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MEMORANDUM

Attention: Nigel Binks, Department of Conservation

Date: 14 September 2023

From: Elena Miller – Ecologist, Ecology New Zealand Ltd;
Dylan Smith – Senior Freshwater Ecologist, Ecology New Zealand Ltd

RE: 230067.3-001Rev0: Amur Carp Surveillance and Culvert Assessment Completion Memo

1. INTRODUCTION

Ecology New Zealand Limited (ENZL) was commissioned by the Department of Conservation (DoC) to undertake surveillance data collection to support the management of the unwanted organism/noxious fish species[1]; *Cyprinus rubrofuscus* (Amur/koi carp) of ongoing control efforts within the Mangaotama and Mystery Creek catchmentswithin the Ohaupo district of the Waikato Region. Amur carp are known to be strong swimmers[2], both catchments currently have an absence or limited distribution of Amurcarp compared to other catchments within the region.

The aim of this assessment was to determine whether there is any inhibition to fish passage associated with the culvert structures, to determine whether the absence of koi carp and providing insight into possible future methods of controlling pest fish migration. This memorandum[3] presents a completion report documenting the methods used and the outcome of this assessment.

1 Noxious fish (Freshwater Fisheries Regulations 1983); Unwanted organism (Biosecurity Act 1993).
2 Franklin, P.A., Baker, C.F. and Reeve, K.A., 2021. A comparison of passage efficiency for native and exotic fish species over an artificial baffled ramp. Journal of Fish Biology, 99(6), pp.1928-1939.
3 This memo is subject to the Report Limitations provided in Appendix A.

2. METHODOLOGIES

Culvert Assessment

A preliminary desktop assessment using aerial imagery and Waikato Regional Council maps was carried out of the Mystery Creek and Mangaotama catchments. Each instance where the respective watercourse appeared to intersect with a road was ideantified as a location where a culvert was likely present, in total five locations were identified as potential barriers within the two catchments. The other two sites identified as potential barrier locations during early coms with the Department of Conservation were identified on-site as being bridges and therefore were not classified as barriers and not further considered in this assessment.

On the 1st of June, ENZL ecologists carried out an assessment of culverts along the upper catchments of Mystery Creek and Mangaotama stream, after gaining relevant permissions from landowners to access private land where necessary. A map showing locations of the assessed culverts is shown in Figure 1. At each location, it was confirmed whether there was a culvert present, and if so, each culvert was assessed at both the upstream inlet and downstream outflow for any evidence of obstruction to fish passage. Fish passage assessments were in-line with with fish passage guidelines and assessed based upon the flow regimes of each culvert, how sunken the structure was, culvert length and diameter relative to streambank width, as well as general observations about the stream and culvert conditions.

