Draft Chemical Treatment Management Plan

Mahinerangi Wind Farm Stage 2

Prepared for Riley Consultants Ltd

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Revision 3

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Revision 3

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1. Introduction

EnviroCo Ltd has been engaged by Riley Consultants to prepare this Draft Chemical Treatment Management Plan (CTP).

The document has been prepared to support Otago Regional Councils (ORC) resource consent application(s) for Mahinerangi Wind Farm Stage 2.

In addition, the use of the chemical treatment APAM products is accepted under RM24.455.01 Certificate of compliance in the regional rules in the Land and Water Regional Plan (LWRP) for the Otago region. The Project Manager is responsible for the implementation of this CTP.

1.1 Objectives

The objectives of this plan are to:

- Provide best management strategies for treating sediment laden water.
- Minimise adverse impacts of sediment loading in streams, drains and waterways.
- Ensure all water discharged from stormwater and/or dewatering treatment systems complies with the requirements of resource consents and Permitted Activity (PA) rules.
- Ensure there are no complaints or penalties relating to sediment discharges.
- Specify an approved monitoring program.

This plan has been prepared for the rural windfarm located on Eldordao Track, Waipori, Otago.

2. Site Controls

2.1 Sources of sediment

Works will involve cut and fill activities and the construction of wind turbines and the associated services i.e. transformers etc.

In summary, the proposed development will involve the following land disturbing activities:

- Installation of Erosion and Sediment controls (in accordance with Auckland City Council's GDO5.
- Site Clearance/Stripping and stockpiling topsoil.
- Construction dewatering, as required.
- Earth working, excavating and filling.
- Trenching for the installation of buried pipelines and any associated services.
- Respreading of topsoil and sowing of grass on completed landscaped areas.

Sediment can be generated and mobilised during earthwork activities. Earthworks on this site will have the potential to generate sediment and water is likely to accumulate in low-

lying excavations and trenches. Construction phase sediment laden water and dewatering water will be directed to the water collection areas as defined in the ESCP document. Water is to be treated using Anionic Polyacrylamide (APAM) and Pahea PDM products (supplied by EnviroCo).

2.2 Minimisation of sediment generation

Best practice is to minimise the volume of sediment laden water generated onsite, thereby reducing the volume requiring treatment. Sediment generation can be minimised using the following methodologies:

Limit cleared area:

- Maintain any grass, vegetation cover for as long as possible, thereby minimising the amount of un-stabilised earth.
- Stabilise worked areas as soon as practicable using topsoil, grass, or other non-erodible material e.g., geotextile.
- Reducing the amount of work occurring in or near existing waterways.

Water diversions:

- Clean water diversions can be constructed to reduce the amount of water flowing through the site. If required clean water diversions shall be stabilised with grass or lined to prevent scour.
- Dirty water diversions can be constructed to convey sediment laden stormwater to stormwater treatment devices or a designated retention area.

3. Water treatment chemicals

Water treatment chemicals will be applied to increase the rate of sediment settling out of the water column. This helps to achieve the permitted levels of Total Suspended Solids (TSS) prior to discharge. Any water treatment chemical shall be applied in accordance with guidelines provided by Otago Regional Council (ORC) and Auckland Council GD05. The following descriptions are in line with the current guidelines and reports on the overview of the effects of residual flocculants or coagulants on aquatic receiving environments.

The choice of treatment chemical is dependent on a range of requirements and factors and should be assessed on a case-by-case basis. Treatment choice should be determined by not only the efficacy of the chemical but also factors such as catchment size, stormwater quality and the sensitivity of the receiving environment.

3.1 Anionic Polyacrylamide (APAM)

Anionic polyacrylamide (APAM) is used extensively in the United States as an environmentally safe flocculant for drinking water treatment and other sensitive applications. APAM is produced when acrylamide is polymerized with an anionic comonomer. Anionic and non-ionic polymers are recognised as the safest flocculants to use due to their low toxicity. There is currently no indication of any adverse impacts on aquatic systems when APAM is correctly used for water treatment. During high dose applications any effects on native biota are minimised due to the absorption and deactivation of suspended particles. The risk of toxicity is very low in all but very serious overdose or spill situations. The greatest challenge of APAM use in the field is practical application due to its highly viscous nature. However, APAM can be used in several forms and any difficulty in application can be rectified with the use of alternative application methodologies. EnviroCo has obtained a Certificate of Compliance (CoC) RM24.455.01 for the use and discharge of Applied Polymer Systems APAM flocculants throughout Otago.

