BEFORE	Independent Commissioners appointed by Tasman District Council
IN THE MATTER	Of the Resource Management Act 1991
AND	
IN THE MATTER	Of an application by CJ Industries Ltd for land use consent RM200488 for gravel extraction and associated site rehabilitation and amenity planting and for land use consent RM200489 to establish and use vehicle access on an unformed legal road and erect associated signage

SUPPLEMENTARY EVIDENCE OF SIMON JAMES AIKEN ON BEHALF OF CJ INDUSTRIES EROSION POTENTIAL

19 December 2022

1. INTRODUCTION

1.1 My full name is Simon James Aiken. I am a Senior Water Resources consultant at Tonkin & Taylor Ltd ("T+T"). I am the Team Leader for the Water Engineering Team in Nelson.

1.2 The applicant has applied for resource consents authorising the extraction of gravel, stockpiling of topsoil, and reinstatement of quarried land, with associated amenity planting, signage and access formation at 134 Peach Island Road, Motueka:

(a) RM200488 land use consent for gravel extraction and associated site rehabilitation and amenity planting, and

(b) RM200489 land use consent to establish and use vehicle access on an unformed legal road and erect associated signage.

1.3 My primary evidence addressed the flooding assessment of the activities for which consent is sought. This supplementary evidence addresses the potential for material to be eroded from backfilled areas should inundation of the Stage One works occur prior to vegetation becoming established.

Qualifications and Experience

1.4 I have been employed as a Senior Water Resources Consultant at T+T since 2017. My previous experience (2011-2017) is as a Catchment Planner with the Stormwater Unit at Auckland Council and as a Hydrologist with Auckland University. I hold a Bachelor of Science (Environmental Science and Physical Geography) and a 1st Class Master of Science (Physical Geography) from the University of Auckland (2013).

1.5 My technical skills and experience directly relevant to my assessment include:

(a) Preparing Flood Hazard Models ("FHM") and interpretation of hydraulic model results.

(b) Assessment of engineering 'options' to manage effects of development and flooding.

(c) Assessment of hydrological changes because of land cover change, including the interpretation of the effects of climate change on flood records.

1.6 I have been to site and inspected the floodplain area, including existing vegetation and upstream and downstream reaches that is proposed for excavation.

Code of Conduct

1.7 I have read the Code of Conduct for Expert Witnesses in the Environment Court Practice Note 2014 and I agree to comply with it. My evidence is within my area of expertise, however where I make statements on issues that are not in my area of expertise, I will state whose evidence I have relied upon. I have not omitted to consider material facts known to me that might alter or detract from the opinions in my evidence.

2. EVIDENCE

2.1 My assessment is contained in the **attached** Consultant's Advice Memo.

Simon Aiken

19 December 2022

Tonkin+Taylor

CONSULTANT'S ADVICE MEMO

CAN Subject:	Backfill Erosion Potential		
Project/site:	Peach Island Gravel Extraction	Date:	15 December 2022
Client:	C J Industries Ltd	TT project No:	1015514.1000
To:	Richard Deck (CJ Industries Ltd and Sally Gepp (Applicant's Legal Counsel)		
Copy to:	Commissioner Craig Welsh		

Purpose

We understand that Commissioner Craig Welsh is seeking further information on the potential volume of material that could be eroded from the backfilled area should inundation of the Stage One works area occur, prior to vegetation becoming established.

To fully address this question would require detailed sediment information, including particle size distributions (PSDs) of the proposed backfill material and surrounding floodplain, high resolution landcover and hydrological (duration and exceedance probability of the flood flows) information at the time of the event. In effect a purpose-built hydraulic bedload transport model[1] would be required, this is not available. However, using existing information, literature values and empirical relationships we have attempted to estimate the volume of eroded material.

