BEFORE THE COMMISSIONER APPOINTED ON BEHALF OF THE OTAGO REGIONAL COUNCIL, CENTRAL OTAGO DISTRICT COUNCIL AND QUEENSTOWN LAKES DISTRICT COUNCIL

Under	The Resource Management Act 1991 (the **Act**)
In the Matter	of an application for resource consents for Suction Dredge Mining on the Clutha River/ Mata Au
Between	**COLD GOLD CLUTHA LIMITED** **Applicant**
And	**OTAGO REGIONAL COUNCIL (RM22.434)** **QUEENSTOWN LAKES DISTRICT COUNCIL (RM220834)** **CENTRAL OTAGO DISTRICT COUNCIL (RC220255)** **Local Authorities**

EVIDENCE OF MARK PETER HAMER

(Freshwater Ecology)

25th October, 2023

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EVIDENCE OF MARK PETER HAMER

Qualifications and Experience

1. I am a Senior Freshwater Ecologist at e3Scientific Limited. I have been in this role since January 2023. I have 17 years' postgraduate work experience in freshwater ecology and hold a BSc and MSc in Ecology from Massey University.

2. I have worked as a freshwater ecologist undertaking stream, river and lake ecological assessments in the Waikato for 17 years and the last 10 months in Otago. During my time in the Waikato, I helped develop new monitoring methods and procedures. I also undertook regional council state of the environment monitoring and reporting using stream periphyton, macrophytes, macroinvertebrates and freshwater fish as indicators of aquatic health. I have completed numerous ecological investigations in Otago and Southland in the last 10 months covering diverse habitats and ecosystem types ranging from large rivers to small creeks and wetlands.

3. My current role is as a Senior Freshwater Ecologist at e3 Scientific based in Arrowtown. I previously worked as a field ecologist before becoming Team Leader of the freshwater ecology monitoring team at the Waikato Regional Council. Prior to that I have undertaken contract work for the Bay of Plenty Regional Council, Greater Wellington, Massey University and Fish and Game. I have authored or co-authored over 20 scientific publications and technical reports with topics ranging from large non-wadeable river functional indicators such as microbial breakdown rates and metabolism to demonstrating new fish passage options at culverts.

4. I confirm that I have read the Expert Witness Code of Conduct set out in the Environment Court's Practice Note 2023. I have complied with the Code of Conduct in preparing this evidence and agree to comply with it while giving oral evidence before the Hearings Panel. This evidence is within my area of expertise, except where I state that I am relying upon the specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Involvement in project

5. e3Scientific was engaged by Cold Gold Clutha Limited to undertake an ecological assessment in relation to its application to dredge for gold in the upper Clutha/Mata Au. The following reports have been prepared by e3 Scientific as part of this application process:
    a. Suction Dredge Mining Upper Clutha River – Freshwater Assessment (Jager & Doheny, 2022), which was included with the AEE.
    b. Memo dated 19.4.2023, Response to Cultural Impact Assessment – Suction dredge gold mining in the Clutha River (Hamer & Miller, 2023).

6. Following initial advice the applicant reduced the extent of the proposed application area, to exclude the ecologically sensitive area's around Devil's Nook and the lower section of Clutha/Mata Au River below the Lindis River Confluence.

Purpose and scope of evidence

7. This evidence relates to the potential ecological effects on the ecosystems and waterways and addresses the following freshwater ecological topics which are raised as concerns by submitters, or matters in the section 42A report. Where appropriate I refer back to assessments or discussions in the documents referred to at paragraph 5a and b above:
    a. Effects on fish
    b. Aquatic biosecurity
    c. Sediment plume
    d. Effects on avifauna
    e. Freshwater ecosystem health

8. As a freshwater ecologist I have reviewed relevant information available with regard to the 5 topics outlined above in paragraph 7 within an ecological context.

Effects on fish

Lamprey

9. The freshwater ecological assessment (Jager & Doheny, 2022) found that kanakana lamprey would not be affected by the proposed activity. This finding is based on there being no records of lamprey upstream of the Clyde Dam (Figure 1; Jager & Doheny, 2022). Further to this:
    a. Information supplied to e3s by Contact Energy Ltd after the completion of the Jager and Doheny report show that 593 adult lamprey have been trapped and transferred upstream of Roxburgh Dam in the last 12 years, but not upstream of Clyde Dam (Jenny Bullock Pers. Comm. 19/4/2023). As no lamprey have been recorded upstream of Clyde Dam and none have been moved there, it is very unlikely that lamprey will be present in this section of the Clutha River as the Clyde Dam does not currently have a dedicated lamprey fish pass to enable their movement upstream past this barrier.
    b. Lamprey ammocoetes (a juvenile stage) prefer very slow flowing edge and backwater habitat consisting of silt substrates (Jellyman & Glova, 2002), not the sand and gravels and swift water present in the suction dredge localities.
    c. The only known location of lamprey eggs are on the underside of boulders in small streams (Baker, et al., 2016). This habitat type is not present within the proposed activity footprint so this activity is unlikely to impact on lamprey eggs and development.

