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Surface Watery Sources

As early as 1880, technical experts had advised politicians on the need to collect and analyse information on flows in Queensland rivers and streams. The stream gauging network has provided hydrographers and hydrologists with fundamental data by which water resources can be managed.

It is nigh on impossible to manage water resources or to design and operate water infrastructure without data and analysis. Certainly, engineering – which comes from the same root as ‘ingenuity’ – is adept at making the best evaluation of the available information, but without any reasonable basis, the decisions are bound to be wrong. There is an account written by Dr Henry Olivier, arguably one of the pre-eminent dam engineers of the century, of the design and construction of Kariba Dam on the Zambezi River. There were, of course, no reliable hydrologic data on which to base a design, so estimates of design floods were made on the basis of European experience and empirical rules. During the first year of construction, the ‘design flood’ (which is supposed to be an extremely rare flood – see Chapter 13) was experienced. Accordingly, the design was modified to cater for a substantially increased flood. In the second year of construction, that flood occurred. Again the design was revised and the dam’s construction was completed in due course.¹ It is comforting to note that the dam has operated successfully since its completion in 1959.

Surface Water Resources Branch, in its various guises, has had the dual role of collection and processing of hydrologic data (hydrography) and analysis of the behaviour of dams, weirs and other hydrologic systems (hydrology). As far as the

latter is concerned, there is again a dual role: flood hydrology which is concerned with estimating the characteristics of hypothetical floods that structures have to be designed to withstand; and yield hydrology which determines how much water can be taken from storages or systems and how reliably this can be done. This requires a series of calculations, for which computer analysis of mathematical models has proved invaluable.

Hydrographers are concerned with taking measurements of flows in streams (both instantaneously and continuously) over a long period. The excitement they can experience, particularly during big flow events (floods), will be discussed later.

As early as the 1880s, Rigby alluded to the crying need for accurate river gaugings. His successors also took up the cry but it was a long time, not until 1909, before adequate funds became available for the task and the Stream Gauging Branch was created. The section was small and included Charles Deshon, stream gaugers GN Croker and Archibald Morrison, and an assistant, RL (Bert) Wragge. The son of Government Meteorologist Clement Wragge, Bert Wragge remained with the section until December 1951. The first registered gauging in Queensland was completed by Archibald Morrison on the Brisbane River at Lowood on 23 March 1909.²

Francis James (FJ) Calvert joined the old Hydraulic Engineer's department in 1913 and assisted JB Henderson in the establishment of stream gauges and, in conjunction with Clement Wragge of the Weather Bureau, established flood warning systems. In 1922, Partridge created the Stream Gauging Branch and appointed Calvert as Stream Gauging Engineer. The activities of this branch included shallow groundwater investigations, later transferred to Groundwater Branch.

FJ held this position until he had a nervous breakdown. He gave up engineering and purchased a farm in the Sunshine Coast hinterland. Unfortunately, during the Depression in the early 1930s the farm went bankrupt. Calvert returned to the Sub-Department in 1936 in a temporary capacity, undertaking miscellaneous water supply works. Following the untimely death of WA Conroy in 1946, Calvert was appointed Stream Gauging Engineer, a job he had had 20 years earlier.

When Commissioner Lang reorganised the Commission in 1947, he changed the name of Stream Gauging Branch to Water Resources Branch and appointed FJ as Senior Water Resources Engineer. He also changed the name of Stream Gauger to Hydrographer. Through his innovative work, FJ became regarded as the founding father of stream gauging in Queensland. His series of firsts included introducing registered ratings of meters and sloping gauges. Calvert retired in 1957. He was given a number of six-monthly extensions to do a 'special project'. At the end of each six months he was half-way through a 'special project' and he had to have another six months.³

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Calvert's staff in 1948 included hydrographers Doug Smith, Bert Wragge, Fred Mahoney and Joseph 'Charlie' Ogden, while Len Ezzy was one of two assistant hydrographers.⁴ These officers, who served prior to World War II without the advantages of sophisticated equipment and good roads, were nicknamed the 'old timers' by Harry Stark.⁵ Doug Smith, a former draftsman who preferred outdoor work, served from February 1924 until December 1965. He had an encyclopaedic knowledge of all the jobs he worked on. Fred Mahoney joined in April 1929 and died in service on 19 January 1959. Harold Scholz worked in the section from 1940 to 1981.



Hydrographers Meeting 1957

(Back row) W. Bature, K. Netzel, N. Nedorisoff, S. Granat, G. Beran (Middle row) P. Purich, M. Kotil, L. Moore, K. Smytbe, J. McKinlay, L. Ezzy, F. Mahoney, W. Harman (Front row) J. Ogden, R. Mincher, H. Scholz, A. Seabrook (Snr), A. Seabrook (Jnr), W. Nye, A. McCutchan

Reg Williams and Tommy Lord were transferred from Artesian and Stock Water Supply Branch to Calvert's new Branch. Harold Mortley had joined the section in 1926.⁶

Charlie Ogden joined in December 1919. *A colourful, though forceful, character, his influence on the branch was profound.* He is credited with establishing the work ethics and procedures which still stand.⁷ Charlie Ogden was 'tight'. Harold Scholz recalls *we were all paid to live in hotels when we went on trips, but Charlie used to roll out his swag in the back of the ute and claim full hotel expenses and then he'd go down and have a few beers and ask the publican for a receipt. In Mareeba, Ian Fairweather opened up the office one morning, and there was Charlie sleeping in the office. It was a rainy night, and Charlie had a key to the back of the office, so he went in and slept there – just to save a few shillings.*⁸

Engineer John Ward describes Charlie Ogden as the Sergeant Major. Charlie had little time for engineers. John remembers that after he had been in the hydrology section for a week in 1960 Branch Head Arthur McCutchan *asked Charlie to take me to Rocklea to show me the equipment. Charlie didn't say a word in the car and then he just unlocked the shed and said, "When you're finished, I'll be sitting in the car."* Len Moore offered to show John around but Charlie yelled *"It's not your job. If he wants to know anything about the equipment he can find out himself."*⁹

After the wet season in 1948, the section expanded.¹⁰ Harold Scholz believes the expansion was in part due to the efforts of Tom Lang. In 1943, Lang seized the

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opportunity to publish in the *Courier-Mail* an article about irrigation in response to Ion Idriess' popular book *The Great Boomerang*, about irrigating the dead heart. Money soon came from Parliament.¹¹

