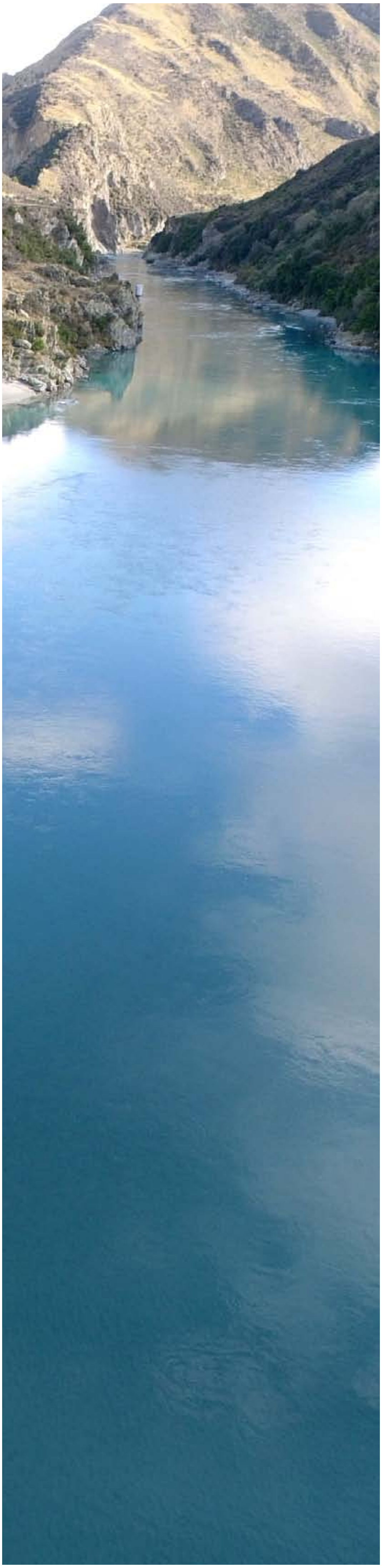

Rangitata Diversion Race Management Limited

Proposed Fish Screen for the RDR: Assessment on Rangitata River Water Quality and Aquatic Ecology

November 2017

Ryder Environmental Ltd

Rangitata Diversion Race Management Limited

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Prepared for HOBEC Lawyers on behalf of the Rangitata Diversion Race Management Limited

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1 Background

Rangitata Diversion Race Management Limited ('RDRML') owns and operates the Rangitata Diversion Race ('RDR'), which is a canal that conveys water abstracted from the Rangitata River. The abstracted water is used for stock water drinking, irrigation and hydro generation purposes. RDRML have lodged resource consent applications to, amongst other things, build a large storage reservoir that would store water derived from the Rangitata River (the Klondyke Water Storage Project). Part of the proposal includes an application to take an additional 10 m^3/s (or cumecs) of Rangitata River water under high flow conditions.

The current maximum intake of Rangitata River to the RDR is 35.7 m^3/s and consists of 30.7 m^3/s for irrigation and hydropower generation, 0.7 m^3/s for the existing fish screen bypass (but up to 3 m^3/s for the October 2010 to November 2015), 1.5 m^3/s for an individual farmer and 0.5 m^3/s for Managed Aquifer Recharge (MAR) (PDP 2017). The Klondyke Water Storage Project would add an additional 10 m^3/s for taking water under high flow conditions. At the time of writing, the maximum take for the BAFF bypass flow is 0.7 m^3/s, however RDRML is currently applying to revert the maximum BAFF bypass take back to 3 m^3/s. It is understand that this variation should be approved shortly by Environment Canterbury.

A new fish screen was proposed as part of the Klondyke Water Storage Project. That fish screen, which is to replace the existing bioacoustic fish fence ('BAFF'), consisted of a gallery and rock bund and was situated downstream of the sand trap on the RDR. As a consequence of the submissions lodged to the Klondyke Water Storage Project, RDRML has revisited the design and location of the proposed new fish screen. As with the existing BAFF, and the proposed rock bund fish screens, the objective of the new fish screen is to restrict the movement of fish down the RDR system, and return them safely back to the Rangitata River.

Associated with the new fish screen fish will be a new bypass back to the Rangitata River. The design concept for the new fish screen requires up to 5 m^3/s for the bypass flow, which represents an additional 2 m^3/s (as noted above a 0.7 m^3/s bypass flow is taken for the BAFF, but has been as high as 3 m^3/s), resulting in a total maximum abstraction rate of 47.7 m^3/s and 42.7 m^3/s in the RDR downstream of the proposed fish screen.

The distance of river length affected by the additional bypass flow (i.e., the distance between the RDR intake and fish screen bypass return flow to the river) is approximately 1.38 km. This section of river affected by RDR abstraction (referred to as the 'affected reach'), and the new fish screen bypass return flow, are shown in Figure 1. The bypass would return water back to the river approximately 1 km further upstream relative to where the existing BAFF bypass return flow discharges.

This report assesses the potential effects of this additional bypass flow discharge (from 0.7 m^3/s, between the period September to January, to a maximum of 5 m^3/s year round) on the ecology and water quality of the Rangitata River. Reasons for the proposed increase in fish screen bypass flow are described by Riley (2017), but essentially it is required to ensure that a strong current is maintained past the entire length of fish screen material (likely to be in the order of 100 m long) to ensure fish are carried towards the bypass entrance. This is referred to as the 'sweep velocity' and is a key factor in a well performing fish screen system. If the sweep velocity is too low at any point along the fish screen, it increases the risk of fish being attracted by the flow of water through the screen face and, in doing so, the risk of impingement against the screen face is increased.

The additional water is also required to ensure that the risk of fine sediment build-up on the floor of the canal in front of the fish screen is minimised. Maintaining a strong current in this section of the canal will enable fine sediment that cannot pass through the screen face to be carried on through to the bypass and returned back to the Rangitata River (Riley 2017).