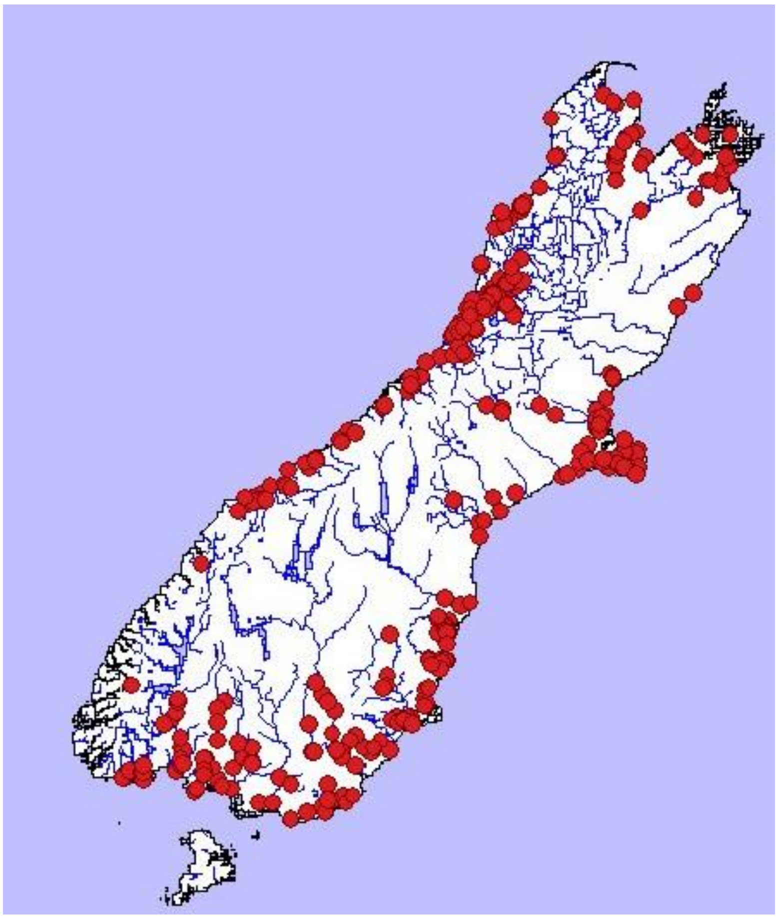

Figure 1: Known lamprey distribution for the South Island from New Zealand Freshwater Fish Database (NZFFDB) records as shown on the NIWA Fish Atlas website (https://niwa.co.nz/our-science/freshwater/tools/fishatlas/species/fish-species/lamprey).

10. Therefore, it is my opinion that the proposed activity will not adversely affect any of the lifecycle stages of lamprey.

Trout

11. The Clutha River / Mata-Au section in which suction dredging is proposed is identified as spawning habitat for brown trout and rainbow trout. Effects on trout spawning is assessed to be low as many trout will seek out smaller tributary streams to spawn. However, some spawning in the mainstem is likely. Harvey et al., (1995) noted that dredge tailings are attractive to trout as spawning substrate due to its looseness and suitable size although they may not be beneficial for egg development. The suspended sediment levels identified downstream of the suction dredge barge reached a maximum level of 9 g/m^3, which is well below the levels

shown to effect brown trout oxygen consumption (600 g/m^3) and feeding rates (450 g/m^3) in New Zealand (Greer et al., 2015). Salmonids are known to feed on entrained invertebrates at dredge outfalls in America (Harvey et al., 1995). For these reasons adult trout will be able to avoid the dredge operation and if they choose to be in the sediment plume the sediment levels are low enough as to not adversely affect them, and juveniles are very unlikely to be present in the vicinity of the dredge as the majority of spawning will occur in tributary streams and fry and young juvenile rearing occurs in slow flowing stream edge habitat (Maclean, 2012). Based on the above, it is my opinion that the proposed activity will not adversely affect trout.

Kōaro

12. A short stretch of the Clutha River / Mata-Au within the proposed application area is identified as kōaro spawning habitat by the MPI NES-PF Erosion susceptibility and spawning habitat GIS tool. However, kōaro spawn at stream edges, in riffles during high flow events (Allibone & Caskey, 2000), and NZ Freshwater Fish Database (NZFFD) records for kōaro presence are located within the tributary streams. These areas will be outside of zones used by the suction dredge and tributary confluences will be actively avoided as recommended in the freshwater ecological assessment (Jager & Doheny, 2022). Juveniles avoid suspended sediment and tend to occupy gravelly shallows in mainstem rivers (Goodman, 2018). In addition to this the proposed consent conditions will avoid tributary confluences with the Clutha River. As shallow river margins are unable to be suction dredged, juvenile kōaro and their habitat will be unaffected by the dredge operation. Based on the known spawning and habitat preferences of kōaro, it is my opinion that it is unlikely that the proposed activity would affect kōaro populations.

Longfin eels

13. Tuna/Eels are trapped and transferred upstream past the Roxburgh and Clyde Dams and elver are released throughout the catchment. Large adult eels are then caught and are transferred below Roxburgh Dam by Contact Energy eel fisherman with 1380 released downstream in the last 5 years (Jenny Bullock Pers. Comm. 19/4/2023). Longfin eels have high

ecological value (At Risk[i]) but are considered very unlikely to be affected by the proposed activity.

14. Juveniles less than 300 mm long prefer shallow riffle habitat less than 0.5 m deep (Jellyman et al., 2002) and larger longfin eels preferring macrophyte beds, along stream edges, undercut banks, instream debris and in shade (Glova et al., 1998; Jellyman et al., 2002). In accordance with the conditions proposed shallow habitats less than 0.8 m and less than 1 m during the trout spawning season deep and *Lagarosiphon major* macrophyte beds will be avoided. The majority of longfin eel habitat is therefore excluded from the area to be suction dredged. It is my opinion that the proposed activity will not adversely affect longfin eels.

