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INDEPENDENT PLANNING COMMISSION

MEETING WITH COAL FREE SOUTHERN HIGHLANDS

RE: HUME COAL PROJECT AND BERRIMA RAIL PROJECT

PANEL:	**PROF CHRIS FELL** **GEORGE GATES** **ANNELISE TUOR** **GEOFF SHARROCK**
ASSISTING PANEL:	**DAVID KOPPERS** **BRAD JAMES**
COAL FREE SOUTHERN HIGHLANDS:	**ALAN LINDSAY** **LEN DIEKMAN** **DOUG ANDERSON** **STEVEN PELL** **BILL RYALL** **MARYLOU POTTS**
LOCATION:	**IPC OFFICE** **LEVEL 3, 201 ELIZABETH STREET** **SYDNEY, NEW SOUTH WALES**
DATE:	**3.37 PM, MONDAY, 11 FEBRUARY 2019**

PROF C. FELL: Good afternoon and welcome. Now, I have to read a formal bit, so if you will just bear with that for a moment, and we will get that over and get on with it. So before we begin, I would like to acknowledge the traditional owners of the land on which we meet, the Gadigal people of the Eora Nation. I would also like to pay my respects to their elders past and present, and to the elders from other communities who may be here today.

Welcome to the meeting today. Hume Coal Proprietary Limited, the applicant, is seeking to construct and operate a new underground coal mine in the Southern Highlands, New South Wales, near Moss Vale, to allow for the extraction of 3.5 million tonnes of mined coal per year over a project life of 23 years including construction and rehabilitation. My name is Professor Chris Fell. I'm the chair of this IPC panel. Joining me are my fellow commissioners: Annelise Tuor, Geoff Sharrock and George Gates. The other attendees at the meeting are – goodness, wrong sheet. No? Thank you very much. My apologies. Alan Lindsay. Len – please. Thank you, Alan.

MR A. LINDSAY: Len – Alan here. Sorry. I thought you were on - - -

PROF FELL: Len Diekman. Doug Anderson. Dr Steven Pells.

DR S. PELLS: Yes.

PROF FELL: Bill Ryall.

DR B. RYALL: That's me.

PROF FELL: And Marylou Potts. Hi. Before I continue, I should state that all appointed commissioners must make an annual declaration of interest identifying potential conflicts of their appointed role. For the record, we're unaware of any conflicts in relation to our appointment to this panel. In the interests of openness and transparency, and to ensure full capture of information, today's meeting is being recorded and a full transcript will be produced and made available on the Commission's website. This meeting is one part of the Commission's process. It is taking place at a preliminary stage of this process and will form one of the several sources of information which the Commission will use to complete the task referred to in the Minister's request dated 4 December 2018.

It's important for the Commission to ask questions of its attendees and clarify issues wherever we consider it appropriate. If you are asked a question and are not in a position to answer, please feel free to take a question on notice and provide any additional information in writing, which we will then put up on our website. I request that all members here today introduce themselves before speaking for the first time. I think we've already achieved that. And for all members to ensure that they do not speak over the top of each other to ensure accuracy of the transcript. We will now begin.

And if I might say, we agreed to meet with your group here rather than on site because it was deemed more convenient for you. So we will treat this in many respects like a presentation at site, the public hearing. So we may ask questions for clarification, but we will be principally interested in hearing what you have to say and including that in our deliberations. So with that, thank you. Can I hand over and - - -

MR LINDSAY: I will take it.

PROF FELL: - - - ask you to – we've got two hours, basically, and there we are.

MR LINDSAY: We should be able to work within that, I think, Professor. Look, my name is Alan Lindsay. I'm a retired chemical engineer and corporate executive, and in more recent times, a small-scale Southern Highlands cattle farmer. I'm also the vice-president of Coal Free Southern Highlands, which is an organisation that was set up to oppose the development of the Hume Coal Mine. This organisation has a large number of supporters. Local residents - - -

PROF FELL: Excuse me for interrupting.

MR LINDSAY: Yes.

PROF FELL: Can we get a copy of that - - -

MR LINDSAY: Yes, I - - -

PROF FELL: - - - at the end of the - - -

MR LINDSAY: You can have it, definitely, but - - -

PROF FELL: That would be wonderful. Just so it makes it a bit easier for our transcribing.

MR LINDSAY: Yes, sure. No. We've got other copies of other things.

PROF FELL: Thank you.

MR LINDSAY: So we're happy to give it to you. I won't be saying all of this - - -

PROF FELL: Okay.

MR LINDSAY: - - - because I timed myself this morning and it was too long. So, anyway. So this battle with – against the establishment of the mine has gone on forever. Eight years now. It's wearing a lot of people down. Now, I've had a lot of interaction with Hume Coal over these years. I was a representative on the Hume Coal Water Advisory Group since about mid-2012, and I've been assisting landowners with land access, arbitration issues and disputes that they had with the

Hume company. Now, the DPE has recommended that approval of the Hume proposal be refused, and we're very clear – pleased that they've reached that conclusion.

As you might expect, though, Hume were not so enthusiastic. The edition of the Southern Highland News for 11 December quoted the Hume spokesman as accusing the DPE of "pandering to the squeaky wheel" and stating that a vocal minority had convinced the government that there was little support for this project. But I'm sure you've seen the number of submissions that were made on the EIS, 12,000, and about over 900 of those were what you might call substantial submissions, and the vast majority were against the project. So the "vocal minority" is in fact a great majority in the Southern Highlands, and we've been able to raise quite a lot of money to fight this battle because I can assure you it's a very expensive exercise, and if it wasn't for the fact that the Southern Highlands is a fairly affluent area, we might not have been able to mount the case that we've been able to.

Also, in this presentation you will see that there's an array of squeaky wheels here who've evaluated the technical aspects of the Hume EIS and put forward a very strong case, which we're very pleased to say has been reflected, at least in part, in the DPE assessment. Coal Free Southern Highlands has had the benefit of advice from these experts and a number of others in formulating its position, and we're really grateful for the fact that we've been able to get a couple of hours to deal with the more significant detail of the issues that we have with this project. My job today will be to give you a Coal Free Southern Highlands assessment of the DPE assessment, and I will leave my colleagues to talk to their areas of expertise. They've all been introduced, so I don't have to do that.

Now, let me first say – and I'm sure this will be no surprise to you – that we endorse the conclusions that the DPE has reached in making their recommendation. This project is not in the public interest and it should not be approved. The DPE has approached their evaluation of this project in a diligent and cautious manner. We've been quite frustrated at the length of time that this has taken, but with the recent release of documentation that they've made available with their assessment, we now have a much better appreciation for the conflicts that have existed and that dragged this particular evaluation out for as long as it has.

Now, the DPE have a number of critical reason for support. I will just quickly run through them. You've probably heard them all many times now. One big issue has been the mine design, the so-called pine feather system, which is a combination of conventional underground development methods with highwall mining added to it. Highwall mining being commonly used in open cut operations. The highwall mining technique has not previously been used in an underground setting in Australia and virtually nowhere else in the world. I think they might have tried it in China at one stage but that's not a great recommendation.

The DPE has accepted the view of their appointed experts – Emeritus Professor Jim Galvin, Professor Ismet Canbulat from the University of New South Wales – that the pine feather mine design, in combination with the plan to impound water in the mined out voids, represents a – in the working area of the mine – represents an inherent safety risk. The New South Wales Resources Regulator supports this conclusion. While we claim no particular expertise here, some of us have worked in hazardous industrial situations, seen fatalities, and we instinctively identify with Professor Galvin's caution on the mining process and his conclusion that the proponent has not provided sufficient justification or put it through a rigorous hazardous analysis.

Hume's response to this – which I found quite astounding, quite frankly – is that the safety issues can be sorted out after they have approval for the operating mine. A sort of a "suck it and see" approach. "We'll have problems but we'll overcome them as we go along." Professor Galvin – who is one of the eminent safety experts in coalmining in Australia, certainly New South Wales – has rejected this approach, mainly because of the new design and the fact that it's totally untested at the moment.

We also support the conclusion that has been reached by the DPE that there's considerable uncertainty with Hume's assertion that the groundwater produced in the mining process can be contained within a primary water dam and the mined voids. They're putting these bulkheads in to block off each area as they mine it, and the idea is that that will stop the water, keep the water down, and control the level in the primary water dam. There has been no assessment of the difficulty that the company would face in putting these bulkheads in.

I sat through a meeting with Boral this morning, who are trying to close the old Berrima Colliery, and they're putting in seven bulkheads. And I asked their engineer how he would go about that, and I was quite staggered at the effort that had to be made to put these bulkheads in, and the time that it would take, and the probability that something could go wrong because you've got the situation in the Hume mine where the bulkhead construction will be taking place here and the operating face of the mine is right here, and this is the way out. And so you've got one juxtaposed to the other, and I'm sure that is one of the reasons that Professor Galvin was expressing his concern as he has.

We feel that it's likely that the delay of time in impounding this water will result in a lot more of the water being pushed up to the surface. I mean, not only we; I mean the department and Professor Galvin and Professor Canbulat. All agree that the chances of this material flowing into local streams, which then flows into the Sydney water catchment, is really quite high. Hume's initial plan was to have a water treatment facility as part of their surface facilities to guard against this eventuality, but this investment has been deleted presumably because they wanted to keep the cost down and they have a belief that their underground operations will work flawlessly to contain the produced water and in my opinion and the opinion of many of my colleagues this is a very courageous assumption.

Moving on to groundwater itself, one of the key conclusions of the department in their assessment was that the project involved what they have termed and have always referred to as an unprecedented number of groundwater bores being affected by the mining operations. Hume have proposed some make good arrangements that are quite frankly unworkable. Marylou will speak to that a little bit later on.

The DPE has concluded that the make good process that Hume have put up will have an unavoidable adverse impact on the landowner community as well as creating problems for themselves because they will have to arbitrate, you know, 118 potential disputes between the mining company and the landowners. And we certainly agree with the conclusion that they have reached here.

Hume are proposing that the negotiations that take place between the landowners and the mining company are based on Hume's groundwater model and they also want to take into account other users of water at the time and it's an impossible situation for landowners to agree to that. They want legally binding agreements before the mining starts in that particular area.

MR G. GATES: Sorry, Alan. I didn't quite understand that point. Could you just go over it again?

MR LINDSAY: What, the ground – the - - -

MR GATES: The – Hume Coal want to acquire water from local bore owners – sorry - - -

MR LINDSAY: No, this is – no, this is the damage that they'll be doing to existing bores.

MR GATES: Make good.

MR LINDSAY: The make good, yes. So they're proposing that in five-year intervals – this is after they've been given approval – they examine the bores that they think will be affected during the next five years and they come to a legally binding agreement with that landowner as to what has to happen. The problem – but we will go into it in a bit more detail – is nobody really knows how bad the damage will be. And they expect landowners who are operating in an atmosphere of significant distrust with this company to enter a legally binding agreement before mining starts in their area. As that famous man from The Castle – I think his name was Kerrigan – said, you know, "they're dreaming", you know. Nobody will sign up for them. And these things will get bogged down and they will all end up in court and the department recognise that that's what happens.

