Don't Frack Katherine – Hearing Transcript

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Knotts Crossing Restaurant, Katherine

Speaker: Errol Lawson

Errol Lawson:	The name's Errol Lawson. I'm a retired person, living in Katherine. I'm a member of the loose group called Don't Frack Katherine, but we aren't in any way presenting an organised set of presentations. My presentation is as a retired citizen-
Hon. Justice Rachel Pepper:	Thank you Dr. Lawson.
Errol Lawson:	Who expects to have great-grandchildren living in this area. If you look at the page, one of the notes, you'll see where I've been and why I think I can say a few things with authority. 27 years as an engineer with the defence in Defence Engineering, where I encountered the problems of the military and helped solve them. Four years with the South Australian government as director of defence aerospace industry development, which honed my skills interfacing with industry, and learnt some of their tricks. Consultancy practice for 10 years, where I was private industry and put those tricks into practice, as you do. And then finally at the end of it all, I thought, "I wonder what all that was about? So I did some research towards a PhD and the research topic was social systems of novel and complex socio-technical engineering projects. And if ever I saw a socio-technical complex novel project, it's the gas industry in its entirety. That was nice. It was successful and earned me some money because I did some lectures on it with the university for a few years. I think it was a successful career, and still going. Why am I here today? Slide two, to discuss the potential sources of contamination of the Tindall Aquifer [inaudible 00:02:14] shale gas industry through all stages from exploration to completion and beyond. The emphasis there is on contamination of the aquifer. There are many other things I could have talked about, but because the aquifers in the Northern Territory are so essential for six months of the year, not generally appreciated down south as the Northern Territory has a six-month drought. The wet season, it comes and goes, and for most of the rest of the year, it depends on the aquifers and the rivers. And so any threat to the aquifers is a threat to the entire social economic environment system that we live in.

And also because the conversation has been controlled very much by the industry and government and focused on exploration, and the act of a single fracking operation of a single well, which tends to confine the time scale, I said from exploration to completion and beyond. So I'm looking well out beyond when the gas industry goes home and what's left behind. I take the risk matrix approach, which is consistent with the issues paper. What I believe I talk about is primary relevance to term one.

That's why I'm here, folks. Potential risks of hydraulic fracking, which is slide two. This is extracted from a presentation in Katherine on the 22nd of November 19- 2013. Haven't been going that long. 60 years but maybe not that long. 22nd of November 1913 ... Sorry, here I go again. 2013, Dr., now Professor Damian Barrett from the CSIRO at a community meeting listed potential risks of hydraulic fracking. That list I think is still in existence. Surface transport spills, well casing leaks, connectivity through rock fractures, drill site discharge, wastewater disposal, retention point release. The largest risk, in italics, wastewater disposal, high epistemic uncertainty. I think he meant episodic, I'm not sure. High flowback volumes in large number of wells.

For this talk ... Let me just put the frog away. I define an event for the purposes of the risk matrix as migration to the aquifer fluids or solid matter from the frack shale bed or spillage at the surface works. The material may possess gas and all that stuff. The likelihood is usually expressed as the probability of the event occurring, which in this case is the probability of the event of a single well failure multiplied by the number of wells. The impact that I've proposed to describe is contamination of the aquifer so as to render it unsuitable for any human consumption, stock water in agriculture, horticulture, fisheries and tourist activities. So I think I've covered the lot.

Excuse me. Hope that didn't come through. I take well casing leaks as the object of the exercise, or one of them. I repeat there that the gas industry processes have as their objective to establish or maintain well integrity by the application of cement to seal the space between the casing and the surrounding geological structure. Now, I've said before that we need to know the number of wells so we can get a decent idea of the probability, so I've gone through an exercise. Later in the day I believe you're going to hear from [Inaudible 00:06:27] of Nutwood Downs. He's given me figures, he's quoted as having been told by Origin Energy that they will have 400 wells on his place. They want to put 400 wells on his place. I assume that they multi-pad wells, which is four wells per pad. That's somewhere between 1600 and 3200 fracked wells on his 958 square metres.

