

# GRAEME HORRELL

ENGINEERING HYDROLOGIST

Graeme Horrell  
Consultancy Limited

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## ACADEMIC QUALIFICATIONS:

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- New Zealand Certificate of Science – 1985
- University of New South Wales – Post Graduate Course in Hydrology – 1990
- University of New South Wales – MSc Engineering Science (Hydrology) – 1992

## SPECIALIST EXPERTISE:

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- Integrated catchment water management
- Hydrological modelling
- Water resource mapping
- Flood forecasting
- High intensity rainfall frequency analysis
- Flood warning in flood prone catchments
- Data processing and quality

## PROFESSIONAL EXPERIENCE:

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2016 -	Graeme Horrell Consultancy Limited
2008 – 2016	Engineering Hydrologist and project Leader, NIWA Christchurch
1990 – 2008	Surface Water Quantity Scientist Team Leader, Environment Canterbury, Christchurch
1986 – 1989	Senior Analyst, North Canterbury Catchment Board, Christchurch
1983 – 1985	Hydrological Engineering Officer Power Investigations (Consultants to ECNZ), MWD, Wellington
1970 – 1981	Hydrological Technical Officer – MWD and MWD Hydrology Centre, Christchurch, Greymouth, Timaru, Lake Tekapo, Antarctica

## PROFESSIONAL AFFILIATIONS/MEMBERSHIPS:

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- New Zealand Hydrological Society (period as executive member) - since 1983
- New Zealand Meteorological Society – since 1984
- New Zealand Deer Farmers Association – since 1997
- Irrigation New Zealand – since 2006
- Waihora/Ellesmere Trust - since 2007
- Ministry of the Environment Hearings Commissioner - since 2013
- Adjunct Fellow, Waterways Centre, University of Canterbury - since 2016

## PROFESSIONAL DEVELOPMENT:

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### High Intensity Rainfall Design System (HIRDS)

- Testing and promoting New Zealand's high intensity rainfall design system to be fit for purpose and readily adopted by design engineers throughout New Zealand.
- Planned and obtained funding for the 2016 HIRDS upgrade, to include NZ's first areal reduction curves and temporal design storm patterns.

### **Integrated catchment management**

- Set up Environment Canterbury's first completely integrated catchment water resource survey on the Orari catchment, this included surface and groundwater interaction as well as the full measurement of all surface and groundwater abstractions.

### **Mapping water resources**

- Overseen the complete mapping of the Canterbury region's water resources at low flow, including concurrent gaugings to detect losing and gaining reaches.

### **Water loss and gain surveys**

- Completed on the, Rakaia, Waimakariri, Rangitata, Orari, Ohapi, Ashburton, Selwyn, Avon, Waipara, and Ashley rivers.

### **Naturalising river flow**

- Advanced the knowledge of the naturalised Ashburton River flow regime to enable integrated catchment water resource management.
- Water Plan scenario modelling of tributaries and main stem minimum flows and allocation, to achieve the same high reliability of supply for all catchment irrigators.

### **Water balance modelling**

- Developed a practical (42 year) daily water balance model of Te Waihora (Lake Ellesmere) for lake level scenario testing for optional management rules, used in two WCO Hearings.
- The key witness at the Hearing for the amendments to the WCO on Te Waihora (Lake Ellesmere) to improve the environmental health of this fourth largest lake in New Zealand.
- Model used in the Selwyn/Waihora Zone limit setting.

### **Environment Court negotiations**

- Advanced the Opihi River Plan environment Court negotiations by modelling the influence of the Opuha Dam.
- Negotiating consent conditions for the abstraction of water from the Hakataramea River

### **Flood Forecasting**

- Successfully developed one of the first flood forecasting systems in Australasia. Forecasts provide 16 hours warning to Christchurch of Waimakariri River floods.
- Forecast floods for the Ashley River to the Rangiora traffic Bridge, from storm rainfalls. Providing up to six hours warning of flood peaks within  $\pm 13\%$  of the actual magnitude and within  $\pm$  one hour of arrival time. The model was used to confirm the 100 year design flood for the Ashley Floodplain Management Regional Plan.

### **Team Leader**

- Led a surface water monitoring team operating a large hydrometric network and successfully increased the annual data processed, from 40% to 99%. Youngest research team leader in the Antarctic.

