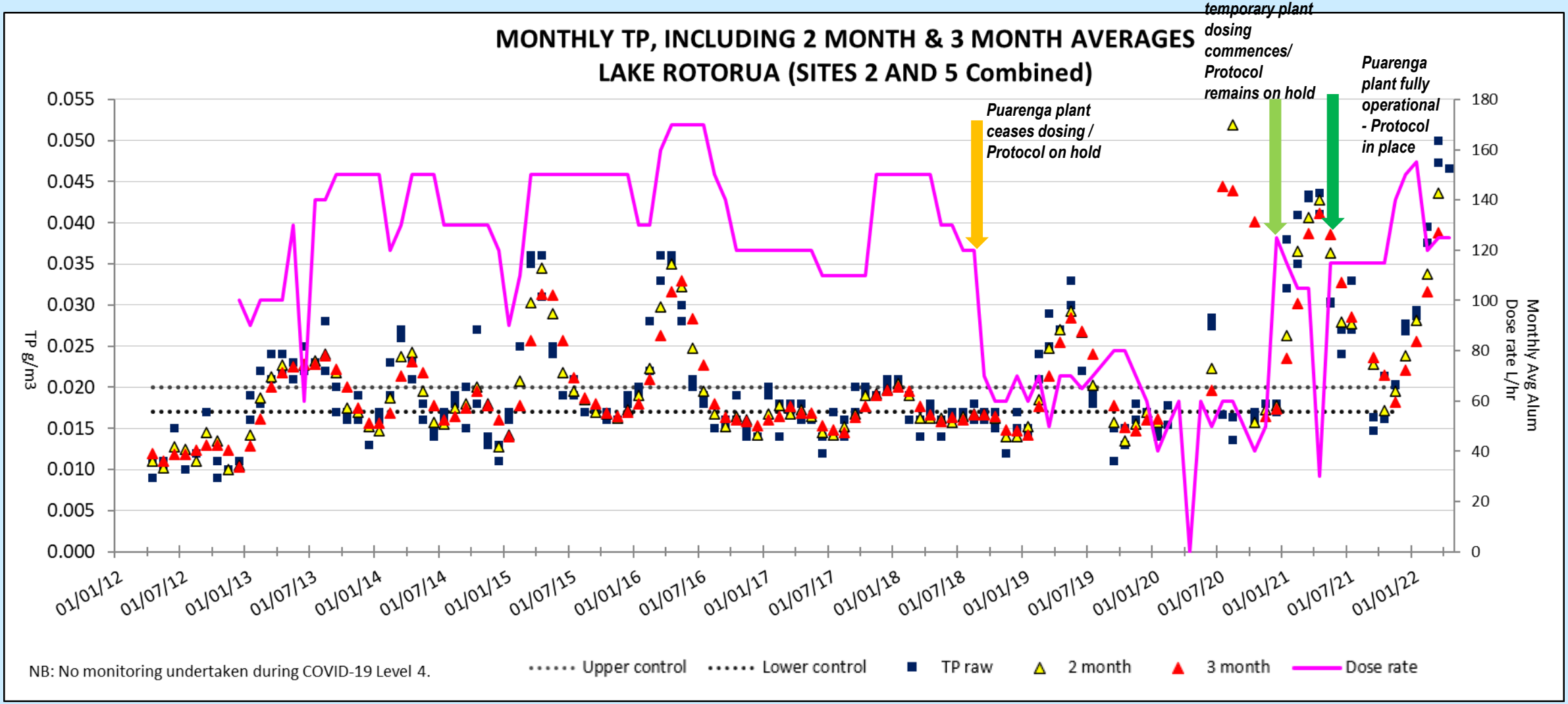
LAKE ROTORUA

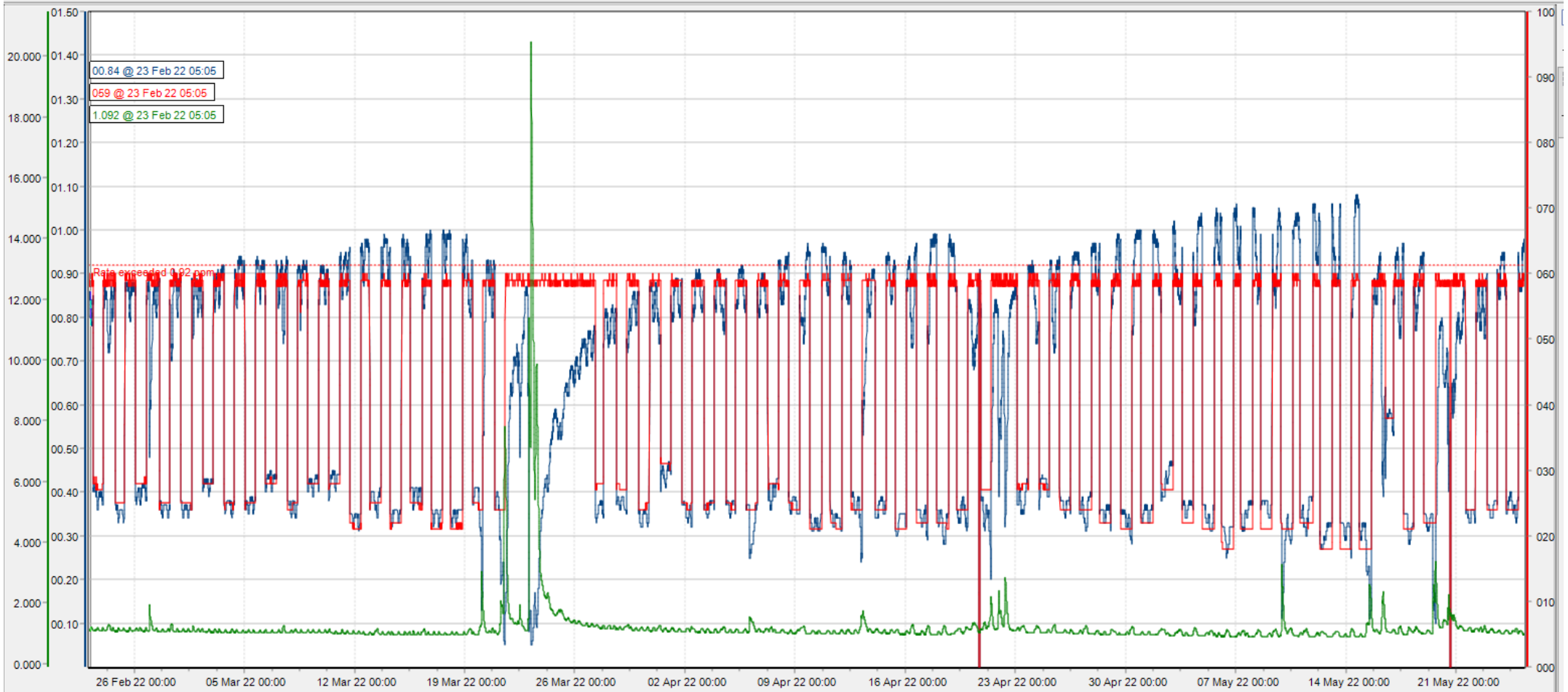
2012 – 2022 - TP vs Control Target, Alum Dose rate



