BEFORE THE INDEPENDENT COMMISSIONERS

IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of Variation 2 (Hinds/Hekeao Plains Area) to the Canterbury Land and Water Regional Plan by the CANTERBURY REGIONAL COUNCIL

EVIDENCE IN CHIEF OF MARK WEBB ON BEHALF OF CENTRAL SOUTH ISLAND FISH AND GAME COUNCIL

May 2015

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QUALIFICATIONS AND EXPERIENCE

1. My name is Mark Whitby Webb.

2. I am employed as a Fish and Game Officer by Fish and Game New Zealand within the Central South Island Region.

3. I graduated from the University of Canterbury with a Bachelor of Science in 1979 and have since worked in freshwater fisheries for the Ministry of Agriculture and Fisheries, the former South Canterbury Acclimatisation Society and subsequently the Central South Island Fish and Game Council. I have 30 years' experience in sports fish and game bird management, most of that in South Canterbury. With that experience I have acquired a sound understanding of habitat requirements of sports fish, game birds and recreation based on these species.

4. I am the Fish and Game representative on the Hinds Drains Working Party and a community member on the Orari-Opihi-Pareora Zone Committee. I have participated on the community steering groups that developed the Pareora Catchment Environmental Flow and Water Allocation Regional Plan and Policies relating to the Orari River Catchment contained in sub-regional section 14.4 of the proposed Canterbury Land and Water Regional Plan.

5. In preparing this evidence I have reviewed:

   (a) In preparing this evidence I have reviewed proposed Variation 2 and the supporting technical reports provided by Environment Canterbury relevant to my area of expertise.

6. I have read the Code of Conduct for Expert Witnesses in the Environment Court Practice Note. This evidence has been prepared in accordance with it and I agree to comply with it. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

7. As referred to above I am employed by Fish and Game, a statutory body whose functions include to advocate for the interest of Fish and Game in the management of sports fish and game and their habitats (section 26C Conservation Act 1987). Notwithstanding this, I am aware of, and in preparing this evidence have complied with, my

overriding duty to assist the Court impartially on matters within my area of expertise.

SCOPE OF EVIDENCE

8. I have been asked by Fish and Game to prepare evidence in relation to salmonid fishery values and impacts of degraded ecosystem health on the Hinds River and Hinds Hekeao Plains Drains fisheries. This includes:

(a) A review of current habitat values of the drains;

(b) Comparison of historical and current sports fish values;

(c) Importance of contributions of tributaries to the lower Ashburton and Hinds rivers to the recreational fisheries of those rivers; and

(d) The operation of the Eiffelton Irrigation Scheme (EIS) as an example of Targeted Stream Augmentation

EXECUTIVE SUMMARY

9. The recreational trout fisheries of the Hinds River and Parakanoi Drain have deteriorated from being well utilised and productive to being non-existent. The period of decline appears to have been from about the mid 1980's through to mid 2000's and may have been caused by declining ecosystem health and associated increases in nutrient enrichment, increased flow variability and increasing incidence and duration of low flows.

10. Detailed surveys of six of the main drains across the Hinds Hekeao Plains indicate all have uniform and simple aquatic habitat and five have excessive silt, prolific periphyton growth and low macroinvertebrate community diversity indicating poor ecological condition.

11. Recent and on-going comprehensive nitrate monitoring indicates nitrate concentrations of around 11 mg/l in most drains from spring through to summer at which time flows likely sourced from shallow groundwater in the lower Hinds Plains reduce nitrate concentrations by about one third.

12. The Hinds Hekeao Plains Drains were a well documented source of juvenile trout for stocking of spawning-limited lake fisheries from the early 1960's through to the 1980's. Most of these drains now suffer from very low or non-existent summer flows on a regular basis and do not sustain the productive trout populations they once did.

13. Wheatstone Drain flows in the northern extent of the Hinds Plains and is believed to have been the most significant trout spawning tributary of the Ashburton River in the 1970's. No trout spawning is recorded after 1983. The similarity of habitat type and condition in the Wheatstone Drain today, with that present in the other Hinds Plains Drains, is matched by the decline in their trout fisheries. Improved riparian management, reduction of silt intrusion, reductions in nutrient loading and enrichment, in particular nitrogen, and improved flow would help recovery of the Wheatstone trout fishery.

14. Taylors and Northern drains are tributaries to the Hinds River and have been the source of juvenile trout recruitment to the Hinds River recreational trout fishery. Flows in these drains, at least until this past summer, have been stable and nitrate levels in Taylors Drain have been less than 6 mg/l. That the Hinds River trout fishery is poor is more likely a function of the reduced and variable flows in the mainstem Hinds River than reduced recruitment from the tributary drains.

15. Windermere Drain is one of the Hinds Hekeao Plains drains that receive supplemented flow in its middle reaches from the Eiffelton Irrigation Scheme. The supplemented section of Windermere Drain retained flow during the 2014/15 summer sufficient to support a varied and abundant fish fauna. In mid May 2015 flows in the Eiffelton drains continue to be sustained by water from the irrigation scheme even though irrigation ceased in April.

16. I believe the first element for safeguarding the ecological health of the Hinds River and Hinds Hekeao Plains drains is an assured flow of water. Drains outside the Eiffelton Irrigation Scheme have non-existent or degraded flows and sports fish populations to match. Having established means for restoring Hinds River and drain flows through direct augmentation, aquifer recharge, review of aquifer management

in the Upper Hinds Plains Area, or other means, the issue then becomes the quality of the habitat.

17. I support policies 13.4.9 and 13.4.10 that require Farm Environment Plans, and staged reductions on nitrogen losses. Along with Policy 13.4.10(a) requiring stock exclusion I believe there should be a requirement for setbacks from cultivation.

SETTING THE SCENE: HINDS HEKEAO PLAINS HISTORICAL FISH AND GAME VALUES

18. The Hinds River is central to the Hinds Hekeao Plains Area. The area includes tributaries to the Hinds River, and modified springs and drains that flow to the coast between the Ashburton and Rangitata rivers. It does not include springs and drains that flow to the Ashburton River or Rangitata River.