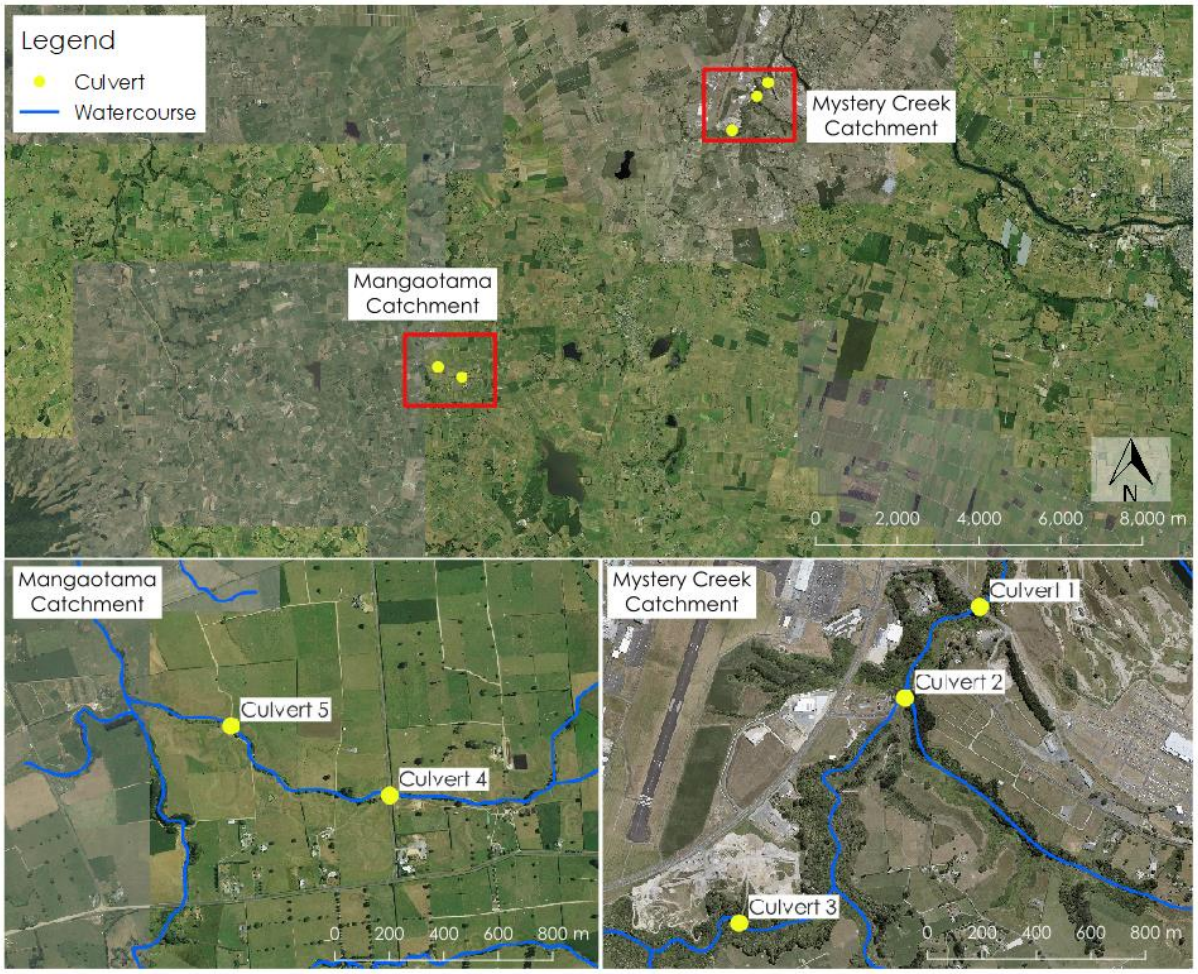

Figure 1: Locations of assessed culverts within the Mystery Creek and Mangaotama catchment systems.

eDNA survey

Using the information collected during culvert assessments to identify areas of interest for potential carp incursion, the sites were identified in the Mystery Creek and Mangaotama catchments. Additionally DoC identified key lakes in the Mystery Creek catchment (Figure 2) that are believed to be carp free for eDNA surveillance to determine whether these waterbodies continued to remain so. eDNA samples were collected on the 3rd and 25th of August using a combination of 5 replicates designed to target amur carp specifically and one comprehensive sample using methodology provided by DoC in line with best practice methodology recommended by Wilderlabs Limited, the provider of the eDNA sample and laboratory services.

Samples were collected and sent to Wilderlabs Limited for processing and results are detailed below.

