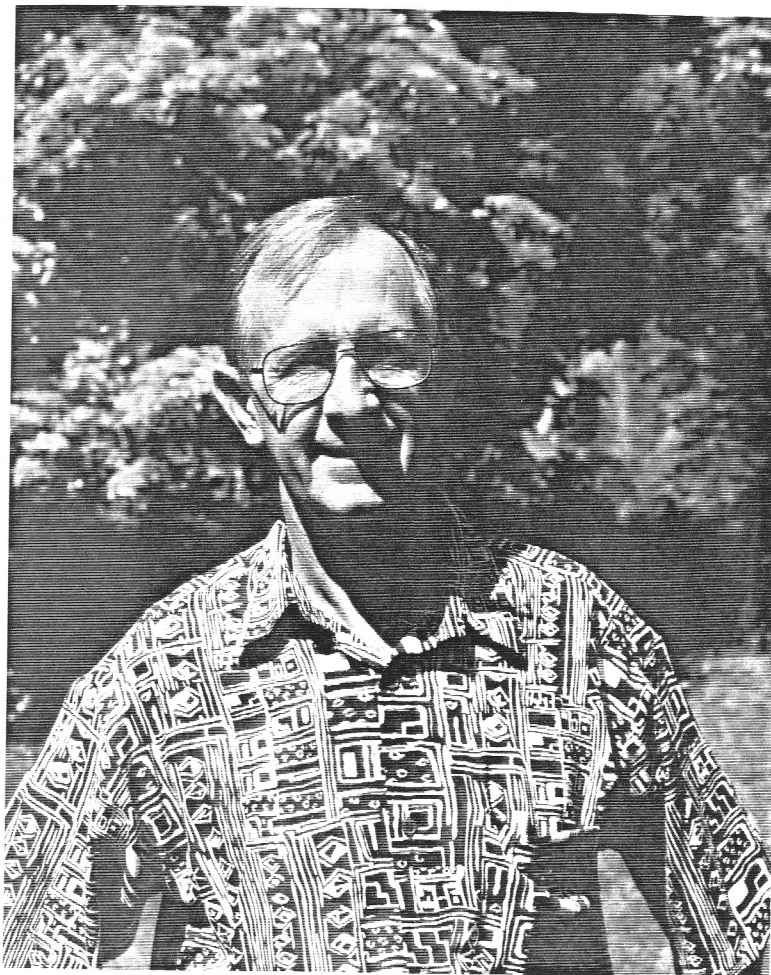


GRAEME KELLEHER

Graeme was born in 1933. He was educated at Canberra High School and the University of Sydney where he studied engineering. In Canada from 1957 to 1961 he worked on a hydro-electric and other projects. In Canberra with the Department of Works during the 1960s, as well as working on Commonwealth Ave Bridge and Woden Valley Hospital, Graeme was resident engineer at Corin Dam. Subsequently he worked on the Darwin River Dam and Googong Dam. His career became increasingly oriented toward the environment and in the mid to late 1970s he was involved with the government's Ranger uranium inquiry and was deputy chairman of the nuclear non-proliferation task force, before becoming, in 1979, chairman of the Great Barrier Reef Marine Park Authority which he remained until 1994. He has held the Chair of Systems Engineering at James Cook University and since 1986 has been Vice Chair (Marine) of the International Union for the Conservation of Nature's Commission on National Parks and Protected Areas. He was awarded an AM in 1988 and the AO in 1996. He and Fleur nee Meachen married in 1959 and they had three children.



Tape 1 Side A

Graeme was in the Department of Works Major Development Division and was involved with Corin's construction from the start. Designer of the dam was Arn Fokkema [also interviewed] and the head of the Division was Don Stockdill. Graeme contributed also to the design, particularly the bridge to the valve tower.

The site was appropriate for an earth and rockfill dam rather than a concrete multi-arch structure. The spillway had to be designed very carefully to avoid overtopping of the vulnerable earth and rockfill wall by large floods. The maximum probable flood for the design was a 1 in 10,000 years event, but Graeme says that these sorts of figures are

full of assumptions and can be wrong. Our flood records simply don't go back far enough for us to really know true flood statistics.

Assumptions about dam design have changed over time. When the Cotter Dam was built, it was thought that the hydraulic pressure under a dam decreased to zero at the downstream side of the wall. But now it is known that pressure can be high at the downstream end. So gravity dams have had to be refurbished to make them safer.

Of the dams on the Cotter, Graeme rates Bendora as 'by far the safest'. Thin arch dams like Bendora have a safety factor of 15:1, whereas gravity dams (eg Cotter Dam) have a factor of 2:1. Regarding Corin, stability is not the question because an earth and rockfill dam can't be overturned, but their weakness lies in being overtopped.

