IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of applications by TrustPower Limited to Westland District Council and West Coast Regional Council for resource consents to operate and maintain the Kaniere Forks Hydro-Electric Power Scheme, and enhance, construct, operate and maintain the McKays Creek Hydro-Electric Power Scheme

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STATEMENT OF EVIDENCE OF MARTIN BERNARD SINGLE

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Introduction

1. My full name is Martin Bernard Single. I am an environmental consultant with 20 years of experience. I hold a Ph.D. in Geography, which investigated coastal processes and geomorphological change. I am a director and principal consultant for Shore Processes and Management Limited, specialising in the science, management and planning of coastal lands and waters.

2. I am an associate member of the Institute of Professional Engineers of New Zealand, a member of the International Coastal Navigation Association PIANC, and a member of the New Zealand Coastal Society. I also hold a position as a Senior Fellow in the Geography Department, University of Canterbury.

3. I have authored or co-authored over one hundred reports dealing with coastal and lakeshore geomorphology and management in New Zealand, Scotland and Fiji, including hazard assessment and mitigation measures, nearshore, beach and estuarine sediment transport, dredge spoil dispersal, beach nourishment, beach management prescriptions, and planning and audit control of consents for coastal protection structures and lake shoreline change.

4. My areas of specialisation are coastal processes and coastal management of New Zealand ocean beaches, lakeshores and harbours.

5. My work on lakeshore morphology has included hazard assessment and, where necessary, the development of hazard mitigation measures and management and monitoring prescriptions for:

   (a) TrustPower Limited (**TrustPower**) at Lakes Kaniere, Mahinerangi, Matahina, Matariki, Mangaonui, McLaren and Rotorangi;
   (b) Genesis Energy Limited (**Genesis Energy**) and the Department of Conservation (**DOC**) at Lake Waikaremoana;
   (c) Meridian Energy Limited (**Meridian Energy**) at Lakes Pukaki, Tekapo, Manapouri and Te Anau;
   (d) Mighty River Power Limited (**Mighty River Power**) at Lake Taupo, and the lakes along the Waikato River;
   (e) Pioneer Generation Limited at Lake Monowai;

(f) Canterbury and Taranaki Regional Councils, Christchurch, Manakau, Auckland and Dunedin City Councils, Gisborne, Westland and Whakatane District Councils, amongst others; and

(g) Peer reviewing Lake Taupo management strategy reports for King Country Energy Limited, TrustPower and Genesis Energy.

6. I am a principal consultant in assessing the physical environmental effect of hydropower operations on lakeshore morphodynamics for Meridian Energy, Genesis Energy, TrustPower, and the Guardians of Lakes Manapouri, Monowai and Te Anau (**the Guardians**). I have assessed the effects of boat wakes on lakeshores for the Guardians, Mighty River Power, and the Canterbury Conservancy of DOC.

7. I am a co-author, along with Dr Mark James and Professor Alan Mark, of the Ministry for the Environment publication "Lake Managers' Handbook, Lake Level Management" published in June 2002.

8. My recent experience in resource consent matters includes scoping and preparation of technical reports for resource consents for Port of Otago and Solid Energy Limited, preparation of technical assessment of effects on the shoreline of Lakes Coleridge and Matahina for TrustPower and review of technical reports on the effects on coastal processes of a previously proposed dam on the Mokihinui River for West Coast Regional Council and Buller District Council.

9. I am presently engaged to give advice on strategic planning and shore management of Lake Waikaremoana for Genesis Energy and Lake Pukaki for Meridian Energy, and to monitor and assess the physical shoreline condition of Lakes Manapouri and Te Anau for Meridian Energy.

10. I have read the Code of Conduct for Expert Witnesses (Rule 9.43, High Court Rules and Environment Court Practice Note 2011) and agree to comply with it. I confirm that I have complied with it in the preparation of this statement of evidence.

11. I have been asked by TrustPower to assess the physical shore environment of Lake Kaniere with regard to effects of the existing Kaniere Forks and McKays Creek Hydro-Electric Power Scheme (**HEPS** or **the Scheme**), and to assess lakeshore erosion issues associated with its consent application and proposed variation to the lake level operating regime.