There seems to be a misunderstanding by the company that the landowners don't actually value the water they've got, whereas, as you would know, they do value it very, very highly and if anybody had any doubt about that, the, what, six months of last year that we had very little rainfall and the groundwater system was worked right to its very, very limits. We even started to see the water table fall in areas that we had never seen before. And so people do value what they've got and they will fight. They don't want to fight – they're sick of this – but they will fight to make sure that it's protected.

On the project economics, I think we all learned something. I think the expert that the department engaged – BIS Oxford Economics – actually, I think, put a very good and very thoughtful paper together to explain how the total economics of these mining situations work. They concluded that the numbers that were being put forward by the company were grossly exaggerated and we would certainly agree with that. in fact, I think it's even worse than what they have concluded because they didn't do a full analysis of the actual economics of the project itself which are extraordinarily poor. So we will talk a little bit more about that later.

Now, while we agree with most things that the DPE has suggested, we disagree on a couple of points. First of all, the geology in the area is quite uncertain. Len will be giving a presentation on that a little later, but this is the very edge of the southern coalfield and there is a lot of geological anomalies in the area, some of which Hume have identified and some of which they haven't. But they have made some assumptions on the conceptual geology which are completely at odds with the experience that people have had in this area for a long time. They seem – anyway, I will let Steve talk about that a little later.

We also question the fact that Hume have decided to produce their EIS without – with a very, very small number of pumping tests. Now, a pumping test ..... just more aware of these things than most – but a pumping test is an overall assessment of the hydrogeological capacity of the area. We know we've got some bores with very, very high capacities. The Rosedale property has a bore that can produce between 40 and 50 litres a second which is a phenomenal amount of water. The property next door – they did a pumping test on the property next door. They ran it for seven days at 20 litres a second. That's 0.6 of a gigalitre pumped out. And we were monitoring it on other bores and we hardly found any movement at all – there was some, but not a lot.

So it surprised me, then, that they only did one other test – two tests out of that whole area. They report another six or so, but they're from the Berrima Colliery and one of those tests was only for an hour, you know. I mean, it was just ludicrous. And we really question the amount of data that they've got and the adequacy of it, and it's one of the bases for our opposition. Hume was historical data, and some recent data, that they were able to do on their own properties, but they're withholding it from evaluation by the community. All I can say is if it really backed up their case, I'm sure they would have put the data out on the table, but it's held within the DIGS system under a confidential basis and we haven't sighted it.

But we do have some data prior to 1985 and that has helped us do an evaluation, plus a lot of us have got bores in the area and we know that the good water is right at the bottom above the coal seam. Hume tell us there's aquitard there and we don't quite believe it. However, Hume were very keen to get more data, and I will just show you this ..... press it down? In 2014, Hume put an application in to the Department of Resources and Energy for some additional drilling. Now, there are 150 drill holes located – nominated there – potential drill holes – and each one of those yellow dots represents a circle of 100 metres diameter. Of those 150 – and they're allowed to drill anywhere within that 100-metre diameter circle – of that 150, they were going to select 90. Now, the DRE rejected this proposal.

A few months later, they approved 25 holes to be drilled. Hume had reduced their request from 90 to 70; 25 now and 45 later. Of these 25 holes, just three were drilled and they were all on the western side of the Hume Highway, the left-hand side of the Hume Highway, one on a property owned by Hume and one on – two others on properties owned by private land. So you can see they were really keen on getting this data. They went to court. There was a court case before Commissioner Dixon and where their exploration manager made a big point of the importance of all of this and I will just quote what he said there:

> *There's a scarcity of data. Targeting these areas will allow data on geological structures and coal quality to be gathered and this information in turn will allow a conclusion to be made about the likely safety of the working environment and the product quality.*

Now, those are the words of Commissioner Dixon, but she – I happened to be in court that day, so she is – it's just reflecting what their exploration manager said. Now, Hume was successful in the initial hearing, but lost the case on appeal. Thank heavens. And then they – so they, therefore, lost their ability to get access to all of the properties there where those little red dots are shown and that just happens to be, according to them and according to others who own this exploration licence previously, that is the sweet spot area, the best coal in that area. As you go to the west, you get a lot of erosion into the coal scene and as you go to the south and the west, you start to run into places like Exeter and Moss Vale and other places that are pretty sensitive about coal mining underneath them.

But having been refused this access, Hume then turned around and said, "We didn't really need that data anyway. They dragged us into court," or "forced us to take them to court and now they say they don't actually need it." And I think a lot of the animosity that that the locals in the Southern Highlands feel towards Hume revolves around this case and the company's reaction to it. So we now have a situation where that data wasn't looked at. Professor Galvin and Professor Canbulat also considered the lack of data and were not all that impressed. This is from Hume Coal EIS and you can see why they would be concerned.

Those little areas there that have got the stripes across them are diatremes. This is a wholly volcanic area. We've got Mount ..... which is the big – what is it – a basalt plug on the right-hand side and the others are all areas where the coal would be eroded, you know, the diatremes had formed by water coming – by basalt lava coming up hitting the water and has a great water supply there and then spreading out and virtually exploding and if there was any coal there, the coal wouldn't survive the formation of a diatreme.

The lines that come across there are fault lines. Some of those fault lines could be quite big. Hume don't know how big they are because they haven't been able to get in there and explore. But there's obviously a lot of activity there, a lot of unknowns. And one of the factors that brought criticism from the two professors is that this is Hume's mine plan and they said, "Where's the allowance for the diatremes?" You know, "Where are the – is the allowance for the faults? Are you just going to – you're pretending that you're able to do this in a very systematic and simple way" – or is in actual fact, a lot of the mining would have to halt if they ran into any of these problems. And once again, that criticism was put forward by the two professors.

They are concerned that a substantial amount of the coal would be sterilised in this sort of event. If you look at the mining method that they plan, it really relies on being able to go in a straight line. This is the pine feather system. You can see down the bottom, you've got your main drives. That's a standard formation in an underground coal mining and the so-called gate roads are the three roads that are going up and off each one of those at an angle of about 60 degrees, you've got the so-called plungers or drives which now ..... the main roads and the gate roads are all properly developed underground mines, you know, with roof strengthened and everything like that.

The panels though, which I will show – this is a close-up. Let's say you've got a gate road up the middle and you've got these plungers that go off at 60 degrees, they are all done by automatic controlled continuous miners and there's a real question as to whether or not that type of mining which is, effectively, a high wall mine can be done in such confined circumstances. You've got large machines working in an area. Those plungers are unventilated, so nobody can get in them if anything goes wrong. If there's a roof fall and the equipment is trapped, it becomes a major exercise in getting out and as Professor Galvin, I thought very eloquently, pointed out those plungers contain oxygen deficient air and, you know, part of the Hume plan is to fill those plungers with coal washery rejects which will displace that oxygen deficient air and if there's a fall inside, you will get a displacement of this air and he considered that a major hazard for the miners who are there and this thing just hasn't been thought through.

Hume have claimed that they have had these risk analysis meetings and so on, but they've never published the outcome of them or given any detail of the risks that would be involved in this type of mining and underground mining is dangerous – very dangerous. Anyway, these geological problems have been, sort of, skimmed over and Hume decided that they could go to the EIS, so they took the ground water model that they developed for a preliminary economic assessment which was, you know, about June of 2015 and they upgraded it. The consultant who previously worked on it for some reason disappeared and they brought in Coffey Geotechnics who are well-known crowd and they had pier reviewers, Professor – Dr Noel Merrick and Dr Franz Kalf.

They looked at Coffey Geotechnics work and declared it fit for purpose and a model class 2 or 3. And if you haven't heard yet, there are three classes of model for ground water and one is the lowest and two and three is extremely high. However, the New South Wales government agencies, who I think did a fairly thorough job in looking at this, declared that it was only class 1 and my two experts here also declared it to be a class 1 model and so Hume decided that they would do – that an audit be done. Professor – Dr Merrick did the audit and some deficiencies were discovered and he took control of the modelling work and made further revisions, changed the software, brought in Monte Carlo analysis – very sophisticated, but they didn't really deal with the uncertainties that were being faced.

Now, we have some problems with the modelling techniques that we used. Steve and Doug will talk about that. But our greatest concern actually is in the data that went into the model. I mean, if you haven't fully reflected the uncertainty of the geological situation in the conceptual model that you develop, all the sophistication of a Monte Carlo analysis will do absolutely nothing for you and yet, that's what we have been presented. Now, in our opinion, Hume has based its ground water model on a conceptual geology that is designed to ensure that the calculated numbers for the water tank, the water that's intercepted by the mining and the bore draw down are minimised. You know, we've been through all these evolutions of the ground water model and, you know, changes are made, new software is put in, uncertainty is examined and we still come up with the same answer every time. It doesn't, to me, seem that it is – is a proper analysis that has been done, even though, I have to say, that the people that have been involved in it are eminent practitioners in the industry, but anyway, that's what it is – anyway.

In their assessment, the department has chosen to accept the ground water model that's put forward by Hume, but they increase the uncertainty. Instead of the 65 per cent – or 67 per cent that Hume had – or the consultants for Hume had put on their uncertainty analysis, they blew it out to 90 per cent. Doug feels it should be higher than that and I tend to agree with him. I mean, we are dealing with a situation here where you're supposed to look at the worst case scenario for the ground water tank and we don't think that they have done the worst case scenario. Anyway, the department accepted their model, went to an uncertainty level of 90 per cent and that allowed them to progress with the rest of the analysis.

Now – and this is a personal opinion. I think the reasons that the department adopted the Hume model are purely pragmatic. They're trying to minimise the number of arguments they had. One of the more esoteric one is modelling. But having accepted it, they were then able to look at the damage that would be done to the water bores by the Hume model and make an assessment and that assessment was that the damage was great. It couldn't be remediated properly and, therefore, the make good mechanisms were unworkable and, therefore, that particular aspect of the analysis would go against the mine. And we certainly agree. And we – but we believe and we would add that if you properly took the uncertainty of the geology into account, that the situation would be far worse. There would be far more water intercepted, far more licensing of water required and far more bores have been affected and the ones that were affected would be affected in a far worse situation. So I will turn over to my colleagues now. Len will talk about the geology and then Doug and Steve will talk about the ground water modelling and issues associated with that.

MR L. DIEKMAN: Thanks, Alan. I had a few short slides if ..... might be kind enough to roll through. I've already been introduced. I'm happy to reintroduce myself as Len Diekman - - -

PROF FELL: Sorry. Please.

MR DIEKMAN: - - - a geologist and geophysicist of some 35 years, give or take a year, working in petroleum gas resources and environmental aspects of petroleum industry contamination therefore ..... and time together, models of geology with groundwater and development of resources. I'm here today in capacity to represent Dr John Connelly who is not here. He is overseas at the moment. Dr Connelly has put in submissions prior to this that are on the record.

