# 2018 NZHS Technical Workshop, sponsored by Hyquest Solutions limited

**Hosted by Horizons Regional Council**

# 2018 NZHS Technical Workshop

**Venue:** Palmerston North Conference & Function Centre,
354 Main Street, Palmerston North

**When:** 6th to 9th March 2018

**Theme:** The workshop is entitled “Discover the real dirt in hydrology”.


**Keynote Speaker:** John R. Gray is Principal at Gray Sedimentology, and a former lead National Sedimentologist with the U.S. Geological Survey’s Office of Surface Water.

John has over four decades of field and office experience in sediment, streamflow, and water-quality data collection. Additionally, he has significant success in program design, implementation, execution, review and summary on behalf of global clients.

The first 14 years of John’s 38 years of USGS experience were field- and project-work centric in three USGS offices in Illinois and Arizona. This experience enables insights on riverine-transport processes and uncertainties, including sampler limitations and data uncertainties that may impinge on the significance of findings ranging from data-collection to monitoring-program levels.

Please visit GraySedimentology.com for more information

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# Exhibitor Profiles


The best presenter is awarded to someone with less than 3 years' experience. The prize money is for attending the Australian Hydrographers biannual conference.

# Workshop Program

## 6/3/2018 Workshop and Social Event

| | |
|---|---|
| 0900-0930 | Registrations |
| 0940-1000 | Introduction:<br>Micah Dodge<br><br>Formal welcoming:<br>Michael McCartney |

| Time | Topic | Speaker | Organisation |
|---|---|---|---|
| 1000-1015 | Overview on sediment monitoring in New Zealand | Jeff Watson | Horizons Regional Council |
| 1015-1030 | Suspended sediment loads in NZ rivers: how much, where from, when, what size sediment, and who cares? | Murray Hicks | NIWA |
| **1030-1100** | **Morning tea** | | |
| 1100-1115 | Earthworks sediment yields: TSS and flow monitoring for consent compliance | Todd Redman | PDP |
| 1115-1130 | Suspended sediment turbidity relationships | Christina Bright | University of Otago |
| 1130-1145 | Experience in deriving suspended sediment loads from turbidity data | Brent Watson | Horizons Regional Council |
| 1145-1200 | Continuous turbidity monitoring in a construction environment | Ryan Evison | NIWA |
| 1200-1215 | The internet of things and environmental monitoring | Rod McKay | NIWA |
| **1215-1315 Lunch** | | | |
| 1315-1515 | John Gray session 1 | -Introduction to workshop content (including alignment with NEMS)<br>-Basic fluvial concepts<br>-TSS vs SSC | |
| **1515-1535** | **Afternoon tea** | | |
| 1535-1635 | John Gray session 2 | -Organic and non-organic fraction<br>-Instruments for collecting fluvial sediment data | |

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|---|---|---|---|
| 1635-1725 | Trade stand presentations | 5 minutes each | |

**1800 Social Event held at Brew Union**
**Sponsored by Aquatic Informatics**

# 7/3/2018 Workshop and Dinner

| Time | Topic | Speaker | Organisation |
|---|---|---|---|
| 0900-0915 | HydroSurveyor and Hypack integration and how it can be used in a sediment application | Daniel Wagenaar | SonTek / Xylem |
| 0915-0930 | Using signal-to-noise ratio data to estimate sediment loads: challenges and opportunities | Ed Clayton | PDP |
| 0930-0945 | Groundwater sampling for the State of the Environment (SOE) | Dirk VanWalt | Van Walt limited |
| 0945-1000 | Monitoring and predicting bedload transport: challenges, methods, and opportunities | Andrew Neverman | Landcare Research |
| 1000-1015 | Flood warning services in the Korokoro Stream catchment | Ethan Coulston | Greater Wellington Regional Council |
| **1015-1035** | **Morning tea** | | |
| 1035-1055 | Vaughan Stream– A catchment undergoing change | Stacey Fraser | Auckland Council |
| 1055-1115 | NEMS and the calibration of turbidity sensors | Evan Baddock | NIWA |
| 1115-1135 | Problems and solutions in turbidity monitoring in NZ - break out group | Evan Baddock, Juliet Milne, Jochen Schmidt | NIWA |
| 1135-1155 | Health and safety discussion, latest findings & breakout group | Steph Bowis | Tasman District Council |
| **1200-1300** | **Lunch** | | |
| 1300-1500 | John Gray session 3 | -Suspended sediment sampling techniques<br><br>-Selection and deployment of auto samplers and “traps” for young players<br>Surrogate technologies<br>-Turbidity sensors<br>-ADCP’s<br>-Density sensors | |

