2. How to Design for Fish Passage
3. Burlington Lifestyle Village Stormwater Facility
4. Fish Passage Design Solutions

Fish Passage: Why?

- Ecology is one of the ‘six values’ of the CCC Waterways, Wetlands and Drainage Guide.
- Department of Conservation (DoC) responsibilities: culverts and fords must not be built in way that impedes fish passage without a permit
- 30% of NZ’s native fish require access to the sea via waterways to complete their lifecycle
- 74% of native fish classified as threatened or at risk

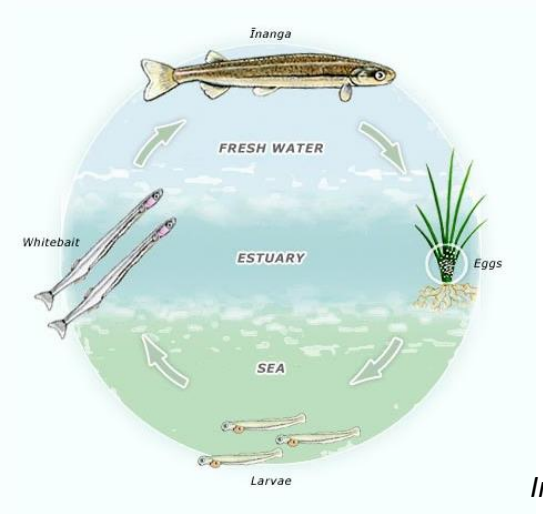


Image from teara.go

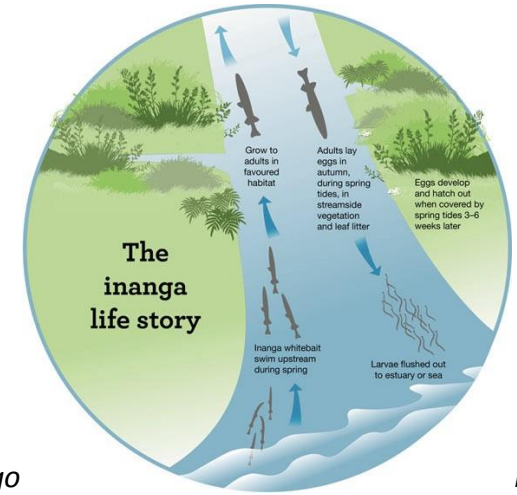


Image from doc.co.nz

Fish Passage: How?

1

Ecological Assessment

- Downstream habitat
- Fish type and size
- Fish swimming behaviour

2

Site Assessment and Project Requirements

- Stormwater requirements
- Client expectations

3

Performance Criteria

- Maximum flow velocity
- Minimum flow depth
- Other design criteria

4

Final Design

- Constructability
- Durability
- Maintenance
- Cost

Fish Passage: How?

Types of Fish

Anguilliformes:
- Long Fin Eels
- Adult Lamprey

Climbers:
- Lamprey
- Juvenile Common Bullies

Jumpers:
- Trout
- Adult Inanga (whitebait)
- Smelt

Swimmers:
- Inanga (whitebait)
- Bullies
- Smelt

Images from doc.co.nz

Fish Passage: How?

Swimming Behaviour (Juvenile Whitebait)

http://www.doc.govt.nz/nature/habitats/freshwater/fish-passage-management/freshwater-fish-videos/

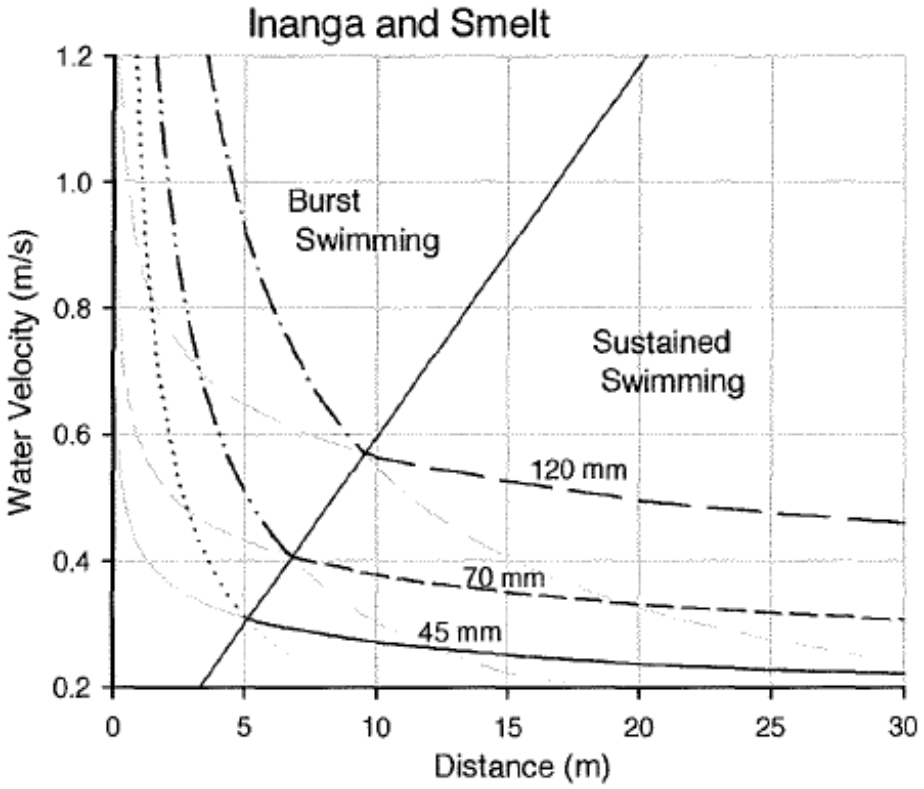
Fish Passage: How?

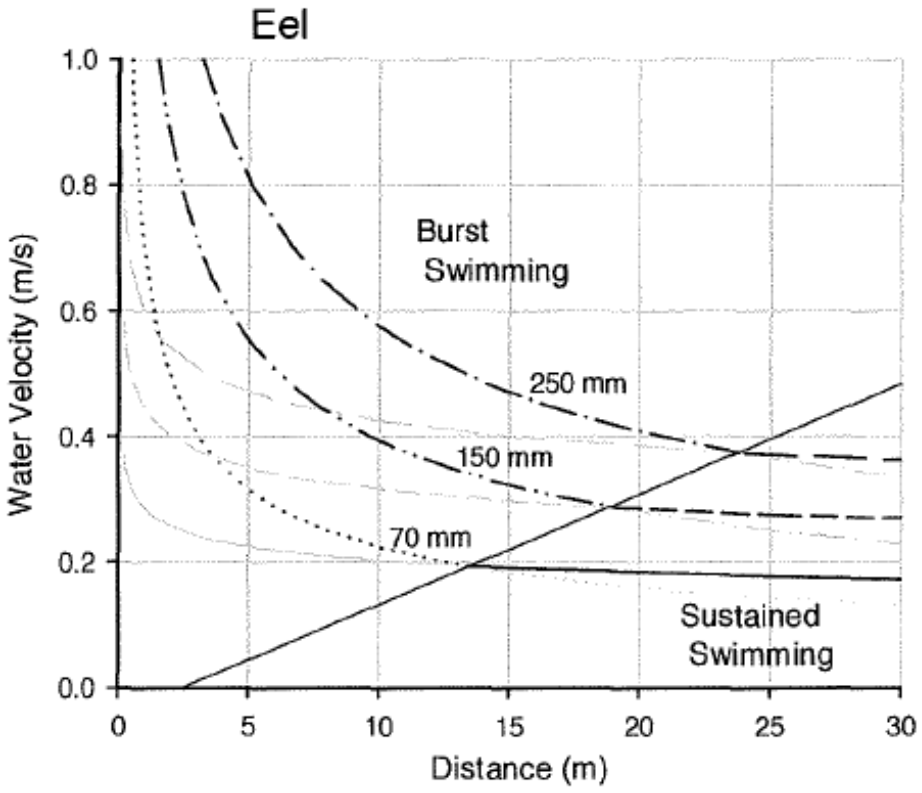
Swimming Behaviour (Lamprey)