12. I have undertaken a field inspection of the shoreline in March 2011 that included circumnavigation of the shore of the lake by boat. The water level at that time was approximately 1.0m local datum (LD). I have also examined photographs of the lakeshore in the vicinity of Sunny Bight, Canoe Cove and Hans Bay, taken when the water level was approximately -0.01m LD.

13. My description of the physical shore environment is based on the field inspection and additional photographs, and an examination of geological maps of the area and literature on the general geomorphology of this part of the West Coast. My assessment of the shore processes and effects of the HEPS operation is based on a background of previous work on general lakeshore dynamics from the scientific literature and from my work on lakes in New Zealand. In particular, my studies on lakes used for hydroelectric power generation such as Lakes Manapouri and Te Anau, Monowai, Pukaki, Waikaremoana, Mahinerangi, and Matahina have provided significant background on the dynamic processes of lakeshore change and response to lake level management.

14. I have read and reviewed where relevant the evidence of Mr Palmer, Mr Greenaway and Mr Bonis, reviewed relevant submissions, and conditions proposed by TrustPower.

15. My evidence addresses the effects of the proposed operating regime for Lake Kaniere on lakeshore erosion. It is my opinion that the effects of the proposal on the physical shore environment, and in particular lakeshore erosion of Lake Kaniere, are likely to be short-term and of little consequence to the geomorphological character of the shore.

Existing lakeshore environment

16. Lake Kaniere (Figure 1) is situated about 19km inland from Hokitika on the West Coast (at about 42˚50'S, 171˚09'E). It is approximately 8.6km long and 2km wide, with a maximum depth of 197m. It has a surface area of about 14.65km^2 at the normal maximum operating level of 1.0m LD, or 133m above mean sea level (MSL). The lake is within a valley impounded by glacial till (at the southern end) and fluvial deposits (at the northern end). The present outlet is the Kaniere River, draining from the north-western corner of the lake. A weir, comprising a concrete section 26.5m long with a spill crest at 1.05m LD, and an 11.0m section with stop logs with a crest at around 1.01m LD, controls the

outlet. Constriction of the outlet capacity can result in the lake level rising above the level of the weir.

17. The lake is normally lower in winter, coinciding with lower inflows, and higher managed flow release. The maximum recorded level is 1.71m LD in January 2002, and the second highest of 1.66m LD was recorded in November 2008. The lowest recorded level is -0.13m LD, measured on 30 April to 1 May 2003. The range for the lake is generally between 1.4m and 0.2m LD. Mean inflow to the lake is $7.25m^3s^{-1}$. There are higher mean inflow periods during June and for September to January. Lower mean inflows occur in the months of March to April, and July and August. Maximum inflows can be as high as $50m^3s^{-1}$, and may occur during any month of the year. The TrustPower hydrological studies (as presented by Mr Palmer) show the mean outflow for the lake for the period 2002 to September 2011 was about $6m^3s^{-1}$.

18. The lake level can rise rapidly from catchment inflows during floods. However, due to the large volume of water in the lake and the relatively small outlet, the current maximum daily drawdown is less than 0.05m.

19. The geology of the western side of the lake is dominated by the block of Pecksniff metasedimentary gneiss of Mount Graham and Conical Hill (greater than 400 million years old, undifferentiated quartzose sandstone), and to the east by material eroded from early Cretaceous Rahu suite of granite that makes up Tuhua peak (greater than 100 million years old). River gravel, sand deposits, glacial till, post-glacial deposits, and landslide debris, younger than 24,000 years, make up the mobile sediments of the shores. Inflows to the lake come from numerous streams from Mounts Graham and Tuhua. Clockwise from Hans Bay, the named streams are Tuhua Creek, Rose Creek, Camp Creek, Dorothy Creek, Geologist Creek (at the northern edge of Slip Bay), Hooker Creek, Kent Creek and Sunny Creek (flowing into Sunny Bight). The catchment area is approximately 54.5 km^2.

