# T R A N S C R I P T

# STANDING COMMITTEE ON THE ENVIRONMENT AND PLANNING

## Inquiry into unconventional gas in Victoria

Melbourne — 22 July 2015

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Dr Matthew Currell (affirmed), hydrogeology and environmental engineering, RMIT University.

**The CHAIR** — I welcome Dr Matthew Currell from RMIT University to the table. Matthew, if you could provide a short presentation, we will then ask questions.

**Visual presentation.**

**Dr CURRELL** — Firstly, by way of introduction I will say a little bit about my background. I am trained as a hydrogeologist. That is the study of groundwater systems. I have a PhD, which was awarded in 2010 from Monash University in this field, and for the past four or five years I have been lecturing at RMIT University in the School of Civil, Environmental and Chemical Engineering in the field of hydrogeology. I teach a number of courses in this field. I am also involved in some way in work that is being done currently within Victoria with DELWP, the department that gave a submission earlier, looking at characterising baseline conditions for groundwater in aquifers that may be future targets for onshore gas.

However, it should be clear that my submission that I have given to the committee and also any views that I express today are my own and are nothing to do with the department. They have commissioned me to do some work separately, but the findings of that work — —

**The CHAIR** — Is that in effect a declaration of a conflict of interest?

**Dr CURRELL** — Not so much.

**The CHAIR** — Quite appropriately; I am not giving that it is inappropriate.

**Dr CURRELL** — It is just that it should be noted that in relation to the work I have done for the department, it is at their discretion to release that work, rather than mine.

Basically, my perspective on unconventional gas is one of looking at the impacts, particularly on groundwater, as that is the field in which I have some expertise. I think it is probably a really good idea for this committee and also more generally the public debate at the moment to be looking carefully around the world at what is happening in terms of unconventional gas and what is happening in terms of the science that is looking at this issue of its impacts on groundwater.

I think the USA is probably the best place to be looking at the moment in terms of working out what these impacts are and how extensive they might be and providing some kind of test case or context for Victoria. In the US, just for the committee and for the audience, there has been quite a rapid growth in the unconventional gas industry in the US in the past 10 years or so.

**The CHAIR** — Absolutely.

**Dr CURRELL** — Between about 20 and 30 per cent of all gas in the US comes from unconventional sources, and the recent report that was put out by the US EPA — it was just last month, which is this report here — was commissioned by the government. It is a five-year study to look at the impacts of unconventional gas on drinking water in the US. In their most recent estimate they think that there are about 10 million Americans who live within a kilometre of a shale gas well in the US now.

**The CHAIR** — Ten million?

**Dr CURRELL** — Ten million, yes. There are certainly well in excess of 100 000 shale gas wells around the country, so that is a really good place for everyone to have a look at what are the impacts of shale gas on water resources, particularly drinking water aquifers.

In Australia the industry is smaller. As we have heard from the previous presenters, in Queensland — that is the area where coal seam gas is most developed around the country — there are about 7000 active CSG wells in Queensland at the moment and a much smaller number in New South Wales. Again, just for context, that is quite a small number compared to what we see in the US at the moment in terms of shale gas.

In terms of the risks to water and environment from unconventional gas, this is something I have reviewed quite extensively and detailed in my submission to the committee. But I can really break it down to three major risks. The first one is the risk of increasing the release of methane into overlying aquifers or even the overlying atmosphere above an unconventional gas deposit. In the literature that is always called ‘fugitive methane’, and it just means methane that is trapped underground either by rock or under pressure of water, becomes mobile and can travel upwards into other aquifers and start affecting people’s bores. People who have their existing bores within those aquifers will start to get more methane coming out of their wells. That can produce problems. Obviously, there is also an issue if that methane makes it to the surface, as it is a very potent greenhouse gas.

The second impact is risk of contamination of groundwater or surface water, equally, due to spills or releases of wastewater that are associated with unconventional gas. All forms of unconventional gas, be it coal seam gas, shale gas or tight gas, produce wastewater. In the case of coal seam gas the wastewater needs to be produced. They call it production water or produced water. That is water that needs to be removed from within the coal seam in order to depressurise that seam and allow the gas to flow to the surface. All coal seam gas wells produce quite high volumes of produced water.