http://www.doc.govt.nz/nature/habitats/freshwater/fish-passage-management/freshwater-fish-videos/

Fish Passage: How?

Swimming Behaviour





WWDG (2003)

Fish Passage: How?

Design Requirements

1. **Maximum Flow Velocity**
   Based on swimming distance
   Must not exceed fish swimming speeds and distance of target fish i.e. maximum velocity = 0.3m/s
   Lower velocity at culvert edges
   Minimise flow turbulence

2. **Minimum Flow Depth**
   100-150mm for native fish species or enough to submerge the largest fish species
   Resting areas

3. **Wetted and Rounded Edges**
   For climbing fish species

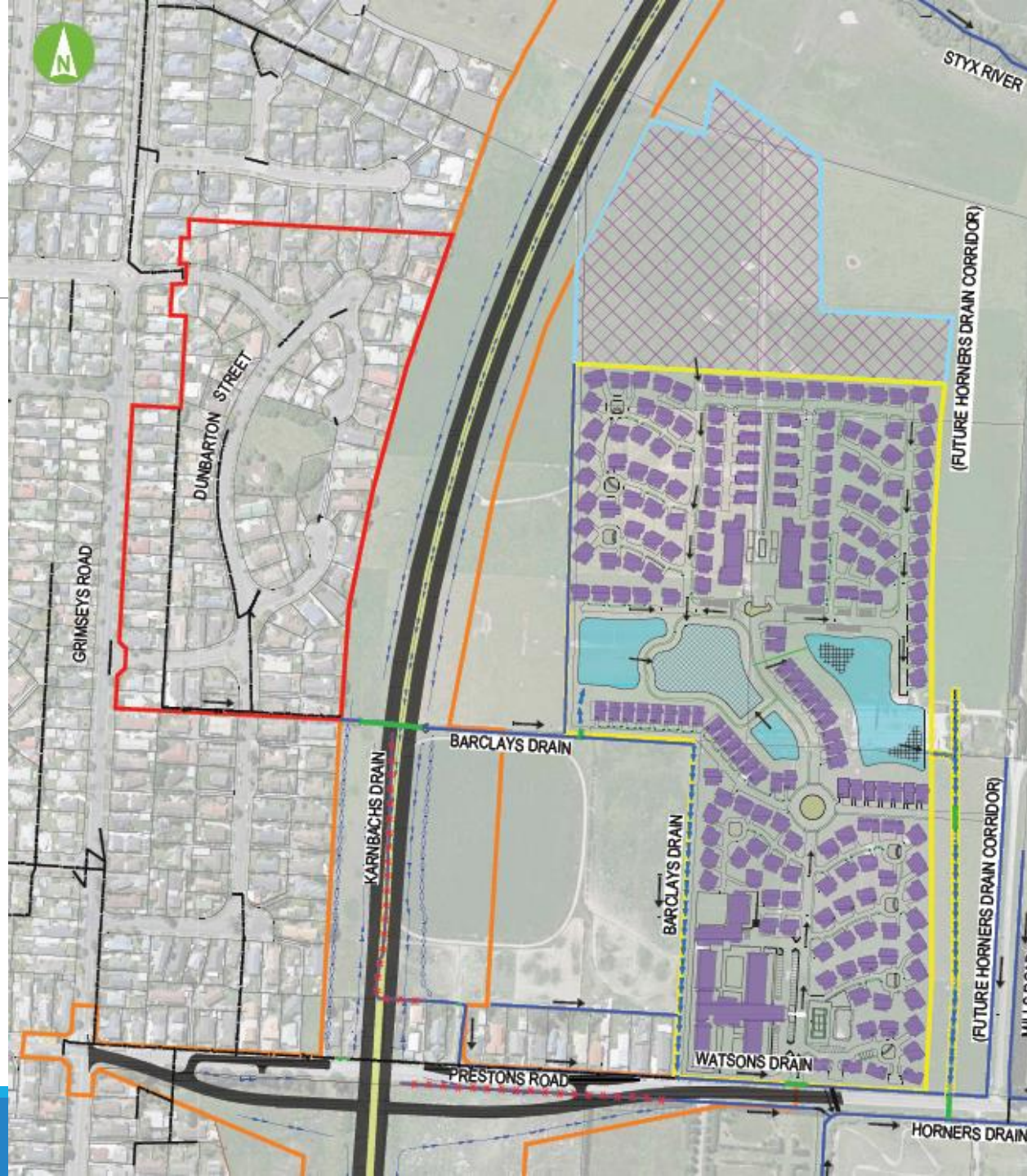
4. **Darkness and Shading**
   Protection from predators and sun/heat