20. The shore of the lake can be characterised as predominantly a boulder shore, with a narrow steep zone that is sometimes inundated. Figure 2 shows an example of this shore type located on the southwestern shore. Much of the shore is forested to the water line. However the main open beach areas are at Hans Bay, and Sunny Bight (Figures 3 and 4). Stream fan deltas at Camp and Big Bays, and at Rose Creek (Figure 5), Geologist Creek, Hooker Creek and Kent Creek provide open areas for boat landing. Figure 6 shows an aspect of

the narrow linear beaches, situated along the southern shore at Lawyers Delight Beach.

21. Along the deltaic shores, the beach materials include large boulders that have been deposited at the shore during floods, and a mixture of gravel and sand sediment sizes that are transported by wave action along the shore from the source. Figure 7 shows an example of the distribution of sediments near Hooker Creek. The largest stream delta has formed at the mouth of Geologist Stream, and a large area of low-lying land extends to the north of the present creek outlet as shown in Figure 8.

22. The main beaches at Hans Bay and Sunny Bight are composed of small gravel to fine sand sediments. The beach at Hans Bay is quite steep, and the appearance of the backshore is indicative of possible periods of higher lake levels. The beach at Sunny Bight is more gently sloping, with a wide shallow fan adjacent to Sunny Creek (Figure 9).

Factors affecting shore morphology

23. The geological base to the topography determines to a large extent the shore character of the lake. Most of the boulder shoreline has very little in the way of finer sediments, and has the appearance of a jumble of rocks arriving at the shore from upslope. The backshore of the shoreline consists of a range of slope facets and plant communities. Where there are beaches, they are formed in sedimentary deposits that are generally unsorted and contain a wide range of sediment sizes that reflect the nature of the deposition (till, fluvial outwash, landslip fan). The surficial sediments of the beaches and nearshore are mainly coarse gravels and sand. Fine sediments appear to have been removed and are likely to have been deposited offshore. Sorting of sediments on the shore is a function of wave action.

24. Wave energy on the lake is limited due to the topography and aspect (in relation to the direction of wave approach) of the lake hinterland. The longest fetch is to winds blowing from the south or north. However, the dominant wind direction is from the west. It is likely that the lake is subject to waves up to about 0.3m high, except along the southern shore. Waves breaking on the beaches of Hans Bay and Sunny Bight have resulted in small erosion scarps at Hans Bay, and possible overwash and inundation at Sunny Bight. It is likely that the process energy is low, and that the shore character is the result of a relatively stable process environment.

25. The level of the water in the lake controls where waves can do work on the vertical extent of the shore. Waves at all levels have the potential to move sediment up and down the shore and along the shore. High water levels can result in sediment being moved onshore, and the formation of beach ridges, or erosion of softer backshore sediments and the development of erosion scarps. Both processes often result in damage to vegetation. Low water levels can result in offshore movement of sediment and slumping of cohesive but unstable deposits of fine sediments. The shores of Lake Kaniere exhibit no evidence of detrimental effects of changes in water level.

26. The shore around Lake Kaniere appears to be relatively stable and well adjusted to the existing range of water level and wave energy. Although short, steep waves generated by winds blowing over relatively short fetches are generally erosive in character, and the work they do in moving shore sediments is also a function of the water level, the limited fetch lengths on the lake and the robust character of the shore sediments limits the work of those waves. However, Figure 10 shows evidence of localised wave induced erosion along the beach at Hans Bay, especially in the vicinity of the jetty and the southern end of the playground. The erosion may be a result of human activities such as boat wake or wave interaction with structures such as the wooden jetty or the rock groyne.

27. Subaerial processes are also evident along the shore. For example, Figure 11 shows a small hillside slip entering the water, while Figure 12 shows slip material that has possibly been moved off Dorothy Falls Road into the lake. The slip debris is likely to extend below the water surface, and lakeshore processes have worked on the debris. However there is no evidence of wave action undermining the slope, or that the slope has become weakened or unstable because of physical lakeshore processes.