4. Application methodologies

4.1 Sediment Retention Key Design Criteria

There are recommended design principles for Sediment Retention Ponds (SRPs) for successful chemical treatment and improved results. These are:

- Choosing a stormwater treatment system suitably sized for the catchment capacity.
- Have a first flush interception / forebay.
- Appropriately sized per engineers' design calculations as per ORC SRP and Decanting Earth Bund (DEB) calculations i.e., the length to width ratio of the pond should be no less than 3:1 and no greater than 5:1. At least 1m depth for sediment drop out, and no deeper than 2m to prevent the pond short circuiting.
- Stabilisation of the pond with vegetation or lining depending on its purpose, operation, and duration of use.
- Baffles across the width of the pond at a third and two thirds the distance from the ponds invert.
- Be designed to have a minimum residence time of four hours.
- A designed outlet and decant.
- An emergency spillway.

Sections of the site are to be built up with site won fill. Stripping of the site will be staged to minimise the total exposed area and grass cover will be retained where feasible. Completed areas will be progressively stabilised with grass further reducing the total exposed ground.

The SRP shall be sized in accordance with the requirements of the ORC ESC Control toolbox whereby earthwork sites with slopes over 18% or greater than 200m in length,

SRPs are to be designed with a minimum volume of 3% of the contributing catchment area, 300m³ for each Ha of contributing catchment. The SRP will be rectified based upon the design below in **Figure 1** and **Figure 2**.

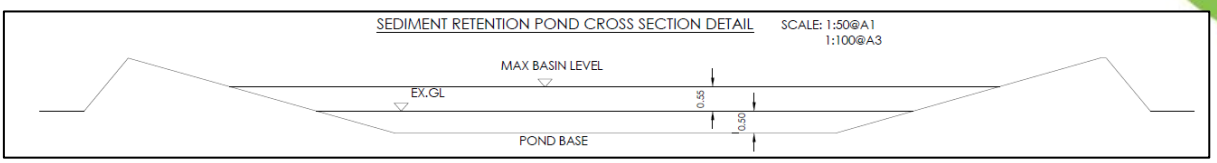

Figure 1. Cross section of SRP.

