AUSTRALIAN HYDROGRAPHERS ASSOCIATION

Australasian Hydrographer

R.I.P. – Gascoyne River at Fishy Pool Cableway.

(Since dismantled due to OH&S issues)

Photo: Russell Marks

August-October, 2008

The Australasian Hydrographer is the Journal of the Australian Hydrographers' Association Incorporated.   ISSN 0812-5090

THIS ISSUE

EDITORIAL

I have had some reflection time on our recent AHA conference. Being arguably our biggest to date, attended well by nearly 200 delegates and industry representatives, we were presented with a wide variety of concepts, ideas as well as personalities.

As a co – convenor with Bill Steen, and this being the first conference I had been involved in organising at the front line, I was initially daunted by the task that was ahead. While we made the decision to utilise a conference logistics organisation to deal with registrations and the mechanics of the conference there was still a lot of hard yards and occasional behind the scenes emergencies that myself and Bill had to deal with in the lead up to the event. It wasn't a sit back and cruise along affair.

Using previous conferences as a guide, this time around we tried a few different things – some worked, some didn't and some created unforseen headaches. Feedback has on the whole has been enthusiastic and positive for how things went – that is not to say that some negative comments have been received about certain aspects. All this information as well as what has worked/not worked from previous conference) will go to your committee and the next conference convening group to design how the next conference will run.

No doubt the renewed focus on water and its future in our society through the injection of federal money into water initiatives was a partial catalyst for the enthusiasm and commitment that I was privileged to be a part of at the conference (in the formal as well as the informal proceedings!)

But what if we were holding the conference now? Would the conference theme actually be "*Water Initiatives, 2008 and Beyond now we have a Global Crisis"*?

I hope that we don't have a situation develop where the programs many of us are now gearing up to be involved in for the accounting and management of the nations water assets for the benefit of our population, now and into the future, will be adversely affected by wildly swinging decisions based on maintaining some sort of Triple A rating! But on our side at present though is the drought (still ongoing and deepening). While this is a poor friend to claim to one's self, it will keep the work we are involved in high on the priority list.

From keeping stations going for years with bits of barbed wire to rumoured creative accounting, hydrographers have kept many networks going when everything was against them!

All I can finish with is - Keep up your good work!

Mic Clayton - Editor

The **Australasian Hydrographer** is the Journal of the **Australian Hydrographers' Association Incorporated**. The Journal is distributed quarterly to Members.
ISSN 0812-5090

Visit our **Web Site** at: **http://www.aha.net.au** to download a Membership application and to find contact details for your state representative.

Editorial and advertising enquiries should be directed to the Association's **Publicity Officer**, Mic Clayton.

Journal editions are generally produced February, May, August and November. Copy is requested to be with the Publicity Officer by the previous month.

e - mail publicist@aha.net.au , or
PO Box 843, COOMA, NSW, 2630.

Snowy Hydrographer Wins Australian Hydrographers Association Sponsored Award.

Achieves State Medal – Hydrography Certificate IV.

Scott Crozier, a hydrographer with Snowy Hydro in Cooma, New South Wales, completed his studies in the Hydrography Certificate IV, through OTEN, in 2007 and as a result of his academic endeavours has won the First in Course Award, sponsored by the Australian Hydrographers Association.

Scott was presented with his award at the OTEN graduation at the Riverside Theatre, Parramatta, in May.

In achieving First in Course, with excellent results throughout his studies, Scott was also Awarded the TAFE State Medal in Hydrography Certificate IV, presented by the Director of the Western Sydney Institute of TAFE.

To achieve a TAFE State Medal is no mean feat as the winner must complete all their studies at a distinction level throughout the course. Scott's Project (8004A), involving monitoring and assessment of the value of 'spilt water' in the Snowy Hydro area of operations, was highly commended by his teachers for its extremely high quality in its content and in the presentation skills component of the study.

Scott began his tertiary studies life via a science degree but moved into Hydrography when he obtained a position as an assistant hydrographer with New South Wales Land and Water in Tumut, before trying his hand at a position with Snowy Hydro in 2003.

Scott was also asked to present the Students Address at the graduation night and highlighted that, as with many hydrographers across Australia, the main way to gain hydrographic qualifications has been via Distance Education through OTEN. This commitment to study via distance learning required a certain amount of discipline on his part as he needed to balance working, family and study demands during his time studying for his qualifications.

Mic Clayton (AHA Committee Member) and Alex Springall (OTEN teacher for the Hydrography Certificate) were on hand to congratulate Scott at the Awards ceremony.

Scott Crozier presents the Student Address to the graduation audience.

The AHA sponsored prize included the crafted glass trophy (pictured with Scott below).

In recent months Scott was also awarded Trainee Of the Year, Western Sydney Institute TAFE, as well as Vocational Trainee of the year from the Illawarra Region of DEET, NSW. Well done Scott!

Australian Hydrographers Association (Incorporated) Annual General Meeting, Friday August 22, 2008

Rydges Lakeside - Canberra
Friday August 22nd 2008

Attendees:

Members:

Kel Baldock, Con Peshkoff, Barry Morrison, Ray Boyton, Mick Yemm, Simon Cruikshank, Penny Challinor, Lloyd Smith, Trevor Besley, Peter Shaw, Mark Schmidt, Andrew Davidson, Malcolm Robinson, Jacquie Bellhouse, Andrew Weatherburn, Frank Davies, John Cameron, Scott Crozier, Graham Parsons, Tony Spandler, Grant Robinson, Martin Doyle, Mark Hopper, Ross James, Tony Polchleb, Mike Lysaght, Joel Broadfoot, Anthony Skinner, Paul Sheahan, Scott Butler, Matt Saunders, Todd Lovell, Bill Barratt, Max Hayes, Bill Steen, Mic Clayton, Paul Langshaw, and Michael Whiting.

Visitors:

Hamish Burrows, Phil Whik, Ben Cohen, Matt Hope, Phil Downes, Mike Edes, Krystal Hoult, Hamish Gorden, Tony Piskot, Peter Stace, Morgain Sinclair, Chris Iwanicki, Glen Murphy, Duncan West, John Fenwick, Aiden Smith.

Apologies:

Mark Johnston – Hydro Tasmania.
Allan Russ – NT Government.
Adam Merhab – Aqualab.
Steve Buckland – Hydro Tasmania Consulting.
Ray Alford – Natural Resources and Mines Qld.
Greg May – Department of Water

Meeting Opened at 08:30

1. Previous minutes of the 27th Annual General Meeting held in Canberra on the 15th August 2007. *Moved by Mic Clayton, seconded by Mick Yemm.*

2. Office Bearer reports, as circulated by email. Commentary on Membership numbers made by the Secretary (Michael Whiting). *Moved by Mic Clayton, seconded by Graham Parsons.*

3. John Skinner Election Monitor for the election of new Office Bearers. *? Moved by Mic Clayton, seconded by Mark Wolfe, All in favour.*

4. Nomination of New Office Bearers.

   Chairman – Sole Nomination – Bill Steen – Declared **Chairman** for the next 3 years.
   Secretary – Sole nomination – Michael Whiting – Declared **Secretary** for the next 3 years.
   Treasurer – Sole Nomination – Max Hayes – Declared **Treasurer** for the next 3 years.
   Publicity Officer – Sole nomination – Mic Clayton – Declared **Publicity Officer** for the next 3 years.
   Committee Members – Nominations received from Bill Barratt and Paul Langshaw – Sole nominations – Both declared **Committee Members** for the next 3 years.

5. Overview of Draft AHA Strategic Plan provided by Bill Steen to the members.

   Currently being reviewed and will be distributed to a number of key agency members
   for comment.

   Expectation in the future (If the Association were to become an Accreditation body)
   would be that Individual Memberships would be in the order of $300 - $400, in line
   with other industry bodies.

   Following finalisation of draft a Special AGM would be called to endorse the changes
   outlined in the document, and make the required constitutional changes.

   Seen as the first stepping stone towards National Guidelines for Hydrographers.

   Comments

   Grant Robinson – "…it is a way of the Association lifting its relevance…the certification path has been undertaken by the Institute of Foresters...way of moving forward…"

Paul Sheahan (BoM) – "…Path to certification requires the customer to want the
Certification…No need if not required…"

Mark Schmidt – "…Agree with Certification….needs support from those benefitting from outcome (Not just financial support from Individual Members)….".

John Hayes – "…Timing?..." Response by Bill Steen "…Five year strategic plan..".

In principle agreement sought by Bill Steen (Chairman) from the floor, with unanimous support from attending members.

6. Training Package (Certificate IV replacement) progress provided by Mic Clayton, developing a Memorandum of Understanding with OTEN for delivery of course, and the new Learning Package is being developed and written by Government Skills Australia.

General Business:

7. Item tabled by Kelvin Baldock regarding increase in Membership fees to cover resources for implementing Strategic changes in the AHA, drew comparison between the AHA and the ECA (WA) where membership fees are $150 each.

Comments:

Ray Boyton – "…could it be linked to CPI?..."

Response from Mic Clayton – "….Membership Fees don't need to be voted on at an AGM, and can be decided by the Committee. The current fee structure is adequate given the current financial situation, and will need to be reviewed in the near future.."

Annual General Meeting Closed at 09:30

Chairman's Report (Bill Steen)

The past 18 months has seen the Association take on massive challenges. The first was to ensure that the Hydrographers Certificate did not finish at the end of 2007. Members may not have been fully aware that this was the case.

The committee worked tirelessly to not only have the course renewed but restructured. This was undertaken by a successful working relationship with Prue Madsen [Government Skills Australia] and Kim Peterson [TAFENSW] and Paul Langshaw. This has resulted in a very successful partnership with the AHA to secure funding for;

- ✓ A hydrographic training video to be distributed to all schools
- ✓ A four page hydrographic careers brochure to be distributed to all schools
- ✓ Funding to undertake the writing of the new course material
- ✓ Funding to have the new course accredited
- ✓ Funding to assist future enrolment through the payment of course fees

Government Skills Australia also funded a series of education workshops attended by each leading State Agency and private consulting companies. These workshops have resulted in the formation of the new certificate and the possibility to extend the qualification to a diploma.

The association also lobbied the Bureau of Meteorology to engage a consultant to look at the current and future education and training requirements for Hydrographers. Paul Langshaw was appointed and as many of you would know he has been in contact with all leading employers of Hydrographers to formulate a report addressing issues facing the industry.