Lake level variation under Kaniere Forks and McKays Creek HEPS operation

28. Mr Palmer’s evidence presents the operational regime of the lake levels in relation to inflows, outflows, generation and spilling. The temporal variability of water level in the lake reflects changes in the inflows to the lake, power demand (and generation) and constraints on the outflows down Kaniere River.

29. Hydrological modelling was carried out to show the lake levels under existing lake level conditions, the proposed operating regime TrustPower has applied

for, and the same regime but with additional seasonal level restrictions as discussed by Mr Palmer.

30. The proposed operating regime (with or without the additional seasonal level restrictions) will result in the lake level being below the crest level of the weir for longer periods of time than the existing situation. However, the seasonal limits result in the lake remaining above 0.1m LD for a longer period, and subsequently at a slightly higher level overall, than if the proposed operating regime is implemented without these additional restrictions.

31. Table 1 shows the median and mean levels for Lake Kaniere under the modelled scenarios. The mean annual lake level will be about 0.42m lower than the existing situation under the proposed operating regime. With the additional seasonal limits, the proposed operating regime will reduce the mean lake level by approximately 0.27m during summer and 0.41m during winter, when compared to the existing situation.

Table 1 Lake Kaniere level statistics for the existing operation (Actual data) and proposed operating regime (with and without the additional seasonal level restrictions) for the period 2002 to September 2011 (After Palmer 2012).

	Mean level (2002-11)		
	Annual	**Summer (Nov-March)**	**Winter (April-Oct)**
Actual	0.84	0.92	0.78
PR (M7K1)	0.42	0.56	0.33
PR with seasonal limits (M7K1_Seasonal)	0.48	0.65	0.37

32. Mr Palmer also presents the findings of modelling drier years (2002/3, 2007, 2009/10, and 2011). He concludes that the level of Lake Kaniere will be lower on average under the proposed operating regime than in the past, but time in the low ranges (below 0.3m in summer, and 0.1m in winter) is limited with the proposed seasonal operating ranges.

Effects of Kaniere Forks and McKays Creek HEPS operation on physical shoreline processes and use of the shoreline resource

Physical shoreline processes

33. From the shoreline inspection, I am of the opinion that the shore of Lake Kaniere is not subject to extraordinary erosion, and the character of any erosion present is predominantly a factor of the underlying topography and geology rather than physical lacustrine processes including water level variation. The effects of the Scheme on the physical shoreline processes and

beach sediments are mainly linked to distribution of mobile shore sediments across the beaches, and to a lesser degree along the shores, at different elevations on the beach profile.

34. Ongoing changes to the shore from wave processes, fluvial currents and subaerial erosion of the hinterland result in a dynamic shoreline. However, the low energy levels of the waves limit the amount of change that occurs. Erosion of the backshore at Hans Bay appears to be a result of high water levels and is probably associated with strong westerly winds occurring after heavy rainfall events. There is no evidence of erosion at similar shore elevations in sheltered areas of the lake, at Sunny Bight or on the exposed beaches at the southern end of the lake. Artificial waves from boat wakes may also have an effect on shore stability on the beaches of Hans Bay and Sunny Bight.

35. Within the normal operating range, the lakeshore exhibits minor vertical variation in shore character for the different shore types. On the boulder shores, the shoreline at low lake levels shows a greater vertical extent of bare rocks and deposits of fine sediment within the interstices of the boulders. On the mobile sediment shores, gravel and coarse sand mantle consolidated sand and finer sediments.

36. The existing operating range of water levels has resulted in no apparent significant adverse effects to the dynamic function of the shore and physical shore processes.

Shoreline resource use

37. A number of activities utilise the lakeshore and can be affected by changes to the physical lakeshore processes. On Lake Kaniere these activities include swimming, boating, fishing and water-skiing.

38. There are concrete boat ramps at Hans Bay and Sunny Bight, and a formed boat-launching site near Tuhua Creek. The upper parts of the ramps appear to be clear of mobile sediment, and provide a firm base to the present low water level. The concrete ramps at Hans Bay and Sunny Bight may impede sediment transport along the shore, as there are low (up to about 0.3m) erosion scarps along the edge of the concrete ramp. However, the ramps may have been poured to perch on the beach slope to provide a gentler slope for launching.

