REPORT ON PROCEEDINGS BEFORE

PORTFOLIO COMMITTEE NO. 5 – INDUSTRY AND TRANSPORT

INQUIRY INTO WATER AUGMENTATION

UNCORRECTED TRANSCRIPT

At Macquarie Room, Parliament House, Sydney on Friday, 2 June 2017

The Committee met at 9:45 am

PRESENT

The Hon. R. Brown (Chair)

The Hon. R. Colless
Mr S. MacDonald
The Hon. P. Sharpe
The Hon. M. Veitch (Deputy Chair)

The CHAIR: Welcome to the eighth hearing of Portfolio Committee No. 5—Industry and Transport. These were called joint standing committees. The Committee is inquiring into the augmentation of water supply in rural and regional New South Wales. This inquiry is examining water demand and supply in New South Wales, and particularly in rural areas, the suitability of existing water storages, flood history, technology to mitigate flood damage, and water management practices, including environmental water. I acknowledge the Gadigal people, who are the traditional custodians of this land. I pay respect to the elders, past and present, of the Eora Nation, and extend that respect to other Aboriginals persons present. Today the Committee will hear from Cotton Australia, the Australian Water Exploration Company, Mr Declan Page from the CSIRO, Dr Peter Main and representatives from Golder Associates.

Before we commence, I will make some brief comments about the procedure for today's hearing. The hearing will be open to the public and will be broadcast live. Any media present can access the broadcasting guidelines on the side table. It is important that anyone in the public gallery not be the primary focus of any filming or photography. There may be some questions that a witness could answer only if they had more time or certain documents to hand. In those circumstances, witnesses are advised that they can take questions on notice and provide an answer within 21 days of receiving those questions.

I remind everyone that Committee hearings are not intended to provide a forum for people to make adverse reflections about others under the protection of parliamentary privilege. I therefore request that witnesses focus on the issues raised in the inquiry terms of reference, and that they avoid naming individuals unnecessarily. Witnesses are advised that any messages or tabled documents should be delivered through the committee staff. To aid the audibility of this hearing, I remind committee members and witnesses to speak into the microphones. In addition, several seats have been reserved near loudspeakers for persons in the public gallery who have hearing difficulties. Finally, I ask everyone to turn off their mobile phones or to switch them to silent for the duration of the hearing.

MICHAEL MURRAY, General Manager, Cotton Australia, sworn and examined

The CHAIR: I note for the record that the Committee has received a submission from Cotton Australia—submission No. 94. Before we proceed with questions, would you like to make some additional or opening comments?

Mr MURRAY: I would like to reinforce some of the things raised in the submission. So often when we have these sorts of inquiries and discussions, the focus is on the engineering solutions; that is, building more dams and so on. The cotton industry very much relies on reliable water supplies, and our production fluctuates greatly depending on how much water is around. We have the Murray-Darling Basin Plan operating across virtually our entire production areas, certainly across New South Wales. That puts great restrictions on what further can be done to increase the take of water in the Murray-Darling Basin [MDB].

One of the key issues with this inquiry is to consider how can it operate within the Murray-Darling Basin Plan either to improve the overall take or, at the very least and probably more likely, to improve the reliability of water supply for irrigation. A number of submissions to the inquiry talk about aquifer recharges, and that is certainly possible from an engineering and physical point of view. However, the challenge is how that fits within our water management framework. Every drop of water is allocated at the moment to either the environment or to extractive uses of one form or another. Therefore, any change requires a change in shares. Even if the aquifer were recharged—when it is considered in terms of a flood going down a system at the moment and redirecting that into an aquifer by artificially recharging—that would mean that that water was allocated either to the environment or an extractive user downstream. They are the policy and resource management issues that need to be examined closely by this Committee.

The CHAIR: Thank you. As a point of clarification, I assume that the last statement you made was in reference to westward flowing rivers.

Mr MURRAY: In general across New South Wales, all water is allocated one way or another to either the environment or extractive uses under the water sharing plans. The westward flowing rivers also have the added complication of the Murray-Darling Basin Plan overlaying them.

The CHAIR: I have had a brief look at your submission, and I thank you for its thoroughness. I will ask one question before I hand over to my colleagues. It is a question the Committee has been asking individual producers and representatives of groups of producers—smaller versions of Cotton Australia. Were the Federal and State governments able to address the water supply problem to the extent that your industry had no restrictions placed on it, shall we say, would you be able to answer now or take on notice what you believe the increase in economic output from your industry would be?

I acknowledge the normal restraints of competition with other producers for land. Members would like to get an idea for our own benefit of what sort of production would we be able to get—we will call it crystal ball gazing—given that the water equation were solved? As you say, cotton crops vary greatly—as do crops like rice—based on water availability. We are talking about what dryland opportunities could be made available were they irrigated. I guess all these things are limited by demand. If you had the opportunity to develop your industry further, and the water equation or problem were solved—that is, the availability of water to your industry—where do you think that might go looking forward to the next 20, 30 or 50 years?

Mr MURRAY: As a general rule, we talk about converting one megalitre of water into one bale of cotton, which today is worth about $550 a bale. The long-term average is about $450 a bale on farm. The reality is that that conversion factor has been improving over the years, and it is probably more in the order of 1.3 to 1.4 bales of cotton per megalitre. Additional megalitres will give us an additional bale or bale and one-third of cotton worth $450 a bale. If we look at the overall production history over the past 20 or 30 years, and it is national so it takes in Queensland and New South Wales, as a rough rule of thumb it is about two-thirds of production in New South Wales and one-third in Queensland. However, our production has varied from a low in the middle of the 2007 drought of about 600,000 bales to a height of 5.3 million.

Around about 90 per cent of our bales are produced under irrigation and about 10 per cent dryland. With the existing level of infrastructure and development, that would argue that if water was 100 per cent reliable we could at least produce that 5.3 million every year—with existing infrastructure. There is certainly capacity to see further conversion of land to irrigation. I guess if water was unlimited, that conversion would almost be unlimited. I am not too sure where that would stop, but we could certainly see us in New South Wales regularly producing in excess of four million bales per year if we had an absolutely reliable water supply.

The CHAIR: Okay. That is good. Thank you for that.

Mr SCOT MacDONALD: Thank you, Mr Murray. When I read your submission, I get a strong sense of the fact the cotton industry has been around for nearly 50 years and has been very much at the front of water reform and national water initiatives. You guys are really on the ball about the full cost recovery. We have moved from public costing of water to private and the full system costs are being borne by extractive users, if you like. I get a strong sense that, with any changes to water storage or to the system, the cotton industry would be very wary about what capital costs and system costs are coming down the road. Is that a fair comment to make?

Mr MURRAY: Absolutely. We realise it is not completely the case that there is no subsidisation of water supply but we have moved more and more to user pays. We accept that and that is our expectation. I guess in terms of some of the projects that get bandied around such as the Myall River dam or the Gravesend dam at Gwydir, in that context of the Murray-Darling Basin Plan basically saying you cannot extract any more water out of the system, what would be the value of building another dam? Well, it may be you have storages higher up in the system. You are going to reduce evaporation. At the moment that water that comes down the system is collected in on-farm storages.

I am not sure how well people understand the history of that, but back in the 1960s and 1970s when the Government was regularly building dams and that north-west area of New South Wales was developing, at a point the Government said, "We are not going to build any more dams. You guys build the private infrastructure." So the industry has access to headwater dams, be it Copeton, Keepit, Split Rock and the like, but they also spent a lot of money building on-farm storages. In many cases those on-farm storages in total are not too far short—I think, but I do not have the exact number—but, say, in the Gwydir there is probably something like 500,000 megalitres of on-farm storage and Copeton Dam can store 1.3 million. So it is a significant amount. That could have possibly been public expenditure back there but the decision was to make it private expenditure.

We are in a situation of: "Should we build these other dams if we cannot increase the take?" What would be the advantage? We could possibly reduce evaporation. If we made those savings, that water would be available for use. So the question is: Would that be economic? I think one of the good things that could come out of this inquiry would be a recommendation that says, "Let's have a serious look at that." Would the efficiency savings, bearing in mind that there has already been a lot of sunk investment on-farm, make it worthwhile to lose some of those assets on-farm and replace them with a headwater one? Would that make a difference? Would it be able to tweak the reliability that might make higher value use permanent crops such as nuts or whatever may be the crop of the day, but that requires highly reliable water? Would that make it more attractive? I think that would be a very valuable thing to come out of this inquiry.

Mr SCOT MacDONALD: We talked a bit about the other challenge facing the cotton industry, and that is the energy costs. There are some things you can control and some things you cannot control. Could you make a general comment around the energy?

Mr MURRAY: There are a couple of things. In general, over the last decade energy has gone up in the order of 100 per cent at the same time as the consumer price index [CPI] has been about 25 per cent, so we have seen a complete divergence between CPI and energy costs. There was and still is in some quarters the idea that the solution to irrigation and water efficiency is pressurised irrigation systems, be they centre pivots or lateral moves or drip irrigation and the like. Our view is irrigation systems are very much horses for courses. I think the Committee was in Moree where they may have talked about the project that they have on a property called Keytah there that now has four years of data.

They set up four systems—two gravity based, a bankless channel and a furrow irrigation system, a pressurised lateral move system and a drop system. They have four years of data. They crop it every two years. It has actually been going for eight years, so they have four years of actual crop data. I think the numbers are that the lateral move has been the most water efficient on two occasions and two of the other remaining three have been the most efficient. The difference in efficiency is actually quite tiny. It is in 0.1 of a factor. The cost of pressuring a lateral move system and a drip system is something in the order of $300 a hectare. The additional capital cost of putting in a lateral system is somewhere in the order of $4,000 a hectare.

Putting in a drip system has a capital cost of somewhere in the order of $6,000 to $9,000, so on those soil types and under those conditions it is not an attractive water efficiency option. However, I was up in the Macquarie Valley where they might have had some lighter red soil. They have certainly put in drip systems that have not only made significant water savings but have also led to significant yield increases, and for them it works. So there is not one-stop fix for water efficiency. It is a matter of recognising that it is horses for courses. While it is not particularly sexy, gravity under some circumstances is still by far the best option.

The Hon. RICK COLLESS: It is good to see you, Mr Murray. I will follow on from Mr Scot MacDonald's line of questioning about the economics of efficiency savings from large dams versus on-farm storages. One key issue with the large on-farm dams is that you would get more evaporation losses but you would get more transmission losses from the upland storages. Do you have any comments on those sorts of things?

Mr MURRAY: That is certainly the case. Prior to joining Cotton Australia six years ago I was the chief executive officer of Gwydir Valley Irrigators in Moree, so I often reference the Gwydir because I am most familiar with it. It works on an average transmission loss, from Copeton Dam to delivery, of 30 per cent. In drought years it can be a lot higher than that. In good years it can be a lot lower but we work on 30 per cent. Evaporation in areas like Moree could be up to one metre per year, so it can be a significant amount of water.

You also have to understand the history. When areas in the north-west were being developed, typically two things happened. Firstly, farmers did not understand a lot at the time so they developed their best soil for cropping and often put storages on poorer soil. The problem with that is that the best soil is probably also the best water-holding soil. They also built the storages using the technology that they had at the time. They were relatively shallow. They might have been only two or three metres deep. Now, people tend to make their storages seven to eight metres deep and divide them into cells. So they are stacking that water higher to try to minimise evaporation losses and building them on better soils. Using a Gwydir example, I know that Auscott took out one of its best performing cotton-growing fields to put storage on it, because it was also the best site on which to put an efficient storage.

The Hon. RICK COLLESS: You mentioned that transmission losses would be higher in drier years. In any year—I expect it would be higher in drier years—has the environmental value of that productive water going through the river system been accounted for in any way?

Mr MURRAY: It is part of that overall balance. I do not know whether someone has worked it right through. The word "loss" in water is a bit of a misnomer. Water is the ultimate recyclable resource. There is, effectively, the same amount of water in the world today as there was 300 or 400 years ago—or what ever length of time you want to go back. The water that is a transmission loss is largely being put into the ground water system. It will cycle around at some point in time. So it must have some environmental value, particularly in those drier times.

The Hon. RICK COLLESS: You commented about the infrastructure and who pays at the end of the day. When the Pindari Dam was enlarged—I think it was in the early nineties—

Mr MURRAY: In the mid-nineties, I think.

The Hon. RICK COLLESS: —the cotton industry was to make a contribution to that. Is that still being paid for?

Mr MURRAY: My understanding is that they might have made the last payment in the last year or two. I think it is all paid for now but it was the case that they all, as in industry, agreed—I could not tell you what the number was; whether it was 50 per cent or 100 per cent—and make a capital contribution. It was paid for as an additional charge on their water charges—probably over a 20- or 25-year period. I am pretty sure that it did wind up two years ago.

The Hon. RICK COLLESS: What is the industry view of that as a process if we were to look at extra storages—particularly the upland, more efficient storages?

Mr MURRAY: Ours is an industry that accepts, to a greater or lesser extent, that there has to be a fair amount of user pays. If the numbers stack up and people have the security and the right to that entitlement I am sure they would look at it, as they look at anything else, in terms of a business plan.

The Hon. RICK COLLESS: You mentioned in your submission the embargos that have been put in place, supposedly to improve the town water supplies in western towns. The town of Walgett was cited as one of the reasons for an embargo despite the fact that there had been a flow past Walgett only a few months before. In some of those western towns do you think there is a need to have an enhanced town water supply storage so that they can make use of those enhanced flows when they do go past?

Mr MURRAY: Absolutely. No-one is going to argue that towns and critical human needs have to be the highest priority. But we have to have that set up in a way that they do not unnecessarily impact on other users. I am not personally familiar with the engineering at Walgett but I gather they had some changes made to their water supply. It seems to be that their off date was set relatively high because there was a flow early to those embargos being put in place. It topped up the weir but it seemed that within a matter of months they were back at a critical level. So I think that that needs to be looked at.

The main trigger for the embargo has always been the impact on Broken Hill's water supply. To put that into perspective, Broken Hill uses somewhere between 6,000 to 10,000 megalitres of water per year. To assure them of 18 months forward supply they need, I think, 240,000 megalitres in Menindee Lakes. Menindee Lakes is a shallow, very broad water storage. It is never going to be an efficient storage place. It can be made more efficient but it will never be efficient. Nor is there any great alternative in terms of a perfect gorge to put a dam in upstream or downstream, so it is what it is. However, when you put an embargo in place, with those sorts of losses, it has an impact on the towns upstream. During the 2015 embargo, access to something like 70,000 megalitres was denied to titleholders which, otherwise, under water-sharing plans, it would have been perfectly legal for them to take. That was embargoed. At $450 or $500 a bale for cotton, that is a $35 million impact on the farm gate. Different people have different views on what the multiplier number should be used, but in general it is considered that there is a three times multiplier effect for local communities. So that means $100 million taken out of the local community.