19. There are more than 20 named springs and drains in the area. Historically the drains of most interest to Fish and Game are those that:

    (a) have sustained sports fisheries in their own right e.g. Hinds River, Parakanoi Drain;

    (b) have been a source of juvenile trout for stocking e.g. Flemington, Parakanoi and Windermere drains, and the Hinds River; and

    (c) have contributed directly to sustaining sports fisheries in other fisheries e.g. Taylors and Northern drains that have provided spawning and rearing habitat for trout contributing to the Hinds River fishery.

Hinds River

20. The Hinds River is not an alpine fed river. It arises in the Moorhouse range at a maximum altitude of about 1,400m asl and is predominantly rain and spring fed. Its low summer flows and dried reaches are typical of many Canterbury streams of a similar size and catchment elevation e.g. Selwyn and Orari rivers.

21. I believe there has been a long term decline in surface flows of the Hinds. I consider there are two possible reasons for this.

22. First, there have been changes in irrigation practices in the catchment. In the mid-catchment there has been significant conversion to spray from border dyke and in the lower catchment there has been increased groundwater abstraction. Both of these practices are likely to lead to a reduction in groundwater contribution to Hinds River base flows. There are currently few if any surface water takes directly from the flowing channel that if present in sufficient numbers could reduce surface flow in the river.

23. Second, the Rangitata Diversion Race (RDR) regularly discharged excess water of high quality to the Hinds River up to 20 years ago. In recent times with greater efficiency of use of RDR water, discharge from the canal to the Hinds is infrequent and not consistent enough to sustain an increased salmonid population.

24. In 1962 and 1963 the Freshwater Fisheries Advisory Service (FFAS) of the Marine Department undertook surveys of the Hinds River to ascertain the level of the trout stocks in the river and to find out if the addition of irrigation water at three sites between 2km and 15km above SH1 was having any effect on those stocks. It was concluded that the brown trout population was very high and approaching over-population, silt sourced from irrigation water was having little effect on the trout population and only localised effect on bottom fauna (Lane, 1963).

25. During the FFAS survey it was reported that flow into the Hinds from the RDR ranged from 0.25 m^3/s to 3 m^3/s and that spawning Chinook salmon were present in autumn and sea run trout were present in winter. The presence of these fish indicated a river mouth that was regularly open to the sea providing fish passage.

26. Angler diaries returned by seven anglers for the 1962/63 fishing season recorded catch of 188 trout of average length 305mm from the Hinds River. Eighty-five percent of trout were caught below SH1.

27. In the last National Angler Survey (NAS), completed for the 2007/08 season by NIWA for Fish and Game New Zealand, no anglers were found who had fished the Hinds River (Unwin 2009). Prior to this the

NAS in 1994/95 recorded 210 angler days and the 2001/02 survey recorded 320 days (Unwin and Brown 1998, Unwin and Image 2003).

28. From at least 1947 until 1990 the Hinds River was a source of juvenile trout for transfer to recruitment-limited lake fisheries in the upper Ashburton Lakes area. In years with good flows up to 20,000 juvenile trout were removed from the lower Hinds River, often several years in succession.

29. In summary, with improved ecological health, reduction in nutrient enrichment, and improved flow, the Hinds River could be reinstated as a productive and well utilised trout fishery. This could be achieved by reducing nutrient, sediment and faecal contamination of freshwater from agriculture, improving management of riparian margins, and direct augmentation of the mainstem or by improved flows in the lower river tributaries of Taylors, Northern and O'Shaughnessy's drains.

Tributaries to the Ashburton and Hinds rivers – Wheatstone, Taylors and Northern drains

30. Small tributaries may contribute to recreational sports fisheries in larger downstream water through provision of spawning and rearing habitat. In the case of the Ashburton and Hinds rivers the tributaries themselves may too small to provide habitat for resident adult trout and instead provide spawning for adult trout that migrate out of the larger downstream water. Trout fry and juveniles use rearing habitat in the tributary providing steady recruitment to the downstream fishery as they grow.

31. The significant contributions of Wheatstone, and Taylors and Northern drains to downstream Ashburton and Hinds river fisheries respectively, was recognised by the Acclimatisation Society. Wheatstone drain was never targeted for removal of fish for stocking other fisheries and there are only two records of stocking from Taylors and Northern, in 1970 and 1971 respectively. It was believed natural production from these three drains was too important to the Ashburton and Hinds river fisheries to be compromised by removing juveniles to other places.

32. Up to 1984 Wheatstone drain was a valuable trout and occasional salmon spawning water. Trout spawning surveys in the mid to late

1970's identified between 80 and 110 trout redds (nests) annually. This would have easily qualified Wheatstone as the most valuable trout spawning stream in the entire Ashburton Catchment and in today terms this level of spawning is more than occurs in the entire catchment. By the mid 1980's trout spawning had reduced to between 10 and 60 redds annually although the presence of two salmon redds was recorded in 1983. No spawning surveys are recorded after 1983 until the drain survey I undertook in August 2014 that found no evidence of trout or salmon spawning in 12.7km of its length.

33. Wheatstone Drain is not considered in this plan. I believe that in all respects other than the line on a planning map, that it qualifies as a Hinds Hekeao Plains drain. It will be affected by land use and management rules put in place by Variation 2.

34. In 1970 the Acclimatisation Society transferred 892 juvenile trout from 3,140 m of Taylors Drain at an average density of 0.28 fish per metre for stocking high country lakes. The following year 2,527 fish at an average density of 0.55 fish per meter were transferred from 4,590m of Northern Drain.

35. Other in these two years of salvage these figures indicate the scale of contributions Taylors and Northern drains origin trout made to the Hinds River fishery.