The Bureau also sponsored a two day national workshop to discuss the future education and training options for Hydrographic staff working within Australia. The Bureau's interest, of course, is primarily about the benefit to the national water information system having a widespread base of appropriately qualified data collectors. The workshop was supported by representatives from all leading state water authorities and private sector hydrographic companies. What the Bureau required from this workshop included;

- o Identify what skills and competencies are needed
- o Identify what training needs to be set in place – theory and practical
- o Identify new skills that will be required to meet emerging needs
- o Look at what training is available currently
- o Identify gaps in available training and design ways to fill these gaps
- o Build support for this procedure through Government, community, industry, education sector, etc. to

create a sustainable training and accreditation system

Although the discussions were centred on education it became evident that the industry is looking for representative to not only address education but a much wider range of issues. The following dot points include issues discussed however the list is by no means definitive;

- A national body to assist in the definition and support of national data collection and data management standards, in association with the Bureau of Meteorology to enhance the national water dataset.
- Provide technical advice to the Bureau of Meteorology, principally with regards to data collection
- Coordinate industry involvement and the development of specialist working groups
- Develop, maintain, and circulate industry guidelines
- Certify [licence] Hydrographic professionals
- Coordinate competency training
- Collate and manage a national hydrographic education register
- Serve as an education and information resource to all members of the Association
- Coordinate and undertake supplementary practical training and professional development for Hydrographic staff
- Revitalise the content and delivery of the academic course for Hydrographers. This will be achieved in partnership with Government Skills Australia and the Registered Training Organisations. The aim is to develop a qualification that articulates from a Certificate IV, through to a Diploma and possibly a Graduate Certificate.

The participants at the workshop unanimously identified the AHA as the logical body to manage the process. However to establish the AHA as the national industry representative requires a major refocus on the AHA's current constitution and manner in which it conducts its activities. Importantly, since the AHA Committee is run by a small team of volunteers, funding options and employing staff to professionally manage these issues is essential.

The recommendation by the industry was for the AHA to develop a strategic plan highlighting both activities and sustainable funding options. It was also indicated that once the AHA strategic plan is developed the Lead Agencies may then apply for Bureau Modernisation and Extension Funding future rounds on behalf of AHA to enable then to proceed with the National Hydrographic Training and Education Program and the implementation of issues identified.

The first step in this process is to seek support for 'the concept'. Once the overall strategy has your support in principle, the AHA would consult with State and industry groups to develop and publish a strategic plan to outline the activities that will benefit the industry as a whole and propose various funding options.

The AHA is looking at mechanisms to address the critical shortfall of Australia's hydrographic skills and the need for capacity building.

I'd like to take this opportunity to thank all the members of the committee for their hard work throughout the year.

William Steen
Chairman
The Australian Hydrographers Association

Secretary Report
Michael Whiting

This is the third year that I have held the position and probably the most challenging and exciting in terms of the future direction of the AHA, and I am proud to be able to be involved as the Secretary of the Association.

Member Summary:

One key role of the position has been the development and management of the membership database. The membership database has now been in place for three years and has minor updates over the last year to improve administrative efficiency. More than one hundred renewal notices this year were sent out to Members by email, with membership forms including details held in the database, attached. This was able to be collated in only a few hours compared with the considerable effort required in printing and posting renewals in previous years.

Membership over the last year was fairly stable, however since renewals were sent out in July, membership numbers have risen dramatically with the majority of Members now corporately sponsored by their employees.

Membership Type	2006/07	2007/08	2008/09 (Current)
Individual	76	59	49
Cadet/Student	6	6	
Retired	7	6	4
Life	2	2	2
Bronze Corporate	9	7	3
Silver Corporate	-	2	2
Gold Corporate	2	3	2
Platinum Corporate	-	1	2
Corporate Sponsored	26	41	95
Courtesy	2	2	3
Total	130	128	162

Membership Summary

Platinum membership was introduced in 2006 to cater for companies or agencies willing to sponsor 20 or more employees as Members of the Association. The sole platinum member last year was the Bureau of Meteorology, however this year the Department of Water in Western Australia has become a Platinum+ member sponsoring 42 of its employees as members.

Membership has more than doubled in the last three years from 75 members in 2005/06 to 160 in 2008/09. This I believe is not only due to the resurgence in the
Hydrographic industry (due in part to the National Water Information program undertaken by the Bureau of Meteorology) but also demonstrating the swell of support for the Association as the primary industry representative.

Recent estimates indicate that the current membership of the Association covers approximately 30% of the Hydrographic Industry.

Committee Meetings:

Two committee meetings have been held since the previous AGM in Canberra last year. The first was held in Canberra on the 28th March 2008, and the second recently again in Canberra on the 1st July.

Key items discussed during these meetings were:

Conference coordination.
Future directions of the Association.
Web page redesign.
Development of a strategic plan.
Training and Education.

Correspondence

The majority of correspondence received over the last year by the Secretary has been via email, mostly associated with Membership renewal and queries.

Michael Whiting
Secretary
Australian Hydrographers' Association

Account Summary, December 31, 2007
Australian Hydrographers Association Incorporated

Westpac A/C 033-259 13-0104

Opening Balance: 1 January, 2007	$44,403.81	
Income:		$16,268.00

		$60,671.81
Expenditure:		$30,579.00

Closing Balance, December 31 2007:	**$30,092.81**	

Reconciliation:	
Closing Balance, December 31 2007 (as per statement)	$30,092.81
Plus receipts not credited:	$0.00
Less Unpresented Cheques:	$0.00
Closing Balance, December 31 2007	**$30,092.81**

Westpac Investment A/C 033-259 21-5838

Balance as at 01 Jan 2007:

Opening Balance: 1 January 2007	$42,933.25	
Income		$23,564.00
Total		$66,498.25
Expenses	$2.50	
Closing Balance 31 Dec 2007		**$66,495.75**

Australian Hydrographers Association Incorporated
Statement Of Receipts and Expenditure,
January 1, 2007 to December 31, 2007

Cheque Account (Operating Account)

RECEIPTS 2007

Subscriptions	6,118.00
Subscriptions Corp	10,000.00
Interest	150.00
TOTAL	**16,268.00**

EXPENSES 2007

Newsletter Expenses	5,793.00
Bank Charges	720.00
Air Fares/Acomm Committee	1,235.00
Web Site	549.00
Refund Fuel Expenses	473.00
Cooma Florist	73.00
Trans. To Max-Direct Acct	20,000.00
Australia Post	693.00
Stationery	120.00
Out Of Pocket Expenses	80.00
Reimb M. Clayton Airfares (BoM Workshop Melbourne)	840.00
TOTAL	**30,579.00**

MAXI-1 Investment Account, 2007

Interest Max1 Investment Account	3.565.00	
Trans. From Main Account	20,000.00	
TOTAL		**23,565.00**
Expenses	**2.50**	

Publicity Officers Report For Australian Hydrographers' Association Annual General Meeting, August 22, 2008

Publicity Activities for the last 12 months have centred around Journal Production, Mailman Distributions, Web site updating and co-ordination, AHA promotion at education award ceremonies and promotion of the 14th AHA conference.

Unfortunately only two Journals were produced over the last period due to the lack of submitted material from members (both individual and corporate) despite repeated encouragement to submit technical articles, items of interest and so on. When reflecting on why this has been an issue this year it has been apparent in responses from potential contributors is that workloads in delivering the rush of national water initiatives may be a contributing factor – preparing a voluntary item for a Journal tends to takes a back seat to the cut and thrust of securing and spending the funding achieved through work programs! This is expected to pick up though following the 2008 conference and as the Association becomes further involved in a number of national activities. The Journal can look forward to improved inputs as activities increase amongst our members.

Complimentary copies of the Journal continue to be forwarded to the New Zealand Hydrological Society and the Australasian Hydrographic Society. The Journal is also being forwarded to the State Library of NSW for archiving. The ISSN number for the Journal is 0812-5090.

Our Website continues at www.aha.net.au. The greatest activity on the site occurs with distributing information about employment opportunities in our industry/science which continues to be a popular information service on our site. One Hundred and Seventeen positions were posted in this time – a record!. Admittedly about 45 of these were for Met Bureau programs initiating the National Water Initiatives, but more than sixty from Australia, New Zealand and the Pacific are an indication of the continuing demand for our profession. Given the known small size of qualified hydrographic practitioners this indicates the pinch now being felt in the profession as a result of the hydrographic skills shortage.

Promotion of this year's conference has been a significant feature of our site this year. A new look and feel for the front pages of the site has been trialled as part of the conference organisers' services brief and we are looking to a new web design in coming months.

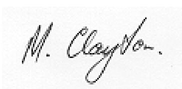
The Mailman Service continues operating as a main information service. All financial members are listed into the Mailman member database as well as interested individuals who have subscribed to the list. The list stands at over 220 members. The Mailman service is used by the committee to disseminate information about employment opportunities, short courses and other events or happenings around the place.

The Mailman email service is also available for members to pass on items or events of interest to other members. The list is moderated to reduce inappropriate use but generally users have been well behaved!

Spamming was greatly reduced over the last twelve months until the last month when the AHA address seemed to be part of an 'attack' On one day the server was overloaded with approximately 3000 emails of spurious addresses. Spam filters are only as good as the known threats but things seem to have calmed down in recent weeks.

In the first half of this year the Association sponsored 'The Australian Hydrographers Association – First In Course Award". The award recognises a person who has achieved first in course, with exceptional results and through advice received from supervising teachers as to the suitability of a nominated completing student, in the Hydrography Certificate undertaken through OTEN. Sponsoring industries and professional bodies received prominence at the OTEN awards and graduation ceremony held in Parramatta in May. This award is expected to continue on a year by year basis depending on completions in the course and recommendations from academic staff.