Another recruit was English meteorologist Bernard 'Bill' Harman. Bill had accepted a job with MGM film studios in Sydney, who wanted reliable weather forecasts. He migrated, only to find that MGM had decided not to proceed with their new studio. He saw an advertisement for hydrologists with the Commission and applied without really knowing what a hydrologist did. Arthur McCutchan recognised the affinity between the weather and streamflows and wisely employed Bill Harman, whose maps of rainfall patterns graced the pages of the Annual Reports for many years.¹² Michael Barry, as a brand-new cadet draftsman, watched with fascination as Bill did his magic on Thiessen polygons to decipher the cyclone of 1957 that had wreaked havoc on Mackay.¹³



Hydrographers vehicle 1950s

Post World War II brought a second group to the section. Known affectionately as 'Charlie's Balts', these officers were displaced persons, Europeans fleeing from war and upheaval and employed by Charlie Ogden. These people approached hydrology with *exemplary enthusiasm*.¹⁴ Bela 'Bill' Sebestyen, an ex-Hungarian army officer employed in 1955 as a hydrologist, retired in 1978. Peter Gosse was a White Russian, trained in the Ukraine, and the first full-time surface water hydrologist. Field Officer Stefan Granat was a World War II Polish army officer.

Wally Baturo, a former Polish teacher, joined in 1951 and became a specialist drawer of rating curves and wrote the first procedure on it. Karol Netzel, who held a Polish Diploma in Agriculture, joined the Commission as a survey labourer in 1955. George Beran, who could have been a member of the German gymnastics team before World War II, joined the Commission in 1951 as a construction gang member installing floatwells in the Border Rivers, before moving to Rockhampton in 1958. He became a legend, remembered for his generosity and love of a good social life, while displaying persistence and determination at work. George once tried to cut a log with a chainsaw on which someone had put the chain on backwards. *He succeeded – he just about blew up the chainsaw, but he wasn't going to let it beat him. That was his personality. No thing or person would beat George. He was determined, tough and hard but very friendly.*¹⁵

Training was virtually non-existent. While camping at the future Moogerah Dam site, Harold Scholz was recruited by Len Ezzy as a surveyor's labourer. After two months

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they went to Birdsville and *had a wonderful time. We were the first two there. We went out in a one ton GMC truck with a shovel each. There were no four-wheel-drives then. It was just two chaps with the sand, and we did a lot of shovelling.*¹⁶

Prior to 1954, there were no regional offices; everyone worked out of Brisbane. Up to the end of the war, officers often travelled by train to a town, hired a horse and buggy, went out and stayed until the work was done. *The reporting in those days was by letters backwards and forwards to Brisbane. There were little paper wars with some of the old fellows.*¹⁷

The post office was the point of contact where a telegram of instructions would be waiting. Don Alexander explained, *you could work your way around Queensland without ever going to an office. Harold Scholz went to Mareeba for six weeks in 1954. The trip was extended and extended again, as the work piled up. He finally made it back to Brisbane briefly for a conference 11 years later in 1965.*¹⁸

Harold Scholz *choofed off, out through the Gulf Country and all around the place. Every Thursday we used to send a telegram to say where we'd be the following Thursday so they could send our wages to a post office. That went on for two and a half years, and then I got a letter from Head Office saying that if I didn't apply for my leave soon, I'd lose it! Well, I'd been on paid holidays for two and a half years, what else could I want?*

Scholz was summonsed to Brisbane where Calvert asked him, "Do you like it up there?" I said, "It's not too bad." *Nobody else liked it because they were all southerners and it was too hot up there, too wet, too everything else, and too far away from your family. I loved it. I had a family in Brisbane, but it was good to get away.*

*When I went to Brisbane in 1954, I made myself out to be a real b—— so they'd just want to get rid of me. So I was sent back up there again.*¹⁹ *I hardly knew my kids when they left high school. Their mother was very capable, very strong-willed and she managed everything. The money was paid into the bank and she had full control of the purse strings and if I wanted a couple of beers I had to get down on my knees and beg for five dollars.*²⁰

Regionalisation of hydrography occurred in 1954 when Queensland was split into five administrative districts. Harold Scholz was made responsible for the far northern district, an area between the Burdekin River to the tip of Cape York Peninsula, and west to a point to be decided. Scholz *took that to be the western border, so that was my area, bigger than the whole of Victoria.*²¹ The other areas were from the Burdekin to Mackay, Mackay to Rockhampton, Rockhampton to Bundaberg and then Brisbane.

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Chief Engineer Harold Mortley is regarded as the father of the gas-electric automatic water level recorder system. He worked on its development with Works Supervisor George Wilson, who joined the Commission in 1950. Many of these machines were built and used successfully until they were replaced by imported machines which used different principles.

Arthur McCutchan, who became Chief Investigation Engineer on Mortley's retirement, visited America several times and introduced much of the automation, automatic records and the first digital recorder. After McCutchan joined the (Commonwealth) Department of National Development, he was involved in the Australian Water Resources Council (AWRC) and the Commonwealth and the States entered into agreements over the acquisition of water resources data through the country. Queensland took the opportunity to expand the existing gauging station network greatly, with Commonwealth Government money. The number of gauging stations grew from 164 in 1950 to a peak of 613 in 1979.²² Not only did the number increase, but the coverage increased too. More hydrographers were recruited.²³



Hydrographers vehicle 1980s

In the 1960s, a system of cadets was introduced. After three years as a cadet you became an assistant hydrographer and after completing a correspondence course you became a hydrographer in the fifth year. Nigel Kelly was one of the first. Training was still minimal. Nigel Kelly recalls *I started in 1973 and in early 1974 they threw me the keys to a Land Rover and gave me a whole lot of gear, and said, "OK, you can go up to the Gulf area and the Upper Barron." It was a huge chunk of the State. I went with Wally, a younger cadet, so it was a pretty steep learning curve.*²⁴

Staff were needed and gaining employment was not difficult. Peter Thompson recalls he started in 1961, coming in as a cadet draftsman, and was interviewed by Harold Mortley. *The interview must have taken all of ten minutes. He was more interested in what sport I played than anything else.*²⁵ Roy Mincher remembers Bernie Credlin showed him an advertisement for a hydrographic assistant and advised him to apply. *He had my application typed up. I was called to Brisbane and interviewed by FJ Calvert.*²⁶

As part of the Commonwealth programme, the Snowy Mountains Authority (SMA) was hired to install a network of 600 gauging stations throughout Queensland. Jim Scott and Nev Caton managed the programme.²⁷ Harold Scholz, for part of the