For shale gas and tight gas the wastewater is predominantly the water that is used in the fracking process. When an aquifer or a formation is fracked water needs to be sent down wells under pressure, and then, as we heard earlier from Professor Cook, a lot of that water comes back up to the surface and needs to be treated at the wellhead. I think this is potentially, and the US EPA report probably agrees with this, the biggest, at present, current risk associated with unconventional gas — how that water is managed, how it is handled on site, where it goes, whether it is treated and the waste associated with that treatment. This is a significant issue, and, as I have pointed out in my submission, the EPA report from the US does indicate that somewhere between about 1 and 10 per cent of all shale gas wells, based on the stats that they have, have been the site of at least one sort of spill of this wastewater. There definitely are impacts from this which have happened, so upscaling with the number of wells that we have in the US we are probably talking about hundreds to thousands of pollution incidents at the surface from the management of this wastewater.

It is also true that it is an issue in Queensland and New South Wales associated with CSG. In a lot of the early coal seam gas developments that occurred up there this wastewater was treated as something that you just stored on site in an open dam, and there were cases where this water has then spilled or leaked into groundwater or surface water streams and created a pollution incident. This is the big issue.

People have been using the word ‘risk’ a lot in these hearings today. They are not just risks, they are impacts, and I would encourage you all to have a look at the EPA report. All of these things have happened, they have been demonstrated and there is scientific evidence showing that these things have occurred in areas of shale gas. Where the EPA’s report is also very valuable is in providing the context. Are these sorts of incidents things that happen at every shale gas well? No, absolutely not, but you should be aware that if you are going to have a lot of shale gas wells in an area, it is almost impossible to say that there will not be an impact because there will always be a percentage of wells where something goes wrong and you get either a spill of wastewater or some kind of well that does not function properly and creates a fugitive methane problem.

The third risk — and this was discussed earlier, I think, by the VFF — is this issue of potentially increasing the connection between aquifers. That could cause increased cross-flow of water, including, in some cases, contaminants between aquifers, so obviously the concern is that by increasing cross-contamination or cross-flow between aquifers existing water users may be impacted by contaminants by that mechanism. In the EPA’s work and also in the rest of the international literature, this mechanism, where you actually get water in large amounts crossing between different aquifers, there is not much evidence that it has actually happened in areas of unconventional gas to a great degree. That may be because groundwater systems typically respond pretty slowly and groundwater flow rates even at the best of times under natural conditions are quite slow, so it may be that there are going to be some delayed-onset impacts that we are yet to see.

It may also be, though, that some of the modelling associated with shale gas indicates that you need special geological circumstances to really have a lot of cross-flow starting to happen in these aquifers, and you are not always going to have those situations, so understanding the geology of an area is pretty important for working out whether this, in the long term, is going to be a risk.

This next slide is another visual representation of what happens underground when we have unconventional gas here. A point that probably has not quite been given air today in the hearing is the nature of drilling for unconventional gas. It is not just your standard vertical drilling; it is also directional, horizontal drilling, so this is what a horizontal drill pad might look like under the surface there. So you can see that if a shale formation is in close proximity to a drinking water aquifer and there are less low-permeability formations in between the gas reservoir and the drinking water aquifer, you obviously increase the risk of things like fugitive methane and connectivity between the aquifers. I think I have covered, in what I have said now, these major impacts that can occur from unconventional gas on groundwater.

I think a lesson to be learned from the US is that shale gas development probably did move a little bit quicker than the science. Clearly there was a lot of drilling of wells happening in the US well before there was science to work out what the impacts are and how widespread they are, and there was a long period of catch-up. People started noticing impacts probably pre-2010; there were some high-profile films that came out and a lot of community concern about impacts, and clearly there was not a lot of science done at that time to inform what was going on. That provides us with a pretty good opportunity in Victoria, because we have taken a relatively conservative approach so far and we can look at science that has come from the US and other places around the world and make good decisions.

This is another interesting study that I would encourage the committee to have a bit of a look at. Among some of the figures produced in this study, they flag a particular issue — that is, the issue of well integrity and how important it is to have a very, very good inventory of all types of wells that are anywhere near an unconventional gas operation, because predominately in the cases where we have leakage of methane, it is a problem associated with abandoned wells or poorly constructed wells that act as conduits. In this paper by Jackson and colleagues, they indicate that there is a quite a high percentage of wells out there that just sort of get abandoned, particularly in areas of intensive oil, gas or even water boring, so unless you have a really good handle on every one of these wells, they potentially are a risk of creating that conduit for fugitive methane for quite a long time to come.