UTUHINA DOSE RATE, DILUTION RATE, STREAM FLOW

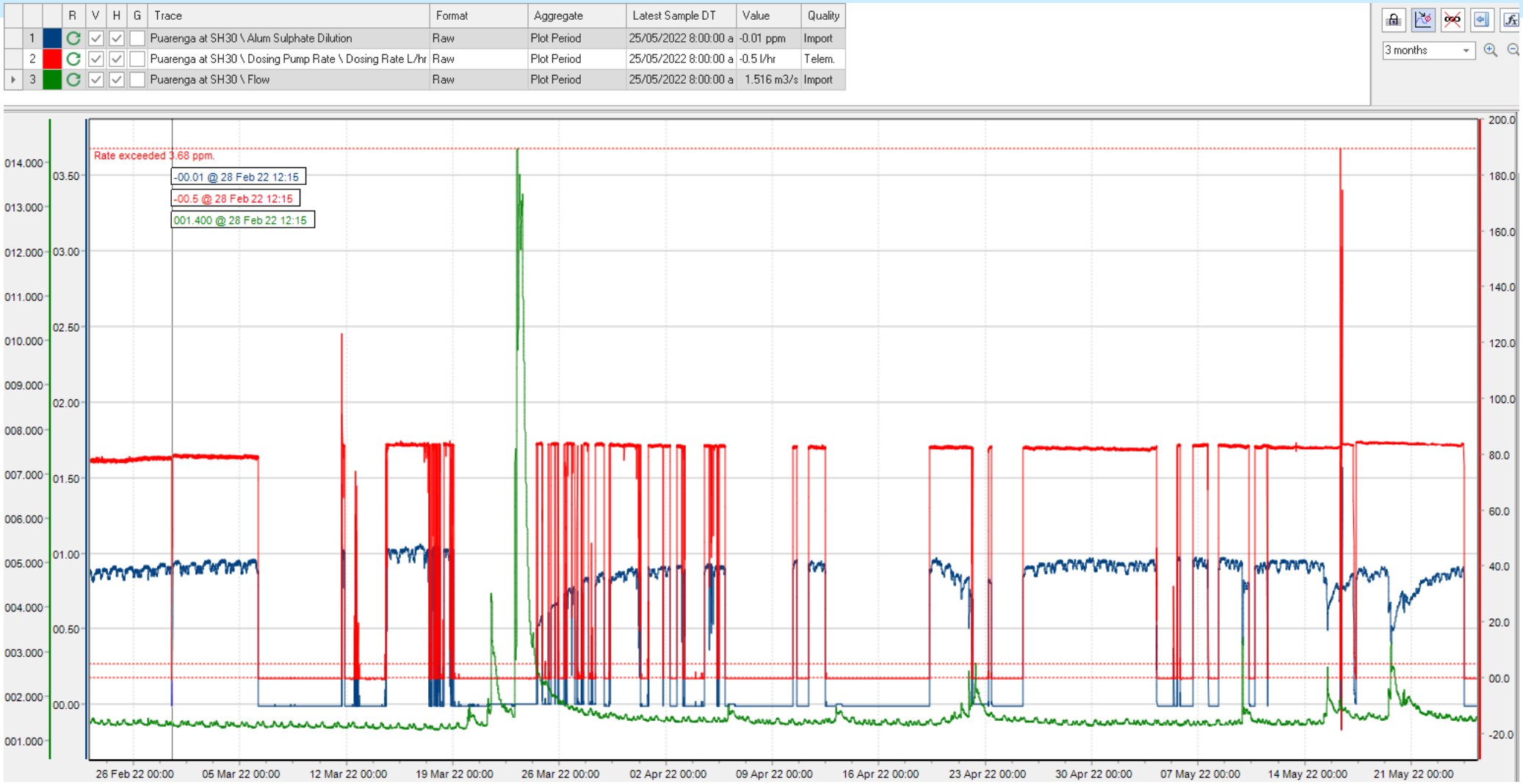
		R	V	H	G	Trace	Format	Aggregate	Latest Sample DT	Value	Quality
1		☑	☑	☑	☐	Utuhina at Depot St \ Alum Sulphate Dilution	Raw	Plot Period	25/05/2022 8:00:00 a	0.97 ppm	Import
2		☑	☑	☑	☐	Utuhina at Depot St \ Dosing Pump Rate \ Dosing Rate - L/hr	Raw	Plot Period	25/05/2022 8:00:00 a	59 l/hr	Telem.
3		☑	☑	☑	☐	Utuhina at Depot St \ Flow	Raw	Plot Period	25/05/2022 8:00:00 a	0.966 m3/s	Import

3 months



PUARENGA DOSE RATE, DILUTION RATE, STREAM FLOW

		R	V	H	G	Trace	Format	Aggregate	Latest Sample DT	Value	Quality
	1		✓	✓		Puarenga at SH30 \ Alum Sulphate Dilution	Raw	Plot Period	25/05/2022 8:00:00 a	-0.01 ppm	Import
	2		✓	✓		Puarenga at SH30 \ Dosing Pump Rate \ Dosing Rate L/hr	Raw	Plot Period	25/05/2022 8:00:00 a	-0.5 l/hr	Telem.
▸	3		✓	✓		Puarenga at SH30 \ Flow	Raw	Plot Period	25/05/2022 8:00:00 a	1.516 m3/s	Import

