Memorandum

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To:	Sam Walton (Policy Analyst, Land and Freshwater, Otago Regional Council) Tom de Pelsemaeker (Team Leader, Freshwater and Land, Otago Regional Council) Jacqui Todd (Associate – Resource Management Consultant, Incite)
From:	Dean Olsen, Freshwater Scientist
Cc:	
Date:	17 October 2024
Re:	Supplementary allocation in bespoke catchments

The Otago Regional Council (ORC) is undertaking a full review of the Regional Plan: Water (RPW), and the results of this review will be incorporated into the proposed Otago Land and Water Regional Plan (pOLWRP). This review includes the approach to water allocation at moderate to high flows, currently referred to as supplementary allocation or B-block allocation.

The purpose of this memo is to assist in the consideration of the current approaches to B-block allocation in catchments with existing supplementary allocation and established flow sites. This memo shows the nature of flow modification in catchments with Schedule 2B supplementary minimum flows and allocation and compares these provisions relative to various flow-sharing ratios.

Flow sharing ratios

Flow sharing ratios are often used in water management to give an indication of the degree of hydrological alteration resulting from water abstraction. A flow sharing ratio is the ratio of the volume remaining in the river versus that abstracted. A 4:1 flow share is equivalent to the abstraction of 20% of the natural flow present. Figure 1 represents the default provision of the pOLWRP in a small stream (mean flow <5 m^3/s): the A-block allocation represents a 4:1 flow-sharing ratio (20% of natural flows available for abstraction), while higher-flow allocation represents a 3:1 flow-sharing ratio (25% of natural flows available for abstraction).

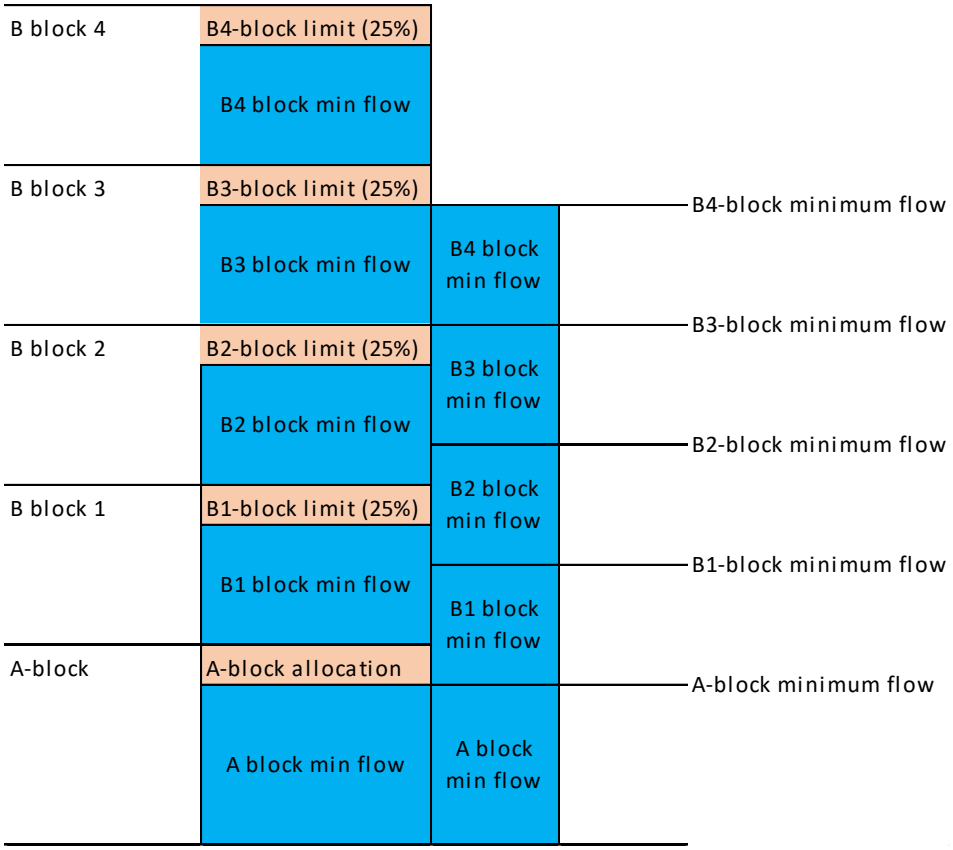

Figure 1 Representation of hypothetical allocation and resulting minimum flows based on 4:1 flow sharing for A-block and 3:1 flow sharing for B-blocks. Blue represents the minimum flow portion of each allocation block and the orange portion represents water allocated for abstraction. The left column demonstrated the flow sharing ratio and 'naturalised' flow scenario, whereas, the right column show the B block minimum flow setting with the water taken/abstracted out of the river

Setting high-flow allocation as part of the consenting process

The following are circumstances where the setting of high-flow allocation regimes may be most appropriately addressed as part of the resource consent process:

1. Catchments for which no minimum flow and/or allocation block size is set out in the RPW and/or pLWRP;
2. Small catchments that do not contain hydrological monitoring sites that are operated in accordance with the NEMS for Open Channel Flow Measurement,[1] or where available hydrological information is insufficient to calculate reliable flow statistics.

Otago has many small catchments that have little or no existing water abstraction pressure. In such cases, the risk of adverse effects arising from water abstraction is very low. In such circumstances, it is reasonable not to list minimum flow and/or allocation limits in the pLWRP, but rather to set out a default method to calculate these should the need arise. In such circumstances, it is also reasonable to set out a default method to calculate high flow allocation block sizes and minimum flows.

[1] https://www.nems.org.nz/documents/open-channel-flow-measurement/

In catchments without a flow monitoring site, or where the flow monitoring site won't measure the effect of the proposed water abstraction, or where the length and/or quality of flow record is insufficient to calculate reliable flow statistics, it is likely that such monitoring would be required to be undertaken by the consent holder as a condition of that consent. In such circumstances, it makes sense to set the minimum flow and block size for high flow takes at the time of consenting.

Catchments where high-flow allocation requires special consideration

Manuherekia catchment

Flow setting for the Manuherekia catchment has been on-going for several years, given the complexity of this process as a result of the large existing allocation of surface waters the presence of substantial storage in the catchment, the redistribution of water within the catchment via a network of water races and water retakes. The complexity of water management within the Manuherekia catchment and the lack of division of allocation into bands means that to address the concerns regarding water allocation within the catchment, allocation pressure will be spread across a wider range of the flow regime. The setting of high-flow allocation bands should be done at the same time as primary allocation, so that water takes that are currently taken at low flows can be shifted into higher flow allocation bands. Setting higher flow allocation bands prior to addressing low flow takes may limit options to redistribute low flow allocation to higher flows.

Taiari catchment

The Taiari catchment currently has minimum flows at five locations and a catchment allocation limit of 4,860 l/s (Schedule 2A or the RPW). Currently, the Taiari catchment is fully allocated, meaning that no supplementary allocation blocks are listed in Schedule 2B, and high flow allocation is provided for under Policy 6.4.10 (further supplementary allocation), which allows further supplementary allocation at flows above the natural mean flow.

The nature of the Taiari system, particularly the linkages between the river and significant riparian wetland systems (such as the Scroll Plain and Serpentine Flat), underscores the importance of a flow regime that supports these systems, such as by maintaining the frequency and duration of events that inundate oxbows and the wetland systems, to maintain ecological health and ecosystem functioning, as per the Flood Pulse Concept of Junk et al. (1989).

The Taiari catchment is currently fully allocated so providing for additional allocation at high flows would seem ill-advised and may limit options to redistribute current flow allocation to higher flows.

Provisions of the current RPW

Kākaunui River

Table 1 presents the current water allocation regime for the Kākaunui catchment (as per Schedule 2A and 2B of the RPW), including five existing blocks of summer supplementary allocation and four blocks of winter supplementary allocation. Further supplementary allocation (following Policy 6.4.10 of the RPW) allows for further high-flow takes with a minimum flow of the natural mean flow (5.650 m^3/s; Table 1).

Table 1 Current summer and winter water allocation regime for the Kākaunui catchment as per Schedule 2A and 2B of the RPW.