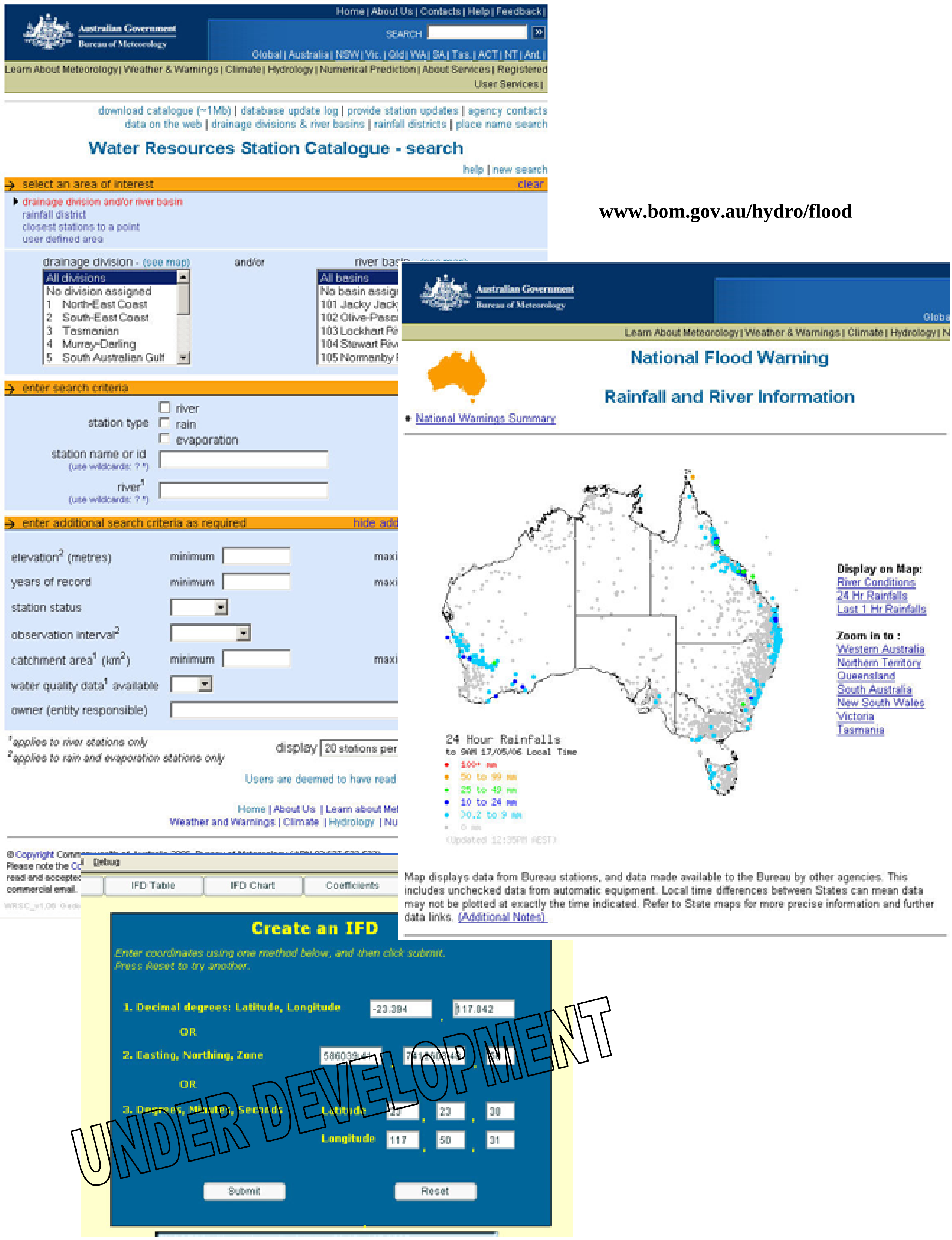
As a last (and ever repetitive!) comment and word of encouragement, don't forget it's your Association and your input to the Journal is valued. Corporate Members are also encouraged to submit articles in relation to the work they are doing.



BUREAU OF METEOROLOGY RESOURCES ON THE WEB

www.bom.gov.au/hydro/wrsc

www.bom.gov.au/hydro/flood



Methane Monitoring –

Assessing Lakes and Reservoirs as Potential Sources or Sinks of Greenhouse Emissions.

Recently consultants from Quebec Hydro were in our brown land working on a program of methane monitoring of lakes and reservoirs.

The team of two French Canadians, Valerie and Robyn, worked on a program of monitoring lakes and natural water bodies in Tasmania, the Snowy Mountains and in Northern Queensland.

Working to a tight program, hydrographers from a number of organisations, including Tas Hydro Consulting and Snowy Hydro, were called upon to assist with the program, providing:

- Vehicles and boats for getting onto lakes and into the more remote areas of Tasmania and the Snowy Mountains
- Reservoir water quality profiling in conjunction with the methane monitoring
- Undertaking pH measurements
- Undertaking turbidity observations
- Organising the logistics (transport, accommodation, food, repairs and additional equipment)
- Ensuring the safety aspects of working on water and in remote locations were in place and operational.

While the program was tight, it needed to be flexible enough to allow for the vagaries of the weather, equipment issues and so on.

In the Snowy Mountains part of the program the team had to contend with days of majestic conditions (get out the sunscreen!) through to a strong front that came through, bringing a strong windy dust storm, which then turned to 'mud' rain in the evening covering every surface on the boat with fine Mallee and Western Plains dirt, and this front eventually became a snowfall overnight depositing 20 cm of snow in the northern areas of the Snowy Mountains. And it was still March!

The methane sampling equipment looked like lots of tubes hooked up to analysis equipment that measured methane and carbon dioxide "fluxes". The equipment was laboratory equipment that needed to be transported safely, powered continuously on sampling days (to maintain warmth for some equipment that contained heaters).

A wonderful collection of lab equipment, tubes and connections that required transporting by road, boat and legs to the sampling locations!

Working in remote locations (and on boats) required overcoming the challenge of suppling power, especially for equipment that had heaters in the boxes, and was achieved through large battery banks that required solid recharging each night. On top of having enough grunt for the equipment the teams also had to deal with differing voltage requirements for the equipment (120 Volt systems).

Each night the equipment was check calibrated in preparation for the next days sampling so evenings were spent working as well.

Not just a 5 minute job at the start and end of each days sampling!

Sampling for methane from a water body though isn't just a matter of simply grabbing a water sample and submersing a handheld sensor in it. The technique used in this program was to measure a series of methane fluxes with sufficient system purge times between flux measurements to separate readings.

In the technique used in this study dried air is pumped though a chamber that sits on the water surface. Return air, with potential methane traces after passing over the water surface, then returns via another line back to the monitoring equipment. The returning air stream is then continuously measured and data recorded for methane and carbon dioxide traces.

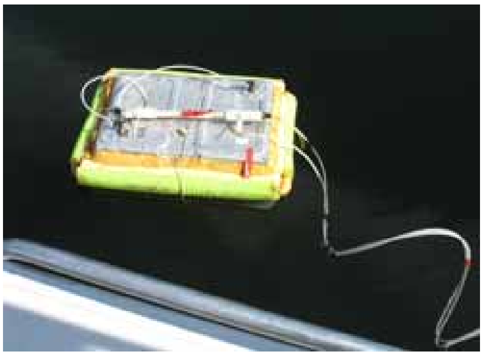
A low down view of the measuring chamber that floats on the water surface collecting the methane fluxes

The flux readings don't occur instantly but rather build up slowly and then plateau off. This required constant monitoring via laptops connected to the lab machinery. Thus each 'flux' measurement took between 7 to 10 minutes to take as one "sample".

Between fluxes the system needed purging of at least ten minutes to normalise the system back to natural gas levels in the air. During these purge periods the team had to be aware to not contaminate the purge process with their breath (resulting in starting the purge process again!) and keep other sources of greenhouse gases away or downwind of the sampling zone – including engine exhausts and even cigarette smoke!

At least three fluxes were required at each sampling location (for averaging) and some water bodies were requiring up to 10 sampling locations to be sampled – these made for long boating days!

While the fluxes were being monitored the hydrographers undertook profiling using sondes, defining the thermoclines and collecting and logging data on various water quality parameters in the water column. Profiles ranged from only a meter deep to over 100 metres. Those of us who use sondes know how difficult some sonde situations can be with submerged trees still at the bottom of reservoirs!



Peacefully floating on the reservoir

Another test undertaken by the hydrographers was to ascertain the slope change points in the pH slopes of the water being sampled at the time.

This process involved micro millilitre additions of sulphuric acid to a water sample, monitoring the pH levels and recording them. The area of interest was the pH range between 4 and 5. While I don't fully understand the full process I learnt that the slope changes that occur in this 4 to 5 pH range are an indicator of aspects of the water body being a greenhouse gas sink or source at the time of sampling.

Troll under a bridge! Robyn undertakes the pH monitoring process beside a stream in the Snowy Mountains.

Not just reservoirs were monitored but also the streams feeding the reservoirs and naturally occurring lakes. The reason for this was to assist in identifying whether or not the lake might be a carbon sink or source. Here is the theory on this aspect.

- If a lake has readings indicating it is a potential carbon emitter but the streams are equally high in emissions then an argument would be that <u>the streams are potentially the source of the greenhouse emissions.</u>
- If a lake has emission readings lower than its feeder streams then <u>the lake is potentially acting as a carbon sink</u>
- If a lake has emissions higher than the feeder streams then <u>the lake is potentially acting as a carbon source</u>

So potentially the natural environment may be a greater carbon source than the man made reservoirs.

Some preliminary results from the monitoring indicated that some natural lakes may in them selves be massive carbon emitters while neighbouring man made reservoirs were acting as fantastic carbon sinks!

<u>So why bother going undertaking this work?</u>

Many industries are being required to undertake a greenhouse gas audit, in preparation for nationally proposed Emissions Trading Schemes (ETS), in whatever form these final schemes may take.

Some groups claim that hydro electric dams are high greenhouse gas producers because hydro dams have submerged hundreds of kilometres of vegetation that is now rotting on the bottom of the reservoirs and liberating copious amounts of greenhouse gases – a counter claim by these groups against hydro power producers claiming a clean green renewable energy image.

Theoretically, and simplistically, under an ETS so called polluters might try to reduce their emissions or might be permitted to continuing having high carbon emissions if they purchase carbon credits from industries that are classified as carbon sinks. This would be a commercial decision, depending on how the legislation and rules of an ETS might work.

As you can see some industries have the potential to profit from such a scheme – including hydro power schemes!

So if someone wants to sell their carbon credits to someone who wants to buy them you need to have a way of at least assessing/measuring the net carbon value that you are trading so the trading scheme can be effectively managed – this in turns comes back to a common hydrographic adage, you can't manage something unless you measure it!

Australian hydrographers are well placed to provide the data and information required to develop such a trading scheme, having a diversity of skills not only related to water resource management but a wide range of environmental monitoring technologies that many have become involved in.

"*A (Continuing) Technohead Special!"*

WATER INFORMATION – Clarifying Its Quality and Making Others Understand.

A couple of issues ago Technohead dealt with how data quality might be applied to water data with reference to the most basic of data collected by hydrographers, water level. This continuation of the theme discusses applications of quality to water quality data.

A quick review of what was a main point last time:

Quantitative – Not Qualitative.

"This data is good because it looks OK." How many times have you heard this?

It is a ***<u>qualitative</u>*** statement. The qualitative statement is often an ***<u>intuitive</u>*** or ***<u>experiential</u>*** statement. Intuition does not have bounds and the inputs that go into intuition are not necessarily consistent between individuals. Experience improves ones intuition with the data being assessed and the methodology of measurement and data collection in the field goes a fair way in providing a more dependable qualitative assessment.

Of course some peoples 'intuition' (based on experience) is better than others and, because humans are free thinking, we can't train everyone to have the same repeatable levels of intuition no matter how much experience we think we have. The proof of this statement is clearly exemplified by the footy tipping comp at work isn't it!

What is "Good" quality data? In fact, taking it a step further, what is the difference between 'Good' and 'Excellent' data?