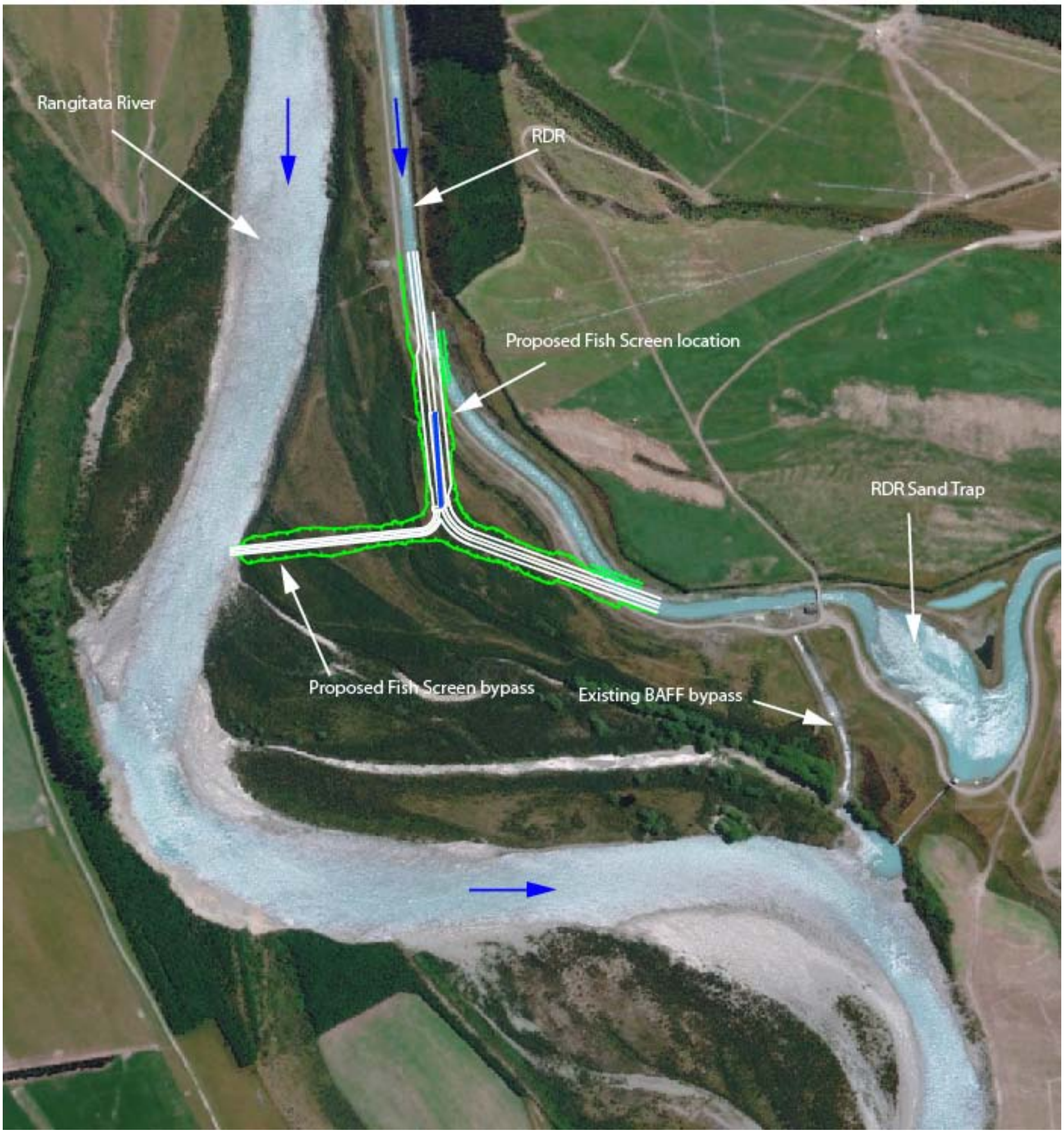

Figure 1. Location of the proposed fish screen and associated fish bypass channel in relation to the Rangitata River and existing BAFF bypass channel.

The anticipated changes in flows associated with RDR abstraction rates, fish bypass return flows, and Rangitata River flows downstream, are presented below in tables 1 (700 l/s bypass flow) and 2 (3 m^3/s bypass flow). Note that the table shows intake flows compared to the (upstream) river flow at the Klondyke recorder and river flows immediately downstream of the RDR intake but upstream of the BAFF bypass discharge (the 'Affected Reach'). Table 1 also takes into account RDRML's proposed taking of an additional 10 m^3/s during high river flows for irrigation as a part of the Klondyke storage pond proposal.

Table 1. Existing and proposed fish bypass flow regimes in relation to Rangitata River flows and RDR abstraction rates. Existing Scenario - current consented environment and existing fish bypass flow (0.7 m³/s from 10 September to 31 January only). Proposed Scenario - current consented environment plus 10 m³/s flood flow take and proposed stepped fish bypass flows. Existing Scenario - current consented environment and existing fish bypass flow (700 L/s from 10 September to 31 January only) Natural Scenario - flows given by Rangitata @ Klondyke flow recorder with no abstractions. (Data supplied by Bas Veendrick, PDP).