I work that out, I get a well spacing of 1.5 kilometres, which conflicts with what Mr. Crowhurst said earlier, four kilometres. Immediately you see this subtle emergence of misleading information, with the best of intentions. It's not malicious misleading information, I think it's accidental through incomplete, out of date information. I put that bit in very early, that's it's so difficult to find out immediately up to date correct information that people tend to think the worst of everybody else.

It's an evolving engineering system. Being developed by evolution is the whole fracking system. It's not being designed from scratch, if I can make that point as an engineer. You've got two choices when you design a system. Design it from a specification and/or you evolve from what you know, and you work out from what you know into what you don't know. My view of the fracking industry with horizontal high volume slick water fracking is that it's evolved and no one's ever gone back to square naught and said, "Let's design this from scratch." And it's full of incipient thoughts. I speak as someone who studied complex novel socio-technical systems. Have to get that bit in.

Further on, there's a bit more there which is more interesting on how this misinformation gets promulgated. At 4,000 wells, I crosschecked by to the Frogtech report. The Frogtech report is the call of first report, not the call second report that Dr. Hawke quoted so heavily from. They later derived the number of wells in a given area by a formula of a well spacing of .8 of a kilometre. Fairways are 5% of the shale deposit, and that gave them the 67,000 wells throughout the whole of Northern Territory that's so often quoted.

The provenance of the 67,000 wells is right back to the Frogtech report. I get 1,260 on Nutwood Downs compared with 400 from Origin. Probably if I put in the fourth kilometre spacing that Mr. Crowhurst has quoted, it would be less than that. Immediately again there's this emergence of discrepancies. If you were in Origin there, in its Camp, and you said, "I know I've said 400 wells," and someone's quoting 67,000, you're wrong, you're bad, go away. Again, misinformation, it just breeds like flies.

What do we do? We've got this cement seal that's trying to virtually replace the earth structure that's been removed to let the pipe, the casing go through. As an engineer, I can say it's exposed to a very hostile environment. On that slide five, mechanical shock, we'll talk about that. Vibration, thermal shock, moisture, salt, pressure differential, temperature differential, and the earth moves. During my engineering career, I was exposed and encountered all of those, except the earth never moved to me. But on one occasion I was up in the air in the mast of a destroyer escort, and every time a ferry went past, I can tell you, the mast moved. After 20 minutes of that I wasn't well.

I've now gone from, those are the environmental factors that are likely to affect the integrity of the well. I then talk about failure mechanisms. At this point I have a dilemma, because I realised that I'd done something that I didn't want to do, I had reduced the old reductionist trap. I had reduced the whole fracking operation to a series of sequential linear operation. This is by no means a sequential series linear operation. It's a complex operation and one of the features of complexity is the interaction and interdependence of the elements. And so I'm going to divert from my little talk and say, there's another way to look at this as a complex system. None of the presentations that the industry or the government give us address that issue. The key point is this interdependence between the elements. And so you touch one element, you change it, and you think in your linear model, that's okay, I can change the perforation. I can change the length of the well, the horizontal arm. I can move from a vertical world to a horizontal well. I can move from fracking in sandstone to fracking in shale.

Those are big steps. If it was linear and there was no change to the interaction between the elements, you might get away with it. When you have a design philosophy that is really evolutionary, then you're really staggering from problem to problem. That's what I see when I look at the ... I didn't realise it till I wrote it out. When I woke up this morning, I said, "You've got it wrong, buddy." You've got a choice. You read it and stick with it, or at this point you say, "I've got it wrong." This is not the way to look at this system. When you include on top of that, the social effects and the environmental effects and the economic effects, then you have a system which is virtually uncontrollable, the way it's being addressed now.

Let me give you an example. On slide 6, there's two references that relate to the perforation gun. Because at one stage of course you stuck a tube down there, you seal it up with cement, and the next thing you do is you divide the shale bed up into stages and you blow holes in the casing in stages. Now, you can say that quickly and it sounds, "Well, that's good. We'll do that." But then when you have a look at these patents, one is 1999 and one is 2011 and you can immediately see as much as you can from a patent that there's been work done that's been developed within that area.