To even begin attempting to define a difference between these two descriptors above, one needs to set bounds, limits and ranges to separate them if we are to discern between them down the track in our data use trail. This is where we enter the world of ***<u>quantifying</u>*** the quality of the data collected.

Measuring The Invisible World – Water Quality!

In our previous article we looked at water level quality. You can **<u>see</u>** your gauge plate, you can **<u>measure the level reference</u>**. You have something you can grasp. You even have a good chance of constructing small bits of missing data based on other forensic evidence (flood debris etc)

But what about water quality? With the advent of digital recorders and low powered sensors for long term deployment, clever hydrographers decided that gauging stations could be expanded to measure the physical and chemical properties of the stream they were measuring.

Can you look at a stream or even a sampling container of water and do a good guess on its conductivity or temperature? Most likely not by just looking at it! Here we need calibrated references to begin our data quality journey for water quality parameters.

In today's hydrographic world , as mentioned in a previous issue, we have the ability and skills to calibrate sensors and systems to within acceptable errors. Often the initial calibrations and setup are done in the instrument facility under relatively stable conditions and inside.

But there is more to water quality measuring than just an expensive handheld meter that goes ping!

The use of the reference meter needs to be appropriate for the site, the in situ sensor location and stream section, not to mention being in calibration!

Based on the concepts of the previous article and the concept of using a calibrated secondary reference or standard for data traceability. A suggested quality code regime is highlighted here for conductivity.

Quality Code Description	QUAL CODE	CONDUCTIVITY
Good Data	1	Data within ± 5% of calibrated reference value taken in close proximity to sensor, Value representative of cross section validated regularly by conductivity gauging across section
Fair Data	21	Data within ± 10% of calibrated reference, or not validated as representative of section by regular conductivity gauging
Good Estimate	22	
Poor	31	Data within ± 20% of calibrated reference, no conductivity gaugings to validate section representativeness
Fair Estimated data	32	
Poor estimated data	42	
Data Not Recorded	151	Data was not recorded. Metadata comment to be inserted in the database

Again the assertion in this proposal is that a 'Good Estimate' in reality **shouldn't be any better than actual recorded** 'Fair Quality' data.

The assertion continues to be that ***a qualitative assessment of data should not be accorded greater accuracy than quantitatively measured data accuracy.***

In this example though should we even have any estimates for water quality data? How can you estimate data for something you can't even see.

I would suggest that an occasion for using an estimate for time series water quality data would be in the situation where the calibration of a sensor or system for water quality is found to be in error but can be corrected to some extent by a 'correcting algorithm', assuming a mathematically valid assessment of the calibration error can be achieved. Is it linear, can a correcting curve be used and so on.

Comparing Apples and Oranges

As can be seen from this proposal for conductivity the attempt is to try and align the quantitative accuracy and confidence in the data being assessed with the same methodology for assessing quality of water level.

While a water quality parameter is a chemico/physico aspect of water and water level is a physical aspect we should attempt to use some sort of system that could be considered comparative in the way data is measured and assessed for its accuracy.

Thus the end user of the data, knowing the assessment criteria for assessing the quality of each parameter, can understand better the accuracy and, perhaps more importantly, the limitations of the data they are about to use in their models or studies. So building up a couple more water quality parameters into a table alongside water level, an information matrix about water data quality begins to emerge as shown on the following page.

Through this process it can be seen that we can work to standardising and rationalising the number of quality codes required in our system.

This successful use of this requires though that the end user has access to these quality definers, not just a data bit tagged with an obscure number or symbol that has no definition supplied.

In a QA world….

Applying a methodology such as this is important in linking the data collected at the end of the day to the QA systems in place where the reference equipment is calibrated and traceable records kept in the preliminary stages of the data collection process (those checks and measures that we do even before we load the equipment in the vehicle for our big data collection trip.)

At the end of the day we need to have the end user fully understanding of the quality of data they are about to use in the models that might make many presumptions about the data

Quality Code Description	QUAL CODE	LEVEL	CONDUCTIVITY	WATER TEMPERATURE	WATER TURBIDITY
Good Data	**1**	Record Processed ± 5 mm, time within ± 10 minutes. No correction of data necessary when referenced against observed datum at time of data reference point	Data within ± 5% of calibrated reference value taken in close proximity to sensor, Value representative of cross section validated regularly by conductivity gauging across section	Data +/- 1.0°C of calibrated reference value taken in close proximity to sensor. Value representative of stream cross section	Data within ± 5% of calibrated reference value taken in close proximity to sensor,
Fair Data	**21**	Record processed ± 10 mm, within ± 30 minutes. (Code may be affected by recorder type.) Referenced against observed datum at time of data reference point	Data within ± 10% of calibrated reference, or not validated as representative of section by regular conductivity gauging	Data ±2.0°C of calibrated reference	Data within ± 10% of calibrated reference value taken in close proximity to sensor
Good Estimate	**22**	Estimate based on accurate techniques and other information (eg debris marks in formed channels) to an accuracy of ± 20 mm, time within ± 2 hour and QA procedures			
Poor	**31**	Record Processed ± 50 mm time within ± 2 hours Referenced against observed datum at time of data reference point	Data within ± 20% of calibrated reference, no conductivity gaugings to validate section representativeness	Data ±5.0°C of calibrated reference	Data within ± 20% of calibrated reference value taken in close proximity to sensor
Fair Estimated data	**32**	Estimate based on accurate techniques and other information (eg debris marks in formed channels) to an accuracy of ± 50 mm, time within ± 2 hour and QA procedures			
Poor estimated data	**42**	Estimate which reasonably reflects the actual event Edit comment/s shall be inserted in the data file explaining method of estimation and / or collection >100 mm, time within ± 2hour and QA procedures			
Data Not Recorded	**151**	Data was not recorded. Metadata comment to be inserted in the database	Data was not recorded. Metadata comment to be inserted in the database	Data was not recorded. Metadata comment to be inserted in the database	Data was not recorded. Metadata comment to be inserted in the database

Investigating the uncertainty in flow at gauging sites in Gippsland using Australian Standard 3778.2.3

N. Ozbey1, P. Scanlon2, A. Western2

1Thiess Services, Woori Yallock, AUSTRALIA

2Department of Civil and Environmental Engineering The University of Melbourne Parkville 3010 AUSTRALIA E-mail: psc@civenv.unimelb.edu.au

Presented at the 14th Australian Hydrographers Association Conference, Canberra, August 2008 (and previously at Water Down Under 2008, printed with permission)

Abstract

The methodology outlined in Australian Standard 3778.2.3 was used to estimate the uncertainty in the flow data reported for 80+ sites in Gippsland. The flow data is obtained by applying a rating table to monitored water levels. The uncertainty estimated in these flow data results from two sources: the uncertainty in the flow estimates due to uncertainty in the recorded water level; and the uncertainty in the flow estimates due to the uncertainty in the rating table.

A number of problems were encountered using the methodology, not all of which could be satisfactorily resolved and which had to be worked around. However, given that at present there are no uncertainty estimates for flow data routinely available, an indication of the range of uncertainty in the reported flow values was calculated from the data available. Results indicated the uncertainty in the annual flow at most monitoring sites in Gippsland ranged from +/- 5% to +/- 15% in 2005-2006. These results provide valuable guidance for decisions on changes in monitoring protocols to reduce uncertainty where desired and possible.

The process of estimating the uncertainty in the flow provided additional valuable information about the data collected at the monitoring sites. In addition, uncertainty calculations can contribute to auditing procedures by highlighting sites that require investigation. However, further work is required to enable the consistent calculation of uncertainty by different parties. Uncertainty in the flow should be reported as a routine part of data dissemination to enable the user to take into account the confidence level of hydrological data in decision making.

1. INTRODUCTION

In Victoria, much of the stream flow data available in the State is collected through four Regional Water Quantity and Quality Monitoring Partnerships (RWQQMPs), administered by the Victorian Government Department of Sustainability and Environment (DSE), and serviced by Thiess Services, a private contractor. The stream flow data are used by the Monitoring Partners, and many other organizations, for many purposes ranging from assessing long term water resources, to predicting impacts from event-based flooding and to real-time compliance with environmental flow requirements, among others.

To measure flow at most of the RWQQMPs flow monitoring sites, water levels are recorded continuously, and rating tables/rating curves are used to estimate instantaneous flows from the water level. The instantaneous flows are integrated to estimate daily, monthly or yearly flows.

In any measurement, there is some degree of error and uncertainty. In measurement of flow in natural channels, a number of factors combine so the uncertainty can be significant. With increasing pressure on water resources, around the world there is an increasing awareness of the need to provide quantitative indicators of the accuracy of flow data. The World Meteorological Organization (WMO)'s Commission for Hydrology is currently developing a framework for assessment of uncertainty in discharge measurement that includes a synthesis of recommended standardised approaches to uncertainty analysis for discharge measurements (WMO, 2007). In the USA, the US Geological Survey currently publish Annual Water Data reports, with site data rated from "excellent" to "poor" based upon 95 percent of daily discharges having less than a given percentage uncertainty. (USGS, 2005). The USGS is planning that in the future all flow information provided by its Data Access Centres will have uncertainty estimates to define data confidence (USGS, 1999). Currently in Victoria, there is only limited qualitative information available to flow data users for them to assess the accuracy of reported flow data. Being able to quantify and report the uncertainty in the flows reported for each monitoring site would:

• Allow uncertainty to be included in water resource reporting,

• Allow uncertainty to be considered when the data are used for modelling or analyses,

• Help identify sites where the rating table needs to be improved,

• Help identify sites where existing infrastructure or instrumentation does not allow flow to be measured with sufficient certainty,

• Provide a measure that could be audited to help both the service providers and the Partnership administrators judge how well they are performing in providing useful flow data.

Australian Standard 3778.2.3 specifies methods for determining the stage-discharge relationship (i.e. the rating table) and provides a methodology to estimate the uncertainty in the flows estimated using a rating table. AS 3778.2.3 is identical to ISO 1100-2, which is based on recommendations in the *Manual on Stream Gauging* (WMO, 1980). Using AS 3778.2.3 to estimate the uncertainty in RWQQMPs flows ensures the results should be readily accepted by and defensible to all parties interested in the reported flows, whether they are paying for the data to be collected, collecting the data, or using the data.

In 2007, DSE commissioned a collaborative project between Thiess Services and the University of Melbourne to apply AS 3778.2.3 to the flow monitoring sites in the Gippsland RWQQMP for the year July 2005 to June 2006 (at the time, the most recent year of data corresponding with a published State Water Report) to:

• Obtain a quantitative appreciation of the uncertainty in the flow data collected at the sites,

• Provide some insights into the usefulness of quantitative estimates of uncertainty to be used in developing policy on reporting the uncertainty in estimated flows,

• Identify possible improvements to the monitoring contractual arrangements or to the infrastructure and/or instrumentation at sites that might be necessary to ensure the level of uncertainty in the reported flows are acceptable to the various users of the data.