Rangitata @ Klondyke Flows (m³/s)	Fish Bypass Flow		Total RDR Intake		Residual Flow in Affected Reach	
	Existing	Proposed (bypass flow as % of abstraction rate)	Existing	Proposed	Existing	Proposed
EXISTING FLOW REGIME (1 SEPTEMBER TO 31 MAY)						
Above 142.6	0.7	5.0 (12%)	32.7	42.7	Above 107.7	Above 93.4
At 142.6	0.7	5.0 (12%)	32.7	42.7	107.7	93.4
At 132.6	0.7	4.0 (12%)	32.7	32.7	97.7	94.4
Above 64.0	0.7	3.0 (10%)	31.2	31.2	Above 32.1	Above 29.8
60.1 - 64.0	0.7	3.0 (10%)	31.2	31.2	28.2 - 32.1	25.9 - 29.8
50.1 - 60.0	0.7	3.0 (11%)	26.7	26.7	22.7 - 32.6	20.4 - 30.3
43.1 - 50.0	0.7	3.0 (13%)	22.3	22.3	20.1 - 27.0	17.8 - 24.7
40.1 - 43.0	0.7	3.0 (15%)	19.4	19.4	20.0 - 22.9	17.7 - 20.6
38.1 - 40.0	0.7	3.0 (17%)	17.4	17.4	20.0 - 21.9	17.7 - 19.6
36.1 - 38.0	0.7	3.0 (19%)	15.4	15.4	20.0 - 21.9	17.7 - 19.6
34.1 - 36.0	0.7	3.0 (22%)	13.4	13.4	20.0 - 21.9	17.7 - 19.6
32.1 - 34.0	0.7	3.0 (26%)	11.4	11.4	20.0 - 21.9	17.7 - 19.6
EXISTING FLOW REGIME (1 JUNE TO 31 AUGUST)						
Above 142.6	0.0	5.0 (12%)	32.7	42.7	Above 108.4	Above 93.4
At 142.6	0.0	5.0 (12%)	32.7	42.7	108.4	93.4
At 132.6	0.0	4.0 (12%)	32.7	32.7	98.4	94.4
Above 64.0	0.0	3.0 (10%)	31.2	31.2	Above 32.8	Above 29.8
60.1 - 64.0	0.0	3.0 (10%)	31.2	31.2	28.9 - 32.8	25.9 - 29.8
50.1 - 60.0	0.0	3.0 (11%)	27.0	27.0	23.1 - 33.0	20.1 - 30.0
40.1 - 50.0	0.0	3.0 (14%)	22.0	22.0	18.1 - 28.0	15.1 - 25.0
38.1 - 40.0	0.0	3.0 (13%)	22.5	22.5	15.6 - 17.5	12.6 - 14.5
36.1 - 38.0	0.0	3.0 (15%)	20.5	20.5	15.6 - 17.5	12.6 - 14.5
34.1 - 36.0	0.0	3.0 (16%)	18.5	18.5	15.6 - 17.5	12.6 - 14.5
32.1 - 34.0	0.0	3.0 (18%)	16.5	16.5	15.6 - 17.5	12.6 - 14.5
30.1 - 32.0	0.0	3.0 (21%)	14.5	14.5	15.6 - 17.5	12.6 - 14.5

Table 2. Existing and proposed fish bypass flow regimes in relation to Rangitata River flows and RDR abstraction rates. Existing Scenario - current consented environment and anticipated fish bypass flow (3 m³/s from 10 September to 31 January only). Proposed Scenario - current consented environment plus 10 m³/s flood flow take and proposed stepped fish bypass flows. Natural Scenario - flows given by Rangitata @ Klondyke flow recorder with no abstractions. (Data supplied by Bas Veendrick, PDP).

Rangitata @ Klondyke Flows (m³/s)	Fish Bypass Flow			Total RDR Intake		Residual Flow in Affected Reach	
	Existing	Proposed (bypass flow as % of abstraction rate)		Existing	Proposed	Existing	Proposed
EXISTING FLOW REGIME (1 SEPTEMBER TO 31 MAY)							
Above 142.6	3.0	5.0	(12%)	32.7	42.7	Above 105.4	Above 93.4
At 142.6	3.0	5.0	(12%)	32.7	42.7	105.4	93.4
At 132.6	3.0	4.0	(12%)	32.7	32.7	95.4	94.4
Above 64.0	3.0	3.0	(10%)	31.2	31.2	Above 29.8	Above 29.8
60.1 - 64.0	3.0	3.0	(10%)	31.2	31.2	25.9 - 29.8	25.9 - 29.8
50.1 - 60.0	3.0	3.0	(11%)	26.7	26.7	20.4 - 30.3	20.4 - 30.3
43.1 - 50.0	3.0	3.0	(13%)	22.3	22.3	17.8 - 24.7	17.8 - 24.7
40.1 - 43.0	3.0	3.0	(15%)	19.4	19.4	17.7 - 20.6	17.7 - 20.6
38.1 - 40.0	3.0	3.0	(17%)	17.4	17.4	17.7 - 19.6	17.7 - 19.6
36.1 - 38.0	3.0	3.0	(19%)	15.4	15.4	17.7 - 19.6	17.7 - 19.6
34.1 - 36.0	3.0	3.0	(22%)	13.4	13.4	17.7 - 19.6	17.7 - 19.6
32.1 - 34.0	3.0	3.0	(26%)	11.4	11.4	17.7 - 19.6	17.7 - 19.6
EXISTING FLOW REGIME (1 JUNE TO 31 AUGUST)							
Above 142.6	0.0	5.0	(12%)	32.7	42.7	Above 108.4	Above 93.4
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40.1 - 50.0	0.0	3.0	(14%)	22.0	22.0	18.1 - 28.0	15.1 - 25.0
38.1 - 40.0	0.0	3.0	(13%)	22.5	22.5	15.6 - 17.5	12.6 - 14.5
36.1 - 38.0	0.0	3.0	(15%)	20.5	20.5	15.6 - 17.5	12.6 - 14.5
34.1 - 36.0	0.0	3.0	(16%)	18.5	18.5	15.6 - 17.5	12.6 - 14.5
32.1 - 34.0	0.0	3.0	(18%)	16.5	16.5	15.6 - 17.5	12.6 - 14.5
30.1 - 32.0	0.0	3.0	(21%)	14.5	14.5	15.6 - 17.5	12.6 - 14.5

2 Key Issues

2.1 Physical character

The additional water for the new fish screen will be taken from the river at the existing RDR intake structure. No changes to this intake are proposed. The outfall of the bypass at the river channel will be constructed largely as an open channel. The outlet to the river will be framed by rocks and other material similar to the gravels found in the main river fairway, and will require some erosion protection in the form of rocks (Riley 2017). The footprint associated with the outlet area of the bypass will be small compared to the width of the river. Construction will result in local disturbance of the bank and wetted edge on the true left side. Any resident fish species are likely to quickly move away from the area once construction and disturbance commences. Some small benthic dwelling fish (e.g., bullies) may be destroyed by habitat disturbance is they unable to quickly move away. Benthic invertebrates in disturbed areas may drift downstream or be destroyed. Recolonisation of invertebrate communities in braided rivers is rapid and likely to be largely complete within one month, although flood flow conditions can prolong recolonization. Bullies are also able to quickly recolonise new habitat.