Block	RPW			
	Summer		Winter	
	Minimum flow (m^3/s)	Allocation block (m^3/s)	Minimum flow (m^3/s)	Allocation block (m^3/s)
Primary	0.250	0.750	0.400	0.750
Secondary	0.300		0.400	
1st supplementary	1.050	0.300/0.500	1.500	0.500
2nd supplementary	1.350	0.300	2.000	0.500
3rd supplementary	1.650	0.300	2.500	0.500
4th supplementary	1.950	0.300	3.000	0.500
5th supplementary	2.250	0.300		
Further supplementary	5.650	-	5.650	-

Figure 2 presents the relationship between observed flows to naturalised flows in the Kākaunui River and compares this relationship to the relationships expected under the current (RPW) maximum take under the allocation regime outlined in Schedules 2A and 2B of the RPW. This flow allocation regime is compared with various flow-sharing ratios. While further supplementary allocation is available at flows in excess of the mean flow following Policy 6.4.10, this is not considered here because there are numerous supplementary blocks available at flows well below the mean flow. In addition, there are numerous practical considerations (silt and debris in the water, whether there is sufficient storage capacity to fully exercise the take) that are expected to limit the take at high flows.

The RPW primary minimum flow and allocation results in highly modified flows that exceed a 1:1 flow ratio when flows are less than 1.5 m^3/s (maximum ratio ~1:3[2]), while the summer and winter supplementary blocks would result in flows that approximate 1:1 flow sharing (Figure 2). Observed flows (based on naturalised flow time-series of Lu (2023a)) suggest that the supplementary allocation blocks are not fully exercised and when the natural flows exceed 3 m^3/s, the observed flows meet or exceed a 3:1 flow sharing ratio (Figure 2).

[2] For every three units of water abstracted, 1 unit remains in the source waterbody

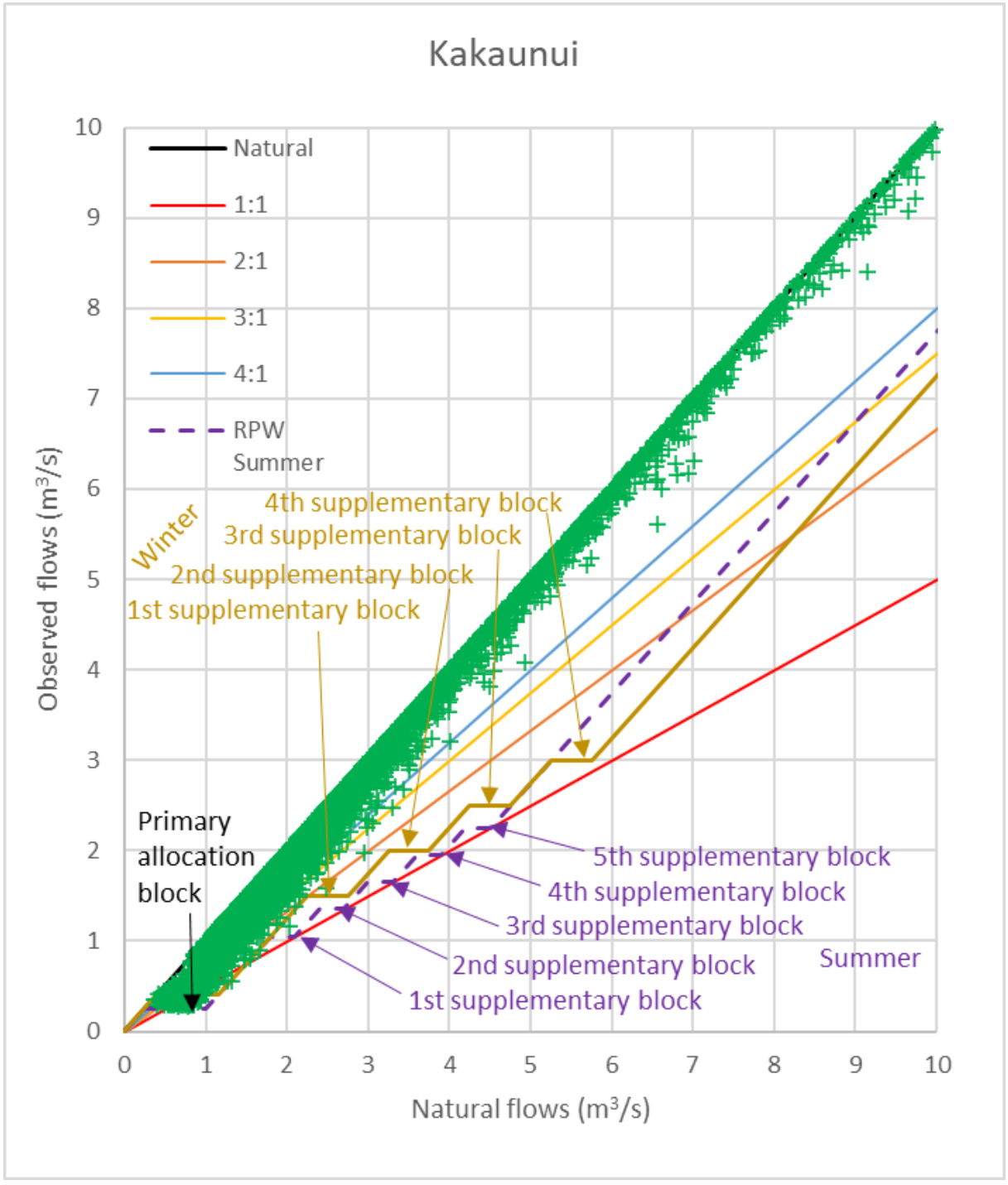

Figure 2 Relationship between observed and natural flows in the Kākaunui River at McCones and comparison to current summer and winter supplementary allocation regimes and flow sharing ratios.

Waihemo/Shag River

Table 2 presents the current water allocation regime for the Shag/Waihemo catchment (as per Schedule 2A and 2B of the RPW), including two existing blocks of supplementary allocation. Further supplementary allocation (following Policy 6.4.10 of the RPW) allows for further high-flow takes with a minimum flow of the natural mean flow (2.388 m^3/s; Table 2).

*Table 2 Current water allocation regime for the Shag/Waihemo catchment as per Schedule 2A and 2B of the RPW. Red values are additional supplementary **blocks and minimum flows** that were calculated using Method 15.8.1A of the RPW.*

Block	Minimum flow (m^3/s)	Allocation block (m^3/s)
Primary	0.150	0.280
1st supplementary block	0.650	0.100
2nd supplementary block	0.750	0.100
3rd supplementary block	0.850	0.100
3rd supplementary block	0.950	0.100
Further supplementary	2.388	-

Figure 3 presents the relationship between observed flows to naturalised flows in the Shag River/Waihemo and compares this relationship to the relationships expected under the allocation regime outlined in Schedules 2A and 2B of the RPW with two additional supplementary allocation blocks that were calculated using Method 15.8.1A of the RPW. While further supplementary allocation is available at flows in excess of the mean flow following Policy 6.4.10, this is not considered here because there are numerous supplementary blocks available at flows well below the mean flow. In addition, there are numerous practical considerations (silt and debris in the water, whether there is sufficient storage capacity to fully exercise the take) that are expected to limit the take at high flows.

The RPW primary minimum flow and allocation results in highly modified flows that exceed a 1:1 flow ratio when flows are less than 0.5 m^3/s (maximum ratio ~1:2.8), while the supplementary blocks result in flows that are slightly less than 2:1 flow sharing (Figure 3). Further supplementary allocation allows for further high-flow takes with a minimum flow of the natural mean flow (2.388 m^3/s) and while Figure 3 suggests that this could result in a very high level of flow modification, practical considerations are expected to limit the take at high flows.

Observed flows (based on naturalised flow time-series of Lu (2023b)) suggest that the supplementary allocation blocks are not fully exercised and that observed flows meet or exceed a 3:1 flow sharing ratio at all but the lowest flows in the Waihemo/Shag River (Figure 2).