1.1. Distinction between types of flow rates

In the following discussion, two kinds of instantaneous flow rate are distinguished, and the distinction between them is important. The first is the flow rate estimated from measurements of water velocity and cross sectional area in a stream at a monitoring station, which will be termed the "gauged discharge". The process of measuring a gauged discharge is referred to as gauging, and the resulting gauged discharge at the gauging height is also called a "gauging".

The second is the flow rate estimated from measurements of water level and converted to a flow rate using a rating table or rating curve, which will be termed the "rated discharge". The rating table describes the relationship between water level and discharge at the site, and is constructed by fitting a rating curve to a number of gauged discharges measured at various stream water levels at the monitoring site. AS3778.2.3 also describes the determination of a rating table.

It is worthwhile noting that the rated discharge given by the rating table for a particular water level is considered to be a more accurate estimate of the true discharge than an individual gauged discharge measured at the same water level because the rating curve is a "line of best fit" to many gauged discharges.

2. ERROR AND UNCERTAINTY

Whenever something is measured, it is unlikely the true value of the quantity will be measured and recorded. So it is accepted the true value of the quantity is never known with complete certainty (even if the true value is recorded, there is no way of knowing it is the true value). The difference between the true value and the value recorded is the error.

Because the true value is uncertain, the error is never known with complete certainty. It is possible, however, to make an estimate of what the range of the error is likely to be – this is the uncertainty in the measured value. Another definition of uncertainty is it is an estimate of the error which in most cases would not be exceeded.

The confidence level is a measure of the probability the error is equal to or less than the uncertainty, and should also be reported. Most uncertainties are reported with a 95% confidence level. Uncertainty can be reported in the units of measurement e.g. 0.73 m +/- 0.01 m at the 95% confidence level, or as a percentage e.g. 0.73 m +/- 1.4% at the 95% confidence level.

A large uncertainty in a value does not necessarily mean the measurement has been made badly. It means the way the measurement is made has introduced large sources of uncertainty into the reported value (it still might be the best practical method to make the measurement). Reporting the uncertainty lets other users of the data know the range of values which is likely to include the real value.

2.1. Major factors affecting uncertainty in the rated discharge

The rated discharge is found by measuring the stream water level and using the rating table to convert it to the flow rate. By considering this process, a number of major factors can be identified that contribute to the uncertainty in the rated discharge:

• The number of gauged discharges available to fit the rating curve. This depends not only on how often the site is gauged, but how often the rating table “shifts”, so that past gaugings no long reflect the present relationship between flow and water level,

• How the available gauged discharges are distributed through the range of the rating curve from low flow to high flow. While the middle ranges of flow may be gauged often, there are fewer opportunities to gauge infrequent high and low flows. Logistical and safety considerations may also mean there are few gauged high flows,

• The “spread” of the gauged discharges from the rated discharge at the gauging heights (factors affecting this are discussed further below),

• The resolution of the instrument measuring the water level,

• The resolution of the instrument recording the water level (often the data recorder is a separate piece of instrumentation from the measuring device).

• The “sensitivity” of the control. The “control” is the physical characteristic of the stream channel that is the dominant influence on the stream water level at a particular stream flow rate. Some examples of controls include weirs which cause a pool of water in front of them, rapids where water flows freely, or the shape of the channel and its “water transporting capacity”. An insensitive control is one where a large change in discharge results from a very small change in water level (e.g. a very wide horizontal weir)

Factors which may affect the spread of gauged discharges from the rated discharge at the gauging height, and perhaps increasing the uncertainty in the rated discharge, include:

• The stability of the control at the gauging station. If the characteristics of the control can change due to natural processes in the stream, through scour, silt deposition, debris build up, or vegetation growth, the control is unstable and different gauged discharges may be measured for the same stream level over time,

• A hysteresis (or “loop”) effect, where flow at a given water level is significantly different depending whether the water level is rising or falling, and how rapidly,

• The degree of turbulence in the flow. The technique for measuring gauged discharges needs relatively smooth water flow perpendicular to the cross section being measured. Turbulence induced by the stream bed, or changes in direction of the stream channel, can contribute to different gauged discharges being measured at the same water level,

• Factors which make it physically difficult to perform the gauged discharge measurement at a particular water level, such as rapidly changing water levels, low water velocities that instrumentation cannot measure, or high flows where accurate measurements may be compromised by safety considerations,

• The uncertainty introduced by the gauging technique itself, which samples individual points in the velocity field rather than measuring the entire velocity field. The most common method, the velocity-area method employing a current meter, is itself subject of a part of another Australian Standard, AS 3778.3.1.

3 OVERVIEW OF AS 3778.2.3

AS 3778.2.3 specifies methods for determining the stage-discharge relationship (i.e. the rating table) at a flow monitoring site. AS 3778.2.3

includes a methodology for estimating the uncertainty in a rated discharge for a given water level and from there estimating the uncertainty in the daily, monthly and annual flow derived from hourly recorded water levels.

3.1. Uncertainty in a rated discharge for a given water level

AS 3778.2.3 estimates the uncertainty in a rated discharge from the combination of the uncertainty associated with the rating table; and the uncertainty associated with the recorded water level used to "read" the rated discharge from the rating table.

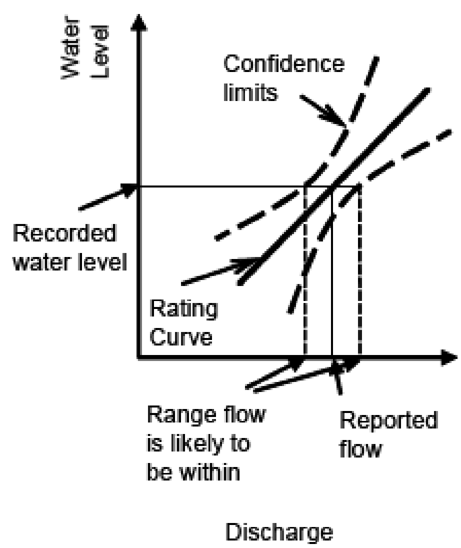
The uncertainty due to the rating table is calculated from a statistical analysis of the gauged discharges. This is illustrated in figure 1(a). The rating curve has been drawn by the hydrographer by fitting a line to the gauged discharges measured at the site, keeping in mind the hydraulic characteristics of the site. Using statistical analysis of the how well the rating curve fits the gauged discharges, it is possible to calculate the 95% confidence limits for the rated discharge (shown in figure 1(a) as dashed curves). Using these confidence limits, it is possible to determine the likely upper and lower values of flow for a given water level. Equation A.2.4 in AS 3778.2.3 calculates the percentage uncertainty in the rated discharge due to the rating table directly from the Standard Error of the rating curve.

The uncertainty in the rated discharge due to the uncertainty in the water level measured at the site is illustrated in figure 1(b). By considering the uncertainty in the water level reading, due to the measuring device, the resolution of the recorder, or the setting of the datum, it is possible to determine the range of values about the recorded water level which is likely to contain the true value of the water level. This range of water levels translates into a range of rated discharges around the rated discharge for the recorded water level. The percentage uncertainty in the rated discharge due to the uncertainty in the water level can be estimated from the difference between reported flow and the upper bound of the likely flow range indicated by the upper range of the likely water level. The Standard calculates the percentage uncertainty in the rated discharge due to the uncertainty in the water level numerically using the water level, the slope of the rating curve, and the uncertainty in the water level.

The uncertainty in flow due to the uncertainty in the rating table (figure 1a) and due to the uncertainty in the water level (figure 1b) are then combined, essentially by adding the variances of each, to give the overall uncertainty in the rated discharge.

3.1.1. Division of the rating table into segments

Inspection of the rating curve often reveals distinct changes in the slope of the rating curve that occur at different water levels. Hydraulically, these usually correspond to a shift in the stream characteristic that "controls" the relationship between flow and depth. One example is where there is a small weir. When the water depth becomes high enough that the weir is "drowned", so the weir no longer influences the depth of water, there is a shift from a "section control" with the weir controlling the flow-depth relationship to "channel control" where the slope and roughness of the channel controls the flow-depth relationship.



(a)

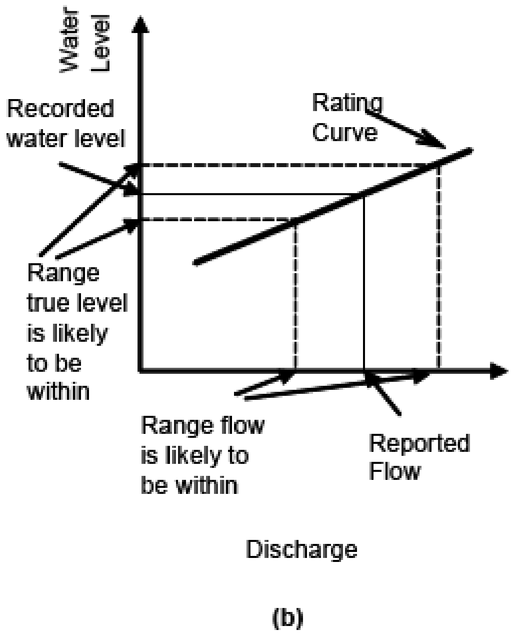


Figure 1 Uncertainty in discharge due to (a) uncertainty in rating table, and (b) uncertainty in recorded water level

Where a distinct change in slope in a rating curve can be identified, AS 3778.2.3 requires the curve to be broken into segments which are considered separately when calculating the statistics used to calculate the uncertainty in a rated discharge. Each segment must be analysed separately because gaugings made in one segment defining a flow-depth relationship governed by one control provide no information about the relationship between flow and depth in a different segment governed by a different control.

3.2. Uncertainty in daily, monthly and annual flows

AS 3778.2.3 employs a tabular calculation method for calculating the daily mean flow and its associated uncertainty. The method effectively finds the rated discharge for the water level recorded at each hour of the day and averages it to obtain the daily mean flow. The uncertainty in the rated discharge for each hour is also calculated and a flow-weighted average is calculated to obtain the uncertainty in the daily mean flow. The monthly flow is calculated by averaging the daily flows and its uncertainty is estimated as the flow-weighted average of the daily flow uncertainties. The annual flow and its uncertainty is calculated similarly from the monthly flows and their uncertainties. All uncertainties are reported as percentages with 95% confidence.[1]

4. PRACTICAL AND TECHNICAL DIFFICULTIES WITH AS 3778.2.3

A number of practical and technical difficulties were encountered using the Standard to estimate the uncertainty in the annual flow at monitoring sites in Gippsland. They are listed and discussed in the following sections.