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programme, *accompanied them in the aeroplane with Arthur McCutchan, Keith Smith from the Snowy, Don Galvin and another bloke, and we overflew all of those stations. They picked the spots for the gauges from aerial photographs – 116 sites in my area alone.*

The Department then took over the surveys and designs from SMA. This group designed the cableways and other innovations.²⁸

Harry Stark succeeded Walter Peak as Senior Engineer Surface Water Resources in 1966²⁹ and remained in the position until his retirement in 1981. Towards the end of that period, Harry frequently claimed that he was the only engineer in the Commission who had not been promoted during the 1970s. He was a very cheerful soul who was renowned for his ‘management by walking around’ technique and for always being accompanied to meetings by someone, usually his deputy, John Ward. He was strongly supportive of data collection programmes and did all he could to foster the development of his hydrographers. Harry was always conscious of his mortality as no male ancestor had survived much past fifty. Through a healthy regimen of diet and exercise (he was an enthusiastic tennis player), Harry added virtually 20 years to his statistical expectation, dying in November 1994 at the age of 73.³⁰

Harry’s favourite story was of the private school (perhaps his beloved Alma Mater, Toowoomba Grammar) which decided to change its fee structure and wrote to parents informing them that, in future, term fees would be abolished and there would be only one fee applied ‘per anum’. One father wrote back stating that, as he was used to paying through the nose, he expected he could get used to the new arrangement.

Len Ezzy was the Chief Hydrographer in 1978. He had joined the Commission in January 1940 and served as an Army Officer in World War II. He started the School of Military Engineering course with Fred Haigh, but lasted only five months. Thereafter, Haigh called him ‘Lazy Len’. An expert in bomb disposal, Ezzy’s carefulness was renowned. *You couldn’t rush him. That is why he survived the floods because he wouldn’t go out in the flooded Burdekin until he checked everything. He was very careful.*³¹

In 1978, the Department introduced age 60 retirement. Len Ezzy didn’t think he would go but *he went and found out how much he was going to get in his little payslip, and he was gone!*³²

Following Harry Stark’s retirement in 1981, John Ward took over. Shortly after, Surface Water and Groundwater were amalgamated and John became the Director

of Water Resources Division. In 1987, he returned to Planning Division as Director and Col Hazel was appointed Director of Water Resources Division. Keith Smythe, who was the previous principal hydrographer, left in 1988 and Don Alexander has held this position ever since.⁵³ He is regarded today as the father of hydrographers. A smart, good-looking man, Don is admired by his peers for his ability in the field and in Head Office and for keeping abreast of technology.⁵⁴

Hydrography is concerned with collecting records of stream flows. It is comparatively easy to measure the height of a flow at a gauging point, provided someone is there and there are convenient reference points. It is even possible through the use of technology to install automatic recorders which mark a chart to indicate continuous changes in heights with time. And, in more recent times, the advent of satellite-based telemetry has made it possible to interrogate a recorder by telephone to obtain an instantaneous height measurement.



Flow meter

But the height is, of itself, of very limited use. It needs to be translated to a flow rate and that requires the derivation of a rating curve which plots discharge against gauge height. In turn, the discharge is calculated as the product of the cross-sectional area of the discharge and the average velocity of the discharge. Stream gauging is necessary to measure the velocity at different points. This is done by dangling a flow meter into the water (held down by an appropriate weight) and reading the rate of rotation of the propeller and measuring the co-ordinates of the location. All very simple, but how does the hydrographer locate himself to make those measurements, particularly if the river is flooded, velocities are high and there are lots of logs and other debris being swept downstream? The answer is, with great difficulty and often at great peril.

Hydrographers are remarkable people. Like other field staff, they have to cope with the problems of operating in remote, rugged environments. But unlike other officers who are not expected to drill or survey or operate water distribution systems during floods, hydrographers are not allowed to come in out of the rain. Indeed, the more extreme the conditions, the more important it is that hydrographers are out in them.

This can cause concern for relatives. In 1988 Rod Dew's *mother was watching TV during the Cyclone Charlie floods. She saw a helicopter dropping Rod off on the Isaacs River while everybody else was being evacuated. That was typical. Everyone else would go indoors and we'd go outdoors.*⁵⁵

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When Cyclone Winifred hit the Tully River in February 1986, Greg Long was in the thick of it. *About 11 o'clock at night, I took my offsider, Paul Webb, to read the gauge. By the time it took me to walk up the bank the stream had risen about 0.2 of a metre. I said, "Hop in the car, we're out of here." In no time there was water over the headlights. I said, "Get ready to swim" and I headed the vehicle in the current towards a ridge, as it began to float. I just managed to beach out. We slept for a couple of hours, then about 4 a.m. we went back and continued gauging.*³⁶ Bill Souter and Henry McDermott went to rescue them. *You could actually see in the grass where the Toyota had been washed sideways. Longy was a hero in Henry's eyes because he'd held his station.*³⁷



Measuring flows in flood conditions

The danger of drowning was real, more so if you couldn't swim. Doug Smith and Fred Mahoney were measuring the Mary River *when their weight and meter got snagged, the flood was rising and the boat was about to go under any minute. Fred said "We'd better swim. We'll put the data book in something and we'll swim." Doug said, "I can't swim. You go, Fred, while I finish off these computations." Fred said, "Come on, Doug, I'll give you a hand." "No, no, she'll be right." With that, Fred dived in and started swimming ashore. Doug sat working in the jumping boat and the wire suddenly came loose. He calmly wound it up and said, "We've got the gauging." That was typical of Doug Smith.*³⁸

Crocodiles were a real threat. Harold Scholz and Nigel Kelly came across a 23 foot crocodile when fishing. Towards dusk while they were bathing, Nigel was all soaped up and he said, "What's this, Hal?" "Get out of there," I yelled, "It's the crocodile!" He came rushing out, and the sudden movement frightened the croc and it took off downstream. Nigel said, "Well, I've got to go back in and get the soap off" – and he went back in there to get the soap out of his hair. I thought, "That bugger's mad!"³⁹ Nigel dismissively recalls,⁴⁰ *I went to bed soapy that night, very soapy.*



Another hydrologic hazard

Hydrologists also risk accidents and getting lost. One time Don Alexander and John Ridler went to the Gulf and rolled the truck in loose gravel. *Don instinctively grabbed the quarter glass window*

*which cut right through his thumb. They were miles from nowhere. John did as much first aid as he could and then put out the surveyor's chain, of all things, 330 feet of it, as an aerial and got through to the Royal Flying Doctor on the transceiver, who alerted the Atherton Ambulance.*⁴¹