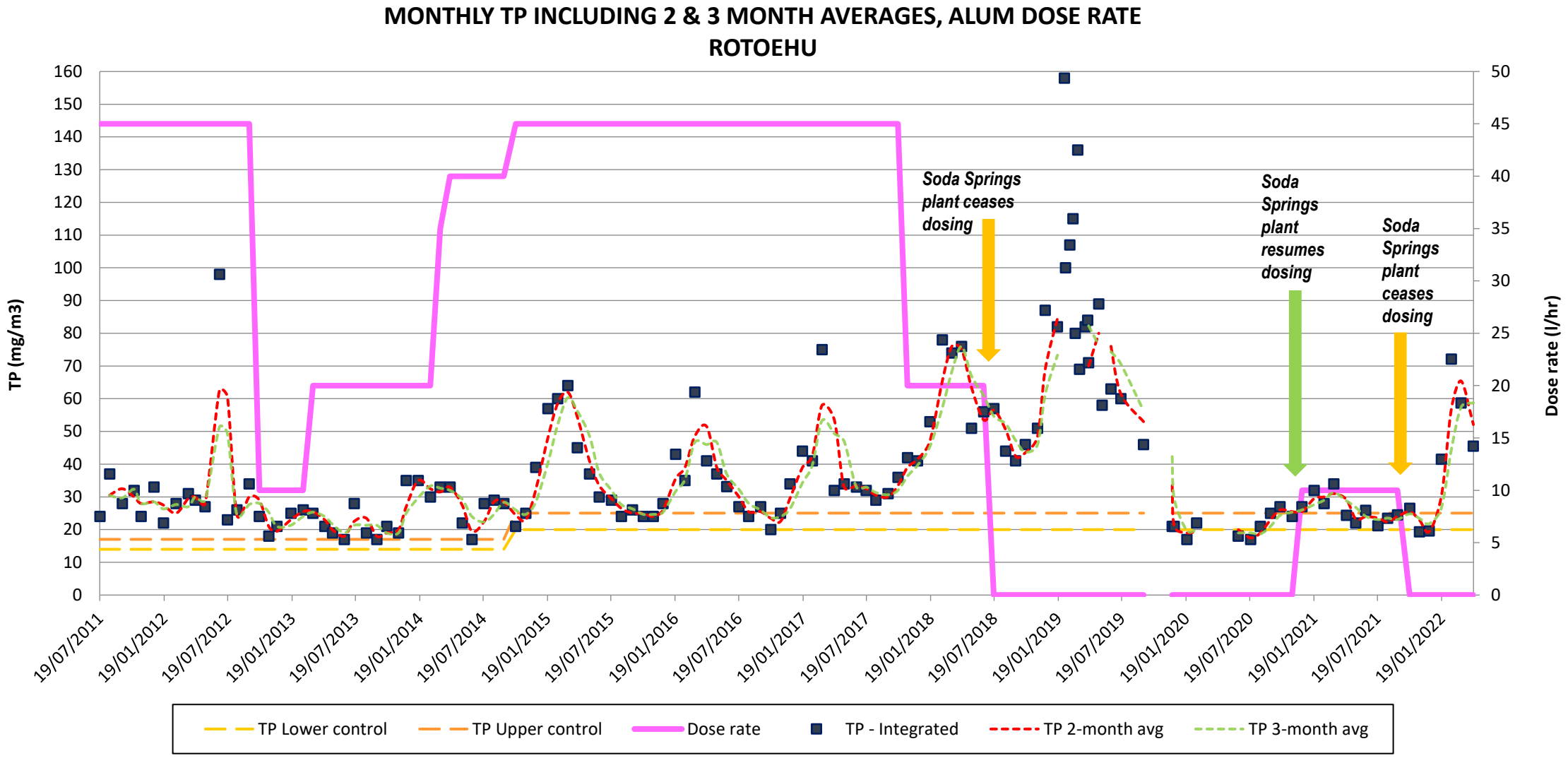


LAKE ROTORUA ALUM DOSING PROTOCOL

	Control Chart	Alum Dose Rate	Cumulative Alum Dose Rate	Explanation
Increase	Monthly average TP > 0.020 g/m^3	plus 10 L/hr	plus 10 L/hr	Use control chart in next tab and look at 1 month data compared with previous month
	Two monthly average TP > 0.020 g/m^3	plus 10 L/hr	plus 20 L/hr	Use control chart in next tab and look at 2 month data compared with previous month
	Three monthly average TP > 0.020 g/m^3	plus 10 L/hr	plus 30 L/hr	Use control chart in next tab and look at 3 month data compared with previous month
	TP trending upwards or static and the 3 statistics above TP > 0.020 g/m^3	plus 10 L/hr	plus 40 L/hr	This should only be considered if the month after all 3 monthly averages have past the upper control. This means the second consecutive month with all 3 monthly averages above and treading upward would constitute for the additional 10l/h.
Decrease	Monthly average TP < 0.017 g/m^3	reduce by 10 L/hr	reduce by 10 L/hr	Use control chart in next tab and look at 1 month data compared with previous month
	Two monthly average TP < 0.017 g/m^3	reduce by 10 L/hr	reduce by 20 L/hr	Use control chart in next tab and look at 2 month data compared with previous month
	Three monthly average TP < 0.017 g/m^3	reduce by 10 L/hr	reduce by 30 L/hr	Use control chart in next tab and look at 3 month data compared with previous month
	TP trending downward and the 3 statistics below TP < 0.017 g/m^3	reduce by 10 L/hr	reduce by 40 L/hr	This should only be considered if the month after all 3 monthly averages have fallen below the lower control. This means the second consecutive month with all 3 monthly averages below and treading downward would constitute for the additional 10l/h reduction.
Summer Protocol	**Changes to protocol**	**Occurs when?**		
	Start at 150 L/hr (combined dose)	1st November		Protocol further solidified at WQTAG on 11 Dec -2017 where it was agreed dosing will start at 150 L/hr on 1st Nov.
	Ignore protocols call to reduce dose rate	1st November - 1st April		It was discussed at WQTAG (2016-10-07) that due to the lag time as we approach summer the protocol may call for a reduction in dose rate in Nov-Jan and doesn't call for a dose rate increase until Feb-March. Because of this we may miss opportunities to control phosphorus or be more efficient with the product. It was agreed that if the protocol calls for a reduction in dose rate after Nov we would ignore until April.