I have said in my submission that a critical issue is whether, in an area where you potentially have hundreds or thousands of wells, you can keep tabs on every one of those wells for a long enough period and make sure that they are sealed and the integrity is good to prevent future problems with fugitive methane cross-contaminating aquifers.

Here are just some of the very high profile studies coming out of the US which have documented methane contaminating drinking water. As I just mentioned, in most cases these studies have shown that really it is a case of badly cemented wells or old wells that people did not keep track of that have then acted as conduits for methane, and it has meant that people living close to shale gas operations have suddenly got increases in methane in their water.

These are another couple of papers here which are important studies looking at those surface contamination impacts. As I mentioned, I think this is a very big issue that often gets overlooked. It is just a simple case that shale gas wells — all unconventional gas wells — produce pollution, wastewater, and because of that, particularly in an area where you might have lots of wells, there are incidents that occur with that wastewater, and so that is the most direct and simple and probably most common form of contamination that affects groundwater and surface water in areas of unconventional gas.

That is all I have. I am happy to take questions.

**The CHAIR** — Thank you, Matthew. I think that was most enlightening and helpful, and I am sure the secretariat will want to be talking to you through some of this process as we go forward. I have a couple of questions. You mentioned three areas of particular concern: fugitive methane; spills and wastewater; and cross-contamination between aquifers. In terms of cross-contamination you said, I think, in effect, that there is no evidence of that at this point. There may or may not be in the future, but certainly in Australia there is no evidence of that particularly occurring to date.

**Dr CURRELL** — To my knowledge that is, yes.

**The CHAIR** — Secondly, in terms of fugitive methane, again you were not pointing to a particular problem in Australia at this point, but you were pointing more to the United States, where this is a greater problem. Then thirdly, on spills and wastewater of various types, you were indicating — and I am paraphrasing here — that there have been such spills in New South Wales and Queensland and that some of this can perhaps be attributed to the early phase in both of those states, but I would be interested in, in a second, your view on the regulatory regime that is in place now in those states with respect to spills and contamination, whether that is a good regime, an adequate regime, or whether there are things if we were to be supportive in some way of this area that we would be willing to look at there.

**Dr CURRELL** — I think that the most important piece of work that has been done on this is the report prepared for the New South Wales chief scientist and engineer here, that was Professor Stuart Khan, which documented a number of spill incidents that happened in New South Wales. I think that, yes, there have been changes to the way coal seam gas wastewater is regulated in these areas in response to these sorts of contamination incidents — —

**The CHAIR** — Learnings.

**Dr CURRELL** — Perhaps some learnings, yes. I am still not sure that things are ideal. I think that this wastewater is something that people just sort of tend to think that there is going to be a nice silver bullet. 'We'll build a treatment plant. We'll treat the water. We'll sell it to people. It's not going to be a problem'. My issue is that the full life-cycle is not considered when gas projects are approved, so in many cases coal seam gas wells start producing this wastewater and then after the fact there is a period where the company then has to work out what to do with this water and things are not fully spelled out from the very beginning as to where all that water is going to go. It has to go somewhere. If it is a large volume and it is poor quality water, that is a significant issue, and there have been incidents in New South Wales where recently a gas company tried to shop this wastewater around, find a utility willing to take it and treat it and had real trouble actually getting a solution to what to do with this waste.

**The CHAIR** — Perhaps in that context — not necessarily now — any further light you could shed on best practice regulation there, whether it be in the States or New South Wales or Queensland, we would certainly be interested to see.

**Dr CURRELL** — Sure. One really important point on that would be the importance of our Environment Protection Authority, the EPA, which regulates waste and pollution incidents. Recently in New South Wales there has been some progress made based on really close cooperation between the New South Wales EPA and the Office of Water, and the Department of Primary Industries. There has been a lot of work together by those agencies to tackle this issue.

**The CHAIR** — Finally, you talked about unconventional — with fracking and hydraulic fluids and so forth — would you be interested to make some comment on onshore gas that does not involve material going down, but involves lifting conventional gases that were from onshore.