For the purposes of this assessment, I have assumed the following:

- Extracting average flood velocities (m/s) from the Stage One area for the 10% AEP 48-hour storm event is suitable.
  - Discussions with CJ Industries that the Stage One Area will be expected to be operational for a period of 12 – 15 months, therefore assessing a more frequent event is appropriate.
- The existing floodplain topography (as currently modelled) is a fair representation of the backfilled surface.
  The floodplain topography stays 'static' through the event
- Sediment transport and deposition are not explicitly accounted for
- PSDs supplied by CJs from the Riwaka Quarry Overburden (Appendix B) are generally representative of the material that will be used to backfill the extraction borrows.
- Sediment erosion can be represented using velocity alone and that the Hjulström curve is suitable for determining erosion potential
  - The entire excavation volume has erosive flows acting upon it
- Analysis of a single excavation is suitable

[1] The Motueka-Riwaka TUFLOW model was developed for the purpose of assessing flood hazard risk, not floodplain erosion or bedload transport

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In my opinion the assumptions set out above are a reasonable scenario to be tested.

Methodology

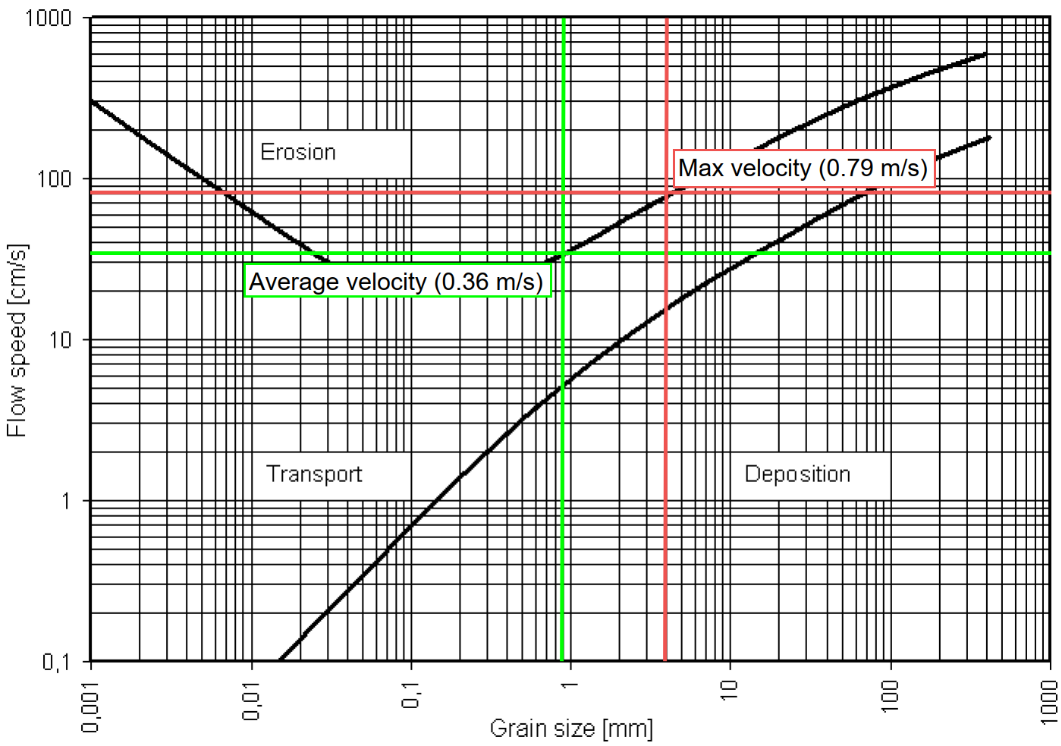
For the purposes of this assessment, I have described my workflow and methodology below

- Extracted mean and maximum velocities for the Stage One extent for the 32-, 39- and 46-hour mark. These timesteps relate to the time in which the majority of the floodplain is first inundated, the flood peak and during the recession of flood flows. This is shown in Appendix A i.e the max areas are in red, and shown in Table 1 (below)

Table 1: Mean and Max velocities for the Stage One Area.