Nigel Kelly and Harold Scholz travelled from Laura through swamp after swamp. Eighty miles into really rugged, rough uncharted country, petrol supplies grew low. Using the Royal Flying Doctor network, Harold radioed Don Alexander, "We're not lost, Don, but we don't know where we are." At a property a few days later he was quoted word for word, so the grapevine was working.⁴²

Roy Mincher remembers *driving a Toyota with a high built-up canopy back near Riversleigh Station and I caught the canopy on a tree. Although it was only just a touch, it was enough to kink the chassis. So there was nothing I could do but cut the body free, then put a pulley up in a tree and pull the body up into the air; cut a couple of logs and put them across the chassis rails of the vehicle and lower the body back onto the chassis rails and tie the whole lot up with number 8 fencing wire to become mobile again. It took a couple of days to do that.*⁴³

Teamwork is a principal tenet of hydrography. Faced with crocodile-infested streams, as hydrologists travelled in pairs, they'd take turns to jump in. *We had our rotational scheme.*⁴⁴ Hydrographers are proud of their camaraderie. There is a good network amongst the hydrographers. *They are an excellent group of people, and the diversity of tasks they undertake is amazing. One week up to your belly in mud driving a gauge through, and the next week you're probably presenting something at a workshop on clean water quality in George Street. Some people chose to stay in the field and not seek promotion. It's typical of technical and professional areas that to move up, you have to be prepared to move to a new position.*⁴⁵

One method of information exchange was the Hydrographers' Conferences. If you happened to be in a Shire when the show holiday occurred, you were entitled to the day off. A number of hydrographers arranged to turn up from all around for the Charters Towers Show one year. That is generally believed to have been the start of the Hydrographic Conferences.⁴⁶

Co-operation was vital. As Peter Thompson says *you had to get on with other people because you were virtually in the one spot with them for 24 hours a day, for weeks on end. Times have changed. Now you come home for weekends, but that was unheard of. If there were a few bad apples, you'd find various ways to weed them out. There's one story of a misfit who was sent down a well. They closed the door, went away and had lunch, then came back and let him out afterwards. He*

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*resigned a couple of weeks later. Under today's management strategies, you'd be sacked for such behaviour.*⁴⁷

Hydrologists were a tough breed. Living conditions could be horrible. Harold Scholz spent three and a half months at Koombooloomba Dam where *I didn't see the sun because of the really dense rainforest. We'd cut saplings for tent poles, and believe it or not, when I left those saplings had suckered. We'd just stuck them into the ground, and there were sprigs on them.*⁴⁸

Working on investigations for the QEC Tully–Millstream hydro project in the pristine rainforest around Coolmon Creek and Blunder Creek, Greg Long's party had to cut the tracks through the rainforest to establish a gauging site, a traveller-way⁴⁹ and a hut. *Because it rained every day, it was pretty hard. I finished up getting the pre-mixed concrete in behind a Toyota with four-wheel chains on. You'd throw the chains every now and then and you'd go and search for the chains in the mud. We were there for weeks with mud to our thighs. Not a safe working environment.*⁵⁰

A week after beginning work, Ray Maynard was sent to a wet season camp on the Wenlock River for 23 days in February/March. It rained every day. *When we got there we could just walk across about shoulder deep, like moon-walking. The level then rose when a cyclone put 30 feet of water into the river. The meat we took from Mareeba only survived a couple of days. The heat was so bad – and this was a fairly benign climate compared with the rest of Cape York – we used to get up early in the morning and do some work, and again in the evenings, but in the heat of the day we could only lie around and do a bit of reading. I thought it was great! The best thing that ever happened to me!*⁵¹

Clearly, tales of poor conditions became legendary and Roy Mincher tells of a trip with hydrologist Bill Sebestyen. *I don't know what sort of stories he'd been told, but when we pulled up north of Camooweal to camp, and I opened up the car fridge and got out a couple of beers, he was more than agreeably surprised and even more so when I produced a camp stretcher for him.*⁵²

You could never tell how new recruits would perform. When Doug Walker joined the Commission, an engineer from Head Office rang Harold Scholz, whom everyone termed 'The Hun' or 'Bull Terrier',⁵³ to warn *"I don't know how you'll find him. His mother's been onto me that he's not to go into any rough country". I sent Doug up on a trip with another bloke to Cape York Peninsula, which was really rough, and when he came back he said to me, "Is there any chance of getting that district?" Doug turned out to be one of the really good, honest blokes.*⁵⁴

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As dams and other hydraulic structures are always designed to withstand flood events greater – usually very much greater – than any event that has actually occurred, the rating curve has to be extrapolated. The more extreme the events that have actually been rated, the more accurate the extrapolation will be. Thus there is a strong incentive, reinforced by a natural desire to win, to measure the peak flood. Competitiveness, apparently a common characteristic amongst hydrographers, led to acts which defy present Workplace Health and Safety policy.⁵⁵ *In those days there was just a job of work to be done, so we got on and did it. They would know what the risks were, but at times there have been some very hazardous things.*⁵⁶



At work on the Jindalee Bridge – 1974 Flood

Hydrographers believe they been pushing the limit more and more in the last 15 years or so, getting gaugings of bigger and bigger floods than ever before. Tony Wolfe and Ray Maynard went to *Fitzroy Gap in February 1988 with George Beran, Nigel Kelly and all the Rocky fellers. We got some of the biggest flood gaugings ever done in Australia – over 9,000 cumecs in water over 25 metres deep. One afternoon we were out in the boat. The peak of the flood was past but it was still dangerous. All of a sudden there was a bang and we were floating off downstream. The big rope that we had tied on to the cable across the river had gone through a nylon cleat when the force just melted the high-grade nylon. If anyone had been standing on the coil of rope, it would have removed his leg. It was quite hairy and it would have frightened the safety officers if we'd had any there.*⁵⁷

In 1992 Allan McDougall and Ray Maynard were at Reids Creek when the highest flood since 1893 occurred. *It came up right across the river flat. During the night it blew like hell, then it would go quiet and come again.* They agreed it was too dangerous to put a boat in the creek because the water was too fast and there was too much debris. So they used the cableway and got record gaugings. A couple of months before, Tony Wolff had crowed about a record gauging of about seven cumecs *but we got 538 cumecs! It was just one of those flukes that we happened to be there. We cleaned up the whole rating in one day. It was a great feeling.*⁵⁸

Harold Scholz took 23 measurements in 24 hours, his record, and went through three offsidars in the one night at Tinaroo Dam. It began raining, the Barron River started to rise and Frank Learmonth ordered that gaugings be taken. Harold started at 8.00 a.m. on a Friday. At 8.00 p.m. the offsider was *too tired. So Lenny Standon*

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*worked through to about 4 o'clock next morning. Then Billy West worked through to about 9 o'clock the next day, but by then the river was going down. My wife used to bring down a big dixie of soup every couple of hours to keep us going. Through penalty rates Lenny got as much for that one night's work as I took in a month. He had to take his wages home in a wheelbarrow!*⁵⁹ Harold Scholz claims to have measured three times more streams than any other hydrographer in Queensland, but such a claim would be impossible to verify.