The reality in that case, and when previous embargoes have been put in place, is that the Barwon-Darling River is such a long, flat river that unless there is a big flow the water is not going to get to Menindee anyhow. Embargoing small flows makes very little difference. Yes, it wets the water holes a little bit further down the river so maybe the next flow that comes along will get a bit further, but history says that the only time that the water gets to Menindee is when there is a really big flow. That is not an impact from irrigation or development. If you read some of the stories of the riverboat captains you learn that in good years they got their steam-paddle boats up past Burke. But there were plenty of times when they sat on the mud bank waiting for two years for a flow to come down. They were tough guys. They would hook winches to the front of the paddle steamer and drag their riverboats across one mudflat into the next waterhole. They would then go another mile or two and hook the cable up to another big red gum and drag themselves forward.

The Darling is an ephemeral system and it needs to be managed well. If we can provide good water supplies for the regional communities so that we are not making resource decisions based on making sure that they do not run out of water it will give people a whole lot more flexibility on how to best use the remaining water.

The Hon. RICK COLLESS: What are your views on the Wentworth to Broken Hill pipeline?

Mr MURRAY: I think that that is a fantastic initiative. We have been calling for an alternative water supply for these very reasons for Broken Hill for quite some time. Certainly, the quality of the water that they will get out of the Murray compared to the water that comes from sucking out the water from the bottom of Lake Menindee or Copi Hollow is going to be far, far better. I think the Government deserves congratulations for that initiative.

The CHAIR: While the Opposition is working out their second question I will use my captain's prerogative to jump in. Can you advise us now—or suggest where we may go if there are any existing publications—on estimates of what future demand for your product, cotton, may be. Has Cotton Australia done any long-term forecasting as to what the markets may be? If so, how far into the future have you looked?

Mr MURRAY: Cotton is a world commodity We are fortunate that every bale that we have produced we have been able to sell. We are at the mercies of the world market; however, we also produce a premium product, which provides us with extra demand, over and above the world demand. That has been growing, and we have had some great success lately with Australian brands, be they Target, where you can buy 100 per cent Australian cotton shirts, Kmart, where you can get 100 per cent Australian cotton sheets and the like. There is some work happening right at the moment with some other very prominent brands. Also, on an international level, we are part of what is called the Better Cotton Initiative, which seeks to build to the overall sustainability of the world's cotton industry and also to provide major brands, be they IKEA or Reebok, with assurance that their supply chains are sustainable. Those are all building demand for Australian cotton. However, we will still be part of world demand. That fluctuates, and at the moment world production is about 100 to 120 million bales per year, and consumption has been running a few million bales above that for the last couple of years. But if you went back to four or five years ago there was a growing stockpile.

While I certainly represent the Australian cotton industry, more importantly there is no person out there who actually has "cotton grower" tattooed on their forehead. They are a person with access to resources including water resources, land, skills, machinery, and they will produce whatever they believe is the best return per megalitre. That brings me to make the comment that it is not unheard of to hear people say, "Why do we grow cotton and why do we grow rice in Australia? They are thirsty crops and we should ban them." You could ban the growing of rice or cotton tomorrow, and you would not use one less megalitre of water in Australia. The irrigator has a right under an entitlement to a share of the available resource. In the areas we operate in, the

reason why they tend to grow cotton is that it tends to provide them with the greatest return per megalitre, given the general security nature of their entitlement.

Mr SCOT MacDONALD: National Water Initiative.

Mr MURRAY: Yes. If you were to take away the right to grow cotton, they would just grow whatever happened to be the second-best return for their megalitre of water, and we would all miss out.

The CHAIR: Are there any publications or is there any research you could point the Committee to where we might find whether forecasts have been made for the future of cotton?

Mr MURRAY: The International Cotton Advisory Committee [ICAC], which is a government organisation of which the Australian Government is a member, collects statistics and market reports. The biggest threat to cotton in the long term is someone coming up with the perfect synthetic fibre.

The Hon. MICK VEITCH: Thank you for your very good submission. I would like to explore three themes, and the first one takes me back to the Hon. Rick Colless' question about the pipeline at Broken Hill. This Committee took testimony in Deniliquin and Griffith, and irrigators there raised concerns about from whose allocation this pipeline flow would come. Has your industry raised this concern?

Mr MURRAY: I understand their concern, because they are saying that 6,000 megalitres would come out. By providing Broken Hill with an alternative water supply, it gives both the New South Wales Government and the Federal Government—as you are probably aware the control of the lakes varies depending on how much water there is—far greater flexibility. Why this makes real sense for the guys in southern New South Wales, even though they might see 6,000 megalitres coming out of the river system, is that if management is done right, they will make far greater than 6000 megalitres in savings in evaporation losses by having the freedom to use the water out of Menindee Lakes earlier to meet the requirement for downstream users, including the flows in South Australia, and maintaining water longer in the more efficient storage of Dartmouth and Hume, and to a greater or lesser extent Blowering and Burrinjuck. If you were a reasonably uninformed person you might think there is going to be 6,000 megalitres coming out of the river and you would be receiving a loss, but if you actually look through the process and the savings that better management of Menindee will deliver, they will be well and truly compensated by a greater reliability in their systems.

The Hon. MICK VEITCH: In your opening statement you refer to aquifer recharge, which is also mentioned in your submission. If I understood your opening statement correctly, you said there was no real benefit to aquifer recharge. Other witnesses have said that aquifer recharge is something to explore because it is another way of storing water for a later time—a bit like building a dam, but it is underground.

Mr MURRAY: Sorry if I gave the impression that there was no real benefit. My issue is that within the current New South Wales water-sharing framework, all that water is already allocated to someone, be it to the environment as either adaptive or planned environmental water or as an entitlement to a user. Even the water coming down during a flood, which at a common-sense level might be seen as additional water so let us whack it underground to use it later, is technically largely already allocated to the environment as a flood flow. We need to have a discussion and develop a policy framework that says it makes sense to put that water aside for later, be it for the environment use or for extractive use. How would we do it? As I said, the technology is already out there and it is not that difficult to recharge an aquifer. But how do we make sure that we are working within the rules that we have established?

The Hon. MICK VEITCH: Thank you for clearing that up. The Independent Pricing and Regulatory Tribunal [IPART] will appear before this Committee on Monday. We have heard from irrigators around the State that there are concerns about the way IPART develops user charges. There is concern about the transparency of the formula and how community service obligations [CSOs] and other inputs are determined. What is your view of the IPART process for determining usage charges? How could it be improved?

Mr MURRAY: We need some sort of independent umpire to do it, and IPART on the whole has done that job reasonably well. Interestingly enough when the Australian Competition and Consumer Commission [ACCC] did it for a year, they did quite a good job as well. The biggest questions are almost policy questions for government. They are: What should be the extractive users' share and what should be the share of government? If a dam has a dual purpose of storing water for irrigation and a flood mitigation role and therefore expensive gates have to be maintained so they open and shut, who should pay for that? Flood warnings is another classic question. Building a fishway is another one. For better or for worse, when Copeton Dam was built in the 1970s no fishways were put in. If they need to be retrofitted, should an irrigator wear that cost? I would argue no, it is going to be an environmental improvement for the whole community. If you are planning a new dam today knowing it would make an impact, maybe it is fair for the users to pay. Probably the most difficult part of the IPART process is arguments about user shares and where you land.

The part that I used to personally find quite difficult is that WaterNSW could say, "We need to spend $60 million doing an upgrade for X, Y or Z reason." Without the resources to get an independent engineer to tell you whether the cost was reasonable or not, it leaves you scratching your head. Another difficult area to debate is the weighted average return on capital on the regulated asset base and the weighted average cost of capital, which is applied to the RAB. Those areas are very difficult to work through; I am not too sure if there is a better way of doing it. The one where transparency falls over is that up until now the Murray-Darling Basin Authority [MDBA] has been able to say to the New South Wales Government, "These are our costs," and IPART has had to accept them. There has been no transparency on those costs at all, which certainly is a frustration.

The Hon. MICK VEITCH: Thank you for your very good explanation because a number of people have flagged their concerns about the process and the lack of transparency. When it comes to the environmental flows and accountability measures put in place, we have heard that there are no key performance indicators or some sort of outcomes measure. Does Cotton Australia have a view about how that could be improved or enhanced?

Mr MURRAY: We certainly share that frustration. There are quite a few issues around the Murray-Darling Basin Plan but prior to the plan coming out the then Murray-Darling Basin Authority had commissioned the sustainable river audit and did two rounds of that. The interesting thing was that it rated the health of rivers on various factors, including hydrology, vertebrate health, invertebrate health, turbidity—and I cannot think of the fifth factor. In virtually all the catchments, the highest scoring area was the area of hydrology. Then it came out with a basin plan that focuses entirely on hydrology: Just add more water and you will fix the problems. That is flawed and very difficult for people to measure success or failure. You can say, "Yes, we achieved an improvement at that river gauge on 10 per cent of the times.

We are now getting 20 per cent more water," but did that actually make it any better for the fish, the bird breeding event or the like? What I think they really need to do is drill down at a local and catchment level and come up with some very specific and measurable targets that people can relate to: "Yes, we achieved twice the number of successful ibis chicks bred that managed to fly away or "Yes, we have improved the level of native fish spawning". One of the other real frustrations I have is that there is a reasonable amount of focus on saying, "We need to build native fish numbers," and I do not think too many people would agree with that, but what is the point of releasing water out of a dam like Copeton or Pindari at a temperature that is far too cold to get them to breed—

The Hon. RICK COLLESS: Could kill them.

Mr MURRAY: —yes, it can actually kill them. It is just stupid. I know they have had a few problems with the thermal curtain at Burrendong Dam, but that was world-leading technology and every time there is a first there are some issues, but what it has shown is that there is a reasonably cost-effective way of retrofitting a solution to thermal water pollution. If there was one thing that we actually do to really improve environmental outcomes it would be to sort out the problems with it, install it properly and have a fantastic outcome.

The CHAIR: For the purposes of Hansard, I think Mr Murray might have misspoken by dropping a word out. I think he meant to say that there would not be too many people who would not agree.

Mr MURRAY: Yes, sorry.

The Hon. MICK VEITCH: In your submission you also talk about the need for an urgent, almost immediate audit of town supplies in the western part of the State. There is a number of arrangements for how local communities get their water and for water utilities, not just at Broken Hill. The strain on and inadequacy of that is often highlighted when there is a drought and there is no water, and suddenly communities need to have water trucked into them. Could you talk more about your suggestion?

Mr MURRAY: I do not know what the exact trigger point is, and people would have to look at the records of the river flows on the Darling, but as a starting point I would have thought that each town would need to have a reliable supply that could at least meet two years without a flow because that is certainly not uncommon. The guide that has been in Menindee for 18 months is probably inadequate. Certainly, unless there were some other compounding factors, the fact that Walgett was basically running out after a couple of months is just ridiculous. We need to make sure that they have good reliable supplies.

The Hon. MICK VEITCH: When the Committee was in the Central West for hearings, we looked at the site for the proposed Cranky Rock 2 storage. The questions we asked the downstream irrigators related to an economic model—for example, if, applying their formula, it was too expensive to draw and use the water, would they support the dam? In your submission you articulate some economic criteria before storage construction is considered. In the Peel they say it is just too expensive. In your submission you talk about the capacity of irrigators to pay, is that right?

Mr MURRAY: Yes.

The Hon. MICK VEITCH: That needs to be considered before the construction of dams. I suggest that we are reaching the point where the cost of construction alone would nearly rule out construction of new storages.

Mr MURRAY: It certainly would rule out construction of traditional and small dams. Up in Tamworth you would have heard their arguments about wanting postage stamp pricing and the like—

The Hon. MICK VEITCH: We heard that very strongly.

Mr MURRAY: Yes, you probably would have. If you had been around long enough, you would have heard it for the last 15 years.

The Hon. MICK VEITCH: Mr MacDonald was lucky to get out of Tamworth.

Mr MURRAY: The simple fact of the matter is that it costs you just about the same amount of money to run a big dam as a small dam. Why are WaterNSW charges in the Murrumbidgee $3 or $4 a megalitre? Because it pushed 1.5 million megalitres through a year. Why are they in the Peel $50 or $60 or whatever they are? Because it pushed 20,000 or 30,000 megs through it. It is a numbers game, saying the ones in the Gwydir or the Namoi are more than the Murrumbidgee because they do not push as much water through and the cost of running them is the same. You would have to have a very high-value crop that could really support high charges just to make it worthwhile, but that is not entirely out of the question as well. The Barossa Infrastructure company, I think it is, runs a pipeline service in the Barossa Valley. If you want to get water in that I think you now have to pay $10,00 a megalitre to get basically a right of entitlement, and it is about $1,000 a megalitre to actually use that water. It argues that it has a high-value product—red wine—and it only needs to put in a relatively small amounts of water. It makes sense for them, so it works.

At the moment I am involved in a project that is re-looking at an old business case to bring Brisbane's wastewater up onto the Darling Downs. The Darling Downs is 700 metres, so it is an awfully big lift. We know it is going to be expensive water. However, when they looked at it back in 2004—and at that stage the growers would have been looking at paying $300 or $400 a megalitre for it—a number of growers said, "Yes, under our system of agriculture, we can actually make that pay." Again, it is horses for courses, but in terms of wanting to be building a relatively small storage to underpin the cotton industry in the Lachlan Valley and paying $100 a megalitre, it is properly not going to stack up.

The Hon. PENNY SHARPE: Where is Cotton Australia at regarding predictions of climate change and less water into the future? Have you done or commissioned any reports in terms of the modelling that you would be willing to share with the Committee or any general thoughts about where that is going?

Mr MURRAY: No, we do not have any reports that we have done. The Cotton Research and Development Committee may have some work on that on its website, but I am not aware of anything. In general, what is our approach to it? All water entitlements in New South Wales are based on the share of an available resource, so if it gets wetter that resource increases and if it gets drier it decreases. We just have to live with that. As an industry, we are well used to dealing with reliability. As I said, in the last decade we have gone from as little as 600,000 to 5.3 million. We do have some water sharing rules, particularly things like continuous accounting, which allow us to try to manage that variability internally. That is what we do there.

To that extent, climate change will happen. It may happen in different ways in different areas. There is certainly a school of thought that, particularly in the more subtropical zones—therefore north-west New South Wales—we might see more and sharper storms which may create more run-off, so it may increase in reliability. The suggestion in southern New South Wales is that it is more likely to be drier and we might see a downturn over time. Climate change, if it occurs, is sort of up here. Decade influences are probably like this, going down with some gentle up and down at the end. Annual influences are like this, up and down more sharply. We can live with it and as an irrigation industry within that framework we are probably better placed than lots of other areas of society that are probably a little bit more rigid in the way they operate.

The CHAIR: Thank you. We are out of time. Mr Murray, there will be some questions on notice. We have already discussed what some of those might be. Could we ask that any replies to questions on notice be sent back to us within 21 days of you receiving them in writing from the Committee?

Mr MURRAY: I would appreciate a little bit of extension. I am going to be on leave from 10 to 25 June, if that is possible. Another week on top of that would be great.

The CHAIR: We will take that into account and consider it 28 days.

Mr MURRAY: Perfect, thank you.