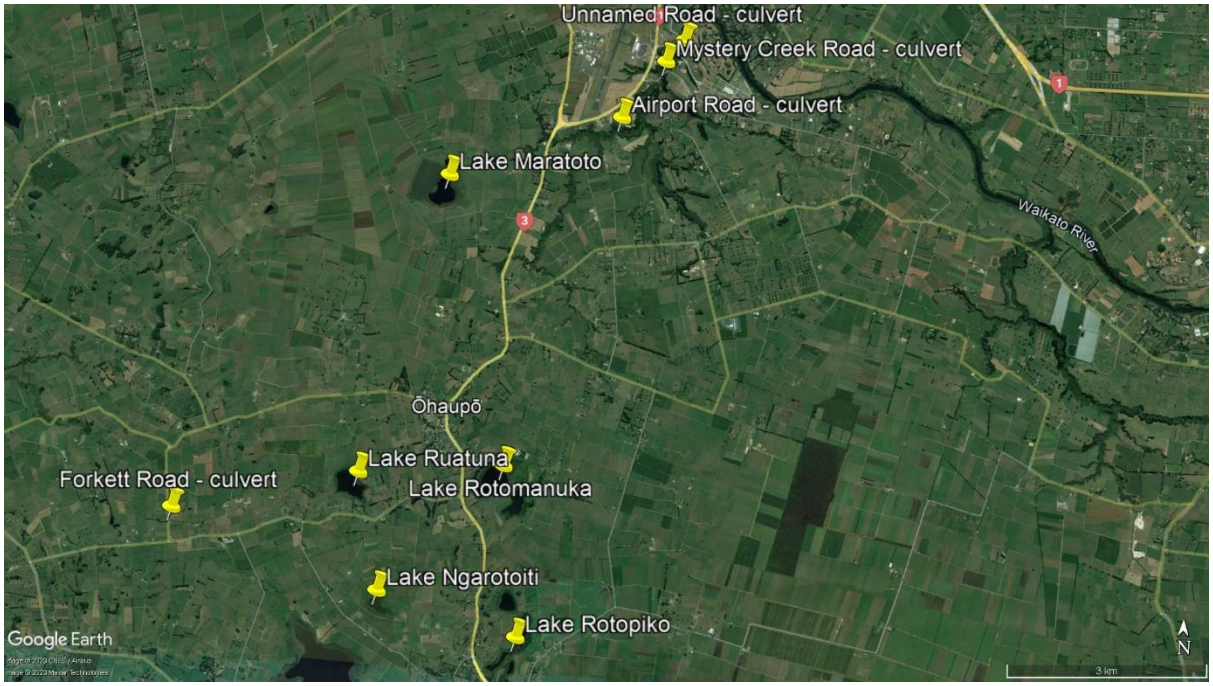

Figure 2: Location points of identified lakes and culvert structures for eDNA sampling. Note the Forket road point is associated with three sites for sampling in close proximity to one another.

3. RESULTS

Culvert Assessments

Three culverts were assessed in the Mystery Creek catchment, and two were assessed in the Mangaotama catchment. These results are presented in Tables 1-5 below. It sould be noted that, due to health and safety hazards associated with stream access, not all data was able to be accurately recorded at every culvert (data not recorded has been marked 'n/a'). This did not impact the outcome of the culvert assessment.

Table 1: Assessment results from Culvert 1, located in the Mystery Creek catchment system.

<table>
<tr><td>CULVERT 1</td><td colspan="2">Location: Unnamed Road (Mystery Creek Catchment)</td><td colspan="3">Coordinates: -37.866790, 175.343537</td></tr>
<tr><td colspan="2" rowspan="2">Type of culvert: round metal culvert</td><td colspan="4">Length: c. 23.5 m</td></tr>
<tr><td colspan="4">Width: 2.9 m</td></tr>
<tr><td colspan="2" rowspan="2">Wetted width of stream:</td><td colspan="4">Upstream: 2.4 m</td></tr>
<tr><td colspan="4">Downstream: n/a</td></tr>
<tr><td colspan="2" rowspan="2">Velocity[4] of the stream:</td><td>Upstream:</td><td>d1 = 540</td><td>d2 = 588</td><td>d2 – d1 = 48 mm</td></tr>
<tr><td>Downstream:</td><td>d1 = n/a</td><td>d2 = n/a</td><td>d2 – d1 = n/a</td></tr>
<tr><td colspan="6">Upstream Observations:
• Top 75% of culvert is sunken at least 25%
• Culvert is at least 50% smaller than upstream bank width
• Lower velocity upstream of culvert than downstream (by observation)</td></tr>
<tr><td colspan="6">Downstream Observations:
• Culvert is over 75% smaller than the downstream bank width
• Ledge present in the culvert approximately 75% of the way downstream, potentially due to the culvert sinking in the structure, creating hetereogenity in flow dynamics.</td></tr>
<tr><td colspan="6">Fish Passage:
• Fish passage obstruction likely for weak swimming species, but no impediment for stronger swimming species.
• Does not comply with NPS[5] freshwater regulations</td></tr>
<tr><td colspan="3"> 
Figure 3: Photo taken from upstream end of Culvert 1.</td><td colspan="3"> 
Figure 4: Photo taken from downstream end of Culvert 1.</td></tr>
</table>