| | | | |
|---|---|---|---|
| **1500-1520** | **Afternoon tea** | | |
| 1520-1700 | John Gray session 4 | -Bedload data collection in sand and gravel bed rivers<br><br>-Bottom material data collection in sand and gravel bed rivers<br><br>-Special sediment data collection problems and practical solutions | |
| 1700-1730 | Field day organisation and discussion | Micah Dodge | |

**Workshop dinner held at Palmerston North Conference & Function Centre – Sponsored by Kisters**

# 8/3/2018 Field Day

0900-1600 Sediment sampling practical - Large and small stream field techniques and ADCP Gauging regatta – Manawatu at Teachers College

# 9/3/2018 Workshop - Advanced Techniques and Processing - John Gray

| Time | Topic |
|---|---|
| 0900-0945 | Quality control of suspended sediment data collection |
| 0945-1015 | Particle size analyses of suspended sediment samples |
| **1015-1035 Morning tea** | |
| 1035- 1115 | Derivation and application of box coefficients for automatic samplers and sediment surrogate technologies |
| 1115-1200 | Sediment record computation and interpretation |
| **1200-1300 Lunch** | |
| 1300-1430 | Recap and discussion |

# Abstracts

**Sediment Monitoring – A Brief NZ history** Jeff Watson - Horizons Regional Council

New Zealand has some of the most significant soil erosion issues globally, with an estimated 200-300 million tonnes of soil being lost to our oceans every year.

The 1941 Soil Conservation and Rivers Control Act provided a mechanism by which our countries soil resources and flood hazards could be better managed.

As a consequence of this legislation, a more scientific approach to gaining an understanding of the magnitude of the problems commenced. The investigative work associated with understanding our river flows and associated sediment transport was led primarily by the North Island Hydraulic Survey Party of the Ministry of Works, and to a lesser extent the fledgling Catchment Boards.

**Suspended sediment loads in NZ rivers: how much, where from, when, what size sediment, and who cares?** Murray Hicks - NIWA

This presentation overviews some important things to know about suspended sediment in New Zealand rivers. It covers: how loads and concentrations vary around the country and why; which flows transport most of the time-averaged load; how the size-grading varies; and what the current needs are for suspended sediment information.

The main spatial controls on sediment load and concentration are climate (closely related to topography), geology, and land use – these drive a 1000-fold range in sediment yield per unit catchment area. The bulk of the time-averaged load is carried during freshes and floods, with, on average, 76% transported at flows between the mean and the mean annual flood. Catchment lithology is the main control on particle size, and the sand content varies from zero to 85%. Current/anticipated needs for suspended sediment information include: (1) development and validation of predictive models; (2) directing soil conservation initiatives and evaluating their effectiveness; (3) managing/policing catchment load limits; (4) linking sediment-related environmental attributes (e.g. water-clarity, fine sediment deposition) to sediment loads and sources; (5) assessing climate-change effects (e.g. sand supply to beaches); and (6) downstream environmental effects of water-use schemes (e.g. dams, water diversions) and earth-moving projects (e.g. highway construction).

**Earthworks sediment yields: TSS and flow monitoring for consent compliance** Todd Redman - PDP

Land disturbance has historically been a major contributor to sediment loads in freshwater. This land disturbance can vary from forest clearance to urban development. In Auckland, demand for housing has resulted in large blocks of land being developed for housing. These residential developments can consist of 50-100 ha land parcels developed over several years. Given the proximity to sensitive receiving environments, some developments have been required to monitor discharges from sediment retention ponds in order to assess sediment yields and measure the efficacy of site sediment controls.

PDP monitors several different earthworks sites, building v-notch weirs and deploying automatic samplers to collect physical samples for TSS analysis. Results from the monitoring inform clients on

the rate of sediment generation. This in turn helps site responses and continual improvements and adaptations in site sediment controls.