(The witness withdrew)

COLIN JOYCE, Research Officer, Australian Water Exploration Company, affirmed and examined

JAMES LINDSAY, Research Officer, Australian Water Exploration Company, affirmed and examined

ROGER SHORE, Representative, Australian Water Exploration Company, affirmed and examined

CHRIS SHORE, Research Officer, Australian Water Exploration Company, affirmed and examined

PETER LAYTON, Research Engineer, Australian Water Exploration Company, affirmed and examined

The CHAIR: It is probably two years now since I first met with the Australian Water Exploration Company [AWEC] and the inquiry is proceeding now, slowly. We are taking our time. I would like to thank you very much for appearing here today and bringing to the table your considerable expertise in these matters. Before we begin with questions from the Committee members, would one or all of you like to make an opening statement or add anything to your submission?

Mr R. SHORE: Yes, we would like to give a brief presentation between us. Thank you very much for firstly accepting our submission, and secondly for inviting us here today and the opportunity to speak with the Committee. I am sure that you would be aware of who AWEC are. The Australian Water Exploration Company is an organisation dedicated to researching Australian water projects to meet the challenges of this dry continent in which we live and share. AWEC holds a firm belief that water is Australia's most precious and renewable resource and the management of this resource is critical for the furtherance and development of this nation. The committee consists of a group of concerned Australian citizens—who are with me here today—and between them they have spent many months prior to 2005 visiting every Australian State and inspecting many sites and possible water opportunities throughout Australia, including remote areas of Queensland, the Northern Territory and Western Australia. During these visits opportunity was found to meet with a number of senior well-informed government, community and business personnel.

There has also been international travel involved. Members of this organisation have been to successful projects in Arizona, California, Colorado and the Mexican borders in the United States of America and Mexico and inspected key water infrastructure sites at a very high level. I am wondering whether I could just hand over to Mr Jim Lindsay to give us a firsthand account. Mr Jim Lindsay has lived all his life in Leeton, and now in the latter years in Griffith, and has had firsthand account and witness of the impacts of the reduction of water through the Murray-Darling Basin scheme on the rural sector. I wonder whether we could get him to give us a few words on that situation?

Mr LINDSAY: I also thank you for the opportunity to speak today about this very important matter. I am a director in a family business. As Roger Shore alluded to, I have spent all my life in the Riverina, and I have lived through years of high productivity. As members know, the Riverina is one of the nation's food bowls—and a very productive one. You could say that I was at the coalface in the food bowl for many years and saw it prosper. There have been wonderful results. I suppose that is the result of 100 years of development. It was something that the Government designed and over 100 years it has developed into the productive area it now is. New water controls were introduced in 2007, and we are learning how they have evolved. A few years after that I started to take a deeper interest in what was unfolding on the water scene. I am not an irrigation farmer myself, but I have lived in the area and I have seen every facet of life in regional communities. You get a fair feel of what is happening across the board.

It was 2010 when I realised that I needed to study this more closely. I could see that there was more in it than I thought. It was very interesting. Over the years I have attended many regional meetings. I have travelled down to Murray-Goulburn and around our area. If you listen at these meetings, you learn a lot from businessmen and from the farming or producing groups. There is a real cross section. There are the personnel from the shires in various areas, the headmasters, and health divisions. I have found that the impacts are intensifying over the years. That makes this meeting today so important; we must drill down into some of these things.

The Committee would have heard a lot of this before, but it is extremely important. I decided to do my research in the cotton valleys. I travelled from Queensland down through every cotton valley, right down to southern New South Wales. I was in touch with the chairmen of each of the cotton groups, and I asked them about the situation: did they have enough water, what were they paying, did they need more, and so on. I was getting the same answer from every cotton valley—they were all short of water. Many of them said they had the infrastructure and perfect soils, but they did not have water. That was very interesting. There were variations up and down and different prices, but it was very instructive.

Every megalitre of water in our area develops about $1,999 in product. The flow-on effect is very great positively, and, of course, negatively. It is very hard to put a number of some of these things, but impacts either way can be large. Taking the water away from our area is certainly blowing holes in our rural economies. It is having impacts on food and fibre production, which is critical in our nation. It has had huge negative flow-on effects: job loss, businesses becoming unviable, families breaking up, and, unfortunately, suicides. I heard some doctors give evidence, and there was so much to take in. Investor confidence was also crushed. I respectfully suggest—this is based on my own impression after hearing so many people speak over the years—water management in New South Wales needs a serious upgrade. I say that carefully, but it must be said. On a brighter note, the Australian Water Exploration Company has a concept that we feel is the answer to this problem. I am sure following speakers will touch upon that. New water can be ushered into our areas, and that will make a great difference.

The CHAIR: Would anyone else like to say something?

Mr R. SHORE: Chris Shore, my father, would like to say something about famines and the lack of water worldwide.

The CHAIR: Now we are getting to it. The Committee would welcome that. Someone is finally telling the Committee what they think about the future.

Mr C. SHORE: Thank you again for this opportunity to express our views and concerns about what we believe is needed in New South Wales. There are many facets to the shortage of water. We must understand what has happened since the Water Act was implemented in 2007. The implications of that Act are still unfolding. From what I have observed, and what I think is generally accepted, more and more water is being taken away from the agricultural sector, and that is certainly having an impact. I do not know that I could quantify that in dollar terms, but it is a very widespread concern.

The population in Australia in 1987 was about 16 million, and it is now about 24.5 million. It is predicted that in 2037, Australia will have about 32.5 million people, which will be a doubling of the population over 50 years. Virtually no dams have been built over those years. Even if we make a decision to build dams now, it will be many years before we see the benefits. My concern is how we provide for not only our own needs but this extra population, which will need food and clothing, as will our neighbours. There are areas, especially in Africa, where there are severe famines and malnutrition. Eradicating hunger and malnutrition across the world is probably our biggest challenge, and we must address it.

Australia is a resource-rich nation; it has an abundance of most things. I believe our consciences will encourage us to take a very unselfish view of the needs of people around us, especially in some developing countries. I think we are seeing evidence of extreme weather conditions. Whilst I could not enlarge on that too much, there is a certain amount of uncertainty as to our weather patterns. I think it is very appropriate that we take into account the needs that are present and that are likely to escalate. I believe we have plenty of water; I do not think Australia is short of water. We have a challenge ahead of us as government to be able to secure that resource for the benefit of the nation. I think this matter of famine is something that is a slow process. It often comes about very rapidly when it does hit. It moves silently and then finally cascades into a large-scale disaster. We are also seeing war and other economies collapsing due to famine. That brings a lot of stress to humanity. That is probably sufficient for what I had to say. Mr Layton was hoping to say something.

The CHAIR: Go right ahead, sir.

Mr LAYTON: Thank you very much for your consideration and willingness to listen to us. I guess I have looked at this thing more from an engineering point of view, being an engineer.

The CHAIR: Strength, brother.

Mr LAYTON: My background was in municipal engineering—water supply—and then as a consultant, but I did spend 10 days in California and Nevada just to see what has been done and what can be done. In many ways it is a similar situation to the one we have here, in that they have abundant water but they do not have it where they want it. What has happened is that the water has been successfully transferred from catchment to catchment to produce an amazing result. Basically California has 40 to 50 inch rainfall in the north, up towards Canada. The Los Angeles Basin, where there are over 20 million people, has a 12-inch rainfall. It is similar to western New South Wales.

The problem was seen early. The first movements for a State water plan there were in 1919. There was a plan produced in 1931, a proposal to start in 1933, which was crippled by the Depression, but the Federal Government took over and there was substantial work done by the end of the war. And it was needed, because the population nearly doubled during the war. But then they produced a State water plan. The water comes from

the north. There are two very substantial reservoirs there—the Shasta Dam and the Oroville Dam—which I have been to. The water is then transferred down the Sacramento River and into a system of aqueducts that takes it through the whole of the Central Valley and over the mountains at the end and down into Los Angeles. It is an absolute engineering marvel, but it shows what can be done. It is marvellous in the sense that every sector of the community has been looked at and provided for so that the fish do not suffer—the economics of that are looked at. They have reservoirs so that, during the month when the fish run, they do not draw from the river. There is sufficient storage to cover that.

The aquifers have been at least in part recharged. One of the reasons this thing was got going was that there were some surface distortions of up to five metres caused by the drawing down of aquifers. That was fairly drastic. But what has proceeded there is that they are able to provide water supply for 20 million people and irrigate 600,000 acres of land so that the Central Valley of California, which has rainfall of 25 inches in the north and five or six inches in the south, produces 10 per cent of the agricultural production of the United States. It is an absolute garden. It is beautiful. It is not only the fact that they have got the water but that they have managed the water. They have managed it so that all their conduits are put in to minimise evaporation, to allow accurate control of quantities, and to allow water trading so that drier areas can buy from wetter areas and the transport of that is allowed for.

It is a marvellous scheme. The water at the southern end of that valley is pumped vertically 2,000 feet—that is 670 metres. To do that they have fourteen 80,000 horsepower pumps. That provides about 30 per cent of the total water needs of the Los Angeles Basin, which is over 20 million people.

The CHAIR: Aren't they fortunate that they have got cheap coal-fired power?

Mr LAYTON: Well, they have one coal-fired station, but two-thirds of their power needs they generate themselves.

Mr SCOT MacDONALD: Hydro?

Mr LAYTON: Yes, hydro. Water is pumped up, it is stored, and it is dropped down at times of high-cost power. It is a marvellous system. I only draw attention to it because it shows what the prospect is, what could be done. We need more water. They have diverted the water from catchment to catchment. We have things like the Clarence River. We have the Snowy Mountains Scheme as an example of what can be done. We did overdo it a bit, but we can learn from those mistakes. We do not have to do that again. The Clarence has the capacity to supply as much water to the Western Plains as the Snowy does.

I would love to see the money that is now being spent by the Federal Government on pumping up and down—that is great and it is going to add to the efficiency of the power supply, but it is not going to produce any more water, whereas it could be that, if we got into a scheme that is similar to the Snowy in the north of the State, we could produce probably a huge amount of water—as much water as the Snowy produces. And we can see what that is doing in the Murrumbidgee Irrigation Area and down those rivers.

I also think that we need to have abundant storage. I have looked into the figures in California and they have a total storage of 7.2 megalitres and a usage on average of 3 megalitres, so they have 2½ years supply in reserve to ensure the reliability and sustainability of their water supplies. The system is huge. They are dealing with a population as big as Australia. We are not going to replicate that. But the principles are there and can be applied in our areas, because we are essentially doing the same thing. We are needing to take water from areas of high precipitation to areas of low precipitation. I am sure there are many lessons that can be learnt from what has been done there.

We did look at others too. I cannot go into it now but there is a system in the north of Denver, where water from the Upper Colorado is taken through the mountains to the east. It is the only one where they go east. It irrigates substantial quantities on the South Platte River, because that is once again an area of probably 10 or 12 inch rainfall. It is verdant. It is beautiful. They were just some points I wanted to make to emphasise the fact that we can do these things without detriment to the ecology of the area and we can do it without detriment to our people. We can be positive about it.

It is interesting that if you look at the brochures about any of these dams—there are 32 of them—they will tell you, initially, about the recreational benefits and the ecological benefits. Right at the bottom it will tell you about the water benefits. It is attractive to everybody. It can be done that way if we are careful. We can provide the water that we need to boost our economy and our agriculture and provide for our own nation and for other nations, as Colin has just mentioned.

The CHAIR: In your submission—submission No. 60—you have provided us with quite an amount of additional information, including listing some of the publically available documentation from the United

States. Does the Australian Water Exploration Company have any of the documentation which you could table today? If not, would you be able to provide the Committee with it, or tell the Committee where to go to get that document?

Mr LAYTON: I do not have it with me.

The CHAIR: That is okay. We will probably send you a question on notice, asking you to help us to get some of that information that you have mentioned today. Just to provide you with a bit of information, the Committee has had site visits across a great deal of New South Wales, certainly in terms of where the major systems are, and is planning to go to Lismore to look at flood mitigation. The river system there is probably characteristic of the Clarence, which you mentioned. In your notes you have given us some history of the development on some of those schemes going right back to Bradshaw.

The Hon. RICK COLLESS: Bradfield.

The CHAIR: My apologies, Bradfield. Did you say that the schemes in California were first mooted in 1909?

Mr LAYTON: 1919.

The CHAIR: And then after the Second World War those were largely completed. Is that right?

Mr LAYTON: Yes. There were two schemes. The State government started it in the twenties, and then started construction in the thirties. They ran out of money during the depression. In 1937 the Central Valley Project was taken over by the Federal government.

The CHAIR: Essentially, you are talking about 50-plus years, from thinking about it to getting to a position where you could switch it on.

Mr LAYTON: That is right. After the war, because of the enormous increase in population in California—because of the war industries that were there—the State set up a separate State water plan in 1951. The major facilities were finished in the mid-seventies.

The CHAIR: The point I was trying to make was that we are looking at time periods that are beyond a normal electoral cycle of four years, obviously.

Mr LAYTON: Definitely.

The CHAIR: I take it that one of the foundations of your submission is that planning must be long term, and needs to start as early as possible.

Mr LAYTON: Yes.

Mr JOYCE: I just want to speak very briefly on the benefits of new water for future rural production, including the provision of export produce and the proper care of the wetland areas of inland Australia. My contact with the water industry goes back to when I was a lad doing some of the maintenance on some of the cotton farms around Wee Waa and Narrabri—for Hampsons, Ferris brothers et cetera. I was very closely associated with the early part of the cotton industry. In later years I attained a commercial pilot licence, which gave me the opportunity to visit many regional centres of Australia. I was also able to study the land forms—the river valleys and mountains et cetera. I would like to thank you for your energy in keeping these hearings rolling. My brief comments are that new water is the only possible solution for fixing New South Wales water restraints.

There is currently no possibility for future growth in irrigated farming in New South Wales. It does not matter how we cut the pie, the New South Wales share of the Murray-Darling Basin water can only be cut so many ways. As it stands today, the water available for agricultural production is much less than it was 20 years ago. The reasons for this have been presented to this Committee at every hearing—at least every hearing that I have been to. There is plenty of water. We just need to catch the water that the heavens bring. We have to be responsible and not waste the water that is providentially provided. There is plenty of water. We just need to catch the flood waters and store them. No-one has found a better way for storing water than a dam—especially dams built high up on the eastern tributary rivers where there is little evaporation.

Dams have been the tried and true way of storing water since civilisation began. As the Deputy Prime Minister said, "If water is wealth, the dam is a bank." Along with the new water concept, hydro-electricity can be generated—possibly close in magnitude to that provided by the Snowy Hydro. If we accept that New South Wales farm irrigation provides income of $8 billion from four million megalitres, if we add another one million megalitres of new water it is reasonable to expect that this figure could increase to $10 billion.

We do not want to stuff up the rivers, but people do want a balance—including flood mitigation. The gold with this new water is that it is totally available for future growth. The Murray-Darling Basin Authority has already addressed the environmental needs. We hold the same concerns—that the environment receives proper care. Providing New South Wales inland agriculture with an additional one million megalitres of new water is absolutely doable. It is achievable and can be done within two terms of government. Thank you for your patient attention.

The CHAIR: Thank you for your submission.