Mid Plains Drains – Parakanoi, Flemington and Windermere Drains

36. Until the mid 1980's the summer flow of the Parakanoi was sufficient enough to attract anglers to fish for brown trout. Trout caught were up to 2.5 kg although mostly around 1kg. Fishing was dictated by the flow with flow over 300 l/s preferred. In the mid 1980's flows became more variable, low flows became more common, and weed coverage increased. The decline of the Parakanoi recreational fishery is possibly linked to increased irrigation upstream and occurred at a similar time to the decline in the Hinds River fishery (Bruce McLaren pers. comm.).

37. Windermere Drain was also fished by a few local anglers in the 1970's an 80's and was rated more highly than the Parakanoi by virtue of a higher catch rate (Bruce McLaren pers. comm.).

38. In the early 1960's the Ashburton Acclimatisation Society obtained its first electric fishing machine. This enabled the sourcing of juvenile brown trout for stocking, from the Hinds Hekeao Drains to supplement and eventually replace the resource intensive fish hatchery run by the Society in Tinwald.

39. The Society's records for the number of juvenile trout obtained from up to 18 drains and 20 km total drain length annually during stocking operations provide a measure of trout productivity and juvenile population density. Windermere and Parakanoi were the most consistently surveyed drains (Table 1).

Table 1. Length of drain fished and density of juvenile brown trout in Parakanoi and Windermere drains at approximate 10-year intervals.

		1969 to 1973	1977 to 1981	1984 to 1986
Windermere	Years salvaged	3	4	3
	Length (km)	13.8	12.4	5.6
	Fish	3,284	8,307	2,736
	Fish per meter	0.29	0.73	0.48
Parakanoi	Years salvaged	5	3	1
	Length (km)	32.8	6.7	1.2
	Fish	14,546	2,579	159
	Fish per meter	0.44	0.39	0.13

40. It is possible that by 1986 the unreliable flow of the Parakanoi was starting to impact on juvenile trout productivity. Windermere, with supplemented flows, provided a more stable environment for fish.

41. There are no records of trout spawning surveys being completed by the Acclimatisation Society to index the size of the adult trout spawning population. I believe that to produce the numbers of juveniles that were salvaged would have required 20 to 100 redds (nests) annually in each drain.

42. In late winter 2014 a foot survey of 12.6km, 11.6km, and 13.6km of the Parakanoi, Flemington and Windermere drains respectively, failed to identify any trout redds.

43. Anecdotal evidence from HDWP members who have lived many years in the area is that there have been no obvious physical changes in the basic drain habitat characteristics of width and depth but significant change in season flow particularly summer low flows. I will present evidence from more detailed drain surveys that will also implicate sedimentation, periphyton growth and declining quality of the macroinvertebrate community as reasons for loss of ecological values from the drains.

Drains South of the Hinds River

44. In the 1960's and probably earlier, Northern Drain, a tributary to the south side of the Hinds River, and Stormy and Boundary drains that flow directly to the coast south of the Hinds River, were trout fished with success. Robert Wright a long time resident of Hinds recalls learning to fish with his father and Grandfather catching sea-run brown trout on fly and worm in Boundary Drain when there was more flow to enable these larger trout to enter.

45. Northern drain was a prolific trout fishery. Up to 100 trout were caught by one angler in one season in the early 1970's in the 2km of drain above its junction with the Hinds River. On one occasion this angler took a daily limit bag of four trout of average weight 2kg (Robert Wright pers. comm.).

CURRENT CONDITION OF THE HINDS HEKEAO PLAINS DRAINS

46. In August and September 2014, I surveyed on foot 68.3km of six Hinds Hekeao Plains drains to gather basic ecological and physical habitat information (Figure 1). Northern, Taylors and Wheatstone drains were selected to evaluate the importance of their contribution to identified fisheries in the Hinds and Ashburton rivers. Windermere Drain was selected for being part of the Eiffelton Irrigation Scheme

and Flemington Drain was surveyed to compare and contrast conditions in an unsupplemented drain in close proximity to the Eiffelton Scheme drains. The Parakanoi Drain is the largest drain in terms of flow in the Plains area and has historical sports fish information. It was chosen for these reasons (Table 2).

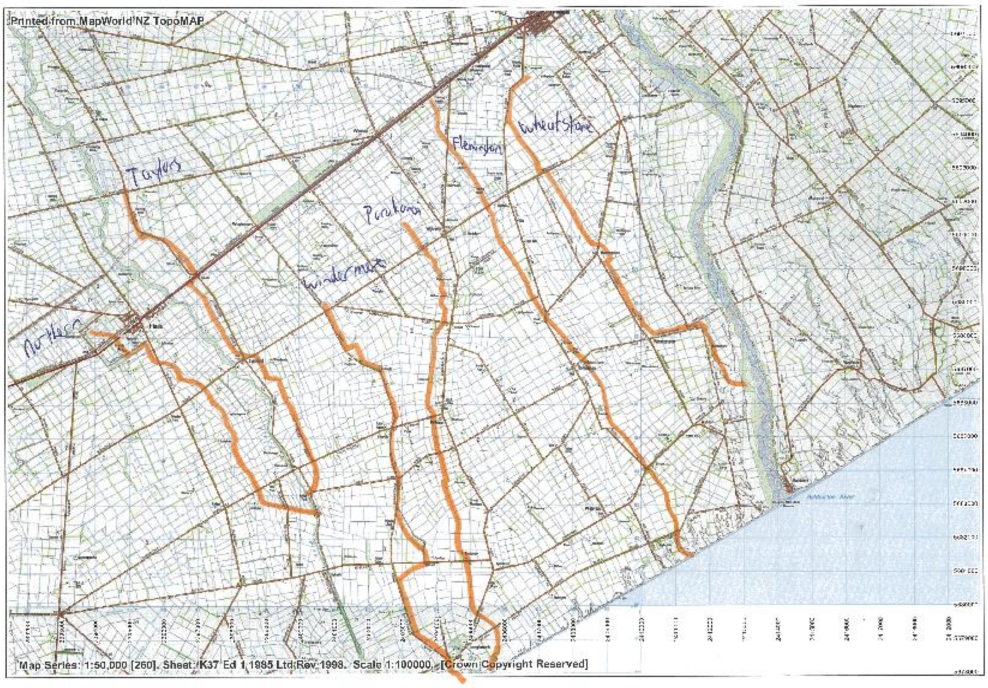

Figure 1. Location of survey reaches in six Hinds Hekeao Plains drains

Table 2. Drain origin, flow characteristics at the time, and minimum flows for abstraction of surveyed drains.