Entrainment

15. Brown and Rainbow trout are mobile pelagic species; and I consider that trout will be entrained into the suction dredge very infrequently. This is consistent with the anecdotal evidence from the applicant. Given their known responses to disturbance in the water column it is more likely that they will move away from the activity. However, if a juvenile trout were in fact to be entrained available information suggests that they are unlikely to die. A study where juvenile trout were purposely fed into a suction dredge, found that all 36 survived passing through the dredge (Griffith & Andrews (1981); Harvey et al., (1995)). Therefore, the likelihood of mortality or adverse effects on adult and juvenile trout from entrainment is expected to be low. Mortality of trout fry, if present, has been found to be increased by suction dredges (Griffith & Andrews,1981; Harvey et al., (1995)); however, the locations where the suction dredge barge will operate is not considered ideal spawning and trout fry development habitat as trout fry require velocities of less than 0.6 m/s (Raleigh, et al., 1984). The applicant also plans to avoid depths less than 1 m deep during the trout spawning season. Adult eel mortality is known from passing through floodwater pump stations (David, et al., 2019) and power station turbines (Beentjes, et al., 2005). However, suction dredges use water suction from a seperate screened pump to draw up sediment and water from the river bed rather than an axial pump with an internal

[i] (Dunn, et al., 2018).

propellor such as at flood pumps. Interestingly, suction dredges have been used effectively to target and sample live eel elver in esturine environments in Europe (Westerberg, et al., 1993). Bearing in mind eels are unlikely to be present where dredging will occur (see paragraphs 13 and 14), if eels were to be present, in the unlikely event that eels were to be entrained, it is likely eels would pass through unharmed as shown by elver in Europe and trout in North America.

16. Based on the above, it is my opinion that it is very unlikely that fish spawning, juveniles and adults will be present within the suction dredge footprint and if they are present the mitigations and avoidance measures outlined in the ecological assessment (Jager & Doheny, 2022) and proposed consent conditions of the proposed activity will minimise adverse effects on fish values.

Aquatic biosecurity

Lagarosiphon

17. Lagarosiphon (*Lagarosiphon major*) is known to be confined to the river edge and found in back eddies, baylets, the lee of bends in the river and under the occasional willow tree on the Clutha River (Clayton, 1993). Water clarity is good in the upper Clutha River and Lagarosiphon will grow to similar depths to what it is found in lake Wanaka, approximately 6 m. River velocity and flow is the primary limiting factor of Lagarosiphon in the Clutha River (Clayton, 1993). Further to this, the application outlines that Lagarosiphon beds will be avoided. Therefore, provided care is taken by the applicant, the chance of increasing the spread of Lagarosiphon is low.

Sediment plume

Gravel settlement

18. In response to a submitters concerns that gravel will not settle immediately downstream of the suction dredge, I cover here some sediment deposition dynamics. There are a number of variables that influence the rate at which substrate falls through the water column to the

stream bed including, size, density, shape, water viscosity, resistance and drag. It has been demonstrated that larger heavier particles will drop to the bed quicker than smaller particles. Figure 2 below, shows that smaller particles will settle more slowly through the water column (bottom left of graph) and larger particles will fall faster through the water column (top right of graph).

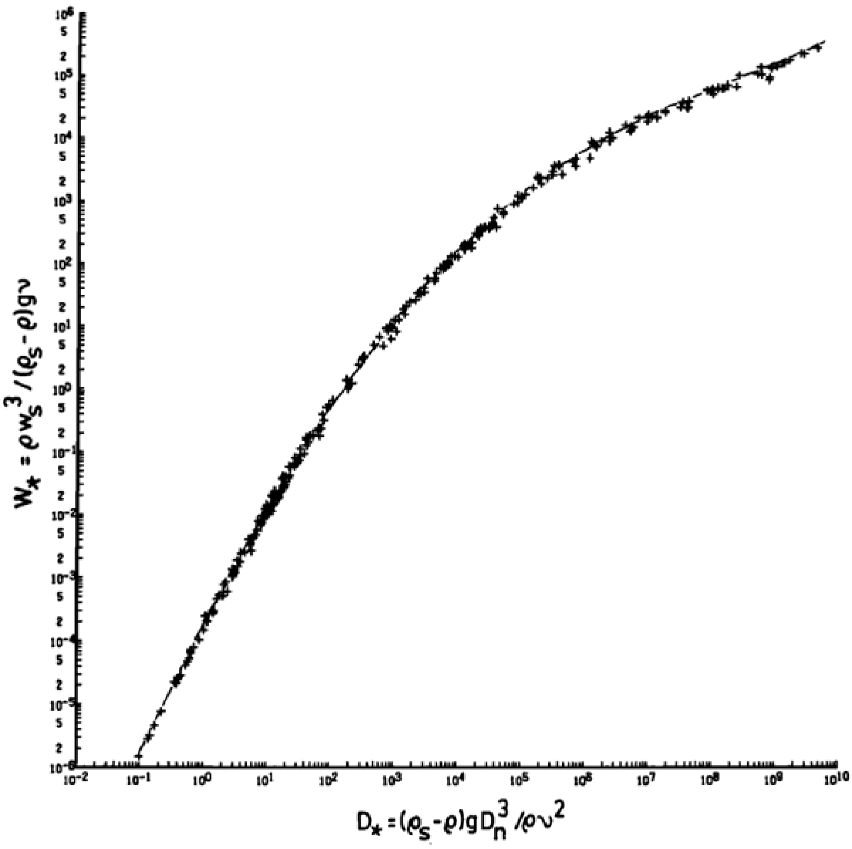

Fig. 1. Settling velocity of spheres plotted as a function of W_* and D_*. Sources of data given in Table 1. Curve is a least squares fit of a fourth order polynomial (equation (9)).

Figure 2: from Detrich (1982) where W* is the dimensionless settling velocity and D* is dimensionless particle diameter.

Appropriateness of Secchi disk

19. There are 3 widely accepted options to measure the suction dredge sediment plume. These are Secchi disk, Black disk, and Turbidity meter.
    a. Secchi disk – Within previous correspondence (see s92 response Final – Response to Cultural Impact Assessment) I have recommended the use of a Secchi disk to measure water clarity by the suction dredge operators to ensure potential consent conditions are met. I have used Secchi disks in flowing water from

boats in river mouths in the past and I am aware that this method is reasonably difficult in flowing water. A weighted disk can be lowered over the side of a boat and the distance to where sight of the disk is lost is measured as per best practice. This approach does require a skilled boat skipper. Using a Secchi disk has the benefit of measuring down through the water column to where sediment may be settling below the surface. This method is not typically undertaken in flowing environments; however, can be adapted via the use of weights to reduce the effect of current drag.

b. Black Disk – Using a black disk is the preferred method for river environments as outlined in the National Environmental Standards (NEMS). In my experience black disk measurements are difficult in swift water when used from river banks. The black disk method is not possible if water clarity is similar to or greater than the boat length as you cannot reach beyond the usable area of the boat. The water clarity, as measured by black disk, at the nearest long-term water quality site "Luggate Bridge" has a 5 year median of 5.4 m (Figure 3; LAWA website). With this in mind it appears unlikely the black disk method would be possible from a 5.5 m boat at least half the time.