The Hon. MICK VEITCH: In light of the time—we only have 10 minutes for questions—I have one quick question. Your submission is critical of the air space management regime of our water storages. How can that be improved?

Mr JOYCE: I guess the methodology that has been used to calculate that storage could be revisited. Apart from that I can only suggest that it could be improved by providing more water.

The Hon. PENNY SHARPE: I am sorry that I missed some of what was said because I was outside. I hope I do not repeat questions. I am interested in your support for the Clarence proposal. What work have you done with people locally in the Clarence? I understand that there is really strong community resistance to this, so I am interested in what work, if any, you had done with people on the ground there in explaining the concept, and whether you have been able to reassure them in relation to their concerns.

Mr JOYCE: I can answer that very briefly. In 2005 we had a meeting with the mayor of Grafton.

The Hon. PENNY SHARPE: Who was that, then?

Mr JOYCE: I will have to take that on notice.

The Hon. PENNY SHARPE: You can take it on notice; that is fine.

Mr JOYCE: Following the meeting he said, "We understand that for the good of the nation this project concept finally has to be done."

The Hon. PENNY SHARPE: Would anyone else like to comment?

Mr LINDSAY: I recently heard someone in the rural farming groups making a comment. They felt certain that if a survey was done—and this was not long after the Lismore floods—they would find from the agricultural scene that they would be very supportive of flood mitigation. I had in mind to follow that up, but I thought it was very striking because there has been serious devastation at Lismore.

The Hon. RICK COLLESS: I am sure you are aware that politically the issue of diverting water west from the eastern side of the catchments has had considerable airplay over the years. If we were to proceed with an east-west diversion, how could we handle that? The engineering side is a no-brainer and it is certainly feasible, but the political aspects of it and convincing communities on the coast that it would ultimately be a good thing not only for the people of the west but for them would not be easy. How do we address that issue?

Mr R. SHORE: I would say that the Government needs to get a specialist panel or company to complete the environmental and construction project in its entirety, and around that model some numbers on the amount of water that would come out. It is easy to go to Grafton and say, "I will stop all the water coming down." You might be working for the fisheries—

The Hon. RICK COLLESS: That is the perception there, of course, that you are going to take away all the water. It is a bit like what happened in the Snowy River.

Mr R. SHORE: We understand that they may well have gone too far in the Snowy, and we can learn in retrospect what has happened. But we believe that, once we have that clear modelling, there is less than 20 per cent of the water that would be diverted. We know that since 1980 there have been 12 major floods—major being higher than 5.6 metres—through Grafton. That is nearly one every three years. If we went to Grafton and said, "We are going to fix the problem and you are not going to have floods through your house again, and we can control this," are they going to be happy if we say to them that their rivers are going to run dry and their fisheries will be gone? They will turn around and say, "Go and get lost." It comes down to, first of all, having a clearer and more in-depth study done and tendered to a company of specialists. That company would then come back to the Government with this information.

It should not take them forever. They would then quantify the amount of water and the benefit would be how to mitigate the flood damage to the Grafton or the Clarence area. You have the ability then to either return water to the Clarence in the drought years that the Clarence Basin endures, and to send the water inland. It is just holding up the resource. We know that every three years they get large amounts of rain, and it is getting

wise and smart about how we do it. There is the ability to build five power stations. No-one would disagree—not even those primarily concerned with the environment—that power generation since the Snowy started, had that not been there and we had continued to use coal-fired power stations—looking forward to the increased power needs of a growing population, it is a no-brainer that new hydro power generation has to be the way to go.

The Hon. RICK COLLESS: You mentioned 20 per cent. In your submission you say that there is 5 million megalitres in the annual run-off from the Clarence, I guess, and only 1per cent of that is taken at the moment for extractive uses. What proportion could be extracted or turned west without having any impact on the industries in the Clarence, including the offshore fishing industry? We know that the offshore fishing industry relies on fresh water coming through the system.

Mr R. SHORE: Yes. I would say that mitigating the damage done by major flooding to the fishing industry would mean that the fishing industry would be in support of that.

The Hon. RICK COLLESS: I have pretty good contacts in the fishing industry and there is a view that a drought on land is also a drought at sea—that is the term they use. By taking water out of that system, they would see that as exacerbating the problem. I am certainly not against the proposal per se, but we need to address all the issues if we go forward with this concept.

Mr JOYCE: If I can add to that, the fact is that the water will be regulated, so the tributary rivers to the Clarence will have a regulated flow of water, as we have on the western side now. That should make the fishermen very happy.

The Hon. RICK COLLESS: You also commented that water management needs to be upgraded dramatically or substantially. Does that need to change legislatively or bureaucratically, federally or at State level, or all four? What is the basis of your statement?

Mr R. SHORE: The crisis that we currently face, realistically if put in layman's terms, is that there has been a large reduction to the farmers. Had they never had that allocation, they probably would not be jumping up and down today. Like any businessmen, once a farmer gets his hands on a quota or an allocation to enhance his income then he is very loath to give it up. That is why we have the situation we have. Farmers have built infrastructure around the availability of water, and we as a company believe that the only solution is new water. As I said earlier, whether you take it from the environment or you take it from the farmer, there is no more water. I understand that we could do better by using better infrastructure to stop evaporation and so forth. It can also be argued that you would have less evaporation if we have less rain. I do not think anyone will argue that if you take water from the east of the Great Divide and send it inland there is more water, especially considering the number of major floods they get in the basin.

Mr LINDSAY: In relation to water management, I happened to hear what I would call a guru from an irrigation group. This person is very knowledgeable on how the New South Wales water system works. That person said that she understood most of it, but there was a fair bit she could not understand. Originally there was one Water Conservation and Irrigation Commission but now there are probably 15 plus, and even a specialist cannot understand it. When I heard that comment I thought this is serious because a guru cannot really follow. It is very difficult for the average farming entity to understand it. I hope that throws some light on it for you.

The CHAIR: It does. I wish we had another hour, because I have a few questions that I will put on notice. I am sure other members will have also questions they would like to put to you. We would like replies to our questions within 21 days of your receiving those questions. I thank you for taking the time to come here today and for your submission. I also thank you for your visit a couple of years ago, when you put forward some of your views. Some questions we have put are trying to put a nail into future numbers, and your submission has some concepts relating to the future. If you cannot answer our questions, perhaps you could tell us whom to ask—including overseas sources. We have a very good research system through the Parliamentary Library, and this Committee can avail itself of research provided we know whom to ask.

(The witnesses withdrew)

(Short adjournment)

WARWICK MACDONALD, Research Director of the CSIRO Water Resource management Program, CSIRO, sworn and examined

DECLAN PAGE, Group Leader - Groundwater Contamination and Remediation Technologies, CSIRO, affirmed and examined

The CHAIR: Welcome to the hearing. The Committee does not have a submission from the CSIRO so, if you have anything you would like to put on the record, such as an opening statement, please proceed before we begin questions.

Dr PAGE: I thank the Committee for the invitation to appear. Although we did not make a submission, I am very happy to answer any questions. I currently have the role of group leader at the CSIRO, and I run a group called Groundwater Contamination and Remediation Technologies. Our group has a number of teams but our skills include things like groundwater quality management, groundwater modelling and things like contaminated site remediation. CSIRO has a longstanding history in water resource management, and we have, recognised in Australia and even internationally, expertise in managed aquifer recharge. Our research here in Australia has been significant in that we have led the research and help to develop MAR in Australia—

The CHAIR: The first time you use an acronym, you might like to—

Dr PAGE: You are right: MAR is the acronym for managed aquifer recharge, and I tend to use that automatically now. We have worked in collaborative projects with partners from Federal, State and local governments, private companies and education providers. I guess one of our fundamental pieces was to develop the national managed aquifer recharge guidelines as part of the National Water Quality Management Strategy. I would be happy to give a brief potted history of MAR over the last 20 years or so in Australia if that is helpful.

The CHAIR: Yes, please. We have plenty of time.

Dr PAGE: Originally MAR started in about the 1960s with the Burdekin Delta projects in Queensland. There they just used spreading technologies where they took the river and each year they would scour the riverbed. It probably really took off in about the 1990s, and I will talk briefly about some projects that are well known across Australia. I am from Adelaide and some of the first projects we worked on were looking at stormwater harvesting in urban areas—

The CHAIR: Is Salisbury one of them?

Dr PAGE: That is an area, yes—that is right. They use a technology called aquifer storage and recovery. In managed aquifer recharge there are a number of ways to get the water into the aquifer and get it out. Aquifer storage and recovery uses a single well but they can use other things like a basin or multiple injection wells: They all basically get water in and out of an aquifer. In the 1990 there was a research project that went on for a couple of years. They showed that it could produce a water resource that could be used to keep Adelaide, or this suburb, green over the summer period. Since then stormwater aquifer storage and recovery [ASR] has grown in South Australia. It is currently sitting at about 20 gigalitres a year for non-potable use, but we aim to get to about 60 gigalitres per year by about 2050.

Another really notable project from about 2010 onwards was the use of reclaimed water or treated wastewater aquifer storage transfer and recovery in Perth as part of the potable water supply in the Beenup project. Perth uses predominantly groundwater supplies for its town water supply and it has a diminishing groundwater resource due to over-extraction, so it needed to somehow augment that supply. It went through various options—it has done desalinisation as well—but after a three-year trial it came to develop this technology where it highly treats its wastewater and injects it at one part of the aquifer and then can extract it later on from another part. Apparently in 2016 it began officially and it is now looking at 14 gigalitres a year recharge, and it is going to be ramping it up each year because it has found it to be cheaper than some of the other competing water options available.

We are involved in that as part of the three-year trial project to I guess give them the confidence that they are managing it properly and that human health and environmental risks can be managed, because public water supply is, of course, one of the highest value uses of water. MAR has also been used in other areas, such as—

[*Due to a technical malfunction, a short portion of the transcript could not be produced*.]

Mr SCOT MacDONALD: People are concerned about the connectivity of the river and what that might mean for the water budget. Would you have separate licences for everything you do?

Dr PAGE: It would depend on the individual State and how they manage it. In Australia, you have a licence both to inject and to recover the water. One is managed by the water resources group and one is managed by the—

Mr SCOT MacDONALD: The licence to inject?

Dr PAGE: Yes, you are allowed to put a certain amount in. Both the Environment Protection Authority and the water resources people have a stake in how that goes, as does public health.

Mr SCOT MacDONALD: And extraction would be the normal groundwater extraction allocation.

Dr PAGE: Yes, and managed as an aquifer itself. In the Salisbury example referred to earlier, they allow for things like water trading. Salisbury does inject an aquifer where it is over-exploited. It is then given credits and is allowed to take extra water out at a different part of the same aquifer where normally no-one is allowed to take any more water.

Mr SCOT MacDONALD: Does the Murray-Darling Basin Authority have a view on this; does it encourage or discourage it?

Dr PAGE: You would have to ask the authority; I am not sure of its view.

Mr SCOT MacDONALD: Do you have any final comments to make about connectivity with surface water?

Dr PAGE: Connectivity is a big issue. You cannot take water next to a river and call it groundwater; it can be river water. There is a technology called "bank filtration" that is commonly used in Europe. Rather than taking water from the river, you take it from a well that might be 30 metres from the river. In effect, you are filtering that water through the bank. They use that technology deliberately to get cleaner water because rivers are highly episodic in terms of quality. Groundwater tends to be much more steady in terms of quality and quantity. When it comes to drinking water supply, or any water supply, having reliable quality water is very important. Not all water it is created equal.

Mr SCOT MacDONALD: You are talking about the Australian experience. We often hear that America is doing this, that or the other. Are they transferrable? Are there any commonalities or is Australia unique?

Dr PAGE: There are commonalities in science. However, the legislation and policies are very different in the United States. Generally, as I understand it, they have to treat to a much higher level. They would reverse osmosis treat all the water—

Mr SCOT MacDONALD: Before injecting it?

Dr PAGE: Yes. That is cost prohibitive in many cases. If you are going to recover that, they do not—

The Hon. PENNY SHARPE: So it is drinking quality when they inject it.

Dr PAGE: Yes.

The Hon. PENNY SHARPE: What is the quality when they pull it out?

Dr PAGE: Less than drinking quality. That is according to legislative requirements and that is how they do it. They have a very large and transmissive aquifer and water trading. The water can be injected here, and both pressure and water will transmit very quickly. That is not the case—

Mr SCOT MacDONALD: In weeks?

Dr PAGE: In a short timeframe—enough that they feel confident they can trade water, much as we do with river systems.

The CHAIR: Mr MacDonald, can you give the Committee an idea of the scale of the water resource management program within the CSIRO? How big is it? Where is it located? You said you were from Canberra. I know you cannot comment on policy, but does the way the CSIRO funds and mans—or persons—these programs indicate that water management is a serious issue for the organisation, or is it a minor issue?

Mr MacDONALD: The water resource management program within the CSIRO has about 80 researchers. We are located around all the major capital cities, with the exception of Hobart and Darwin. The background to the program that I lead is that it has undertaken water resource assessments for a decade on behalf of the Federal Government. That was kicked off by the Prime Minister requesting the CSIRO to undertake the so-called sustainable yields assessment of the Murray-Darling basin in 2006. Water research is core and central to the CSIRO's work, and it will continue to be so as long as it is an issue for the nation.

The CHAIR: You say this science group is 10 years old.

Mr MacDONALD: No, the history of the science group goes back multiple decades. It has been working at the scale of catchments and basins and providing views on water availability into the future under scenarios of climate change. That has been the core of what my program has delivered over the past 10 years, among other things.

The CHAIR: Does your program consult to State governments or other bodies, or does it strictly provide research behind policy for the Federal Government?

Mr MacDONALD: No, we work with Federal, State and industry partners who are keen to solve their water management challenges. The program in which Dr Page is involved focuses primarily on environmental contaminants and mitigation technologies. That is where the expertise around management of aquifer recharges is held. That is separate from the water resource management program itself.

The CHAIR: Does your research cover disciplines like hydrology, geophysics and so on? Do you have scientists in those fields?

Mr MacDONALD: Absolutely.

The CHAIR: Or do you rely on other science for that?

Mr MacDONALD: My program holds all the surface water and groundwater assessments and characterisation capability. As I noted, it has been applied at that broader scale, and the more detailed sites-based scale is in Dr Page's programs and with his teams. We are complementary, but not overlapping

The CHAIR: We are not supposed to deal in hypotheticals, but were this Committee to recommend that the New South Wales Government enter into research or undertake further work, I assume from what you have said that it would not necessarily have to go overseas or anywhere else; it to could go to the CSIRO for assistance and that would be within your remit?

Mr W. MacDONALD: It is absolutely within our remit. We welcome being approached by the New South Wales Government.

The CHAIR: Thank you.

The Hon. PENNY SHARPE: Thanks very much. I am very interested in the work you are doing around aquifers. I am particularly interested in two things. Could you comment about the state of mapping of aquifers, particularly in New South Wales, and what would be needed to bring that up to scratch? We have received a lot of evidence that it is pretty patchy. The second question I am interested in is examples of aquifers that are in poor condition and what sort of technology and works you have been involved in around remediating those and how easy or difficult some of that is.