And I'm going to talk today about the – some complexities in the geology that really have not been captured by Hume in their submissions, hat the consequences of those complexities are with respect to mine planning to contamination of groundwater and also to the groundwater models itself. I won't be talking about the groundwater – groundwater models in detail. I will leave that up to my colleagues here today. So if we might go and flip through that first slide. So what I really wanted to highlight first off is that the geology in this area is quite complex. Hume has assumed in there, either tacitly or in other ways, that the geology is quite simply; in other words, their mine plan assumes a simple geological layout enabling a simple mine plan, which is the diagram ..... brought up recently. So I might just explain this slide up here. On the – that colourful section up there is a - - -

MR ....: I've got a pointer if you want one.

MR DIEKMAN: Terrific. That will be wonderful if it will work. Perfect. This is a seismic section. For people may not be aware of what a seismic section is, it's a profile that covers an area over the ground and soundwaves are reflected off the rocks, underneath received and processed and then recorded at the surface, and you get an image of what the subsurface geology looks like. And you're able to tie these images in with coal bores, and there's a coal bore there, and there's also information from logs that – data that's acquired down the hole that you can tie the geological structure in down the hole and get an idea of what the earth looks like underneath rather than just above.

So it gives you more than expression of the geology of the surface. It actually penetrates beneath. So we – Hume actually published these three profiles I'm going to show, this one here and two more, in their 2012 relinquishment of – their partial relinquishment. So whilst these lines are not within the ..... area themselves, they are immediately adjacent, and I will speak to a slide as to where they are further on. So the main point here is that these images give us an idea of the typical geology that's in the area and the typical geology is complicated.

Now, what do I mean by that, well, I will explain what I mean by highlighting some things on the slide. First of all, in the profile, these red lines that are drawn here are fault lines interpreted through the earth. Just to give you an idea, this area from the left here over to the right is of the order of about three to five kilometres. And we're looking down here, about one kilometre depth here, and around about 500 metres to the base of these boreholes here, and that's in round numbers.

The reason it's round is because there's a scale down here. That is not actually depth. That is in – that's recording time. That's how much time it takes for sound to bounce off the rock surface and be received at the surface. And there are ways of roughly calculating what that is, and that's what we tie these boreholes in. So these are the fault marks here along these plains, and also the – there's a horizon, which is this marker here, this blue line, which is cut up by the faults.

And that's roughly the top – what the structure of the top of the Wongawilli coal looks like, which is the target that will be mined. Because this Wongawilli coal is less than one metre in thickness, you actually cannot see on the side because it's far too thin to see that, but you can see the top of the coal measure sequence, so it's the top of that whole package which contains the Wongawilli coal. That formation is the – it's called the ..... I'm not going to go over the geology because I've done that previously. So that does give us an accurate idea of the structure of the geology. Some of the things you notice here are as the – there's a tilt on that surface, if for a moment you disregard the faults, going down to the middle of that section, and then it comes up.

So there are dips, if you like, or what I call synclines in that surface that do not make it a planar surface. So it's not a very simple layer-cake model. It's very, if you like, bumpy and hilly underneath that surface. And if you look and do some numbers and do the calculations, you can see that that top of the Wongawilli coal in certain faults is thrown a distance down that fault. And I've put some labels up here on some of the faults: 13 metres there, about 20 metres there.

MR GATES: Sorry. Then where is Hume Coal in this section of the mine?

MR DIEKMAN: The – the mine. This – these lines, if I might – just to answer that question, we might jump forward very quickly I think two slides.

MR ....: Jump forward.

MR DIEKMAN: These are lines that were acquired by Hume Coal – one more, I think. I think we must have missed it. There's a map in there. There it is there. Okay. Okay. This is authority 349, the red outline. That's the MLA in block. Those seismic lines are highlighted here in those pink lines. Now, they were in the previous part of the – of the authority before it was relinquished in 2012. So these seismic lines are here, so they are within a kilometre of the western part of that mine plan. This black line is within the MLA. That's the outline of that mine plan that Alan showed earlier.

So that's the extent of the mine. If you can – might just go back to – to that area. Okay. So the main points here is that geology is not as simple to allow the type of mine that they are allowing, and also because of those displacements of 10 and up to 20 metres, those continuous mineshafts would have to stop right there where they hit the fault face. If one of those drives was coming down here and hit there, they could not then simply stop down 10 – or step up as the case may be – you know, 10 or 20 metres. They would have to terminate that.

MR SHARROCK: Excuse me. They say different. They say 10 metres they can do, 20 they can't.

MR DIEKMAN: 20 they can't.

MR SHARROCK: Yes. That's 20 – 20, exactly.

MR DIEKMAN: There's – okay. Well, there's 20 metres, 13 metres, and the next five is a number. There's a whole range there. I think the point is that they will again have to stop and that drive would be terminated. There would be no access to it. So what that means is (a) the efficiency of that mining process is compromised, and the second part of it is that the integrity of that mining process may well be compromised too because of this ..... so the other thing this does too is that the – directly above the coal there, which is above the blue, is the Hawkesbury Sandstone that Alan has mentioned, the very highly efficient and important aquifer in the area.

What these faults do is they directly juxtapose in a position like that the coal which would be mined to the base of the Hawkesbury Sandstone aquifer. So you would have the mine and – later on which would be filled with the rock and stone that I believe that I refer to. So that's the slurry of the mine waste would be directly exposed to, or juxtaposed to, that aquifer in many instances. Just bear in mind, if that's roughly three or four kilometres, I've been in the major faults there – there's a dozen faults in that small area there. So in round numbers, over that mine plan you are looking of the order of, if the geology is as complicated as it is here, of the order of about 100 faults of that size. It might be 50. It might be 200. But that's a fee for it.

PROF FELL: Is such faulting common generally in coal seams?

MR DIEKMAN: Faulting, yes and no - - -

PROF FELL: Well, particularly in sandstone over .....

MR DIEKMAN: Yes. The closer you get to the surface, sometimes the more accentuated that faulting can be. The critical thing is the seam thickness. If you're on a – in a domain like Northern Queensland where seams are eight or 10 metres thick, faulting like this doesn't have as high an impact because you can continuously mine through that coal because actually you don't even see the fault, from a miner's point of view.

PROF FELL: Sure.

MR DIEKMAN: Whereas here, you're stopped short in your track.

PROF FELL: Yes.

MR LINDSAY: If you look at other mines in the area, in the southern coalfield, that mine, the Wongawilli seam, they are usually three and four hundred metres below the surface. So you have got the Hawkesbury sandstone then you might have 100 metres of silt stone and then you have the Wongawilli seam. And the silt stone is a lot more robust, aquitard at least slows things down, whereas the Hawkesbury sandstone is fractured, as Len has being saying. And the big difference between this mine and the others that exist in that coalfield are the depth of the coal and the mining that - - -

MR DIEKMAN: The depth from the coal, the thinness of the coal and the general lack of a thick aquitard on top. So in many of the Hume representations there was a one or maybe two metre thick aquitard or barrier above the coal. That is breached by these faults that are an order of magnitude greater. So in many cases their proposal that there is an aquitard is not really accurate because there is one there but it's highly fractured, highly compartmentalised and does not really provide a barrier to water flow. And the effect of mining along those shafts, hitting one of those faults exacerbates that issue because it would allow flow of water in a much more – in state of higher permeability, if you like.

It would enhance the flow. So in other words, cross-contamination, etcetera. So there's some quotes there. You will get a copy of this so I won't read them out in this forum. So in summary, the Wongawilli, it's highly fragmented, really just into a lot of separate bodies. It's not one continuous body so one continuous mine plan will not – even if it's only in that 10 metre toleration step level, will not be able to access the coal to the level that they're talking about. An attempt to do so would compromise the aquifer. I might just go to the next slide. The next slide are two more seismic lines in that area, in the next slide that I showed previously it shows the location.

Again, these were acquired in 2011 by Hume under their licence that has now been partial relinquished. I only put those up there by way of illustration to say that the geology is very similar here in that there's the same level of faulting and the same level of unevenness in that surface. The top of the Wongawilli coal in that blue line is not a nice sloped surface which the mine plan would indicate. You can see here it rises up and then rises down and is displaced. So it is not a simple geological structure in the subsurface. I might just go to the next one then. In the relinquishment report of May 2012, of which the diagram on the right is reproduced from, they – Hume did report on a magnetic survey.

They had two magnetic surveys; a ground based and a high resolution airborne based magnetic survey. What these magnetic surveys do is they do two things. They pick up things like the diatremes, batholiths, laccoliths, any igneous feature that contains magnetic material or, you know, basalt, those sort of things and the like, and they have identified quite few of those on the surface. What they also show up is faulting and on this diagram here – I might then point out those two seismic – or the three seismic ones they show were in this area here, there, there and there, and this is now the south-western boundary of the Authority 349 at the moment.

So this magnetic survey was actually shot right up to the boundary of the relinquished area. Now, in this interpretation that they did at that time, they interpreted all these faults. So all those linear features you can see are false, that they have identified within the subsurface. So they have previously identified this level of ..... however, that was really omitted in their design of the mine in later years. So that hasn't been captured.

PROF FELL: Yes.

MR DIEKMAN: That was an omission that, for whatever reason, is not really embodied in the current mine plan or valuation. Now, that's – just go over to the next one. So the conclusion of what I showed there is that the available data – the magnetic data and the geophysical data from the seismic lines show that the geology is much more complicated than what their mine planning seems to imply. And the consequences of that geology I have spelt out here and I might just briefly go through those. As I said before, the Wongawilli coal is highly fragmented. It's in separate non-continuous bodies; in other words, not able to rely on for one mine plan itself.

So the mine layout, as I said in the previous slide, doesn't really lend itself to following that resource. So a lot of that resource, a lot of the coal will have to be left in the ground at that time so the recoveries, for a start, will be much less than what they expect. In other words, that mine cannot be executed. You have to stop when you hit those big faults greater than 10 metres, as Hume does suggest themselves. That widespread aquitard which I think will be talked about later and also has been placed in previous submissions, is going to be breached by that faulting. That's clearly visible on the seismic data. And Hume has published that seismic data as well.

PROF FELL: I can accept the first point and I guess the third one I start to have a bit of trouble with was if that exists, why hasn't the aquifer been contaminated already?

MR DIEKMAN: In

PROF FELL: In geological time?

MR DIEKMAN: In that area there?

PROF FELL: Mmm.

MR DIEKMAN: Well, the mining at the moment – well, it's not taking place in this MLA.

PROF FELL: All right.

MR DIEKMAN: The threat is that once the mine does go ahead and according to their plan they will be storing – well, if that's a slurry – well, rocks and stone as they call it - - -

PROF FELL: Yes.

MR DIEKMAN: - - - you then expose that mine waste material directly to the Hawkesbury sandstone which is the main aquifer in the area.

PROF FELL: Yes. That's appreciated.

MR DIEKMAN: Yes. So - - -

MR LINDSAY: ..... but I think one point though is that the coal seam itself is an aquifer and as long as it's not broken up - - -

PROF FELL: Yes. I appreciate that.

MR LINDSAY: As long as it's not broken up, the water that comes out of it is typical water for – groundwater for the southern highlands, which tends to be a little bit irony and needs – often needs a little bit of treatment by the - - -

PROF FELL: Are you saying that after the waste is put back in you actually get a different groundwater associated with it?