LAKE ROTOEHU

2011–2022 - TP vs Control Target incl Alum Dose rate

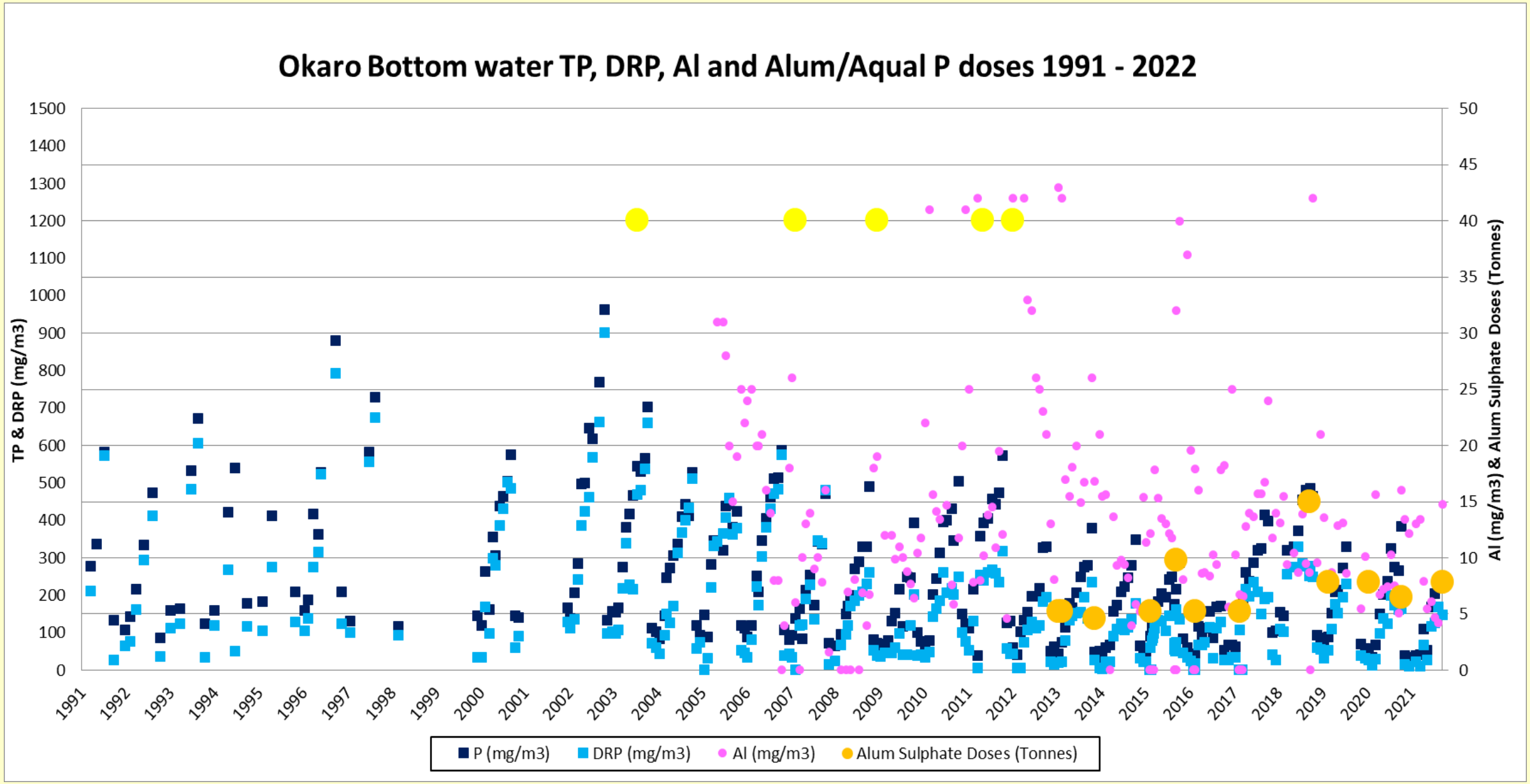


Lake Okaro Alum Dosing

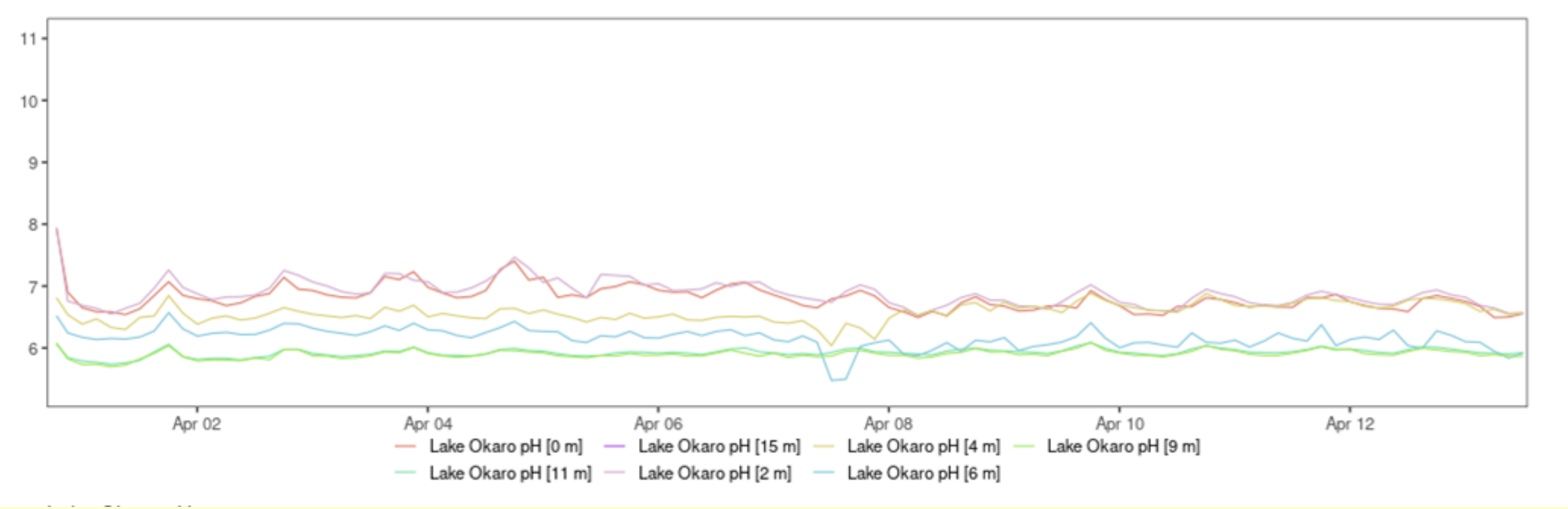
YEAR	MONTH	TONNES	APPLICATION	TOTAL FOR CONSENT YEAR	NOTES
2013	August	5.2	Surface		
	September	5.2	Surface		
2014	June	4.6	Injected	15	
2015	September	5.2	surface		
2016	April	9.8	Injected	15	
2016	September	5.2	Surface	5.2	
2017	September	5.2	Surface	5.2	
2019	April	15	Injected	15	
2019	September	7.8	Surface		
2020	April	0		7.8	COVID
2020	August	7.8	Surface		
2021	May	6.5	Surface	14.3	
2021	August	0			COVID
	April	7.8	Injected	7.8	