Dr PAGE: I have only been involved in probably two aquifer projects in New South Wales that I really feel can comment on, one being the City of Orange, where they have looked at augmentation to their urban water supply—

The Hon. PENNY SHARPE: We visited that.

Dr PAGE: —back in 2010 or so. The other one is we did some investigations in the Broken Hill area. That involved extensive mapping using aerial technology as well as a drilling program, but my part was confined to looking at the laboratory scale and looking at what managed aquifer recharge [MAR] might look like there. In terms of mapping, as I said before, of urban areas only Perth, Melbourne and Adelaide have been extensively mapped in terms of the urban water supply.

The Hon. PENNY SHARPE: Are you saying that you are not aware that Sydney has been properly mapped?

Dr PAGE: I do not think it has been properly mapped. They may not have the prospective aquifers and that might be the reason it has not been done, but that needs to be properly assessed. I have not been involved in any assessment there. I have heard rumours of schemes but I have not been involved. I have only been involved in those two. In terms of remediation of aquifers, you could look at both quantity and quality. A lot of our work has been looking at trying to balance the water budget. You can manage a water resource by trying to cap extractions but you can also manage it by increasing injections. It would be good to see a move towards a more holistic approach where, rather than trying to continually cap down, if a community or whoever was to look at an aquifer as a holistic unit, can you manage by both increasing injections and managing extractions? In terms of quality there is a whole heap of work being done by groups in Perth, looking at things

like contamination from hydrocarbons, exploration mining and that type of thing as well. I have been less involved in that sort of work personally.

The Hon. MICK VEITCH: As the Hon. Rick Colless said, managed aquifer recharge is an interesting area. Are there places where managed aquifer recharge or aquifer recharging has been used and it has failed? Where has it gone wrong?

The Hon. RICK COLLESS: Or would it be picked up before it got to a failure?

Dr PAGE: I guess it depends on what you call failure.

The Hon. PENNY SHARPE: Well, what levels of failure are there?

Dr PAGE: Economic success is one level—commercial success. I can give an example of one that I have been involved in where the aquifer simply clogged so we were no longer able to get water into the aquifer. This was for non-potable use. I do not know if you would call that a failure, but we were not able to meet our objectives in terms of recovering the water.

The Hon. RICK COLLESS: That might be a constraint that would eventually apply to all those systems anyway—is that a fair comment?

Dr PAGE: I guess managing clogging is a really important thing in aquifer recharge. That can be managed well by both having the right quality of water to match the sort of aquifer you have and also then regular maintenance of your well. That can be managed. Some of these systems in Europe have been going on for many, many years—decades and decades. I think the experience has shown—and certainly South Australia's has worked for the last 20 years—that they can be managed. They are not all economical. They are not all viable. They all need diligent work put into them to see if they are going to be feasible.

The Hon. MICK VEITCH: Is there an environmental impact that needs to be managed?

Dr PAGE: In the national guidelines that we developed, rather than taking the approach of saying everything has to be reverse osmosis treated, which would basically preclude many systems, we take the approach of having what we call an attenuation zone. For example, in South Australia if you are going to inject stormwater into a brackish aquifer—generally choose aquifers that are not already used for drinking water, because you do not want to put a system at risk that is already good quality when things can go wrong—we take a staged approach again where we inject and recover the water. We extensively test the water. But we recognise that there might be an attenuation zone in which the water would be different from the groundwater more generally. In the examples we use, there might be a 50-metre zone where you are injecting stormwater but beyond that area—if you were to extract after 50 metres and recover it—the water will—

The CHAIR: It changes characteristics.

Dr PAGE: Yes, it changes characteristics. The pathogens will have died off. The organic chemicals would have decayed. There might be some increase in things like salt and mixing, but again it needs to be managed and people have different thresholds depending on the use, whether it is for irrigation, toilets or drinking. In that case, sure the aquifer changes there. It is a balancing act, I suppose, between the cost of doing a project and the cost of drawing water from a river and the environmental cost of that. I guess in each case they need to be carefully examined.

The Hon. MICK VEITCH: One of the submissions—I think it is that of the witness appearing after you—talks about the Lake George aquifer—

Dr PAGE: I read that one.

The Hon. MICK VEITCH: —and the benefits of using that as a trial. Do you have any views about the merits or otherwise of that proposal?

Dr PAGE: I read the proposal but I must admit I skim read it. It talks about water banks and trusts in that. There has been a lot of work done in the United States on water banks and trusts, especially in California and places like that. They have been quite successful over there. They have not, to my knowledge, set one up in Australia in the same way. I think in an urban area that could certainly have a lot of merit. I cannot comment specifically on the hydrogeology of Lake George but it might be.

The Hon. MICK VEITCH: If there was anywhere in New South Wales where we could look at a larger-scale aquifer recharge scheme, are you aware of where that would be?

Dr PAGE: As I said, in New South Wales I have only been involved in two projects, one being the City of Orange and the other the Menindee Lakes-Broken Hill area. Certainly in the Menindee Lakes area in the

Broken Hill managed aquifer recharge scheme they identified between 2,000 and 4,200 gigalitres of suitable fresh water that could be used. There were 14 sites prospective for aquifer recharge at that time.

The CHAIR: Could you please clarify a point? On the Menindee Lakes research you did, who was your client?

Dr PAGE: We were subcontracted to Geoscience Australia. They did a broader study. All the Broken Hill MAR documentation is still on the website.

The CHAIR: Is Geoscience Australia a commercial operation of some sort?

Dr PAGE: No. They are a Federal entity.

The CHAIR: Federal Government. I am suspecting then that the New South Wales Government probably asked the Federal Government and the Federal Government then subcontracted you.

Dr PAGE: Geoscience Australia brought us into the project for our expertise in managed aquifer recharge.

The Hon. RICK COLLESS: Was that in the Talyawalka Creek recharge area, east of Menindee?

Dr PAGE: I would have to refer you to the actual specifics. I did fly up there, I admit, and had a quick look around, but the majority of my role was actually in the laboratory to see things like clogging, water quality interactions and the like. They rely on water from the Darling River, which was at the same time suffering from both a decrease in flow and quality problems associated with both salinity and algal blooms.

The CHAIR: I carry on from my earlier line of questioning. Mr MacDonald, could you give the Committee some idea of where we should look to get some marketing information or community information on the particular work that the CSIRO does in this area? Have you got any brochures or descriptors of what the program is?

Mr W. MacDONALD: The CSIRO website has quite a good window on the type of work that we do in water and also land related research, so I refer you there.

The CHAIR: Great. Thank you.

The Hon. MICK VEITCH: From a public policy perspective, do we need to map all of the aquifers in New South Wales or do we need to be a bit more strategic about that and look at a strategic process for mapping aquifers?

Dr PAGE: It is not really my place to comment on policy, of course, but I guess I would always recommend a more strategic approach rather than a general approach. That would depend on—

The Hon. MICK VEITCH: What is the cost? Is there a ballpark figure for mapping an aquifer?

Dr PAGE: I guess aquifers can range in size from things like the Great Artesian Basin down to little units. It would depend very much on things like the depth of the aquifer and how remote it is. We are working right now in northern Australia. Some of the largest costs are in things like logistics and moving people in and out of these areas to do things like drilling because some of these areas are so far away. The costs can be dominated by different things depending on where you are.

The CHAIR: You mentioned before, when you were discussing the Menindee Lakes issues that you used aerial mapping of some sort, or some sort of technology.

Dr PAGE: I am no expert, but I can give you a lay view.

The Hon. PENNY SHARPE: That is fine.

Dr PAGE: There is a plane. There is a magnetic rig under the plane and they run it over the landscape. From it they bounce waves up and down. They can tell the salinity and the quantity of the resource by mapping it at different depths. They have done that around the Menindee Lakes, where I have been involved. I know they have done mapping in Western Australia and other parts of Australia. It is not work that I have been personally involved with, or have a great knowledge of.

The CHAIR: What sort of organisation does that sort of work?

Dr PAGE: Parts of our organisation do it. Geoscience Australia does it. Private companies do it. A whole heap of different people do it.

The CHAIR: So there is quite a resource available to tap into if you wanted to have that work done.

Dr PAGE: Yes, you could certainly use a private supplier to look at it.

The Hon. MICK VEITCH: Looking at the costs and community benefits of aquifer recharge as opposed to building new storages or stormwater harvesting, has that work been done? Is there a model or process that you could follow to determine what would be a better way of storing or managing our water in the future?

Dr PAGE: We did some work with the Water Recycling Centre of Excellence based in Queensland recently to look at the cost-benefit of managed aquifer recharge. As with all economics some of the benefits can be really difficult to bring into an economic model. For example, in Alice Springs they wanted to look at aquifer recharge because the discharge was going to a swamp which was causing dengue fever outbreaks. It is a really difficult thing to bring into an economic model the avoided costs of having no dengue fever. If you just look at thing like pumping costs, and water in and out, it can be difficult to fully quantify the externalities.

That being said, there are many commercial operations that are viable and increasing. In South Australia, for example, stormwater re-use is very viable. Councils are expanding all of them in that area. In the City of Perth the Government with the water corporation has shown that this is their preferred option, moving forward, in terms of augmentation of their supply. Each site has its own characteristics. It is not as if you cannot put a container on a skid and just truck it over. It does need to be investigated. There are sites where it is not as prospective—where the aquifer is not as transmissive, for example. There might be cultural or other issues which would mean that it was not a prospect.

The Hon. PENNY SHARPE: Mr MacDonald, with all of the work that your program is doing, what are the two or three areas that you think would be of most interest in relation to looking into the future? The idea of this Committee is that we are looking into the future—the next 50 years. With respect to the work that is emerging from the science of your group can you give us a general overview of the two, three or five things that you think are promising?

Mr MacDONALD: When the millennium drought hit the south east of South Australia—I will not call it the Murray-Darling Basin because it was more than that—basically the rule book had to be thrown away. The way in which water sharing plans were constructed did not take into account the extremes that we were confronting. The research that we have done, which has supported policies and programs in Federal agencies—and to some degree State agencies, as well—is now taking into account those extremes of the future. I guess that is a re-setting of the way in which water resources are managed, and the risk profile.

The Hon. PENNY SHARPE: That is taking into account the modelling that says there will be more intense wet events, more frequently, and less, overall, in some areas. Is that right?

Mr MacDONALD: That is right. There will be an intensification of patterns that have previously existed. When it is wet it will be wetter. When it is dry it will be drier. That is one key thing that science, more broadly, has brought to water resource management in Australia over the last decade—a greater understanding of the envelope of possible futures. It is not giving the exact answer, I have to stress.

As we scale down and we need to get to the levels of individual systems at sub-catchment scale we rely on observations and models to try and represent the world as we understand it, because we cannot measure everywhere. But there are emerging technologies that help us prove, or better prove, whether our model characterisation of the way water resource systems—surface water and ground water—work, is valid. There has been the emergency of the use of noble gas environmental tracer measurements. That is one area which CSIRO has just built some cutting edge facility around.

The Hon. PENNY SHARPE: How does that work—in lay terms?

Mr MacDONALD: There are constituents that sit in water that can tell you the age mix in ground water. There is no single age—there is a mix depending on the source of ground waters. If you look at the periodic table the noble gases are neon, argon, krypton and helium, for example. So this technology looks at the mix of the signature of those natural elements in water. That can tell us something about the age mix of waters, which can then tell you the connection of those waters between aquifers and with the surface water systems. That gives us a greater degree of confidence—referring to a previous question—about the environmental consequences. If you know that two systems are connected you will be able to make a judgement about whether that is a risk that you are willing to take or not. Those are two really important things at very different scales but they give us a better handle on how to manage our systems.

The CHAIR: That sort of technology could be put into the mix of the general statement of mapping.

Mr MacDONALD: Yes.

The CHAIR: We now want to know where it is and how big it is, but we also want to know the characteristics of the water. We are developing the technology now to be able to determine those characteristics. Is that correct?

Mr MacDONALD: That is correct.

The Hon. PENNY SHARPE: What is the role of wetlands in aquifer recharge and remediation. Could either or both of you comment on that. We went out to Orange. I know you are very familiar with the Orange system. The health of wetlands is obviously very important. We know that there are lot of demands on the water that is there. As the Committee has seen, there is a lot of conjecture and disagreement about environmental flows and how they happen. Could you point us directly to the role of wetlands in relation to recharge and remediation.

Dr PAGE: My research interest is broadly natural treatment, which includes things like wetlands and aquifers, and even what happens if water sits in a lake. Quality changes over time. Most of my work has been done looking at artificial wetlands. I have not worked in a natural wetlands and I cannot really talk about that.

The Hon. PENNY SHARPE: You have not done Lake Burley Griffin, have you?—it was a joke.

Dr PAGE: I have. Many years ago I lived in Canberra.

The Hon. PENNY SHARPE: I am from Canberra; I am allowed to ask about that.

Dr PAGE: People can now tailor-build things like bio-filtration systems with different footprints, different types of communities of plants with different hydraulic properties to match managed aquifer recharge systems. The problem with stormwater harvesting is that the water comes really fast. You then have a bottleneck with a pump trying to get the water into the sub-surface. You need to capture it somewhere.

Mr SCOT MacDONALD: A surge sort of dam.

The Hon. PENNY SHARPE: Or a wetland.

Dr PAGE: Effectively. They used a wetland in this case.

The Hon. PENNY SHARPE: We have bio-swales—the tiny ones—already around Sydney.

Dr PAGE: These are huge ones—a gigalitre. They are off stream, you could say. The water rushes down and when it gets above a certain height these big basins will fill. It is on an airport—land that is not used for anything else. The water is then pumped through a series of basins. Certainly the quality is cleaned up dramatically. All the coke bottles, tennis balls and stuff comes out in the first basin, and the gravel and a lot of the grit sinks quickly. There is also what is called phytoremediation with the plants absorbing the nutrients. There is transformation of things like some of the pathogens, the ones that are most at home in your gut, all dying.

Typically, in that example, it might be seven to 10 days resident in a wetland prior to injection into the aquifer. That gives them the quality they need to manage things like clogging of the aquifer itself. Rather than using a mechanical process, such as filtration, they use the aquifers. That being said, places like the Adelaide Botanic Gardens have gone with a modern filtration system because they do not have the urban land available in the central business district to build a system. They are effective for things like suspended solids and nutrients, but they are not so effective for things like, say, organic contaminants like herbicides.

The CHAIR: Thank you for coming all this way to share your experience. Groundwater systems are a large part of what we will try to get to the bottom of. Mr Macdonald, thank you for providing information as to where we might go for advice, should the Government wish to take some advice. Obviously, we will have some questions on notice, because it is a highly technical area and we are just laypeople. We would like to have answers to our additional questions within 21 days of your receiving them. Would that be suitable?

Mr MacDONALD: Yes, that is fine.

(The witnesses withdrew)

Dr PETER RONALD MAIN, Private researcher, before the Committee via teleconference, affirmed and examined

The CHAIR: Would you like to provide some additional information to the Committee or make an opening statement?