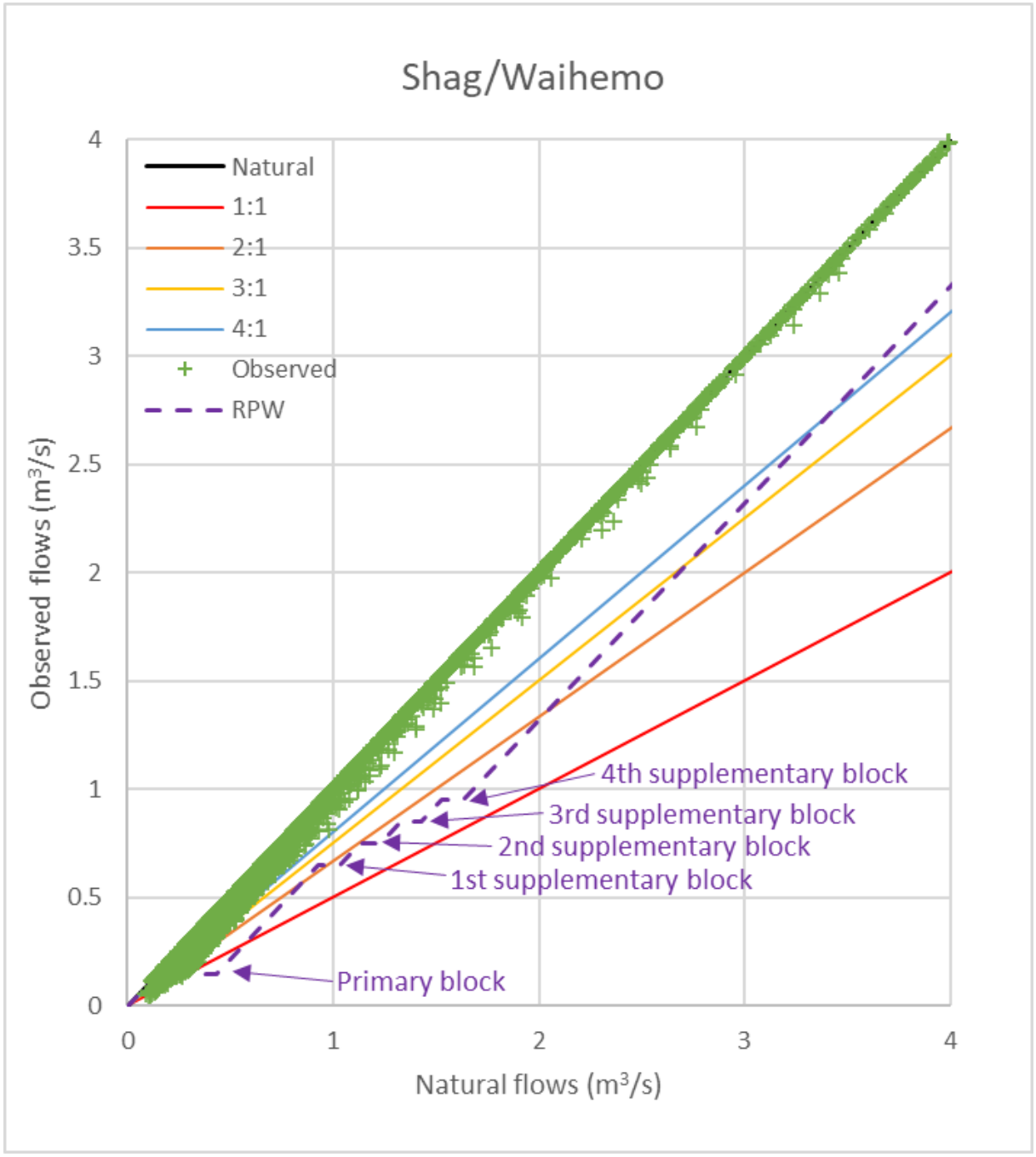

Figure 3 Relationship between observed and natural flows in the Shag River/Waihemo at Craig Road and comparison to current flow regime and flow sharing ratios.

Waianakarua River

Table 3 presents the current water allocation regime for the Waianakarua catchment, including four existing blocks of supplementary allocation. Further supplementary allocation (following Policy 6.4.10 of the RPW) allows for further high-flow takes with a minimum flow of the natural mean flow (3.257 m^3/s; Table 3).

Table 3 Current water allocation regime for the Waianakarua catchment as per Schedule 2A and 2B of the RPW.

Block	RPW	
	Minimum flow (l/s)	Allocation block (l/s)
Primary (A-block)	200	190
1st supplementary (B-block)	311	100
2nd supplementary (C-block)	411	100
3rd supplementary (D-block)	511	100
4th supplementary (E-block)	611	100
Further supplementary	3.257	-

Figure 4 presents the relationship between observed flows and naturalised flows in the Waianakarua River and compares this relationship to the relationships expected under the allocation regime outlined in Schedules 2A and 2B of the RPW. While further supplementary allocation is available at flows in excess of the mean flow following Policy 6.4.10, this is not considered here because there are numerous supplementary blocks available at flows well below the mean flow. In addition, there are numerous practical considerations (silt and debris in the water, whether there is sufficient storage capacity to fully exercise the take) that are expected to limit the take at high flows.

The RPW primary minimum flow and allocation and supplementary minimum flows and allocation blocks (4 supplementary allocation blocks) results in flows that approximate a 1:1 flow ratio when flows are less than 1,200 l/s (Figure 4).

Observed flows (based on naturalised flow time-series of Olsen, 2024) suggest that the supplementary allocation from the second supplementary block and above is not fully exercised and that observed flows meet or exceed a 3:1 flow sharing ratio when natural flows are higher than approximately 1,200 l/s (Figure 4).

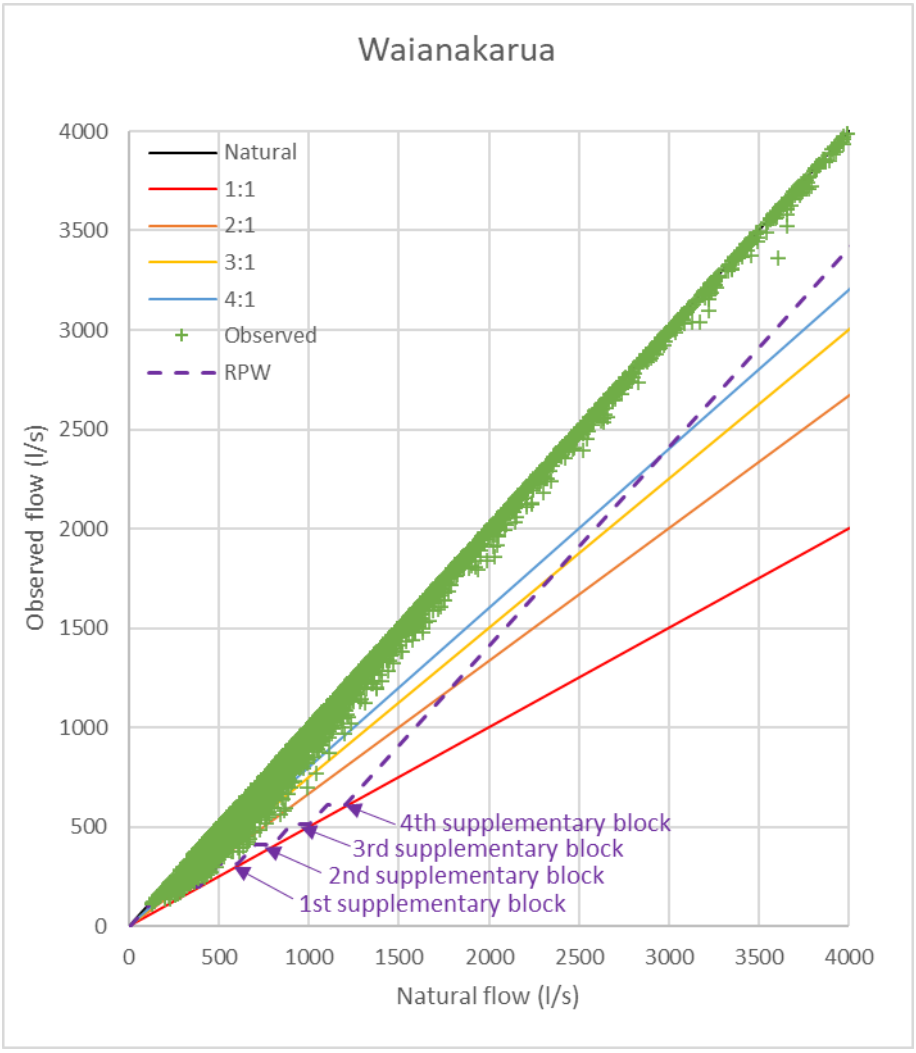

Figure 4 Relationship between observed and natural flows in the Waianakarua River at Browns Pump and comparison to current flow regime and flow sharing ratios.

Waiwhakaata/Lake Hayes Catchment (Mill Creek)

Table 4 presents the current water allocation regime for the Waiwhakaata/Lake Hayes Catchment (Mill Creek) catchment. Schedule 2B of the RPW does not include supplementary allocation blocks for the Lake Hayes/Waiwhakaata catchment. Table 4 presents minimum flows/allocation blocks for one supplementary allocation block that was calculated using Method 15.8.1A of the RPW. Further supplementary allocation (following Policy 6.4.10 of the RPW) allows for further high-flow takes with a minimum flow of the natural mean flow (0.431 m^3/s; Table 4).