Consent allows for 15 tonnes of alum to be discharge to Lake Okaro over an annual period 1st August to 31st July

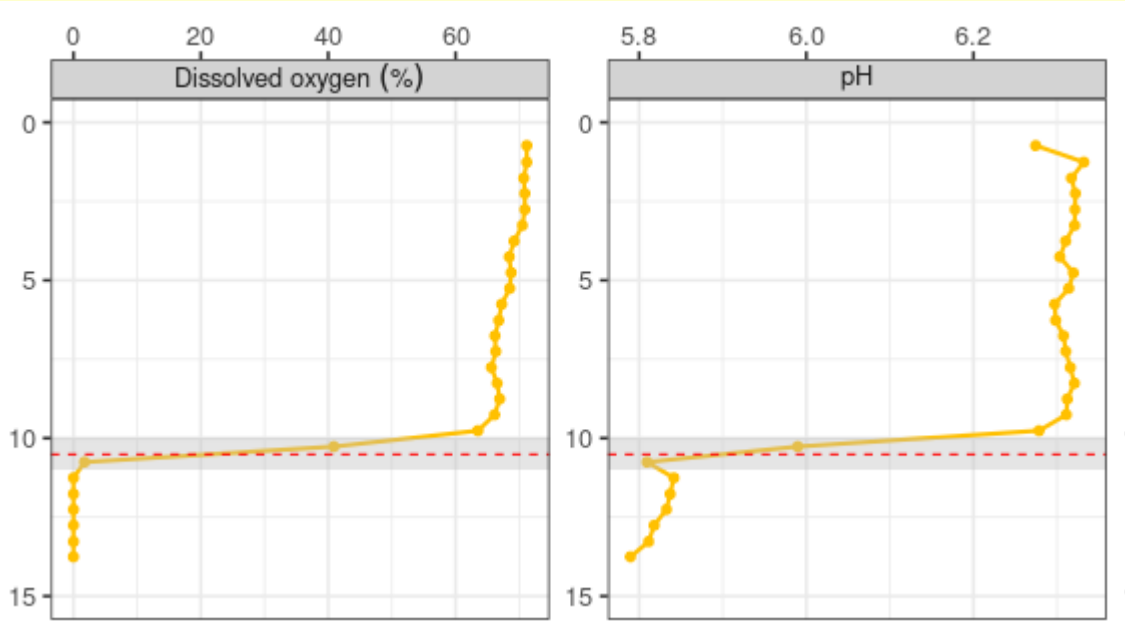
LAKE OKARO

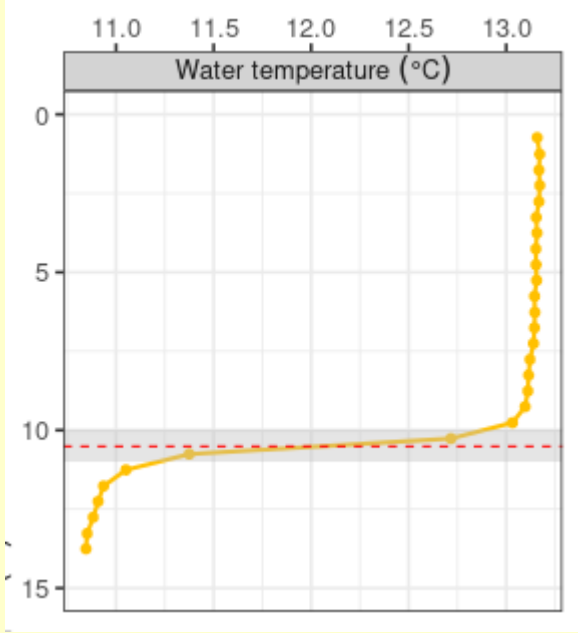

Okaro Bottom water TP, DRP, Al and Alum/Aqual P doses 1991 - 2022
TP & DRP (mg/m3)
Al (mg/m3) & Alum Sulphate Doses (Tonnes)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
0
5
10
15
20
25
30
35
40
45
50
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
P (mg/m3)
DRP (mg/m3)
Al (mg/m3)
Alum Sulphate Doses (Tonnes)