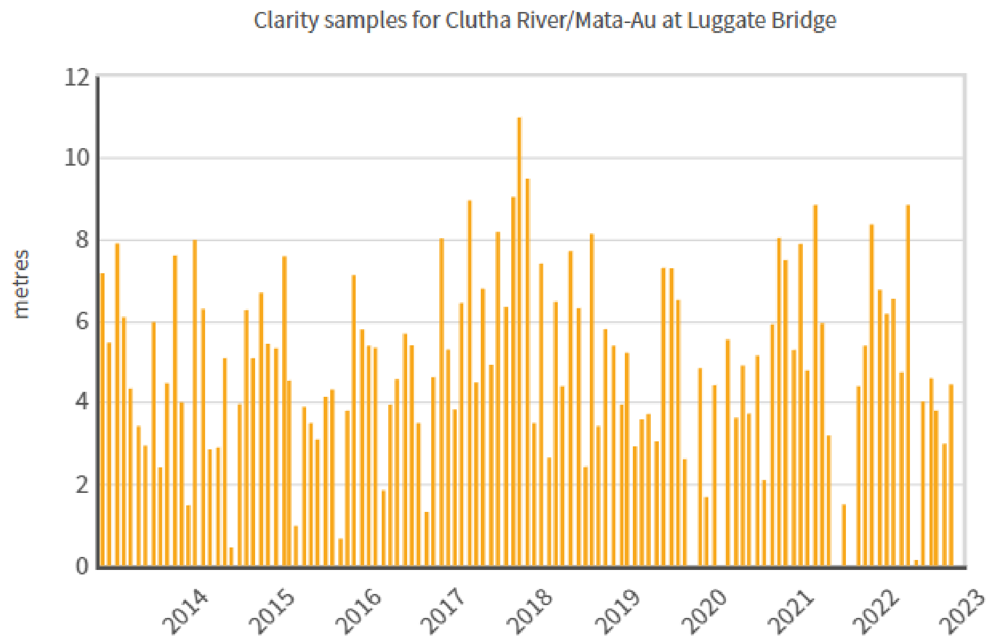

Figure 3: Water clarity data gathered by black disk method at Luggate Bridge upstream of the proposed suction dredge reach. Sourced from

LAWA Website. (https://www.lawa.org.nz/explore-data/otago-region/river-quality/clutha-rivermata-au/clutha-rivermata-au-at-luggate-bridge/).

c. Turbidity meter – A turbidity meter could be used to compare water upstream of the dredge to water downstream of the suction dredge in the sediment plume. Turbidity samples were used in the original e3s assessment of the sediment plume. Using a turbidity meter is likely to be the easiest method to use in this environment from a boat in flowing waters. For long-term sediment monitoring it is best practice to periodically collect water samples to validate the turbidity readings. It is also recommended to regularly service the meter to ensure the sensor does not 'drift'. However, the use of a turbidity meter could be beneficial to provide easy comparison to published Turbidity guidelines such as the "*British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture - Guideline Summary*" (British Columbia Ministry of Environment and Climate Change Strategy, 2023).

d. In summary, the use of black disk to measure water clarity is not practical in this situation from a boat. While I have previously recommended the Secchi disk method as an option it will come with some difficulties also. Use of a regularly validated and serviced turbidity meter is likely to be the most practical option for accurately measuring the sediment plume upstream and downstream of the suction dredge outfall.

e. If a turbidity meter is to be used to assess the sediment plume. I would suggest more frequent assessments for the first year of the consent to better understand the typical sediment plume characteristics, then with that knowledge a reduced turbidity assessment regime of once per day may be appropriate. With that in mind I would suggest assessing the turbidity of the water immediately upstream of the dredge, and 5 m, 50 m, 100 m and 200 m downstream of the dredge every 4 hours while the dredge is operating. In terms of performance standards, at least 80% of the downstream assessments should have turbidity less than 5

NTU as per receiving water group 2 of Schedule 15 of the Otago Regional Plan (Otago Regional Council, 2022). The difference between upstream samples and the assessment 100 m downstream will be less than 2 NTU as per clean water guidelines in table 44 of the British Columbia Turbidity Guidelines (British Columbia Ministry of Environment and Climate Change Strategy, 2023). The turbidity meter used should conform to ISO 7027, be validated monthly and calibrated annually as per the Discrete River Water Quality NEMS (NEMS Working Group, 2019).

Effects on avifauna

20. The applicant has volunteered to avoid endemic bird nesting on the Clutha River banks by 250 m. To aid in identifying potential river gravel bed area's where endemic riverine birds may nest, I have undertaken a desktop exercise using Satellite imagery and GIS. I suggest that if suction dredging is planned to be undertaken within 250 m of these 11 beaches (Figure 4; Table 1) during the breeding season of late August to early February (Braided river website - https://braidedrivers.org/ecology/birds/). Then the applicant will ensure they assess these beaches (within 10 days) prior to undertaking works using the relevant sections of the Protocol for best practice in monitoring braided river birds (Mischler & Malony, 2019). Using the Birdlife International Data Zone tool, black-billed gulls and black fronted terns are the primary birds of importance potentially present, but observations should also be made for Australasian crested grebe, South Island pied oystercatcher, pied stilt, banded dotterel, southern black-backed gull and caspian tern that could be present (Birdlife International, 2023).