**Dr CURRELL** — Yes. I believe there are some somewhat conventional reserves of gas in the Otways that have been extracted from previously around Port Campbell, the gas field down there. I am not sure that there is much else in the way of conventional gas reserves in Victoria. Coal seam gas is, as I said, a type of gas extraction that does not always involve hydraulic fracturing — —

**The CHAIR** — That was my next point. I am starting at one end of the equation, and my next point was to move to seam gas that does not require treatment, if I can pick a phrase.

**Dr CURRELL** — When you are taking water out of a coal seam to depressurise it and get gas flow, basically what you are doing is just taking that formation water straight off the well to the surface and you have to take enough of that water out until the gas starts flowing from the well. The problem with that is that water that is naturally occurring in coal seams is usually pretty awful quality stuff. It is salty, and it is containing all sorts of heavy metals, potentially radionuclides. The water that sits for thousands of years in contact with coal generally is pretty poor quality water, and so that is the type of water that is brought to the surface in coal seam gas operations.

**The CHAIR** — It would depend on the specifics.

**Dr CURRELL** — It would, yes, but typically water from a coal seam is not fit to just go straight onto a farm or to be used, so that is what creates a lot of the issue — I think in the northern states — with what to do with that water.

**Ms SHING** — Thank you very much, Matthew. That has been really informative, particularly in relation to the drilling down, I suppose — to excuse the pun — into the very granular level of information and technical detail that is needed for the purpose of satisfying these terms of reference.

I would like to ask about your views on the declaration of a number of specific areas and sensitive areas within New South Wales, which has occasioned a buyback by the government following the consequences that occurred after the initial granting of licences whereby the Gloucester coal seam operation ended up selling licenses back again.

In terms of what might be determined to be a sensitive area, I would be interested in a hydrogeological take on that as far as what the risks might be, how they might be identified and how best to prevent any sort of contamination in those circumstances. The reason that I am asking this is because I, along with another member of this committee, Melina, am situated in Gippsland and we have some very high stakes at play here in the context of our local environments as well — so just understanding what a sensitive area might mean from a hydrogeological perspective and how best to manage that and manage foreseeable risk.

**Overheads shown.**

**Dr CURRELL** — Yes. So hydrogeologically, a sensitive area would be one where there are existing high-quality groundwater resources and particularly areas where those groundwater resources are depended on by other people. When I showed that little graphic of a layer cake of the earth, if you had a very valuable water resource in close proximity to a shale formation that a gas company wanted to explore for, I would flag that as a high-risk activity. Clearly the protocols around assessing risk and the assessment of whether that is a good activity to do are probably much more serious. So yes, in relation to areas of Gippsland where there are high-quality water bodies which directly overlie target rocks for gas, that is a decision that needs to weigh heavily, because, yes, the risk to the hydrogeological system is greater with greater proximity to the gas deposit.

**Ms SHING** — I understand that topography is of itself very unique and it needs to be assessed on a case-by-case basis, but do you have any views on proximity to aquifers or to useful water quantities in the context of distance from wells and whether there is a rule of thumb based on international or domestic experience?

**Dr CURRELL** — There is some guidance from the US on this. In terms of the depths at which you can have a gas reserve and exploit that gas reserve within proximity to a drinking water aquifer, some states actually mandate that there needs to be separation distance of a certain number of hundred metres. It probably varies state by state. There is no national regulation in the US for that, but some states deem that it is worth having a buffer distance if there is a drinking water aquifer, for example.

**Ms SHING** — If you do have any further information on that particular issue, and we are not holding you to that, but that sort of context would be useful, particularly in what we are looking at as far as certain parts of Victoria are concerned. Thank you very much.

**Dr CURRELL** — Sure.

**Mr DALLA-RIVA** — I was actually fortunate enough to be in the US when New York State banned fracking. There was much widespread support for that. You mentioned about the fact that flowback can occur even if you do not frack. Is that right? Is that part of the process? You need to frack to get the flowback?

**Dr CURRELL** — Yes, flowback is definitely associated with fracking. That is when you put stuff down a well and then that is recovered back to the surface.