[4] Measured using 'ruler method'. Harding et al., 2009. Stream Habitat Assessment Protocols. School of Biological Sciences, University of canterbury.
[5] Ministry for the Environment, 2020. National Policy Statement for Freshwater Management 2020.

Table 2: Assessnent results from Culvert 2, located in the Mystery Creek catchment system.

<table>
<tr><td>CULVERT 2</td><td colspan="2">Location: Mystery Creek Road Culvert (Mystery Creek Catchment)</td><td colspan="3">Coordinates: -37.870368, 175.339997</td></tr>
<tr><td colspan="3" rowspan="2">Type of culvert: double concrete box culvert with double wing wall and apron</td><td colspan="3">Length: n/a</td></tr>
<tr><td colspan="3">Width: c. 5 m</td></tr>
<tr><td colspan="3" rowspan="2">Wetted width of stream:</td><td colspan="3">Upstream: n/a</td></tr>
<tr><td colspan="3">Downstream: n/a</td></tr>
<tr><td rowspan="2">Velocity[6] of the stream:</td><td>Upstream:</td><td>d1 = n/a</td><td>d2 = n/a</td><td colspan="2">d2 – d1 = n/a</td></tr>
<tr><td>Downstream:</td><td>d1 = n/a</td><td>d2 = n/a</td><td colspan="2">d2 – d1 = n/a</td></tr>
<tr><td colspan="6">Upstream Observations:
• Water velocity unable to be measured due to limited accessibility, but appears slow to moderate with no obstructions
• Culvert appears sunken (unknown depth)
• Water level is consistent throughout the culvert
• Culvert width is in line with stream wetted width</td></tr>
<tr><td colspan="6">Downstream Observations:
• Culvert width is in line with stream wetted width</td></tr>
<tr><td colspan="6">Fish Passage:
• No fish passage obstruction</td></tr>
<tr><td colspan="3"> 
Figure 5: Photo taken from upstream end of Culvert 2.</td><td colspan="3"> 
Figure 6: Photo taken from downstream end of Culvert 2.</td></tr>
</table>

[6] Measured using 'ruler method'. Harding et al., 2009. Stream Habitat Assessment Protocols. School of Biological Sciences, University of canterbury.

Table 3: Assessnent results from Culvert 3, located in the Mystery Creek catchment system.

CULVERT 3	**Location:** John Roberts Contracting (Mystery Creek Catchment)		**Coordinates:** -37.877472, 175.333808	
Type of culvert: double concrete box culvert with double wing wall and apron		**Length:** c. 20 m		
		Width: 4.3 m		
Wetted width of stream:		**Upstream:** 5.3 m		
		Downstream: 5.6 m		
Velocity[7] of the stream:	**Upstream:**	**d1 =** 580	**d2 =** 589	**d2 – d1 =** 9
	Downstream:	**d1 =** 580	**d2 =** 600	**d2 – d1 =** 20

Upstream Observations:

- box culver is significantly sunken (25-40%)
- stream angles right by 45 degrees when it reaches the culvert
- velocity is relatively uniform upstream and downstream
- culvert is smaller than wetted width, possibly influenced by the angling of the stream

Downstream Observations:

- Similar width between culvert to streambank widths upstream and downstream.

Fish Passage:

- No fish passage obstruction

Figure 7: Photo taken from upstream end of Culvert 3.

Figure 8: Photo taken from downstream end of Culvert 3.