Table 4 Current water allocation regime for the Waiwhakaata/Lake Hayes Catchment (Mill Creek) catchment. Red values are minimum flows/allocation blocks for four additional supplementary allocation blocks that were calculated using Method 15.8.1A of the RPW.

Block	RPW	
	Minimum flow (m^3/s)	Allocation block (m^3/s)
Primary	0.180	0.260
1st Supplementary block	0.360	0.100
Further supplementary	0.431	-

Figure 5 presents the relationship between observed flows and naturalised flows in Mill Creek and compares this relationship to the relationships expected under the current maximum take under the current allocation regime (as per Schedule 2A of the RPW and one supplementary allocation block calculated using Method 15.8.1A of the RPW) as well as further supplementary allocation at flows in excess of the mean flow following Policy 6.4.10. This flow allocation regime is compared with various flow-sharing ratios.

The RPW primary minimum flow and allocation and supplementary minimum flows and allocation blocks (one supplementary allocation blocks calculated using Method 15.8.1A of the RPW) results in flows that approximate a 1:1 flow ratio (Figure 5). However, the further supplementary allocation allows for high-flow takes with a minimum flow of the natural mean flow (0.431 m^3/s) and while Figure 5Figure 10 suggests that this could result in a very high level of flow modification, the magnitude of this effect depends on the actual amount of take, which is likely to be limited by practical considerations such as the risk of sedimentation of storage ponds, debris clogging the intake and the risk of damage to the intake structure, in addition to factors such as available water storage.

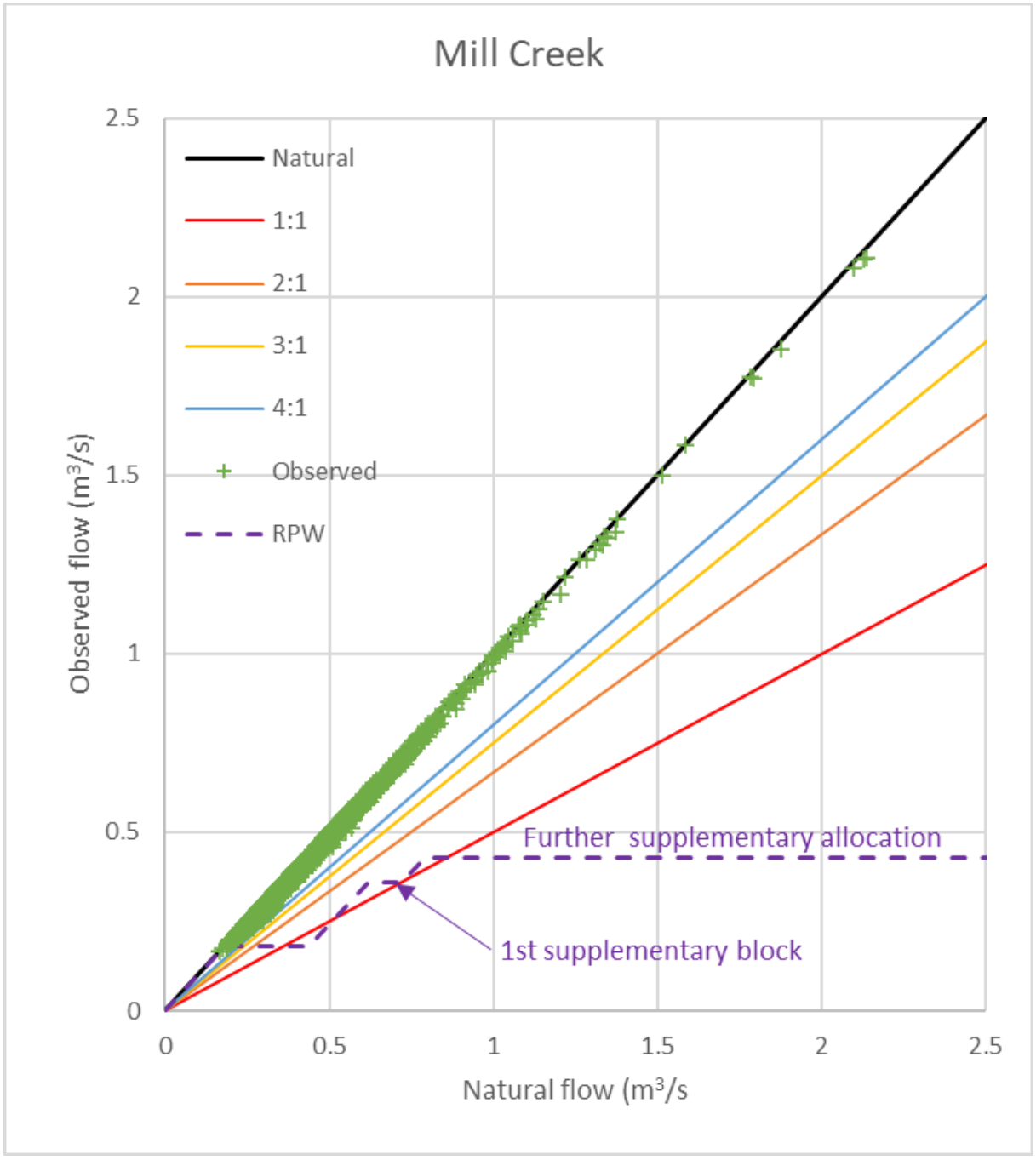

Figure 5 Relationship between observed and natural flows in the Mill Creek at Fish Trap and comparison to current flow regime with one supplementary allocation block calculated using Method 15.8.1A of the RPW and further supplementary allocation (as per Policy 6.4.10) and flow sharing ratios.

Luggate Creek

Table 5 presents the current water allocation regime for the Luggate catchment based on the existing primary minimum flow and primary allocation listed in Schedule 2A of the RPW, including two blocks of supplementary allocation as well as minimum flows/allocation blocks for two additional supplementary allocation blocks calculated using Method 15.8.1A of the RPW. Further supplementary allocation (following Policy 6.4.10 of the RPW) allows for further high-flow takes with a minimum flow of the natural mean flow (1.595 m^3/s; Table 5).

Table 5 Current water allocation regime for the Luggate catchment. Red values are minimum flows/allocation blocks for two additional supplementary allocation blocks that were calculated using Method 15.8.1A of the RPW.

Block	RPW	
	Minimum flow (m^3/s)	Allocation block (m^3/s)
Primary	0.180	0.500
1st supplementary block	0.788	0.250
2nd supplementary block	1.038	0.250
3rd supplementary block	1.288	0.250
4th supplementary block	1.538	0.250
Further supplementary	1.595	-

Figure 6 presents the relationship between observed flows and naturalised flows in Luggate Creek and compares this relationship to the relationships expected under the current maximum take under the current allocation regime outlined in Schedules 2A and 2B of the RPW with two additional supplementary allocation blocks that were calculated using Method 15.8.1A of the RPW as well as further supplementary at flows in excess of the mean flow following Policy 6.4.10. This flow allocation regime is compared with various flow-sharing ratios.

The RPW primary minimum flow and allocation and supplementary minimum flows and allocation blocks (2 current supplementary allocation blocks and two additional supplementary allocation blocks that were calculated using Method 15.8.1A of the RPW) results in flows that exceed a 1:1 flow ratio when flows are less than 1 m^3/s, while supplementary flows approximate a 1:1 flow sharing ratio (Figure 6). However, the further supplementary allocation allows for high-flow takes with a minimum flow of the natural mean flow (0.431 m^3/s) and while Figure 6Figure 10 suggests that this could result in a very high level of flow modification, the magnitude of this effect depends on the actual amount of take, which is likely to be limited by practical considerations such as the risk of sedimentation of storage ponds, debris clogging the intake and the risk of damage to the intake structure, in addition to factors such as available water storage.