### **Rainfall research**

- Set up and serviced climatological and hydrological stations across a transect of the Southern Alps of New Zealand from Mt Hutt to the Waitaha Valley on the West coast.

- Included organised teams of up to 28 scientists and technicians to complete monthly measurements using helicopters in a rugged mountainous area, where the weather can change very quickly. Measurements of 13000 mm annual rain and winds of 210 mph were common.

#### **MANAGEMENT SKILLS:**

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- Ability to motivate people to undertake and complete projects
- Highly organised, experienced coordinator and delegator of tasks
- Patient listener with empathy for people's opinions and feelings

#### **PUBLICATIONS:**

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##### **SCIENTIFIC PUBLICATIONS:**

Horrell, G.A., Jenkins, J.V., 1980. Index to hydrological and climatological recording sites under Alpine Processes control. Water and Soil Science Centre Christchurch, WS 323, 15 p.

Whitehouse, I.E., McSaveney, M.J.; **Horrell**, G.A. 1983. Spatial variability of low flows across a portion of the central Southern Alps, New Zealand. *Journal of Hydrology, (New Zealand)* 22: 123-137.

Griffiths, G.A.; Pearson, C.P.; **Horrell**, G.A. 1989 Rainfall-runoff routing in the Waimakariri Basin, New Zealand. *Journal of Hydrology, (New Zealand)* 28:111-122.

Horrell, G., Pearson, C., (May 2014) Planned upgrade of NIWA's High intensity rainfall design system (HIRDS). Proceedings to the Storm Water conference in Christchurch. 9 p.

Horrell, G.A., (November 2014). Water balance model for management and restoration of Te Waihora (Lake Ellesmere), New Zealand. Proceedings to 15<sup>th</sup> World Lakes Conference. ISBN 978-88-96504-04-8. 249-255 p.

##### **REPORTS:**

Horrell, G.A., 1977. Feasibility study of snow fences in the Cobb catchment. Water and Soil Science Centre Christchurch, WS 17/9, p 4

McSaveney, M.J., Chinn, T.J., **Horrell**, G.A., Longson, C.K., 1978. The measured distribution of precipitation across the Southern Alps. Hydrological Society Conference proceedings. Water and Soil Science Centre Christchurch, 7 p.

Jowett, I. G., **Horrell**, G.A., Young, J., 1984. Lower Waitaki catchment Hydrology Report. Power Directorate, Ministry of Works, Technical report, No 84/5. 114 p.

Jowett, I. G., **Horrell**, G.A., 1984. Manuherikia River Falls Dam spillway capacity and design flood study. Power Directorate, Ministry of Works, Technical report 92/11/90/2/2. 9 p.

Horrell, G.A., 1985. Estimates of Arnold River flows at the Arnold Power Station. Power Directorate, Ministry of Works, Technical report No 85/5. 20 p.

Horrell, G.A., 1990. Map of mean annual rainfall, South Westland, New Zealand. Environment Canterbury, Technical Report, R90/16. 7 p.