21. I am not an ornithologist however the suction dredge activity will be limited to the riverbed below 0.8 m deep (1 m during trout spawning season) and as such will not directly affect gravel beaches where endemic birds may nest. It is my opinion that the proposed activity will not adversely affect endemic riverine avifauna if the conditions proposed by the applicant are followed and when planning to suction dredge within 250 m of the Table 1 (Figure 4) sites the applicant ensures beaches are assessed prior to suction dredging starting in proximity to them, and

beaches are avoided by 250 m during the breeding season (late august – early February) if endemic river birds are found to be nesting on the designated beaches.

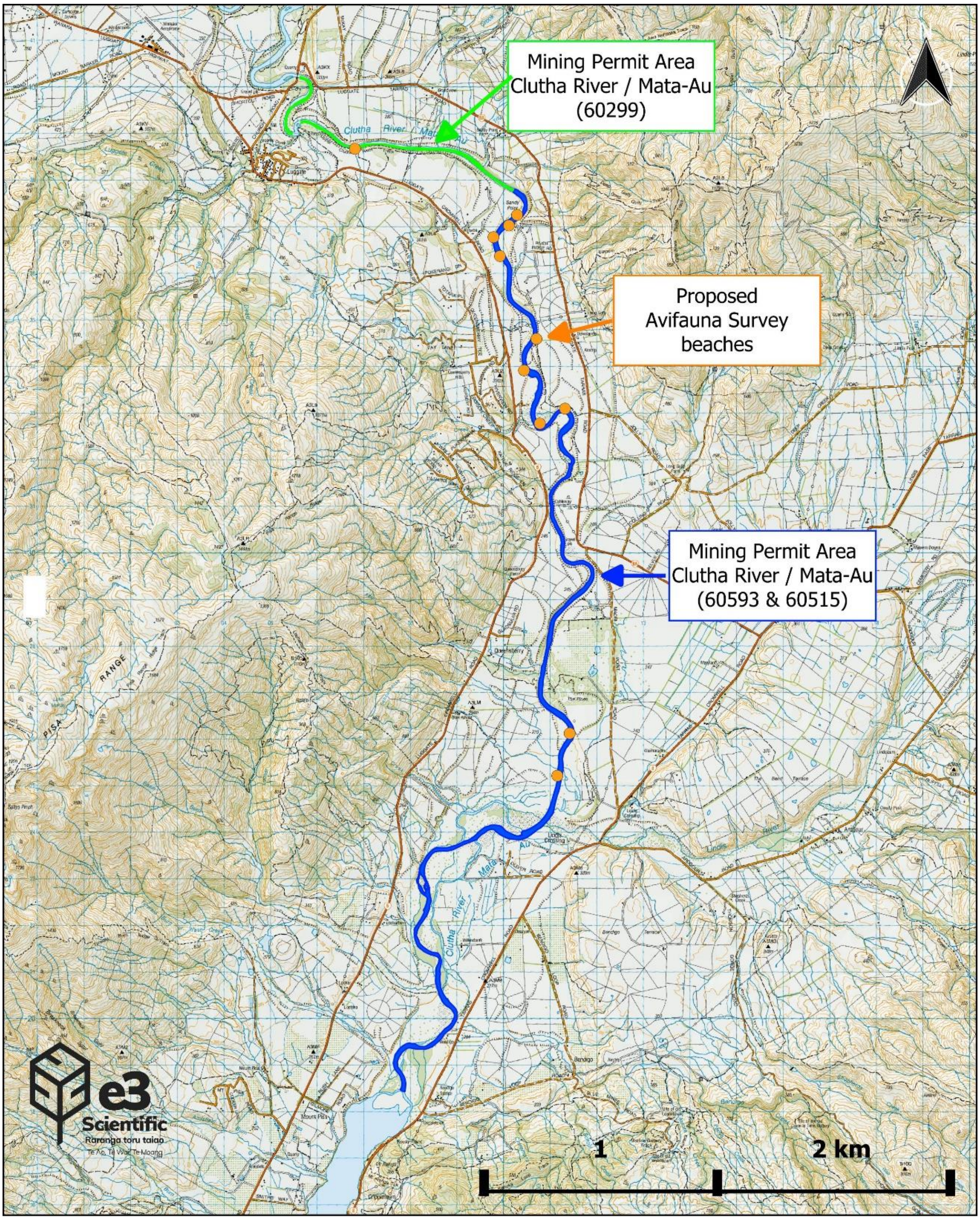

Figure 4: Location of proposed endemic riverine bird (avifauna) survey beaches.

Table 1: Table of proposed beaches where endemic riverine bird surveys should occur prior to suction dredging within 250 m during the breeding season.

Beach number	NZTM Easting	NZTM Northing
Beach 1	1306798.3	5038683.2
Beach 2	1310279.3	5037263.1
Beach 3	1310103.1	5037036.9
Beach 4	1309772.0	5036786.2
Beach 5	1309910.6	5036378.4
Beach 6	1310693.3	5034601.4
Beach 7	1310427.2	5033923.9
Beach 8	1310767.2	5032784.1
Beach 9	1311308.2	5033102.5
Beach 10	1311406.9	5026128.5
Beach 11	1311141.5	5025218.5

Freshwater ecosystem health

22. Freshwater Ecosystem Health Indicators – The s42A report suggested that it would be helpful to demonstrate how each Ngai Tahu health indicator (see Appendix A) is met by the proposed activity. The applicant considers there are synergies between the 70 Ngai Tahu indicators of health and western science freshwater ecosystem health indicators. I have previously co-authored a report investigating the use of environmental data to inform mātauranga māori frameworks. It was clear from that assessment that cultural health assessments should be an "iwi led undertaking" (Hamer, et al., 2020). As such I discuss these indicators of health parameters from a science standpoint only e.g. not from a cultural standpoint that would incorporate wairua and whakapapa connections.