Project Application: Burlington Lifestyle Village

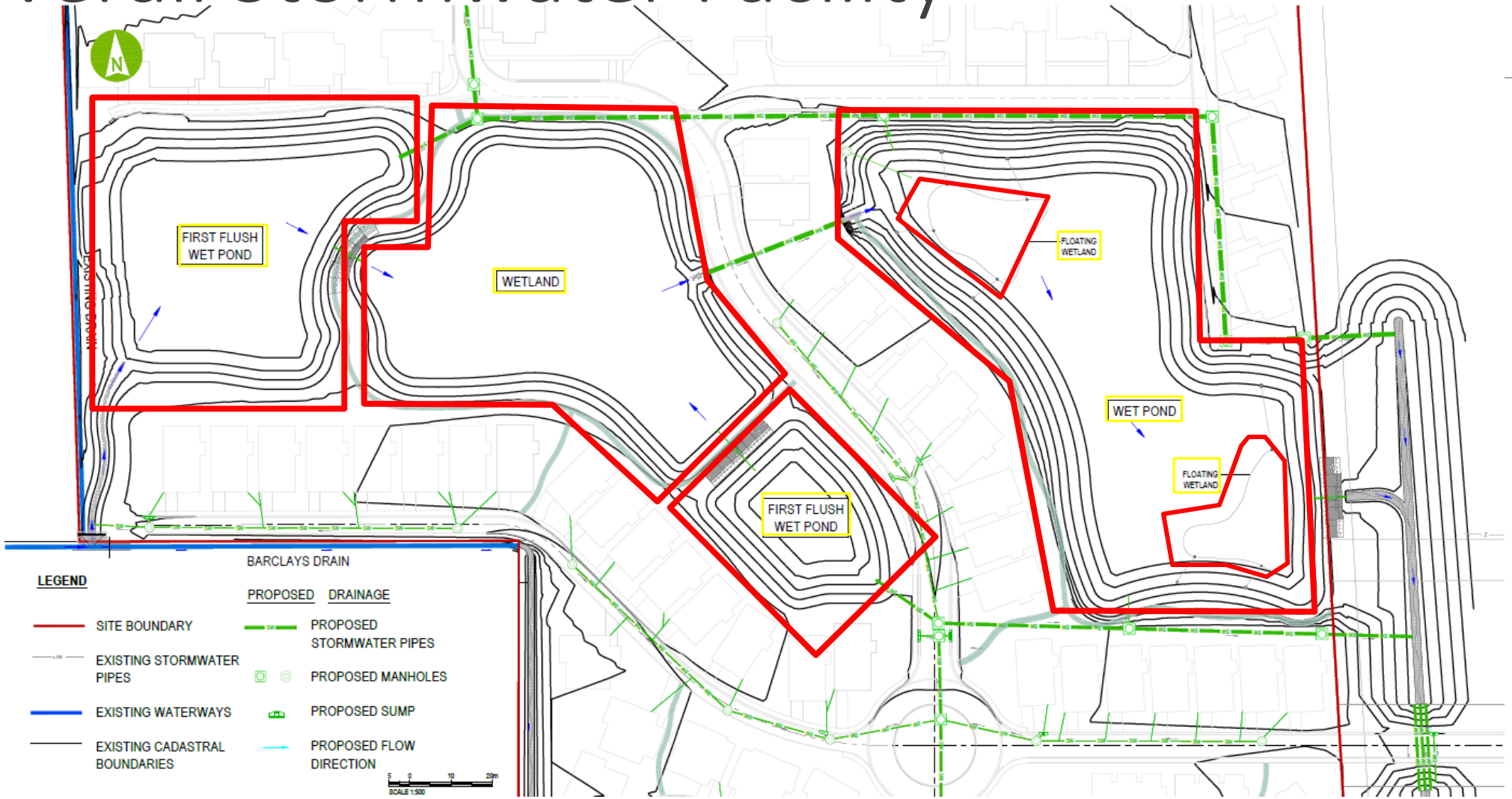
Stormwater Requirements

Styx Stormwater Management Plan (SMP):

- Stormwater Treatment
  - Primary treatment of first flush volumes
  - Secondary treatment (typically with conventional wetland)
- Partial attenuation in 2% AEP 48 hour rainfall event
- No inundation of the wetland in events up to and including 10% AEP rainfall events