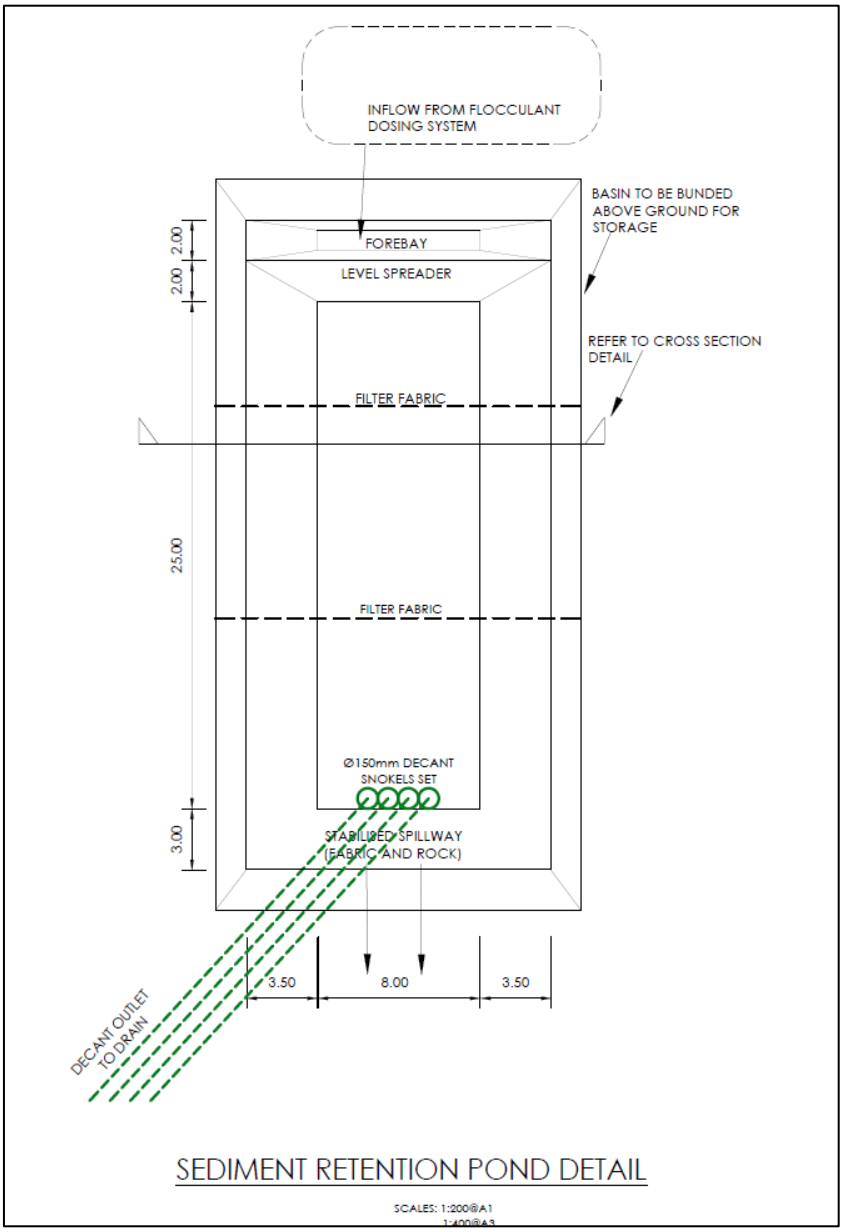

Figure 2. Plan view of generic SRP.

4.2 Site Decanting Earth Bund (DEB) Design

The Decanting Earth Bund (DEB) will be sized in accordance with the ORC guidelines whereby earthwork sites with slope under 18% and less than 200m in length, construct a DEB with a minimum volume of 1% of the contributing catchment area $10m^3$ for each Ha of contributing catchment area. On earthwork sites with slopes greater than 18% or greater than 200m in length, construct a DEB with a minimum volume of 2% of the contributing catchment area, $20m^3$ for each Ha of contributing catchment area. The DEB will be rectified based upon the design below in **Figure 3**.