39. In addition, there is also a wooden jetty at Hans Bay. The shore at the landward end of the jetty has retreated by about 2m, and the gap between the soft backshore and the jetty has been bridged with rock and other material. A rock jetty has also been constructed at the southern end of Hans Bay. Retreat of the backshore on either side of the rock jetty is uneven, with the northern side retreating further than the south. The eroded scarp is well vegetated, and does not appear to be actively eroding.

40. The backshore at Sunny Bight and Hans Bay has been landscaped to provide recreational areas. The beach at Sunny Bight is well nourished and has a low accretional berm, while the nearshore lakebed is mantled in sand and gravel to a depth of about 0.0m LD. A low, vegetated erosion scarp backs the beach at Hans Bay, and the nearshore lakebed is mantled in coarse gravel out to a depth of about 0.0m LD. Lakeward of this depth at both sites, the bed appears to steepen. There are fine sediments within the coarse gravel matrix, and there is a cover of aquatic vegetation.

41. There are potential hazards for boat use on the lake in the form of floating and semi-submerged trees and logs. Some of these are a result of slips along the shore margins, while some enter the lake via streams. The hazard is a natural occurrence on lakes with trees close to the shore, and especially where the catchment is subject to hillslope erosion.

42. Boat wake may be a cause of erosion at Hans Bay, but there is no evidence of wake-induced erosion at other sites on the shoreline of the lake.

Effects of a revised operating regime

43. I have assessed the effects on the physical lakeshore environment and processes of the proposed (revised) operating regime detailed in Mr Palmer's evidence, both with and without the additional seasonal restrictions he describes. The proposed operating regime (with or without the additional seasonal restrictions) will result in lake levels remaining within the existing consented range, but generally being at lower levels more often than at present. The difference between the existing and proposed operating regimes would be reduced by the imposition of the additional seasonal restrictions. These additional restrictions would also preclude very low levels being reached in dry years.

44. The shoreline and shore vegetation appear to be robust and have adapted to the existing regime. In particular, the physical aspects of the shore and the terrestrial vegetation associated with the upper part of the water level range appear to be in equilibrium with the existing operating regime.

45. The proposed operating regime is likely to result in minor shoreline changes at elevations exposed when lake levels are towards the lower end of the proposed operating range. This is because the water level, and the elevation to which waves can work, will on average be lower, and therefore more energy will potentially be expended on lower elevations than at present.

46. However, the coarse nature of the shore sediments and the low wave energy mean it is unlikely that there will be significant erosion or movement of sediment on the beaches under the proposed operating regime (with or without the additional seasonal restrictions). Under the proposed operating regime (even with the additional seasonal restrictions), lakebed that is presently seldom exposed will be exposed to wave processes and open air more regularly, and for longer periods. This increased exposure will be long enough for fine sediments to dry out and potentially be moved by wind and/or wave action. However, it is likely that the shore will adjust, and that after time, the shore and lakebed will retain its present character, but with a wider range of exposed beach.

Submissions

47. A number of submissions refer to adverse effects of lowering the lake level. The concerns generally cover three themes. These are:

(a) Problems for boating through making the launching ramps unusable, and increasing the potential for boating hazards such as exposed rocks,
(b) Safety concerns for swimmers due changes to the nearshore conditions, and
(c) Exposure of the lakebed leading to loss of visual amenity values, increased mud on the beaches and changes to the lakeshore.

48. The first two themes relate to recreational use of the lake and lakeshore. I have also raised these points in my assessment of effects of the proposed operating regime and have proposed possible mitigation through signage to make users aware of the shore and lake conditions related to low water level, and identification and marking of boating hazards. These matters are covered in more detail in the evidence of Mr Greenaway.

49. The third theme relates to changes to the amount of the lakeshore exposed by low water levels, and the effects on the amenity and landscape value. For example, the pro-forma submission states: “The proposed lowering of the lake will substantially affect the visual appeal of the lakeshore and river mouth.” Ms Buckland addresses these matters in her brief of evidence.

