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Compliance with Permitted Activity Rule 4.2.9.2: Ensuring Culverts Provide Safe Passage for Fish

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Executive summary

Diadromous fish (species that migrate between freshwater and marine environments) have varying abilities to cope with in-stream barriers, such as culverts, fords and weirs. Some species can move in and out of water (e.g. shortfinned and longfinned eels), others can climb wetted margins (e.g. lamprey, koaro) but others, such as inanga, smelt and grey mullet, rely on swimming to move upstream.

Culverts within catchments under 100 hectares were identified and assessed for compliance with permitted activity rule 4.2.9.2 from the Waikato Regional Plan which allows the use, erection, reconstruction, placement, alteration or extension of a culvert as a permitted activity, subject to a number of conditions. These conditions include that "the structure shall provide for safe passage of fish both upstream and downstream".

60 catchments in the Waikato Region were chosen randomly by GIS analysis and 52 of these were visited over the summers of 2006/2007 and 2007/2008.

The likely severity of fish passage restriction was assessed according to the following categories:

- None or minimal restriction
- Restriction at low flows only
- Restriction at high flows only
- Restriction at most flow conditions

Nearly 60% of culverts assessed would restrict fish at most flows, low flows or high flows. As such, those culverts were non-compliant with the condition in the permitted activity rule which states that culverts must provide for safe fish passage both upstream and downstream. Over half of the culverts assessed as being restrictive to fish passage did so because they were perched.

1 Introduction

There are 56 species of fish in New Zealand, of which 35 are indigenous. In the Waikato Region, there are 22 species of indigenous and 14 species of introduced fish. Of the 35 native fish species, 18 are diadromous (Kelly and Collier, 2007).

Diadromy is the movement of fish between marine and freshwater environments and is a critical part of life history. The diadromous species that make these migrations between freshwater and marine environments have varying abilities to negotiate in-stream barriers, such as culverts, fords, weirs and dams (Barnes, 2004).

Some species, such as shortfinned and longfinned eels have the ability to move both in and out of water. Other species, such as lamprey, juvenile kokupu and juvenile koaro, can climb wetted margins of waterfalls or spillways, and some species, such as inanga and smelt, primarily swim to move past obstacles and rely on low velocity flow to rest while moving upstream (Kelly and Collier, 2007).

Poorly designed or installed structures can pose a barrier to fish migration if:

- the water flow is too high and/or there are no resting places provided within the structure
- there is no low velocity zone or wetted margin provided at the water edge
- water turbulence is too great (usually because the culvert is too narrow or too steep)
- the crossing is too dark (because the culvert is too long or too small)
- water depth within the culvert is too shallow
- the river bed within the culvert is too smooth for bottom swimmers (often because the culvert has a concrete or steel bottom and normal bed material has not been able to develop)
- the gradient is too steep
- the bed level of the crossing has been raised (e.g. culvert floor is perched above the streambed)
- debris has built up and formed a weir
- scouring has occurred and caused the culvert to become perched

(Speirs and Ryan, 2006)

In catchments not exceeding 100 hectares permitted activity rule 4.2.9.2 of the Waikato Regional Plan allows the use, erection, reconstruction, placement, alteration or extension of a culvert as a permitted activity, subject to a number of conditions. These conditions include that “the structure shall provide for safe passage of fish both upstream and downstream” (Waikato Regional Plan, Environment Waikato, 2007).

In order to assess the effectiveness of the permissive approach, 60 catchments less than 100 hectares have been selected randomly from across the Waikato Region and culverts within those catchments identified and assessed for fish passage restriction.

2 Methodology

The assessment methodology was carried out in accordance with that recommended in a report produced by Alchemists Ltd for Environment Waikato (Kelly, J. and Fenton, T. 2007: Methodology for assessing compliance of permitted activity rules for culverts 4.2.9.1 and 4.2.9.2).