4.1. Insufficient gaugings in a segment

An important factor in the statistical analysis of the uncertainty in the rating table is the number of gaugings, N, available for the analysis. AS 3778.2.3 states at least 20 gauged discharge measurements are required in each segment of the rating table for a statistically valid estimate of the uncertainty in the flow. No sites in Gippsland meet this requirement in all segments, for two reasons. Firstly, particular problems are associated with the number of gauged discharge measurements in the top and bottom segments of the rating curve. These segments cover flows which occur infrequently, so there are fewer opportunities to perform gaugings. In the top segment with high flows, often safety, access, and logistical difficulties further reduce the opportunities for carrying out gaugings. Secondly, current monitoring practice in Victoria, where generally, gaugings are made four times a year during routine monthly visits to the site, meant that obtaining gaugings in a particular segment was somewhat random. This study has already contributed to improving the uncertainty in flow at some Victorian sites by targeting gaugings in particular flow ranges.

The requirement for at least 20 gaugings in each segment assumes the hydrographer is trying to avoid the increase in uncertainty in the flow that comes as a result of a using a small N. Budgetary restraints may require a trade-off between minimising the uncertainty in the flow estimates and the cost of performing gaugings. A decision was made to calculate the uncertainty due to the rating table using the available gaugings, with the understanding that in many segments the lack of information defining the rating curve (i.e. the small number of gaugings) will contribute to higher estimates of uncertainty than would be the case if 20 gaugings were available in the segment. Consequences of this decision include:

• Very high uncertainty estimates in segments with less than 5 gauged discharges – especially in the bottom and top segments where there may be significant extrapolation away from the lowest or highest gauged discharge, which can be a significant source of systematic error (Kuzera, 1996) ,

• It not being mathematically possible to calculate the uncertainty for segments with less than 3 gauged discharges.

The authors believe a method for estimating uncertainty in segments with small numbers of gauged discharges needs to be incorporated into the Standard to overcome these problems. Additionally, monitoring technologies that can be installed and left in place at a site until sufficient information is obtained to generate a rating table with acceptable uncertainty in the rated discharges may need to be identified and adopted at critical sites.

4.2. Identification of segments and transitional curves.

AS 3778.2.3 requires the separate statistical analysis of segments of the rating curve. The Standard describes a number of techniques useful for identifying the segments, but the analyst is still called upon to make a judgement whether two segments are necessary or whether one will suffice when small changes of slope occur. This can have large consequences for the uncertainty results when there are limited gaugings available for the analysis. Additional guidelines should be developed to ensure a consistent approach by different hydrographers.

Division of the rating curve into segments also causes problems calculating the uncertainty when water levels are recorded which fall on the transition curve between segments. This is not discussed in the Standard. For this study, the solution adopted was to extend the range of water levels for which the segment parameters applied, so the full range of the rating curve was covered by the segment parameters and the transition curves omitted.

Despite these problems, the authors believe the philosophy of breaking the rating curve into segments and acknowledging there are different hydraulic controls at the site at different water levels, gives better understanding of the uncertainty in the flow estimates than using techniques which fit smooth continuous curves to the full range of the rating table.

4.3. Using historical gaugings when the rating curve shifts

At times, especially at sites with an unstable control, or after a significant flood that modifies the stream channel, a gauged discharge measurement is made that is significantly different from the rated discharge for that water level. Current practice in Victoria deems that if the next two gauging measurements are also significantly different from the rated discharge, a “shift” in the rating table has occurred, and a new rating table is constructed that reflects the new relationship between water level and flow at the site.

The hydrographer uses the three latest gaugings, their understanding of the hydraulic conditions and stream cross section at the site, and the general shape of the rating curve defined by the collection of historical gauged discharge measurements, to construct the new rating curve.

A shift in the rating table causes some difficulties in the calculation of the uncertainty in the flow at the site in the short term. Initially, there are only three gauged measurements in the section of the rating table that has shifted that are definitely known to represent the current conditions at the monitoring site. However, the historical gauged discharges that were used by the hydrographer to guide them plotting the new rating curve should also be able to be used in the statistical analysis of the rating curve. In this study, periods of time in the past where conditions appeared similar to the new, current conditions were identified, and all gauged discharges from those periods used in the statistical analysis. An important part of routine reporting of uncertainty will be maintaining sufficient records so the statistical analysis of the rating table can be audited.

As more time passes after the shift occurs, the number of current gaugings in the new rating table will increase, which should improve the estimate of the uncertainty in the flows. Reporting protocols should be developed that address updating uncertainty results as more gaugings become available for the statistical analysis of the rating table.

4.4. Uncertainty in the period before a shift in the rating table is identified

Identifying when a shift in the rating table occurs is a factor which affects the uncertainty in reported flows, but is not incorporated in the methodology in AS 3778.2.3. This is most likely because the Standard was written assuming hydrographers would be following the recommended gauging frequencies in the Manual for Stream Gauging (WMO, 1980). If 12 to 18 gaugings are carried out each year as per the Manual's recommendations, determining when the shift in the rating table occurred will usually affect less than a month's data. Current Victorian monitoring practices mean that up to three months of data may be affected. For this study, an abrupt switch from the old rating table to the new rating table on the first day it is valid has been used to do the uncertainty calculations. Additional work is required to investigate more appropriate techniques. At sites where uncertainty due to shifts in the rating table may be significant, the preferred method for limiting the uncertainty in the flow due to this source is to perform gaugings on a relatively frequent and regular basis.

4.5. Allowing for drift

Drift is a gradual cumulative error in the recorded water level over time. Drift is identified at monitoring sites by checking the recorded water levels against water levels measured manually by field personnel. In Victoria, any drift occurring in the recorded water levels is corrected as part of the QA/QC procedures by the monitoring program service provider when it archives the water level data.

AS 3778.2.3 includes provision for additional uncertainty in the water level due to the uncertainty introduced by drift – but provides no guidance as to how to estimate the uncertainty due to drift. For this study, uncertainty due to drift was not included, so at any sites where drift occurred, the uncertainty calculated should be considered an estimate of the minimum uncertainty at the site.

4.6. Missing or in-filled data

There can be gaps in the time-series of recorded water levels, due to instrumentation damage or failures. In Victoria, as part of QA/QC procedures, the monitoring program service provider examines these gaps and depending on their length and circumstances, may:

• Infill the data by interpolation (where weather data indicate this is reasonable)

• Infill the data by correlating the water level at the site to the water level at a suitable nearby site

• Infill the data using other methods

• Leave gaps in the data

In each case, a "quality code" assigned to the archived water level indicates there was a gap in the record, and how it has been treated. And in each case, a different source of uncertainty is introduced into flow data.

For the periods where gaps have been infilled, a method of estimating the uncertainty in the rated flow should be used that reflects the uncertainty introduced by the method of infilling the gap, not the method described in the Standard. This was not done in this study, however, because the level of uncertainty at a site due to its rating table, instrumentation and infrastructure was of primary interest, and introducing sources of uncertainty from other sites would have made interpretation of the results more difficult.

4.7. Extremely shallow water depths

At some sites in Gippsland during the period July 2005 to June 2006, water levels were recorded that indicated the water depth in the stream was only a few millimetres. At a few sites, the stream ceased to flow, and the water depth was recorded as zero. Using AS 3778.2.3, recorded water levels smaller than the uncertainty in the instrumentation lead to the calculation of very high uncertainties in the rated discharge (up to and greater than +/- 1000%). On first inspection, these high uncertainties are disturbing, but the extremely small discharges they are associated with means they are of little practical consequence. It may be worthwhile developing a reporting protocol that avoids the publishing of high uncertainties of little consequence.

5. RESULTS FOR UNCERTAINTY IN THE ANNUAL MEAN FLOW

Despite the problems described in section 4, given that at present there are no uncertainty estimates around flow data available, the uncertainty in the reported annual flow values was estimated using the data available and the methodology outlined in AS 3778.2.3. We persisted with using AS 3778.2.3, rather than attempting to design an alternative method using other statistical methods available in the literature that might be less problematic, because it provides an easily accessed, industry-wide recognized and trusted, foundation on which the hydrographic community can build a methodology that should be acceptable to all parties involved in funding, collecting, and using the data.

Working around the practical and technical difficulties encountered using AS 3778.2.3, the percentage uncertainty in the Annual Mean Flow for July 2005 to June 2006 could be estimated for the full year for 42 of the 76 sites in Gippsland. At 30 sites, the annual uncertainty could not be calculated due to one or more segments of the rating table having two or less gauged discharge measurements, so that it was not mathematically possible to calculate an uncertainty for flows in these segments. At these sites, the proportion of the year for which it was possible to estimate the uncertainty in the hourly discharge was calculated, and the uncertainty associated with that flow period estimated.

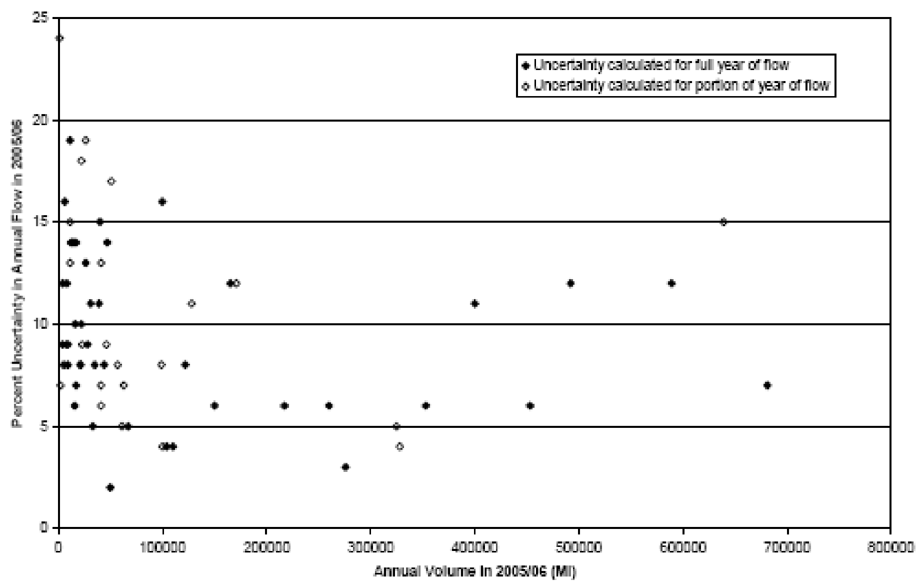


***Figure 2 Uncertainty in annual flow for July 05/June 06 for 72 sites in Gippsland*.**

At all the sites, there were one or more segments of the rating table with less than 20 gauged discharge measurements, so that according to the recommendations of AS 3778.2.3, the results should not be considered "statistically valid". The study results should therefore be considered as indicative only, and for this reason, the results are shown plotted in figure 2 with percentage uncertainty plotted against the annual volume, rather than summarised in a table. The results for sites where the uncertainty could only be estimated for a proportion of the annual flow are still plotted against the annual flow at the site. No estimate at all of the annual uncertainty could be made for 4 sites with non-standard rating tables due to backwater effects, tidal effects or infrequent flow. This is an important result from the study – a recognition that at some sites it is not possible to use AS 3778.2.3 to obtain an estimate of the uncertainty at the site.