Drain	Origin	Flow (l/s)	Minimum flow (l/s)
Wheatstone	Ashburton R trib	80 (estimated)	50
Northern	Hinds R tributary	500 (estimated)	210/80
Taylors	Hinds R tributary	100 (estimated)	25
Windermere	Eiffelton Scheme	320 (flow recorder)	80
Flemington	Non-Eiffelton	390 (flow recorder)	25
Parakanoi	Hist. significance	410 (flow recorder)	30

47. Spring flows in all drains at the time of survey were above normal. The previous summer and winter had been very wet. Local advice indicated flows were about 30% above normal.

48. All drains were very similar in width and depth. This was expected in man-made channels that are aligned down the fall line and have been constructed for the primary purpose of transporting drainage and flood waters (Table 3).

Table 3. Average width, depth and proportion of water depth greater than 0.4m for six surveyed drains

	Average width (m)	Average depth (m)	% Depth >0.4m
Wheatstone	1.8	0.17	2.1
Northern	2.4	0.2	2.2
Taylors	1.3	0.19	1.2
Windermere	2.2	0.21	5.7
Flemington	2.4	0.25	14.7
Parakanoi	2.4	0.23	8.1

49. Substrate composition was dominated by gravel and most of this was pea gravel of 5mm to 25mm diameter. This provides very little habitat for small fish. The origin of boulder substrate in Parakanoi and Flemington drains was from its addition for bank stabilisation, none was naturally occurring. Windermere had the lowest silt contribution (Table 4).

Table 4. Substrate composition of six surveyed drains

	% silt (<2mm)	% gravel (2 - 64mm)	% cobble (65 – 256 mm)	% boulder (>256mm)
Wheatstone	24.5	72.1	3.4	0
Northern	9.1	72	18.9	0
Taylors	9.2	86.2	4.6	0
Windermere	1.5	94.5	4	0
Flemington	4.1	91.7	4	0.2
Parakanoi	11	79.9	7.8	1.3

50. The source of a minor proportion of the silt in beds of the drains was likely to be sites of active erosion on the banks. Occasionally these were where obstructions in the drains such as fallen trees or poorly maintained culverts and boundary fences caused flow to attack the banks. More often it was where there was stock access to the banks, or vegetation in the fenced buffer had been sprayed. Overall these sources of silt were small and localised in comparison to the volume and distribution of silt in the drains. I believe the greater silt load may be coming from side drains that are largely unmanaged, overland discharge during rain, and cultivation down or over the drain banks.

51. In all drains there were reaches where macrophytes or periphyton completely covered the bed. Windermere had by far the least macrophyte and periphyton average coverage of 0.5% and <20% respectively. In Wheatstone drain periphyton coverage (44.6%) was limited by highly silted substrate (24.5%). Other than Windermere all other drains had periphyton coverage ranging from a low of 27% for Taylors to 81.8% for Flemington.

52. Variation 2 contains periphyton indicators for Chlorophyll A biomass, filamentous algae and cyanobacteria coverage. Periphyton measurements I took in the field did not measure the Variation 2 indicators. I was surprised by the high periphyton presence considering the end of winter timing of the surveys. In my opinion the

periphyton growth I saw was excessive and evidence of poor ecological health caused by nutrient enrichment.

53. I considered the invertebrate communities to be uniformly poor in the six drains surveyed. Nowhere were invertebrates abundant or diverse and in large sections, kilometres in length, there were no invertebrates at all. The fauna, when present, was dominated by stony cased caddis with a few mayflies. Often stony cased caddis were the only invertebrates present and on closer inspection the cases were empty of life. Chironomids, snails, and snail eggs, were found in some silted habitat. Generally I considered the thick crust of periphyton-bound silt limited invertebrate colonisation.

54. Macroinvertebrates are the main food source of juvenile salmonids with the energy content, size and abundance of invertebrates determining the carrying capacity and condition of fish present. The presence of mayflies, caddisflies and stoneflies, sometimes called the EPT taxa, indicates a high quality food source while snails, chironomid midges and worms are poor food items for trout and often found in silted low quality habitat. Some members of the EPT taxa were found in the drains in low numbers but I believe their numbers are limited by silt and periphyton coverage.

55. The Qualitative macroinvertebrate community index (QMCI) is a measure of the quality of a habitat based on the species composition of the invertebrate community found in that habitat. Results of QMCI scoring of samples taken by CRC from most of the drains along Lower Beach Road in 2001, 2006 and 2012 showed significant decline in macroinvertebrate health between 2001 and 2006, with further decreases (which varied in statistical significance) between 2006 and 2012 (Lessard, 2013).

56. All drains were a virtual monoculture of run habitat and within this category fast runs with velocities > 0.5m/sec contributed about 80% (Table 5). Run habitat is important for fish feeding as invertebrates produced in riffles are washed downstream. However run habitat in the drains was too fast, too shallow and too common. If runs have a proportion of bigger cobbles and boulders they will provide diverse habitat to sustain a greater variety and abundance of fish species.

Table 5. Stream habitat type and abundance for six surveyed drains

	% Pool	% Run	% Riffle
Wheatstone	3.3	95.7	1
Northern	1.3	98.4	0.3
Taylors	1.2	98.6	0.2
Windermere	2.7	95.8	1.5
Flemington	1.2	98.8	0
Parakanoi	1.3	98.4	0.3

57. Pools and riffles were rare and I estimated they were present at about one fifth to one tenth of what might be found in an average small stream. Riffles are important as food producing habitat and pools provide refuge when overhead cover is lacking elsewhere.