Sites (catchments) were selected randomly by GIS analysis subject to certain criteria, e.g. catchments were to be approximately 100 ha in size, and catchments within the Regional Plan Natural State classification were to be excluded (because any culvert within these areas is not a permitted activity). The Alchemists report, (i.e. Kelly and

Fenton, 2007), provides a compete description of the criteria and GIS generation of the catchments.

Two sets of 30 random sites were generated and the first set of 30 was visited in the summer of 2006/2007 and the second set in the summer of 2007/2008. At each site a starting point was identified (the bottom of the catchment) and every drainage channel upstream of that point was surveyed. Culverts upstream of the starting point were identified and a separate survey form (see Appendix 1) completed for each. The survey sheet was designed to collect all data needed to ascertain if the conditions in permitted activity rule 4.2.9.2 are being met. However, it is only the condition pertaining to safe passage of fish that is reported on here. The likely severity of fish passage restriction was assessed according to the following categories (From Kelly and Collier, 2007):

- **None or minimal restriction**, where the culvert poses no significant barrier to upstream or downstream passage of fish likely to be found in the stream within the normal range of flow conditions.
- **Restriction at low flows only**, where the culvert poses a significant barrier to the passage of fish likely to be found in the stream, but where this barrier is only present at low flow conditions.
- **Restriction at high flows only,** where the water flow in the culvert is likely to increase and become too swift to allow the passage of fish during high flows, (generally the culvert will be half full at normal flows).
- **Restriction at most flow conditions,** where the structure poses a significant barrier to the passage of fish likely to be found in the stream at the normal range of flow conditions.

3 Results and discussion

52 of the 60 catchments selected by the GIS analysis were visited over the two field survey seasons. Time constraints prevented visits to the remaining eight. Of those 52, the number of culverts found in each catchment ranged from zero to ten, (the majority containing between one and four culverts). Only two catchments contained zero culverts. The total number of culverts assessed in the 52 catchments was 187.

Nearly all (185 in number, or 99 %) of the culverts assessed were pipe culverts. The majority (157 in number, or 84 %) of the culverts were made from concrete, the rest were plastic (11 %) and galvanised steel (4 %).

The table below shows the number of culverts that were assessed as posing none or minimal restriction to fish passage, or as posing a restriction to fish passage at most flows, low flows or high flows.

Fish passage restriction category	**Number of culverts** (Total number of culverts assessed = 187)	**Percentage of culverts assessed**
None/minimal	77	41 %
Low flows	22	12 %
High flows	23	12 %
Most flows	66	35 %

59 % (111 from 187) of culverts assessed would restrict fish passage at some flow conditions (i.e. low flows, high flows or most flows). 35 % of culverts assessed would restrict fish passage at most flow conditions.

36 % (68 from 187) of culverts assessed were perched at the outlet; the majority (59) of these would restrict fish passage at most flows, and the remaining 9 would restrict fish passage at low flows. A perched culvert represents a major barrier to most fish species (Barnes, 2004). Species that rely on swimming to move past obstacles, such as the inanga, and even those that can climb wetted margins, such as koaro, cannot negotiate an overhanging pipe.

Other culverts assessed as restricting fish access were either over half full at normal (or low) flows, and therefore would become un-navigable by fish at high flows. Others restricted fish passage at low flows because of a lack of water coverage on the culvert base, often because the culvert is too wide and flat.

59% of the culverts assessed in this study restricted fish passage, which would considerably limit habitat available to migrating fish species in the Waikato Region. Over half of the culverts that pose a barrier to fish do so because they are perched.

Nearly 60% of culverts assessed would restrict fish at most flows, low flows or high flows and so were non-compliant with the condition in permitted activity rule 4.2.9.2 which states that culverts must provide for safe fish passage. The permissive approach is therefore not effective in this regard.