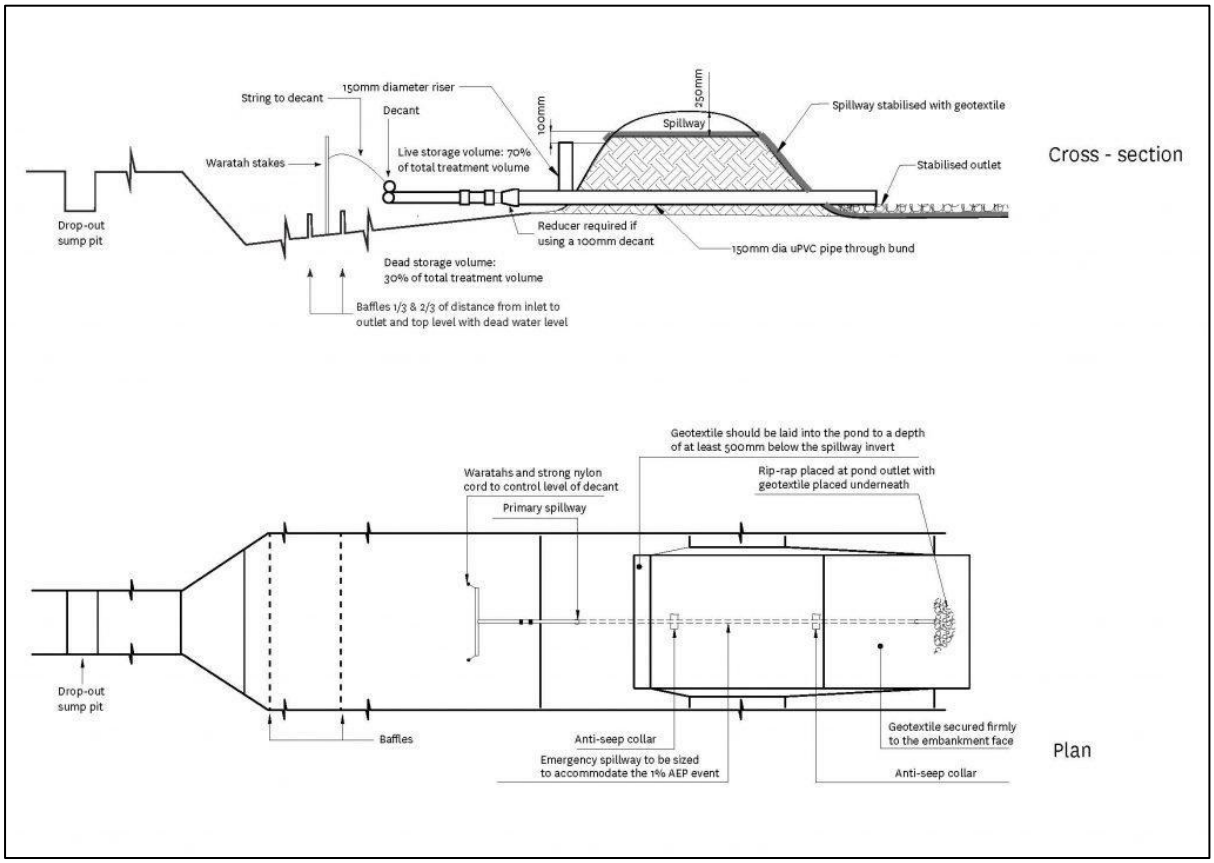

Figure 3. Plan view and cross section of generic DEB.

4.3 Passive flow-based dosing

Passive flow-based dosing is achieved by placing APAM Floc Logs in a series either in a dirty water channel or via a 450mm plastic culvert which conveys dirty water to the SRP forebay (**Figure 4**). The logs progressively dissolve as the dirty water flows past. Thorough mixing of the treated water is essential and additional weirs or obstacles may be placed in the dirty water channel or culvert after the Flog Logs to facilitate this. The number of Floc Logs used will be dependent on the sediment loading of the influent dirty water. The Wai Mā Solutions APAM Application Guide 2024 user guide suggests 1 Floc log per 190-265 Litres per minute of flow. With a minimum of 4-6 Logs at any one time.

Floc logs can also be placed at intervals along a channel lined with coir matting. Sediment logs are also typically placed at intervals along the channel to permit additional mixing of water and the treatment product. An illustration is shown in **Figure 5**.

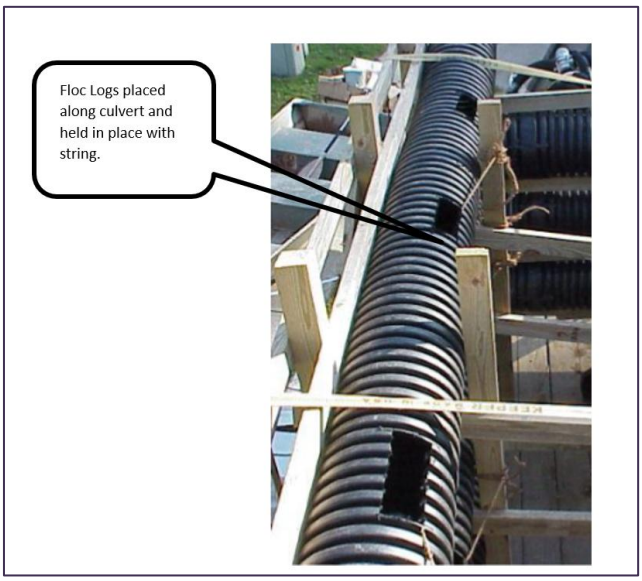

Figure 4. Example illustration showing a setup for floc log installation.