**Turbidity is more than just sediment** Bright, C.E.[1] Mager S.M.[11] Department of Geography, University of Otago

Turbidity is a measure of water clarity and measured as a requirement of regional councils in their Water Plans as mandated by the National Policy Statement for Freshwater Management. In New Zealand it is common to use turbidity as a proxy variable to derive suspended sediment concentrations, enabling established turbidity and suspended sediment relationships to be produced and a significant body of research validates the application of such relationships in both the New Zealand and global setting. However, it is not uncommon in published academic studies to see cautions on the use of turbidity as a single proxy measure for suspended sediment, and yet in the regulatory setting, it is unclear how well these limitations on turbidity use are implemented.

There exists a large body of research that identifies how turbidity responds to the presence of more than just suspended sediment, and that its effective measurement relies on an understanding of the total suspended material composition and the characteristics (size, density, refractive index) of the suspended particulates. Suspended material comprises both organic and inorganic portions, and as turbidity is a net optical measure of water clarity, it provides an optical measure that includes mineral inorganic sediment and organic material, both particulate organic material and dissolved organic material.

Research conducted in Otago New Zealand has identified the significance that organic matter can have on fouling turbidity measurements, causing a negative bias. When in large enough proportions of total suspended material, this negative bias has led to an inability to produce statistically significant relationships between suspended sediment and turbidity. This research is now focused on understanding the catchment characteristics that control the delivery of organic material to the fluvial environment, and whether in organic rich environments it is possible to account for the effect this has on turbidity records, therefore successfully enabling the prediction of suspended sediment concentrations. This paper will present an overview of the theoretical considerations for using turbidity in a regulatory environment, with reflection on the implications these have on a dataset that comprises a variety of Otago catchments. The effect that significant concentrations and proportions of organic material can have on turbidity measurements will be shown, highlighting the negative bias caused by using a nephelometer operating on a method sensitive to the effects of organic material in comparison to a method that is less sensitive.

**HRC Experience Deriving Turbidity to Continuous Suspended Sediment Concentration using Catchment Characteristic Ratings for Continuous Sediment Load in the Region.**
Michaela Rose – Horizons Regional Council
Brent Watson – Horizons Regional Council

Horizons has been monitoring turbidity as a surrogate for suspended sediment for almost 20 years. Overcoming initial teething issues of sensor technology, in-situ sampling, indirect sampling via pumping systems, recording and measuring standards, sampling parameters, to develop our current network deploying Turbidity ISO standards and suspended sediment concentration validation sampling.

Turbidity measurements provide a reading of the amount of scattered light. By directly relating a gravimetric equivalent (suspended sediment concentration), using a rating curve we are able to use

turbidity as a surrogate for measuring suspended sediment. The relationship between attenuation and concentration is strongly influenced by particle size, density/ distribution of sediment particles, shape and colour (Lambert-Beer). We have assumed surface-area relationship to be constant within the assumptions of generalised sediment transport, further work required to account for particle size distribution analysis specific to and within context of the catchment and flow events. Consideration of sediment transport through the catchment, sources and sinks, across the channel and through the water column are required as well as the collection and validation of representative turbidity data without removing natural variation or artificial smoothing, is also important.

We have developed continuous suspended sediment loads from catchment characteristic turbidity to suspended sediment concentration loop sediment ratings. Knowledge of the effects and response of each catchment, and sediment rating (calibration to each sensor) curves have been used to broadly account for the dynamics, geology, lithology, soil type, land use, vegetation cover, hydrological response, geomorphology, stream power and relative sediment supply of each catchment. Catchment suspended sediment loop ratings account for the hysteresis and assumptions of the behaviour of sediment being transported, size and source, and effects of suspended sediment diffraction by the turbidity sensor. Results show individual signals from different events originating within the catchment in response to the relative origin of the event, differing soil, lithology, and geology in that region.

Derivation of continuous suspended sediment load from turbidity requires knowledge of the effects of catchment behaviour and context. Future work is required to accurately account for particle size distribution and differential sediment transport through the catchment and across the channel.

**Turbidity – it's complicated** Ryan Evison - NIWA

Turbidity can be used as a proxy for how dirty water is. However, estimating suspended sediment loads from continuous turbidity measurements is complicated by numerous factors including; stream flow changes, type and positioning of sensors, sediment flux, and biological fouling and debris causing false readings (to name a few). Obtaining consistent and robust relationships between turbidity and suspended sediment are particularly challenging in smaller streams with dynamic flows and mobile beds, and that much more difficult in construction environments where restrictions to site access and multiple contractors are at play. This presentation will illustrate some of the challenges in turbidity monitoring and raise some questions for discussion.

