Prepared for To Tātou Vai

By Tiu Te Matangi Ltd

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Acronyms

AVG	Automatic valveless gravity filter
EIP	Environmental improvement plan
MMR	Ministry of Marine Resources
NES	National Environmental Services
OEMP	Operational environmental management plan
PACl	Poly Aluminium Chloride
SOP	Standard operating procedure
SS	Suspended solids
ST	Settling Tank
TEIP	Turangi environmental improvement plan
TTV	To Tatou Vai

Units

µg/L	milligrams per liter
Kg	Kilograms
E. Coli	*Escherichia coli (E. coli)* bacteria normally live in the intestines of people and animals. Most *E. coli* are harmless and actually are an important part of a healthy human intestinal tract. However, some *E. coli* are pathogenic, meaning they can cause illness, either diarrhea or illness outside of the intestinal tract. The types of *E. coli* that can cause diarrhea can be transmitted through contaminated water or food, or through contact with animals or persons. (https://www.cdc.gov/ecoli/general/index.html)

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Turangi Environmental Improvement Plant (TEIP)

1. Background

1. Mitigation strategies identified in the operational environmental management plan (OEMP) for the Turangi water treatment plant (WTP) informs this environmental improvement plan (EIP).

2. The Turangi WTP ranks the second biggest supplier of water to Rarotonga's water supply system supplying around 3.5 million liters per day with an average flow at the intake of 35 liters per second.

3. The Plant comprises of the following systems: a weir and screen intake, two settling tanks of 209,000 liters each, a PACl mixing shed with one 5,000liters storage tank and a 40liters PACl header tank, two AVG, one 51m^3 sludge pond and one 51m^3 backwash pond with decants (and access platform) and a 2.4 million liters storage tank on an approximately 4,000 square meters of land.

4. The Plant uses seven 20kg bags of PACl per mix into a 1,000liters tank of supernatant water to load into a 5,000L PACl holding tank and then onto the 40liters PACl header tank linked to the WTP. The amount of PACl or coagulant released into the WTP varies for each month and with the wet and dry season.

5. A coagulant makes small particles of dirt (suspended materials and microbiological contamination) stick together and settle to the bottom of the settling tank forming a sludge.

6. The Plant is part of the five north WTPs, checked daily by two operators using the TTV WTP check list (a sample is attached to this EIP as Appendix I), and worked by four operators during desludging and cleaning of one settling tank when required. The decision to desludge is based on the volume of sludge estimated by the operator. For Turangi, having two settling tanks and AVGs and one storage tank, desludging of one settling tank can take place while one is operating.

7. For the Turangi WTP, the removal of debris from the back of the weir at the intake is removed by a Contractor using machineries. Debris are not removed off the valley except if landowners require them and transportation costs will be met by them, otherwise removed debris is stored on site.

8. At this WTP the removal of sludge to a better drying place, e.g., to the Papua WTP, is carried out, when required, by a septic desludging contractor. Disposal of backwash is an issue here due to high water intake which results in frequent AVG backwash and the receiving pond requires to be resized or extended.

9. Maintenance work around the Plant, e.g., landscaping, weed and higher trees control and management is contracted out to local contractors.

10. The AVG operations is not included in this EIP as the systems manufacturers has provided SOP for its operations and maintenance. The OEMP provide preventative measures ensuring larger items or sludge do not enter the system. Should the AVG become inoperable it should be replaced.

2. Purpose

11. This EIP establishes the environmental controls at the Turangi WTP implemented by TTV and its contractors. Appropriate systems control sites are provided in Figure 1.0.
12. Where EIPs are implemented, new standard operating procedures (SOPs) will be prepared and subsequently reviewed and informed by the new experiences gained. A SOP template is attached as Appendix II.

13. This plan will be used by:

    a. TTV operators in their daily work at the plant;

    b. TTV operators as an environmental management guide during emergency responses to a breach or breaches at the plant; and

    c. NES to monitor the approved conditions of the project permit.