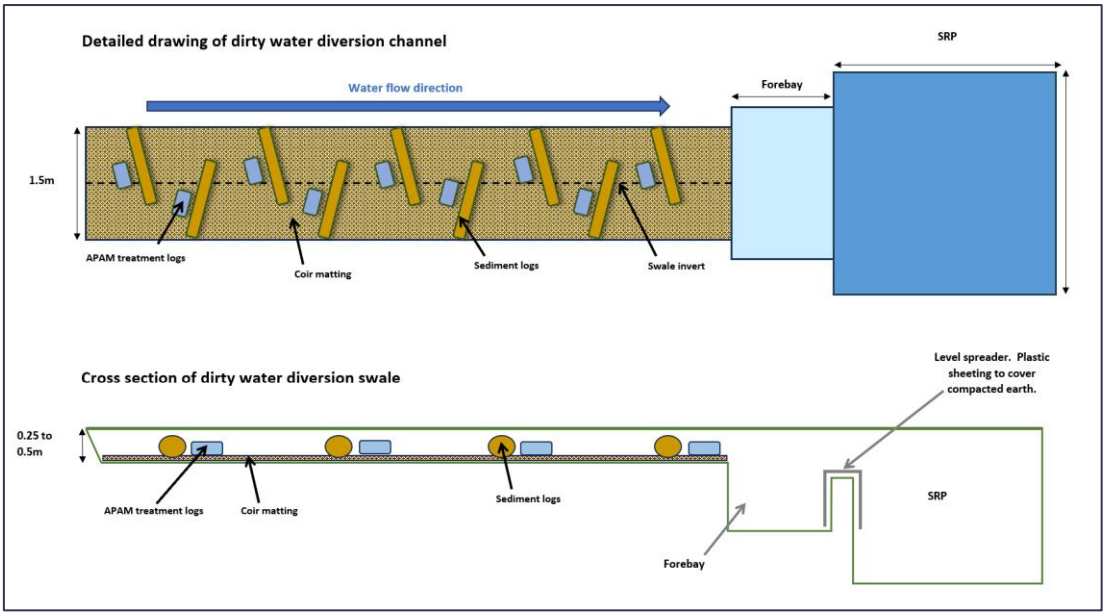

Figure 5. Dirty water diversion channel and installation of Floc logs. Note that on this particular project a sediment retention pond will not necessarily be used due to the nature of construction and that there will be slightly differently design to a standard SRP design.

4.4 Rain Activated Floc Dosing

The Floc Box system is a rain-based system based on the traditional timber floc shed. The area of the 'roof catchment' is directly proportional to the amount of flocculant dosed into the SRP forebay. The 75L Floc Box is supplied by Erosion Control Ltd based in Hamilton. Details of the design and operation of the Floc Box can be found at https://www.erosioncontrol.co.nz/Services/flocbox.html.

The Floc Box was selected because it is easily adjusted for different size catchments, has relatively simple operation, is re-useable on multiple projects, and is accepted by a number of regional and district councils. A disadvantage of the Floc Box is that it is not suitable for dewatering applications. Where the treatment of dewatering water is required, batch dosing or flow-based electronic dosing systems are more suitable methods.

Installation and use:

The Floc Box shall be placed on a level 2x2m area adjacent to the dirty water diversion channel 3 – 5 meters up gradient of the forebay. The final 5m of the dirty water diversion channel should be lined with an impervious material and the discharge from the Floc Box set to drip into the centre of the invert as indicated in the figure below.

- To prevent an uncontrolled discharge of flocculant into the SRP, a 300mm high earthen bund shall be formed between the Floc Box and surface water as indicated in brown in **figure 8** below.
- The catchment tray is to be fastened on the Floc Box to set the correct rain collection size based on the calculations provided by Erosion Control Ltd.
- The bulk tank of flocculant is to be placed either within a bund that can hold 125% of the volume of the tank, or be further than 25m from surface water.
- Once the Floc Box and bulk flocculant tank are in situ, flocculant is to be pumped into the Floc Box holding tank using the methodology supplied by Erosion Control Ltd. Flocculant should be added until dripping is observed from the discharge line.
- During a rainfall event, rainwater landing of the catchment tray of the Floc Box flows into the header tank increasing the weight of the header tank and displacing flocculant from the storage tank below.

The Floc Box shall be checked following rainfall events greater than 10mm and at least weekly as part of routine inspections. During each inspection the following should be checked:

- The area around the Floc Box, e.g. check there is no subsidence, and the containment bund is intact.
- The catchment tray is secured in the correct location.
- The header tank is empty, and the storage tank is at least 2/3 full of flocculant.
- The flocculant discharge valve is open, and the end of the discharge pipe is correctly located above the dirty water invert.

Following each rain event levels in the header and flocculant storage tank should be checked. Rainwater should be removed from the header tank and flocculant added to the storage tank as required.