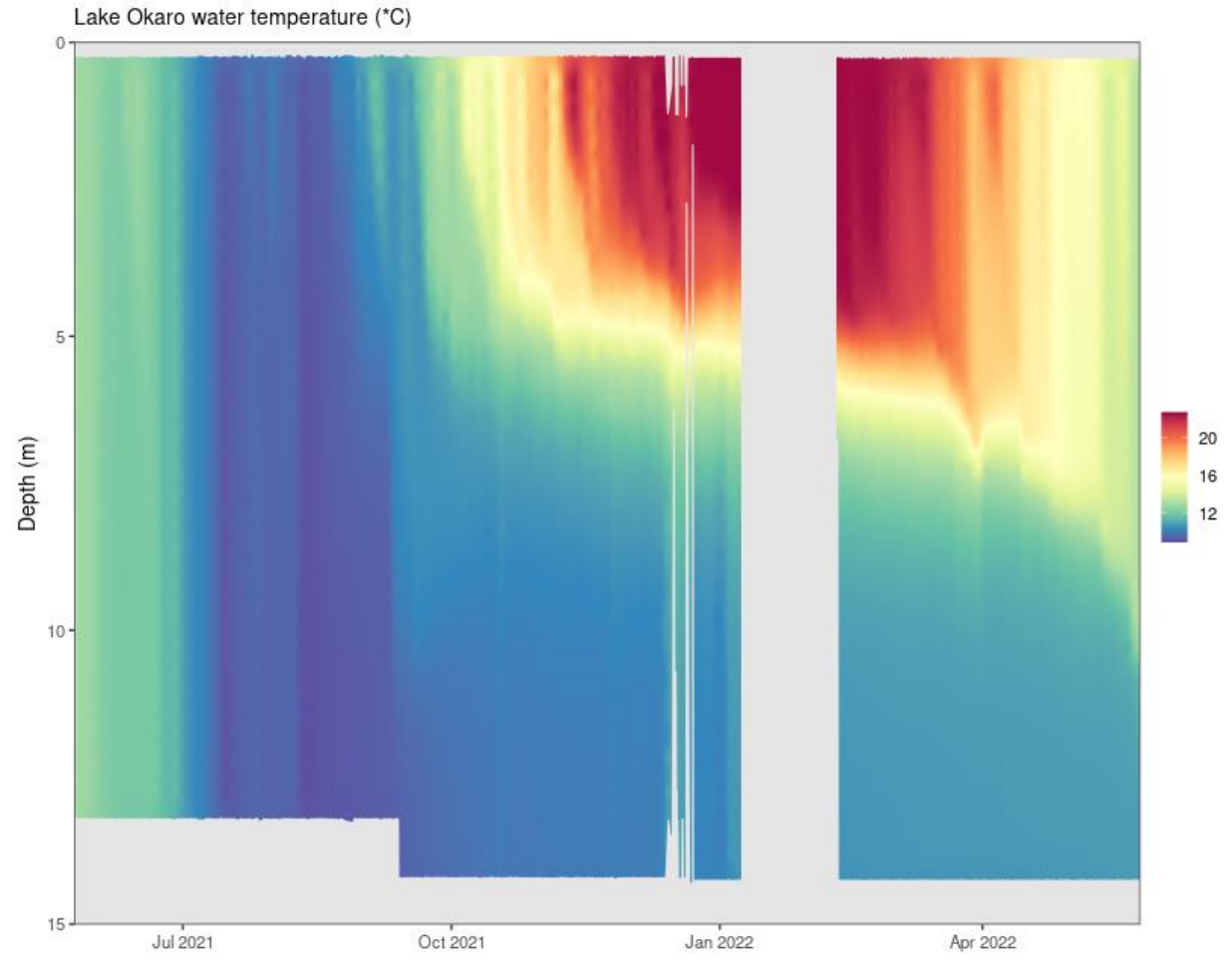
LAKE ŌKARO
pH after April Alum Dosing



LAKE ŌKARO
Buoy Data







WEED HARVESTING

Rotoehu 2022

- 4-week operation in March/April 2022 to remove Hornwort
- 296 weed harvester loads collected - estimated at 1036 tonnes
- Estimated nutrient removal based on 1036 tonnes removal:
  - P = 291.94 kgs
  - N = 1708.7 kgs
- 364 tonnes (semi-dewatered) transported and disposed of at vermicomposting facility in Taupo – all loads over weighbridge
- Estimated nutrient removal based on 364 tonnes removal:
  - P = 102.6 kgs
  - N = 600.3 kgs

WEED HARVESTING

Rotorua 2022

- 11 day operation in Feb/March 2022 to remove washed up weed after Cyclone Dovi
- 107 weed harvester loads collected - estimated at 375 tonnes
- Estimated nutrient removal based on 375 tonnes removal:
  - P = 83.6kgs
  - N = 870.5 kgs
- This operation was purely for amenity and access purposes only and the operation was undertaken in collaboration with RLC.

Summary of Lakeweed Harvesting in Lakes Rotorua, Rotoiti and Rotoehu 2006 - Present