The main physical change to the river will be the taking of more water at the higher abstraction rates as set out in tables 1 and 2. As flows in the affected reach reduce, either naturally or as a result of abstraction, there are likely to be changes to the wetted width, water depth and water velocity. The exact changes to these physical dimensions as flow reduces depends on the channel profile and factors such as slope, channel alignment, cross-sectional profile and substrate size and distribution.

The affected reach is a single channel that has a relatively gentle curve from the intake for approximately 950 m before then running relatively straight for another 450m where the bypass outfall would be positioned (Figure 2).

Instream habitat in the affected reach is characterised largely by runs interspersed with riffles. Large boulders are present throughout the reach and these along with cobbles become more prominent in the riffle areas. The banks and beach areas are all cobbled. The end of the reach ends with a riffle that drops into a pool that flows almost a right angles to the affected reach. This change in direction is caused by the presence of a cliff formation situated immediately downstream of the affected reach, forcing the river to change direction. These characteristics are shown in figures 4, 5 and 6.

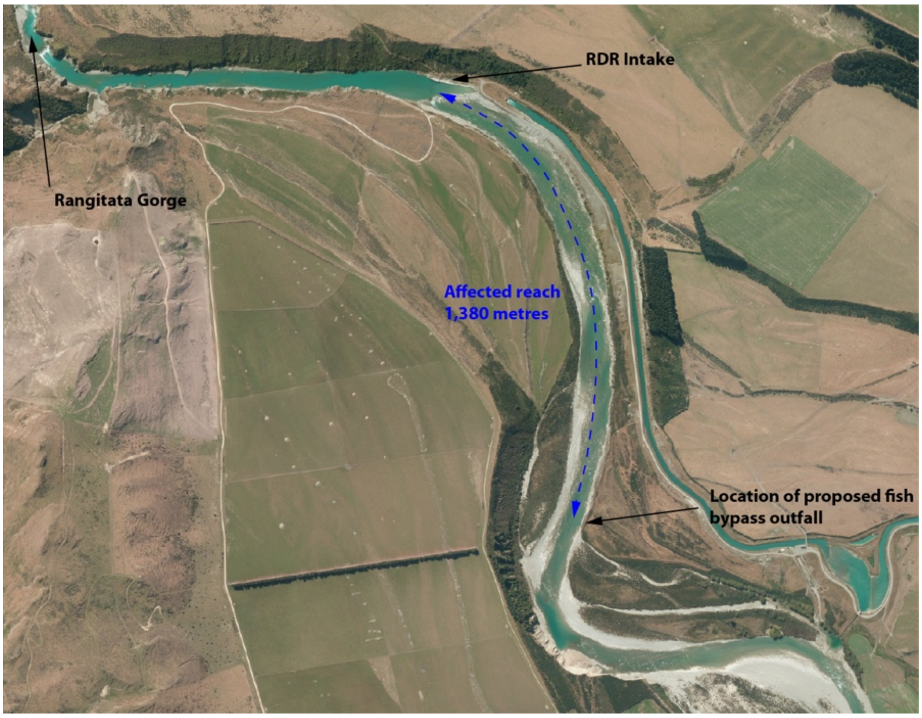

Figure 2. *Aerial showing the general shape of the Rangitata River reach affected by the proposed fish bypass flows. Canterbury 0.4m Rural Aerial Photos (2012-2013). License: Creative Commons Attribution 3.0 New Zealand.*

Average wetted width of the affected reach under normal flows is approximately 72 m. This is similar to the width of the river at the single channel Arundel determined by Jowett using a 1-D IFIM approach (Jowett 1998) (Figure 3).

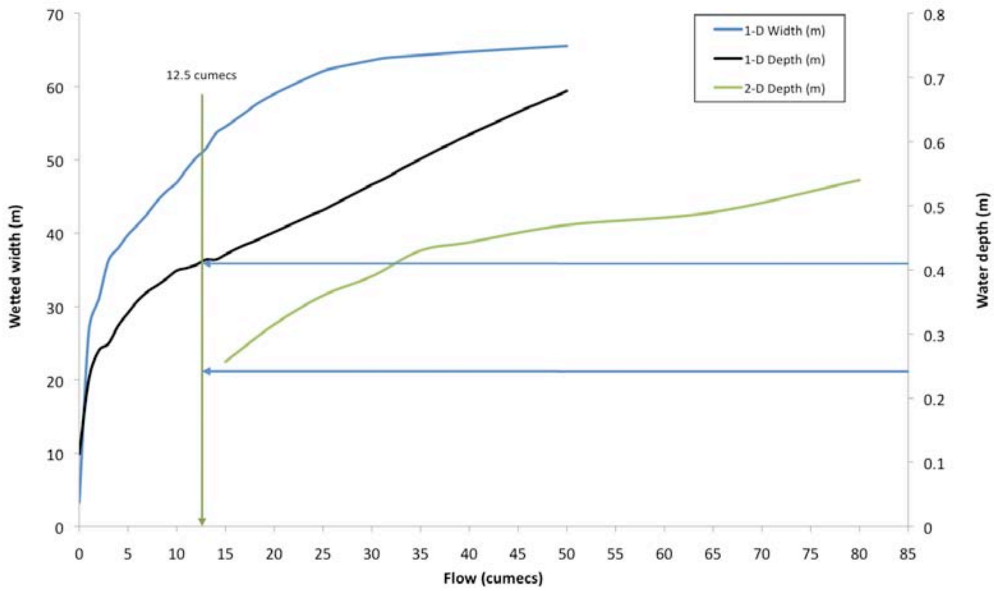

Figure 3 *Relationships between flow and modelled wetted width and water depth at the single channel Arundel reach based on 1-D (Jowett 1998) and 2-D surveys (Duncan and Hicks 2001) and associated modelling.*

Predicted water depths at low flows (12.5 – 20 cumecs) in single channel reaches of the Rangitata River range between approximately 0.22 and 0.41 m (Figure 3).