MR LINDSAY: Bill will be dealing with that in detail.

MR DIEKMAN: Yes, I agree with that point. So you will have – the mine effectively will open up those areas where the seam has been mined and they will be juxtaposed directly without an aquitard. Yes. Does that clarify?

PROF FELL: No. It has to do with the concentration of analytes, if you like.

MR DIEKMAN: Okay. Perhaps the groundwater people might - - -

DR S. PELLS: Are you saying why isn't the signature of water within the coal seen within the water in the - - -

PROF FELL: Quite.

DR PELLS: Well, I'm the wrong person to ask. I don't - - -

MR LINDSAY: Bill is the right - - -

DR PELLS: ..... mystery at all.

MR LINDSAY: Bill is the right person and does – will take care of that matter.

PROF FELL: Well, let's handle it when we get to Bill - - -

MR LINDSAY: Yes. Right.

PROF FELL: - - - but I will flag it as a question; right.

MS A. TUOR: You have got time to think about it.

MR LINDSAY: Okay.

MR DIEKMAN: That's fine. That's fine.

MR LINDSAY: However - - -

PROF FELL: I just need to understand. I mean, I understand what .....

MR DIEKMAN: Of course. I guess the flow on, if you will pardon the analogy with groundwater, from that is also – and I will – in that – we might just go back to that previous slide, on the map. Actually must have been the next one, I do apologise. It's the map that I'm – yes. The flow on from that is that after the mine is opened and then if you look at the aquifer of the coal seam itself or the actual coal measures themselves, those coal measures do outcrop here. That dark blue is the Illawarra coal measures outcrop so approximately just over one kilometres, 1.1 to that 1.5 kilometre, those coalmines do outcrop in the two creeks, in Red Arm Creek and Long Naked Creek just here. So they will be – that contaminant will be placed in that position in the tributaries of the – basically, the Warragamba and the Wollondilly, ultimately into the Burragorang catchment. That's - - -

MR GATES: So your concern is mostly about where the groundwater discharge is and what the water quality would be - - -

MR DIEKMAN: It's - - -

MR GATES: - - - rather than you have got some bores there that might draw this poorer quality water into the bores?

MR DIEKMAN: It's both.

MR GATES: Both.

MR DIEKMAN: You will have that discharge – that risk of discharge, so, in other words, the water catchment is involved in that system. And, also, you will have the base of the wall to be sandstone in close communication with a high-risk contamination body, which would be the mined Wongawilli seams, because of the geological complexity. So it's a two-fold system of risks there to be looked at: the receptors in the water catchment and also contaminants reaching the water bores, let alone the – you know, the risks of drawdown of the aquifer.

MR SHARROCK: May I ask you two questions in relation to that. On that map – pardon me – that you have there, do you think the existing mine that's recently closed – Berrima mine is on that?

MR DIEKMAN: Berrima. Up here somewhere.

MR SHARROCK: It's up that – it would be off that map, would it?

MR DIEKMAN: It would be - - -

MR LINDSAY: On that side of - - -

MR DIEKMAN: Be up here.

MR LINDSAY: Just above your arrows, actually.

MR DIEKMAN: Yes.

MR SHARROCK: How far away would the Berrima mine be from their authorisation? Is it - - -

DR PELLS: I've got a picture of it - - -

MR SHARROCK: - - - two or three kilometres?

DR PELLS: I've got a picture of it later that you can judge off, but - - -

MR SHARROCK: Okay.

MR DIEKMAN: But, roughly, would that be eight kilometres, 10, something like that?

DR PELLS: I don't want to say on record about, you know - - -

MR DIEKMAN: Okay.

MR SHARROCK: I thought it was four or five in the report.

MR GATES: Four or five - - -

DR PELLS: Okay.

MR SHARROCK: ..... to ask.

DR PELLS: Right. Okay.

MR SHARROCK: One other question, that is, you showed two seismic lines, which were instructive, but have they done any seismic themselves subsequent to that?

MR DIEKMAN: Not to my knowledge.

MR SHARROCK: On the remaining - - -

MR LINDSAY: It really surprises me that they haven't, but – or – that they've told us about. I mean, because they own quite a bit of land in that area. The government, I think, would be quite cooperative if they wanted to do the Belanglo Forest and put a seismic line through there. They haven't tried to do any seismic along roads, which is quite a common technique. But they haven't been able to get on the properties that we mentioned before because of the land access rules that have gone against them. But, yes, they may have it but they haven't shared it with anybody.

MR DIEKMAN: And, just, in DIGS there would appear to be no reports lodged. Even if there were, we would not be able to access them. They're not open file.

MR SHARROCK: Yes. But it's not unusual, actually, to do exploration and it doesn't go to DIGS until you relinquish something or you reduce the size of it.

MR DIEKMAN: Yes. Correct.

MR SHARROCK: So I suppose while you still have the tenure of the authorisation or the MLA it's seen as yours. I mean, it belongs to the State, as we know, but - - -

MR LINDSAY: Well, that's definitely the way they see it. But, on the other hand, they're being challenged on the geology and you would have thought, if they had some evidence to support their case, they would put it out on the table.

MR DIEKMAN: Your point is good that in that if I was their exploration manager, or even their mine development manager, I would like to see some additional data of that nature to give me comfort in designing, or guidance in designing that mine. And I guess that's the point, is that they probably do need some more guidance there, with more data.

MR SHARROCK: Well, you know, I'm not at liberty to point out what we did with the proponent, but that question has been asked.

MR DIEKMAN: Yes. And, of course, none of us at this table here are Hume Coal and, you know, they are at liberty to explore and, according to whichever philosophy they deem fit.

MR SHARROCK: The point is well made, is my point.

MR DIEKMAN: Yes – yes. It does beg the question, you are right, why not? Okay. I think, can we just go back then to that one there. The only other comment I think I was going to make was just to emphasise the topic that Alan spoke about previously, and that was the presence of igneous diatremes ..... and so forth, which adds another complication to that project and is not taken into account in that mine plan, you know, that was and has been submitted in the various proposals. I think that wraps up what I wanted to say about the implications of the complexity about challenging.

MR LINDSAY: Now, David, we need to change to another program, because other colleagues have decided to use the wide format PowerPoint and we haven't been able to put them all together. We will have to come back to that one later.

DR D. ANDERSON: Okay. You've done one on this computer?

MR LINDSAY: Yes. It's on there, yes. I think it's called "Anderson Fells" or something. There it is, the top of – that's it. Okay. Doug.

DR ANDERSON: Okay. I'm Doug Anderson, principal engineer for groundwater modelling at the water research laboratory of the School of Civil and Environmental Engineering at the University of New South Wales. I have a background in environmental engineering and a Masters in Groundwater Studies, and I've been working in hydrological site characterisation and modelling for the last 18 years. I was engaged by the Coal Free Southern Highlands to undertake a peer review of the groundwater assessments and modelling in the EIS and the response to submissions.

So I'm going to present today – next slide, please – on, basically, my review of the key modelling assumptions and limitations, in the hope that this sort of summarises to you my understanding of the project risks and challenges. From my review, the key modelling assessment issues I identified related to joints, fractures and structures, as Len has just discussed. I have identified assessment issues around the interpretation of the geological and geophysical logs, issues around interpretation of the field hydraulic conductivity data that was available.

I was concerned about various model calibration claims and observations from model calibration in relation to sensitivity of their model to the aquifer storage parameters, and their observations of sensitivity in transient calibration and their confidence levels. Identified a few assumptions in numerical model and ..... analysis that were questionable, that should be documented. And, then, a further concern I had was that while the New South Wales government owns the water resource and is responsible for its management, their relevant technical specialists in DoI Water haven't been given the field data, the geological model or the groundwater modelling files to aid in their assessment of the EIS and RTS. I will touch on those in more detail later.

I will give you a high level summary of my findings in relation to these issues and, before I get into the details, I'm just going to make a few quick points about the project ..... water management in New South Wales generally, groundwater values in the southern highlands and generally, and the Hawkesbury sandstone formation, which is the primary aquifer from which the landholders are producing from. Next slide, please. And, also, at the bottom of the page you will see, when I'm talking about these things, there's a reference to further details if you would like to follow up at any stage. My submissions to DPE are noted with my report number and reference number. Next slide.

So, my findings. Firstly, the groundwater predictive model, it's biased towards predicting slow flow through the Hawkesbury sandstone rock matrix, not fast flow at structures, like Len showed. The second finding was the model will underpredict the magnitude and timing of drawdown at many surrounding groundwater works. That's because these groundwater works that are high-yielding are intersecting structures, which aren't in the model. The third finding was, therefore, that the model may underpredict the rate at which groundwater may flow into the mine workings, because these structures haven't been represented in the model.

An implication for that, then, is that if the project does proceed and correct errors in past projects that I've observed in management of mine sites elsewhere in New South Wales, is the requirement to make good an alleged drawdown impact must not be negated by the absence of any ..... model impact prediction of the landowner's bore because the structures have been ignored, simply, or because an alleged drawdown impact is observed during periods of low average rainfall, which has been another reason mining companies have gotten out of making good in the past.

Very simply, groundwater needs to be used during periods of below average rainfall. Groundwater levels will decline when groundwater capture exceeds recharge, and adding a large underground mind to a catchment increases groundwater capture and, therefore, falling groundwater level rates.

PROF FELL: Just hold on there for a sec.

DR ANDERSON: Yes.

PROF FELL: Isn't he aim to put mine water back into so there aren't voids, basically?

DR ANDERSON: But there will still be seepage through the roof of the workings into the mine voids. There will be a water management system. But, over time, water will be added and there will be a loss of pressure head from the water going into the mine workings, the over-lying formations. The fifth finding – Hume Coal's model calibration and model confidence level classification, which has been revised from class 3 down to class 2, are still overstated. It's a class ..... model and that's because when the transient model calibration was attempted, the supporting field observation data and modelling workflow that was used to calibrate that model actually didn't allow for a successful transient calibration.

The next reason is that the key geological and geophysical and hydrogeological field observation data weren't adequately represented in the model. For example, the horizontal and vertical hydraulic conductivity values, the permeability of the rock to water, weren't integrated with the geological and geophysical observations to provide appropriate Kh and Kv values at the scale of the model and then that information wasn't encapsulated in their calibration workflow. So when the model was run and compared to observed and predicted water levels, they didn't look at the K values that they got as a result and compare those back to the field data. So they've just – it's – basically, it's the modeller's interpretation of it and I will cover that in a bit more detail in due course.

And then the third reason that the model calibration and confidence level is overstated is just because their faults, fractures and faults and other geological structures that significantly influence groundwater flow simply weren't represented in the model. They assumed homogenous hydrological conditions in each layer of the model. Next slide, please. On the project SEARs, they were quite limited for this project. The information is up on the slides, there. I just wanted to raise one administrative issue on that point in that the model was supposed to be peer reviewed in accordance with the Australian Groundwater Flood Modelling Guidelines but it's actually peer reviewed in accordance with an older guideline, the Murray-Darling Basin Guidelines 2001. Next slide, please - - -

MS TUOR: Sorry. Just on that point.