Overall Stormwater Facility



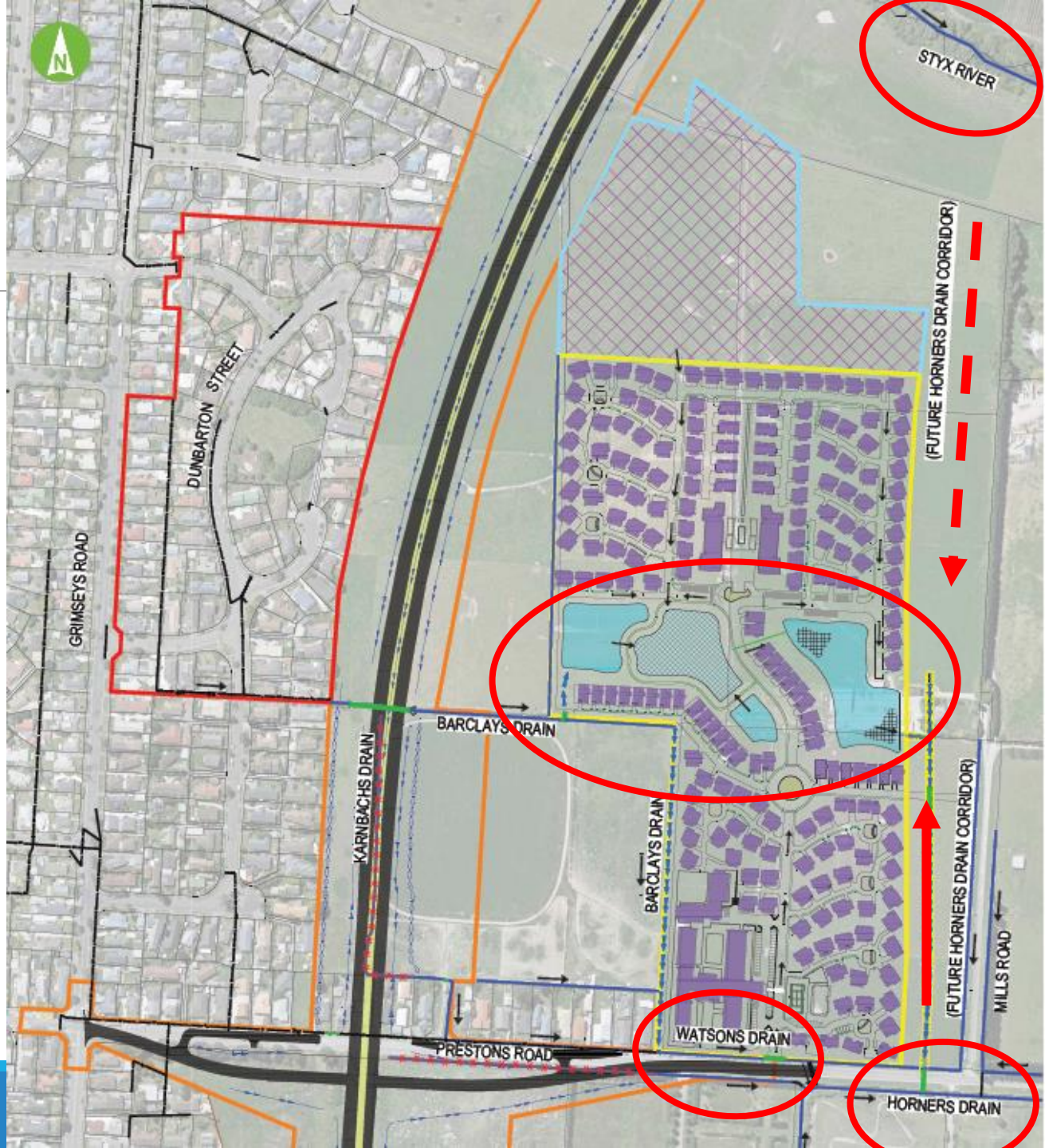
Ecological Assessment

Styx River: Inanga eggs

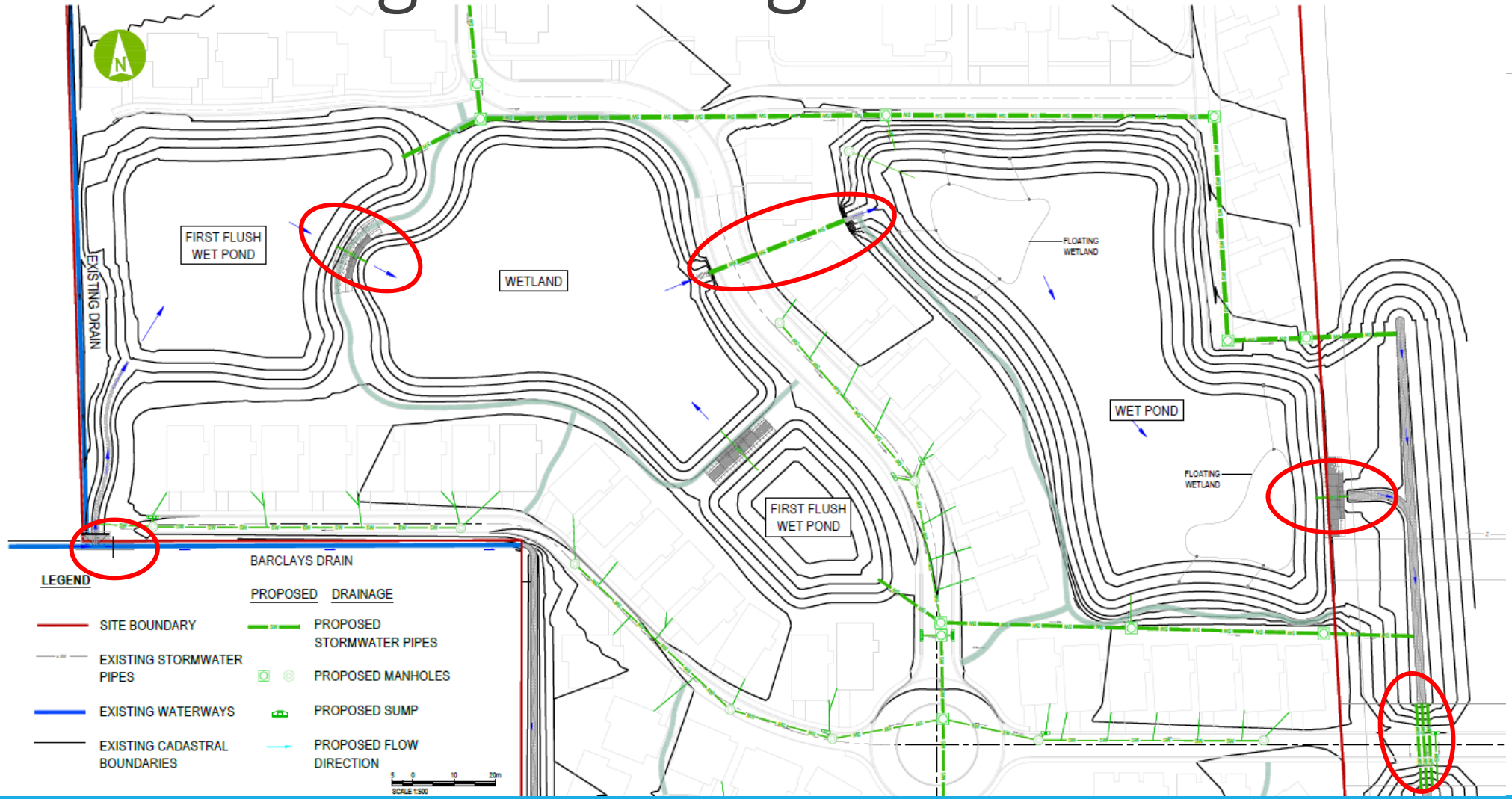
Watsons Drain: Adult Inanga

https://www.thestyx.org.nz/longfin-eel

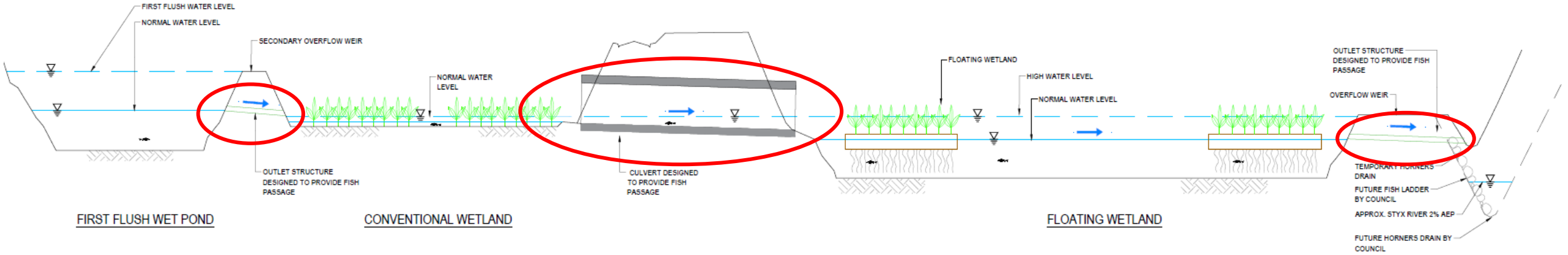
Horners Drain: Adult Longfin Eels



Fish Passage Challenges

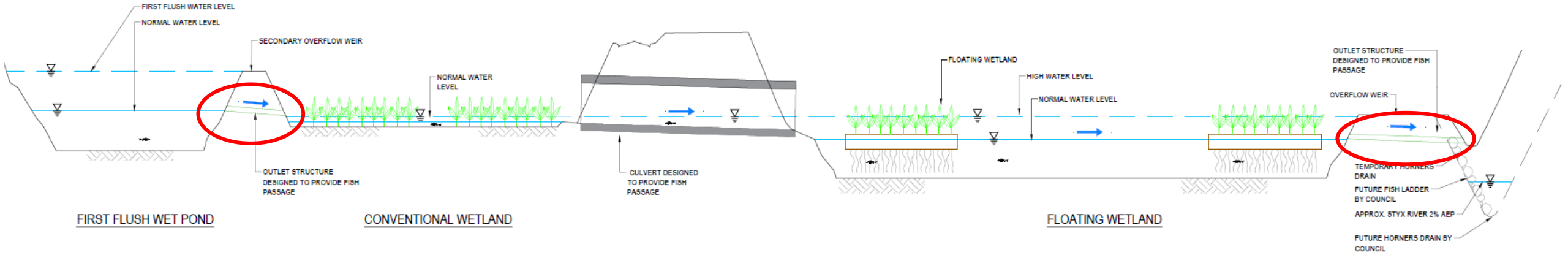


Fish Passage Challenges



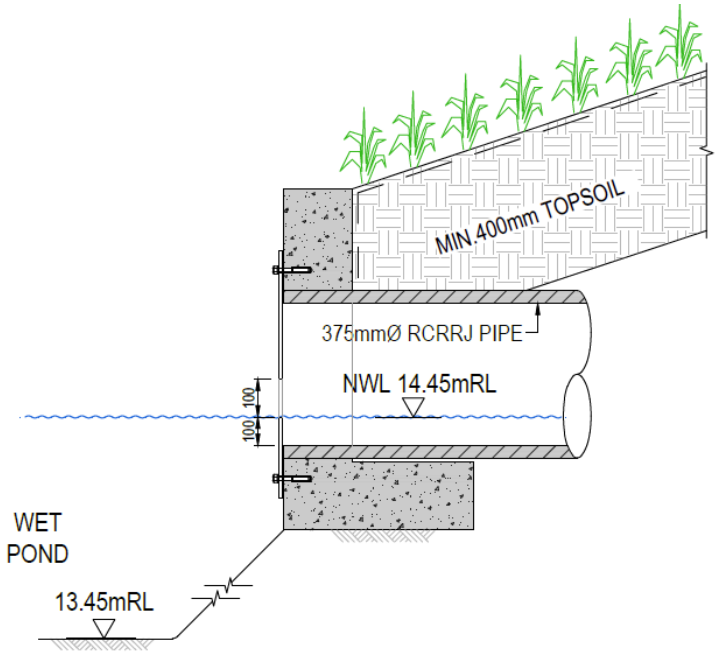
Fish Passage Challenges

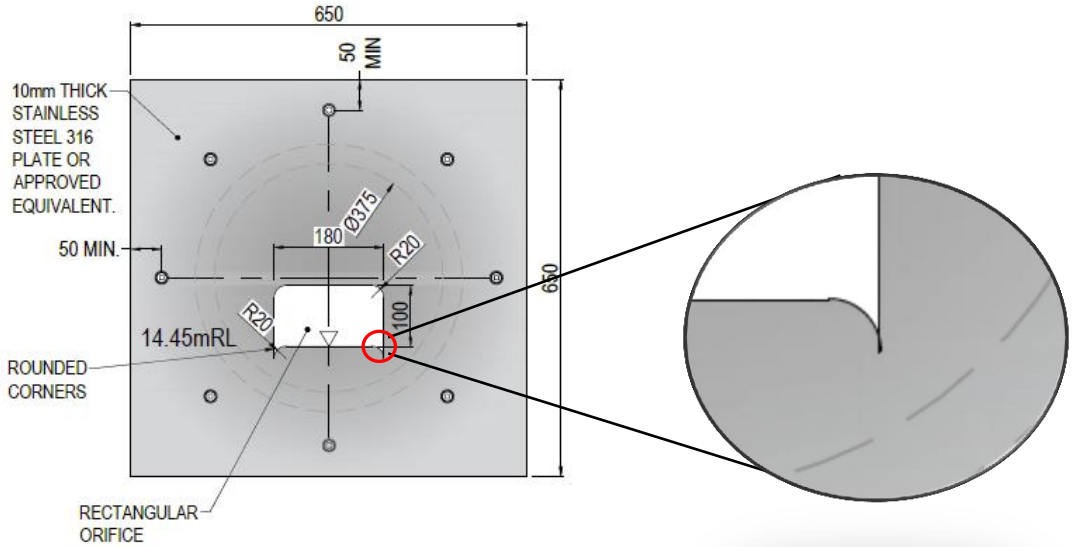