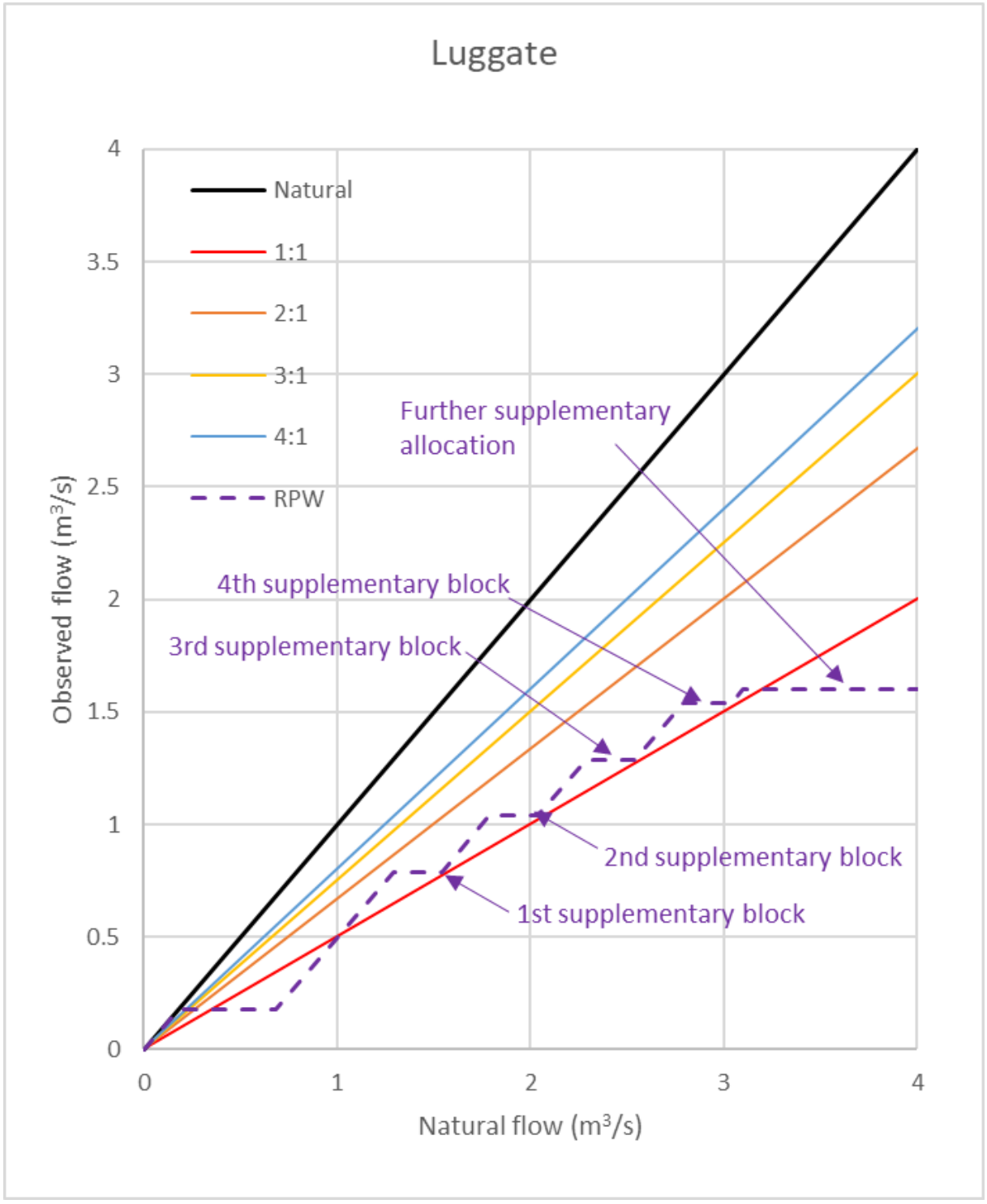

Figure 6 Relationship between observed and natural flows in the Luggate River at SH6 and comparison to current flow regime with two existing supplementary allocation blocks and two additional supplementary allocation blocks calculated using Method 15.8.1A of the RPW and further supplementary allocation (as per Policy 6.4.10) and flow sharing ratios and flow sharing ratios.

Pōumahaka River

Table 6 presents the current water allocation regime for the Pōumahaka catchment based on the existing primary minimum flow and primary allocation listed in Schedule 2A of the RPW, including one block of supplementary allocation listed in Schedule 2B of the RPW as well as minimum flows/allocation blocks for three additional high-flow allocation blocks calculated using Method 15.8.1A of the RPW. Further supplementary allocation (following Policy 6.4.10 of the RPW) allows for further high-flow takes with a minimum flow of the natural mean flow (25.4 m^3/s; Table 6).

Table 6 Current water allocation regime for the Pōumahaka catchment. Red values are minimum flows/allocation blocks for three additional supplementary allocation blocks that were calculated using Method 15.8.1A of the RPW.

Block	RPW	
	Minimum flow (m^3/s)	Allocation block (m^3/s)
Primary	3.600	1.000
1st supplementary block	13.000	0.500
2nd supplementary block	13.500	0.500
3rd supplementary block	14.000	0.500
4th supplementary block	14.500	0.500
Further supplementary	25.400	-

Figure 7 presents the relationship between observed flows to naturalised flows in the Pōumahaka River and compares this relationship to the relationships expected under the current maximum take under the allocation regime under Schedule 2A and 2B of the RPW with three additional supplementary allocation blocks that were calculated using Method 15.8.1A of the RPW as well as further supplementary allocation at flows in excess of the mean flow following Policy 6.4.10. This flow allocation regime is compared with various flow-sharing ratios.

The RPW primary minimum flow and allocation and supplementary minimum flow and allocation block results in flows that are relatively unmodified compared to natural flows (Figure 7). Even with an additional three supplementary allocation blocks fully exercised, result in still maintain a flow-share ratio in excess of 5:1 (Figure 7). While further supplementary allocation is available at flows in excess of the mean flow following Policy 6.4.10, this is not considered here because there are numerous supplementary blocks available at flows well below the mean flow. In addition, there are numerous practical considerations (silt and debris in the water, whether there is sufficient storage capacity to fully exercise the take) that are expected to limit the take at high flows.

Observed flows (based on naturalised flow time-series of Lu (2023c)) suggest that the primary and current supplementary allocation blocks are not fully exercised and that flows in the Pōumahaka River are very close to natural (Figure 7).