DR ANDERSON: Yes.

MS TUOR: Are there differences between those peer review documents?

DR ANDERSON: Minor differences but just in terms of administrative due diligence, I just thought I should raise that.

MS TUOR: But it wouldn't necessarily change the outcome of the peer review?

DR ANDERSON: It doesn't necessarily change the outcome but it – as – it flows through the SEARs - - -

MS TUOR: Sure.

DR ANDERSON: - - - as a requirement. So I felt like the SEARs technically weren't met on that point. Moving on to groundwater management in New South Wales – and I just want to make a few points. The first is that water resources are connected and water taken or captured from one groundwater source is eventually water lost from another water source or a surface water receptor at some time in the future. The next point is that the New South Wales Government is responsible for managing water resources for current and future generations and that's enshrined in our policy and statutory instruments.

We have two generalised instruments for managing water resources in the state. The first is water sharing plans and they're like our macroeconomic instrument for managing water, to make sure we don't take too much water from any resource and the second is the Aquifer Interference Policy and that's designed to capture everything that's not captured at the macro level, so preventing local scale impacts between neighbouring landowners using water differently.

That policy requires the proponents to develop a complex groundwater model to predict groundwater impacts for their projects but it doesn't specify any minimum standards of acceptable technical work in making that prediction. That's a – that's left to the purview of the decision-maker. Next slide, please. Moving on to groundwater values and project risks, there's a New South Wales Government report from 2004 which explores the groundwater resources of the Southern Highlands and states that the groundwater resource is highly valued.

MR GATES: Is that photograph from the Southern Highlands?

DR ANDERSON: No, that one is not.

MR GATES: I see.

DR ANDERSON: That's - - -

MR SHARROCK: Quite dangerous, isn't it?

DR ANDERSON: It's ..... on your GOB ..... but what it's going to provide – ecosystem services and water supply security during drought are the main two ones. Primary producers in the Southern Highlands value-add to the groundwater resource there. They invest ..... capital in groundwater works and they require security of the groundwater supply for a return on that investment and for production during drought. If a modelling decision or a management program is based on a computer model which employs too many simplifications, you can end up having groundwater mismanagement because you're not using the right tool for the job.

And if that impact water supplies at existing boreholes, there will be lost economic primary production which is less revenue for New South Wales; there will be lost income for the primary producers, potentially exposing them to financial challenges; there will be sunk costs if the water levels can't be recovered in terms of decommissioning of bores, pumps and infrastructure; there will be new capital costs for sourcing and establishing alternative water supplies; and then there will be management costs from resolving unanticipated impacts that weren't predicted by the model, basically disputes.

So making good modelling assumptions is really important and basing management plans on good modelling assumptions is important. Next slide, please. Now, I just wanted to touch briefly on the Hawkesbury Sandstone aquifer, which is where all the local landowners are producing their groundwater from. It's the principal groundwater aquifer in the Sydney Basin. Some people might not even call it an aquifer because the yields are generally quite low. You only get large yields from the Hawkesbury Sandstone when your boreholes are intersecting joints, fractures and regional structures.

And so that makes this Hawkesbury Sandstone a dual porosity aquifer material and that just simply means that water flows slowly through the pores in the sandstone and a lot more quickly through the defects, the joints, the structures, the other faults. On the right-hand side of the slide there, you can see some examples of horizontal and sub-vertical joints in the Hawkesbury Sandstone and the influence of these sub-vertical joints and defects and faults is that water can move quite easily over small to large vertical distances and so in the presence of these joints and sub-vertical defects, you can have vertical hydraulic conductivity that's much higher than the horizontal, so water can move more easily vertically than it can horizontally.

And then, alternatively, you might come to a shale or a clay shale interbed in the sandstone sequence from where the water flow was slower in the past. In those cases, it's harder for – more difficult for the water to move vertically than it is horizontally and so a model's prediction of how water moves through the Hawkesbury Sandstone is highly dependent on high you conceptualise the structural features. Next slide, please. And that brings me to – so here's an example here of an excavation in the Sydney CBD and it shows contaminated groundwater leaking out of a vertical cutting in the sandstone. As you can see, the water is only flowing through very small parts of the Hawkesbury Sandstone and it's through these joints and bedding planes. Next slide.

MR GATES: Is that natural contamination or - - -

DR ANDERSON: It's an industrial – it's industrial .....

MR GATES: Industrial?

DR ANDERSON: Yes.

MR GATES: Thanks.

DR ANDERSON: So the first issue – and Len has raised it already – is that the principal issue with the predicted model for this site is that they observed numerous structures or mapped numerous structures during the desktop and field investigations. This has a significant influence on groundwater flow but it's not represented in their impact assessment model. They modelling the Hawkesbury Sandstone as a homogenous slab of layered rock in multiple layers down to the coal seam. And the next slide, please.

PROF FELL: Well, just before we move on.

DR ANDERSON: Yes.

PROF FELL: I mean, in the end, what can you do? You can't micromodel the whole thing. So it's usual just to pick some sort of figure and then do a sensitivity analysis subsequently with varying permeabilities and see if you can - - -

DR ANDERSON: I would say that's correct and also you can – there is the capacity to model structures in models, definitely the larger ones. So you can do it two ways. You can have a complex representation of - - -

PROF FELL: All right.

DR ANDERSON: - - - or you can have the – an engineering representation which is here's a best case average, here's a worst case high permeability distribution - - -

PROF FELL: Well, that's what I see. And when I look at these in different mines typically - - -

MR LINDSAY: And, indeed, when we did our modelling – we produced a model, as well. And that is basically what we did. We took a fairly wide range of sensitivities which we feel has to be done in a situation like this because of the complexity - - -

PROF FELL: Well, my understanding is they have done that, have they not?

MR ....: I will comment on that.

DR ANDERSON: And I will touch on it in a bit more detail, but I think – one of the reasons I think a more complex representation of the geology is important in this area is because the coal seam is in direct contact with the sandstone, which is more of an unusual occurrence than I would think - - -

PROF FELL: I appreciate that.

MR GATES: Doug, before you move on, do you want to make – just make a comment about the algorithm that has been used for decreasing conductivity with depth.

DR ANDERSON: I'm going to cover that on slide - - -

MR GATES: So you're going to come to that? All right.

DR ANDERSON: - - - 3 or 4. Yes.

MR GATES: That's good. Yes.

DR ANDERSON: Yes. Next slide, please. The next issue I want to touch on was, like, the numerical model layer conceptualisation. So they've simplified their model into a set of layers and effectively assigned them a decreasing permeability with depth but I dispute that simplification because they've got an extensive downhole gamma log data set from across the site and what the gamma log shows you is differences in – well, the gamma log tool – differences in density and also clay content in ..... and so if you look down this log on the right-hand side, you can see high gamma counts and low gamma counts.

And so you can clearly see in this diagram here areas where the Hawkesbury Sandstone has got less clay content and more clay content. And when I look at that picture just there – and that's just one of many – I see that there would be appear to be more permeability at the base of the Hawkesbury Sandstone formation and yet the Hume Coal Response to Submissions document suggests that there is no evidence of more aquifers at the base of the formation.

MR GATES: Sorry. I can't see that. Could you point it out. Have you got a pointer or something? So we're looking at the dark blue line.

DR ANDERSON: Yes, the dark blue line.

MR GATES: For the gamma count.

DR ANDERSON: Yes.

MR GATES: Yes.

DR ANDERSON: And so I've highlighted these areas in red with the red dot – horizontal dotted lines and the shaded areas.

MR GATES: Yes.

DR ANDERSON: And so, I've highlighted the areas with the lower gamma log counts in red there.

MR DIEKMAN: From a geophysicist point of view, if I might just add, the closer that blue line is to the left-hand side, the less clay content, which is associated with more sand, which is associated with higher ..... higher permeability.

MR GATES: Yes.

MR DIEKMAN: So in the – on that log up there, close to the 180 mark, just below that, that red zone that has been highlighted, would be, on that log, interpreted as the highest permeability zone.

MR GATES: Yes, I can see it now.

MR DIEKMAN: Yes.

MR SHARROCK: The highest – I just missed a word. The - - -

MR DIEKMAN: The highest permeability. So the – in other words, the best aquafer.

DR PELLS: Can I just add, in regard to that question, that their trend with depth, in my looking at it, it means that their model has hydraulic connectivity that is independent of geology. So I see it as a geologic parameter, whereas, they just have it just as a function of depth. So it doesn't recognise their position, or the geological formations. And – and this idea of overburden controlling the permeability, I – only just today, for example, we were doing a tunnelling job in Sydney, and we've plotted all the – the – hundreds of packet tests for it as a major project, and there was no correlation with depth at all. We did a job at the – for the Snowy Mountains Scheme, which had bores down over 1000 metres – again, no correlation. Now, I'm not saying that correlation never exists. I just think geology dominates permeability more than the overburden pressure. That's – that's – that's my experience.

MR SHARROCK: But it's interesting - - -

DR PELLS: Yes.

MR SHARROCK: - - - isn't it, that you say that it has got a lot of logs, like this, and they don't seem to have taken any notice of them in coal?

DR PELLS: Yes. Well, I will – that's what I think. I will come to that, but it's not my turn.

DR ANDERSON: That would be my assessment also.

DR PELLS: Yes.

DR ANDERSON: In terms of other things about the geology, I – they put some – some detailed engineers – geological logs in the back of the IS. I went through all of those. I observe that the Hawkesbury Sandstone was in direct contact with the Wongawilli coal seam that they picked in 80 per cent of the logs. So that means if that rock is not competent or it's easier for the – to pressurise, you know, there would be a direct – leakage of water from the Hawkesbury Sandstone directly into mine voids. So hopefully they were avoiding mining those areas. Yes.

I went through and looked at the actual thickness of the Narrabeen Group rocks, which they stated were located between the Hawkesbury Sandstone and the Wongawilli coal seam. They were absent in 80 per cent of the locations, and when I calculated the average thickness of where they were, I got a value of .4 metres, not 2 metres, as it was modelled.

So there's five times less resistance to vertical flow towards the coal seam than the model simulated in the model. And they also simulated model layers 6 to 10 of their model with the same hydrogeological properties of the same storage and hydraulic conductivity values. Now, these layers represent Hawkesbury Sandstone, Narrabeen Group, the Farnborough claystone, and the Wongawilli meters. So these are all different geologies. They shouldn't have the same hydraulic conductivity value.

PROF FELL: But the end effect is – I understand you're saying there will be more flow into the mine.

DR ANDERSON: I'm saying that's the potential risk. The issue with the model is that it's a single porosity, single permeability model, assuming fully-saturated conditions. So it doesn't have partially-saturated flow. It doesn't have a desaturation condition developing up from the – from the mine workings as – as – as the mine is proceeding. So I – I can't conclude that, but I – I suspect it's a risk, if they haven't modelled the geology properly in their model.

PROF FELL: Well, we do have data for, say, the Berrima mine, do we not – some figures from that that might give us some guidance?