23. Indicators of Health - There are a number of health indicators I have considered not applicable due to not being present near the proposed activity, not effected by suction dredge activity or are outside my expertise as a freshwater ecologist. Indicators excluded from my evidence are:

a. Form – “wetland condition”, “ephemeral streams”, “springs”, the “river mouth” and “hydro schemes”.

b. Riparian margins – “riverbank condition”, “riparian habitat corridors” and “stock access”.

c. Cultural practice and Use - It is not appropriate for me to comment on cultural aspects such as the “river channel” or “margin” use, “transportation and accessibility”, “river name as an indicator”, traditional “harvesting experience and methods”, “perception of health risk” and “desire to return to site”.

d. Quality - “catchment land use”, “estuary siltation”, “smell of the water”, “microbial pathogens”, “faecal contamination”, “eutrophication”, “sediment contamination”, “contaminated sites”, “consented discharges to water”, “lake quality/condition”, “groundwater quality/condition”, “estuary quality/condition”, “land and soil quality/condition” or “drain and small stream clearance”.

e. Quantity - “flow characteristics/variations/regime”, “flood flows” and “connectivity”.

f. Aquatic life - “indigenous vs exotic species”, “threat classification of species”, “temperature”, “oxygen”, “nitrate and ammonia toxicity” or “disease and parasite load”.

24. The following paragraphs cover indicators of health which I do consider pertinent to the proposed activity and are fully or partially within my area of expertise.

25. Regarding “Form” matters:

a. I am not a fluvial geomorphology expert; however, with regard to ecological aspects pertaining to the “shape of the river”, there will be some localised sediment transport and mobilisation from the activity. but due to the minor level of substrate re-distribution in my opinion this will not impact the overall shape of the river.

b. “Comparison with Historical state” will depend on when you compare too, certainly prior to gold mining activities of the 1860’s and the establishment of two hydro-electric power stations downstream this section of the Clutha Mata-au River would have had better ecological condition, however the proposal will not have detrimental effects on the current ecological state that are more than minor, short-term and localised. In terms of water quality, the Clutha River at Luggate is generally in the best 25% of water quality sites across the country currently (LAWA website; https://www.lawa.org.nz) and I do not expect the proposed activity to change that.

c. “Pools and overhanging banks”, pools have generally filled with sediment due to past practices such as sluicing, however the suction dredging activity may promote habitat heterogeneity by creating short-term deeper areas in some instances; overhanging banks would not be affected by the proposed activity as the dredge will not operate in shallow water close to the banks.

d. “Tributary presence and condition” the applicant has volunteered to not undertake suction dredge activities within 50 m of tributaries in the suggested consent conditions allowing a buffer zone around tributaries to ensure these are not affected by the activity.

e. Overall, there may be some short duration micro-scale effects but no macro-scale effects on the overall river form. Therefore, in my opinion the proposed activity will not impact the form of the river.

26. Regarding “Riparian margins” matters:

a. There will be very limited effect on the “nature and extent of riparian vegetation” where the boat slipway will be established. This has been discussed within the associated ecological report (Jager & Doheny, 2022).

b. It is also unlikely the proposed activity will influence “cover and debris” contribution to the Clutha River. In my opinion the proposed activity will not impact on the riparian margin indicators.

27. Regarding “Cultural practice and Use”, my comments on this matter are limited to ecological considerations relating to “use” of this section of the Clutha River.

a. The proposed activity will not alter the risk of “kai contamination” or effect the safety of plants or “fish to eat” and “water to drink” as no contaminants are being introduced to the waterway.

b. “Fish diversity” and “catch rates” may be reduced in the immediate vicinity of the suction dredge due to fish avoidance of the dredge activity. It is possible that the “condition of fish” may be reduced if they remain in the sediment plume; however, it is likely they will temporarily move away from the dredge disturbance and not have reduced condition.

c. Therefore, in my opinion the proposed activity will not impact on these aspects pertaining to use of the river.

28. Regarding “Quality” matters:

   a. In terms of overall “catchment water quality” the proposed activity with the proposed consent conditions should not adversely affect the catchments water quality.
   b. “Turbidity”, “clarity of the water” and “sediment in the river” aspects are considered to be affected for a short distance downstream of the suction dredge. This is discussed in the ecological report (Jager & Doheny, 2022) and consent conditions have been proposed to minimise these effects. Monitoring of this is discussed in further detail in paragraphs 18 and 19 of this Statement of Evidence.
   c. “Periphyton”, “cyanobacteria” and “algae” will be physically disturbed, if present. However, as deeper water (> 0.8 m) will be targeted by the dredge the presence of periphyton is likely to be limited to low biomass thin green and red algae along with cyanobacteria films due to reduced light and cool temperatures (Biggs, 1990; Biggs, et al., 1990; Clausen & Biggs, 1997). Figure 5 below shows that algal biomass as measured by Chlorophyll *a* is highest at moderate (approximately 10) disturbance events per year rather than high or low levels of disturbance. The physical disturbance of algae (if present) may lead to some nutrient release to be incorporated to the otherwise natural river nutrient spiralling process. The clarity effects are localised and of short duration and the river has low periphyton productivity.
   d. Therefore, in my opinion the proposed activity with the suggested consent conditions will not impact on the Quality health indicator in an ecological sense.