50. Four submitters noted possible adverse effects relating to the physical composition of the shore. For example, Nelson Bradley (Submitter 7 and 147) notes that “Sandy beaches would be lost to recreational users due to exposed foreshore, rubble etc.”, while Bruce and Heath Barcock (9), and Jackie Gurdon (12) note that rocky shores would be exposed. Based on my assessment of the shore, the beaches would not change in sediment character. Ken Copplestone (93) notes a need to “wade through mud to get to water”. The lower water levels would expose a wider shore, and in some places there would be an initial presence of mud and aquatic vegetation exposed at the water edge. Some rocks and otherwise submerged logs that are embedded in the beach would also become exposed. However these features are not out of character for the shore of Lake Kaniere, and with more regular exposure to wave action, the beaches will adjust to be similar in appearance but wider than presently seen.

51. West Coast Regional Council asked whether consideration was given to increasing the height of the Lake Kaniere weir. This was not investigated for this project. However I did consider the effects of raising the maximum operating level of Lake Kaniere. In my opinion, the effects on the shore geomorphology, vegetation and use of the shore would be adverse and irreversible.

Officers’ Report

52. I have reviewed the Officers’ Report. It does not raise any matters relevant to my expertise on which it is necessary for me to comment.

Conclusions and recommendations

53. The shore of Lake Kaniere appears to be in dynamic equilibrium with regards to the ongoing physical lacustrine processes of waves and currents and use as part of the HEPS. The lake level operating range does not appear to have an adverse effect on the shore development or on the viability of the shore vegetation.

54. I have assessed the effects of the proposed operating regime, both with and without the additional seasonal limitations. In my opinion, it is unlikely that there will be significant erosion or change to the physical process environment. However, lower elevations of the shore will be exposed more often and for longer durations, and it is likely that fine sediments will be exposed to wind and waves. This sediment will probably be transported offshore. The proposed additional seasonal limitations result in fewer excursions to the lower lake levels, and a slightly higher median and mean level during summer and winter than the proposed operating regime alone. The beaches and sections of the shore with mobile sediments will adjust to the new water level regime over time, developing an equilibrium character that is similar to that presently seen.

55. Use of the shore resource may be adversely affected due to the greater periods of lower lake levels. The concrete boat ramps may need to be extended offshore, and potential semi-submerged hazards to boating should be identified. Mr Greenaway addresses these points in more detail.

56. Turning to concerns raised by submitters, I make two recommendations with regard to management of the physical lakeshore environment. These are:

    1. The level of effect does not warrant a monitoring plan for assessment of the lakeshore. However, a regular 5-yearly inspection of the lakeshore should be carried out. This is covered by Conditions 7 and 8 Lake shore erosion inspection of Water Permit RC10001/36 of the WCRC consent conditions for McKays Creek HEPS.

    2. A well-marked water level indicator (pole with markings) should be installed at the boat ramps to provide day-to-day information so that users will be aware of potential hazards due to different water levels. This is covered by Condition 4 Lake levels of Water Permit RC10001/36 of the WCRC consent conditions for McKays Creek HEPS.

57. I note that the draft Construction Plan includes proposed upgrades to the boat ramps at Hans Bay and Sunny Bight. This work appears appropriate in maintaining launching opportunities under the proposed operating regime.