Graeme feels the biggest challenge for him at Corin 'to be frank, was living away from my family for 2 years' (he returns to this matter later). He points out that public servants, ie Works staff, had far less comfortable conditions at Corin than the staff of the contractor. Some public servants work harder than some private workers, and bashing of public servants is ill-based.

The biggest technical challenge was one Graeme set himself: 'to build the dam for lower than the estimated cost and lower than the contract price and still retain high quality'. Minimising the work done also reduced the environmental impact. The contract was on a 'schedule of rates' basis and Graeme used this to pursue his aim. The clearing of trees was able to be reduced, as was the amount of overburden removal at the quarry.

The first Environmental Impact Statement for the Commonwealth Government was written in the 1970s for Googong Dam. Graeme organised it. Environmental awareness started formally in 1969 with the passage of the Natural Environmental Policy Act in the US, which required EISs to be written.

As seen throughout the interview, a big aspect of Graeme's work at Corin was maintaining that the contractor did quality work. 'It's always the hardest thing. Often you get a kind of unhealthy degree of interrelationship between supervising staff and the contractor' in construction projects generally. Because there is a savings attraction for contractors in using lower grade materials, reducing materials or not fully following specifications, the supervisor 'needs a very great degree of determination to ensure that your friendliness with the contractor doesn't extend to being soft to the slightest degree'. At Corin, on the earth core of the dam for example, compaction and moisture content were vital aspects for supervision. Similarly the filter zones (which stop core clay particles moving downstream through the dam) are vital. As the wall is rising the trucks bringing in the core often can contaminate the filters with clay on their wheels, and the supervisor has to demand that the contaminated material be removed. If you and your staff are constantly insistent, there can be punitive repercussions.

Graeme had under him 12 supervisors, 2 engineers, a resident geologist and lab staff. They all lived in the Works barracks built by World Wide Camps at Corin camp. They were accommodated separately from the Thiess staff, but they ate in the same dining room and drank in the same bar. There was some socialising between Works and Thiess staff, but sometimes this lead to compromising situations.

Graeme feels that the project as a whole was successful and a very high standard of workmanship was achieved through diligence and insistence on standards. The quality of the concrete and fill is 'as good as any I've seen anywhere'.

Discussing various elements of the project, Graeme describes the grouting of the foundation rock to fill fissures. There were several grouting teams each of 2 or 3

men. The process was simple and the cement:water mixture was pumped in under pressure.

The diversion tunnel was discussed next. 'Tunnelling is one of the most dangerous engineering activities. You have vehicles running through the tunnel removing rock as it's excavated. And it's very easy for someone to get behind a vehicle and get run over when the vehicle reverses...The tunnel is a terribly dangerous place. The noise in a tunnel, nobody can imagine how loud it is. People who work in tunnels generally end up deaf...The noise is more than a jet plane taking off when you're standing next to it'. No ear protection was worn. Graeme tells of a terrible tunnel accident in Canada where a man had his leg taken off, and then while mates were carrying him away he was dropped down a surge shaft. No-one was killed at Corin.

Graeme describes how one Works engineer was fairly dour and showed little emotion with the contractors. The workers, annoyed at this, played a joke on him during grouting of the tunnel. Several times when he went past, the hose 'accidentally' came off the grouting pump and he emerged covered in cement and water, to the entertainment of those nearby. The incidents 'heightened general morale', says Graeme.

The concrete for the dam was batched on site. The critical issue with concrete is the water:cement ratio. Mixing of the concrete, and compacting it with vibrators, were potential sources of conflict between supervisors and the contractor.

The bridge to the valve tower consisted of concreted piers and a deck of steel girders supporting a concrete slab on top. One windy evening during construction, one of the girders fell down. No-one was hurt, but the incident showed the importance of correct supervision of temporary structures.

Tape 1 Side B

Graeme was on leave at the time of the girder fall, and when he returned ACT Director of Works Aldo Ferrari told him not to take any more leave until Corin was completed.

Construction of the spillway was routine, except for the way the poor rock dictated that the design be changed to buttressed walls. The crest was an interesting project. Water passing over a crest can by cavitation cause erosion of the concrete. So the design profile for the crest had to be followed absolutely and the concrete had to be top quality. The job was not easy, especially in the transition area between formwork and freestanding concrete areas. There was some poor concrete and it had to be removed and replaced with epoxy. The crest was pre-stressed into the bedrock to prevent it being overturned.

Surveyors have a big role on a dam, although civil engineers can do some surveying tasks. Surveyors are especially needed on the spillway. Department of Interior surveyors worked at Corin, and they, like the BMR geologists at the dam, had good relations with the Works staff.