14. It is recommended this plan to be reviewed every three years.

3. Reporting

12. TTV produces an annual report summarizing the following:

    a. Monitoring and sampling undertaken;
    b. Critical analysis of compliance and potential adverse environmental effects;
    c. Recommendations for changes to future permit conditions; and
    d. The annual report will be issued internally to TTV and NES.

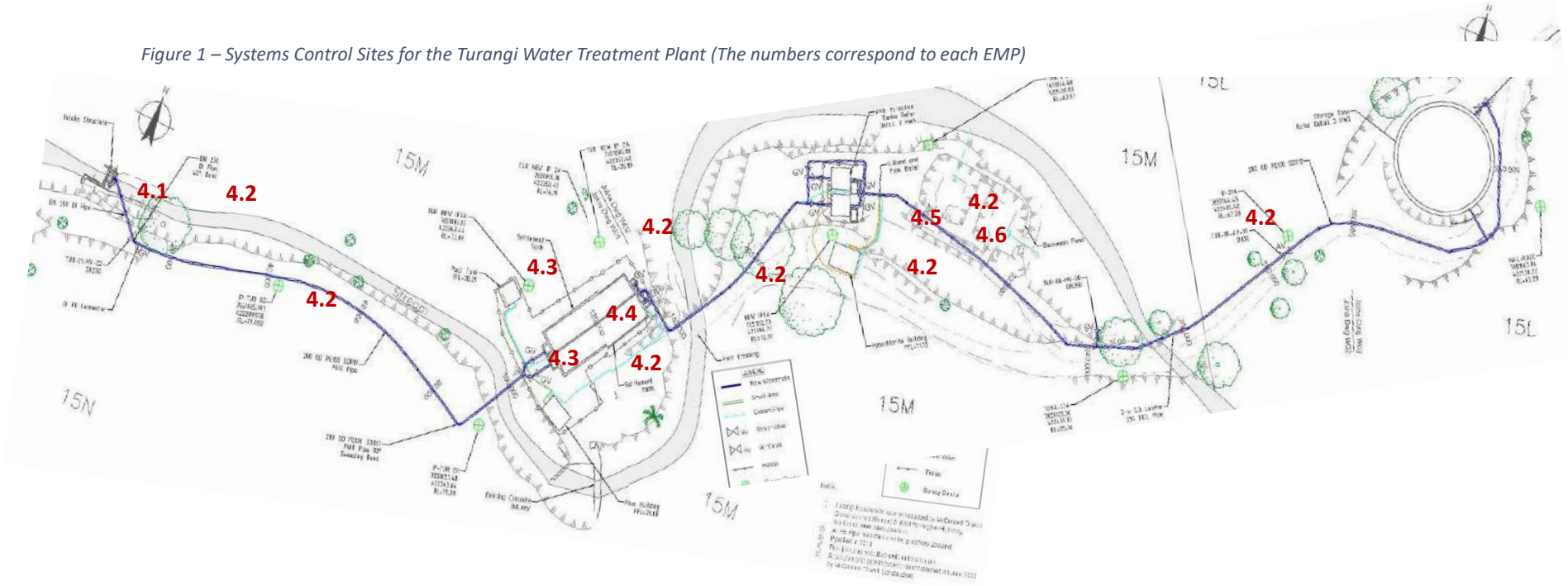
13. The NES can review and change the conditions of the consent annually.

14. During the operation of each of the WTP the TTV Team will undertake an ongoing 3 monthly compliance audit and also after major flood to ensure the commitments contained in the OEMP are being met.

15. A compliance report will be prepared that:
    a. Summarizes compliance with the OEMP conditions
    b. Provides details of any incidents of non-compliance with the OEMP conditions as well as corrective actions implemented.