Martin Single
June 2011

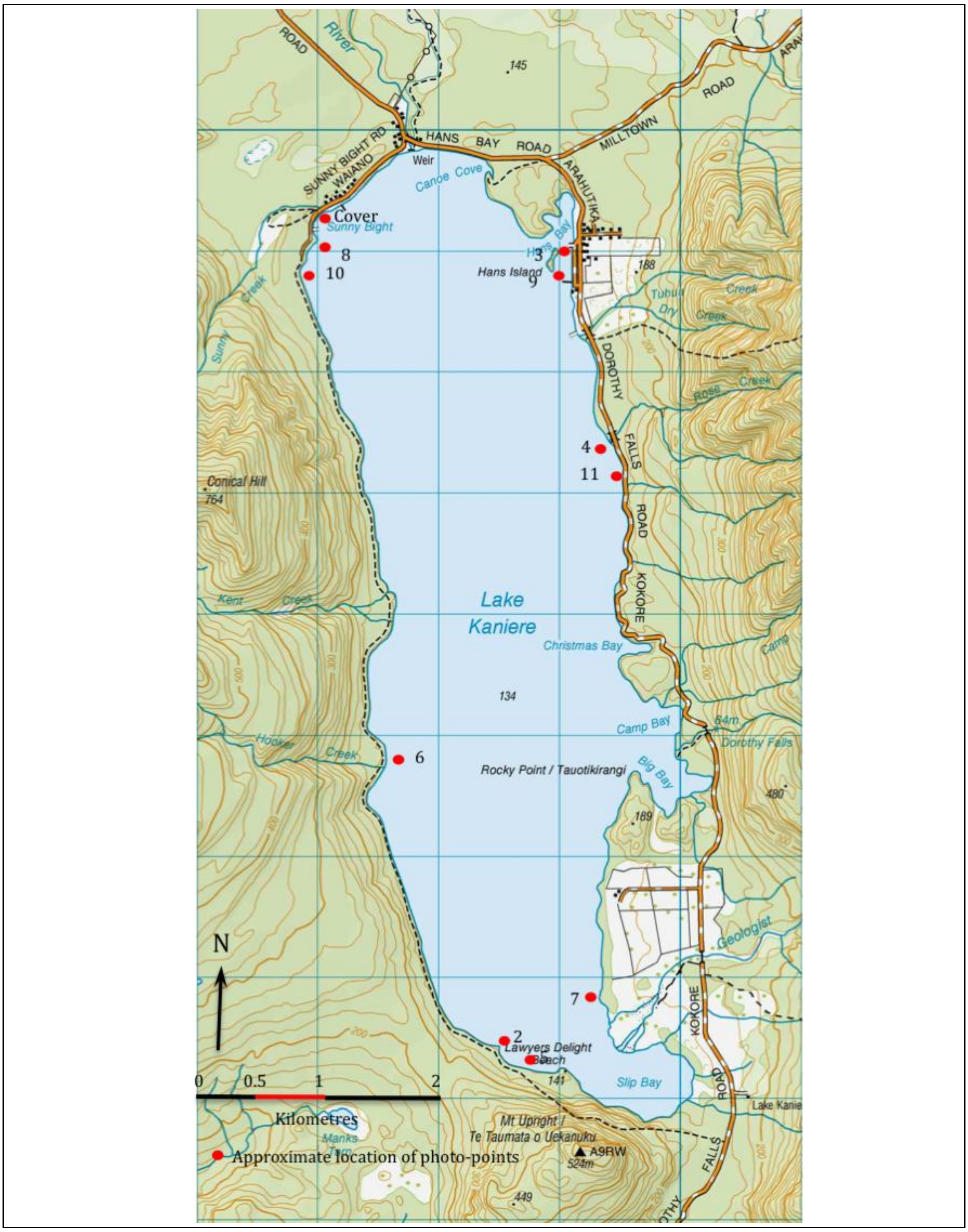

Figure 1 Lake Kaniere (Source: NZTopo50 BV19). Numbered dots relate to Figure photopoints.

Figure2 Boulder shoreline with vegetation to the waterline.

Figure 3 Hans Bay, looking south along the shore from the boat ramp towards the picnic and playground area.

Figure 4 Sunny Bight, looking north along the shore from the boat ramp towards a camping area.

Figure 5 Rose Creek delta

Figure 6 Lawyers Delight beach

Figure 7 Hooker Creek

Figure 8 Geologists Creek delta extends from a large low-lying area at the southeastern corner of the lake

Figure 9 Sunny Bight Creek

Figure 10 Erosion at the jetty at Hans Bay.

Figure 11 Slip south of ski lane at Sunny Bight

Figure 12 Slip south of Rose Creek