**Mr DALLA-RIVA** — The other one then — produced water — is that the same?

**Dr CURRELL** — That is different. As I was just explaining with coal seam gas, produced water is something that you need to remove from the formation — —

**Mr DALLA-RIVA** — To allow the cap to come off.

**Dr CURRELL** — To allow the gas to come on.

**Mr DALLA-RIVA** — That is the water that you are saying has all the heavy metals?

**Dr CURRELL** — Yes.

**Mr DALLA-RIVA** — You have got radionuclides, radium, barium, uranium, thorium. Are they the types of heavy metals?

**Dr CURRELL** — Depending what is in the coal seam, yes, that is right.

**Mr DALLA-RIVA** — The reason I am asking that is that you mentioned about the US gas reserves and the unconventional gas reserves. What is your view — this is obviously an opinion, so you may need to take this on notice — about undertaking coal seam gas in areas where there is another high-value industry? That other high-value industry might be, for example in our case, the dairy industry. What is your view about undertaking that type of activity — coal seam gas activity — adjacent to high-value dairy industries that are already in existence? Obviously we are just taking your opinion. Perhaps if you want to qualify it, you can.

**Dr CURRELL** — That is a complicated question.

**Mr DALLA-RIVA** — I realise that.

**Dr CURRELL** — The factors at play are many. One of those factors is: from the hydrogeological perspective, could you impact that water resource that the dairy operation uses? From my point of view, a very, very careful and rigorous assessment would need to be made to project what might be the impact on that water resource. If it were deemed that the coexistence of the new industry — coal seam gas — with the dairy farming would compromise the dairy farming, then obviously there would need to be some sort of resolution, negotiation, decision by the regulator.

**Mr DALLA-RIVA** — Following that, the potential risks to groundwater, and you have listed them out there — again, I am asking the same question in a different way. I am trying to get some clarity. We have heard evidence that 'Coal seam gas is fine. We will just proceed with it' and equally, 'We do not want coal seam gas because it is the worst thing in the world'. We respect both views. I am trying to get to the factual view about if we were to place at risk another important industry, are you saying that based on what the evidence is from overseas and based on what has occurred already in New South Wales, there would be sufficient doubt to allow coal seam gas until such time as we are certain that there are enough protections to protect another industry that has already been established?

**Dr CURRELL** — As someone whose job it is to think about groundwater and understand it and think about ways to protect it, I think that a conservative approach is warranted. I think there is plenty of science that can still be done here in Victoria. I think the VFF's proposition of a five-year extension on the moratorium is reasonable. I think it would take time before we could really make a well-informed and good assessment of that issue you are talking about exactly, of whether an industry like dairy and coal seam gas can — —

**Mr DALLA-RIVA** — What about exploratory areas that are far removed from the dairy industry? Do they still possess the same risks?

**Dr CURRELL** — I guess from the technical point of view the things that can happen can happen in any area. Proximity is a big issue, though. If you are close to a high-value resource or a high-value industry, the risk is greater. Your level of care and the conservativeness of your approach needs to be commensurate with that proximity.

**Mr DALLA-RIVA** — One other what-if question: if we went down a certain path and there was contamination that occurred, be it through processes that were not followed or an accident or whatever —

**The CHAIR** — Or regulation.

**Mr DALLA-RIVA** — or regulation — and I am not a farmer; I like milk and everything else — what would be an example of some of these contaminants? What is an example that could occur to a cow producing milk? It may be out of your area of expertise, but from your understanding what are these contaminants, what is the adverse risk and how long does it stay in the system before it is out of the system?

**Dr CURRELL** — It is a really good question. As I mentioned before, people are often surprised by the slowness of groundwater systems — how slow the flow rates actually are.

**Mr DALLA-RIVA** — What is it?

**Dr CURRELL** — So if we are talking about a big regional aquifer system, it can take thousands of years for water to go from one end of the basin to the other end, sometimes tens of thousands of years. When you contaminate an aquifer, it is not a simple matter of just, 'Let's go and clean it up'. It takes time, and it takes effort. The aquifer can be slow to respond to the treatment, and you can have residual contamination effects. I always think that a conservative approach is warranted with groundwater, because it is very hard to monitor everything that is going on below the subsurface, even though we have good tools and good knowledge now. But there is also that fact that they are slow to respond, so if you contaminate them, they are also slow to respond to any treatment or remediation.

**Ms HARTLAND** — If I can follow on from there, I think you have outlined what the problems are in dealing with a damaged aquifer, but as I understand it, this is a relatively young industry — 10 or 15 years — so how long do you think it will be before we actually see the true damage in relation to abandoned wells or wells that have not been monitored or have not been remediated?