16. All compliance report and records will be kept by TTV Team and available for inspection by the NES.

Figure 1 – Systems Control Sites for the Turangi Water Treatment Plant (The numbers correspond to each EMP)



4. Environmental Management Plan

4. 1 Intake (Screening and maintenance work)

Table 1 - Environmental Management Plan for the Intake area

Objective(s)	▪ Screen at the intake is not blocked by any material that may impede its performance. ▪ Prevent accumulation of organic material behind the weir especially during low flow periods					
Performance Criteria	▪ Clear pathway for water entry into the WTP ▪ Dissolved organic carbon minimized					
Mitigating Measures		Monitoring Parameter	Monitoring Frequency	Monitoring Responsibility	Staffing and Equipment Requirements	Oversight
	Operation					
	Clearing of accumulated organic detritus and inorganic materials at Coarse Screen and intake	Organic detritus and inorganic material accumulation as per developed SOP.	Daily check and after heavy rain as per SOP.	Operator	1 WTP operator, with shovel if required.	Supervisor
	Accumulated debris and organic material behind the weir	Level and volume of debris as per developed SOP.	Twice weekly, when debris level is critical and after a heavy rain as per SOP.	Operator	1 WTP operator to keep an eye on the Contractors when removing debris and organic material when required.	Supervisor
	For EIP					
	Investigate the construction of silt trap options further inland of the intake and weir to minimize erosion.	Feasible silt trap or debris management options and developed SOP, seek NES approval for options.	As per developed SOP for option (s) chosen.	Engineering Division	Materials for options chosen.	Chief Engineer, Manager and CEO

Corrective Action	▪ In the event of any natural caused risks, e.g., land slips near or around the sites, or unexpected falling trees as a result of extreme weather events, on the advice of the Supervisor, the CEO shall activate the emergency response team to carry out temporary short-term solution as per the relevant SOPs to address the situation and enable the continuation of water entry to the WTP, and as soon as practicable a long-term solution shall be implemented. ▪ Corrective actions for listed environmental improvement activities will be developed with new experiences.

4. 2 Vegetation Control and maintenance work

Table 2 - Vegetation Control and maintenance work

Objective(s)	▪ Prevent the spread and effect of invasive species around the plant and in the catchment area					
Performance Criteria	▪ Zero invasive species around the plant					
Mitigating Measures		Monitoring Parameter	Monitoring Frequency	Monitoring Responsibility	Staffing and Equipment Requirements	Oversight
	Operation					
	Clearing of vegetation along lower slopes and keeping them short, eliminate invasive species around the plant, e.g., pīpī-vai, rau-māniota and kākā	Overgrowth level, presence of young invasive species as per developed SOP.	Fortnightly as per SOP.	Operator	2 WTP operator to quickly weed out young invasive species and to keep an eye on the Contractors when doing regular clearing of vegetation.	Supervisor
	Risk of falling trees and slips	Visual inspection and Reporting as per developed SOP.	Daily check, especially during and after heavy rain as per SOP.	Operator	1 WTP operator to activate emergency response team as per SOP and to keep an eye on the Contractors while removing	Manager and CEO

					debris and fallen tree (s).	
	For EIP					
	Training of operators to recognize young invasive plant species for quick eradication at an early age.	Young invasive plant species of pīpī-vai, rau-māniota and kākā and developed SOP.	When training is completed and as per developed SOP.	NES Biodiversity Division	Operators at all levels.	CEO and Manager
	Maintain and improve relationship with Contractors.	Performance level and developed SOP.	During delivery of service.	Supervisor	Operators at all levels	Manager and CEO.
	Investigate the construction of silt trap options further inland of the intake and weir to minimize erosion.	Feasible silt trap or debris management options and developed SOP, seek NES approval for options.	As per developed SOP for option (s) chosen.	Engineering Division	Materials for options chosen.	Chief Engineer, Manager and CEO
Corrective Action	▪ In the event of any natural caused risks, e.g., land slips near or around the sites, or unexpected falling trees as a result of extreme weather events, on the advice of the Supervisor, the CEO shall activate the emergency response team to carry out temporary short-term solution as per the relevant SOPs to address the situation and enable the continuation of water entry to the WTP, and as soon as practicable a long-term solution shall be implemented. ▪ Corrective actions for listed environmental improvement activities will be developed with new experiences gained.					