[7] Measured using 'ruler method'. Harding et al., 2009. Stream Habitat Assessment Protocols. School of Biological Sciences, University of canterbury.

Table 4: Assessment results from Culvert 4, located in the Mangaotama catchment system.

CULVERT 4	**Location:** Forkett Road Culvert (Mangaotama Catchment)		**Coordinates:** -37.933365, 175.260295	
Type of culvert: single concrete box culvert with wing walls and apron		**Length:** 15 m		
		Width: 2.5 m		
Wetted width of stream:		**Upstream:** 2.55 m		
		Downstream: 2 m		
Velocity[8] of the stream:	**Upstream:**	**d1 =** 284	**d2 =** 315	**d2 – d1 =** 31
	Downstream:	**d1 =** 280	**d2 =** 294	**d2 – d1 =** 14

Upstream Observations:

- Concrete bottom is present at entrance to culvert
- No instream sediment deposition
- Not in line with the natural flow path of the watercourse, offset to the left looking downstream
- Culvert width is in line with the wetted width of the stream

Downstream Observations:

- Just past the edge of the concrete apron there is undercutting and pooling, causing initial stages of a fish barrier.
- Faster velocity at the end of the apron, creating bank incision and undercutting
- Slip on the true right downstream bank

Fish Passage:

- No fish passage obstruction

Figure 9: Photo taken from upstream end of Culvert 4.

Figure 10: Photo taken from donwstream end of Culvert 4.

[8] Measured using 'ruler method'. Harding et al., 2009. Stream Habitat Assessment Protocols. School of Biological Sciences, University of canterbury.

Table 5: Assessment results from Culvert 5, located in the Mangaotama catchment system.

<table>
<tr><td>CULVERT 5</td><td colspan="2">Location: 530 Ryburn Road
Culvert (Mangaotama Catchment)</td><td colspan="3">Coordinates: -37.931236, 175.253571</td></tr>
<tr><td colspan="3" rowspan="2">Type of culvert: piped culvert</td><td colspan="3">Length: 12 m</td></tr>
<tr><td colspan="3">Width: 1.6 m</td></tr>
<tr><td colspan="3" rowspan="2">Wetted width of stream:</td><td colspan="3">Upstream: 3.1 m</td></tr>
<tr><td colspan="3">Downstream: 3.6 m</td></tr>
<tr><td rowspan="2">Velocity[9] of the stream:</td><td>Upstream:</td><td>d1 =</td><td>d2 =</td><td colspan="2">d2 – d1 =</td></tr>
<tr><td>Downstream:</td><td>d1 = 650</td><td>d2 = 690</td><td colspan="2">d2 – d1 = 40</td></tr>
<tr><td colspan="6">Upstream Observations:
• Culvert is situated above the streambed
• Stream width is significantly wider than the culvert (~1.5 m).
• High nutrient levels in the stream (periphyton present)</td></tr>
<tr><td colspan="6">Downstream Observations:
• No evidence of embeddedness or sorting and deposition processes within the culvert.</td></tr>
<tr><td colspan="6">Fish Passage:
• Moderate impediment to fish passage
• Adverse impact to weak swimming species
• Does not comply with NPS[10] freshwater regulations
• Koi burst swimming would likely overcome this during regular flow conditions</td></tr>
<tr><td colspan="3"> 
Figure 11: Photo taken from upstream end of Culvert 5.</td><td colspan="3"> 
Figure 12: Photo taken from upstream end of Culvert 5.</td></tr>
</table>

Additionally, while on-site, a conversation with the landowner of 490-530 Ryburn Road (the location of culvert 5), it was brought to the attention of ENZL ecologists that unusually high concnetrations of heavy metals had been privately recorded within the stream (located within the Mangaotama catchment). Heavy metal concentrations are known to have adverse impacts on fish, particularly juvenile carp[11].