In figure 2 it can be seen that the uncertainty in the annual mean flow at the sites in Gippsland ranges from 2 to 20%, with most sites having an uncertainty between 5 to 15%. This plot also indicates that there is no correlation between annual mean flow and uncertainty, especially at low volumes where the uncertainty at the sites is evenly distributed between 5 to 15%.

6. INTERPRETING THE RESULTS TO ASSESS IF AND HOW UNCERTAINTY AT A SITE CAN BE REDUCED

The uncertainty in the annual mean flows provides a useful "summary" of the uncertainty at each site by averaging the uncertainties estimated for the range of flows observed at the site between July 2005 and June 2006. However, for the manager interested in reducing the uncertainty, an appreciation of the major factors contributing to the uncertainty at the site is required. For each site, three graphs of information used to estimate the annual uncertainty were prepared:

• A plot of the combined uncertainty, the uncertainty due to the rating curve, and the uncertainty due to the recorded water level in the hourly rated flow against the hourly rated flow for the 8760 hours of the year,

• A type of flow duration curve where the percentage of time and percentage of the annual volume contributed by flows less than a given flow were graphed,

• The rating curve, with the water levels used to divide it into segments, and the gaugings available for the statistical analysis of the rating curve also shown.

These were arranged together to aid interpretation of the information. An example, for site 221208A (Wingan River @ Wingan Inlet National Park), is shown in figure 3. At this site, the uncertainty in the annual mean flow was +/- 15%.

In figure 3, the top plot is the flow duration information, which gives an appreciation of how much time was spent with flows in a given range, and the contribution these flows made to the annual volume. In the example, a rated discharge of 10 Ml/d or less was observed for 21% of the year, and contributed less than 1% of the annual volume. Rated discharges of 1000 Ml/d or less were observed for 98% of the year, implying flows greater than 1000Ml/d occurred for 2% of the year, or a total of 170 hrs. However, rated discharges of 1000 Ml/d or less only contributed 68% of the annual volume, implying the flows greater than 1000Ml/d, which occurred for only 2% of the year, contributed 32% of the annual volume. It is also possible to calculate the percentage of the annual flow contributed by flows within particular flow range.

The second plot shows the uncertainty as a function of rated discharge. The combined uncertainty is shown in black, the uncertainty due to the rating table in gold, and the uncertainty due to the recorded water level in blue. This plot can be used to identify flow ranges with high uncertainty, and the relative contribution of uncertainty in the rating curve and the recorded water level. In figure 3, there is very high uncertainty in rated discharges less than 20 Ml/d (>25%). For these low flows, especially in the range of 7 to 17 Ml/d, most of the uncertainty comes from the recorded water level. Yet while these are high uncertainties, the top plot shows that even though they were observed for around 45% of the year, discharges less than 17 Ml/d only contributed 3% of the annual volume, and so have little impact on the uncertainty in the annual mean flow, although the high uncertainties may be of concern for other data uses such as environmental flow management. While it may be possible to improve the uncertainty in these rated discharges by upgrading the measuring equipment or modifying the low flow control, it would not make a big improvement in the uncertainty in the annual mean flow.

For the range of flows between 20 and 100 Ml/d, the combined uncertainty varies from 15 to 25%. Nearly all the uncertainty is due to the uncertainty in the recorded water level. Improving the uncertainty in the water level (which may require upgrading the measuring equipment or modifying the low flow control) should enable the uncertainty in this range of flows to be lowered to values much closer to the 4 to 8 % uncertainty due to the rating table. This should have some impact on the uncertainty in the annual mean flow, because (from the top plot in figure 3), this flow range contributes about (22-3)=19% of the annual volume.

The estimate for the combined uncertainty for flows observed in the range between 100 to 2000 Ml/d varies from +/- 17 to +/- 9% (shown in the middle plot). From the top plot, this range of flows contributes about 58% of the annual volume, and makes a large contribution to the uncertainty in the annual mean flow being held to +/- 15% whereas much higher uncertainties are calculated for other ranges of flow. The combined uncertainty in this range is contributed almost equally by the uncertainty due to the rating table and by the uncertainty due to the recorded water level, indicating both factors must be addressed to improve the uncertainty in this flow range.

For high flows greater than 2000 Ml/d, the uncertainty increases from +/-15 to +/-23% with increasing flow. Since from the top plot, flows greater than 2000 Ml/d contribute 20% of the annual volume, these high uncertainties also impact the uncertainty in the annual mean flow. Most of the uncertainty in this flow range is due to the rating table. To give an indication if the uncertainty can be reduced in this flow range, some information about the rating table is required. This can be found in the third plot in figure 3.

The third plot in figure 3 is the rating table, with the segments and gaugings used for the statistical analysis also shown. At this size it provides a rough indication of the number of gaugings available in the segments, and the spread of gaugings around the rating curve, although it is very difficult to see the change in slope that required the curve to be broken into segments. In figure 3, it is clear there are very few gaugings in the top segment where rated discharges are greater than 150 Ml/d. This suggests much of the uncertainty is due to insufficient gaugings for the statistical analysis, rather than a large “spread” in the gaugings around the rating curve. It is likely more gaugings made in this flow range will improve the uncertainty, especially gaugings greater than 1000 Ml/d. However, inspection of the top plot indicates that there was limited opportunity to obtain a gauging in this range during this year, as the flow was greater than 1000 Ml/d for about 2% of the time (for a total of about 170 hours).

This suggests it will require deliberate, planned efforts to obtain more gaugings in this flow range.

Figure 3 also shows flows greater than 1200 Ml/d have been estimated using an extrapolation of the rating curve past the highest gauging. A useful subsidiary indicator of uncertainty might be the proportion of the annual volume contributed by flows in the extrapolated part of the rating curve. These plots were used to assess the uncertainty in the rated discharges reported for each site. At many sites, uncertainties greater than 30% were observed for some of the range of flow. Most often the cause of these high uncertainties was the small number of gaugings in the segment, or high percentage uncertainties in the recorded water level due to water levels less than the instrumentation uncertainty, two problems that have been discussed in section 4 .

CONCLUSIONS

Results from this study indicate the uncertainty in the annual mean flow at most monitoring sites in Gippsland ranges from +/- 5% to +/- 15% in 2005-2006. Whether this level of uncertainty is acceptable must be assessed in light of the information available to calculate uncertainty, and the issues the flow data are used to address.

Uncertainty in the rated discharge can be greater than 30% for at some sites for some flow ranges. Inspection of the information used to calculate the uncertainty is useful for identifying opportunities to improve the uncertainty at the sites. The process of calculating the uncertainty has also provided a useful opportunity for the Monitoring Partnerships’ administrator (DSE) and service provider (Thiess Services) to audit how adequately the current arrangements are delivering the State’s stream flow data.

While AS 3778.2.3 provides a foundation for a methodology for estimating the uncertainty in reported flows that is readily accepted by all parties involved with the data, the issues raised in section 4 of this paper need to be urgently addressed to enable the consistent calculation of uncertainty by different parties. Uncertainty in the flow should be reported as a routine part of data dissemination to enable the user to take into account the confidence level of hydrological data in decision making.

Finally, it is important the concept of the uncertainty in the flow data should continue to be introduced and explained to all who use the data.

Figure 3 not available in PDF format

8. ACKNOWLEDGEMENTS

This work was conducted in collaboration between the Water Information Section, Victorian Government Department of Sustainability and Environment, Thiess Services, and the Department of Civil and Environmental Engineering at the University of Melbourne. All funding was provided by the Victorian Government Department of Sustainability and Environment.

9. REFERENCES

Australian Standards International, (2001). *Australian Standard, Measurement of Water Flow in Open Channels, Part 2.3: General—Determination of the stage-discharge relationship*, AS 3778.2.3-2001, Australian Standards International, Sydney, Australia.

Australian Standards International, (2001). *Australian Standard, Measurement of Water Flow in Open Channels, Part 3.1: Velocity-area methods—Measurement by current-meters and floats*, AS 3778.3.1-2001, Australian Standards International, Sydney, Australia.

International Organisation for Standardization, (1983). *ISO 1100-2:1983 Liquid flow measurement in open channels, Part 2: Determination of the stage-discharge relationship*, International Organisation for Standardization, Geneva.

US Geological Survey (USGS), (1999). *Streamflow Information for the Next Century*, A Plan for the National Streamflow Information Program of the U.S. Geological Survey, Open-File Report 99–456, US Geological Survey, Denver

US Geological Survey (USGS), (2005). Water *Resources Data, Florida, Water Year 2004*, Water-Data Report FL-04-1A, Hydrologic Records Section, US Geological Service, Florida

World Meteorological Organization (WMO), (1980), *Manual on Stream Gauging*, Secretariat of the World Meteorological Organization, Geneva

World Meteorological Organization (WMO), (2007). *Proposal and Project Implementation Plan for the Assessment of the Performance of Flow Measurement Instruments and Techniques*, Commission for Hydrology, http://www.wmo.int/pages/prog/hwrp/documents/Proposal_20070606.pdf

Kuczera, A. P. G., 1996, Correlated rating curve error in flood frequency inference, *Water Resour. Res*, 32 (7),2119-2127

Australian Hydrographers' Association Educational Grant

The Committee of the Australian Hydrographers' Association has instituted a number of awards/grants to encourage younger (and not so young) cadets and hydrographers to undertake studies in the Hydrography Certificate IV. This has been implemented in 2006 and the following information is provided to AHA members. AHA members are also encouraged to make their employers and others aware of this grant and that the Association wishes to support the development of cadetships and traineeships within the industry, this grant being one aspect of the Associations support.

Along with this Grant the committee has also instituted an Educational Travel Grant (closed end of April 2006) and the Committee is currently considering applicants for this Grant

The following describes the requirements and conditions for the Educational Grant.

PURPOSE

The purpose of the Educational Grant is to:

- promote the principle objective of the Association to further the development of the science of hydrography/field hydrology and its application to the under-standing monitoring and management of Australia's water resources, and
- assist students undertaking the Hydrography Certificate IV (accredited under the Australian Qualifications Framework to undertake the final year Project (Subject 8004AA) as required in the course

THE GRANT

The Grant will be of a value of <u>up to</u> $1000 to assist the students undertaking studies in the Hydrography Certificate IV to purchase material/equipment and services necessary to undertake the Project in the final year of the course.