Small Diameter Pipes



Fish Passage Solutions

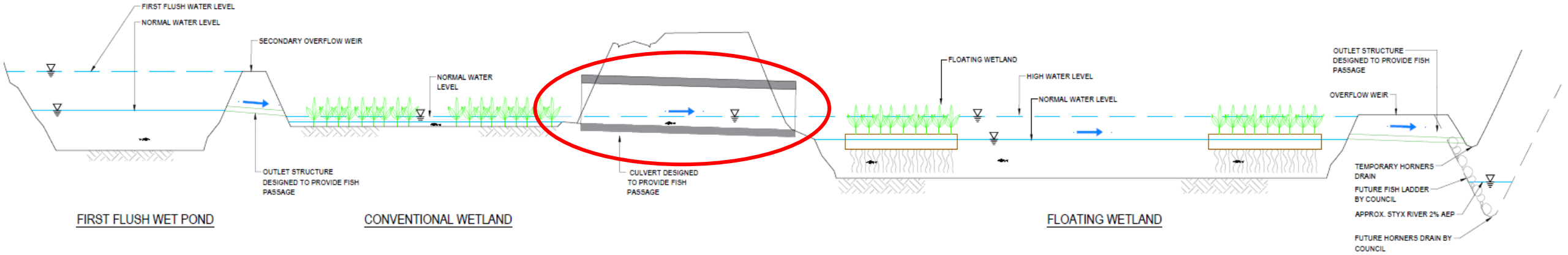
Solution to Small Diameter Pipes





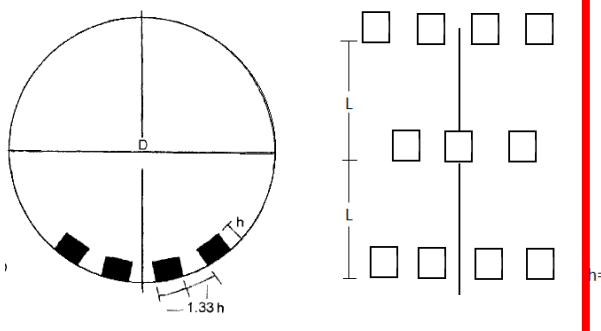
Fish Passage Solutions

Solution to Long & Steep Culvert

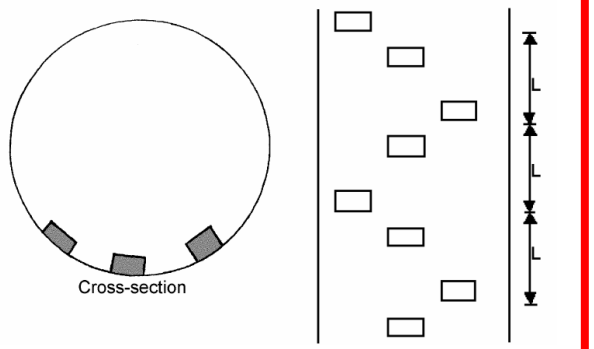


Fish Passage Solutions

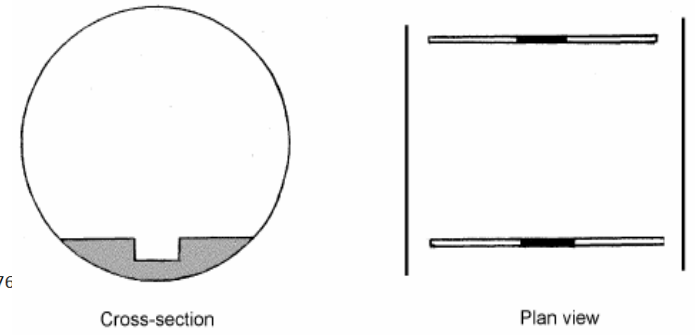
Solution to Long & Steep Culvert



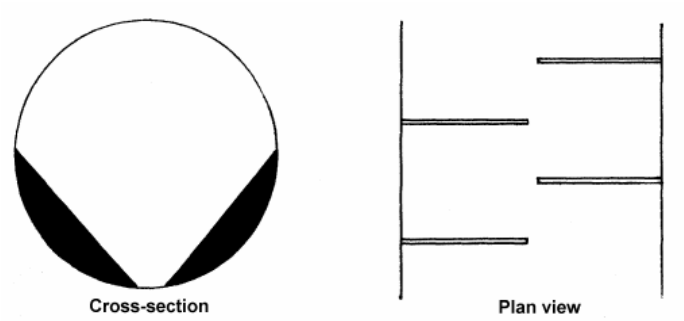
Spoiler Baffles



Alberta Fish Baffles



Alberta Fish Weirs



Wall Baffles

DOC(1999)