2.2 Instream habitat

2.2.1 General

Assessments of aerial photos under various flow conditions indicate that the general physical character of the affected reach does not change appreciably between flows of approximately 20 and 65 cumecs. Riffles sections become more noticeable with large boulders becoming more prominent, however instream habitat does not change greatly (riffles remain as riffles and runs remain as runs).

Jowett (1998 and in evidence presented at the Rangitata Water Conservation Order hearing) presented information on the maximum utilisation of instream habitat in single channel reaches of the Rangitata River, using 1-D instream habitat modelling. Apart from salmon angling, flows for maximum utilisation of habitat for salmonids and food production were 25 cumecs or less (Table 2).

Changes in the amount of potential instream habitat for food production and fish species are minor for flow changes of plus or minus 5 cumecs, particularly in flows above 30 cumecs, when the affected reach is most affected by additional abstraction for the fish bypass. No habitat would be lost for fish species potentially resident in the affected reach, or for food production, at flows as low as 15 cumecs, which would occur only rarely in the affected reach under the proposed RDR abstraction incorporating additional water for the new fish screen bypass.

Table 2 Flows (m^3/s) that provide the maximum utilisation of habitat (WUA%) in single channel reaches (from Jowett 1998 and Duncan & Hicks 2001). Reproduced from Ian Jowett's evidence presented at the Rangitata Water Conservation Order.

Use	Rangitata River (m^3/s) Single channel reaches
Salmon angling	50
Juvenile salmon and yearling brown trout	5
Adult brown trout	10
Food production	25

Affected reach, approximately 450 metres downstream of the RDR intake

12 October 2017 Flow = 62 cumecs

13 October 2017 Flow = 57.6 cumecs

17 October 2017 Flow = 49.5 cumecs

19 October 2017 Flow = 47.5 cumecs

Figure 4 Aerial views of the Rangitata River approximately 450 m downstream of the RDR intake, October 2017.

Affected reach, approximately 730 metres downstream of the RDR intake

12 October 2017 Flow = 62 cumecs

13 October 2017 Flow = 57.6 cumecs

17 October 2017 Flow = 49.5 cumecs

19 October 2017 Flow = 47.5 cumecs

Figure 5 Aerial views of the Rangitata River looking downstream, approximately 730 m downstream of the RDR intake, October 2017.

Affected reach, approximately 1,250 metres downstream of the RDR intake

12 October 2017 Flow = 62 cumecs

13 October 2017 Flow = 57.6 cumecs

17 October 2017 Flow = 49.5 cumecs

19 October 2017 Flow = 47.5 cumecs

Figure 6 Aerial views of the Rangitata River looking downstream, approximately 1,250 m downstream of the RDR intake, October 2017.

2.2.2 Fish passage

Adult salmon have the greatest water depth requirements for passage. Adult salmon upstream migration occurs on average January - April/May, so the relevant flow statistics are those in the 1 September to 31 May period (tables 1 and 2).

The Arundel reach can be regarded as a conservative surrogate (in terms of physical character) for the reach affected by the proposed RDR fish screen bypass flow. Based on the relationship between flows and water depths at the Arundel reach, there should be adequate water depth for adult salmon and trout passage within this reach for flows down to 15 cumecs. It should be noted here that flows in the affected reach would not drop below 17.7 cumecs during the adult salmon migration season as a result of RDR abstractions, including water for the fish screen bypass.

The 2-D habitat survey and associated modelling by NIWA included the Arundel reach of the river, which was dominated by a single large braid, and considered to be more or less a single channel (Duncan & Hicks 2001). At the lowest flow assessed in the 2-D modelling (15 cumecs), the average water depth was 0.26 m and the analysis showed that continuous passage for salmon (water depth >0.24 m) was provided for (Figure 7).

Further, salmon and other fish species often migrate upstream in response to freshes. An analysis of natural flow variations in the Rangitata River, and flow variations under the current level of abstraction and with the additional abstraction required for the proposed RDR fish screen bypass, shows that freshes will be unaffected in frequency relative to the existing situation while the magnitude of flows greater than the median flow will reduce by between approximately 3.5 and 12 % (figures 8, 9 and 10).

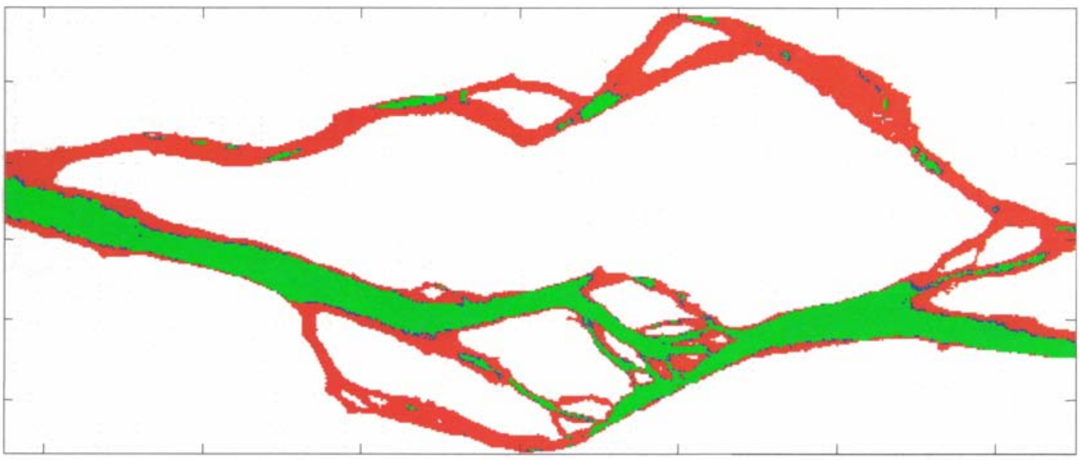

Figure 7 The Arundel Reach with a modelled flow of 15 m^3/s showing continuous passage for adult salmon in green (depth > 0.24 m) (red = depth < 0.2 m, blue – depth 0.2 – 0.24 m). Redrawn from Duncan and Hicks (2001).