What starts off as shape charges being ignited and holes being blown in the steel casing and the cement surrounding it now becomes a much more complex thing where there's two explosions, a bit like a car safety bag exploding. There's two operations, one is the immediate explosion, many many tens of thousands of pressure in a few microseconds, the ejection of not just the gas but the ejection of very heavy weight pellets, including depleted uranium. That distracts a lot of people. I say, "Hey, they're using depleted uranium for perforation." Does that mean we have an atomic explosion down there? No, no, no. Depleted uranium is heavy stuff. So you get this vision, idea, of, they might call it continuous improvement; I'd call it evolutionary development.

And so you say, "What does that do to this wonderful cement seal?" And say you've got that many stages, somewhere between six and 25, you've now got an incredibly powerful and complex explosive chain repeated that many times. My belief is that that would administer, even in its primitive form, a great shock along the length of the tube, and that shock is in fact a pressure wave in the steel, and that's going to cause differential movement between the steel and the cement. They're both rigid bodies, they're both rigid materials, and so you've got differential movement. What that means to me is, no matter how slight, the bond is being stressed. Do that many times and the bond is broken. And you can go down the list.

But that's the example where I say, here's where the gas industry is adopting the linear model rather than the complex system model, and they're doing something in the perforation process, which is accelerated, increased the pressures and the shape of the pressure with no consideration of what that's doing to the cement seal. And so we could waffle on, I could waffle on for 45 minutes if you like, but I'll wind up, I promise.

So we have there one example of what we have. Do I have another one? Let me think. The fracking process is preceded by a plug of hydrochloric acid. Nowhere in the literature could we find that nowhere in the wonderful idealised diagrams that we get shown does it say we've found it necessary to pump in a slug of hydrochloric acid to clear out the debris from the holes. So we've got the holes, but there's debris from the inside, and there's an inrush from the outside. Because we accidentally have fractured some of the rock and we've got gas, at least I think that's what has happened. So we've got this additional thing of hydrochloric acid going down. Then we go down with their brew of 95% water, 5% sand, and stuff like that. That gets pumped in.

And again, there's a difficulty there I think of recovering what comes back up. The good folk tell us that they can capture it and reuse it. What do they do to it before they reuse it? What comes up, what happens to the acid and the products of combustion? That really is me departing from the script. I'd probably like to take questions there but if I can just take it to the end, which is my little plea to be philosophical, which says, I ask the panel to accept the conclusion that the project of unconventional gas is of relatively short duration, it exploits a non-renewable resource and entails an unacceptable risk of severe consequences to the existing and future enterprises and community. I ask the panel to accept the conclusion and in judging it, be mindful of the seventh generation principle of the Iroquois Nation, which is when you make a decision of any consequence, look seven generations ahead.

I got my own version of that. I look three back and three forward, because I think your decisions are much more meaningful if you have personal knowledge of the people you're thinking of. I knew my great grandmother, I know very intimately the history of two of my great grandfathers, and I know pretty well the history of one of my great granduncles. So I can look three generations back and I can follow their trail, particularly their behaviour, their ethics, and then I think I can look forward three generations. Haven't got any great grandchildren yet. I prefer my version to theirs, but I'm not a nation.

So I would stop talking there and hope to have a good talk with you.

Hon. Justice Rachel Pepper: Thank you very much, Dr. Lawson. And thank you very much for the preparation of the paper, that reference paper. A considerable amount of work has gone into this and the inquiry certainly appreciates it. I'm sure as a result of this, which we've got in advance again, thank you for that as well, there are probably some questions. Yes, Dr. Jones?

Dr. David Jones: Dr. Lawson, when you talk about these factors, I presume you're talking about a linear sequential combination of risk factors as opposed to all these factors imposed at once. When a system's being tested, often it's tested for one thing at once rather than multiple factors. Is that what you're getting at in your analysis there?