4. 3PACl Mixing and management

Table 3 - Environmental Management Plan for the PACl preparing area

Objective(s)	▪ Prevent the release of PACl into the environment to limit aluminum entering the ground water at each WTP.
Performance Criteria	▪ Absence of spill at PACl mixing, PACl storage tank, PACl header tank and no overdosing at the coagulation chamber.

Mitigating Measures		Monitoring Parameter	Monitoring Frequency	Monitoring Responsibility	Staffing and Equipment Requirements	Oversight
	Operation					
	PACl Mixing Shed	Manual mixing practice, onsite spill, volume of onsite spill.	Daily Checking as per current SOP, when mixing, while mixing, when the mixed PACl in the storage tank is 20-30% full and when there is high rainfall in the area.	WTP Operators	2 WTP operators, bunding around the mixing are (See IEP).	Supervisor
	PACl Storage tank	Manual mixing practice, onsite spill, volume of onsite spill.	Daily checking when mixing, while mixing, when the mixed PACl in the tank is 20-30% full, when there is high rainfall in the area.	Operators	2 WTP operators, bunding around the mixing area and the holding tank platform (See IEP).	Supervisor
	Outflow pipe to the PACl header tank.	Crystallized PACl, onsite spill, volume of onsite spill.	Daily checking, when crystal formation in the outflow pipe is visible.	Operators	2 WTP operators, bunding around the holding tank (See IEP).	Supervisor

	PACl Header tank – Risk of float valve arm breaking due to wear and tear.	Condition of PACl Header tank lid, condition of float valve arm and spill.	Daily check, especially during heavy rain.	Operator	1 WTP operator, spare float valve arm (See IEP).	Supervisor
	For EIP					
	PACl Mixing Area – Consider containment options.	Bunding or appropriate option around mixing area.	When design is completed, Contractor engaged and SOP developed.	Engineering Division	Contractors	Manager and Chief Engineer
		Use mechanical mixer to prevent spill.	When procured and SOP developed.	Engineering Division	Contractor/Supplier of equipment	Manager and Chief Engineer
	Outflow pipe to the PACl storage tank	Outflow pipe to discharge into appropriate container.	When design is completed, Contractor engaged and SOP developed.	Engineering Division	Contractor/Supplier of materials.	Manager and Chief Engineer
	Outflow pipe to the PACl header tank	Bunding or appropriate option around PACl storage tank.	When design is completed, Contractor engaged and SOP developed.	Engineering Division	Contractors	Manager and Chief Engineer
	Risk of float valve arm breaking due to wear and tear at the PACl header tank.	Investigate and find a stronger longer lasting float valve arm or another option to control PACl dosing from the header tank	When procured and SOP developed.	Engineering Division	Contractors	Manager and Chief Engineer

	Water test at the 200meter mark downstream from the Plant.	Discharges from the settling tank must not exceed the values provided in Section 6.4.1 of the main OEMP Report.	Monthly per the Monitoring Plan provided in Sections 6.4.2 and 6.4.4 of the main OEMP Report and as per developed SOPs.	WTP Operators, TTV laboratory staff, appropriate NES and MMR staff.	WTP Operators and laboratory staff, sampling equipment.	Supervisor, Laboratory Manager, NES and MMR.
Corrective Action	▪ In the event areas of IEP are not implemented or investigations into options have to overcome other barriers, all efforts must ensure current operating SOPs developed are followed to ensure operations reduce spillage of PACl to zero value and water quality test results must continue to advice further actions.					