58. There are aspects of drain management, water quality and instream habitat quality that the Hind Drains Working Party discussed and will or are acting on as a result of this survey. In respect of this Hearing the relevant issues are –

(a) Water quality - nitrate

(b) State of fisheries values now in comparison to historical records

(c) Contributions of Ashburton and Hinds river tributaries to sports fisheries in those rivers

(d) Comparison of Windermere Drain as an Eiffelton Irrigation Scheme flow-supplemented drain, with other Plains drains

Water quality - nitrate

59. As part of the HDWP process Fish and Game have been undertaking 7 to 14 day conductivity testing of up to 32 drain sites in the Hinds Hekeao Plains area since August 2014. Water conductivity can be used as an index of nitrate concentration. Water samples have also been collected by CRC and F&G staff at approximately monthly

intervals to identify current drain nitrate levels and trends, and for confirming the nitrate/conductivity relationship.

60. Ten sites representing top, middle and bottom of Wheatstone, Flemington and Windermere drains, and four sites representing top and bottom of Taylors and Northern drains have been tested for nitrate concentrations on up to nine occasions since 8 August 2014 (Figure 2).

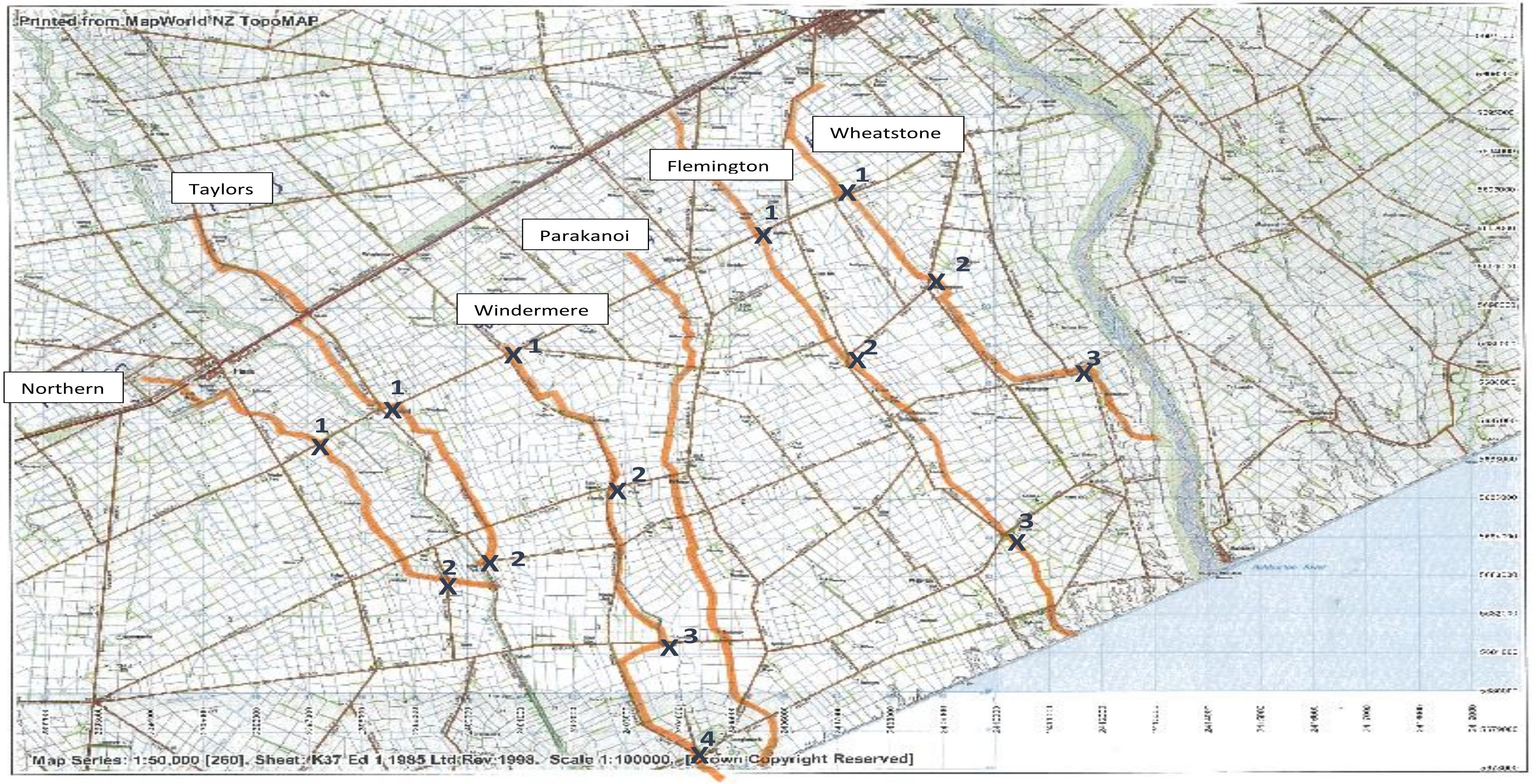

Figure 2. Hinds Hekeao Plains drains sites for monthly nitrate sampling from 8 August 2014 to 21 April 2015.

Figure 2. Hinds Hekeao Plains drains sites for monthly nitrate sampling from 8 August 2014 to 21 April 2015.

61. Not all sites were able to be sampled on every occasion. From December onwards drains started to dry and sampling of these sites did not recommence until flow reappeared.

62. At all 14 sites nitrate concentrations declined over the period of sampling (Figure 3). Windermere had the most significant declines – from between 11 and 14 mg/l at all four sites in August down to less than 5 mg/l at three of the four sites from February onwards. Other drains generally reduced nitrate concentrations by about one third over the sampling period.