Errol Lawson: The linear sequential system is the actual process. You dig a hole, you stick a tube down, you surround it with cement, you divide it into stages, you pump holes in it, you clean it out, you push hot water under pressure, the gas comes out, you get the gas, you go home, and you close it off. That's a linear sequential description. And if you say it quickly, then you think, "Oh, they know what they're talking about." But if you tease it out and you say, hang out, it doesn't happen that way. In the history that I've come to deduce is that they've had a little bit here and a little bit there.

They introduced, for example, the history in America, when they went to horizontal wells, horizontal drilling, their first ventures at fracking were to frack the entire leg at once, and it caused ... The energy was just dissipated. So they started to divide into stages and they got some gas. Then they discovered accidentally that the guar gum is what the stuff that's in ice-cream.

Dr David Jones: Guar gum.

Errol Lawson: That stuff, yeah, which they put in as a thickener to carry the sand, was then clogging up the cracks, which is sort of defeating the purpose. They discovered by accident that if they put in thinners rather than thickeners, water tensioning releases. Then the sand stayed and the water came out. If you gave that problem to first year engineering students and said, "This is what you're trying to do. You're trying to put some sand in water and crack open some rocks, and then you're trying to get the water out," then you'd fail them if they didn't. Well, I would. Maybe I wouldn't, I would have come and had a talk to them. I'd say, "How'd you get that solution?" You'd be pretty worried if they couldn't visualise. Engineers visualise, we model things. The fact that the thickener would thicken, and you've got high temperatures down there, and you want to get it out. That wasn't a designed solution, that was an accidental solution.

I didn't answer your question, did I?

Dr. David Jones: What I was getting at was in terms of the estimation of risk, which is one of the things we're going to be doing, is are you saying that this kind of approach underestimates the risk that's actually there?

Errol Lawson: Who does?

Dr. David Jones: The accumulative risk of the process, taking that view, does that underestimate risk?

Errol Lawson: Very much so. You can be nicely reductionist and say, well, if I wanted to solve the problem of mechanical movement, seismic movement, because you have a long pipe and there's definitely seismic movement and seismic movement or shock is what will relax this bond. And you could test that. And in fact Halliburton I believe is developing self-healing cement. When I saw that, I thought that was wonderful. How come the spin doctors are telling me that the cement is wonderful, well engineered, and is guaranteed for in perpetuity, and one of them actually said that to us twice. We never saw him again, because Matt Damon was his minder and took him away.

But if you have to have self-healing cement, what are you trying to stop? The effects of that mechanical movement. So yeah, you can address each one individually. Or you can dissipate shock, stuff like that.

Hon. Justice Rachel Pepper: Dr. Beck has a question.

Dr. Vaughan Beck: Thank you for your presentation. I agree with you on your observation that this is a-

Errol Lawson: I haven't got my ears in, I'm older than I look.

Dr. Vaughan Beck: I'll speak louder. I agree with you in terms of your characterisation that it's a complex system. But also I think we would collectively agree that three are many complex systems, not only in engineering but also in things like medicine, law and finance. We're dealing with many complex systems in society at the moment, and so complex systems are intrinsically prone to some type of failure at some stage, and you've identified that that's the case. I think then you went on to look at some potential mechanisms for fire for the casing cement bond failure as a way of potentially looking at some failure mechanisms. There has been recently published by the United States environment protection agency a survey of failures in United States across their hydraulic fracturing and conventionally fracked wells. What they're looking at in effect is a statistical aggregation of multiple failures, presumably from multiple causes, one of which would be from bond failures as between the casing and the cement. It's instructive also to look at the evidence at the other end, to have a look at what is the aggregated number of failures, not only in terms of the well itself but all other factors, which I think you started to list in your very comprehensive presentation. There is some evidence around to look at failures and statistical data on that.