When Bob Bird was employed he was told *this is a good job. All you have to do is read the gauge, measure the stream, and have a cup of tea with the gauge reader. The limiting factor on how many stations you can do in a day is how strong your bladder is.* Despite many changes in his career, the one constant for Bird is that *hydrographers still need superior bladders.*⁶⁰

Culinary skills, however, did not seem to be a strength amongst hydrologists. Nigel Kelly recounts a tale when he, Steven 'Pedro' Parker and a helicopter pilot were camping at Wenlock River. *We were living on tinned food and whatever fish we could catch. We caught a couple of bream this evening, and because the pilot was getting a bit toey about being there, we let him have the fish.* The next morning the pilot had stomach aches and the works. Nigel noticed a mechanical oil bottle in the rubbish pit and asked Pedro why he'd thrown it out. *He said, "Well smell it. It's gone off. It didn't smell too good last night when I cooked the fish in it!" If the pilot hadn't been as sick as he was, he would have killed Pedro.*⁶¹

John Ward, who has travelled with a wide cross-section of hydrographers, including one who lived for a week on a diet of tinned fruit (forcing John to the same gastronomic delights), considers Roy Mincher the doyen of hydrographic chefs.⁶²

George Beran was camping with hydrographers Nigel Kelly, Neale Searle and Ray Maynard at the Fitzroy Gap dam site. Appointed cook, George Beran shot a rabbit and made soup with it. He ladled it out to everyone, insisting they try it. *Neale Searle was the first to try it but he disappeared and surreptitiously threw it over the fence. George knew something was up and watched like a hawk till everyone else had eaten it all up.* The recipe for George's stew is available on application!⁶³

George Beran was a tough nut. When he was x-rayed for cancer, two cracked vertebrae were discovered. He had had an accident in his hydrology vehicle some years earlier and had done nothing about it.⁶⁴ There were lots of stories about George, many of them unsuitable for a family publication like this one.⁶⁵

Other domestic skills were also optional extras. Ted Walker was a schoolteacher and a builder who ended up as a hydrographer. He was a real gentleman. *You'd go*

*and pick up Ted for a field trip for a couple of weeks, and he'd have one little box with him. That was everything he took, with his toothbrush and toothpaste in there, one change of clothes and that was it. When you came to a decent waterhole, he'd walk in and walk out, and that was washing day.*⁶⁶

While the basic *modus operandi* of the hydrographer and the fundamentals of data collections have not changed since 1909, technological change has brought improvements. Many of the gauging stations, particularly the older ones, were staff gauges and the Commission relied on local landholders to read them on a regular basis in return for an annual honorarium. They were usually read at 9.00 a.m. each



Hydrographers at Raglan Creek, September 1973
(Back Row) Ron McMahon, Bob Bird, Peter Kelly, Ian Wallace, Dave Amos, Don Ferrier, John Driver, Jan Smith, Harry Stark, Len Ezzy, Keith Smythe
(Front Row) Darryl Griffiths, Ron McPhee, Rod Dew, George Beran

day.⁶⁷ Not surprisingly, some readers were more conscientious than others and the quality of the data was sometimes suspect. When the yield for one particular storage (which had better remain unidentified) was recalculated after a few years of operation, it appeared that the gauge reader had found it more convenient to fill in the readings from the comfort of the hotel verandah rather than make the effort to actually read the staff gauge. The lack of variation in readings through changes in rainfall gave a clue to the fact that the readings were not reliable and should be discarded.⁶⁸

Recording the time of the reading was important but equipment was valuable and scarce. When one worker asked for a watch, FJ Calvert reputedly told him that before gauging to note the time on the post office clock of the previous town and start his stopwatch. When he was ready to start the reading, he was to calculate the time of day.⁶⁹

Bill Stickland in Mackay had one of the longest cableway traveller spans in Queensland, so long it was hard to see what was happening when the weight was on the other side of the river. He requested binoculars to overcome the problem but was sent a monocular, which was cheaper.⁷⁰ Perhaps it was this that prompted Bert Wragge to store his level tripod and staff (priceless possessions) in the hotel room rather than leave them in the truck overnight.⁷¹

SURFACE WATERY SOURCES

New equipment and techniques were steadily introduced. In 1910, the first traveller gauging was completed by GN Croker on the Albert River, where the meter was suspended from a cross-wire and traversed using endless rope. A 30-pound weight was used, with 10-pound increments if required. The traveller was not left permanently on site but was erected for specific gaugings and then moved to the next site.⁷²

In 1913, Calvert installed current meters on Enoggera Reservoir which were checked every eight months. The meter was fixed to a boat which was towed by a horse. In the 1950s, a mean table for Price and Eskdaile meters was introduced and another for Alberta meters, which obviated the need for regular measurements.⁷³ Later more reliable Ott meters were introduced.⁷⁴

Early gauges were placed near bridges to facilitate readings, but this changed with boat gaugings. These were made possible in 1920 with the development of a stream gauging winch by Bert Wragge and Charlie Ogden, which had an electrical wire round the main cable with tags for depth. A boat was permanently placed at Walla on the Burnett River in 1920 and at Yenda in 1923. Measurements are still commonly taken from boats, the 'tinnies' that hydrographers carry on the roofs of their vehicles, powered by outboard motors. At many gauging stations, the Commission also set up cableways from which measurements could be made. These were introduced in 1957 by Phil Purich, probably based on a US design, and modified by AWRC standards. The cableways *considerably reduced the labour of flood work as it was very difficult to row across a flooded river towing a marked cable. Most times, of course, you didn't arrive until after the flood.*⁷⁵ Purich also introduced a new traveller in 1957 based on a NSW design. Cableways and travellers were both banned in 1986 by the *Queensland State Government Safety Act*. However, Don Alexander introduced the first powered traveller in 1989.