References

Barnes, G. E. 2004: *Barriers to fish passage in the Hunua Ranges and Waharau Regional Parks : a Comprehensive Survey*, Auckland Regional Council Technical Publication No. 236, June 2004. Auckland Regional Council, Auckland

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Appendix 1: Field survey sheet

(From Kelly and Fenton, 2007)

Date:…… **Monitoring** **Officer**:……

Site Number:…….. **Catchment Number:**……

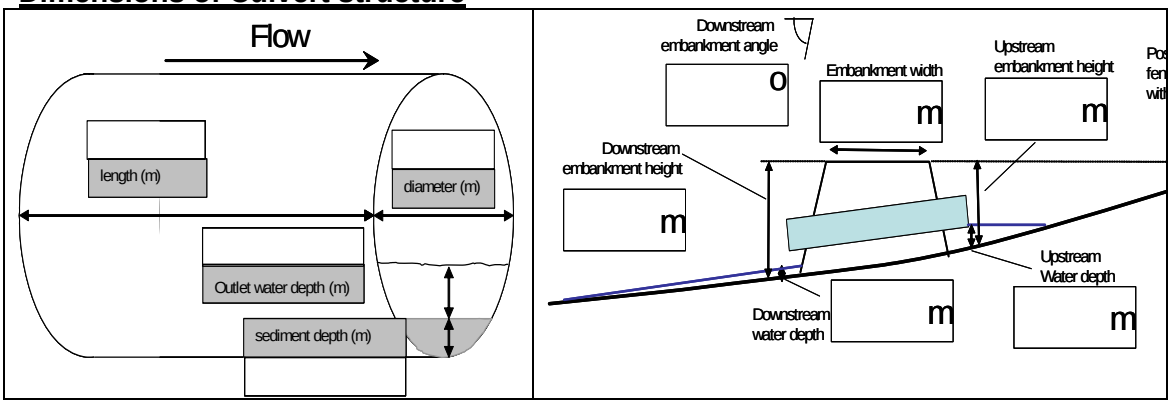
Co-ordinates: (GPS) E…… N……

Culvert Description: Culvert | Concrete Slab Ford with….Culverts | Concrete Slab Ford without Culverts
(circle)

Culvert type: Pipe | Box | Arch | Ford
(circle)

Culvert Materials: Concrete | Steel | Galvanised Steel | Plastic
(circle) (Corrugated Iron)

Dimensions of Culvert structure



OUTLET:

Culvert cross section :

Outlet **FLAT** **POOLED** **PERCHED**

For perched culverts provide an estimate of water fall (for multiple culverts note maximums only):

Height (m)…… Undercut length (m)……

Likely Severity of Fish Passage Restriction

None/Minimal Low flows Most flows Highflows

Downstream Embankment Stability

Vegetation Cover: Bare (< 25%) Partial Veg. (25-75%) Vegetated (>75%)
(Circle)

Erosion: ……

Surface reinforcement:……

Spillway (circle) Present Absent

If present: Material constructed in: ……

Spillway width……m Spillway depth ……..m

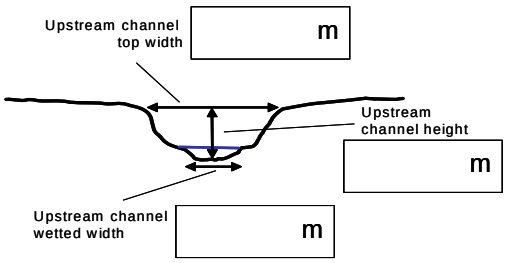
(measured at top of spillway)

INLET:

Culvert cross section :

Inlet **FLAT** **POOLED** **PERCHED**

Immediate upstream channel dimensions



Flooding of Neighbouring property

Fence present in potential ponding area behind embankment?	Yes	No
If yes does it look like a boundary fence (i.e. no gate)?	Yes	No
If yes does fence correspond to property boundary on your map?	Yes	No

Debris upstream of culvert

Is there debris on upstream face of the culvert that impedes flow?	Yes	No

Erosion caused by structure

Upstream - is there evidence of erosion around the inlet?	Yes	No
Downstream – is there evidence of erosion around the outlet?	Yes	No

Photograph any significant erosion caused by the culvert

Permanent Flowing water? Yes No

Track runoff - is it likely that runoff from track either side of the culvert would flow directly into the stream?

Yes No

Photos

INLET ……. OUTLET …….

Comments:

…… …… …… ……

……