MR LINDSAY: I think you have to be very, very careful about referencing to the Berrima mine. You have to remember that up until 2007 or 2008, there was absolutely no data available from that mine other than day-to-day logs. There had been drilling in that mine, and the other thing that forced ..... had eventually was the fact that the government told them that they had to go and get an operating license because they didn't have one. The thing had been around since 1880 or I think in a big way since about 1925. It was a totally date-free zone, and - - -

MR SHARROCK: Underground quarry.

MR LINDSAY: Underground quarry, that's correct, yes. Lovely people, but they managed to destroy the ..... entirely wherever they mine, but that was a slightly different situation because it was a total caving exercise, but the references – using the Berrima mine – Steve will talk briefly to this, but using the Berrima data as a reference point is fraught with danger because the data is extremely poor.

DR ANDERSON: And I will cover Berrima in a moment.

MR GATES: Wasn't that one of the calibration parameters – that Berrima flow information?

MR DIEKMAN: That was ..... yes.

DR ANDERSON: Yes. I will touch on that in a moment. Next slide, please, Alan.

MS TUOR: So just on the logs.

DR ANDERSON: Sorry. Yes.

MS TUOR: Are the logs comprehensive? So when you say 80 per cent of logs, are you – do you think there has been sufficient logs done?

DR ANDERSON: I didn't. I didn't include that question in the scope of works.

MR LINDSAY: I can comment on that. They say they have data from several hundred bores, but the only data that they showed in these logs where the sites where they had piezometers, so even though they show 40 or so bore logs, you've got to divide that by three because piezometers – there are usually three drill holes nested together for a piezometer. So the answer is yes, they produce data, but there's a lot more that they've got that has been hidden from us. And they wanted even more, as I showed in that slide before. Data is a real problem in this project. It really is. Dough.

DR ANDERSON: Yes. Next slide, then, please. Okay. So the next issue that George was asking about just a moment ago, interpretation of field hydraulic conductivity data. You will see a little wiggling red line over on the right-hand side. And my concern with the model, they've represented what they think is an average hydraulic conductivity value in the formation by looking at all the different types of tests from the smaller scaler in a laboratory core test in the vertical direction to packet tests on individual wells, or they see a ..... interval of the well and do a pressure test on it, to pumping tests which are the black and – black square and black circle on the figure. So on the right-hand side you will see a black square and circle. That's the horizontal permeability or hydrologic conductivity from their pumping test interpretation.

And on the left – dotted left-hand line to the left, those are their vertical hydrologic conductivity interpretations from the pumping test. Now, it's – in my experience it's standard hydrological practice to take the pumping test hydrologic conductivity values as representative of the formation, and certainly if you're building a model for environmental impact assessment to predict the impacts of drawdown from the mine on surrounding landowners who have put all their wells into defects to get high-yielding bores, you would want to have a model which represents the high hydrologic conductivity values seen in those wells. But what this – what the assessment model does is choose values which are about an order of magnitude lower. So that's sort of the substantiation for my point that they're predicting slow flow through the rock pores rather than the defects that are observed in the Hawkesbury Sandstone rock mass.

Based on other pumping tests compiled by others that I've seen, they all tend to have a hydraulic conductivity value that falls in that wiggling red line. The next point I wanted to make was specific yield in the model. This is assigned towards the lower literature values for sandstone, so one or two per cent, which in my experience is drainage of water from defects in the rock mass and not the rock mass itself. The rock mass of Hawksbury Sandstone can sometimes store up to 10 to 20 per cent of its volume by water. The next issue I had was that the model has assumed ..... is always 10 to 100 times lower than the hydraulic conductivity. Wherever there may be fault throws or sub-vertical joints in the ground, that assumption is not realistic. So the model is biased towards underrepresenting the amount of vertical water movement in the model.

It's assuming more horizontal flow than may exist in reality. So that brings me to my summary of model limitations from this modelling approach and that is that defects and structures are ignored. It predicts slow flow through the Hawksbury Sandstone rock matrix. If you have unrealistic geology and hydrogeology, you will have an unrealistic prediction. I think the timing and magnitude of drawdown impacts of surrounding groundwater works, intersecting joints, fractures and structures, will be underestimated by the model. It may under predict the amount of groundwater flowing through mine workings but there's some complications in relation to them. I think Steve is going to touch on the modelling of water flow into the mine workings. And I think because of these reasons, the model as presented can't be used as a reliable tool for decided make good arrangements at landowner works, particularly the question of whether a loss of pressure or drawdown on landowner work is due to mining or is due to some other effect.

MR GATES: Like another pumping bore nearby.

DR ANDERSON: Like another nearby pumping bore or – yes, who is talking more water than this allocation, or something like that.

MR GATES: Yes, that's a good point.

DR ANDERSON: Yes.

PROF FELL: I'm very conscious it's now 5. It leaves us only half an hour to complete your presentation, so - - -

MR LINDSAY: We will have to accelerate that.

DR ANDERSON: Yes. Okay. So - - -

PROF FELL: Manage it how you think appropriate.

DR ANDERSON: So next slide, please. I will move quickly through the slide. All the information is there for reading, but basically they said the model is not sensitive to the specific storage value or a storage coefficient. Models are sensitive to storage coefficients, so I think that's just – that just means that there wasn't enough information for transient calibration in the model, and therefore it won't predict the timing of impacts the landowner works quickly enough. Next slide, please. Their claims about transient model calibration. They said they've calibrated to Berrima mine.

Well, basically, in the IS there was no time series plot of observed and modelled Berrima mine groundwater levels and inflows and outflows from the start of the mine to the end of the mine and if you go back to the groundwater flow equation which is shown on the top right-hand side of the slide there, to calibrate a model, modellers estimate K and SS in the equation by measuring the rate of pressure decline through time, the distribution of groundwater levels through space, and changes in recharge and discharge, so if they haven't been able to present a calibration with all that information in their report, their model is not calibrated to Berrima mine.

Another reason it can't be well calibrate transiently is because without those detailed stress level history from the past, they might have short-term stressors in their models from aquifer pumping or changes in recharge from year to year, but their model stress period, or time step, is half a year, so any transient disturbance to the aquifer to calibrate an aquifer storage value is lost. So – and also that the recharge rates for the calibrated model are quite different to what was modelled at Berrima mine. They've modelled groundwater recharge as 1.8 per cent of rainfall whereas Boral's model of Berrima mine had one to four per cent of rainfall everywhere and eight per cent over the Colliery.

So I would suggest that their model strictly is plus 1 and it's not as well calibrated as Hume Coal have claimed it to be. Next slide, please. And lastly, the uncertainty analysis. They used a Monte Carlo approach. They come up with statistical distribution, has described a possible range of values for each model input parameter. They ran the model but then they dismissed in their reporting summary tables – everything outside the 33^{rd} to 37^{th} percentile of results.

Standard scientific practice is to present either 95 to 99 per cent confidence interval based on your appetite for risk. Their inputs for the uncertainty analysis had initial model inputs biased towards lower end Kh and Kv values – Hawkesbury rock matrix. The Monte Carlo approach itself in groundwater doesn't provide calibration constrained outputs, so some of the outputs may have been de-calibrated, and so it didn't affect – didn't consider the effect of structures.

There has been some recent advice from draft – draft advice from the IEFC on uncertainty assessment and they say geological model uncertainty has become crucial in situations where ground models are history matched to head and discharged data from historical pumping or climate record that are then used for extrapolation beyond the conditional collaboration bays.

In such out of range simulations, the geological structure uncertainty may often be the dominant source and, thus, alternate hydro geological conceptualisation should form part of the uncertainty assessment. And so Hume's uncertainty assessment didn't include alternate geological conceptualisations. Next slide, please.

DR PELLS: ..... That's me, I think.

MR GATES: Can I get a question in before you - - -

DR ANDERSON: Yes.

MR GATES: - - - swap to Steve. We've read your reports, you know, and so well, it seems really helpful to us. You mentioned in one line in one of your reports was in the Monte Carlo assessment, it still has to be run through a ground water model and the ground water model is not perfectly calibrated, so those biases or errors carry across into the Monte Carlo uncertainty analysis. Is that what you're saying?

DR ANDERSON: Yes. Well, what I'm suggesting is you come up with a potential range of parameters that you think could be valid and you just throw that at them.

MR GATES: Yes.

DR ANDERSON: You throw them at random in the ground water model. It makes a prediction.

MR GATES: Yes.

DR ANDERSON: But you're starting – it's – essentially, it's like a shotgun approach. You just throw – throw a range of values at the model, answers come out, but you're starting from some starting point and your shotgun blast is centred around your initial assumption of what is true. But if their cave values are one order of magnitude too high, there's not going to be many shotgun pellets around the upper-end Kh values and those that do have the high cave values may have the wrong storage values and, therefore, that model output is somewhat meaningless. I'm just saying that there are better techniques for doing uncertainty analysis in ground water studies that look at the – look at constraining the calibration inputs ..... - - -

MR GATES: Okay.

DR ANDERSON: ..... methods, for example.

MR ....: Steve.

DR PELLS: Right. With respect to Bill and Marylou, I will smash through this, but I welcome any questions. So next – sorry. My name is Steven Pells. Back in 2013, I produced a report for a community group. The mine hadn't been proposed at that stage – or had been proposed, they didn't have an actual mine plan. I was asked to comment on the ground water effects and I ran a numerical model. The outputs for those showed a lot of drawdown and a lot of inflows, more than – so you can go back, Alan.

MR LINDSAY: Yes.

DR PELLS: More than – than I had seen at other mines in the Sydney basin. So I thought, "This is quite a lot." It adds up to me at the time because it's quite shallow. There's no – it's quite high yielding by all evidence that I was given and also there's no magical way. A lot of previous mining assessments of ground water models have relied on the Borde Hill claystone or some layer to, sort of, separate what's happening on the surface from what's going on in the mine. So there was nothing of that here and so my conclusions on the matter, and we said it publicly and it was very unpopular, that, "Look, there's nothing this mine can actually do to make effects not very high."

But – so when Hume released their mine plan, they showed quite a low drawdown compared to other mines and quite low inflows and their claim is being, "Well, we calibrated our onto Berrima mine and also we've got this amazing new mine technique." So as a scientist, I think we've always got to be prepared to be shown that we might be wrong, so I spent not an insignificant portion of my life trying to figure, "Well, why the differences?" And this is just a snippet into my journey, I suppose. Next slide, Alan. So regarding Berrima, so this is the slide I was referring to with Shane, this is the Hume proposed column. This is Berrima. So Berrima mine – well, if I drew a – around the first workings, there's approximately 700 hectares.

And my understanding is the coal seam dips to the south and they – most of the flow gets collected out here and that – and as far as I've seen it, I am personally satisfied that that what they measure here is a good representation of what's going into the mine. You got to keep in mind, this mine – this is at the end of life. This mine has been going for 120 years. So when you first do a perturbation into the ground, you get a lot of inflow because you're under a lot of water. The evidence that we have is that it has been drawn down to seam level at Berrima mine and so this outflow that we see – observe of three to four megalitres a day is now what we see after 120 years for a 700 hectare mine – drawdown to the seam.