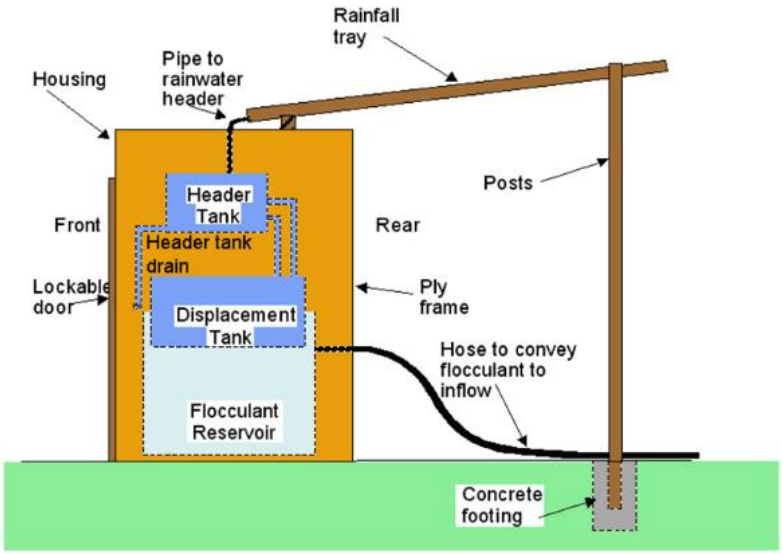

Figure 6 Example of Rain Activated Floc Dosing setup.

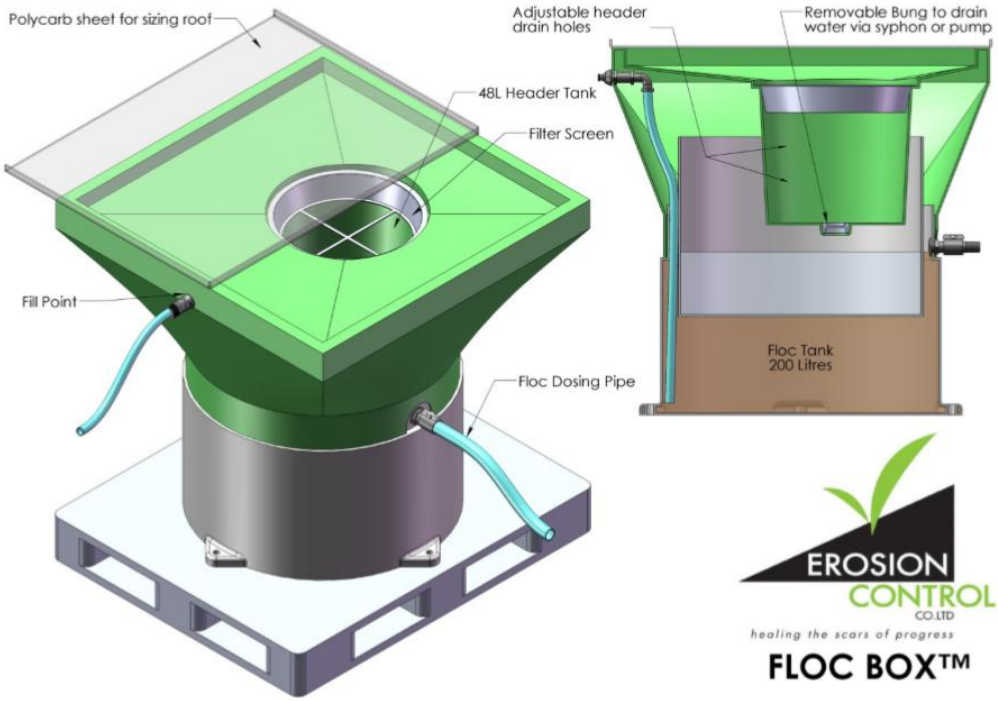

Figure 7 Schematic design of Floc Box from Erosion Control Ltd

Figure 8 Example of Floc Box setup. Note discharge line staked in drip into the centre of the dirty water diversion

5. Bench Testing Results

Three soil samples were taken from across the site. These three soil samples were bench tested using water treatment chemicals to ascertain the best flocculant/coagulant to meet the TSS discharge limit. Due to distance between the samples the results have been split into locations. The locations have been labelled based on the name of the soil samples provided by Riley Consultants Ltd. The soil samples are called TP224, TP261, and TP291. Soil samples were then mixed with water to make up a concentration of sediment laden water used for bench testing. The TSS was around 1500 mg/L for each sample. The results show which flocculants and coagulants was the most effective product at lowering the TSS.