Dr MAIN: Sure, I will make a brief opening statement. By background, I am a longstanding general practitioner in outer suburban Canberra and I have a longstanding research interest in information science, knowledge gaps or the transfer of knowledge. I am interested in aquifer recharge, which is part of your terms of reference. I included a few definitions in notes that I distributed to the Committee. I usually study by example and look at a topic as if it demonstrates something like knowledge gaps or different knowledge between different parts of society or disciplines. I drill down as much as I like until I find some things of interest and then I explore those to my heart's content.

That leads me to some conclusions about what knowledge is missing or has not made it across to practice. That is particularly what I am interested in, and that is what I have done with aquifer recharge. The document I sent to the Committee included some analysis of various sites through the Murray-Darling Basin region, which is a prime inter-systemic. I find it a fascinating topic, but I am glad I do not have to get across everything, as the Committee has to.

The CHAIR: Yes, it is unfortunate that we were not able to broadcast our previous witnesses from the CSIRO. One is the Groundwater Contamination and Remediation Technologies Group Leader—

Dr MAIN: I think Declan Page.

The CHAIR: That is the gentleman. The other was probably his boss, Mr Macdonald, Research Director of the Water Resource Management Program. They gave us information on the state of the nation, so to speak, in relation to aquifer transfer, aquifer recharge and aquifer use. It is valuable for us to hear from you after the previous witnesses. Do you have anything else you would like to add?

Dr MAIN: There might be. I am not a hydrologist but I have had an interest in geology for a long time. The principal perspective I can bring to the Committee is a perspective of information science or knowledge science. I have not included any of the stuff I might talk to my research advisers about, because I am sure you would find it dead boring. I think a good summation of our interests is that we tend to be drowning in information and starved of knowledge. I would define knowledge as information with understanding, and that is what I would really like to finish with before I take questions.

The CHAIR: Looking through your extensive submission, one of the things this Committee is trying to establish is whether we could get some support for the notion that issues surrounding water and a water future need to be considered beyond the normal electoral cycle. We as a nation or as a State should consider water issues and try to transfer that knowledge by exploring what water is all about. Do you have any ideas about how knowledge transfer can be converted to policy? Would you like to suggest how to structure a system of knowledge transfer and policy development to give it longevity—in other words, to span the vagaries of political changes every four years?

Dr MAIN: I think you have hit the nail on the head in terms of cooperation—whether we are going to cooperate as a nation or we are going to have different shows all over the place, and whether we are going to switch off after three years and have another election, another fight, and then we will get back to it and have another committee. It is a long-term problem, and I have some suggestions. The simplest approach is identified by one of Declan Page's colleagues who identified the problem with aquifer recharge as being perhaps not enough hands-on experience. Unless engineers, water operators and others get something to play with—more toys to play with in the sandpit—they are not going to get used to it. I think another insight for that is: When you start with small systems and you have a go at it and you do something wrong, it does not seem to be such a big disaster as if you are having a go with a big system.

That is the first thing I would say in terms of participatory education. The second thing would be an educational network of some sort that brings together the expertise and also the people on the ground doing stuff. The third thing would be to say that it needs to be ground up reform, not top down. Top down is fine, and I think that is what was attempted at Menindee—I call it a Rolls-Royce project of aquifer recharge, but we also need to have electric bicycles that are suited to everyone, and that includes at the farm level. It is about what is possible.

The other thing to say is I note that you have tended to refer to overseas experience, but we do have in my experience—or my findings, anyway—two examples. One is the Burdekin River in Queensland, and there is

one down south at the north end of Lake Alexandrina, the Angas Bremer aquifer recharge or ASR project. Both of those would have people who are very much used to dealing with the practical side of it, and they probably have lots to share with councils throughout New South Wales that might proceed with any aquifer recharge project. But as far as your insight into the long-term view, yes.

I would add the view, almost as a challenge to the Committee, that I could give you a mechanism about achieving the challenge, but there should be a consensus view about problems that we have struck with the Murray-Darling Basin Authority which I think relate to unwarranted expectation or unwarranted assumption that you can develop expertise to attend and master such a complex thing and such a complex system, which involves many different interests, within a short time frame. That time frame could variously be put as three years to 10 years, but I would estimate one to two generations, three, five to 50 years to acquire that and change those practices. I think you are spot-on with respect to looking for ways to progress in a long-term sense that is non-partisan. I am probably raving a bit, but you really have hit the nail on the head with respect to time frames.

The CHAIR: You mentioned the development of the knowledge base from the ground up rather than the top down. Scientists such as Dr Page are employed by the Government, and therefore work on what they are told to work on. People like you, who have an interest and therefore advocate certain interests at the grass roots level, are very rare. Some witnesses this morning have had a long-term—a couple of decades—interest as individuals and have formed a company to look at water future. The problem I see is this: If you start from the bottom up, there needs to be some sort of process whereby policymakers would agree that that this grey science, lay science or "ground up" approach could get to the bureaucratic level and then the policy level. Do you have any ideas as to how such "ground up" networking could gain credibility with bureaucrats and governments?

Dr MAIN: I have a few ideas. In terms of establishing a grassroots network, there is a motto in education: See one, do one, teach one. I think that that should be applied in this thematic domain and applied rapidly. What you then acquire, if you have a few pilots and processes working, you can start to shoot at. These days we can use the internet, particularly closed social media—also open if you want but I think there are other issues in that—and each pilot project demonstrates the strengths and weaknesses of what you are doing. The pilot project may succeed or fail—it may fail totally. If you want an example of how this sort of stuff works, I would direct you to the desalination tomato plant in South Australia, which is desalinated seawater using solar power. They ran a pilot project first, enough to get enough information to establish that they could make money, and then they expanded it. It is a good example of how you then build on a small pilot project.

The kind of project needs to be chosen, sometimes carefully, to demonstrate things that you are not certain of. I think the essence of the pilot project at Menindee was one of the key issues: There was nothing working there to get a guesstimate or estimate of what the long-term costs of the freshwater producers and the whole system were going to be, and if that had been implemented at an early stage, I think the outcome might have been different. But I do think that the way that you demonstrate to a bureaucracy or administrating political structure that there is potential for success, and how it might be advised, is by demonstrating in a small way that this is not rocket science and it is not imaginary; there are real benefits. In terms of the real benefits, there are scientists who know a lot more about it than you or I will ever know, but the benefits to my mind are the coordinated use of underground and aboveground water, particularly with respect to preparation for the next drought.

We should be transferring water from the service stores to underground before the next drought and, when the drought hits and we are a year or six months into it and realise we are in trouble, all of our aquifers are still full, reasonably desalinated and right to go for the next five- or 10-year drought. That drought immunisation is what I see in particular as of great benefit. Of course, there are other things too, particularly what goes with it, but as far as demonstrating and developing policy, I think that sound pilot projects which can be administered and invested in by local communities or local farmers are one way to harness that process. Does that answer that?

The CHAIR: Yes, it does. I will move onto the next question. I am not attempting to verbal you but I want to know your view on this process so that the Committee can make a recommendation to the Government. Can I assume that you are saying, firstly, that the best way to advance the knowledge transfer is by developing pilot projects; and secondly, that those projects must be accessible to a broad range of stakeholders, not just scientists or bureaucrats? Thirdly, and this is my great leap of logic: Perhaps one could argue that the best role that government could play would be to make sure that adequate resources were provided such that multiple trials or pilot programs could be started. Have I encapsulated that correctly?

Dr MAIN: The first two I would agree with and think are reasonable. With the third one, I am not sure about resources. My studies in the area indicate that the best thing a government could do at times is to assess a reasonable and rational framework, encourage this change at a pilot level and basically get out of the kitchen.

Delegation of authority to experiment tentatively within a small local context, together with a sufficient length of time for it to make sense as an investment for a farmer or whatever it might be—it might be an industry that uses water that must have water for drought supplies—that framework does not need to be the same everywhere but it needs to enable that sort of process. What you do not want is a person or group that wants to have a go at this and has 17 organisations to deal with first before they get to first base—in other words, we need some sort of process to cut the Gordian knot and get things rolling with a few of these systems.

The model that I advanced at Tamworth, which is when I released what the implications from the Menindee research were, was that there is a way of using the riverbed of rivers to remove or move water out from the riverbed using the riverbed as a filter, which effectively bypasses some of the costs involved in treating water. The issue of how you design your MAR system or aquifer recharge system is important for the potential costs because the agricultural cost has to be often low or you are not going to get any agriculture from it.

The Hon. MICK VEITCH: I want to explore further with you now your proposal for Lake George. Your submission contains interesting and broad-ranging information. You refer to the Lake George aquifer trust. Are you talking about the trust as in a governance model, and if so how do you envisage that to be established?

Dr MAIN: Lake George was the result of visiting the Turallo Creek farmers who were faced with a $1 million fine per week, I think, unless they pulled out their concrete low level weirs across the creek. They had an open day, which was advertised in the *Canberra Times*. I went out there and inspected the place and there are wombat burrows all over the place and there are frogs and the water is clean and it looks like a miracle restoration of a drain. The consequence of that, I thought about well, how would you change that because the Landcare people were there and pretty enthusiastic, and the concept of the local aquifer trust really arose from how do you coordinate or initiate grassroots activity to restore an aquifer which is damaged.

Of course, the aquifer under Lake George is chock a block full of salt and many of the aquifers south of Bungendore are also salt-affected. It does not have to be a trust. I do not really have any idea about whether it should be a trust or a council, but it should be some structure that brings together people at a community level, similar to Landcare. It might even be an offshoot from Landcare that mobilises people that are enthusiastic about fixing up the water that is underground, in addition to having clean rivers and streams. The concept of whether it should be a government or other one I think is open. In Lake George's case my perception of it is that there is not any community-driven desire for reform, as there is now in other parts of inland New South Wales, which has arisen from the changes from the Murray-Darling Basin Authority and the Murray-Darling Basin Plan.

But, at the same time I can see that Lake George has major potential for change. The one problem I have with change is if there is no competent or hydrologically competent governing body or governance or focus for the community, I do not think that would be a good foundation for it. I did note the other week a published project to build some houses on an old toxic dump site south of Bungendore, and that is the sort of thing that I would be very concerned about with respect to attitudes, but it may be possible to do that safely. The concept of what structure; if the New South Wales Government could establish a simple form that started things off, it might change to something else later on. It does not have to be called a trust, but the concept of a trust, the word "trust" comes in because it is something that does engender—you need to have a degree of trust in the process because the water is not easily seen and a lot of the effects from damaged aquifers are very long-term and very difficult to fix.

It is easy to contaminate an aquifer, but it is very hard to clean it up afterwards. I do not think I have a fixed view about that but I do think it is something that the Government could foster as an overarching authority and it would guide perhaps the development of that grassroots interest. Within that grassroots interest there should be a recognition that in the end economic use of the water is what is going to drive sensible aquifer reform, and that comes from a concept of what water is worth. Obviously water is the foundation for life but water affected by salt in an aquifer is worth exactly what it costs to remove the salt and that is too expensive to engage in many activities. Does that answer your question in part?

The Hon. MICK VEITCH: It does, in part. Thank you. Your submission contains quite a bit of detail about Lake George itself, its history and the damage to the aquifer. You have obviously drawn on some research and expertise.

Dr MAIN: Yes. Geoscience Australia—used to be the old Bureau of Mineral Resources—has as part of its development an online data base. They have got drilling records from bores, they have got a number of papers produced. It is a very good site and a comprehensive site, and you can explore that and then go through the stuff. I think, I have to remember, the central one was done in the seventies and eighties. They studied the type of sediment there. By the way, I did notice one of my errors, it is about four million years is the estimate from some of the geologists, not two million years. They are developing a fair bit of knowledge and at the

moment there is a lot of activity south of the lake. I know a group from the Australian National University are now cooperating with the gravel or sand companies and they are interested to see if they can recover a few fossils there, which will be good. Because there must be some somewhere, they just have not found them yet.

The Hon. MICK VEITCH: I drive past Lake George regularly and will look upon it now in a different light. What is the gap in the knowledge that we have to what we need?

Dr MAIN: In terms of Lake George?

The Hon. MICK VEITCH: Yes.

Dr MAIN: Lake George; it is potentially very simple in my view to clean up parts of the aquifer and start using it in different ways. One of the ways, of course, that has been looked at in the past is as a water storage or water reserve for Canberra, which of course is not going to come into the equation unless it is desalinated. I do not know whether you picked up but Lake George is isolated from the Murray-Darling Basin.

The Hon. MICK VEITCH: Yes.

Dr MAIN: There is not really any hydrological reason to have it under the umbrella of the MDBA. It could be done as a separate experiment zone where there must be some salt communication at the low level through the fractured rock aquifer at Geary's Gap. There exists the palaeochannel, which is a valley that has been buried by sediment, that goes from Geary's Gap down to Bungendore, and that is a natural channel to look at desalinating first if you wanted to do something about the lake. But the lake also has other issues. Obviously it is a splendid view when it is full of water.

The Hon. MICK VEITCH: Yes.

Dr MAIN: A lot of people graze beasts on it but Lake George would not be what I would call a well-developed hydrological or surface water zone. If you compare that area to Canberra—we have some magnificent lakes here. A lot of people think that is a waste of time. I would not agree with them. I think how you use water, we use water recreationally for fishing and swimming and stuff like that. Bungendore does not have anything much, and I think that is something that could be fixed, depending upon the way you wanted to go about it. But, it would be a major project. It is clearly something that you would bring in lots of different perspectives to, but I do not think it is impossible, I think it comes from understanding the way the lake works. The water basically shoots out onto the surface of the lake and then it evaporates as a playa lake and turns into salt eventually when it gets right down. It is a fascinating area, as you probably gathered, certainly a tourist attraction and it does not have much in the way of tourist facilities at this point.

The Hon. RICK COLLESS: Thank you for contributing via this somewhat difficult method of teleconferencing. My background is in agricultural science and from your background, as you describe in your submission, agricultural science is a good example of what an interdisciplinary science might be. I am interested in your comments about a computer-assisted bridge of gaps in knowledge. How could that be applied to assess the water augmentation programs that this Committee is looking at?

Dr MAIN: That is where I started on this study about 12 or 13 years ago. I started because of a medical topic, which I will not go into. It was clear that something had been missed somewhere along the line and had not migrated across the practice. As far as the methods you might use are concerned, at one stage I imagined that I could use all sorts of techniques. You could discard that and say the tools we use now for information science are married to a good understanding of how people learn, and how differently they learn, and link that to the concept of mentoring, which is good concept. It is what helps people to acquire what we call "implicit" knowledge. I will have to explain that.

Explicit knowledge is what you can write down and talk about; and implicit knowledge is what you acquire that you cannot readily write down, talk about or transfer. We tend to acquire implicit knowledge through experience. When we are doing something difficult or complex that we are experienced in, we would not know how to start explaining it. It is what our gut or instinct tells about the problem. That implicit knowledge can be transferred by networked groups of people. In my case, I adopted the simple expedient of case studies. I pick a topic that I think is interesting. I might have a patient and I will study them and there might be an aspect of their problem that I am not up to scratch on. I will then do some quick research or study on the latest and greatest knowledge gaps or practices on that topic.