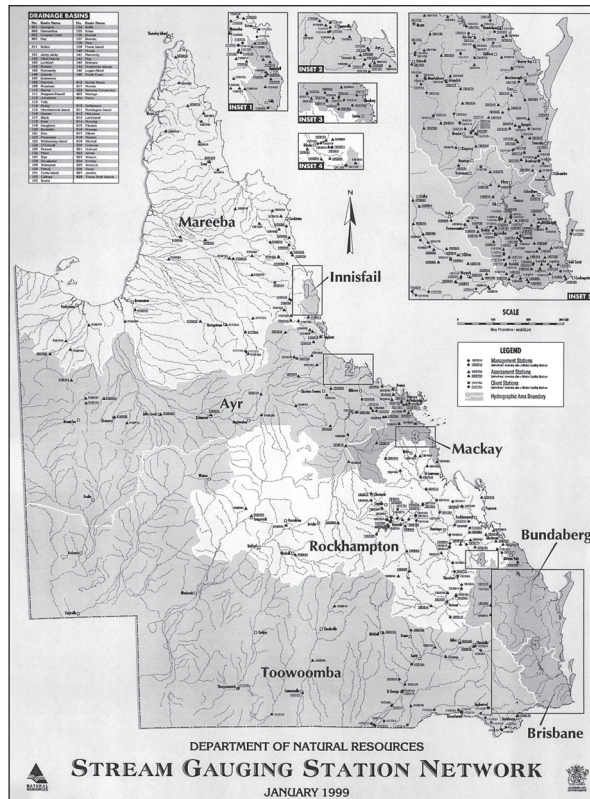
Constructing a recorder but at Munduran Creek are Ed Donobue atop structure, Ray Findlay passing up rock fill, labourer in foreground

The Armco floatwell system was introduced by Calvert in 1953 on the Border Rivers. The gas/electric recorder system, designed by Harold Mortley in 1957 and developed by George Wilson and Lionel Otto, allowed automatic readers to be installed economically in sites not suitable for conventional floatwell recorders. It overcame a lot of problems with missing records from gauge readers.⁷⁶

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Increased funding in the 1960s brought improvements in stream gauging equipment. Unmanned travellers (a misnomer as they are manned from the bank) were installed using heavy duty Ott winches.

By 1965, a small number of automatic strip chart recorders had been introduced.⁷⁷ Gradually, the manually read staff gauges were replaced by automatic recorders.



Map of State's gauging stations

Early varieties were the Fischer and Porter model that punched readings on a paper tape and the Leupold Stevens machine which operated on a gradually falling weight and recorded with an ink pen on a rotating disc. The Instrument Shop at Rocklea was intimately involved in the development of instrumentation. The two principal officers, Mike Bartlett and Bart Lommerse, developed such a high level of innovative skill that they resigned to set up their own business of Barlo Instruments. This, however, did not occur until after Mike had met, wooed and married Nerida Porter, one of the Commission's hydrologists.

Charged with the duty of maintaining the equipment was Ray Alford, at the Rocklea technical centre. He provided an invaluable service. Says Ian Wallace *we can go and do whatever we need to do and the equipment just turns up. We can give him a call and say we need whatever and it will come up certified and tested with all the right bits of gear and line diagrams to put it in.*⁷⁸

Changes in transportation transformed hydrography. Post-World War II four-wheel drive vehicles were introduced. The early vehicles were war surplus signals vans and weapon carriers. This made wet season camps redundant by 1959 as hydrologists could reach the sites after the rain began, rather than having to set up camp before hand in preparation.

SURFACE WATERY SOURCES

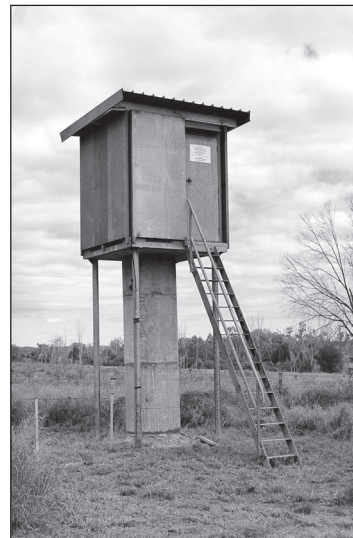
In 1966 a new era began with the introduction of helicopters for wet season work and light aircraft for gauging western streams. Nigel Kelly remembers having a helicopter based in Mareeba, one wet season from December right through to April and *everyone lined up for turns. By the end of the few months we'd had enough of it, but we saw the country.* He remembers travelling back from Normanton to Croydon one day following the main dirt road. *Three of us were squeezed together in this little Bell 47, with the open frame on the back and the glass bubble on the front, carrying the gear on the side. We reckoned the trucks and cars used to go faster than we did.*⁷⁹

Helicopters brought other dangers. In one accident, the pilot was killed, one officer (Ian Wallace) ended up in a wheelchair and another (John Stephenson) was badly burned. *We used to have absolute faith in the pilots and only later came to realise how vulnerable we were.*⁸⁰

Boats also improved. The boats in the 1960s were aluminium. There was only one with an outboard motor, for which there was fierce competition. Otherwise you'd have to row. A two-winch boat gauging rig was introduced by John Pitts in 1977, followed in 1979 by the Zodiac. Now the hydrographers have state-of-the-art radio transmitters, and have gone up from a 2 HP Seagull to 40 or 60 HP motors.

Other technology such as radios and refrigeration in the bush was strongly resisted by Head Office, creating tension between the hydrology staff and the George Street boys! In the 1960s, the Snowy Mountain Authority staff travelled with two vehicles in tandem and two-way radios and were on the Royal Flying Doctor network as well. Commission cars had neither.

The Commission experimented with various fridges, such as Coolhardies, without success. *They were all gas-fired, and in rough country they shake around and the gas gets air bubbles in it, and they won't work. It worked on a dead level keel, but get into rough country, and it's hopeless.* When Engel fridges were invented, Harold Scholz requested they be provided. After two years the Commission tested them in Brisbane and Townsville, but they didn't test them out in the Gulf Country or Cape York Peninsula. They did eventually get fridges that worked.⁸¹



Recorder hut

WATERY SAUCES

In 1989, a major review of the gauging network was undertaken. As part of the process, a Value Engineering study was conducted. In the course of that study, pressure was placed on hydrologist John Ruffini to venture an opinion on what was the minimum length of record (in years) that could produce 'reliable' yield analyses. While there is clearly no precise answer because it depends on the proximity of other stations, the availability of rainfall records and the variability of streamflow, John was eventually persuaded to come up with a 'Ruffini Number' of 15.⁸²

Following the Value Engineering study, Col Hazel led a review of data requirements and by eliminating all 'unnecessary' stations, the network was reduced to just 407.⁸³

'Unnecessary' was judged against a number of criteria including the level of development in a catchment and the likelihood of further investigations that would require streamflow data.