CONDITIONS

- The recipient will supply an initial abstract paper and a final project paper for publication in the Association's Journal "Australasian Hydrographer", and win advanced consideration for the right to present the Project paper (describing the work undertaken) at the Australian Hydrographers' Association Conference (at a future date) upon applying for the Conference Educational Travel Grant. (See previous section)
- The recipient will be a financial member of the Australian Hydrographers' Association.
- The recipient will normally be enrolled in the Hydrography Certificate IV (AQF).
- The recipient's project will have been approved by OTEN and/or the recipients employer as an appropriate project activity meeting the requirements of the Project (Subject 8004AA) in the Hydrography Certificate IV.
- Applications will include the approved Project proposal, a budget detailing other sources of financial/material support (for example from the employer/supervisor).
- Applications will be assessed by the Association's Committee who may invite advice from appropriately qualified people. The Committee may liaise with the employer where necessary. More than one grant may be awarded annually, at the Committee's discretion.
- The grant will take the form of a reimbursement to the awarded value, paid to the individual, or as a rebate to the employer that has initially covered the recipients costs incurred, after presentation of proof of purchase of items/services.
- Items purchased with the Grant will become the property of the recipient's institution/employer or in the case of a stand alone student, the student.
- Proof of purchase of the items/services must be supplied to the Treasurer prior to reimbursement if this grant is awarded.

Further information and application forms can be found on the Associations website at ***<u>www.aha.net.au</u>***

Membership Renewals

Membership renewal reminders have been distributed, encouraging your continued participation in the activities of the Association.

Those who have received them will notice that the hard work is done for you and the information you last provided to the Association is already filled in!

Its as simple as correcting the information (if needed) and returning the form with your payment to:

The Treasurer
Australian Hydrographers' Association
14 Kosciusko St,
Traralgon, Victoria 3844

The Association accepts payment of subscriptions by cheque, credit card and Electronic Funds Transfer. If you wish to debit from your account direct to the AHA account please email the treasurer to get our bank account details for EFT. (treasurer@aha.net.au)

Corporate Memberships

4 levels of Corporate Membership are currently offered as follows:

Corporate Membership Grade	Annual Cost	Included Membership
Bronze	$500	1
Silver	$1,000	6
Gold	$1,500	12
Platinum	$2,000	20

Main features of Australian Hydrographers' Association Membership (for both Individual and Corporate) include:

- Knowledge and information sharing amongst peers.
- Promotion and sponsorship opportunities at a biennial conference.
- Four journals, *Australasian Hydrographer*, per year.
- Association Website and peer group mailing list with discussion threads.
- Commitment to supporting continuing education of Hydrographers (Certificate IV Hydrography).
- Travel grant assistance scheme for student/cadet members to attend conferences.
- Educational grants.
- Job advertisement network to industry.
- Investing funds for educational support for hydrographic industry (Member of Industry Advisory Group).
- Supporting State based industry workshops.

AHA Office Bearers and Contacts

Chairman, Bill Steen,
chairman@aha.net.au

Secretary, Michael Whiting
secretary@aha.net.au

Treasurer, Max Hayes
treasurer@aha.net.au

Publicity Officer, Mic Clayton
publicist@aha.net.au

Public Officer, John Skinner

Committee Members, Bill Barratt, Paul Langshaw

AHA CONFERENCE 2008; THROUGH THE EYES OF A NON-HYDROGRAPHER

Jo Gregory

The conference *really* started with the meet and greet held on Wednesday evening prior to the formal events. This was a great opportunity for "old" colleagues to catch up informally with each other and to mingle with new kids on the block (people like me). It was a very noisy event with the ratio of men to women being approximately 1:25 and the average age being 45+. The following evening this did not escape the attention of comedian Jean Kitson, who provided excellent entertainment at the conference dinner.

The conference was opened by ***Bill Steen*** (Australian Hydrographers Association Chairman) and over the course of two days had 19 speakers on a wide variety of subjects. Here is a precis of some that caught my ear.

BoM and the development of the Australian Water Resources Information System (AWRIS) and beyond. ***Rob Vertessy***, the Deputy Director of BoM, talked about the current issues surrounding water security, water reform and staffing for the AWRIS project. He also spoke about an R&D joint venture with CSIRO called the Water Information R&D Alliance (WIRADA), a $50 million, five-year project with approximately 40 FTEs involved. This project will contribute to the development of AWRIS and help "prepare the development of future systems and methodologies to deliver a national water account and water assessment products".

There was a presentation about the Snowy Hydro Scheme, specifically about water being lost from aqueducts in the Murray Development of the Snowy Hydro Scheme. I really enjoyed the presentation titled “Satellite and Land Based Telemetry Options for Water”. This was a very interesting talk about the different types of satellites and the need to make appropriate informed choices regarding the best network to use, taking into account factors like the frequency of data upload required, communication costs and data loss tolerances. It was interesting to learn that the location of a telemetered site in a river valley had a very real bearing on the most appropriate satellite network to use.

Frank Davies spoke about the DoW Bookshelf and generated interest from other organisations that do not have a comprehensive system like ours in place.

There was a lot of discussion about the training and skills required to support a national water information network for the future and about the transition of the Hydrography Certificate into the Australian Qualifications Framework. With a large proportion of hydrographers due to retire within the next 10 years there is a huge skill vulnerability if it is not addressed now. The Department of Water, WA was mentioned on several occasions as having the best hydrographic staff training system currently in place in Australia.

Other subjects included flood warning and real-time telemetry, information quality and two presentations on how to get the best result out of your Acoustic Doppler Current Profiler (ADCP) for current metering.

The second last presentation on the final day was an amusing account of the upgrade of the Hydrographic Support Current Meter Calibration Facility for the Department of Natural Resources and Water, Qld. It was both interesting and very funny providing a bit of light relief at the end of three sometimes heavy-going days.

Mark Wolf from Greenspan was the final presenter. He described the collaboration between engineers, hydrologists and hydrographers to develop “SMART” (Stormwater Management and Road Tunnel) which is a first of its kind project in the world. This consists primarily of a dual-layer 11 km tunnel that runs under the city of Kuala Lumpar. It is designed to minimise flooding by diverting stormwater under the city as well as providing a traffic tunnel on the upper layer to reduce traffic congestion. In normal flood events a proportion of the water is diverted into the lower level of the tunnel and discharged downstream of the city. This has occurred six times since the tunnel’s inception in June 2007. In extreme flood conditions (> 150 m3/s) the traffic is emptied and the flood waters are also diverted into the top layer of the tunnel. This has occurred once since June last year. The operation of the tunnel in response to flooding is underpinned by an awesome real-time telemetry network that has been established to a very high specification to ensure that it will not fail. A National Geographic documentary has been made about this project. For those with Foxtel, keep a look out for it.

Field Trip Day

We learnt much more about the Snowy Hydro Scheme on our field trip on the Saturday. Snowy Hydro is now a commercial organisation concerned more with power supply rather than water supply.

The trip started at their information centre where we learnt about the research program that they are conducting to increase snowfall by cloud seeding. Increased snowfall makes more water available for power generation when the snow melts. At their operational centre we were shown the main control room, which was amazing and would put Homer Simpson’s process control job to shame. The trip continued over the Jindabyne Dam wall, which we later inspected in more detail on the return journey.

No doubt, the most interesting stop for the hydrographers was their snowfall measurement site at Thredbo. This also offered an opportunity to experiment with snowball construction and deployment.
Frank Davies (wisely) disappeared…you could say melted away!

Overall, it was a very interesting and enjoyable experience, though the -3 °C walking back from town after dinner on the Friday night convinced me that Canberra is not for me on a permanent basis!

Some of WA's representatives who attended the AHA 2008 Conference:
Ben Cohen (Agriculture & Food), ***Jacquie Bellhouse*** (Water Corporation), ***Jo Gregory***, ***Kelvin Baldock*** (Hydrosmart), ***Mick Whiting***, ***Andrew Weatherburn***, ***Frank Davies***

The Gauge-Off *(Alex Springall)*

Plus ca change, plus c'est Ie meme chose. The more things change, the more they stay the same. Back in the 1970's South Australians persistently claimed that the upstream states, NSW and more particularly Victoria, were ripping them off when it came to water. Queensland, in those days, was too far upstream to matter.

Flow into South Australia was measured for accounting purposes at GS 426200, Murray River dis Rufus River Junction. The South Australians alleged that the Victorians were using devious means to over-estimate the flow into SA. Firstly, they were using Gurley cup-type current meters, when everyone else used propeller-type meters. These, it was further alleged, over-registered if the river was at all choppy. Secondly, their stage-discharge ratings were questionable. Ah, those devious Vies. Why, they'd even allocated their own GS number to the station.

Exchanges took place at a high level. Each state argued its case. The predecessor of the MDBC, the River Murray Commission, lost patience, and threatened to set up and operate its own station if the states couldn't reach agreement. Eventually, it was agreed that gauging parties from each state would set up and gauge the station according to their own practices. The results would be compared, as would the methods of plotting ratings.

I was working in SA at the time, and was tasked with preparing historical ratings as SA believed they should be. Not only should they be accurate, but, more importantly, they should not favour Victoria. Always loyal to my employer, I did as ordered.

At the appointed hour, three gauging parties met at the station. Victoria's hydrographer was the legendary Andy Keep; Pat Pauling led for the NSW team, while Geoff Whitbread opened for SA, with Volker Aeuckens and I in reserve. Each party set up at its favourite section and carried out several gaugings according to its standard procedures, while keeping an eye on the opposition for any signs of foul play. When all the gaugings were computed, there was negligible difference between them. All parties then adjourned to the Wentworth RSL, where the debate was to be taken up by engineers and hydrologists from each state.

We arrived at the RSL well before the assorted engineers, so proceeded had a few quiet beers, except for Andy, who didn't drink. He did, however, playa very good honky-tonk piano, and proceeded to do so. The combined effect of the alcohol and the music was to dissolve any animosity that may have existed between the hydrographic parties. We discussed the issues and agreed on solutions. By the time our bosses arrived, all had been resolved.

When the formal proceedings began, we hydrographers somehow put up proposals that made sense to the engineers. Dick Francis, representing the RMC, congratulated all concerned on solving these technical issues. Only one problem remained unresolved -the correct gauging station number. This occupied the engineers until well into the evening, until Dick pulled rank and decreed that it was 426200, and that was that. It is important to get the big things right.

Each state's engineers left the meeting feeling that they had pulled off a good deal, and the Victorians felt that their concession on the GS number was a small price to pay for victory.

Unfortunately, the pax aquaria was not to last. Further gauge-offs were held, with inconclusive results. For all I know, they may now be an annual fixture.