4.4 Settling tank (discharge of supernatant water and maintenance work)

Table 4 - Environmental Management Plan for the management of PACl at the settling tank (ST)

Objective(s)	▪ To reduce Aluminum entering the stream through discharged supernatant water during desludging and tank maintenance. ▪ To manage the coagulation, flocculation and sedimentation process					
Performance Criteria	▪ Consistent flow entering the settling tank ▪ Consistent dosing and addition of coagulant during high turbidity from rapid changes in stream flows					
Mitigating Measures		Monitoring parameter	Monitoring frequency	Monitoring responsibility	Staffing and Equipment Requirements	Oversight
	Operation					
	Rapid Mixing Chamber – Risk of float valve arm (dozing leaver) breaking[1].	Condition of float valve arm and its function.	Daily check, especially during heavy rain.	Operator	1 WTP operator, spare float valve arm.	Supervisor

[1] When the settling tank backs up, i.e., reservoir is full and the water flow into the reservoir shuts down at the pressure reducing valve before the reservoir, water backs up through the AVG and shuts off before the AVG, the float valve will shut the incoming water off by raising the release valve so water is diverted to the stream outflow. When this happens PACl will be released into the stream. The vibration caused by the incoming water at the rapid mixing chamber can

Settling Chamber – Potential for release of sludge at mid-level drain of ST during desludging and maintenance work.	Sludge level as estimated from the bottom of the tank to the mid-level drain as per developed SOP.	During desludging and tank maintenance.	Operator	2 WTP operators, the more the better.	Supervisor
For EIP					
Rapid Mixing Chamber – Risk of float valve arm (dozing leaver) breaking	Investigate and find a stronger longer lasting float valve arm or another option to control PACl dosing from the header tank	When procured and as per developed SOP.	Engineering Division	Contractors	Manager and Chief Engineer
Water test at the 200meter mark downstream from the Plant.	Dissolved Aluminium, pH, suspended solid, turbidity, conductivity, photographic survey, species diversity comparison as provided in Section 6.4 of the OEMP Report.	Monthly per the Monitoring Plan provided in Sections 6.4.2 and 6.4.4 of the main OEMP Report and as per developed SOP.	WTP Operators, TTV laboratory staff, appropriate NES and MMR staff.	WTP Operators and laboratory staff, sampling equipment.	Supervisor, Laboratory Manager, NES and MMR.
Water test of samples taken from the stream at the point of Supernatant discharge from the settling tank during desludging and tank maintenance.	Dissolved Aluminium, pH, suspended solid, turbidity, conductivity	During desludging and as per the Monitoring Plan provided in Section 6.4.2 –	WTP Operators, TTV laboratory staff,	WTP Operators and laboratory staff, sampling equipment.	Supervisor, Laboratory Manager, NES and MMR.

cause the ball valve arm to break. There is no part on the island and the TTV uses home-made part made from PVC. This has happened in some of the WTP during times of heavy rain and heavy flow.

			6.4.4 of the main OEMP Report and as per developed SOP.	appropriate NES and MMR staff.		

Corrective Action	▪ In the event areas of IEP are not implemented or investigations into options have to overcome other barriers, all efforts must ensure current operating SOPs developed are followed to ensure operations continue using the current practices and water quality test results must continue to advice further actions.

4.5 Sludge Pond

Table 5 - Environmental Management Plan for the sludge pond

Objective(s)	▪ To prevent surface water from entering sludge pond or drains into pond ▪ To ensure sludge is properly dewatered (dries out) ▪ To minimize PACl carry over to streams ▪ Avoid environmental impacts on stream ecology					
Performance Criteria	▪ No surface water entering pond ▪ Sludge ponds retain capacity to accept sludge discharge from settling tank ▪ Environment Permit discharge standards are met for pH, suspended solids, turbidity, dissolved aluminium at pond discharge point ▪ No significant impacts on benthic macroinvertebrate fauna					
Mitigating Measures		Monitoring parameter	Monitoring frequency	Monitoring responsibility	Staffing and Equipment Requirements	Oversight
	Operation					
	Keep discharge outlet clear and visible	Vegetation overgrowth	Fortnightly	Operators	1 WTP operator to keep an eye on the Contractors	Supervisor
	Maintain drainage system	Visual Inspection	Fortnightly	Operators	1 WTP operator to	Supervisor