5.1 TP224

The Floc log that would achieve the best outcome are 703d#3 and 706b. The most effective liquid-based chemical treatment is Mahea PDM Results are shown in (**Figure 8, 9 & 10**) and **Table 1**.

EnviroCo ENVIRONMENTAL COMPLIANCE **Bench Testing Results:** 29 May 2025 **Site:** Mahinerangi - TP224

TSS +1500 pH 7.38

Chemical	IBC concentration %	Standard dose volume (mL)	Optimal doses	pH at optimal dose	TSS at final dose (mg/L)	Dose rate per m^3 (mL)
Wai mā PAC	37.5	0.5	4	7.08	132	20
Mahea PDM	1	0.1	1	7.15	31	2

Table 1 – Bench testing results

5.2 TP261

The Floc log that would achieve the best outcome is 706b and the next best was 730b. The most effective liquid-based chemical treatment is Mahea PDM. Results are shown in **Figures 11, 12 & 13** and **Table2**

EnviroCo ENVIRONMENTAL COMPLIANCE **Bench Testing Results:** 29 May 2025 **Site:** Mahinerangi - TP261

TSS +1500 pH 7.50

Chemical	IBC concentration %	Standard dose volume (mL)	Optimal doses	pH at optimal dose	TSS at final dose (mg/L)	Dose rate per m^3 (mL)
Wai mā PAC	37.5	0.5	4	6.85	94	30
Mahea PDM	1	0.1	1	7.15	31	2

Table 2 – Bench testing results

5.3 TP291

The Floc log that would achieve the best outcome is 703d followed by 730b. Once again, the most effective liquid-based chemical treatment is Mahea PDM Results are shown in (**Figure 14, 15 and 16**) and **Table 3**.

EnviroCo ENVIRONMENTAL COMPLIANCE **Bench Testing Results:** 29 May 2025 **Site:** Mahinerangi - TP291

TSS +1500 pH 7.41

Chemical	IBC concentration %	Standard dose volume (mL)	Optimal doses	pH at optimal dose	TSS at final dose (mg/L)	Dose rate per m^3 (mL)
Wai mā PAC	37.5	0.5	4	6.83	503	20
Mahea PDM	1	0.1	1	7.48	14	2

Table 3 – Bench testing results

5.4 Summary

There was not one stand out APAM product that was suitable across all three samples with each different sample reacting differently to the chemicals. However, Mahea PDM (Cationic poly DADMAC) was an effective liquid treatment method that work across all the soils tested. Despite this due to the sensitive nature of the receiving environment and the greater risk posed by Mahea PDM compared to APAM products no further consideration of this product was taken. Another product that was appropriate for all sites was Silt Clear. Silt Clear is a granular product that can be hand casted to water as a treatment method. It is very useful in unforeseen circumstances when sediment laden discharges are occurring as a backup method of treatment. As mentioned previously the chemical treatment method will depend on a variety of aspects such as the site topography and the method for managing dirty water discharges this chemical analysis is an indication but the exact combination of chemicals used will vary. Furthermore, it was noted that the sediment settled out of the water naturally without any chemical treatment

over 24 hours. This is very unusual and was not something that occurs often in nature. Therefore, rain activated chemical treatment may not be necessary for this site. This will be subject to monitoring of turbidity and total suspended sediment of water within sediment retention devices during the early stages of earthworks. This does also require enough water storage capacity to retain water onsite for 24 hours before discharging. It is however, as a minimum, highly recommended to have chemical treatment products onsite as a back up to facilitate flocculant dosed treatment. For example, APAM products that can be implemented into sediment laden discharges via passive or controlled dosing systems. These products will be used as a contingency in the event of spill or discharge of contaminants, and/or during dewatering processes.