Parameter/Timestep	32 hour (m/s)	39 hour (m/s)	46 hour (m/s)	Average Event Value (m/s)
Mean	0.26	0.6	0.23	**0.36**
Maximum	0.66	1.1	0.61	**0.79**

- Using the *Average Event Values* and the Hjulström curve (Figure 1) below to determine the potential erosion. The upper curve shows the critical erosion velocity in cm/s as a function of particle size in mm, while the lower curve shows the deposition velocity as a function of particle size.
- This shows that the *Mean Average Event Velocity* across the Stage One area has the potential to erode grain sizes up to **0.9mm** and that the *Maximum Average Event Velocity* across the Stage One velocity has the potential to eroded grain sizes up to **4mm**[2].



[2] I acknowledge that instantaneous maximum values are high (1.1 m/s) however these are not representative of flood velocities across the duration of the event

Figure 1 The Hjulström curve showing the relationships between particle size and the tendency to be eroded, transported, or deposited at different current velocities.

- Using the supplied PSD data (reproduced in Table 2) and the values derived from the Hjulström curve I determined the proportion of the material that could potentially be eroded from a single excavation[3]
    - For the *Mean Average Event Velocity* approximately **57-58%** of the backfill material could be eroded.
    - For the *Maximum Average Event* Velocity approximately **69%** of the backfill material could be eroded

Table 2: Particle Size Distribution Test Report for Riwaka Quarry Overburden

Sieve Size (mm)	Sample (Percent Passing)
63	100
37.5	92
19	81
9.5	77
4.75	73
2.36	67
1.18	60
0.6	53
0.3	45
0.15	34
0.075	23

- Using the dimensions of a single excavation, material volumes and potential erodible percent value I determined the total volume of material that could be eroded for *Mean and Maximum Average Event Velocity.* In both cases I have assumed that all the topsoil has been eroded. These results are shown in Table 3
    - For the *Mean Average Event Velocity* approximately 4,246m^3 of the backfill material could be eroded.
    - For the *Maximum Average Event Velocity* approximately 5,314 m^3 of the backfill material could be eroded
    - These values were converted to tonnes equivalent using a value of 1.75[4]

[3] The supplied PSD data and sieve sizes do not exactly match the grain sizes determined from the Hjulström curve I used an average of both

[4] CJs indicated that 8,000m^3 is approximately 14,000 tonnes equivalent (including topsoil)

Table 3: Excavation dimensions, volumes, and erodible material

	Excavation Dimensions				Eroded Material	
	Width (m)	**Depth Below Ground (m)**	**Length (m)**	**Volume (m^3)**	**Mean (m^3)**	**Max (m^3)**
Excavation Borrow Topsoil	20	0.4	80	640	640	640
Excavation Borrow Backfill	20	4.6	80	7,360	3,606	4,674
Total (m^3)	-	5	-	8,000	4,246	5,314
Total (Tonne)				14,000	7,431	9,299

- Using literature values[5] for suspended sediment yields from the Motueka Catchment (noting this *excludes* bedload so would underestimate the total sediment discharge) I compared these to the tonne equivalent values calculated in to contextualize the erosion of material from the backfilled excavation
    - During the period 2002–2008 seven sites were instrumented with flow gauges, turbidity sensors and automatic water samplers to monitor sediment yield within the catchment. The 7 years of 15-min records from the site at Woodmans Bend, near the coast, were used to develop a suspended sediment rating curve which was then used to estimate annual and average loads since the commencement of flow records in 1969. This produced a mean annual yield of **401,800 t y^{-1}**
    - If the *Mean Average Event Velocity* did occur and it eroded 7,431 tonnes of backfill material this would be the **1.85%** of the long-term average annual suspended sediment load.
    - If the *Maximum Average Event* Velocity did occur and it eroded 9,299 tonnes of backfill material this would be the **2.31%** of the long-term average annual suspended sediment load.
- In my opinion it is unlikely that the erosive forces would extend to the 4.6m depth. Therefore, the numbers presented above are conservative and likely an overrepresentation.