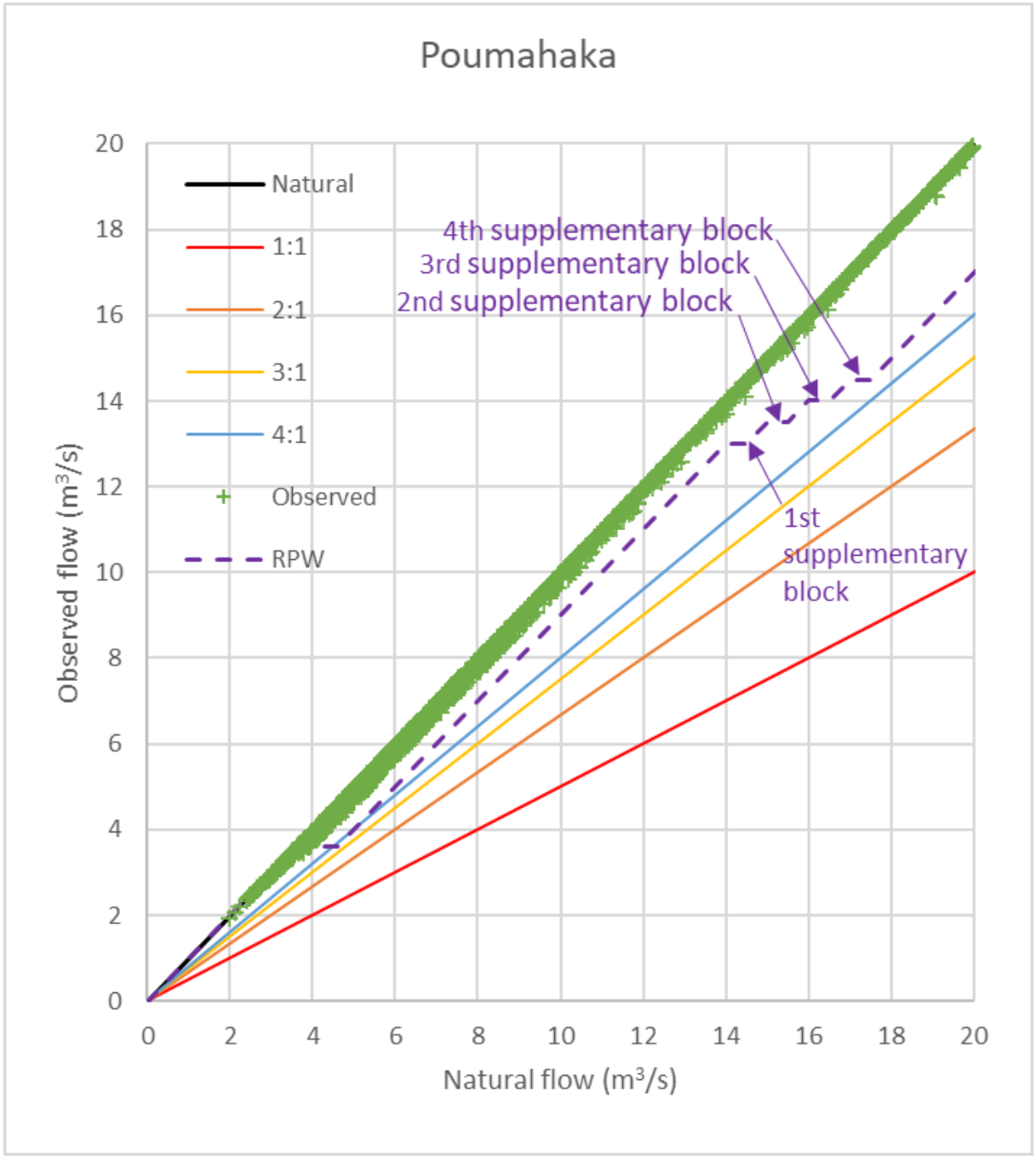

Figure 7 Relationship between observed and natural flows in the Pōumahaka River at Burkes Ford and comparison to current flow regime with three additional supplementary allocation blocks that were calculated using Method 15.8.1A of the RPW and flow sharing ratios.

Waiwera River/Te Waiwhero

Table 7 presents the current water allocation regime for the Waiwera/Te Waiwhero catchment based on the existing primary minimum flow and primary allocation listed in Schedule 2A of the RPW, including one block of supplementary allocation listed in Schedule 2B of the RPW as well as minimum flows/allocation blocks for three additional high-flow allocation blocks calculated using Method 15.8.1A of the RPW. Further supplementary allocation (following Policy 6.4.10 of the RPW) allows for further high-flow takes with a minimum flow of the natural mean flow (2.285 m^3/s; Table 7).

Table 7 Current water allocation regime for the Waiwera/Te Waiwhero catchment. Red values are minimum flows/allocation blocks for three additional supplementary allocation blocks that were calculated using Method 15.8.1A of the RPW.

Block	RPW	
	Minimum flow (m^3/s)	Allocation block (m^3/s)
Primary	0.280	0.150
1st supplementary	0.600	0.100
2nd supplementary	0.700	0.100
3rd supplementary	0.800	0.100
4th supplementary	0.900	0.100
Further supplementary	2.285	-

Figure 8 presents the relationship between observed flows to naturalised flows in the Waiwera River/Te Waiwhero and compares this relationship to the flows expected under the current maximum take under the allocation regime under Schedule 2A and 2B of the RPW with three additional supplementary allocation blocks that were calculated using Method 15.8.1A of the RPW as well as further supplementary allocation at flows in excess of the mean flow following Policy 6.4.10. This flow allocation regime is compared with various flow-sharing ratios.

The current primary minimum flow and allocation outlined in the RPW and supplementary minimum flows and allocation blocks (4 supplementary allocation blocks) results in flows that approximate a 2:1 flow sharing ratio at when flows are higher than 1 m^3/s (Figure 8). While further supplementary allocation is available at flows in excess of the mean flow following Policy 6.4.10, this is not considered here because there are numerous supplementary blocks available at flows well below the mean flow. In addition, there are numerous practical considerations (silt and debris in the water, whether there is sufficient storage capacity to fully exercise the take) that are expected to limit the take at high flows.

Observed flows (based on naturalised flow time-series of Lu (2023d)) suggest that the primary and current supplementary allocation blocks are not fully exercised and that flows in the Waiwera River/Te Waiwhero are very close to natural (Figure 8).

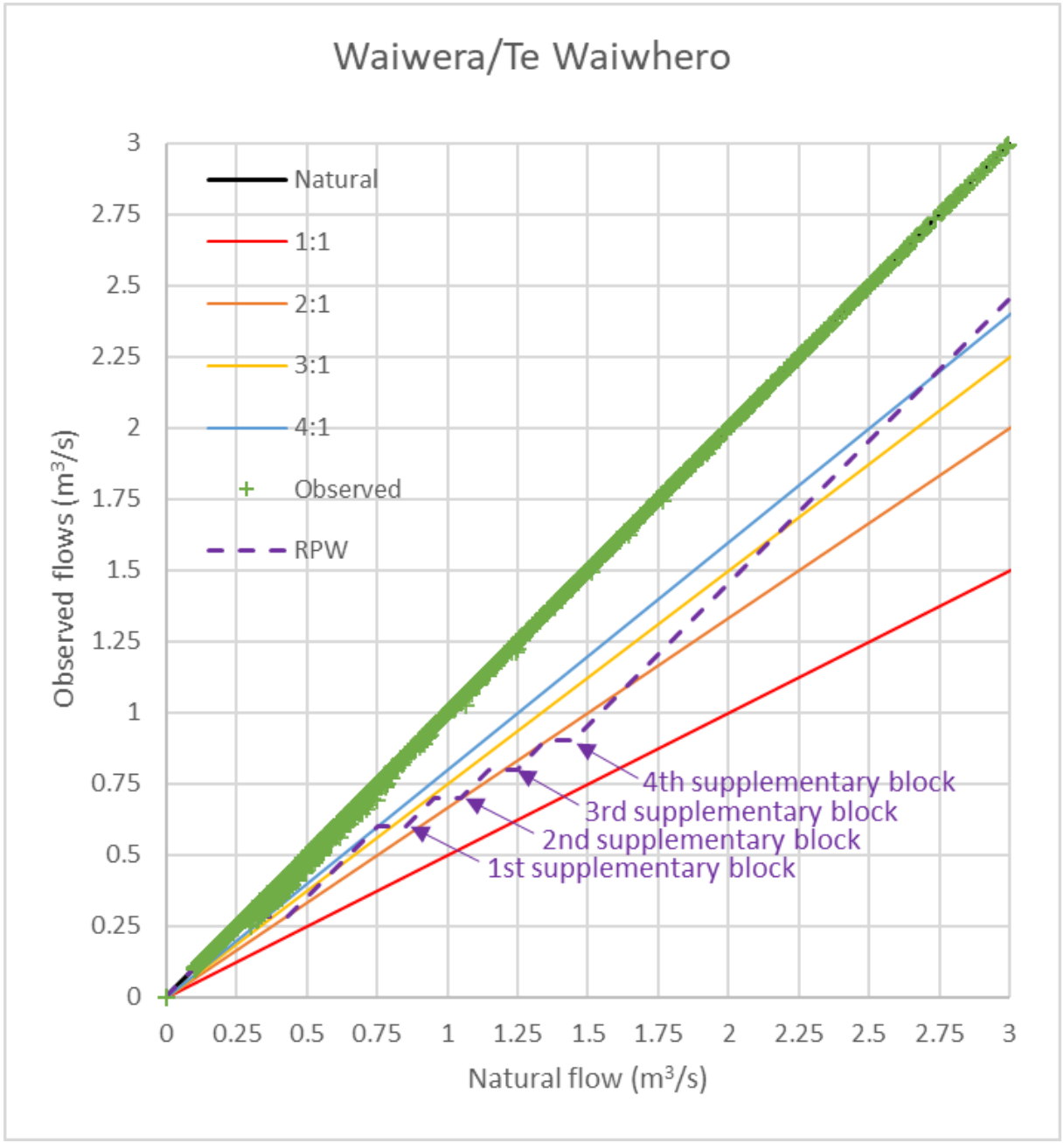

Figure 8 Relationship between observed and natural flows in the Waiwera River/Te Waiwhero and comparison to current flow regime and flow sharing ratios.

Waikouaiti River

Table 8 presents the water allocation regime for the Waikouaiti catchment based on the residual flow that applies to the only primary take that would be subject to environmental flows (RM13.299.01) and current primary allocation (~130 l/s), as well as minimum flows/allocation blocks for four additional supplementary allocation blocks calculated using Method 15.8.1A of the RPW. Further supplementary allocation (following Policy 6.4.10 of the RPW) allows for further high-flow takes with a minimum flow of the natural mean flow (2.497 m^3/s; Table 9).

Table 8 Current water allocation regime for the Waikouaiti catchment. Red values are minimum flows/allocation blocks for three additional supplementary allocation blocks that were calculated using Method 15.8.1A of the RPW.