[9] Measured using 'ruler method'. Harding et al., 2009. Stream Habitat Assessment Protocols. School of Biological Sciences, University of canterbury.
[10] Ministry for the Environment, 2020. National Policy Statement for Freshwater Management 2020.
[11] Cano-Viveros, S., Galar-Martínez, M., Gasca-Pérez, E., García-Medina, S., Ruiz-Lara, K., Gómez-Oliván, L.M. and Islas-Flores, H., 2021. The relationship between embryotoxicity and oxidative stress produced by aluminum, iron, mercury, and their mixture on Cyprinus carpio. *Water, Air, & Soil Pollution*, *232*, pp.1-21.

eDNA results

The eDNA results were collated into Table 6 displaying the presence/absence of amur carp in each sample replicate at each site. Notably, carp were detected in the lower reaches of the Mystery Creek catchment, with two of the three sites having multiple replicate detections at MC1 and MC2. Lake Ngarotoiti also had detection of amur carp in all samples which was expected.

The Forkett Road tributary into the Mangaotama remains amur carp free.

Regarding the site located at John Roberts Contracting (MC3), the composite sample indicates the area appears to be devoid of any fish species watercourse, as no fish were detected with an exception of Inanga (*Galaxias maculatus*). It is difficult to ascertain the likelihood of inanga, a species known for its poor ability to navigate barriers, to get into this reach while other species failed to do so. That, coupled with the fact the sample was considered to be extremely weak suggests this detection may be attributable to excrement of a predatory bird being deposited in the stream.

It is worth noting there was one weak detection of amur carp produced from the multi-replicate samples taken. This could indicate that amur carp are present in the area. Follow up sampling should be undertaken.

eDNA sampling failed to detect the presence of any fish species in Lake Maratoto, indicating the lake is devoid of any fish life.

Table 6: eDNA results of amur carp presence/absence in samples extracted from stream and lake samples of interest points in the Mangaotama catchments on the 3rd and 25th of August 2023.

Sample location	Site Code	Amur carp specific samples					Composite Sample
		Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 1
Mystery Creek Showgrounds	MC1	✓	✓	✓	✓	✓	✓
Mystery Creek Road	MC2	✓	✓	✓	✓	✓	✓
John Roberts Contracting	MC3	✗	✗	✓	✗	✗	✗
Forkett Road Culvert (1)	FR1	✗	✗	✗	✗	✗	✗
Forkett Road Culvert (2)	FR2	✗	✗	✗	✗	✗	✗
Forkett Road Culvert (3)	FR3	✗	✗	✗	✗	✗	✗
Lake Maratoto	MARA	✗	✗	✗	✗	✗	✗
Lake Ngarotoiti	NGA	✓	✓	✓	✓	✓	✓
Lake Ruatuna	RUA	✗	✗	✗	✗	✗	✗
Lake Rotomanuka	ROTO1	✗	✗	✗	✗	✗	✗
Lake Rotopiko (North)	ROTO2	✗	✗	✗	✗	✗	✗
Lake Rotopiko (Middle)	ROTO3	✗	✗	✗	✗	✗	✗
Lake Rotopiko (South)	ROTO4	✗	✗	✗	✗	✗	✗

4. CONCLUSION

This memo, prepared by ENZL for the Department of Conservation, presents a summary of results from culvert assessments in the upper reaches of the Mystery Creek and Mangaotama catchment systems of the Waikato Region. Across the five culverts that were assessed, two culverts exihibited features that would impede fish passage for weaker-swimming species migrating upstream through the culvert structures. Overall, no significant barriers were detected in the two catchments and it is unlikely that these culverts cause impedement to koi carp passage.

eDNA results were inline with our expections that carp were present in the lower Mystery Creek catchment, absent in the Mangaotama tributary and absent from all lakes within the wider catchment with the exception of Ngarotoiti.

We recommend a follow up survey of water quality sampling within the Mangaotama catchment to determine whether iron and other heavy metals may be the factor causing the species to avoid this watercourse. We also recommend further eDNA sampling to track any changes in amur carp movement through the catchments and an additional site walkover of the lower Mystery Creek catchment to determine where the potential fish barrier is located between Mystery Creek Road (MC2) and the John Roberts Contracting site (MC3).

APPENDIX A

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