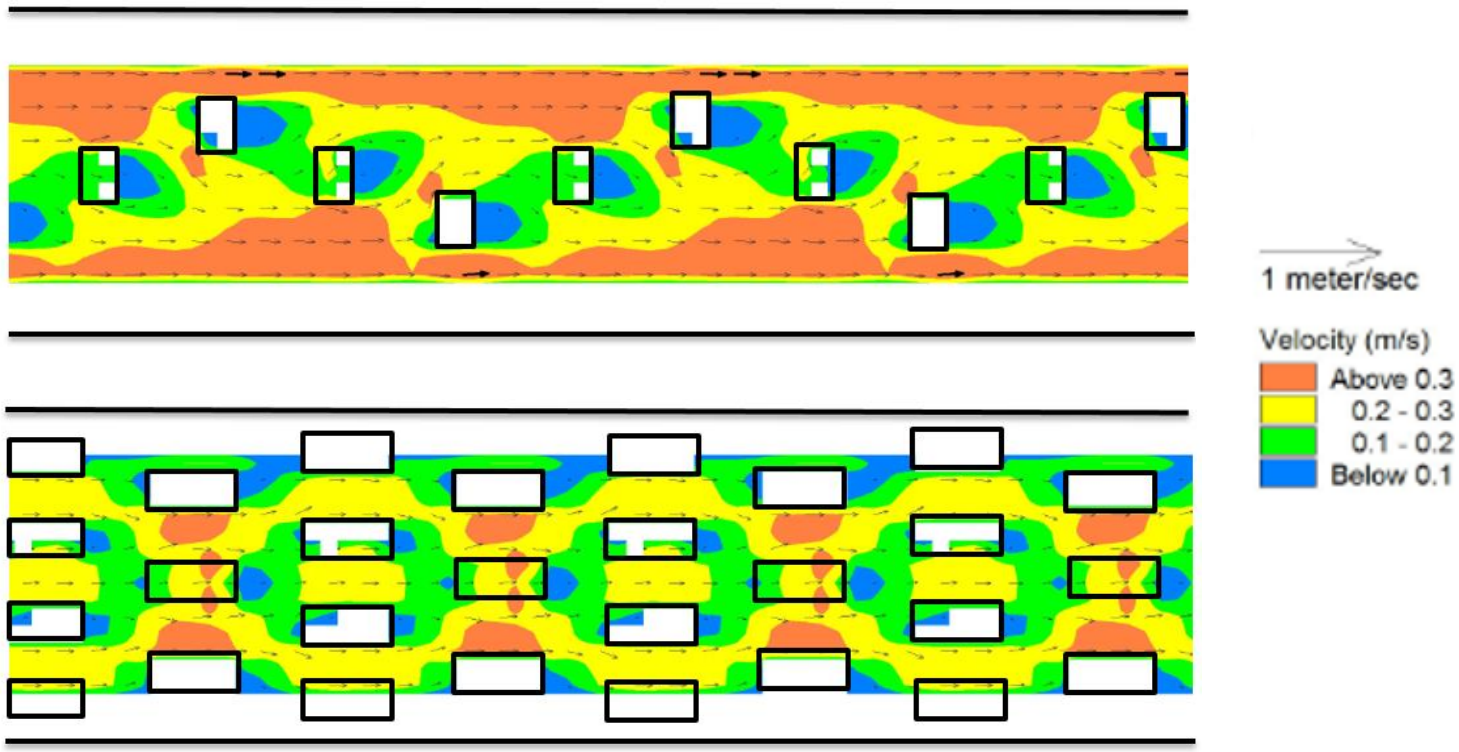
Fish Passage Solutions

Solution to Long & Steep Culvert

MIKE 21 2D Hydraulic Modelling: Flow Velocity

Alberta Fish Baffles

Spoiler Baffles



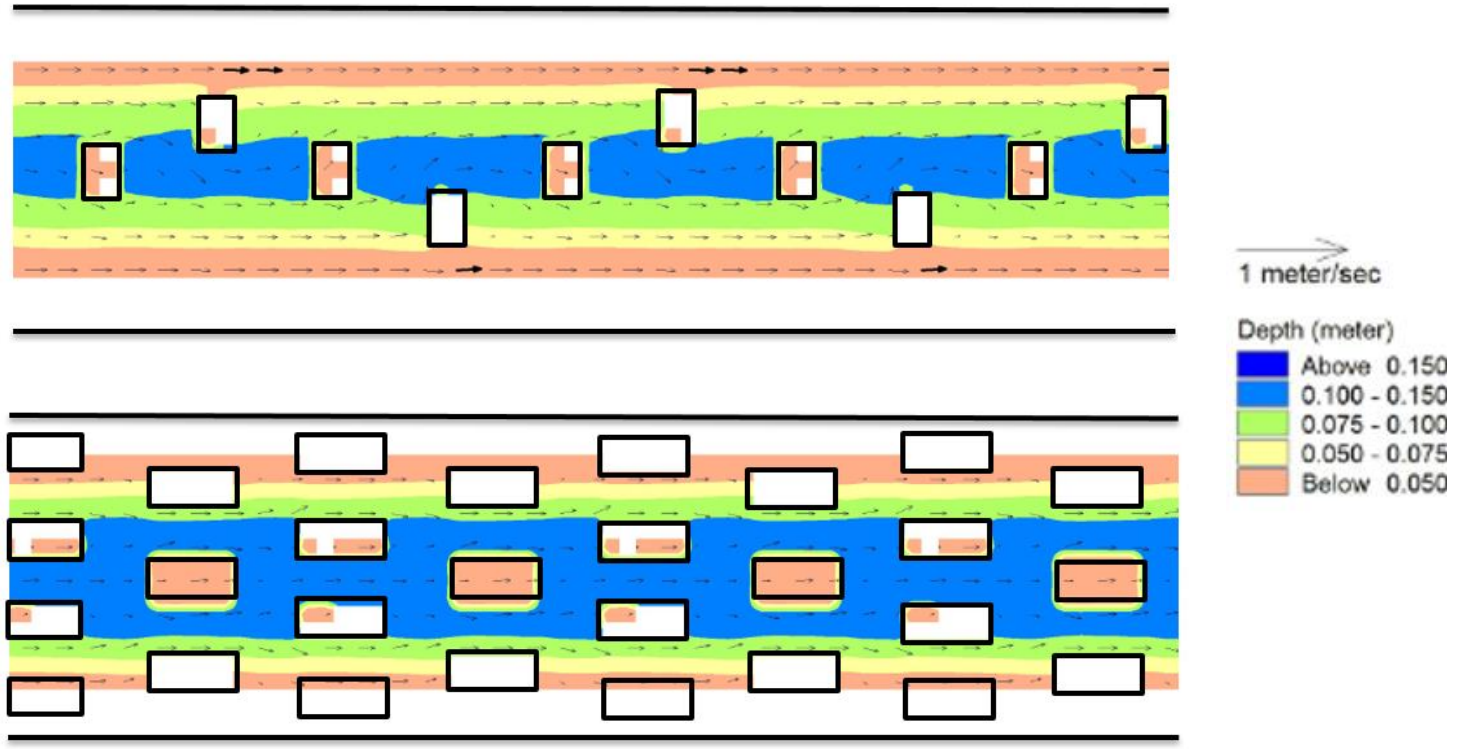
Fish Passage Solutions

Solution to Long & Steep Culvert

MIKE 21 2D Hydraulic Modelling: Flow Depth

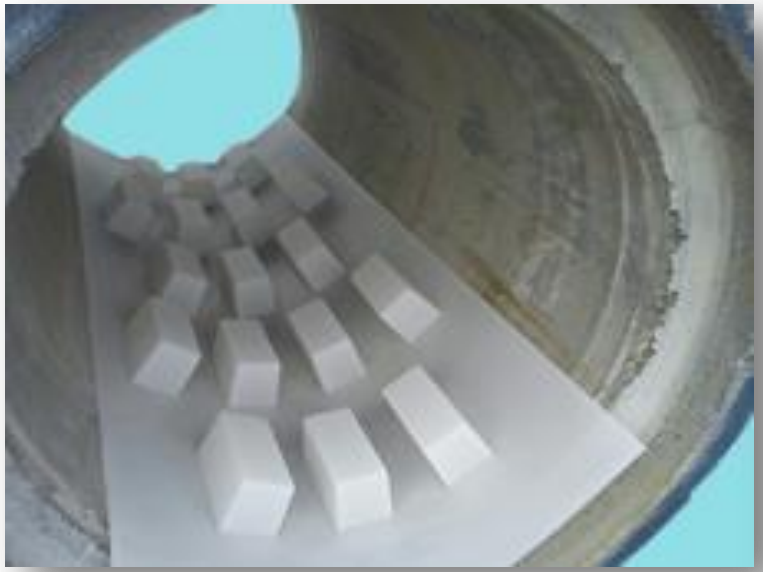