Block	Minimum flow (l/s)	Allocation block (l/s)
Primary	150*	130
1st supplementary block	230	100
2nd supplementary block	330	100
3rd supplementary block	430	100
4th supplementary block	530	100
Further supplementary	2,500	-

* This is the residual flow that applies to RM13.299.01

Figure 9 presents the relationship between observed flows to naturalised flows in the Waikouaiti River and compares this relationship to that expected under the current maximum take under the RPW primary allocation with four supplementary allocation blocks that were calculated using Method 15.8.1A of the RPW as well as further supplementary allocation at flows in excess of the mean flow following Policy 6.4.10. This flow allocation regime is compared with various flow-sharing ratios.

The current residual flow and primary allocation and four supplementary allocation blocks that were calculated using Method 15.8.1A of the RPW results in flows that approximate a 1:1 flow ratio (Figure 9). While further supplementary allocation is available at flows in excess of the mean flow following Policy 6.4.10, this is not considered here because there are numerous supplementary blocks available at flows well below the mean flow. In addition, there are numerous practical considerations (silt and debris in the water, whether there is sufficient storage capacity to fully exercise the take) that are expected to limit the take at high flows.

Observed flows (based on naturalised flow time-series of Lu (2023e)) suggest that the primary and current supplementary allocation blocks are not fully exercised and that flows in the Waikouaiti River are very close to natural (Figure 9).

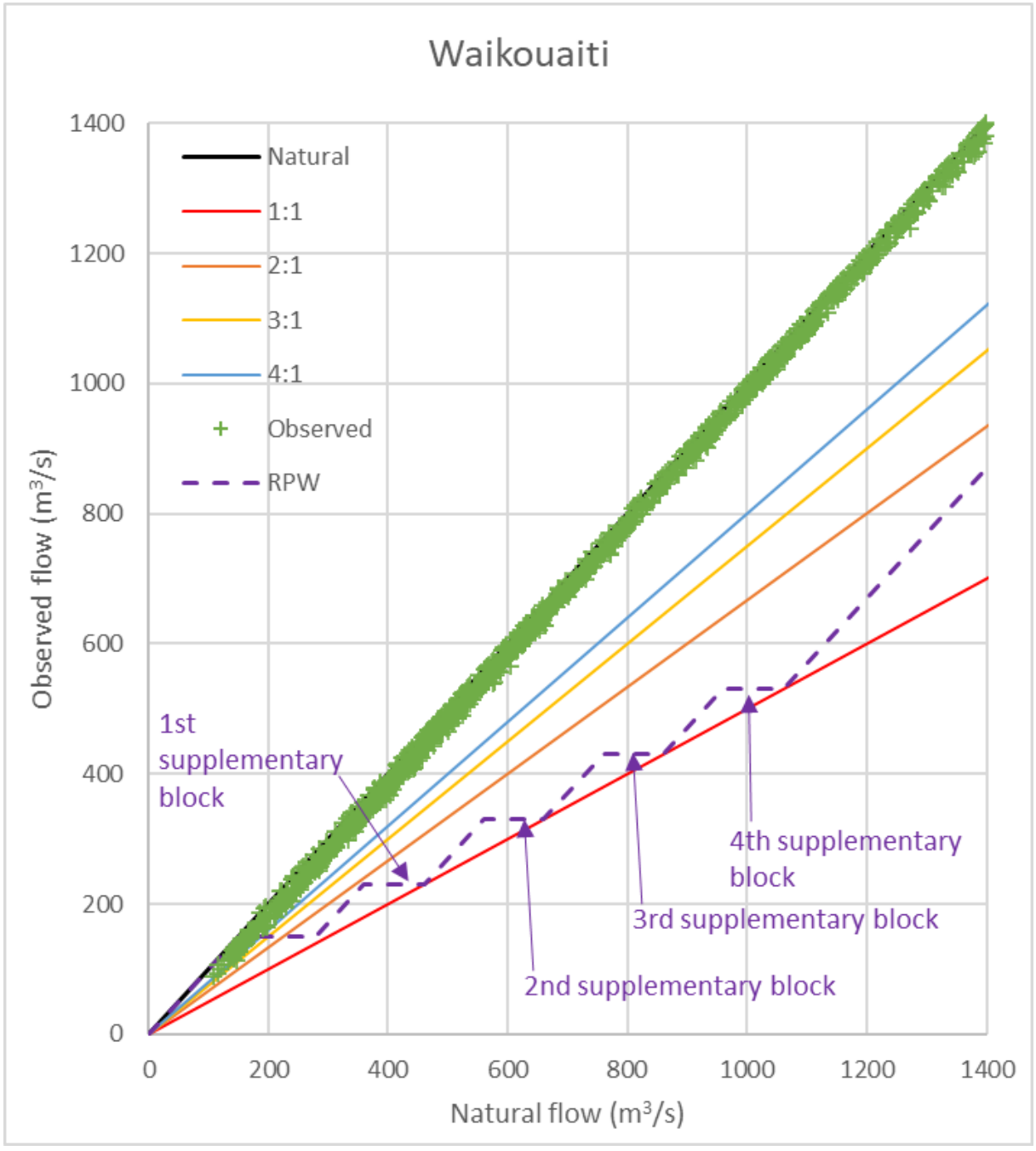

Figure 9 Relationship between observed and natural flows in the Waikouaiti River and comparison to current flow regime and flow sharing ratios.

Arrow River/ Haehaenui

Table 9 presents the water allocation regime for the Arrow/Haehaenui catchment based on no minimum flow[3] and current primary allocation and minimum flows/allocation blocks for four additional high-flow allocation blocks calculated using Method 15.8.1A of the RPW. Further supplementary allocation (following Policy 6.4.10 of the RPW) allows for further high-flow takes with a minimum flow of the natural mean flow (3.490 m^3/s; Table 9).

Table 9 Current water allocation regime for the Arrow/Haehaenui catchment. Red values are minimum flows/allocation blocks for four additional supplementary allocation blocks that were calculated using Method 15.8.1A of the RPW.

Block	RPW	
	Minimum flow (m^3/s)	Allocation block (m^3/s)
Primary	-	0.700
1st supplementary block	1.200	0.500
2nd supplementary block	1.700	0.500
3rd supplementary block	2.200	0.500
4th supplementary block	2.700	0.500
Further supplementary	3.490	-

Figure 10 presents the relationship between observed flows to naturalised flows in the Arrow River/Haehaenui and compares this to the relationships expected under the maximum take under the current allocation regime, and various flow-sharing ratios. The current primary allocation and four supplementary allocation blocks that were calculated using Method 15.8.1A of the RPW results in flows that approximate a 1:1 flow ratio (Figure 10). Further supplementary allocation allows for further high-flow takes with a minimum flow of the natural mean flow (3.320 m^3/s) and while Figure 10 suggests that this could result in a very high level of flow modification, practical considerations are expected to limit the take at high flows.

Observed flows suggest that the primary allocation block is fully exercised and that flows in the Arrow/Haehaenui are highly modified when flows would naturally be <2 m^3/s, but that the degree of modification declines at higher flows (Figure 11).

[3] The RPW does not currently include a minimum flow for the Arrow River/ Haehaenui.