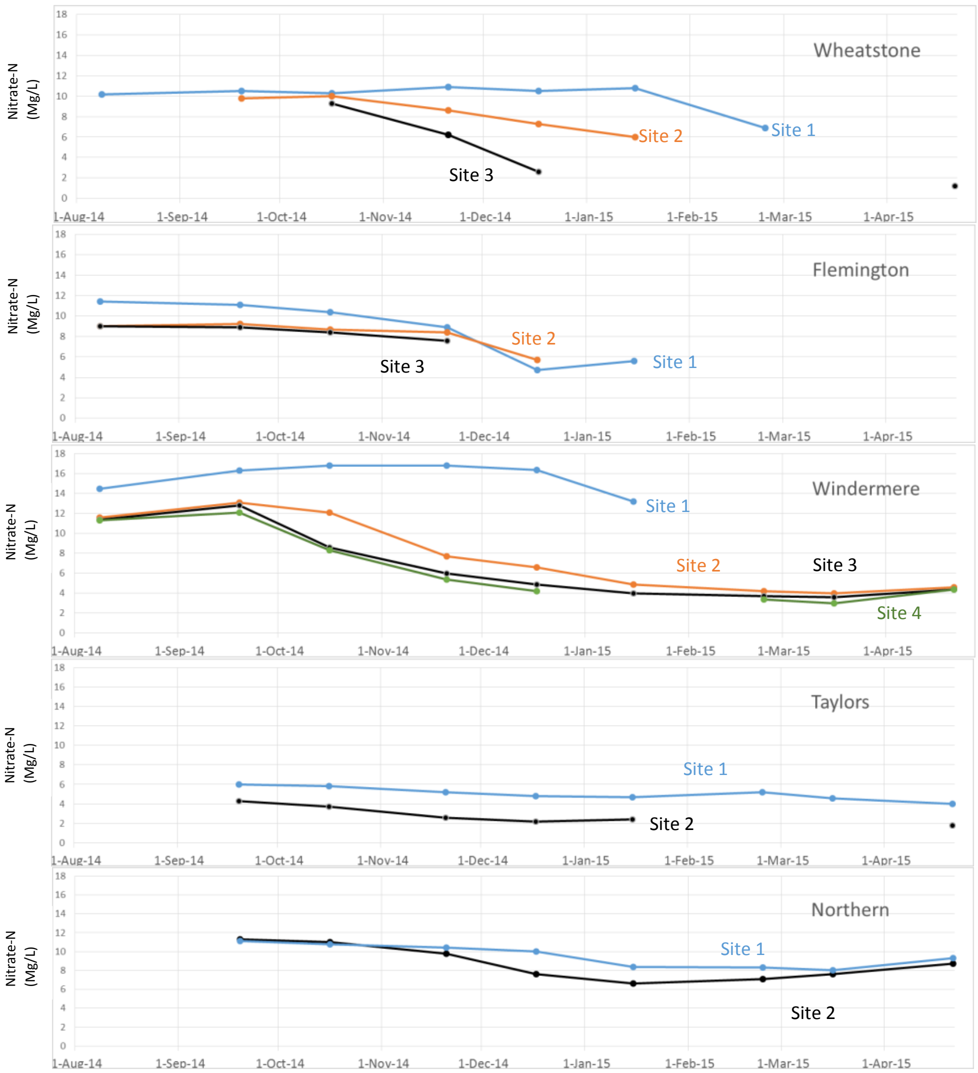

Figure 3. Monthly nitrate concentrations at 14 sites on five Hinds Hekeao Plains drains from August 2014 to April 2015

Figure 3. Monthly nitrate concentrations 14 sites on five Hinds Hekeao Plains drains from August 2014 to 4 April 2015

63. Taylors Drain had the lowest nitrate concentrations ranging from 6 mg/l in September through to less than 4 mg/l and the Windermere Drain had the highest concentrations at nearly 17 mg/l at its top site.

64. In both Taylors and Northern drains, the two Hinds River tributaries, the bottom sites had consistently higher nitrate concentrations than the top sites. This suggests nitrate enrichment down these drains of the order of 1 mg/l to 2 mg/l. While Northern Drain has nitrate concentrations similar to the northern plains drains, Taylors as noted previously, has much lower nitrates suggesting its source water may be different from the other drains and of a much better quality.

65. I believe the benefit of the Eiffelton Irrigation Scheme supplementation of the Windermere Drain with deep groundwater, is apparent. First, sites 2 and 3 on Windermere were the only sites able to be sampled on all nine sampling runs confirming flow continuity while other drains were drying. Second, at sites 2, 3, and 4 nitrate concentrations in late summer were only about one third of their concentrations in spring. In the early part of the irrigation season, to mid October to November, flow in the Windermere Drain would have been sufficient for irrigation without supplementation. Nitrate concentrations to this time were high and even higher at site 1 indicating source water in the head of Windermere Drain was high in nitrates. As the summer hit, EIS pumped ground water of low nitrate concentration into the drain to enable its abstraction for irrigation lower down the drain. Nitrate concentrations appeared to transition steadily over about 2 months and remained low at around 4 mg/l from January onwards.

66. Across the four drains other than Taylors, nitrate concentrations in source water early in the 2014/15 summer were between 11 mg/l and 14 mg/l. It is not possible provide an indication of source water quality in late summer for unsupplemented Hinds Hekeao Plains drains as Wheatstone and Flemington have yet to recommence flowing at their top sites.

67. Recent research on the toxicity of nitrate on brown trout in New Zealand has been completed in response to the lack of information on possible impacts of land uses yielding high nitrate on the important and widely distributed brown trout fishery. The laboratory-based component of this research found that all developing brown trout eggs

died before hatching when incubated in water with a nitrate nitrogen concentration of 13.6 mg/l. At a concentration of 3.8 mg/l egg to alevin (newly hatched) survival was high but alevin to fry (1 month after hatching) survival was reduced by 25% and survivors were smaller than those hatched in water with total dissolved nitrate concentration of 1.3 mg/l (Taylor and Marshall, 2014).

68. Variation 2 sets limits and targets for nitrate toxicity to be met by 2035 in Table 13(j). I believe the long term goal for nitrate concentration in the Wheatstone, Taylors and Northern drains to protect trout spawning productivity and recruitment, should be no greater than 2 mg/l. Shorter term targets can have higher nitrate limits to provide a stepped process.