Graeme supervised the Corin Road construction (his first road) and his insistence on the design specifications annoyed the road contractor to some degree. The thickness of the fine crushed rock under the road, and its compaction, were central issues, as was the placing of the bitumen and gravel on top. The fact that the road withstood so much construction traffic and still is in good shape, is in contrast to many other ACT roads. Only in some places has it failed. In the course of this discussion, Graeme laments the fact that there is such a division between design and construction engineers. This has helped lead to many construction supervisors adopting an attitude of 'this is the way it's done' even though that 'way' is often at variance with the design specifications. He

points also to the lower guide posts on the inside curves of the Corin Road, something that should be on all roads but isn't.

Links with the Snowy scheme existed. Works consulted with Snowy people on many dams, not just the Cotter Valley ones. Snowy laboratories were better than Works ones.

The 1960s were a period of major construction and Graeme says 'it was wonderful'. There were the dams in the Cotter, Lake Burley Griffin, the bridges over the lake, pipelines, roads etc. Since then he has followed a more environmental course professionally but of the 60s he says 'I think it was all fundamentally necessary'. At Corin he endeavoured to minimise the energy expended so as to save costs and minimise environmental damage. Engineers got a bad name among the public because of their 'single-minded pursuit of a specific objective, to the exclusion of everything else; that they will forget about the adverse affects of what they're doing'. EIS procedures have helped to counteract this.

Regarding anti-pollution measures: 'It was prohibited to urinate on the site. That prohibition was honoured in the breach.' This sort of pollution was, Graeme feels, insignificant. Another leading engineer used to urinate in the river. Graeme cannot recall having any health checks before entering the catchment.

Weather was cold and snowy at times, but not a handicap. 'It was actually extremely scenic and beautiful to look from the site office to the Brindabella Range which would be covered in snow. It was the most idyllic setting.' The Works site office was on the bench below the current ranger's house, strategically overlooking the whole site. Thiess's site office was down in the valley.

Thiess's project managers Peter Charlton and then Eddie Geldard were 'great characters, as guys who work in construction a lot tend to be'. Charlton was big, fair-minded, intelligent and Graeme got on well with him. But they did have differences: 'we argued vociferously but without ill-will'.

The most serious argument that occurred at Corin was about an event on the embankment. A Works supervisor was watching placement of material and insisted that the rockfill had to be of a particular quality and size. He asked the workers to replace the material and they thought him excessive. He and a dozer operator argued. Graeme: 'I saw, from the site office, this dozer — I think it was a D8 — swing around when the supervisor was standing on the embankment and just miss his head with the dozer blade by a fraction of a foot. And it looked to me very deliberate'. Graeme wanted the driver removed from the site, or at least prohibited from operating dozers. A great commotion followed, and pressure (from the contractor, the union and even Works) was put on Graeme to resile from his position, but he didn't. The matter was resolved. It was all very stressful.

Eddie Geldard was an interesting character. Graeme and he and the supervisors would have a few drinks together. Geldard, who was on the job from the start but superseded Charlton as project manager toward the end, was at Corin with his wife and family. He was 'decent, and aggressive like all construction engineers'. Graeme wanted to redesign the top of the dam but Eddie wouldn't agree even though the changes would have saved Thiess work. Eddie's stubbornness dictated the final shape of the dam.

Dug Tonissen, who had been supervising engineer at Bendora (and had helped achieve a very high standard there), only came out to Corin a few times but Graeme knew him well. He had a 'left-handed walk', with one shoulder forward; 'a very strange method of locomotion, but it got him there'. Dug could never remember names, so everyone was 'mate'. Keith Knuckey, one of the Corin Works staff, had worked under him at Bendora and looked up to him like a father. Graeme recalled how they had a party for

Dug one night at Corin, and cards and drink ('20 middies') went all night long. At 6am when Dug and Don Stockdill went to drive home to Canberra, Graeme and the others had jacked up the rear axle of Dug's Peugeot, so the car didn't move until Dug discovered the joke and *lifted* the car off the block. Shortly before, he'd had inoculations for an overseas trip and was warned not to have alcohol. Back in Canberra he went into a coma for 2 days, but suffered no permanent ill-effects.

Don Stockdill was a 'very fine person'. Unfortunately both Don and Dug smoked heavily and died of lung cancer. Stockdill was a 'clever design engineer...wonderful to work for'.

Regarding NCDC contact, there was some at Corin but not as much as with the lake bridges in Canberra. Bill Minty and Rod Dalgleish occasionally came out to the dam. Minty helped set out the alignment for the Corin Road and it was well done.

Tape 2 Side A

The Corin Road had been started earlier [by Forestry] and there was a track to Smokers Gap, but nothing beyond there. Driving the Corin Road in the early period meant getting bogged 7 or 8 times which was 'good fun'. The decomposing granite country was very difficult for road building, and once a D6 dozer sank into the mire.