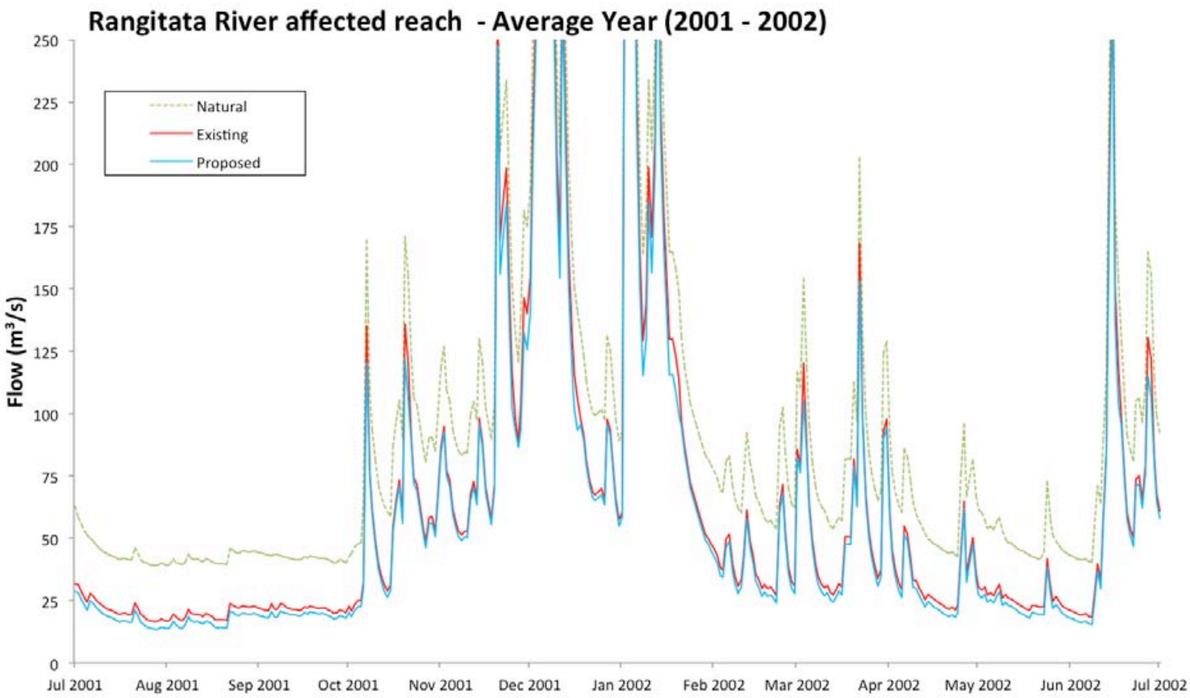

Figure 8 *An* ***average year*** *flow within the affected reach of the Rangitata River showing natural flow (no RDR abstraction), existing RDR abstraction (with 700 l/s for the BAFF bypass for 10 September to 31 January) and proposed abstraction incorporating additional abstraction at high flows and water for the proposed fish screen bypass all year round. Data supplied by PDP.*