I do not think there is anything esoteric that I can say about that other than that there are simple methods, such as social media and question and answer exercises. One technique I find useful is to ask people to define terminology. When I am talking to you about aquifer recharge, if I want to test you I ask you to describe in your words an aquifer recharge or an aquifer. My description would be that it is like an underground sponge or rock strata. When I do analysis of data or text, I do phrase, word and acronym analysis. I often find that a

topic is defined by a small number of concepts. If you get them right, you can broaden it out and find information that is relevant to the topic concerned. The "see one, do one, teach one" concept is important because often it brings home to a person the impact on their perspective on life.

I do not think you need anything more than the common or garden IT tools we all use. For instance, I explored the north end of Lake Alexandrina the other day. I noticed that the vegetation looked identical to some other areas with sand dunes, so I went for a drive using Google Maps. It was done in probably half an hour. I had enough information to say what the landscape was like. There were saline swamps and vegetation on the ridges. There are many tricks to doing it competently, and small group learning is one of the best techniques.

The Hon. RICK COLLESS: It is more a system of thinking rather than some easily acquired computer program, such as a CAD program for the design industry.

Dr MAIN: Yes. I might have started out with the delusion of being able to create that sort of program. These days I use the computer as a tool to help people to connect. Your Committee is a good demonstration of that. I have been impressed by the Committee's work. It has come to grips with a difficult and complex topic. I would probably do a few things to improve it to do with how you connect with different people. However, having a mentor is useful. By the sound of it, the Committee has connected a few mentors today. A year and a half ago, you would not have known that you needed to talk to those people to get that sort of insight. The tools can be simple, and that is probably more where I have ended up in my own studies. I use the simple tools, but while understanding the way that humans learn rather than using a CAD package. That does not mean you cannot use more complicated tools, but I do not need them.

The Hon. RICK COLLESS: Thank you. Congratulations on the rest of your submission about Lake George. I found that very interesting to read. I was particularly interested in the way you arrived at some of those outcomes.

The CHAIR: You have exhausted members' questions. Your submission is on our website as submission No. 13. It requires a bit of attention to understand it. I am not saying that it is difficult to read; it simply contains a great deal of information. The Committee has extensive resources available to it in the Parliament, including the secretariat and the committee directorate. In fact, they do all the work; members merely ask questions—hopefully intelligent questions. We also have the Parliamentary Library.

You have said some interesting things about knowledge transfer in your submission and in our brief telephone conversation. We will try to put them into practice soon to see whether we can wring out areas in the broader scale of what we should be looking at that we have not yet addressed. The Committee did resolve to extend the reporting date for the inquiry, simply because as we move through the process it seems that the requirement for knowledge, or the fact that we understand we do not have the knowledge, is increasing. I will not use the term "exponentially", but it is expanding at an increasing rate. At the end of the day, a standard process has been in place with regard to committees' recommendations to government probably for 30 or 40 years.

The Committee's understanding is that recommendations must be put cleverly enough and interestingly enough to encourage governments—not only the New South Wales Government—to take a serious look at where we need to go over the next 30 to 50 years. I have waxed lyrical, but I am trying to thank you for a most unusual submission, which asked the Committee to look not so much at the subject matter but at the ways we might ourselves increase our knowledge and, perhaps at the other end of the scale, ensure that the people we wish to influence can be influenced in a new way. Thank you very much for the work that you have done.

Dr MAIN: It is my pleasure. There is a simple strategy that is available to you that I think I floated in a background document. It relates to how I work. I appreciate that it is hard to read some of my stuff because my grammar is lousy. I apologise for that. My old English master would probably forgive me because I least I have a go. I try to download every document that I see online, because it may be gone the next week. There might be something in it that is embarrassing to someone or there might be a mistake. The way we deal with mistakes is important. I had a vigorous discussion with one of my draughters about whether we should leave the mistake with a note below it saying, "I am sorry but this is what I did. This is what it really is."

What you could consider doing is creating, if it is effective, a wiki of your own personal collection. There is a public domain program which, if you download your stuff and put it in headlines, so you have a part of your topic that you are exploring and you might have 10 different subdirectories, skips through it and gets the file names and whacks in a text file with HTML references. You create your own HTML references then and you can then scan it and use it as your own personal document resource. The reason that is important is simply because of speed. If you are exploring a topic again—you are going back and having a look—you could do it on your machine at the Parliament. No doubt you have better network service than I have. I often find I am halfway

through something and then it gets slowed up by too many people streaming videos, I reckon. You need to be able to check stuff very quickly.

I practice this myself. I put out a CD for patients at times which includes all the stuff that I have found for their particular condition, which might be a difficult condition—something like a pancreatic cancer which has a very poor prognosis. In that I might put comments in the head HTML file. It is very much a simplified approach to what Wikipedia does or what wikis do. The problem that I have with that is how you deal with copyright and distribution, but there is a ready strategy for that that I could offer you. Probably that is to recognise that when you are exploring a topic you are involved in your own personal research, and research should be fine. That is one aspect that I think you could do to perhaps look at changing the way that you do your committee work. By the way, it provides an incredibly valuable resource because your documents that you publish have, by implication, information about what the person knows about the topic at the time.

The CHAIR: It would be very interesting for us, as this process continues and we have put more and more online, other people's opinions—stakeholders' opinions, witnesses' opinions and expert opinions—if you are interested and have the time, for you to continue to look at what we are doing. If you see something that you could suggest to us at any time then please feel free to do so.

Dr MAIN: Thank you for the invitation. I probably will do that but I would not want to create too much eye rolling in the Committee. I have not dealt with the depth. With medicine we have concepts of the levels of diagnosis and how far you want to drill down. With these sorts of issues I drill down as far as I can go, often, if I have the time. With respect to what this particular Committee is doing, I believe you have some things that you could adapt from modern technologies, but a lot of it is to do with just building on the way that the Committee goes about its task.

Of course there are some committees that probably would not acquire a tick from my grandma with respect to courtesy and respect for other people's views, but I think by and large that is part of the game. The Committee that you are involved in is dealing with a matter that is essential to community health and wellbeing throughout inland Australia and certainly other places too. That sharing of perspectives that you can go back and re-check is an excellent resource for everyone. As I said, again, I am thankful that I have only chosen one small part of your topic. You still have to deal with a lot of other aspects of it.

The CHAIR: Yes. There is a long way to go yet. Thank you very much for joining us. We appreciate the work you have put into it, Dr Main.

Dr MAIN: My pleasure.

(The witness withdrew)

(Luncheon adjournment)

SCOTT FIDLER, Regional Manager, Queensland, Golder Associates, affirmed and examined

DOUG BROWN, Water Management Specialist and Hydrogeologist, Golder Associates (New Zealand), affirmed and examined

The CHAIR: Your company provided the Committee with some expert testimony. Unfortunately I was not available that day, so I apologise for that. I am glad you are here today to give us some expert evidence. Before we begin with questions from the Committee would either or both of you like to make an opening statement or give us some broad information?

Mr FIDLER: I will make a brief statement. We made a presentation previously—in February. I think the key elements from that presentation were that water storage is an important part of balancing the times of relative abundance of water with the relative deficits of water. So you need to be able to store it during times of abundance for use later. Storing it in aquifers is an option that provides the possibility of reducing losses to evaporation so it is an important tool that should be considered in the range of tools for water supply. This technique has been used in a variety of places. Various feasibility studies have been conducted to look at the possibility of it being used for augmenting water supply for agriculture, for example. I think one of the main points of our presentation was that moving to trials in the field to study the practical application—and, through that, learning more about the potential and scaling that up to full-scale schemes—would be the next step, rather than more studies.

The CHAIR: Rather than more studies. A previous witness—it was evidence given via telephone—indicated that trials or pilots were probably the best way to go now to get some hands-on experience. Thank you for endorsing that view. Mr Brown, do you have anything to add?

Mr BROWN: In my capacity as the water management leader in New Zealand, we are in the middle of a major trial of a new filtration of a managed aquifer recharge. In a previous capacity as a general manager of a mining company I was responsible for the implementation of a very large injection scheme—currently the largest injection scheme in the Southern Hemisphere. Both I guess are pilots/trials that have now moved towards operation.

The CHAIR: We would probably be interested to hear a bit more detail about the projects that you are working on in New Zealand. Broadly speaking, are you aware of the submissions that have been posted on our website? Have you been keeping track of that?

Mr FIDLER: Yes.

Mr BROWN: Yes.

The CHAIR: You will have seen the sorts of issues that people have been raising with us and the sorts of questions that we have been asking of witnesses. Particularly where witnesses are agriculturalists or producers, we have been asking them to provide personal or industry views on what potential there might be for their types of production were the water equation to be solved for them—that is, in terms of availability and cost. We had some witnesses this morning who are proponents of east-to-west diversion. From my knowledge of New Zealand, you have some very large water transfer systems between some of the big lakes. There are short, fast-flowing rivers with lots of volume, because of the nature of the country.

You are obviously aware, because of what you do, that in Australia we are going to face potential political problems in taking water from the coast across to the west. We are talking, here, about needs out to the middle or latter part of the century. Would either of you like to present some views about the concept of diverting easterly-flowing rivers in New South Wales to the west? If you have not done on any work on it, that is okay.

Mr FIDLER: I certainly have not done any work on that. The same issues may arise—that if you take water to a high evaporation environment and you are not using it immediately you will lose a large proportion of it.

The CHAIR: So your view would be that whatever science or engineering is used—there will be a solution at some time, somewhere—the solution will be an integrated solution that involves not only the source of water but also the storage of water without losing too much of it.

Mr FIDLER: That is correct. There are relatively large amounts of water diverted from rivers during times of high flow, as it is. There is obvious tension between the various beneficial uses of that water. A large

proportion of that is lost—35 per cent to 45 per cent are the estimates. So there is an existing source of water that is, perhaps, being used inefficiently. It would, in many ways, be similar if you were transferring water. It is good to have a source of water. A solution like managed aquifer recharge may provide that benefit of storing it where there are less losses.

The CHAIR: We heard this morning from the CSIRO that there are a number of case studies or pilots that have been constructed around this country—in South Australia and Western Australia and, I think, in the Burdekin. Can you provide us with any sort of guidance as to what further pilots—or types of pilots-would need to be undertaken here in New South Wales. Are there things that you would like to see proven up?

Mr FIDLER: An amount of work has been done by CSIRO and others looking at the economics of storing water in aquifers, with the primary objective of having more water available for agricultural production—not taking any more water but storing it in a way that more is available for greater use. You have to consider questions of how much of it will infiltrate under natural conditions or enhanced conditions, which obviously costs money, and the costs of building infrastructure and maintaining it over the long term, and how that compares to the economic value of increased agricultural production. So many assumptions are made in making those assessments. While they are all reasonable assumptions, doing it in the field and taking actual measurements of the behaviour is important for understanding questions like how to choose locations for these facilities—so doing geophysical testing or hydrogeological field testing to choose locations and then test how successful they are. Those sorts of things need to come next.

The CHAIR: Has Golder Associates done any exploration work? Are you aware of any sites in New South Wales to recommend further exploration work? We heard this morning that aquifers can be mapped using aerial techniques, which are then approved by putting holes in the ground. Obviously, there might be certain characteristics that would need to be looked at if you want to re-use water. To your knowledge, are there any sites in New South Wales where the Government should be persuaded to put some money into doing some trials?

Mr FIDLER: Studies have been done focused on the Namoi River, but we are not suggesting—

The CHAIR: There was a big Namoi water study.

Mr FIDLER: There have been feasibility or desktop-type studies done for that area. I am not aware that anything has been trialled there. Based on the work done by others, it is an obvious place to consider. Many of the western flowing rivers have alluvial aquifers and agricultural production. Many of the catchments down the western side of the divide could offer that potential.

The CHAIR: The CSIRO told us about the Salisbury re-injection system, where they are re-injecting down to 200 metres, which obviously means a fair degree of pressure, which means a fair degree of cost. Would I be wrong in saying that the types of systems that would perhaps offer the maximum number of options would be the more shallow aquifers, the alluvial aquifers?

Mr FIDLER: That is correct. The studies that have been done so far—yes, they are desktop—indicate that the economics of deep injection simply do not stack up for something like agricultural production. It depends on the value of what the water will be used for. Mr Brown has the experience of very different environment with deep injection.

Mr BROWN: Further to that, a number of techniques can be used for managed aquifer recharge. It is very clear that we can apply all sorts of different methodologies to investigate, but the key aspect is that you can do fairly straightforward pilot projects that are fairly small and scale them. There is not a requirement to go very large-scale to get the sorts of things that you need. Clearly, putting deep boreholes in the ground it is expensive, but to do trial infiltration or trial injection with shallow bores using existing infrastructure is quite feasible and also quite scalable.

Mr Fidler mentioned there been a lot of feasibility studies looking at a lot of unknowns—geology, chemistry, hydrology. When you actually do a pilot on-the-ground trial, all of those things come together and you learn what is really going to happen with your chemical mixing of waters. You learn what your aquifer is really like in terms of physical probability. You can study all of those things, but you need to run that trial and see how it changes over time to further teach understanding and then expand.

The CHAIR: Is the work you are doing in New Zealand based on the economics of agriculture peri-urban or urban?

Mr BROWN: It is about replenishing an aquifer and an agricultural area that has been depleted over time and also has contamination through nitrates from cows, basically. The beauty of the project in the Ashburton catchment is that it has brought together a group of stakeholders with a regional council to do a pilot

study. That pilot study is on infiltration, diverting water from one of the mountain run-offs into an infiltration pond through some quite clever filtration, and then measuring three boreholes what that does. The trial has been running for about 270 days, very successfully replenishing the local aquifer. There been some learnings about infiltration, the mechanism and the volumes. In addition we are finding that we are managing to reduce the nitrates in the water. So far as it stands, it is very successful. The project is currently moving towards more of an ownership from the catchment and expanding to the next stage. The current scheme is about 3 gigalitres per year and there is a belief that it can probably go up to 50 gigalitres per year. It is looking good at this stage. The most important thing is bringing community along with it through engagement, bringing science along with it through lots of monitoring and lots of analysis of data as it goes and very open data sharing. It is a good project.

The CHAIR: Is the New Zealand Government or local government authority doing the work?

Mr BROWN: It is the Canterbury Regional Council, ECan. Again, the strength has been a group of local landholders working together.

The CHAIR: I have been to Ashburton, so I know the area there is highly intensive agriculture. Is that correct?

Mr BROWN: Yes, it is.

The CHAIR: Dairies and that sort of thing?

Mr BROWN: Dairy farming, yes.

The CHAIR: So the pollution is from dairy farms?

Mr BROWN: Absolutely, yes, and it is recognised. This is seen as a really positive solution.

The CHAIR: Has much been published on that scheme so far?

Mr BROWN: There have been some interim publications, but the main publications will come out in the next three to six months. When the year-long trial has finished, there will be publications.

The CHAIR: We will try to get our hands on those publications.

The Hon. MICK VEITCH: I extend my appreciation for the thought-provoking briefing session you gave in February, which has informed a number of the questions we have been asking. It would be important for us to get on record the environmental enhancement as a result of the managed aquifer recharge [MAR] in New Zealand. At the briefing session we were told that springs and creeks started running again. Please advise the Committee of the environmental benefits.