				keep an eye on Contractors	
Regular maintenance of decant including installation of baffles, leaky floats – clearing of algae etc.	Visual inspection	weekly	Operator	1 WTP operator	Supervisor
Dewatering of sludge – transport backwash to Pāpua sludge pond for drying.	Visual inspection	Daily Check	Operators	1 WTP operators to keep an eye on the Contractors	Supervisor.
For EIP					
Earth bund or drain installed upslope of pond and around all drains connected into the pond.	Prepare design of earth bund, procure Contractor	When Contractors procured and as per developed SOP for its maintenance.	Engineering Division	Contractors	Manager and Chief Engineer
Enlarge sludge pond where required.	Prepare design of earth bund, procure Contractor	When Contractor procured and as per developed SOP for its maintenance.	Engineering Division	Contractors	Manager and Chief Engineer
Divert drainage away from drying beds.	Prepare design of earth bund, procure Contractor	When Contractor procured and as per developed	Engineering Division	Contractors	Manager and Chief Engineer

			SOP for its maintenance.			
	Supernatant discharge to stream	Dissolved Aluminium, pH, suspended solid, turbidity, conductivity	Once a month, and after a breach, e.g., flooding and as per developed SOP.	WTP Operators, TTV laboratory staff, appropriate NES and MMR staff.	WTP Operators and laboratory staff, sampling equipment.	Supervisor, Laboratory Manager, NES and MMR.
	Monitor ambient stream water quality above and below WTP discharge points	Dissolved Aluminium, pH, suspended solid, turbidity, conductivity	Quarterly as per developed SOP.	WTP Operators, TTV laboratory staff, appropriate NES and MMR staff.	WTP Operators and laboratory staff, sampling equipment.	Supervisor, Laboratory Manager, NES and MMR.
	Monitor sludge deposition in stream bed 200m downstream of WTP	Photographic survey	Quarterly as per developed SOP.	WTP Operators, TTV laboratory staff	WTP Operators and laboratory staff, photographic equipment.	Supervisor, Laboratory Manager
	Sample benthic macroinvertebrates	Comparison of species diversity with EIA studies	Quarterly as per developed SOP.	WTP Operators, TTV laboratory staff	WTP Operators and laboratory staff, sampling equipment.	Supervisor, Laboratory Manager
Corrective Action	▪ Operators to keep daily records of all inspections including maintenance activities undertaken. In the event of any breach of discharge standards or indication of significant environmental effects identified during monitoring activities, NES to be informed immediately along with a proposed corrective action plan.					

	▪ In the event areas of IEP are not implemented or investigations into options have to overcome other barriers, all efforts must ensure current operating SOPs developed are followed to ensure operations continue using the current practices and water quality test results must continue to advice further actions.

4.6 Backwash Pond

Table 6 - Environmental Management Plan for the backwash pond

Objective(s)	▪ To prevent surface water from entering sludge pond or drains into pond ▪ To ensure sludge is properly dewatered (dries out) ▪ To minimize PACl carry over to streams ▪ Avoid environmental impacts on stream ecology					
Performance Criteria	No surface water entering pond Sludge ponds retain capacity to accept sludge discharge from settling tank Environment Permit discharge standards met for suspended solids, turbidity, dissolved aluminium at pond discharge point No significant impacts on benthic macroinvertebrate fauna					
Mitigating Measures		Monitoring parameter	Monitoring frequency	Monitoring responsibility	Staffing and Equipment Requirements	Oversight
	Operation					
	Keep discharge outlet clear and visible	Vegetation overgrowth	Fortnightly	Operators	1 WTP operator to keep an eye on the Contractors	Supervisor
	Maintain drainage system	Visual Inspection	Fortnightly	Operators	1 WTP operator to keep an eye on Contractors	Supervisor
	Regular maintenance of decant including installation of baffles, leaky floats – clearing of algae etc.	Visual inspection	weekly	Operator	1 WTP operator	Supervisor
	Dewatering of sludge – transport backwash to Pāpua sludge pond for drying.	Visual inspection	Daily Check	Operators	1 WTP operators to	Supervisor.