**Dr CURRELL** — That is another really good question. The US EPA has spent five years collecting evidence. A lot of it is self-reporting, so gas companies in some states have been better than others at providing information. Monitoring networks in some states can cover and actually detect impacts better than others, so I think we are still at an early stage of understanding the full impacts and an early stage of those impacts manifesting. I am glad you raised the issue of the legacy wells and the abandoned wells, because when we are talking about thousands of wells, it is difficult to ensure the integrity of all those wells for a long enough period to say that in the future there is not going to be some methane cross-contaminating an aquifer. This is something that requires pretty careful consideration.

**Ms HARTLAND** — We heard from the department this morning that in fact self-monitoring is the way issues are dealt with currently. With wells that have been finished or abandoned, what kind of regulatory regime would you suggest we need to make sure that damage is not occurring or that we can monitor the damage and make sure it does not happen in the next location?

**Dr CURRELL** — I am an academic, not a regulator, but I know that in Victoria we have a system for licensing the construction of bores through the rural water corporations, and so there are minimum construction standards and supervision of drilling. We have some good regulation of drilling in Victoria. In terms of the ongoing monitoring of the condition of those wells and whether they may be sources of potential issues in the future, I am not 100 per cent sure how that works and how extensive the checking and monitoring programs are.

**Ms HARTLAND** — We have been told that it is actually a self-monitoring system, so I suppose what I am looking for is what would be best. I am always extremely nervous about self-monitoring. I do not think companies should be allowed to self-monitor. What kind of regulations or monitoring do you think we should be considering to make sure that these systems are safe?

**Dr CURRELL** — I think the regulators should be well resourced, and I think they should be given the powers they need to make sure that wells are staying in good condition over the long term. I think maybe the policy probably is there, but whether the resources and manpower are all there, I am not sure.

**Ms HARTLAND** — I found your presentation enormously helpful, especially your diagram. That really explained it well. It is probably one of the best diagrams I have seen during these hearings, so thank you.

**Dr CURRELL** — Thanks. I did not draw it; I took it from a study that — —

**Ms HARTLAND** — It was extremely helpful.

**Ms BATH** — Would it be possible, Matthew, for us to have a copy of that presentation?

**Dr CURRELL** — Sure.

**Ms BATH** — I just thought that quite well encapsulated the issues. Just for clarity, when you are talking about the fugitive gas or the methane gas released as a result of initial exploration, that is not a new phenomenon. It is my understanding that it is not just a phenomenon of well digging or drilling; it has occurred over time. Is that something that is a fair statement — that it may well have, by natural occurrences, wafted up through the ground over thousands of years?

**Dr CURRELL** — Methane is held underground under pressure. That can either be the pressure from geological formations or it could be the pressure of water, so there is an important point to be made here: if water is being extracted from aquifers that contain gas deposits or overlying gas deposits, that potentially does create a new pathway for that methane to start moving through the system. Generally because conventional extraction of groundwater is obviously not as intrusive within the gas deposit itself, it is probably less of a cause of fugitive methane migration, but that is not to say that you do not have some natural fugitive methane migration.

**Ms BATH** — But it is probably just a historical thing as well. I have heard people say that it existed in a light context or a small context before. I guess my question would still be around the treatment of water. If, if and if we went on, the tight and shale gas, removal of that water, could you give us a short — and I know you have had a conversation around this before — idea of what could be done to treat that?

**Dr CURRELL** — The normal go-to method for the treatment of unconventional gas wastewater: for shale gas, it is water that is prepared at the wellhead, fracked in the aquifer and comes back to the wellhead. That water needs treatment. The typical method is to use a reverse osmosis treatment plant equipped with membranes to try to filter out all of the contaminants that might be in the water. Then often there is an attempt to find a buyer — somebody who wants to use the water — or some kind of disposal option that is acceptable to the EPA. Through that whole process of producing that water, then needing to treat it and then needing to find a place for it to end up, there are technical and also, I guess, policy challenges in closing that cycle and making sure that you do not have excess wastewater that has nowhere to go.

**Ms BATH** — Thank you, Matthew.

**Dr CURRELL** — No problem.

**Mr DAVIS** — Thank you. I do think it was a very helpful presentation. Thank you for making it available. No doubt the secretariat will be in contact through the next period.

**Dr CURRELL** — Great. Thanks, Chair, and thanks, committee.

**Witness withdrew.**