Mr BROWN: Really there were three. One was the depleted aquifer to raise water levels, and that has occurred in the local area. We call it a cone of impression moving out into the aquifer. The second was to restart flow from coastal spring-fed streams, which are starting to flow again. The third aspect is really the water quality. The nitrate concentrations in the upper aquifer in particular were high and getting higher, and they have now started to go down through dilutions. It has been a success. It is a trial, so we are still learning and trying to separate natural recharge events—it has been quite a wet time—from the effects of the trial. So far it has been very positive and it is looking very good.

The Hon. MICK VEITCH: At the briefing session you tabled a number of documents. What lessons have you learned from the trial in New Zealand?

Mr BROWN: I think the first thing would be that the trial has been very important. There was a lot of nay-saying and a lot of doubt. The trial itself has been very important to illustrate and demonstration that you can do all the science you like, but you need to do it on the ground. That has allowed the stakeholders, who also know the ground very well, to see this in action and realise it is a solution to bring the community along with them doing that. The second one was that government engagement and support are very important to continue to support and be directly involved in the data analysis as well. It is not just a study in coming back; it has been ongoing analysis.

The idea that you can find solutions has not been as straightforward as that perhaps illustrates. There are complications in just finding the right piece of ground instrumental in boreholes and doing these things, but if you persevere with these things there is an outcome. This has been quite a long time in the making. I am fairly new to it, but it has been going on for a number of years and the trial is really only now starting to bear fruit, so it is a bit of a long-term play and patience is pretty important.

The Hon. MICK VEITCH: Were there any gaps in the data and research that had been conducted prior to the commencement of the trial? Once you started the trial, did you identify things that were missing and that you would have liked to have had before you started?

Mr BROWN: I think there is a lot of information on the complexity of the hydrogeology. It sounds quite simple—we are putting water into an aquifer—but that aquifer is quite variable and part of the process was to characterise the groundwater correctly. That is at multiple depths and also across an area. We have instrumented and put in a lot more monitoring points—a much better feel for the area—before we started the trial. Originally we would not have had the same fidelity of data and that has been very important. For instance, it would be quite easy to put the infiltration site on the wrong ground and then have a much lower rate of infiltration because it is not into gravels but it is into more silty gravels. It is very important to get that right. A lot of work went into establishing the optimal site and then instrumenting that correctly to get the background and then to look at what would happens when we put our scheme on top.

The CHAIR: I request clarification: You say it is critical to pick the right area for the infiltration area. Is there built infrastructure on that—in other words, have you built turkey nests to raise the head, and the water goes into that? Is that what you are talking about?

Mr BROWN: That is right, yes. It basically looks like a mini dam, really. The selection of the site was dominated by where we could bring the water in as well, so there were a number of factors. But, yes, it is about 200 metres by 100 metres banked storage, and then it is excavated to a certain depth, hoping to lay the gravel in that base.

The CHAIR: Is the water coming in from a particular river?

Mr BROWN: Yes, it is coming in through an existing scheme that comes off a river.

The CHAIR: Off the Rakaia or one further south?

Mr BROWN: I would have to check.

The CHAIR: That is all right. I am just trying to demonstrate my knowledge of the area.

Mr BROWN: You are doing well. You know how to pronounce it.

The Hon. MICK VEITCH: Can you explain what you mean by the variability of the aquifer? Is the aquifer like a wild horse in that it changes and is unpredictable in nature? Does it change season by season?

Mr BROWN: I guess I am really talking about the hydraulic properties of the aquifer. The term "aquifer" covers the whole unit, and in that particular case in Ashburton we are talking about glacial outwash sediments, and they have preferential streams through them of gravel and then offbank-type sediments. Clearly with infiltration, where you are looking at the vertical permeability to get water to go down, you are really looking for getting into these gravels and getting the water moving down. If you put the water onto a lower permeability, it just will not infiltrate. So the variability comes out of that particular environment being a highly variable braided historical stream system, so you need to get into the best part of it can.

Mr FIDLER: That would be the same for alluvial aquifers along floodplains and rivers in New South Wales—probably not as high energy and environment, probably not so much change, probably less gravel than you have there—but there is variation in the space. You asked about time; it does not change over time. Typically it would not change over time. It is just that in one location you have highly permeable materials, so the water can flow through it quickly—and in some areas you have silts and clays which impede the flow of water.

The Hon. MICK VEITCH: I think this question was asked in February, but is there a risk that you can overcharge the aquifer? What measures do you put in place to make sure you do not do that? Do you supercharge?

Mr FIDLER: The situation we have just been speaking about and one of the other things we have been focused on is infiltration at surface from infiltration basins, so there is a natural limit to how much you could put into that. It will rise to the surface.

Mr SCOT MacDONALD: The water table rises.

Mr FIDLER: There is a natural limit there. In that situation, you could not really supercharge it. Mr Brown might want to speak about injection.

Mr BROWN: It is not a situation where the water has to keep going in. It is almost like "Clunk! We can bypass the system." It is manageable; it is managed recharged. The point is, if you have an infiltration pond

and it is not infiltrating, you just do not add any more to it. That would not be something that just happens like that—you would have a chance to see why this might be occurring. With injection, because we are using boreholes, you generally see a fall-off in the borehole performance over time. You start to adapt to that, and you might have to do go back and clean out your bores and do things like that. Groundwater is generally quite forgiving. It is not instantaneous—bang, it is full and we are flooding the area—there are ways and means of monitoring, mitigating and managing these schemes.

The CHAIR: Which government departments in New Zealand are involved? Is it their equivalent of the Environment Protection Authority, Environment or someone involved in the project from a monitoring or licensing point of view?

Mr BROWN: I can only partially answer that. As I say, I am fairly new to the project. At this stage Environment Canterbury seems to be the top determinant of licensing. Saying that, there is great interest at the national level in the project, given the profile it is gaining, but in terms of licensing, as far as I am aware it is ECan that is busy looking after that.

The Hon. MICK VEITCH: Today we heard about issues arising from clogging. Is that a problem with the aquifer projects in New Zealand? If so, how do you manage or protect that?

Mr BROWN: Again, the reason we are doing this pilot study is exactly to ascertain whether clogging would be an issue. Clogging would occur when you maybe have an ingress of water with a higher sediment load and it leaves a little layer of lower permeability material on the base of your infiltration pond. The way that is managed in schemes elsewhere—and we have not had to do this in New Zealand—would be periodic maintenance where you empty your infiltration pond, go in and basically take out the material and scrape it. In large schemes in places like California it is just part and parcel of the operation to have pre-audit maintenance.

With boreholes, again the scheme that I have been involved with—a very large injection scheme with 100 injection bores—basically had 70 or 80 of those working at one time and the other 30 would be going through a process of being cleaned out. Your way of managing clogging is basically to over-design in the first place.

The Hon. RICK COLLESS: I find this discussion really interesting.

The Hon. MICK VEITCH: It is fascinating, isn't it?

The CHAIR: It is great stuff.

The Hon. RICK COLLESS: Before politics, my career was in the soil conservation service in New South Wales. In that time I built literally hundreds of farm dams around mainly the wheat belt, the grazing tableland areas of New South Wales. When we were building those dams, we were always trying to make sure that they did not inadvertently become—

The CHAIR: Filtration ponds.

The Hon. RICK COLLESS: —managed aquifer recharge infiltration zones, we might say. We were trying to do the exact reverse: We were trying to make sure they were sealed. I found your comments about how you would manage that by building a dam and making sure that it did leak, as we would say, into the groundwater zones very interesting. If you were looking at a particular potential managed aquifer recharge area, what are the key parameters that you look for first? Is it hydrogeological studies that you would do first to determine what is going on under the ground? Do you have to identify a need for it from the community perspective before you do that part of it? It could be a chicken and egg thing, because there is no point pursuing it if it is not going to work and there is no point initiating the hydrogeological processes if the community simply does not want or need it.

Mr BROWN: The third aspect is you have got to have a source of water or identified excess water somewhere in your cycle that is the water you are going to put into the ground. All three are probably equally important. I think the hydrology clearly has to be there, we are not going to change that, we are not going to do anything to try and enhance that. That has to be there and that can be done at feasibility level just by existing information. The source of water is an important one and that water quality also being compatible with groundwater. It sounds a strange thing but sometimes waters do not mix very well. I do not think that is an issue where you are, but some areas where I have done work with more saline waters and fresher waters, we have had mixing problems and a lot more clogging as a result. And the third one, to have the community to have the understanding of the area that you have to be in and what might be involved in terms of the footprint of the scheme as well is very important.

Mr FIDLER: I would agree with the importance of those three things. Perhaps the starting point would be the community need. Any infrastructure requires that need before you build, I would think.

The Hon. RICK COLLESS: The situation identified by Mr Veitch with overcharging or supercharging the aquifer, in parts of western New South Wales there are already substantial areas affected by dryland salinity with the water table coming to the surface. That would be something else you would need to take into account. As you say, it could be overcome by better management, getting the water out when it gets to a certain level and making use of it rather than allowing it build up.

Mr FIDLER: I think one of the things to consider when you talk about what sites would be suitable, it is not just the permeability of the material, it is how much storage is available. It depends on how deep down the existing water table is. If it is very close to the surface you have very little potential to store water. That is an important aspect, and certainly you do not want to be raising the water table too close to the surface. You have got to have that available storage there. And you do have to look at the potential future use of that water. If you are injecting fresh water or infiltrating fresh water into something that is already saline and then you are drawing it back, inevitably what you are drawing back will not be as fresh as what you put in, unless you are putting in a large surplus relative to what you take back out. But there may be some—and you have spoken to me about this, Doug—options where you have got some relevantly degraded aquifers where the water that is there on its own is not suitable for an end use but if you mixed that with some other water perhaps what you have through that blending—

The CHAIR: Could improve the water quality.

Mr BROWN: Yes. I keep going back to this, but the scenario you described of the water bubbling to the surface, again this is why we stage it and do a proper pilot and you actually understand if that is the case then there is clearly a very finite amount of storage and the scheme is perhaps not suitable and at a pilot scale, or even before then with the modelling, you would have a pretty good idea. I think the opposite is probably more the case, that the water goes in and it is gone and everyone, particularly engineers, will go, "Oh my God it's gone."

The Hon. RICK COLLESS: Which used to happen with dams, our dams would leak.

Mr BROWN: Where has it gone? And perhaps more of an issue might be then who has ownership of that water once it does move away. I take your point, we certainly do not want to have an increase in salinity. But it is very forgiving, groundwater. You would not commit to something that is irreversible, it is just turn it off and nothing is done again. It is probably more likely that you will be chasing where the groundwater has gone, where is this injection water tracking to and where is the mound actually heading to.

Mr FIDLER: Of course it is not gone forever.

Mr SCOT MacDONALD: Someone has it.

The Hon. RICK COLLESS: You mentioned the injection scheme, whereabouts was that and how much water were you injecting?

Mr BROWN: It is in the Pilbara region of Western Australia. The issue there was a mine that was mining a very large aquifer of low quality water and was not allowed to discharge it, so it had to put it back in the ground. The solution was to reinject it back into aquifers of similar quality. That started off in 2009 and the scale of it is about 140 gigalitres per year injection, which is about 3,000 litres or 4,000 litres per second. It is very, very large. To put that in context, the current trial of Ashburton, we are doing three gigalitres per year. So it is very, very large. The purpose of it really was to get rid of the water initially. Now with the mine moving into its middle life they are redrawing some of that water. It is very much managed aquifer recharge, it is put it in, store it, bring it back.

The third aspect is probably the nicest one. The injection bore field is such that they created a barrier between the mine and the environmental feature, which is the Fortescue Marsh. That has allowed them to mine 100 metres below the watertable and maintain water levels in a very sensitive wetland area. It won, won, won and it ended up winning the World Water Award for those three reasons.

The CHAIR: How long ago was that?

Mr BROWN: This is the Fortescue Metals Group Cloudbreak scheme.

The CHAIR: A very forward-thinking company.

Mr BROWN: Yes, and it was a necessity but by necessity what I would like to say is the mining company allowed a lot of us hydrologists and engineers to learn how to do this stuff. They wanted it to happen but we learnt how to do multiple bore injection.

The Hon. RICK COLLESS: What depth were you putting the water down to?

Mr BROWN: We were drawing it out from an aquifer, we draw it down to 100 metres but we put the water into an aquifer about 30 metres down and draw it up probably another 20. But the bores themselves were 100 metres deep through the water tables, and basically just a lot of ongoing monitoring and management.

The Hon. RICK COLLESS: Was it pumped in or under gravity?

Mr BROWN: It is pumped from the dewatering into storage and from the storage slightly pressurised into the bore. It is a very minor head just to keep it driving. A lot of learning about how to do that, it did not just happen overnight, a lot of false starts but in the end it is a scheme, if you like, that demonstrates the feasibility of large-scale aquifer reinjection.

The CHAIR: I am thinking now about turkey nests as big as Cubbie Station in the Northern Territory, they fill up with monsoonal rain then leak out the bottom into the Great Artesian Basin. Would that not be wonderful?

The Hon. RICK COLLESS: That probably happens already.

The CHAIR: You remind me of perhaps 10 years ago when I was conducting research into fish and game management models and I developed a good relationship with Fish and Game New Zealand. They were planning to sue dairy farmers over the quality of water in the lower rivers which was affecting trout and salmon fishing. Your comment that some of the spring creeks have begun to run again in the Ashburton region is interesting because those spring creeks are the spawning areas for the salmon. You will probably find that you have more friends in New Zealand than you know about. I will make a phone call or send an email in a few days to Bryce Johnson, the chief executive of Fish and Game New Zealand, and ask him whether he has had any involvement or knows about that.

As I said, they were planning to sue the Government—which they can do because they are a statutory authority, and that is one reason why governments do not like statutory authorities—over that very issue, the spoiling of a large water system because of the intensification of a highly productive industry. New Zealand in a lot of ways is streets ahead of Australia. In a paddock the size of this meeting room here it is cropping five times as much as what would happen in Australia, and getting away with it. That would be an interesting question for me to ask of them. With the evidence that has been given in the hearing and posted on the website, is there anything that has struck you that you would like to comment on? I do not mean to be necessarily critical but is there anything that you have seen where you think perhaps we should be asking more questions, any areas that you think we might have missed?

Mr FIDLER: I would not say so, no. Nothing springs to mind.

The CHAIR: I am sorry that I missed the first session from your company because I would have loved to have been there and I am glad that we were able to take into evidence the material that you supplied. Thank you very much for appearing today as witnesses. Your input is extremely valuable, given the large opportunity in this inquiry to look at things like aquifer storage long term. We are probably more like the Pilbara than New Zealand, evaporation levels in some of our western districts are extremely high. We appreciate you coming to talk to us. We might put some questions on notice. If we do we would like to have answers to those questions within 21 days of them being sent to you in writing, if that is okay with you.

Mr BROWN: Yes.

Mr FIDLER: Yes, that is okay.

(The witnesses withdrew)

The Committee adjourned at 14.39