So they've proposed this mine which is – I said somewhere in this presentation is five times larger. I think it's more like – I said seven, it's more like five. But anyway, 3400 hectares, despite being five or seven times larger, the inflow is about the same as what you expect as we reserve at Berrima after 120 years and the drawdown is only 20 metres. So – okay. So first, just stepping back and looking at this thing, well, why – how do they achieve that? So my – I guess the next question, Alan – yes, go to the next slide. So their two claims were – well, we calibrated ourselves to Berrima, so ..... well, how does that add up if that's what Berrima is? And secondly, we've got this great mining method.

Now, so I put in my ground water model, I put their proposed mining method in it as per their EIS and we had various different assumptions for how long these panels were open. I did put – well, I will come to that next. But there's three – there's a lot of things that I've said in submissions, but I will distil it down to three things, which I think are the main reasons why my predictions are so different to theirs and that's, one is dismissal of this sandstone aquifer, two is a drain conductance control and three, is what we've already talked about being this low conductivity coal – formations above the coal measure that they've adopted.

Next slide, Alan. So this is a prediction that I've presented in our ground water model and you can see – and I should just be clear that this model represents the mine plan. It includes bulkheads and we made a pragmatic assumption saying, "Look, these bulkheads are going to be open for a while. It's somewhere between probably two years, but we tested five to 10 years that these things were open before they could put a plug in. I didn't assume any longwall mining. I know – I've been – Hume objected that I simulated this is a longwall mine. At no stage have I represented this mine plan as having fracturing or ..... or anything longwall to do with it.

As ..... viewed, our geology was from the Austen & Butta investigations mostly for the mine scene which was a lot of bores done in earlier investigations. For the hydro geological parameters, we relied on the published things by John Lea and I think his personal experience. So he has put in around 26 bores in this region. And we predicted drawdown to the seam which is consisted with what's at Berrima. Next slide, sorry, Alan. And in terms of inflows, the inflows are large, so these – I did a lot of sensitivity tests. I was quite – I guess I've got nothing to prove in a sense. I was quite liberal with how wide I was able to run my sensitivity. These particular ones show a different scenarios for how long the mine was open before a bulkhead went in. But I've got inflows in the order of anywhere between 20 to 80 megalitres a day.

Next slide, Alan. And again, sorry. So the next slide, when you press that, you will see there, their drawdown predictions come up across mine. So whereas mine was going down to about 90 metres to the drawdown – to the seam, you can't see this here, but that little green thing is 20 metres, so they're only getting maximum of 20 metres drawdown above the mine. Next side, Alan. And the inflows are about a tenth of mine, despite the mine being about – and similar to Berrima, but despite it being – I said seven. I think it may be about five, depending on how you measured the first workings, etcetera. And it's a new mine, so you would expect higher inflow.

So why? Next slide, Alan. Why it even ..... impacts? So the first thing as I said is the conceptual model. So from – this is from the published work of John Lea and the paper at the University of Newcastle and he had, sort of, broken up the Hawkesbury sandstone into three units – unit A, B and C – and I just highlighted here in blue from the publication what he deemed to be a good aquifer based on his encountering of conditions and also on various gamma tests and geophysics. So this is his published work and this is what we assumed in our model. So if he's wrong, in a sense we're wrong too.

But – next slide, Alan. I pulled this drawing out from the EIS. So this is data presented by Hume and this picture was in the EIS saying this is the map of a hydraulic conductivity of the Hawkesbury Sandstone at, I think it was between 14 and 44 metres along the coal seam, so this was in this unit A and they had presented then funny units of ..... which when you back calculate it comes out as values around one, two – you know, up to 1.5 metres a day.

Looking at what that is over on the right here, one metres a day, it's around up here. So their data in their EIS is suggesting that for this area of the Hawkesbury Sandstone, you should be around a metre a day. In contrast, they're around about .01 metres a day and down to .001 for the vertical conductivity. So there's no correlation between the data that they've presented there and the data that I adopted from John Lea and what they've simulated.

So next slide, Alan. My first reason for why we've got such different inflows is that from – and I've encountered this in other places too. We can talk it about ..... but I've found multiple lines of evidence that suggest that there's a high yielding formation above the mine, an aquifer in its true sense, and this hasn't been represented in the EIS model at all. They've objected to our use of it saying it's probably representing high fractures, to which I say, "Yes. That's a possible explanation, but you have to explain why John Lea has been so successful in every instant and secondly, if it is due to high fractures, then why don't you represent that in your model rather than just – you know, when we're confronted with data in science that doesn't agree with our hypothesis, we can't just put our eyes over it. You know, we have to do something with it. So it's not in their model at all. That's the first reason.

So next slide, Alan. And the next one is what we've talked about already. So this is from the EIS. This is showing ..... of what they've called interburden and it's up to 10 metres thickness and it corresponds nicely with the proposed mine plan that they've got this layer. So, I mean, when I read this, I, sort of, chuckled to myself and said, "Look, they've found their Borde Hill claystone to save themselves." That, we looked at – there's over 200 boreholes in there. And we looked at them and we could find – in most of them there was hard contact between the Hawkesbury Sandstone and the coal regions. So we didn't find any evidence to support this extra layer in our model and we didn't put it in, based on the evidence.

And this is actually what McElroy and Bryan in the eighties also published, they saying:

> *Direct contact between sandstone and ..... coal seam are 90 per cent of the bores.*

So that's another significant difference between why our model is different from theirs. Next slide, Alan. And so my view on this is that it's a tenuous assumption to have your mine inflows controlled by – to some extent by this layer that, (a), probably – it probably doesn't exist at all, but if it is there, it's very thin. And, (b), it's highly likely it's going to be disturbed by mining. So if that's what you're hanging your hat on, that's a tenuous proposal, in my view. Next slide, Alan.

So the next one is – for me it's the most complicated to explain, and this is to do with how flow is represented into the mine. So they've used this – just remember these numbers of .05 to .1 metre squared a day. I will skip to the next slide, Alan, if that's all right. So – one back, sorry.

MR LINDSAY: Okay.

DR PELLS: Yes, we will just – no. No, it's there for good, sorry. You don't get the latest version. So just leave it as it is. So on the left-hand picture, when you're simulating flow into the coal seam in the groundwater model, you have to tell the model for this layer you're going to let water in because you're going to mine. So the option in the models that we both use is this a drain boundary condition, where you're saying, "Water comes in here". Now, a common approach – which I did and which has been done by many people before, including people working for EIS – is to just provide a very high number to this value.

And what that's saying is that you're not providing any impedance to flow here. The way that flow comes into the mine is just through the formation, and it drains through the formation, and that's what controls how much flow comes in. And when you do that – well, alternatively, what they did is provide a very low number, which is, in a sense, putting an impedance to the flow at the mine interface. Now, when I say a low number, it was an extremely low number, and that has two important implications. One, it controls the flow, and, two, it changes how the head – the pressure profile above the mine. So I did an analogy with hydraulics which I presented in my submission.

I don't have time to present here, but it's an analogy. But you will find that if you run a model where your inflows are controlled by this mine boundary condition, all the head losses will be at that location. It needs to keep up all the energy to come across that boundary condition, and you won't get much drawdown in here at all. In contrast, if you leave – you can have exactly the same flow but not control it by this drain boundary condition and you will get a different pressure profile. So next slide, Alan. I did a quick test in one of our – next again, sorry.

I did a quick test in one of our – just as a conceptual model. I ran two – I got a colleague to say, look, just set up two groundwater models, give them the same geology but – and make sure – yes, and put a drainage ..... in here, and make sure that they have the same flow coming into them. One of them has a flow control because you put a small – a drainage control, and the other one has a completely open drain. And these two sections have exactly the same discharge through them but one of them has drawdown and the other one has no drawdown. And that's because when you instigate an outlet control like that, the equal potentials will take on a different shape.

So the implications for that – if you can click back about five times, Alan, to go back to that map of Berrima coalmine. Right back to the first. One more. Two more probably. No, a lot more. Yes, keep going. That one. So when they talk about calibration, the only bores that they presented or put calibrate to were in the northern extremity. In EIS, they do not present anywhere what the drawdowns to Berrima coal are. So they did get a calibration, but it just isn't – I don't have the information presented to me to show how they represented drawdown to this seam. And my suspicion is if you use a drainage control like that, you won't get much drawdown at all.

We just don't know with the information they've given us. They've given us no information on how they've modelled Berrima mine. There's no grid, there's no cross-section of where they put their drain boundary conditions, they don't present the drawdown, so we just don't know. So, Alan, if you can – if I can labour you to go all the way back to where we were.

PROF FELL: Can I ask a very dumb question?

DR PELLS: Yes, sure.

PROF FELL: My understanding is when they drill, they take the coal out and actually leave a section of coal all round.

DR PELLS: Yes.

PROF FELL: Does that layer of coal all round control the flow into the mine? Because if it did, it would go a long way to explaining exactly what's going on.

DR PELLS: Yes. And there is some evidence that that becomes unsaturated and it provides an impedance. Okay.

PROF FELL: Sure.

DR PELLS: There's no evidence in the scientific literature that would suggest that the value that they chose is a good representation of that process. Yes.

PROF FELL: Well, I'm just interested.

DR PELLS: Yes.

PROF FELL: Is a very simple concept one that you can do a rough order of magnitude sum, because it's going to be a whole lot less permeable than the Hawkesbury Sandstone, which you say is in contact with - - -

DR PELLS: Well, not in their model. Their model – not in – well, in their model - - -

PROF FELL: You get what I'm - - -

DR PELLS: Sorry?

PROF FELL: I mean, it's like putting a coating on the outside of a pipe.

DR PELLS: But it's only a very small thickness, and it becomes disturbed also. So I think the impedance that the coal could provide to flow would be marginal. If you back calculate - - -

PROF FELL: Yes, I'm listening to you.

DR PELLS: Okay. Sorry.

PROF FELL: I'm pushing this hard.

DR PELLS: If you back calculate what the actual drainage value of .1 metres squared per day actually implies for the properties of this layer, I have shown that it's like stuffing the mine full of clay. Now, they've dismissed it and said, "That's not true". But then if it's not true, show me the calculations, you know.

PROF FELL: Write a statement and write a paper and - - -

DR PELLS: Yes. No, show me the calculations of it if it's not true, but that's the sort of impedance that they're imposing upon it. So I think it's completely unrealistic. Now, I just want to get – before I go too – I've gone much too far. My last point I will get to here has been the sensitivity testing. So they say that they've tested it for sensitivity. They never tested this – I get that it's controlled by the drainage thing. So you can't get flow into this mine because they've got this valve closed in the front of the mine, and they've got these parameters up here. And so they – they're not very courageous with how they test this sensitivity and open it just a little bit.

And then – but then they test this ad nauseum, about, "We can the formation going all this way, all the while having this valve closed". And my argument is that that's not a sensitivity test. The analogy of it, however, if you're sitting on a bicycle, and you've got two brakes, and you've got them both closed, and say, "Look, my bicycle doesn't go downhill." And someone says, "Well, that's because you've got your brakes on ,"and saying, "No. Look, see, I can – it doesn't go downhill, " "That's because you've got your left brake on," and go, "See, it still doesn't go downhill." "Well, that's because you've got your right brake on."