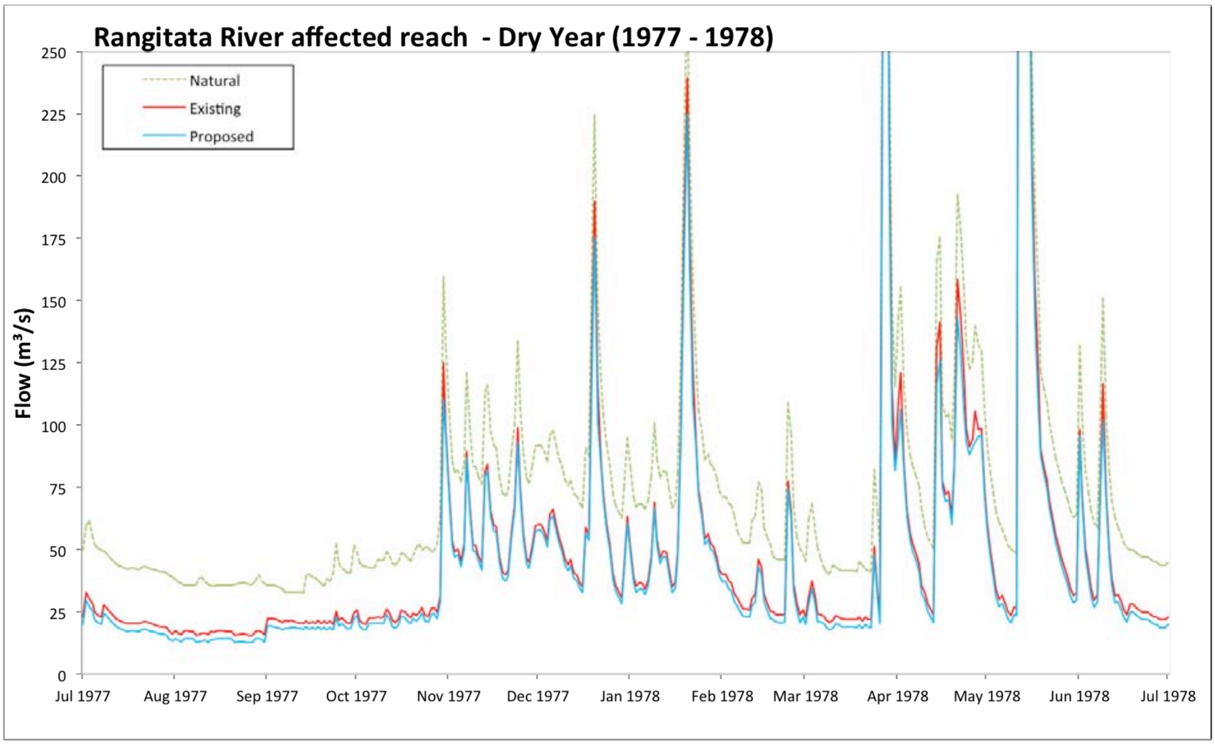

Figure 9 *A* ***dry year*** *flow within the affected reach of the Rangitata River showing natural flow (no RDR abstraction), existing RDR abstraction (with 700 l/s for the BAFF bypass for 10 September to 31 January) and proposed abstraction incorporating additional abstraction at high flows and water for the proposed fish screen bypass all year round. Data supplied by PDP.*

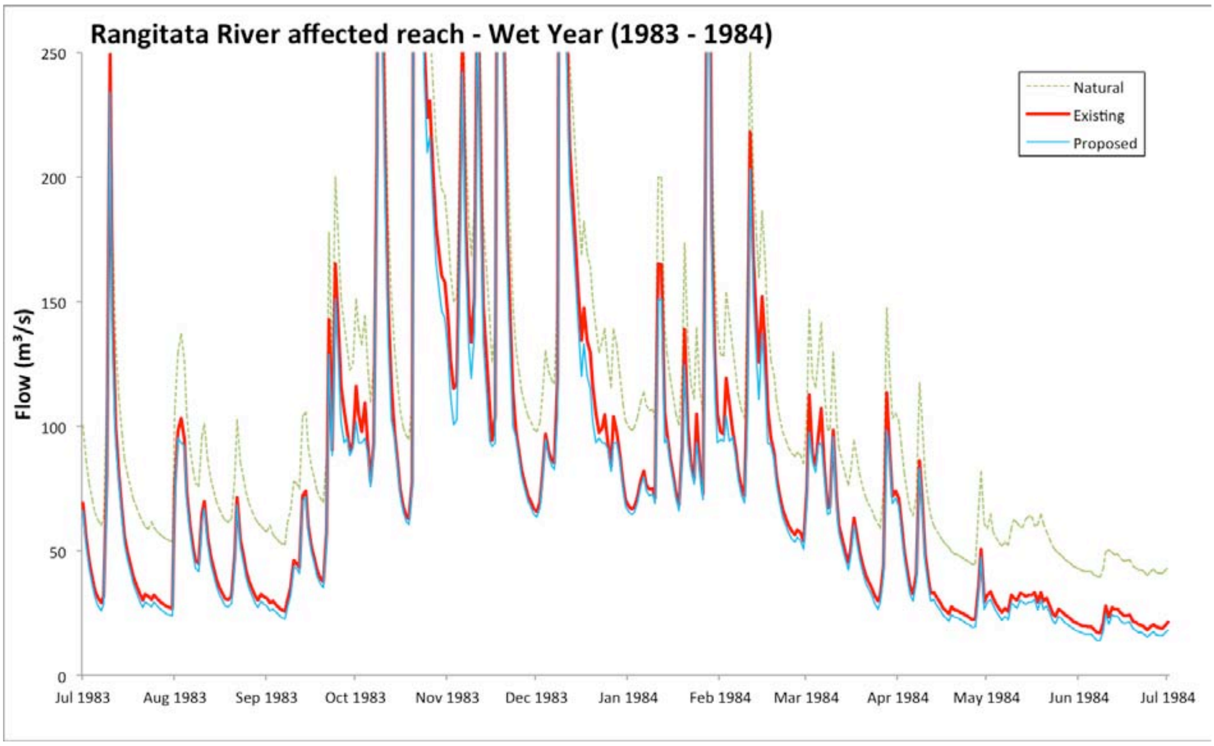

Figure 10 *A wet year flow within the affected reach of the Rangitata River showing natural flow (no RDR abstraction), existing RDR abstraction (with 700 l/s for the BAFF bypass for 10 September to 31 January) and proposed abstraction incorporating additional abstraction at high flows and water for the proposed fish screen bypass all year round. Data supplied by PDP.*

2.3 Water quality

Water quality monitoring data from within the RDR was accessed to gauge Rangitata River water quality in the affected reach. Water quality is monitored regularly in the RDR at an upstream site known as the 'control site', located approximately 1.5 km downstream from the Rangitata River intake, and this essentially represents the water quality of the Rangitata River at this point in the catchment.

A summary of monitoring data over the period December 2012 to August 2016 (number of sampling events = 41) is presented in Table 3. Dissolved nutrient concentrations (nitrate-nitrogen and dissolved reactive phosphorus) are typically very low and DRP concentration rarely exceeds the laboratory detection limit of 0.004 mg/L. *E. coli* concentrations are also low on average. Dissolved nutrient and *E. coli* concentrations on almost all monitoring occasions meet the L&WRP Schedule 5 receiving water standards for alpine upland waters.

Table 3 *Summary of water quality (December 2012 to August 2016) in the upper section of the RDR. Data supplied by RDRML.*

Statistic	**Contaminant**		
	E. coli **(cfu/100mL)**	**NO_3-N (mg/L)**	**DRP (mg/L)**
Mean	81	0.040	<0.004
Median	50	0.037	<0.004
Maximum	370	0.104	0.009
Minimum	5	0.002	<0.004

NZ periphyton guidelines for the management of nuisance periphyton growths suggest that the risk of nuisance algae growths developing in this section of the river are low. The affected reach is very short (1.38 km) and there are no tributary inflows to it, so there is no likelihood of additional nutrient contributions.