					keep an eye on the Contractors	
For EIP						
Earth bund or drain installed upslope of pond and all drains connected into the pond.	Prepare design of earth bund, procure Contractor	When procured and as per developed SOP for its maintenance.	Engineering Division	Contractors	Manager and Chief Engineer
Divert drainage away from drying beds.	Prepare design of earth bund, procure Contractor	When procured and as per developed SOP for its maintenance.	Engineering Division	Contractors	Manager and Chief Engineer
Extension of backwash pond to include wetland taro planting areas.	Approval from MoA to proceed with trial, meeting with landowners, agreement with landowners, design of taro ponds.	When meeting, agreement is completed, procure contractor for construction and as per developed SOP for maintenance of swamps.	Engineering Division, TTV laboratory staff, MoA staff, NES.	Contractors	Manager and Chief Engineer
Supernatant discharge to stream	Dissolved Aluminium,	Once a month as per	WTP Operators,	WTP Operators and	Supervisor, Laboratory

		pH, suspended solid, turbidity, conductivity	developed SOP, and after a breach, e.g., flooding.	TTV laboratory staff, appropriate NES and MMR staff.	laboratory staff, sampling equipment.	Manager, NES and MMR.
	Monitor ambient stream water quality above and below WTP discharge points	Dissolved Aluminium, pH, suspended solid, turbidity, conductivity	Quarterly as per developed SOP.	WTP Operators, TTV laboratory staff, appropriate NES and MMR staff.	WTP Operators and laboratory staff, sampling equipment.	Supervisor, Laboratory Manager, NES and MMR.
	Monitor sludge deposition in stream bed 200m downstream of WTP	Photographic survey	Quarterly as per developed.	WTP Operators, TTV laboratory staff	WTP Operators and laboratory staff, photographic equipment.	Supervisor, Laboratory Manager
	Sample benthic macroinvertebrates	Comparison of species diversity with EIA studies	Quarterly as per developed.	WTP Operators, TTV laboratory staff	WTP Operators and laboratory staff, sampling equipment.	Supervisor, Laboratory Manager
Corrective Action	▪ Operators to keep daily records of all inspections including maintenance activities undertaken. In the event of any breach of discharge standards or indication of significant environmental effects identified during monitoring activities, NES to be informed immediately along with a proposed corrective action plan. ▪ In the event areas of IEP are not implemented or investigations into options have to overcome other barriers, all efforts must ensure current operating SOPs developed are followed to ensure operations continue using the current practices and water quality test results must continue to advice further actions.					

Appendices

Appendix I- Daily Checklist

Date WTP	Sludge Level (%)	Bulk Tank (%)	Dose Rate (mg/L or g/m^3)	Intake (NTU)	ST (NTU)	Post AVG (NTU)	Reservoir (NTU)	Flow Rate (L/Sec)	Reservoir (KPA)	Comments

Appendix II – SOP Template

1. Operation & Maintenance Manual for System (Examples. Intake (screening), Vegetation Control, PACl Mixing, Settling Tank (discharge of supernatant water and desludging), Sludge Pond and Backwash Pond.
2. Name of system (as above)
3. Theory of functioning
4. Working Principal
5. Operating Procedure
6. Efficiency of procedure
7. The functioning of the component
8. Knowledge on the principles upon which the process is based on
9. The primary objective of the system
10. To accomplish this successfully would require… (list how)
11. Frequently asked questions and answers