LakeA3:R75	Year	Location	Contractor	Time of harvest	Number of days/hours worked		Method of weed removal	Reason for removal	Lakeweed species	Weight harvested	Disposal	Nutrient testing data used for calculations	Kg N removed	Kg P removed	Notes
Rotehu	2006	Te Wairoa near Soda Springs	Lake weed Harvesters & Contractors	15/08 - 21/08	48	hours	MRP weed harvester	Nutrient removal as part of the Lake Rotoehu Action Plan	Hornwort	135 tonnes	Weed removed out of the lake catchment to a site on Pongakawa Valley Rd.	Lakeweed tested: 4.0% DM, 3.0% N and 0.4% P (N and P DW basis)	162	21.6	Weed harvesting was carried out as a trial to establish costs for the removal of hornwort as a mechanism to remove N & P from the Rotoehu catchment.
	2008	Te Wairoa near Soda Springs	Lake weed Harvesters & Contractors	14/04 - 12/05 (4 weeks)	160	hours	MRP weed harvester	Nutrient removal as part of the Lake Rotoehu Action Plan	Hornwort	600 tonnes	Weed removed out of the lake catchment to Don Pamments property on Hamilton Rd.	2006 Lake Rotoehu weed harvest test results	720	96	
	2009	Te Wairoa near Soda Springs	Lake weed Harvesters & Contractors	30/03 - 20/05 (8 weeks)	320	hours	MRP weed harvester	Nutrient removal as part of the Lake Rotoehu Action Plan	Hornwort	3073.5 tonnes	Weed removed out of the lake catchment to Don Pamments property on Hamilton Rd.	2006 Lake Rotoehu weed harvest test results	3688.2	491.76	
	2010	Te Wairoa near Soda Springs	Lake weed Harvesters & Contractors	06/04 - 18/06 (10 weeks)	443	hours	MRP weed harvester	Nutrient removal as part of the Lake Rotoehu Action Plan	Hornwort	2744 tonnes	Weed removed out of the lake catchment to Don Pamments property on Hamilton Rd.	2006 Lake Rotoehu weed harvest test results	3292.8	439.04	
	2011	Te Wairoa near Soda Springs	Lake weed Harvesters & Contractors	17/03 - 30/05 (10 weeks)	400	hours	MRP weed harvester	Nutrient removal as part of the Lake Rotoehu Action Plan	Hornwort	3436 tonnes	≈1700 tonnes moved to Paengaroa for composting by Hortworx Ltd and ≈ 1800 tonnes transferred to Taumanu for vermicomposting.	2006 Lake Rotoehu weed harvest test results	4123.2	549.76	Removal of weed for composting/vermicomposting resulted in lower transport costs for the operation.
	2012	Te Wairoa near Soda Springs	Lake weed Harvesters & Contractors	16/04 - 21/05 (4 weeks)	160	hours	MRP weed harvester	Nutrient removal as part of the Lake Rotoehu Action Plan	Hornwort	1472 tonnes	Weed transferred within the catchment to Taumanu for vermicomposting.	2006 Lake Rotoehu weed harvest test results	1766.4	235.52	
	2013	Te Wairoa near Soda Springs	Rob Burrell Earthmoving Limited	17/04 - 24/05 (4 weeks)	234	hours	Two excavators (1 on barge, 1 on shoreline)	Nutrient removal as part of the Lake Rotoehu Action Plan	Hornwort	1622 tonnes	Weed removed and transported to a vermicomposting operation on Tautara Matawhaura Trust	2006 Lake Rotoehu weed harvest test results	1946.4	259.52	Costs per kg N removed were higher than those of previous years due to the change in harvesting methodology from using an aquatic weed harvester to using diggers.
	2014	Te Wairoa near Soda Springs	Lake weed Harvesters & Contractors	19/05 - 31/06 (6 weeks)	198	hours	BOPRC weed harvester	Nutrient removal as part of the Lake Rotoehu Action Plan	Hornwort	2926 tonnes	Composting at Ecocast Kawerau	2006 Lake Rotoehu weed harvest test results	3511.2	468.08	
	2015	Te Wairoa near Soda Springs	Lake weed Harvesters & Contractors	06/03 - 16/04 (6 weeks)	208	hours	BOPRC weed harvester	Nutrient removal as part of the Lake Rotoehu Action Plan	Hornwort	2882 tonnes	Composting at Ecocast Kawerau	2006 Lake Rotoehu weed harvest test results	3458.4	461.12	
	2016	Te Wairoa near Soda Springs	Lake weed Harvesters & Contractors	01/04 - 24/04 (3.5 weeks)	151.4	hours	BOPRC weed harvester	Nutrient removal as part of the Lake Rotoehu Action Plan	Hornwort	1228 tonnes	Composting at Ecocast Kawerau	2006 Lake Rotoehu weed harvest test results	1473.6	196.48	
	2021	Te Wairoa near Soda Springs	Lake weed Harvesters & Contractors	19/04 - 21/04 (5 weeks)	185.2	hours	BOPRC weed harvester	Nutrient removal as part of the Lake Rotoehu Action Plan	Nutrient removal as part of the Lake Rotoehu Action Plan	1981 tonnes (=3.5 x no. of harvester loads)	MyNoke Ltd, Taupo	Lakeweed tested - avg: 7.94% DM, 2.418% N, 0.342% P (N and P DW basis)	3803.31	537.94	All 32 loads over the weighbridge totalled **698.58 tonnes**. Weed samples taken on arrival at MyNoke Ltd = DM of 7.94%, **N removal is 1341 kg, and P removal is 189.7 kg** . Going forward, these removal rates are as close to actual as possible. Previously, the tonnages have been estimates based on harvester loads. However these are still
	2022	Te Wairoa near Soda Springs	Lake weed Harvesters & Contractors		16	days	BOPRC weed harvester	Nutrient removal as part of the Lake Rotoehu Action Plan	Hornwort	1036 tonnes (=3.5 x no. of harvester loads)	MyNoke Ltd, Taupo	Lakeweed tested - avg: 5.92% DM, 2.786% N, 0.476% P (N and P DW basis)	1708.69	291.94	All 20 loads over the weighbridge totalled 363.98 tonnes. Weed samples taken on arrival at MyNoke Ltd. Base on truck weights N removal is 600.3 kg, and P removal is 102.6 kg .
Rotehu totals:										**23135.3 tonnes**			**29654.2 kg N**	**4048.76 kg P**	

LakeA3:R75	Year	Location	Contractor	Time of harvest	Number of days/hours worked		Method of weed removal	Reason for removal	Lakeweed species	Weight harvested	Disposal	Nutrient testing data used for calculations	Kg N removed	Kg P removed	Notes
Rotorua	2020	Lake Front	Lake weed Harvesters & Contractors and RLC Contractors	8-9 July	2	days	BOPRC weed harvester	Weed washed up on to lakefront area after storm affecting business access, aquatic life, and amenity values	Lagarosiphon, Egeria, Elodea	80 tonnes (no. of harvester loads x 3.5)	RLC Sanatorium reserve near WWTP	Lakeweed tested - avg: 5.83% DM, 3.99% N, 0.38% P (N and P DW basis)	185.7	17.8	Main reason for the harvesting was amenity and access rather than nutrient removal.
	2022	Lake Front	Lake weed Harvesters & Contractors and RLC Contractors	17 Feb - 3 March	11	days	BOPRC weed harvester	Extensive weed washed up on to lakefront area after storm affecting business access, aquatic life, and amenity values	Lagarosiphon, Egeria, Elodea	375 tonnes (no. of harvester loads x 3.5)	RLC Sanatorium reserve near WWTP	2020 Rotorua Lakeweed harvest test results	870.5	83.6	Main reason for the harvesting was amenity and access rather than nutrient removal.
Rotorua totals:										**455 tonnes**			**1056.2 kg N**	**101.4 kg P**	
Rotoiti	2009	Okawa Bay	Lake weed Harvesters & Contractors	23/03 - 30/03	6 days (50 hrs)		MRP weed harvester	Pre-empt and remove lakeweed strandings from the bay (surface reaching weed has caused amenity	**Hornwort.** Also present: Lagarosiphon,	125.5 tonnes	Dump site out of the lake catchment located off SH 33	Lakeweed tested: 4.3% DM, 3.42% N and 7320mg/kg P (N and P	184.5	39.5	
	2010	Okawa Bay	Lake weed Harvesters & Contractors	11/03 - 17/03	6	days	MRP weed harvester	Pre-empt and remove lakeweed strandings from the bay (surface reaching weed has caused amenity	**Hornwort.** Also present: Lagarosiphon,	145 tonnes	Composting site outside of the lake catchment	2009 Okawa Bay weed harvest test results	223.2	47.76	Higher densities of weed were present which increased the efficiency and decreased the cost per kg N removed.
	2014	Okawa Bay	Lake weed Harvesters & Contractors	after Lake Rotoehu harvest completed	5	days	BOPRC weed harvester	Heavy strandings of Hornwort towards the end of the summer season, pressure from Okawa Bay	**Hornwort.** Also present: Lagarosiphon,	110 tonnes	Composting at Ecocast Kawerau	Lakeweed from Okawa Bay tested Apr 2014: 2.9% DM, 3.9% N and	124.41	12.44	
	2015	Okawa Bay	Lake weed Harvesters & Contractors	02/03 - 05/03	4	days	BOPRC weed harvester	Pre-empt and remove lakeweed strandings from the bay (surface reaching weed has caused amenity	**Hornwort.** Also present: Lagarosiphon,	99 tonnes	Composting at Ecocast Kawerau	2009 Okawa Bay weed harvest test results	145.59	31.16	
	2016	Okawa Bay	Lake weed Harvesters & Contractors	Feb/Mar/Apr (2 harvesting periods)	291.4	hours	BOPRC weed harvester	Pre-empt and remove lakeweed strandings from the bay (surface reaching weed has caused amenity	**Hornwort**. Also present: Lagarosiphon, Egeria & Myriophullum	1,354.6 tonnes	Composting at Ecocast Kawerau	2009 Okawa Bay weed harvest test results	1992.07	426.37	Cost substainally lower per kg N removed due to the weed harvested from Wairau Bay not being transported for disposal.
		Wairau Bay						Clear weed from beach site used for the wooden boat parade vessels to park		140 tonnes	Weed stacked on shoreline (no take out point to remove the weed)		205.88	44.07	
		Te Weta Bay	Lake weed Harvesters & Contractors	March	49.3	hours	BOPRC weed harvester	Pre-empt and remove lakeweed strandings from the bay (surface reaching weed has caused amenity	**Hornwort.** Also present: Lagarosiphon,	208 tonnes	Composting at Ecocast Kawerau	2009 Okawa Bay weed harvest test results	306	65.47	
	2017	Wairau Bay	Lake weed Harvesters & Contractors	1-Feb	1	day	BOPRC weed harvester	Clear weed from the beach site where the wooden boat parade was to be held	**Hornwort.** Also present: Lagarosiphon,	10 tonnes	Weed was pushed to the shore and raked up onto the beach by volunteers.	2009 Okawa Bay weed harvest test results			Main reason for the harvesting was amenity and access rather than nutrient removal.
Rotoiti totals:										**2192.1 tonnes**			**3181.65 kg N**	**666.77 kg P**	
Weed harvesting operation totals:										**25782.4 tonnes**			**33892.05 kg N**	**4816.93 kg P**	
										25.78 kilotonnes			**33.89 tonnes N**	**4.82 tonnes P**	