**The Internet of Things and Environmental Monitoring** Rod McKay - NIWA

There has been much talk about how the Internet of Things (IoT) will revolutionise data collection, in terms of cheap sensors, cheap networks, and low power consumption. This may be true in an urban environment, but how will it play out in the more rural and isolated environments that are our typical areas of interest?

For the last 18 months, NIWA have been looking various technologies and strategies to leverage IoT technologies, and have gained hands-on experience with some of them. This presentation will explore some of our experiences and findings, and the conclusions we've reached, following field testing of Public, Private, and Local IoT solutions.

**Expand Hydrographic Operations with Perfect Integration** Daniel Wagenaar - SonTek / Xylem

The application of acoustic Doppler technology in hydrographic operations has become a standard for both instantaneous and continuous discharge measurements in wide range of channel and hydraulic conditions. The RiverSurveyor acoustic Doppler instrument versatility in these measurement conditions has demonstrated overall improvement in measurement accuracy and operational effectiveness.
Hydrographic operations are not only limited to the development of stage – discharge relationships and real-time information. The versatility of acoustic Doppler instruments allows users to expand hydrographic operations to other specialized fields within hydrology.
The integration of HydroSurveyor (aka RiverSurveyor) acoustic Doppler instrument in Hypack broadened the scope for hydrographic operations significantly for hydrographic community. The ability to perform velocity, discharge and bathymetry measurements with single instrument allows users to collect data for calculating area-capacity tables, calibration of hydraulic and hydrology models and other scientific related application.
Bathymetry surveys were performed of Lake Miramar and Mission Bay in San Diego, US to demonstrate the versatility of HydroSurveyor instrument and Hypack integration. The bathymetry survey performed at Lake Miramar focuses on the survey processes involved, account for change in temperature and salinity gradients, incorporate change in Lake water levels and combining bathymetry and LiDAR.
The Mission Bay bathymetry survey focuses on the use of national \ local datum's, the collection of bathymetry and velocity data, account for change in temperature and salinity gradients and incorporation of tidal information from NOAA tide stations
The strength of the HydroSurveyor and Hypack integration is the ability to collect wide range of data in conjunction with external data from CTD instruments and surface water level stations. The integration becomes more evident with the reports and outputs developed within Hypack from the measurements performed.

**Using Signal-to-Noise Ratio data to estimate sediment loads: challenges and opportunities** Ed Clayton - PDP

In-situ Acoustic Doppler instruments are valuable tools for measuring flow rates at sites where traditional rating curves may not be applicable. With these tools, multiple other parameters are recorded including temperature and the signal-to-noise ratio (SNR). The SNR is a measure of the particle count in water and hence the strength of the signal returned to the acoustic instrument. Where samples are collected and analysed for SSC, comparison can be made between the strength of the SNR value and the SSC observed.
PDP operates several Sontek Sidelookers at a client project where traditional flow ratings cannot be constructed due to back flow events. Using the USGS SAID model, comparisons between SNR and SSC, and SNR and turbidity were made for specific events. Correlation was dependent on event factors, with the correlation coefficient up to 0.9 for selected events. With this project in its infancy, future monitoring for sediment load using SNR data is possible, but other site factors that may introduce bias need consideration.

**Groundwater sampling for the State of the Environment** Dirk Van Walt - Van Walt limited

Groundwater sampling for the State of the Environment (SOE) has been outlined according to a document published in 2006. This document made no reference to low flow/micro purge techniques and as such most regional councils have had to invest in expensive and high maintenance pumps in order to comply with the traditional "3 x purge" technique. This year the sampling protocol has been updated to include flow sampling as an accepted method. This is great news for field technicians and analysts alike (and accounts) as it offers the possibility of obtaining more representative results, reduced site time and lower maintenance of equipment. The following presentation will explain why.

**Monitoring and predicting bedload transport: challenges, methods, and opportunities** Andrew Neverman - Landcare Research

Measuring and predicting bed load has presented a significant challenge to scientists and river managers, and has been a key area of river science research for the past century. The entrainment, transport, and deposition of bedload drives river morphodynamics. Many management challenges in rivers are associated with morphodynamics including erosion hazards, flood risk, and aquatic habitat change. Alterations to channel cross-sections following bed movement events presents a challenge for monitoring parameters which require accurate calculations of channel cross-sectional area, such as discharge. Knowing when a channel has/is likely to have moved is therefore valuable for a wide range of river management areas.