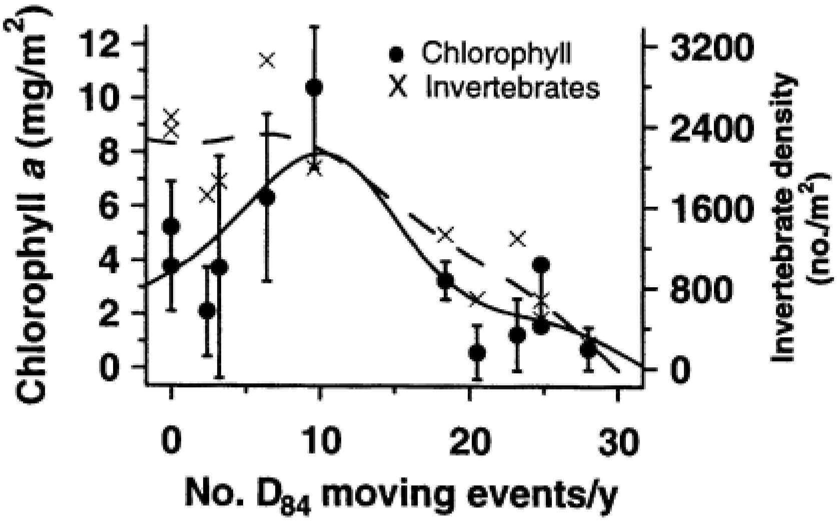

Figure 5: Graph showing how disturbance regime influences algal biomass (as CHL a) from (Biggs, et al., 1999) D84 = sediment up to 84th percentile size fraction.

29. Regarding “Quantity” matters:

  a. Bearing in mind I am not a noise or hydrology expert. The “sound of flow” may be affected by the dredge operation and consent conditions are suggested to limit those noise effects.
  b. Water is used to create a suction effect and raise water and sediment from the bed of the river. As such there will be a very localised influence on “water movement”.
  c. “Gravel movement” will be a result of the proposed activity; however, gravel will settle near (slightly downstream) of the suction dredge operations.
  d. In my opinion, provided consent conditions are met the proposed activity will not impact on Quantity health indicators.

30. Regarding “Aquatic life” matters:

  a. There is potential to locally reduce “macro-invertebrate abundance” for a short time period (Thompson, 2001) by physically removing them from the river bed, and releasing them with low mortality rates (Griffith & Andrews, 1981) at the surface to drift back to the river bed. This has the potential to increase macro-invertebrate availability as a food source to predatory fish

(Harvey et al., 1995). This may influence the aquatic larvae "life stage" of some macro-invertebrate taxa; however, it is very unlikely to influence "population trends".

b. Riverbed "habitat" will be affected by reworking the bed and dropping "cleaned" gravels to the riverbed and finer particles further downstream. It is likely the proposed activity will have both positive (creating interstitial spaces) and negative (re-distributing fines) localised effects on riverbed habitat. Figure 5 above shows how a moderate level of disturbance can be beneficial ecologically.

c. The suction dredge is likely to act as a local deterrent to upstream "fish passage", but due to the narrow plume width in comparison with the width of the Clutha River and the activity ceasing at night, fish will be able to move upstream past the dredge.

d. In my opinion, the adverse effects of the activity are of short duration and localised and the consent conditions provided are appropriate to ensure the proposed activity will not adversely impact on the aquatic life health indicators.

Summary

31. In summary, the freshwater ecological assessment (Jager & Doheny, 2022) and further memo (Hamer & Miller, 2023) along with this Statement of Evidence demonstrates that the potential effects are localised and with the suggested consent conditions applied there will be minimal adverse effect on the aquatic environment.

32. In relation to cultural health indicators, from an ecological perspective the proposal either does not impact on most indicators, or the effects of the proposal are unlikely to compromise the ecological indicators.

References

Allibone, R. M., & Caskey, D. (2000). Timing and habitat of koaro (Galaxias brevipinnis) spawning in streams draining M tTaranaki, New Zealand. *New Zealand Journal of marine and Freshwater Research*, 34(4): 593-595.

Baker, C., Jellyman, D. J., Reeve, K., Crow, S., Stewart, M., Buchinger, T., & Li, W. (2016). First observations of spawning nests in the pouched lamprey Geotria australis. *Canadian Journal of Fisheries and Aquatic Sciences*.

Beentjes, M. P., Boubee, J. A., Jellyman, D. J., & Graynoth, E. (2005). *Non-fishing mortality of freshwater eels (Anguilla spp.).* Wellington: New Zealand Fisheries Assessment Report 2005/34. Ministry of Fisheries.

Biggs, B. J. (1990). Periphyton communities and their environments in New Zealand rivers. *New Zealand Journal of Marine and Freshwater Research*, 24: 367-386.

Biggs, B. J., Duncan, M. J., Jowett, I. G., Quinn, J. M., Hickey, C. W., Davies-Colley, R. J., & Close, M. E. (1990). Ecological characterisation, classification, and modelling of New Zealand rivers: An introduction and synthesis. *New Zealand Journal of Marine and Freshwater Research*, 24: 277-304.

Biggs, B. J., Smith, R. A., & Duncan, M. J. (1999). Velocity and Sediment Disturbance of Periphyton in Headwater Streams: Biomass and Metabolism. *Journal of the North American Benthological Society*, 18(2):222-241.

Birdlife International. (2023, October 17). *Birdlife International*. Retrieved from Birdlife International: http://datazone.birdlife.org/site/factsheet/dunstan-upper-clutha-river-iba-new-zealand

British Columbia Ministry of Environment and Climate Change Strategy. (2023). *British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture - Guideline Summary. Water Quality Guideline Series, WQG-20.* . Victoria B.C. : British Columbia Ministry of Environment and Climate Change Strategy. Prov. B.C.

Clausen, B., & Biggs, B. J. (1997). Relationships between benthic biota and hydrological indices in New Zealand streams. *Freshwater Biology*, 38: 327-342.

Clayton, J. (1993). *RESOURCE EVALUATION AND OPERATIONAL PROGRAMME FOR LAKEWEED: THE UPPER CLIJTHA AND KAWARAU CATCHMENT AREAS.* Hamilton: NIWA Report for the Otago Regional Council.