Figure 8. *TP224 Bench testing results of Flocculants.*

Figure 10. *TPP224 Bench testing results of liquid chemical treatment.*

Figure 11. *TPP261 Bench testing results of Flocculants.*

Figure 13. *TPP261 Bench testing results of liquid chemical treatment.*

Figure 14.*TPP 291 Bench testing results of Flocculants.*

Figure 16. *TPP 291 Bench testing results of liquid chemical treatment.*

6. Handling and Storage

The following safety measures must be adhered to when handling any water treatment chemical:

- The Material Safety Data Sheet (MSDS) for the chemical will be kept with the product.
- A chemical identification label is to be secured to any container used for storage and handling.
- Avoid contact with skin, eyes and clothing. The minimum personal protective equipment includes gloves and eye/full face protection. It is also advised to wear long sleeved trousers and sleeves or wet weather gear.
- If chemical is splashed or sprayed onto skin or eyes, follow the directions of the MSDS.
- If chemical is batch dosed using a spray pump unit, it is advised to spray the flocculant from the up-wind direction.

Bulk storage on site:

- Any chemical stored on site shall be at least 20m away from any diversion channel or surface water body and kept within a bunded area that can contain 125% the volume of the container.
- For 20L drums, the simplest method of containment is a 30L plastic storage container.
- All excess chemical products not in use will be stored in a locked shed or container.

7. Water quality Monitoring

Monitoring shall be undertaken at various stages of the water treatment process. A monitoring guide is provided in **Appendix A**.

General best practise limits are:

- pH – 6.5 – 8.5
- TSS – not to exceed 50mg/L at the discharge point.
- No oils, sheens, floatable or suspended materials.
- Cause scour or erosion to the bed or banks of the receiving water body

7.1 Independent Environmental Monitoring

If the visual assessment and observations undertaken in **Section 7.0** indicate a decrease in water quality at the point of discharge, water quality monitoring shall be undertaken by a suitably qualified provider to ensure compliance.

Water quality measurements shall include:

- pH and TSS measured using a calibrated meter.
  All monitoring results will be recorded and supplied to council as part of the routine reporting or upon request.

8. Adjustment of pH

The addition of water treatment chemicals has the potential to lower pH. The permitted range of pH is 6.5 to 8.5 in water discharging to surface water. Additional chemicals such as sodium bicarbonate or calcium carbonate can be added to the water to counteract or buffer the acidic effects of the chemical. If pH decreases below 6.5, the following protocol shall be followed:

- The outflow from the pond will be blocked until the pH of the pond is raised to within the acceptable range.
- Dissolve 5Kg sodium bicarbonate in 10L fresh water[1]. The solubility of sodium bicarbonate is relatively high.
- The solution is to be batch dosed directly into the pond using a 1 – 2L container sloshing over the surface at a variety of different locations around the pond.
- After 30 minutes, measure pH. If the pH is less than 6.5 repeat the above steps.
- The outlet can be opened or pumped once pH is raised to within acceptable pH limits.

It is not expected that pH adjustment will need to be made as flocculants (APAM) do not alter pH nearly as much as Coagulants (Pac).

9. Spill Response

The following protocols must be followed in the event of a spill:

- If a spill of chemical greater than 10L occurs, the site manager is to be notified immediately. All personnel to keep 5m away from the spill unless wearing appropriate PPE.
- If possible, the cause of the spill must be identified and stopped, e.g. close valve, up-right container, turn off pump. Bund the spill with earth, sediment logs or other material.
- Once contained, the spilt material is to be removed. If on soil, mix soil and chemical and place in plastic drums for transportation from site. Soil should be removed until there is no remaining residue.
- If a spill greater than 10L occurs where any of the product enters surface water, ORC should be notified immediately to minimise the potential for any adverse environmental effects.

[1] https://www.algone.com/adjust-ph-aquarium and https://edis.ifas.ufl.edu/fa028

- Drains or sumps where the chemical has accumulated may be hydro-vacuumed to remove all product if required.
- The MSDS sheets will be kept with the product.

Appendix A: Discharge Monitoring Form

EnviroCo ENVIRONMENTAL COMPLIANCE

Discharge Monitoring Form

Site: **Maintenance Person:**

Routine Check				**Discharge**				
Dewatering System	Flocculant Used	Discharging (Y/N)	Rainfall (24hrs)	Visual Assessment	Clarity	TSS	pH	Notes