- Horrell, G.A., 1992. Lake Ellesmere water balance model: variable analysis and evaluation. Master of Engineering Science Thesis, University of New South Wales. 153 p.
- Horrell, G.A., 1998. 1997/98 Drought in the Canterbury Region. Canterbury Regional Council Report No. U98/31, Christchurch, New Zealand, 22 p.
- Horrell, G.A., 2001. Ashburton River Low Flow Regime. Canterbury Regional Council Report No. U01/26, Christchurch, New Zealand, 71 p.
- Horrell, G.A., 2001. Avon and Heathcote Rivers: Impacts of lowflow management options upon dry riverbed and tributary flow. Canterbury Regional Council Report No. U01/105, Christchurch, New Zealand, 81 p.
- Facer, S, C., **Horrell**, G. A., 2002. Estimates of mean annual low flows for Lake Ellesmere tributaries and streams in the Little Rakaia Zone. Environment Canterbury Technical Report, Christchurch, New Zealand, U02/29, 53 p.
- Horrell, G.A., 2004. Ashburton River Low Flow Regime – review and update. Canterbury Regional Council Report No. U04/20, Christchurch, New Zealand, 83 p.
- Gabites, S, C., **Horrell**, G. A., 2005. Seven day mean annual low flow mapping of the tributaries of the Waitaki River. Environment Canterbury Technical Report, Christchurch, New Zealand, U05/16, 111 p.
- Aitchison-Earl, O., Ettema, M., **Horrell**, G. A., McKercher, A, I., Smith, E., 2006. Pareora-Waihao River: Water Resources Summary, Environment Canterbury Technical Report, Christchurch, New Zealand. Report No. R06/20 ISBN 1-86937-602-1.
- Clausen, B., **Horrell**, G.A., 2007. Estimation of daily flows in Lake Ellesmere tributaries (1 April 1991 – 31 December 2006), unpublished. Canterbury Regional Council Report No U07/85. Christchurch, New Zealand, 85 p.
- Horrell, G.A., 2008. Lake Ellesmere (Te Waihora) seawater inflows: June-July 2008, NIWA Client Report: CHC2008-131. 47 p.
- Pearson, C.P., Griffiths, G.A., **Horrell**, G.A., 2008. Review of the flood frequency hydrology of the Ashburton River, Canterbury. NIWA Client report CHC2008-148. 14 p.
- Horrell, G.A., 2009. Lake Ellesmere (Te Waihora) water balance model: variable update 1991 to 2007. NIWA Client Report: CHC2009-102. 27 p.
- McKerchar, A.I., Henderson, R.D., **Horrell**, G.A., 2010. Standard procedures for creating and describing synthetic hydrological record. NIWA Client Report: CHC2010-002. 30 p.
- Horrell, G.A, Zammit, C., 2011. Field investigation to determine lake water and seawater seepage through Kaitorete Spit at the narrowest beach barrier location (Taumutu) identified by Valentine (1988). NIWA Client Report: CHC2011-004. 36 p.
- Horrell, G.A, 2011. Te Waihora (Lake Ellesmere) water balance modeling. NIWA Client Report. CHC2011-104. 18 p.
- Griffiths, G.A ,**Horrell**, G.A., 2012. Estimation of flow statistics and regime at ungauged sites

- using concurrent gauging techniques. NIWA Client Report. CHC2012-068. 13 p.
- Henderson, R., **Horrell**, G.A., Griffiths, G.A., Collins, D., 2012. Water Resource Information. Appropriate tools and analysis. NIWA Client Report CHC2012-135. 58 p.
- Horrell, G.A., Henderson, R., Dietrich, J., 2012. Ashburton/Hakatere River flow and allocation regimes: Update and modeling results. NIWA Client Report CHC2012-140. 42 p.
- Norton, N., **Horrell**, G. A, Allan, M., Hamilton, D., Sutherland, D., Meredith, A., (Nov 2012). Selwyn Waihora limit setting project: Predicting consequences of future scenarios for Te Waihora/Lake Ellesmere. NIWA Client report No CHC2012-141 for Environment Canterbury. 94 p.
- Rouse, H., **Horrell**, G. A., Depree, C., Rajanayaka, C., Cooke, J., Giorgetti, A., Norton, N., Snelder, T., Fraser. C. (June 2013 ). Regional Council Freshwater Management Methodologies: accounting systems and limit setting. NIWA Client report No. CHC2013-077 for Ministry for the Environment. 200 p.
- Measures, R., **Horrell**, G. A., April (2013). Opening and Closure of Waituna Lagoon; Review of recent investigations. NIWA Client report No. CHC2013-039 for DairyNZ. 31 p.
- Arnold, P., **Horrell**, G., (July 2013). Data Audit Review: Ngaruroro River at Whanawhana. NIWA Client report CHC2013-084. Prepared for Hawkes Bay Regional Council. 223 p.
- Arnold, P., **Horrell**, G., (July 2013). Data Audit Review: Ngaruroro River at Fernhill. NIWA Client report CHC2013-083. Prepared for Hawkes Bay Regional Council. 83 p.
- Champion, P., **Horrell**, G., MacDiarmid, A., (October 2013). Toreparu Steam, Toreparu Wetland and Waiiau Stream; Review of ecology, hydrology and ecological impacts of water extraction. NIWA Client Report No: WLG2013-51. Prepared for Sinosteel Australia Pty Ltd. 47 p.
- Griffiths, G., McKerchar, A., Collins, D., **Horrell**, G., Zammit, C., (April 2014). Rainfall and runoff estimation in New Zealand: developing a guide. NIWA Client Report No: CHC2014-035. Prepared for IPENZ Rivers Group. 26 p.
- Horrell, G., Yang, J., Sykes, J., (June 2014) Gaining and losing reaches in South Island Rivers. NIWA Client Report No: CHC 2014\_088: Prepared for Core funded projects FWWR1404 and FWWA1408. 31 p.
- Measures,R., Cochrane,T., Caruso, B., Walsh, J., **Horrell**, G., Hicks, M., Wild, M.,(June 2014). Analysis of Te Waihora lake level control options. A Whakaora Te Waihora science project. NIWA Client report CHC2014-076. Prepared for Ngāi Tahu and Environment Canterbury. 160 p
- Horrell, G., (December 2014) Review of the science supporting the proposed minimum flow regime for the Lindis River. NIWA Client report CHC2014-146. Prepared for Otago Regional Council. 14 p.
- Watson, M., **Horrell**, G., Doyle, M., (April 2015) DRAFT National environmental monitoring standards on rating curves: construction of stage-discharge and velocity-index ratings. For MFE. 132 p.