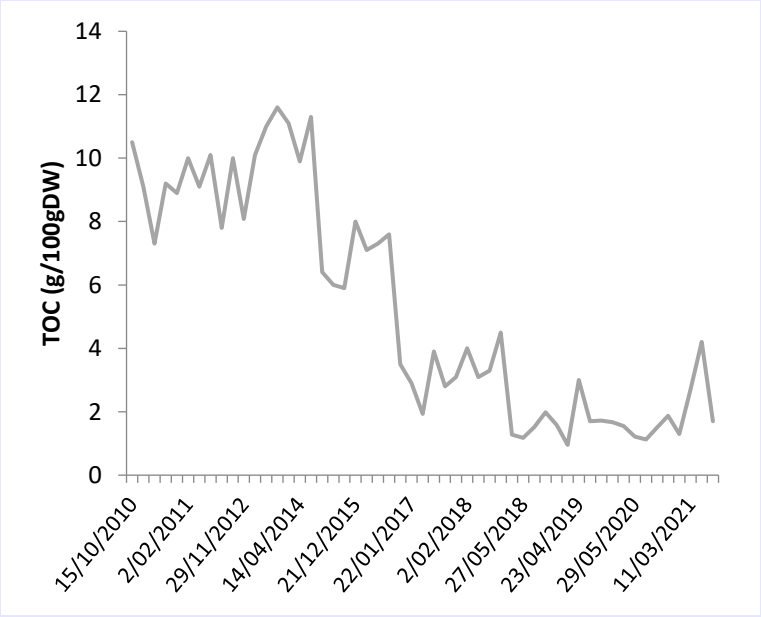
LAKE ROTOEHU
Ōtautū Bay Biotreatment

- Has been undertaken in the bay since 2011 for the purpose of improving water quality in the bay.
- Non-toxic sediment and nutrient digesters (natural soil and water bacteria) is applied to the bay to help break down organic plant and sediment material in the bottom waters.
- Monthly consented bacteria application limit is 2.1×10^{14} cells.
- Currently using 'MuckBiotics' pellets containing Bacillus bacteria. In the past have used various other products such as 'sludge bombs', and liquid products such as Aquaboost and SL 1000-0024 Support.
- Applied from Dec thru May each year
- Monthly sediment samples collected before each application
- Consent expires 31 Dec 2025 so the last possible treatment season is Dec 2024 – May 2025 (so 3 more seasons).

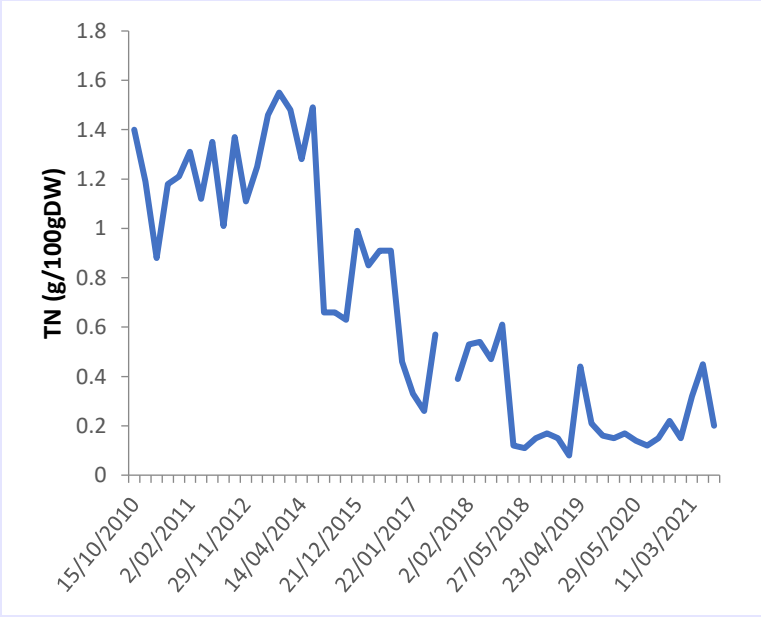
Ōtautū Bay Biotreatment – Sediment Results

- Since approximately 2018 results have started to plateau
- Although sediment condition appears to have improved, the bay is still impacted by lake-wide algal blooms.
- What is the TAG's thoughts on continuing with the Biotreatment programme? Costs are approx. around $25K per season

TOTAL ORGANIC CARBON



TOTAL NITROGEN



TOTAL PHOSPHORUS