Conclusions

There are several factors that contribute to the potential erodible volume of material. Including the degree of vegetation establishment at the time of the event, the magnitude of the flooding and other factors not explicitly accounted for in our assessment (i.e. depth of flow, availability of erodible material etc)

Based on our simple assessment, including the previously detailed assumptions and existing information/literature values we estimate the maximum material that can be eroded is between approximately 4,246m^3 and 5, 314m^3 should all the material be exposed to erosive flows. In my

[5] Fuller et al., 2014. Towards understanding river sediment dynamics as a basis for improved catchment, channel, and coastal management: the case of the Motueka catchment, Nelson, New Zealand.

opinion this is unlikely to occur. If such an event was to occur (noting that there is a 10-15% probability this could occur during the 12–15-month operational period of the Stage One area) it would represent between 1.85% to 2.31% of the long-term annual average suspended sediment load.

Applicability

This Consultants Advice Memo is issued subject to our terms of engagement with our Client. Where issued to a person who is not our Client, it is intended to assist that person in carrying out their work on the project.

Tonkin & Taylor Ltd
Environmental and Engineering Consultants

Prepared by:

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Simon Aiken
Water Resources Consultant

19-Dec-22
document3

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Appendix A Stage One area flow velocities

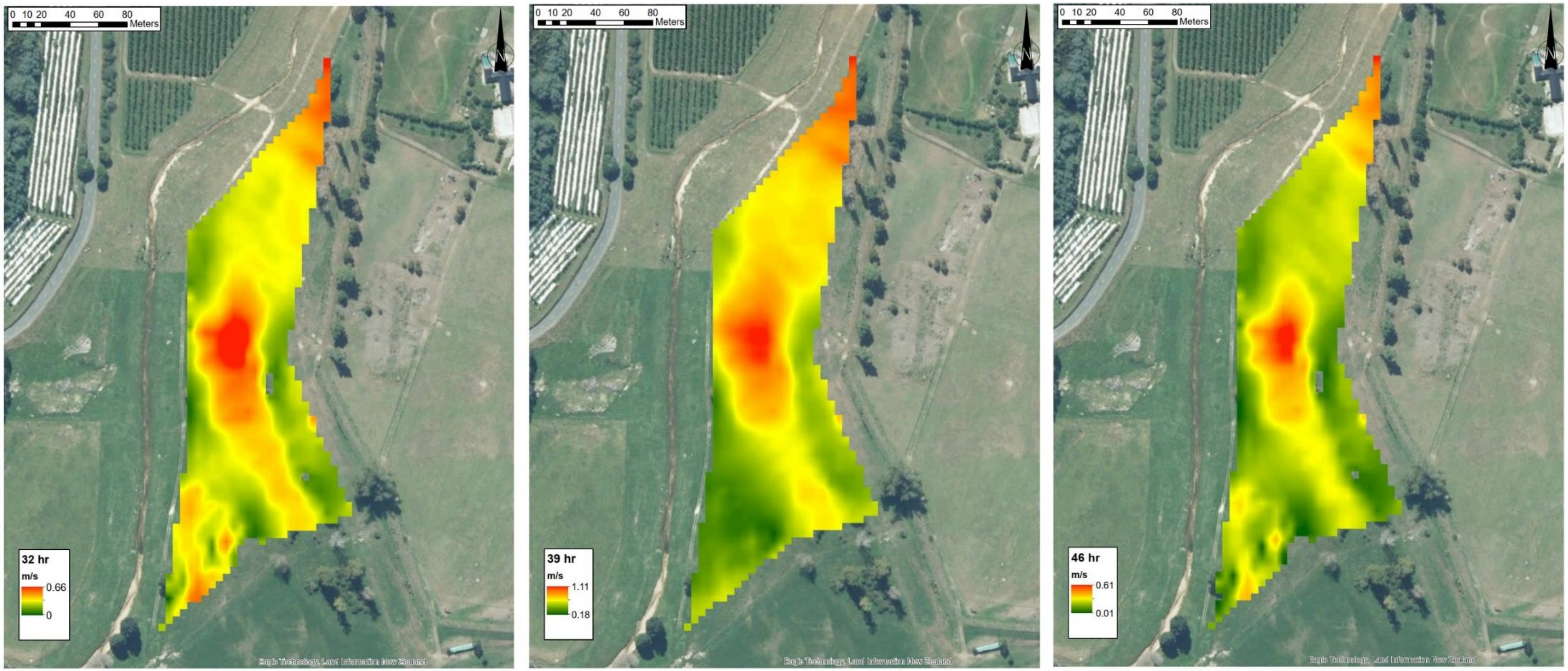

Figure: Stage One flow velocities for the 32-, 39- and 26-hour timestep. Highest velocities are shown in red, lowest velocities in green.

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Appendix B Particle Size Distribution

Lab Ref No : **22/1758**

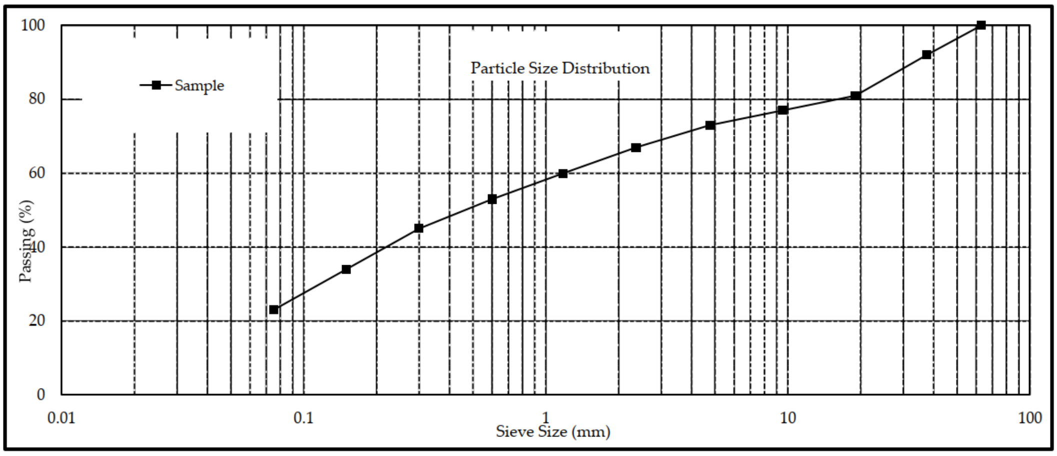
Civil Engineering Laboratory Services Ltd
PO Box 1424, Nelson Unit 3/30 Echodale Place Stoke
Ph 03 547 0110 Mob 027 4457071

PARTICLE SIZE DISTRIBUTION TEST REPORT

Project :	**Product Assessment**	Date sampled :	**15/12/22**
Location :	**Riwaka Quarry**	Sampling method :	**Hand**
Client :	**C J Industries LTD**	Sampled by :	**C J Industries LTD**
Contractor :	**C J Industries LTD**	Sample description :	**Overburden**
Source :	**Riwaka Quarry**	Sample condition :	**Damp**

Particle Size Distribution

Sieve Size (mm)	Percentage Passing Sample	
63	**100**	
37.5	**92**	
19	**81**	
9.5	**77**	
4.75	**73**	
2.36	**67**	
1.18	**60**	
0.6	**53**	
0.3	**45**	
0.15	**34**	
0.075	**23**	
	% passing the finest sieve is obtained by difference	



Test Methods		Notes
Particle Size Distribution	NZS 4407 : 2015 : Test 3.8.1	

Date tested : 16/12/22
Date reported : 16/12/22

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Sampling is not covered by IANZ endorsement

Andrew Hayward

Designation : *Senior Laboratory Technician*
IANZ Approved Signatory

ACCREDITED IANZ TESTING LABORATORY 1021

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

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