69. The physical survey of six drains undertaken in August/September 2014 identified high periphyton, >27% coverage, in all but Windermere Drain. In the 11.6 km of Flemington Drain surveyed, periphyton cover averaged 87% and 4.39km of the drain had 100% coverage of cyanobacteria. In my opinion all six drains had excessive periphyton growth and likely to have been caused by nutrient enrichment to the extent that it impacted on macroinvertebrate health. This is discussed further in the evidence of Mr Canning who recommends dissolved inorganic nitrogen and dissolved reactive phosphorous instream concentration limits be included in Variation 2 to provide for the ecological health of the Hinds River and the Hinds Hekeao Plains drains. I support his evidence.

State of fisheries values now

Wheatstone Drain

70. I believe the loss of the Wheatstone Drain sports fishery contribution to the Ashburton River can be attributed to four factors.

71. First, truncation of the lower 2km of the drain to provide for wetland treatment of the Ashburton District Council sewage waste water in 2004 under consent CRC031005. Approximately half of trout spawning in Wheatstone in the 1970’s and 80’s occurred in the section that has been replaced by a 400m cut directly to the Ashburton River berm.

72. Second, increasing incidence of dry reaches of the Wheatstone Drain. Ashburton Acclimatisation Society Annual Reports first record the drain drying in 1983 and then again in 1985.

73. Third, deterioration in quality of the spawning habitat. The physical survey I completed on Wheatstone Drain in August 2014 identified on average one quarter of the wetted area of the bed over the 12,690m of drain surveyed covered with silt. There is no comparable assessment of substrate composition from the 1980's however in my opinion any streambed with 25% silt cover will not sustain trout spawning and I don't believe there would have been a high silt concentration when Wheatstone Drain supported good spawning in the late 1970's and early 1980's.

74. Fourth, high nitrate concentrations in source water coming out of winter promoting macrophyte and periphyton growth that impact on macroinvertebrate habitat quality.

75. Wheatstone Drain is the northernmost of the Hinds Drains. In respect of its physical characteristics (Tables 2, 3 and 5), water source and flow regime, and the farming practices on the land through which it flows, the drain is a typical Hinds Plains drain. The decline of its instream habitat in the last three decades through siltation and flow variability are also typical of the Hinds Plains Drains.

76. While Wheatstone Drain is outside the area under consideration in Variation 2 its current poor ecological health, hydrology, and absence of previously high sports fish values, mirror those conditions in the Hinds Hekeao Plains drains.

Taylors and Northern drains

77. There are no records of Taylors Drain being electric fished after 1970 (paragraph 32) until November 2014, some 40 years later. In that time Taylors Drain maintained a relatively stable and continuous flow compared to the Hinds drains north of the Hinds River to the Ashburton River.

78. On 27 November 2014 two, 50m length sections of Taylors Drain 1,200m and 1,700m above the Hinds River confluence, were stop-netted top and bottom and multiple pass electric fishing was

undertaken. The juvenile trout density estimate for the lower site was 0.04 fish per lineal metre and 0.02 fish per metre for the upper site.

79. While juvenile trout density in 2014 was only about 10% of that in 1970, the proportion of the drain surveyed in 1970 was much more extensive. Of greatest significance, the 2014 survey confirmed that Taylors Drain remains a source of recruitment to the Hinds River trout fishery and provides spawning habitat for adult trout.

80. This year Taylors Drain was dry at Surveyors Rd from mid February to April. The lowest ECan spot gauged flow at New Park Road about 1km downstream from Surveyors Rd and about 200m above the confluence with the Hinds River is 14 l/s on 4th February. According to Peter Lowe, Chairman of the Hinds Drain Working Party, this summer's flows were the lowest he has seen having lived all his life in the area and farming beside the drain for the last 25 years.

Comparison of Windermere Drain as an Eiffelton Irrigation Scheme flow-supplemented drain, with other Plains drains

81. After the ground survey of six Hinds Hekeao Plains drains in spring 2014 I believed the biggest issues limiting current ecological health of the drains were low fish habitat diversity, silt inundation, and enrichment. At that time all of the drains had above average flows for that time of the year.

82. My conclusion assumed that all the drains had assured water. In reality, north of the Hinds River and its tributary drains, only the Eiffelton drains have assured water and this was clearly demonstrated over the 2014/15 summer.

83. On 9 January, 16 January and 20 March 2015, I undertook drive-by photographic surveys of all north Hinds Hekeao Plains drains crossing Boundary Rd, Surveyors Rd and Lower Beach Rd or their equivalent road crossings representing the top, middle and bottom reaches of the drains respectively. Flows present were estimated by eye. Combined with estimated drain flows during the ecological surveys in August/September for the main drains, these three surveys indicate the availability of water in the main drains over the 2014/15 summer.

The surveys on 9 and 16 January were combined, being only 7 days apart (Table 6).

Table 6. Estimated flow in main drains north of the Hinds River in approximate top, middle and bottom reaches from winter/spring 2014 to mid summer 2015

Drain	Date	Flow at top l/s	Flow middle l/s	Flow bottom l/s
Taylors	2 Sept 2014	100	50	100
	9/16 Jan 15	10	10	10
	20 March 15	3	0	5
Wheatstone	13 Aug 2014	10	50	100
	9/16 Jan 15	0	0.5	0.5
	20 March 15	0	0	0.25
Flemington	8 Aug 2014	100	300	400
	9/16 Jan 15	0	0	0
	20 March 15	0	0	0
Parakanoi	10 Sept 2014	150	200	400
	9/16 Jan 15	0	0	0
	20 March 15	0	0	0
Windermere	31 July 2014	40	320	200
	9/16 Jan 15	0	70	0
	20 March 15	0	35	0

84. Taylors Drain between SH1 and Surveyors Rd, a distance of about 6.5km or about 70% of the length of the drain, was dry at the peak of the summer in February to early April. The upper reaches of Taylors Drain are spring fed and as the Hinds River flow drops over the summer so does spring flow in the head of the drain. In the middle reaches drain flow is lost to ground water in almost every summer when the Hinds River ceases to flow. The Hinds River resurfaces at Surveyors Rd about 8km from the coast and the lower 1km of Taylors

Drain gains flow before it joins the Hinds River. Until this last summer local landowners have considered Taylors Drain to have always had stable summer flows.