The average annual frequency of large freshes within this short river section would be slightly reduced from 5.0 to 4.7 (Table 4). However, given the low nutrient status of the river and the short section of the reach, this change is considered to have no meaningful effect on periphyton accrual.

Further, the natural flood frequency in the river will be largely unaltered from its existing state (figures 8, 9 and 10). The accrual period for periphyton is expected to increase very slightly during the summer-autumn period from approximately 39 to 40 days.

Table 4 *Summary of natural, current and predicted FRE3 flow frequency in the affected reach of the Rangitata River. Statistics with ranges indicate differences when comparing proposed rates of take with existing rates of take using either a 700 l/s take or a 3 m^3/s take for the bypass flow. Data supplied by PDP.*

FRE3 summary (1971-2015)		**Statistics for 3 x Median Natural Flow for Period 1 November to 30 April**			
Scenario	**Mean number of distinct events per annum for Period 1 July to 30 June**	Mean number of distinct events per annum	Mean days per annum flow exceeds 3 x median	Mean number of days absent (accrual time)	Maximum number of days absent (accrual time)
Natural	6.1	4.1	12.1	30.2	158.0
Existing	5.1 - 5.0	3.2 - 3.3	8.4 - 8.5	38.8 – 39.0	158.0
Proposed	4.7	3.1	7.5	40.1	159.0

Water discharged in the fish screen bypass will reflect the water quality of the Rangitata River at the RDR intake. The suspended sediment concentration of the bypass discharge may differ slightly to that in the river (due to the effects of deposition in the RDR and flushing of sediment in front of the fish screen), however, the differences are not expected to be significant and changes to river turbidity downstream of the bypass outfall are unlikely to be discernable with the naked eye.

2.4 Fish screen performance

The existing RDR fish screen (the BAFF) has be shown to not effectively prevent fish from moving down the RDR (Ryder 2015). On advice received from Central South Island Fish & Game, the bypass flow was increased to approximately 10% of the RDR flow, that is, from 700 l/s to 3000 l/s. The ratio of bypass flow to downstream flow in the RDR improved significantly as a result of increasing the flow from 700 to 3,000 l/s, and the efficiency of fish diversion increased accordingly.

Effective bypass flows and return systems are critical to the effectiveness of fish screens. The design for the new screen recommends that up to 5 cumecs is available for the bypass when the RDR is abstracting at its maximum. The benefits of an effective fish screen would appear to outweigh any potential adverse ecological effects associated with slightly lower flows in a

1.38 km section of the river. Past assessments (1998/99 irrigation season) have estimated that about 200,000 salmon smolt from the Rangitata River were entrained to the RDR, and it has been suggested that juvenile salmon entering the RDR may comprise 5-25% of Rangitata River migrants (Unwin *et al.* 2005). With a 3,000 l/s bypass flow the existing BAFF fish screen has an average estimated screening efficiency for salmon smolt of about 33% (Ryder 2015). Therefore, a significant number of salmon smolt and other fish species are being diverted from the Rangitata River and not able to return safely to it. The proposed new fish screen (Riley 2017) meets all the requirements of best practice guidelines as outlined in the Canterbury fish screening guidelines (Jamieson *et al*. 2007), and consequently the loss of fish from the river is expected to be significantly reduced. Further, the period of time that fish would be diverted away from the river will be reduced relative to the initial fish screen proposal involving a rock bund and gallery structure situated downstream of the RDR sand trap.

2.5 Reach between the proposed bypass outfall and the existing BAFF bypass outfall

The 1 km section of river between the proposed bypass outfall and the existing BAFF bypass outfall (Figure 1) will see a very small improvement in mean flow in the downstream reach as a result of the proposal. This section of the river is also a single channel with similar character to that found upstream.

2.6 Bypass outfall maintenance

The bypass outfall may require occasional maintenance such as the clearing out of rock material around the discharge point and replacing of rock protection structures. The footprint of these works is small relative to the size of the river. As identified in section 2.1, disturbance to wetted areas will cause resident fish species to move away once construction and disturbance commences. Benthic invertebrates may drift downstream or be destroyed, but recolonisation will be rapid. There are potential benefits of not have large resident fish present in the vicinity of the outfall in order to reduce the potential effect of predation on smaller fish exiting the bypass.

3 Conclusion

There is nothing particularly special or unique (from an ecological and water quality perspective) about the section of river affected by the reduction in flow for the proposed RDR fish screen bypass, and the physical changes to instream habitat are less than minor and likely to be of little or no ecological consequence. It remains a single channel under all realistic flow scenarios, dominated by large runs and riffles.

An important ecological function of this reach is enabling upstream and downstream fish migration for native and salmonid species. Based on field surveys and modelling undertaken at sites further downstream, and an examination of aerial photos of the reach under a range of flow conditions, there is nothing to suggest that fish passage would be impeded on the rare occasions flows reduce to around 15 cumecs. The frequency of flows of this magnitude over the adult salmon migration season (adult salmon have the greatest water depth requirements for fish passage) are rare and would not be caused by abstractions for the RDR as it would be taking almost no water.

The differences to instream habitat and fish passage in the 1.38 km affected reach, due to taking additional water for a fish bypass, in the range 3 – 5 m^3/s, appear to be less than minor, provided the RDR take rules are adhered to, including that to take an additional 10 m^3/s at flow above 142.6 m^3/s.

Water discharged in the fish screen bypass will reflect the water quality of the Rangitata River at the RDR intake and changes to river turbidity downstream of the bypass outfall are unlikely to be discernable with the naked eye.

There benefits of a strong bypass flow are significant in terms of ensuring the new fish screen operates in a highly efficient manner with respect to fish screening and diversion of fish back to the Rangitata River. Fish screen guidelines typically always recommend that the ratio of bypass flow to diverted flow is as high as possible. The benefits of a higher bypass flow and the expected effectiveness of the fish screen in preventing the entrainment of all fish species into the RDR all year round will offset any potential adverse effects associated with the proposed take and discharge. A net positive ecological effect is therefore expected as a consequence of the Proposal.

4 References

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