Constructing a control weir on the Brown R are (top to bottom) Bert Barrie, Alan McDougall, George Beran and Jim Barrie

Another review in 1992 reduced the gauging network by 30% with a corresponding reduction in staff. The money saved bought data loggers (an electronic means of reporting data) and telemetry with which stations could be interrogated by phone. Visits were restricted to repairs, rather than recording.⁸⁴ Tom Fenwick added annual injections of money to allow a *very accelerated changeover into electronic logging. Once you get these electronic loggers in, you can add all other things to them. All they are is a mini-processor, but you can do anything with them.*⁸⁵

Even without stream gauging information, hydrologists can be called upon to calculate yields of systems. Teemburra Dam, for example, was designed on an ungauged catchment. The hydrology was based on comparison with similar catchments which had been gauged and rainfall data extrapolated. Ian White, the resident hydrographer in Mackay, reports that the catchment performance has been remarkably close to the predictions.

There is, of course, a major requirement for the translation of the instantaneous height data (whether collected by human hands or automatons) to a continuous record of flow, together with the statistics on mean annual discharge and so on. While the task has been made easier by computerised data recorders, considerable effort is still needed, if only in terms of verification. For many years, a trace analyser was 'manned' although men displayed very little staying power by comparison with women.

SURFACE WATERY SOURCES

While hydrologists have concentrated on quantity data, there has also been a growing requirement for water quality data. Chemical water quality has been sampled routinely but infrequently at stream gauging stations. The data have generally been suitable for analysis of only a limited number of parameters.⁸⁶ In an attempt to gain samples remotely, various ingenious devices have been used. In order to sample streamflow in Stag Creek prior to diversion of water from Awoonga Dam to Callide Power Station, the Commission borrowed from the Department of Local Government, a stand with a number of sampling bottles whose glass seals were broken by a falling stream.⁸⁷ Since 1995, a program of ambient water quality monitoring has been introduced to measure conductivity, temperature, pH, major ions and chemical nutrient and biological parameters.⁸⁸ The manual collection of water quality samples has also increased the workload of a dwindling number of hydrographers.⁸⁹



660 Years of Hydrographic Service January 1998

(L to R) Ian White (25 years), Dave Amos (27), Ian Wallace (20), Lawrie Patterson (26), Vince Manley (21), Geoff Pocock (29), Phil Kerr (27), Don Alexander (34), Henry McDermott (32), Ray Maynard (23), Greg Long (26), Ray Alford (25), Tony Wolfe (29), Peter Kelly (24), Jim Mobbs (25), Allan McDougall, Doug Walker (23), Nigel Kelly (25), Neale Searle (21), John Ridler (33), Steve Parker (24), Mark Hopper (24), Paul Martin (29), Peter Fiedler (23), Rod Dew (25). Absent Bill Reurich (24).

Hydrology is generally considered by the 'great unwashed' to be one of the mystic Arts. In theory, yield hydrology is very simple. Storages can be treated like buckets and calculations can be made for the movement of water over a period of time called a time step. A simple addition sum can be carried out:

$$\text{Volume at end of time step} = \text{volume at start of time period} + \text{inflow} + \text{rainfall} - \text{evaporation and seepage} - \text{releases}$$

WATERY SAUCES

If a series of calculations is carried out over the period of analysis for a range of trial releases (which over a year total a possible annual draft on the storage), then the draft that can just be supplied in every time period can be selected as the 'safe yield'. Analyses are usually carried out over a substantial period (50 to 100 years), so there are obviously lots of calculations required, even using a monthly time step. The hydrologist has to select a starting point (for example dam full), read the inflow from the hydrographer's record, look up the rainfall and multiply it by the surface area of the lake, look up the evaporation recorded for the month and multiply it by the surface area, include the estimate for seepage, then subtract the releases. He then has to do this for the next month and so on. Then do all of it again with a new trial draft. If, in any time step, the storage cannot supply the required release, then this period is counted as a 'failure'.

Real hydrologic systems can include a number of storages, each with its own storage curve and with stream losses between storages. As hydrologic data are available only for individual sites, they have to be extrapolated to other sites and to other times through correlation with rainfall records and assumptions. Yet, until the advent of the computer, these calculations were made by hand or with the assistance of calculating machines.

John Ward remembers that, before calculators, to work out the size of the 'design flood' for a dam you took the square root of the catchment area and multiplied it by some factor and that gave you the figure. *The longer you had been there the better you became at selecting the factor to use.* Two Facit calculators were introduced in 1959, but only senior people were allowed to use them.⁹⁰ The tedium of trial and error was *quite a horrendous thing*.⁹¹

The University of Sydney established a computer in 1961 – SILIAC. *John Morse and Alan Wickham went to Sydney and they came back scratching their heads and saying you have to be Einstein to work a thing like that.*⁹² IBM reached Australia in 1961 and ran a training centre, where John Ward was sent with Frank Connolly. The IBM was streets ahead of SILIAC and the American trainers were superb. John worked with *one of the lecturers on how to do yield studies on a computer. That's where the first ones were done.*⁹³

When John Ward returned, Chief Investigation Engineer Mortley refused to believe it was possible but agreed to a trial using Ross River. Bill Sebestyen and John Ward, both amongst the hydrologists to graduate from the first three-month University of NSW course in 1961, got all the flows together and John went down to Sydney to the IBM centre. Unfortunately, the trainer he'd been working with had moved on. John was sent to Melbourne – by train. Computer time was restricted in Melbourne and

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so John had to work on the project from 6 p.m. and work all through the night, punching the cards. The yield studies for the Ross River Dam were completed in a week – manually it used to take roughly three months. Arthur McCutchan was absolutely taken with this. John was ordered back to Brisbane by train with six boxes of punch cards. As John Ward recalls *we fell over them there for yonks, they were sent to Rocklea, drowned in the '74 floods and they were never looked at again.*⁹⁴

A machine became available that made it possible to make minor corrections to punch cards and thus save hours of rework. They cost about £70 but John Ward's application to purchase one was knocked back because of the expense. John prevailed on Harold Mortley to reconsider and after an unproductive two hours meeting, John did a calculation and announced, "For the amount this meeting's cost I could have bought three machines." Mort checked the salary calculation and said, "Go and buy one."⁹⁵

John Ward's knowledge of computers developed in France where he worked with a brilliant hydrologist who was doing streamflow generation, statistical methods for working out floods and other flood techniques. On his return he wrote a series of papers to the Institution of Engineers and this was probably the starting point for computerisation.⁹⁶

Computers not only made these calculations easier, it made others possible and the complexity of analysis expanded enormously. It became possible to develop computer models that analysed complete systems on a daily time step taking account of changes in catchment conditions over time. Thus it became possible not only to model what actually happened historically but what would have happened if assumed events had occurred. There have been numerous treatises written on hydrology, most notably *Australian Rainfall and Runoff* in various editions. The Commission has digested these and incorporated them into its own systems.