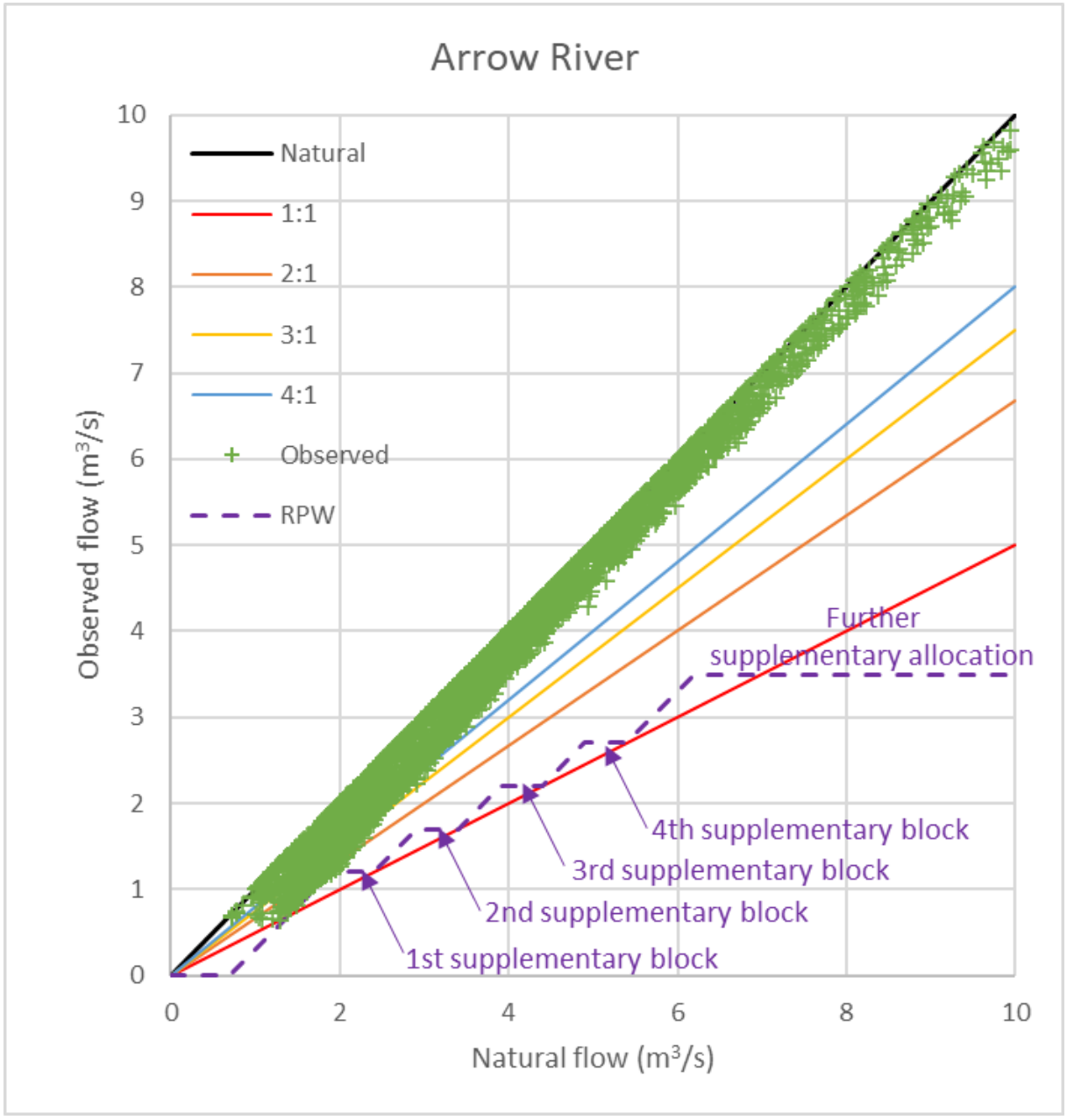

Figure 10 *Relationship between observed and natural flows in the Arrow River and comparison to current flow regime and flow sharing ratios.*

Cardrona River/Ōrau

Table 10 presents the current water allocation regime for the Cardrona /Ōrau catchment (upstream of Mt Barker) based on no minimum flow[4] and current primary allocation and minimum flows/allocation blocks for four additional high-flow allocation blocks calculated using Method 15.8.1A of the RPW. Further supplementary allocation (following Policy 6.4.10 of the RPW) allows for further high-flow takes with a minimum flow of the natural mean flow (3.320 m^3/s; Table 10).

Table 10 Current water allocation regime for the Cardrona/Ōrau catchment upstream of Mt Barker. Red values are minimum flows/allocation blocks for three additional supplementary allocation blocks that were calculated using Method 15.8.1A of the RPW.

Block	RPW	
	Minimum flow (m^3/s)	**Allocation block (m^3/s)**
Primary	-	0.600
1st supplementary block	1.100	0.500
2nd supplementary block	1.600	0.500
3rd supplementary block	2.100	0.500
4th supplementary block	2.600	0.500
Further supplementary	3.320	-

Figure 11 presents the relationship between observed flows to naturalised flows in the Cardrona River/Ōrau above Mount Barker and compares this to the relationships expected under the maximum take under the current allocation regime, and various flow-sharing ratios. The current primary allocation and four supplementary allocation blocks that were calculated using Method 15.8.1A of the RPW results in flows that approximate a 1:1 flow ratio (Figure 11). Further supplementary allocation allows for further high-flow takes with a minimum flow of the natural mean flow (3.320 m^3/s) and while Figure 11 suggests that this could result in a very high level of flow modification, practical considerations are expected to limit the take at high flows.

Observed flows suggest that the primary allocation block is fully exercised and that flows in the Cardrona River/Ōrau are highly modified when flows would naturally be <1.5 m^3/s, but that the degree of modification declines at higher flows (Figure 11).

[4] The RPW does not currently include a minimum flow for the Cardrona River/Ōrau

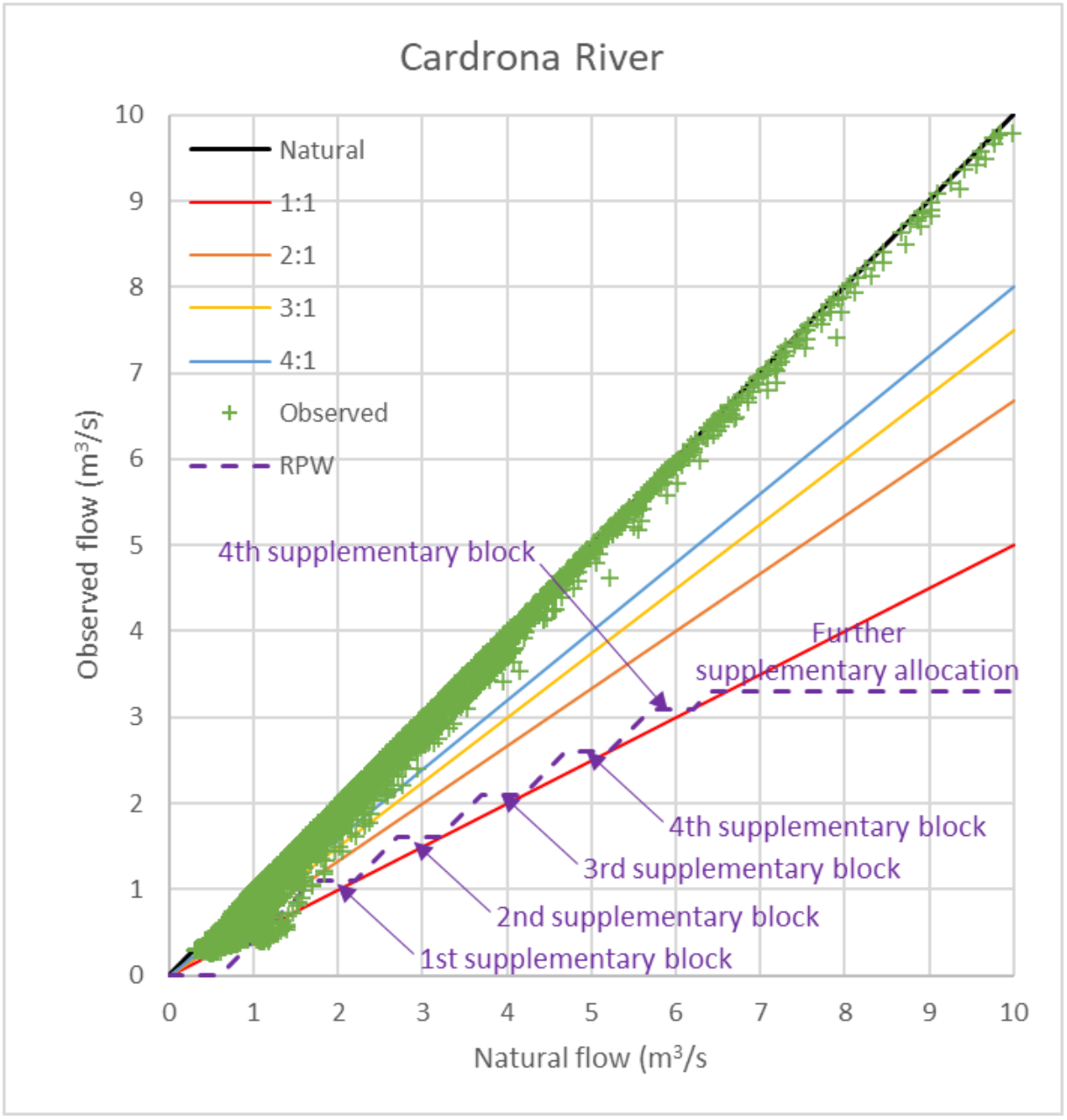

Figure 11 *Relationship between observed and natural flows in the Cardrona River upstream of Mt Barker and comparison to current flow regime and flow sharing ratios.*

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