And they never at any stage do they test both parameters of controlled flow and sweep through those and say, "How uncertain is our analysis?" But that's my analogy. And, in summary, I just – my view is that their model is both under-predicting drawdown and under-predicting inflow.

PROF FELL: I'm conscious now, 10 minutes to go.

MR LINDSAY: Steve has just finished.

DR PELLS: Yes. Sorry.

MR LINDSAY: And we will have Bill. Could we just go back to the other model?

MR SHARROCK: While things are being set up, you're quite right: there's not much coal around when they take out their working section, not to the right or left where those webs are, and they don't even necessarily go to – they might end up with a coal floor, they've said, and other places they're not. But the working section is three and a half metres, and in most places, the seam is 10 metres thick, so they've got six and a half metres of coal above them. It's not right on Hawkesbury Sandstone.

DR PELLS: Well, you will get deformations, and if coal did – look, they've also – the values that they've chosen for porosity of coal is quite low. It's very low to what I've ever used in modelling before, what I've seen tests of, so that's my other question – is that, look, you know, at least provide a fair model, a fair number for the coal formation, but yes.

MR ....: Bill.

DR RYALL: Okay. So I'm a geochemist. I graduated University of Sydney and carried out – my first 15 years in my professional life was in exploration. My last life – I think it's the last one – was in management of contaminated land, and for 10 years, I was site an auditor accredited by the EPA to sign off, essentially, contaminated sites when they're properly cleaned up. So I was asked by Alan to look at potential for contamination of water, groundwater and surface water, by placement of coal washery rejects back beneath the ground. I will make mine very quickly. I also made some geological implications, which are on my slides, which will be provided to you, but my two principal issues are with what they call coal washery rejects to comprise stone and rock. This clearly is not what coal washery rejects are.

New South Wales EPA have given a number of resource recovery exemptions and orders related to coal washery rejects, and they define in there coal washery rejects to comprise fine coal, coal dust, and soil and rock that has been ground and washed. Some of the resource recovery exemption tells you that the coal washery rejects can contain up to 40 per cent of fine coal. This is not the coal that they used in the modelling. Now, I wasn't given the principal consultant, RGS – I wasn't given their report. It was denied to us, but I based my assessment on a report by Geosyntec, who relied upon and quoted the results of the IGS report. So, firstly, I disagree that the samples I used to determine the leaching characteristics of coal washery rejects weren't representative of what will be really happening in true life there. So I go into that in some detail there.

But the other thing that I'm particularly concerned about is the poor documentation of groundwater monitoring that they propose to take. This is critical to assessing contamination of groundwater, that the monitoring is started at a very early stage, pre-mining, and continues through mining and beyond mining – beyond mining because many of these coalmines are known, mostly through the work of University of Western Sydney characters, to often increase after the cessation of mining. The simplistic groundwater monitoring program that they talked about is not sufficient. They didn't adopt, you know, control charts, which are normally used, where we look at the intra-bore characteristics over time and statistically analyse them so that we can detect concentration changes over time very readily and thereby be able to identify the impacts of mining on groundwater quality.

So they're my two issues, basically, that I look at: (1) not representative testing for leaching; they use a method, kinetic leaching, which will produce only limited results. They should have used this LEAF testing method, this leaching environmental technique that was designed US EPA. It's now adopted by some regulators in Australia, and, clearly, it's a much more sophisticated method for estimating contamination of groundwater over long periods of time. That, basically, is my situation.

PROF FELL: We would be grateful. We will get a copy of your overheads?

DR RYALL: You will. You will, yes.

PROF FELL: That's very important. Look, I will have to kind of wind it up there.

MR ....: Can we - - -

PROF FELL: - - - first asking the panel if they have any further questions - - -

MR ....: Can we just let - - -

PROF FELL: - - - then handing to you for just a - - -

MS M. POTTS: Just one more. One more - - -

PROF FELL: I'm terribly sorry.

MS POTTS: Short. Very short.

PROF FELL: I thought you were just there to watch over us, like all good lawyers.

MS POTTS: Well, you know my name is Marylou Potts. I've represented landholders. I'm a solicitor. I have an incorporated legal practice. I've represented the landholders in the Southern Highlands since 2011, all in relation to access to land sought by Hume. In relation to the majority of those landholders – and this is across the authorisation 349 – Hume did not gain access to their land, and so Hume did not undertake any exploration on their land. And you've seen from Alan's slide that they were seeking to undertake intensive exploration on these properties, and they weren't allowed to.

We won in 2016. The dispute sort of went on from 2011 until 2016. We won on appeal before Chief Judge Preston, who found that on these properties, there are innumerable significant improvements, which we described as no-go zones. In other words, you can't drive across it, you can't get in, unless the landholder says, "I give my consent." That position remains. Hume has not been able to get onto these properties. Hume will not be able to get onto these properties unless the landholders give their consent. In fact, these properties are very significantly improved. Bret Walker, Senior Counsel, represented the landholders on appeal. His view of the decision and also the amendment of the definition of significant improvement has not changed the position of the landholders to the extent that Hume would be able to get on.

In relation to Hume's make-good model, it is fundamentally flawed, legally, because they have no right to access. So if they can't access, they can't undertake their field studies. They can't understand – and field studies – their appendix in relation to make good is riddled with provisions saying, "We will have to undertake further field studies. We will have to get onto this land. We will have to assess it. We will have to" – they won't get on. So their model is fundamentally flawed on that level. Legally, under section 31, under their exploration licence, they won't be able to get on, and even if they relinquish the exploration licence because they get their lease, they can't get on again without landholder consent under section 81 of the Mining Act.

So, further, their dispute resolution suggestion that they can use part 8 of the Mining Act in relation to resolution of disputes, I think, is unfounded because part 8 relates to exploration, and resolution of these disputes is not relating to exploration; it's relating to mining. So the jurisdictional basis is unfounded, in my view. I've written this all down, so you can - - -

PROF FELL: Look, I'm very sorry we didn't leave you enough time.

MS POTTS: No, no, no. That's fine. I've - - -

PROF FELL: This will be very useful.

MS POTTS: This is not actually in the slides that have been given to you by Alan because I was unable to do this until his slides ..... so this document includes my assessment of the fundamental flaws in make good. It shows the area of land of the landholders that I acted for, which is about 1000 acres, but there's also another 1200 acres that Hume didn't explore on Dr Nasser's land, so that's for – 2200 acres in MLA 527 have been unexplored by Hume, and my view and my instructions are that the landholders will not let Hume on their land. They will not negotiate with Hume. They have a very poor relationship with Hume, who has cost them very significant sums of money over a very significant period of time in disputes in relation to trying to access their lands.

PROF FELL: Thank you very much.

MS POTTS: That's all right.

PROF FELL: Now, I will just ask members of the Commission - - -

MR SHARROCK: Look, I will be brief. I'm worried about this – the way forward, in the sense that we have heard from many people that Hume haven't done enough geological exploration and they can't.

MS POTTS: No.

MR SHARROCK: And, you know, what is your advice on that? What will the outcome of that be? I mean, they have already been to court so it's not a matter of I will be old fashioned, going to the Mining Board and say, you know, we have a right under an Act. So what will be the outcome of that?

MS POTTS: Well, there is no outcome of that. I mean, they – Hume Coal obviously could seek access under the new definition of significant improvement. I think they will have the same difficulty that they have already had and that the court will find that they won't be able to be given access to these areas which are significant improvements. This – the southern highlands – these properties are – they're magnificent properties. You know, every inch of land has been improved and they love their properties, they really – they really do, and the whole purpose of the Mining Act providing this protection of agricultural land that's significantly improved is to encourage landholders to improve their land. And this is their form of protection.

PROF FELL: Thank you. And thank you, George.

MR GATES: A couple of things. I really appreciate you guys explaining your position on the groundwater because we have been hearing various other positions, you know, and I got a lot out of listening to your discussion. The Department of Planning and Environment are relying quite heavily on their independent expert, Hugh Middlemis, and his review of the modelling and yours – and also your various submissions. Have you got any comment on Middlemis' review, mindful that we're being recorded here, you know.

MR LINDSAY: If we could be polite. I think the problem with Hugh Middlemis – and we were grateful that he actually sat down with us. Hugh – there was supposed to be a meeting of experts that Hugh was going to bring along – presumably Dr Merrick and maybe the other fellow, Kalf. They pulled out the night before, of that meeting. They didn't want to front up to it, you know. They didn't want to have a discussion with these guys. Middlemis was there and he – and we talked and we disputed a lot of his material because, you know, he is from the Merrick school of groundwater modelling, you know. He and Merrick have worked together for years.

I'm not saying that that influenced his output but they have – you know, you could tell that there was a commonality in the arguments that he put up. But the biggest problem we had was he didn't appear to have a good knowledge of the geology. He hadn't looked at it. They haven't given the data to DoI Water, for example. So how on earth are we expected to accept that position that they take on the groundwater when we haven't been granted access to the data. But I think the most important thing about the DPE assessment is that even using Hume's model, modifying it for that ridiculous 67 per cent probability thing up to a reasonable level of 90, even using that model, the groundwater impacts are such that the whole situation is unworkable and you really can't get away from that.

And that doesn't really depend on landowner access or so. The landowners, in my view, are perfectly entitled to use the provision of the Mining Act that was put in place to give them some protection. If a company wanted to seriously mine this area, they should have done it 40 years ago before people moved in and decided to do the developments that they had. These guys are late. Two big companies, Shell Coal and Anglo Coal, had this thing to do on their own and they backed off at 100 miles an hour. The correspondence is available. If you want to see it, I can show you. But – and POSCO knows what it is. We offered it to them and we had a meeting.

So this is a very tenuous situation, to use Steve's word, but the landowners are only doing what they're entitled to do. They're entitled to have their property protected. It's in the legislation to do it. Hume have come in, the DPE have accepted Hume's model but even with Hume's model, you get a drawdown effect that is unworkable. And our position is, quite frankly, the real situation is going to be far worse than that because I have been working closely with Steve over a long period of time and I have been convinced that his figure is right. George, you have had a lot of experience with groundwater modelling. If you take Hume's work in isolation, you would thing that groundwater modelling was the most precise science that's known to mankind, you know.

I mean, they have done all these different models and they come up with the same answer all the time. The fact is you could be out by a factor of two, three, four, and that's what shows up in Steve's work because, in my opinion, and I have had a reasonable amount of experience with sensitivity analyses, you have got to take a wide range when there's a wide range of uncertainty and this is one of the most uncertain situations that I have come across in my business career.

PROF FELL: I'm going to have to call it closed at that stage. I'm very pleased that we worked out a way that your people could come and talk to us - - -

MR LINDSAY: So are we.

PROF FELL: - - - because it has been very valuable and I thank you all for making the effort and we have learnt a lot this afternoon. Thank you very much.

MR LINDSAY: And we thank you very much for giving us the opportunity.

MR DIEKMAN: Yes.

PROF FELL: So I will bring it to a close at that stage.

MR LINDSAY: Good. Thank you.

PROF FELL: Thank you.

RECORDING CONCLUDED **[5.39 pm]**