Alberta Fish Baffles

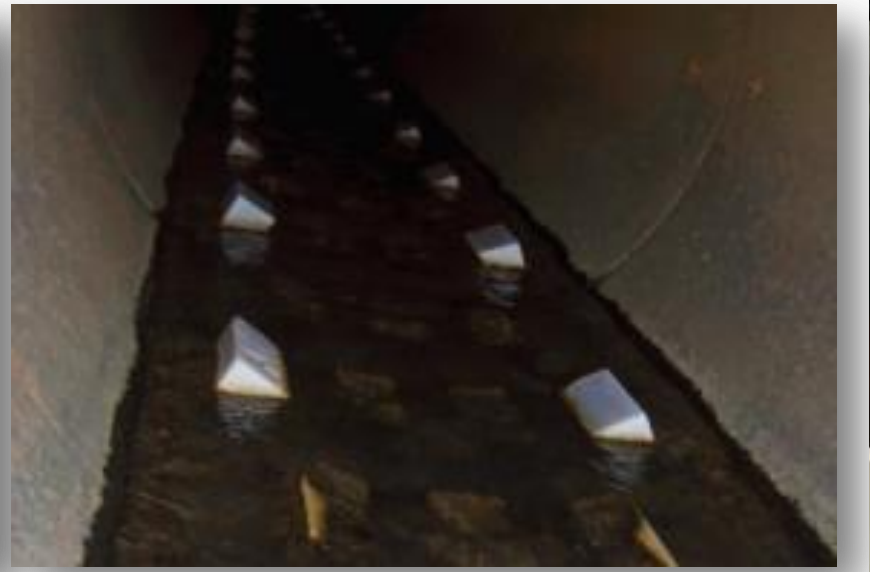
Spoiler Baffles



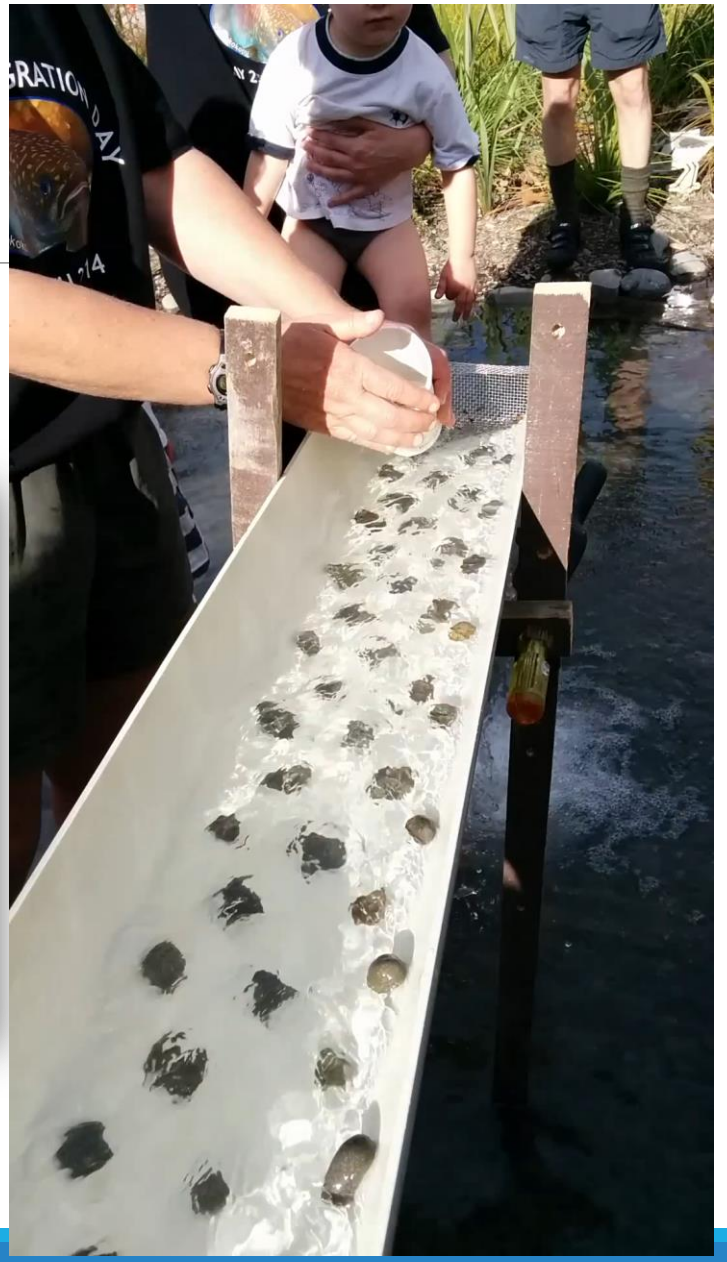
Fish Passage Solutions

Solution to Long & Steep Culvert





Rotational Plastics Ltd

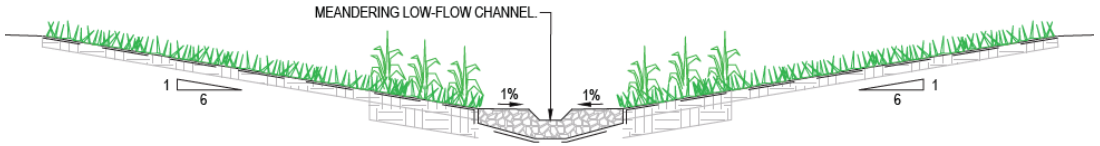


http://www.doc.govt.nz/nature/habitats/freshwater/fish-passage-management/freshwater-fish-videos/