85. Wheatstone, Flemington and Parakanoi flow patterns are typical of the northern plain drains. Flows are higher in winter when shallow groundwater levels are higher and diminish over summer as the groundwater component sourced above SH1 is lost and drain flows are more dependent on shallow drainage below SH1. All of these drains were dry for approximately 10km or about 80% of their length, in their middle and lower reaches from January to early April 2015

86. Windermere, Home Paddock and Deals drains are collectively known as the Eiffelton Drains. They are critical for operation of the Eiffelton Irrigation Scheme where groundwater is pumped into the drains in their upper/middle reaches and the drains convey the water to irrigation off takes lower down.

87. The Eiffelton drains are no different in their geographical and physical instream characteristics from other northern plain drains and sit between the Parakanoi to the north and O'Shaughnessy's, a Hinds River tributary, to the south. However, unlike the other northern plains drains that dried from the bottom up this summer, the Eiffelton drains retained flow in their middle reaches. Approximately 75% of the length of the Eiffelton drains retained flow and fish habitat while about the same length in all other northern plains drains was dry. Had the Eiffelton drains not received the supplemented flow they would have been as dry as the other drains. In addition the Eiffelton Irrigation Scheme continued to supplement flow in the drains after the irrigation season had ceased, when they were not required to, for the sole purpose of maintaining fish habitat.

88. The Eiffelton drains are a living example of the benefits of Targeted Stream Augmentation. Fish and Game supported the Eiffelton Scheme when it renewed its resource consents in 2005 on the basis that the first requirement for a fishery was an assured water supply.

89. The drive-by survey of 20 March 2015 provides a snapshot of the condition of mid reaches of all the northern plains drains crossing Surveyors/Half Chain/Wheatstone roads on 20 March 2015 (Figure 4). Flows were estimated by eye and photographs taken (Figure 5).

Figure 4. Drive-by survey of drains crossing Surveyors/Half Chain/Wheatstone roads on 20 March 2015. Red dots were dry drains, blue dots were drains with flow.

Taylors Drain 0 l/s ponded

Deals Drain 50 l/s

Windermere Drain 35 l/s

Home Paddock Drain 25 l/s

Dawsons Drain dry

Bells Drain dry

Johnsons Drain dry

Spicers Drain dry

Andersons Drain dry

Blees Drain dry

Wheatstone 0.25 l/s from side stream otherwise dry upstream

Figure 5. Photographs of drains surveyed on 20 March 2015. Photographs are ordered horizontally in chronological order from south to north

90. Of the 13 drains crossing the roads only the three Eiffelton drains had significant flowing water. Wheatstone had a flow of about 0.25 l/s from a side drain originating on Stranges Road and was otherwise dry above Wheatstone Road. Taylors Drain had ponded water and within a week had dried out.

91. The Eiffelton Irrigation Scheme does not operate over the entire lengths of all the drains in the Scheme area. Shorter reaches of the drains above and below the supplemented section will dry out as was seen in January and March 2015 and the extent of these dry reaches correspond to the upper and lower dry reaches in the unsupplemented northern plains drains.

92. On 1 April 2015 single-pass electric fishing was undertaken on four sites covering the wetted reach of Windermere Drain. Upland bullies and juvenile and adult brown trout were abundant, longfinned and shortfinned eels were common, and one inanga was caught at the lowest site 2km above the coast. The size and age of the trout in particular identify perennial flow conditions and presence of inanga confirm connection of the drain to the sea occurs of sufficient extent to allow some degree of galaxiid migration.

93. On 1 April 2015 electric fishing could not be undertaken on any northern plains drains other than those in the Eiffelton Scheme as they were dry.

94. Eiffelton Drains survived the 2014/15 summer with continuous flows through the majority of their lengths. Canterbury Regional Council flow records for the Windermere, Flemington and Parakanoi drains at their Lower Beach Rd recorder sites from March 2011 to the present show that the Eiffelton Scheme has supported continuous flow in the Eiffelton drains while Flemington and Parakanoi drains have been dry every year for periods ranging from 10 to 157 days (Table 7).

Table 7. Summer season days of zero flow at Parakanoi and Flemington drains recorder sites since March 2011 and flow conditions at the Windermere flow recorder for the equivalent periods.

	Parakanoi	Flemington	Windermere	
Season	Dry days	Dry days	Dry days	Average flow (l/s)
2011/12	20	77	0	40
2012/13	9	88	0	59
2013/14	9	87	0	25
2014/15	149+	156+	87	12

95. In the 2014/15 summer there were 87 days with zero flow recorded at the Windermere flow measuring site. The recorder site is downstream of the lowest irrigation off take and there is no requirement for the Eiffelton Scheme to provide more water than is used by its members. When summer conditions are as harsh as they were in 2014/15 the Scheme would be intently managing its water. Continuous flow in the drain would have been maintained upstream of the lowest site of irrigation abstraction down the Scheme.

96. Parakanoi Drain flow records extending back to 23 January 2004 identify the drain has been dry at the flow recorder 7 of the last 11 summers. The duration of these periods has ranged from 10 days to 155+ days and averaged 76 days. Three of these events have been greater than 130 days in duration with the current period of zero flow standing at 155 days as of 5 May. No trout fishery can thrive in reaches that are without flow with this frequency and duration.

97. If I have one concern with the process of supplementation of degraded natural water quality in the Hinds Hekeao Plains drains with higher quality water from deep groundwater or MAR/TSA, it is that these solutions do not address the cause of the degradation, only dilution of the symptoms.

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