- Horrell, G., (May 2015). Low flow risk from the Waitara River. NIWA Client report CHC2015-041. Prepared for Methanex NZ Ltd. 14 p.
- Horrell, G., Yang, J., Sykes, J., (June 2015) Gaining and losing reaches of Southland and Otago Regions. NIWA Client Report No: CHC 2015\_021: Prepared for Core funded project FWWR1503 26 p.
- Horrell, G., Yang, J., Sykes, J., (November 2015) Gaining and losing reaches of the South Island West Coast Region. NIWA Client Report No: CHC 2015\_115: Prepared for Core funded project FWWR1603 21 p.
- Horrell, G., (March 2017). Hydrology study for Kerikeri River Flood Scheme. GHCL Client report No 2017-001 prepared for Northland Regional Council. 22 p.
- Horrell, G., Boraman, D., (February 2018). Review of Marlborough District Council environmental data systems. GHCL Client report No 2017-002 prepared for Marlborough District Council. 69 p.

#### **EVIDENCE:**

- Horrell, G.A., 1998. Hydrology of the Opuha flood of February 1997. Evidence for Environment Court on the Opuha Dam collapse. Canterbury Regional Council. Christchurch, New Zealand, 12 p.
- Horrell, G.A., 2005. Selwyn and Irwell Rivers explanation for an apparent reduction in low flows. Canterbury Regional Council, Environment Court Expert witness evidence, RMA 0146/04 Lynton Dairy Limited. Christchurch, New Zealand, 16 p.
- Horrell, G.A., 2006. Surface water flows in decline. Canterbury Regional Council, Consent Hearing Expert witness evidence, applications to use groundwater in the Rakaia Selwyn groundwater allocation zone. Christchurch, New Zealand, 57 p.
- Horrell, G.A., 2007. Overview of the hydrological characteristics of catchments sensitive to the effects of vegetation change, and the identification of flow-sensitive catchments. Natural Resources Regional Plan Hearing, WQN7, expert witness evidence. Canterbury Regional Council. Christchurch, New Zealand, 10 p.
- Horrell, G.A., 2008. Lister prosecution. Expert witness evidence. Canterbury Regional Council. Christchurch, New Zealand, 8 p.
- Horrell, G.A., 2009. Ashburton River/Hakatere flow and allocation regimes: Review and update of options. Natural Resources Regional Plan Hearing, expert witness evidence. NIWA Client Report: CHC2009-009. 23 p.
- Horrell, G.A., 2011. An application by Te Runanga o Ngāi Tahu and the Department of Conservation to amend the National Water Conservation (Lake Ellesmere) Order 1990. Environment Court expert evidence. 14 p.
- Horrell, G.A., 2013. A joint application by the Canterbury Regional Council and Te Rūnanga o Ngāi Tahu for resource consent to open and close Te Waihora/Lake Ellesmere to the sea and other minor earthworks activities and investigations. Consent Hearing expert

evidence. 29 p.

Horrell, G.A., 2015. An application by Infinity Investment Group Holdings Limited for resource consent to abstract water for irrigation from the Hakataramea main stem. Consent Hearing expert evidence. 9 p.

Horrell, G.A., 2016. An appeal by Infinity Investment Group Holdings Limited for resource consent to abstract water for irrigation from the Hakataramea main stem. Environment Court Hearing expert evidence. 19 p.