Fish Passage Solutions

Solution to High Velocities and Shallow Depths

Low-Flow Channel in Cooks Lane Reach of the Matuku Waterway



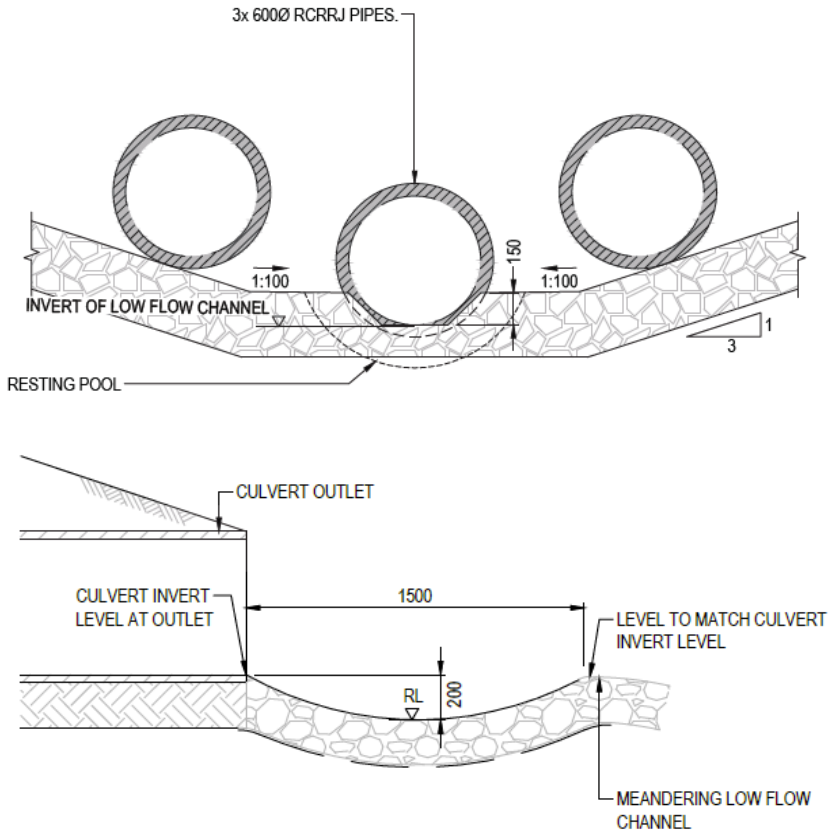
Low-Flow Channels

Source: https://fishpassage.umass.edu/

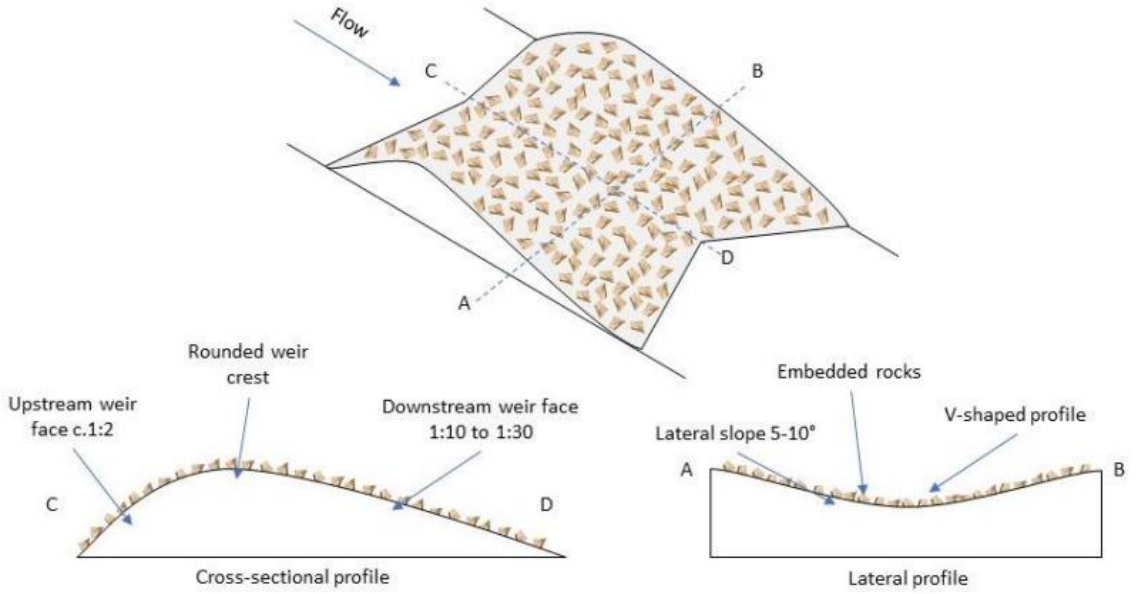
Ramp Fishway

Source: NIWA 2018

Other Fish Passage Solutions



Resting Pools



Source: NIWA 2018

Rock-ramp Style Weir

Other Design Considerations

- Maintenance and operations
- Durability
- Constructability
- Costs

Fish Passage Design Guidelines

Fish Passage at Culverts: A review, with Possible Solutions for New Zealand Indigenous Species, Department of Conservation and NIWA - Boubée, J., A. T., Jowett, I. G., Nichols, S., Williams, E. (1999)

TP366 Culvert Barrel Design to Facilitate the Upstream Passage of Small Fish. Auckland: Auckland Regional Council - Stevenson, C., Kopeinig, T., Feurich, R. & Boubeé, J (2008)

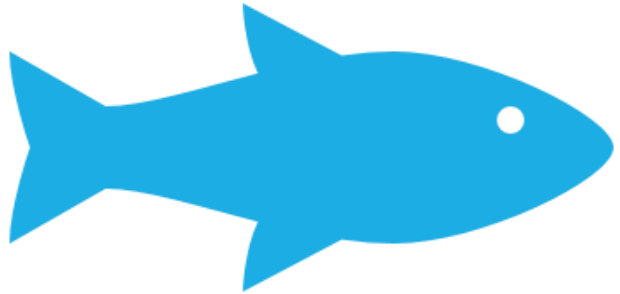
TP 131 Fish passage guidelines for the Auckland Region - Boubée, J. Richardson, J., Williams, E. (1999)

Waterways, Wetlands, and Drainage Guide; Part B: Design, Ch 13 - Christchurch City Council (2003)

New Zealand Fish Passage Guidelines For Structures up to 4 metres – Franklin, P., Gee, E., Baker, C., Bowie, S. (April 2018)

Summary: Fish Passage Design

- Types of Fish
- Swimming Behaviour
- Fish passage Requirements
- Stormwater Requirements (often conflicting)
- Constructability
- Maintenance
- Durability
- Cost



Acknowledgements

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Thank You
Questions?