David, B. O., Lake, M., Pine, M. K., Smith, J., & Boubee, J. A. (2019). Use of a novel acoustic 'listening' method for detecting pump impellor strike on downstream migrating eels. *Marine and Freshwater Research*, 71(6) 571-582.

Detrich, W. E. (1982). Settling Velocity of Natural Particles. *Water Resources Research*, 18(6):1615-1626.

Dunn, N. R., Allibone, R. M., Closs, G. P., Crow, S. K., David, B. O., Goodman, J. M., . . . Rolfe, J. R. (2018). *Conservation status of New Zealand freshwater fishes, 2017.* Wellington: New Zealand Threat Classification Series 24. Department of Conservation.

Glova, G. J., Jellyman, D. J., & Bonnett, M. L. (1998). Factors associated with the distribution and habitat of eels (Anguilla spp.) in three New Zealand lowland streams. *New Zealand Journal of Marine and Freshwater Research*, 32(2):255-269.

Goodman, J. (2018). *Conservation, ecology and management of migratory galaxiids and the whitebait fishery: A summary of current knowledge and information gaps.* Nelson: Department of Conservation.

Greer, M. J., Crow, S. K., Hicks, A. S., & Closs, G. P. (2015). The effects of suspended sediment on brown trout (Salmo trutta) feeding and respiration after macrophyte control. *New Zealand Journal of Marine and Freshwater Research*, 49:278-285.

Griffith, J. S., & Andrews, D. A. (1981). Effects of a small Suction Dredge on Fishes and Aquatic Invertebrates in Idaho Streams. *North American Journal of Fisheries Management*, 1(1): 21-28.

Hamer, M., & Miller, B. (2023). *Memo - Response to Cultural Impact Assessment – Suction dredge gold* . Arrowtown: e3scientifc.

Hamer, M., Douglas, T., Smith, J., Pingram, M., Brown, E., & Hanrahan, N. (2020). *Using state of the environment data to help inform iwi Matauranga Maori frameworks.* Hamilton: Waikato Regional Council Internal Series 2020/11.

Harvey, B. C., Lisle, T. E., Vallier, T., & Fredley, D. C. (1995). *Effects of Suction Dredging on Stream: A review and evaluation strategy.* Washington DC: USDA Forest Sservice.

Jager, M., & Doheny, B. (2022). *Suction Dredge Mining Upper Clutha River, Prepared for Cold Gold Clutha LTD.* Arrowtwon: e3 scientific.

Jellyman, D. J., & Glova, G. J. (2002). Habitat use by juvenile lampreys (Geotria australis) in a large New Zealand river. *New Zealand Journal of Marine and Freshwater Research*, 36:503-510.

Jellyman, D. J., Bonnett, M. L., Sykes, J. R., & Johnstone, P. (2002). Contrasting Use of Daytime Habitat by Two Species of Freshwater Eel (Anguilla spp.) in New Zealand Rivers. *American Fisheries Society Symposium*, 16.

Maclean, G. (2012). *Survey of Juvenile Rainbow Trout in the Upper Tukituki Catchment.* Owhango: Prepared for Hawkes Bay Regional Council by Technically Trout. Client Report : TT 2012-01.

Mischler, C., & Malony, R. (2019). *Protocol for best practice in monitoring braided river birds.* Department of Conservation.

NEMS Working Group. (2019). *Water Quality Part 2 - Sampling, Measuring, Processing and Archiving of Discrete River Water Quality Data.* Wellington: National Environmental Monitoring Standards. MfE.

Otago Regional Council. (2022). *Regional Plan: Water for Otago.* Dunedin: Otago Regional Council.

Raleigh, R. F., Hickman, T., Solomon, R. C., & Nelson, P. C. (1984). *Habitat suitability information: Rainbow trout.* Washington DC: U.S Fish Wildlife Service.

Thompson, R. (2001). *Impacts of gold-dredging activities on benthic macro-invertebrates of the upper Pomahaka River.* Dunedin: Bio-Logic Consultancy.

Westerberg, H., Haamer, J., & Lagefelt, I. (1993). *A new method for sampling elvers in the coastal zone.* Gothenberg, Sweden: National Board of Fisheries.

Appendix A: Ngai Tahu Indicators of Health (From S42A Report point 170).

Form
Shape of the river
Comparison with historic state
Pools and overhanging banks
Natural river mouth environment
Wetland condition
Tributary presence/condition
Ephemeral stream presence/condition
Spring presence/quality/condition
Hydro scheme modifications

Riparian Margins
Nature/extent of riparian vegetation
Riverbank condition
Cover and debris in stream
Habitat corridors
Stock access

Cultural Practice and Use
Uses of the river
Use of the river margin
Safe to gather plants
Fish are safe to eat
Water is safe to drink
River name as an indicator
Harvesting experience and methods
Catch rates
Transportation and accessibility
Legislative and seasonal access barriers
Contaminated kai species
Condition of resources (eg kelp)
Diversity of resources present
Perception of health risk
Desire to return to a site

Quality
Catchment water quality
Catchment land use
Clarity of the water
Turbidity
Sediment in the river
Estuary siltation
Smell of the water
Periphyton
Microbial pathogens
Faecal contamination
Cyanobacteria
Eutrophication
Sediment contamination
Contaminated sites
Consented discharges to water
Algae
Lake quality/condition
Groundwater quality/condition
Estuary quality/condition
Land and soil quality/condition
Drain and small stream clearance

Quantity
Flow characteristics
Flow variations/flow regime
Flood flows
Sound of flow
Movement of water
Movement of gravel
Connectivity

Aquatic Life
Indigenous vs exotic species
Species abundance and diversity
Threat classification of species
Population trends
Food
Habitat
Temperature
Oxygen
Nitrate toxicity
Ammonia toxicity
Disease and parasite load
Life cycle stages and triggers
Barriers to fish passage