There were many migrants at Corin, and there was the 'classical disputation between Serbs and Croats'. Many of the workers came over from Geehi. They reflected the 'ethic of dam construction during the Snowy era', as described in the songs by the group The Settlers, in being itinerant, gambling, drinking people. 'That was the life', says Graeme.

Alcohol and gambling were central to the Corin social life, and even many men with families still drank every night. Graeme used to go for long walks at night, and sometimes fished at weekends. The supervising staff included drinkers and gamblers, but at least there were no fights among them. There was TV in the camp. There was prostitution too, and Graeme was told it was organised by some police; in fact he was interviewed about the allegations by senior officers [see Peter McDonald interview]. The quarters for Works staff were 'spartan' and small.

Graeme got to go home on Wednesday and Saturday nights. Corin's impact on his home life was severe. Graeme's son was 6 to 8 during the period and 'he got out of control' during his father's absence. Although he later grew out of this, it did affect his education and work prospects. Graeme concludes that all of this was 'entirely due, I'm sure, to that 2-year absence'. He found he 'had to grow back into' family life later.

Graeme feels that Corin does not negatively impact on the Cotter Valley, and that a dam can actually improve the aesthetics of a valley in adding variety, providing that the whole valley is not full of dams. He feels the same about Bendora.

There was a dramatic event following the completion of the dam. The concrete plug in the tunnel had a 2 foot diameter pipe through it with a butterfly valve. The motor to operate the valve had gone back to Canberra for repair; the valve was open. Very heavy rain then fell and Graeme and fellow engineer Dick Cross abandoned a skiing trip in the Snowies and headed to Corin, realising that the situation was ominous. At Corin the water already was 30 feet deep and a 50 foot jet was shooting through the open valve. Geldard and workers were trying to close the valve with a chain block. A crow bar flew out, knocking unconscious a nearby worker. 'If the valve wasn't closed the problem would be immense.' It was so noisy you could not hear someone yell. After some hours the valve was eventually closed.

Then there was another time in the valve tower, where there was a needle valve arrangement and a butterfly valve on the end of the discharge pipe in the tower, and the

latter had to be able to be closed under full flow conditions. At Bendora a problem had occurred with this same procedure [Arn Fokkema may refer to this in his interview]. Graeme closed the butterfly valve but it set up a 'tremendous vibration. It really sounded like a series of 25 pounder cannons firing at five times a second right next to your ear. The whole of the intake structure and tunnel were vibrating and shaking!'. But the valve did close, even though the anchor block cracked.

Faulty concrete must be replaced within a certain time frame. Once during the construction of the bridge to the tower, some concrete hadn't been placed properly in a pier and the Works engineer was going to leave it until the whole pier had been poured. Graeme discovered the problem and ordered that it be replaced without that length of delay. Later, Graeme comments on the replacement of concrete where the tower met the tunnel. He is not aware of faulty concrete in the tower [see Waldron interview].

Continuing the description of engineers' mistakes, Graeme says many structures have failed elsewhere due to failure of temporary works. This occurred on the Kings Bridge in Melbourne, at the Second Narrows collapse in Vancouver which killed an engineer friend of Graeme's, and could have happened on Commonwealth Ave Bridge in Canberra if checks hadn't been carried out.

The supervising engineer, in maintaining high standards with contractors, has to have great force of will. 'You have to be absolutely determined. You have to have already programmed yourself to expect ridicule, threats, objections, and not be swayed by them, even if they come from your own supervisor or boss.' If you weaken, the structure could be defective, which would be much worse.

Graeme spent some time on the Bendora Gravity Main in a supervisory role. He states that due to 'lax supervision' on the part of a Works supervisor some of the cut-off walls were built only around the top of the pipeline, and not right around [see Moore interview and Purcell correspondence].

Tape 2 Side B

Perhaps the Works supervisor felt the whole wall to be excessive. The walls were re-done by the contractor. Graeme says the incident illustrates the responsibility of the man at the top in any project or organisation. You can't rely on others; to do so is to be 'ignorant of human nature'. But then the other side of the coin is that one can become obsessive.

The gravity main was 'built pretty well'. Graeme regards the laying of a pipeline, even in that country, as a relatively simple operation.

Are your memories of that Cotter Valley period important to you? 'I was very lucky because my career led to me being an engineer when major civil engineering projects were occurring all over the world'. He worked in Canada, then Australia 'just when we were in the middle of a whole wonderful burst of construction — at the Snowy Mountains Scheme and through the Commonwealth Department of Works in building Canberra — it was just a wonderful opportunity'. Graeme feels very fortunate to have had a career in which you cannot avoid achieving the result. Doctors and lawyers can bury or hide their mistakes, but engineers cannot and if they do the structure will fail and they will be found out anyway. There are no excuses for an engineer. Graeme did not want to stay in civil engineering all his life, and he has subsequently applied his training 'to extremely complex ecological and sociological issues around Australia and the world'.