With the encouragement of McCutchan, John Ward recalls, the *section become quite something and went from strength to strength.*⁹⁷ In his opinion Queensland led Australia for many years in hydrology. The 1960s brought a world-wide interest in hydrographic work through the International Hydrographic Decade.⁹⁸ This excellence continued under Peak, Stark and Ward.

One innovation caused by John Ward and Mike McEniery was the hiring, after selection interviews, of female hydrologists Elizabeth Howard and Rosemary Beeston (Koppitke). Despite some reservations by the hierarchy of the suitability of females for the task, both proved to be outstanding. The experiment was repeated with success, leading to the employment of Janine Hume (who married Richard Duczmal) and Nerida Porter⁹⁹ and many others including Karla Henry (nee Brauer) and Maria Greer in Surface Water and Pru Martin and Vivienne Gaylor (later McNeill) in Groundwater.

Karla found that *being a professional woman in a bloke's organisation was a bit of an oddity at that time and led to a little bit of good natured teasing which didn't particularly worry me. Once people got to know you they accepted you as a human being and acknowledged you for your ability. I actually think we've gone backwards over time. I think now males see females much more as a threat and I certainly find professional women feel threatened by other professional women.*¹⁰⁰

Karla also becomes somewhat annoyed by gender stereotyping. When her manager was absent and she answered his phone, she was unimpressed at being taken for his female assistant.¹⁰¹



Greg Hausler

Queensland hydrologists have always been at the forefront of hydrologic developments, designing their own computer programs. This has been necessary because Queensland is different from the southern States. It has a predominantly summer rainfall with very large cyclonic/monsoonal floods. Whilst annual rainfall in catchments such as the Fitzroy Basin may be more than a metre, runoff may be as little as 30 or 40 millimetres. Southern hydrologists find it hard to accept these differences.¹⁰²

It is apparent that the turnover of expert hydrologists has been much higher than that of other specialists within the Commission, with large numbers of them leaving to take up positions in other organisations. The only senior hydrologist who appears to have retired from the Commission is Bill Sebestyen, but there is some doubt as to whether he was really of retiring age or blessed with the appearance of eternal youth. Bill's contribution was quite remarkable, particularly to the training of younger hydrologists. Neal Ashkanasy, who followed Bill as Executive Engineer, developed new techniques for hydrologic analyses. He was the author of the hydrologic modelling computer program WT16 which, with only slight modification, was used by the Commission for more than 20 years to analyse systems. Neal also advocated a new approach to the issue of an appropriate reliability of supply.

It is very clear that in places like Queensland, where there is a great variation in rainfall from year to year, the 'safe yield' approach may not always be appropriate. Computer modelling of many catchments has demonstrated that if systems are allowed to 'fail', that is supply less than the draft during some time steps, the quantity of water that can be supplied in the other times can be increased substantially. Often a reduction in reliability of supply from 100% to somewhere between 90 and 95% can lead to a doubling of the yield. While this may not be appropriate for some users such as power stations, in other applications the benefits may well warrant the reduction.

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In the post-war era, Queensland had adopted Victorian practice and had analysed systems so that they provided the full yield (for irrigation areas) in say 90% of years, with at least 60% of allocation in 100% of years. By the mid-1970s, safe yield was widely adopted as the target. Neal organised a workshop in April 1980 to discuss the ramifications of reducing the reliability below 100%. Gradually this process gained acceptance, and systems incorporating announced allocations were adopted. But even today there is no universal rule about an appropriate reliability.

Neal resigned in 1986 to pursue a career in management lecturing at the University of Queensland and was succeeded by another very competent leader, Greg Hausler.¹⁰³ The group is currently led by John Ruffini and one can only wonder at how he remains so cheerful and unflappable under the workload.

Another hydrologist who left was Nerida Bartlett (nee Porter), but her departure was to tend her family, and she did return – first on a part-time and then on a full-time basis. One monumental task undertaken by Nerida was the compilation in 1982 of the Orange Book, a complete compendium of all hydrologic results at that date. It described every storage existing or seriously contemplated, the assumptions made in the analyses and the yields as part of the system.¹⁰⁴

Changes in computer technology led to ever-increasing ability to carry out more detailed analyses and, conversely, for demands for more detail. The introduction of the PC in the late 1980s, instead of the main frame, speeded up analysis time enormously. And the introduction of the Power PC made the daily time step models possible.¹⁰⁵



John Ruffini

Even though it falls outside the period of this history, the IQQM (Integrated Quantity Quality Model) project for analysis for the WAMPs (Water Allocation and Management Plans) of the late 1990s must be mentioned. These monsters have tackled catchment hydrology to a degree of detail that could not have even been contemplated by FJ Calvert and his team. Virtually every hydrologist in Brisbane has been pressed into service for this gargantuan task.

In 1991 when the Water Resources Commission (then a Business Group of DPI) was reorganised to only five divisions, Lee Rogers became General Manager of Water Resources Assessment Division and Col Hazel his deputy. Col elected to take a Voluntary Early Retirement when those were offered and the Commission lost the services of a very talented man prematurely.

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When the technical divisions were further reduced to three, Lee Rogers remained General Manager Water Resources. Following the abolition of the Water Resources Commission, the surface water hydrology group became part of the Resource Sciences program while the hydrographers joined the Resource Management program.

For all the sophistication of the new models, hydrology is still viewed as a con. Many members of the public are convinced that the hydrologists 'cook' the results. Those who want schemes to proceed believe the yields are deliberately understated, while opponents are equally convinced that the yield figures are over-optimistic. Hydrologists can spend many hours explaining hydrologic processes without necessarily convincing anyone of anything. Frank Learmonth always believed you should never ask for a hydrologic analysis to be revised because they will always halve the yield and double the flood!¹⁰⁶ This isn't the case – sometimes it has been even worse, and sometimes better. But given that the critical period can only get worse, the yield generally has only one way to go.¹⁰⁷