Bedload transport is notoriously challenging to measure in the field and difficult to predict within one to two orders of magnitude using available formulas. There are two main reasons for these difficulties: 1) direct measurement of bedload in the field is challenging as sensors are often destroyed/lost during high flow events, or require significant infrastructure to be secured to, creating 2) a lack of field-derived data to parameterise and calibrate flow competency models.

This paper presents a field study from the Pohangina River, Manawatu, New Zealand which sought to develop apparatus capable of continuous high temporal resolution monitoring of bedload transport, and measure the local hydrodynamics to provide indications of entrainment thresholds and mechanisms. An impact plate geophone was developed with a novel securing system which allowed the impact plate to be installed in a dynamic bed without significant infrastructure. Such a device has significant potential as a tool for monitoring bedload transport events at a site. This data could alert field teams to a potentially altered cross-section requiring resurveying, or as a warning system for erosion hazards, along with identifying site- or event-specific thresholds for bedload entrainment.

**Flood warning services in the Korokoro Stream catchment** Ethan Coulston - Greater Wellington Regional Council

In December of 2016 Greater Wellington Regional council were requested by NZTA to provide flood warning services in the Korokoro Stream catchment which is located at the north-west end of Petone, Wellington. Flood warning services were required due to the Korokoro stream being susceptible to inundating State Highway 2 downstream, causing road closures and consequent major traffic disruption. This has occurred during two major floods events in 1976 and 2015.

Flooding occurs because the Korokoro stream is confined in its lower reaches by a culvert running under a factory, which has a capacity of 37.5 $m^3/s$ providing it is clear of gravel build up and debris. During large floods the carrying capacity of this culvert can be exceeded or it can be blocked by debris and flooding occurs.

Flood warning has been provided through the installation of a targeted flood warning network and through analysis of flood peak travel time through the catchment. The Korokoro flood warning network consists of two sites including one rain gauge in the upper Korokoro stream catchment and one water level site in the lower catchment main-stem, on a historic dam.

The network is designed to provide as much forewarning as possible for the SH2/ Cornish street hotspot. The upper catchment rain gauge will give early warning that there is heavy rain actually falling in either of the main sub-catchments and can act as a confirmation of MetService issued

Severe Weather Warnings. The river level site will give confirmation that there is a physical rise in water level in the stream and the magnitude of this. A temporary water level sensor has also been installed for the first year in the vicinity of the Cornish Street culvert to provide data for analysis of travel times of flood peaks within the catchment.

As a newly employed Environmental monitoring officer with roughly 6 months of experience, this project was given to me so I could learn many of the core aspects of field hydrology (rain gauges, bubble water level sensors, pressure transducers, site installs etc.) in a single project - thrown in the deep end if you will!

The presentation will consist of all the aspects of this project (planning, execution, analysis, reflection etc) and encompasses all the fundamentals of surface water hydrology.

**Vaughan Stream– A catchment undergoing change** Stacey Fraser - Auckland Council

As rural land is developed into urban, changes can arise for nearby waterways and receiving environments. In order to capture information required for part of the Long Bay structure plan, a monitoring site was installed on the lower reach of the Vaughan Stream to monitor stream level, water quality, flow and event based sediment runoff.

With a sediment record spanning over 16 years, the data gives potential insights into the changing sediment runoff profile for the transition from rural to urban land use. This talk will cover a little information about the site including issues and changes implemented to improve the quality of data.

**Problems and solutions in turbidity monitoring in NZ - break out group** Jochen Schmidt - NIWA

While continuous turbidity monitoring is becoming more used in our networks around the country, there is an increasing ‘confusion’ on how to best conduct the monitoring, do instrument validation procedures, and in particular use the data for various purposes. While there is a turbidity NEMS this does not seem to cover/satisfy all use cases, e.g. for use to assess visual clarity or suspended sediment.

I think it would be good to hold a session on this and ask various agencies/NIWA to share experiences using different instruments, using the NEMS standard etc. We could end with a guided discussion to identity key national issues to be addressed in that regards

In this open session various agencies/NIWA can share experiences using different instruments, using the NEMS standard etc. We could end with a guided discussion to identity key national issues to be addressed going forward.