Errol Lawson: I resisted quoting the 6% failures initially and the 60% failures after 20 years because neither Daniel nor I can actually find the reference. So we've been pretty sticking to the instructions. If we can't prove it, we don't say it. That's why I extended the time scale to 100 years and said they'll all fail. There's got to be evidence starting to emerge. The difficulty is who controls the evidence, and are they from a independent source. One of you I think asked a question about if we had an independent source of information, would that improve the social licence in effect, that's how I interpret the question. Could we ever get the social licence if we had some adjudicator that said it's not 67,000, it's not 1.55, it's not 25 megalitres, it's 11. That ill feeling that's arisen is where the social licence was burnt before it was even printed.

I kind of infer some, from one of the phrases, that you can do social licences in your terms of reference. I can fit them in, but they're pretty ... Are you after social licence as well?

Hon. Justice Rachel Pepper: Absolutely.

Errol Lawson: Okay. Can I say without regulation?

Hon. Justice Rachel Pepper: You can say whatever you wish.

Errol Lawson: Sorry.

Hon. Justice Rachel Pepper: Subject to it being bleeped out.

Errol Lawson: How am I going?

Hon. Justice Rachel Pepper: I know Dr. Andersen wants to ask. We've got two more questions down this end of the table. Sorry, three more questions.

Errol Lawson: I can talk all night.

Hon. Justice Rachel Pepper: I might go to Dr. Andersen's question, if that's all right.

Dr. Alan Andersen: Yeah, Dr. Lawson, I've got a question about cumulative risk, and drawing on your experience in thinking about complex systems. You talked about how one feature of complex systems is their non-linearity. An example of that would be that understanding what happens ... From an understanding of what happens at one single well or well pad, you can't just simply then scale up for an understanding of what that means to a landscape of wells. I'm just wondering if you've got some insights in how the panel could deal with that issue of assessing cumulative risk, because we've recognised that as a major challenge for us.

Errol Lawson: It's as you say, it's the scaling up problem. Heavens, how could you research that when you've got so little field evidence? You know networks, the difference between the linear sequential model is that each element has one input and one output. In a network, all the elements are connected. At one level of scale, some of those connections are not influencing the outcomes. You scale up everything linearly, and suddenly some connection between one element and another becomes active, and immediately starts to affect the output. That's the theory on it.

Until they build the field of 400 wells, this is the horror of the thing. You can look at it in those terms and say, look at Queensland and the coal seam gas, when they scaled up there and they emptied the water out of the coal seam. The problems that that produced of lowering the aquifer, of migrating gas across through the previously water barrier, of what to do with the produced water.

If I had to pick an area to study, it would be the management of produced water. What are you going to do with 25 megalitres per frack? You can handle 25 megaliters per frack, 11 megaliters as they did in [inaudible 00:33:18]. They evaporated most of it, which was very fortunate, because it didn't rain on the tanks. It did rain, they had 60 mills one night which worried them. If you then say, take that problem of 150 wells, all adopting the same principle of evaporation ponds in the expectation that it won't rain

	before the 30th of November, then you can work a few statistics on the bureau of meteorology's, you can think up things to look at, but I don't know. The theory's there, there's enough examples of where the scale-up problem defeats you or surprises you. The engineers of the world are a pretty determined lot, and we will solve problems if you give it enough money and enough time, but sometimes we do unexpected damage, the unforeseen consequences.
Ms. Jane Coram:	Thank you very much for your presentation, Dr. Lawson.
Errol Lawson:	Pardon me for doing this, but I should have worn me ears.
Ms. Jane Coram:	No, I'll try and talk loudly. I had two questions. The first one was, I was just wondering if you could clarify a comment around the use of depleted uranium in fracking explosions. That's what I understood you were saying, but I was just wondering if you could elaborate on that more.
Errol Lawson:	Yes, in that patent reference, really, on slide six, reference two, perforating down assembly method of controlling well bore pressure. I think that's the one that they need to transfer the explosive energy to solid matter, which will then punch the holes through the steel casing, through the cement, and out into the shale. Obviously an attempt to get the maximum mass in such a small place, they've gone for depleted uranium, which is a very, very heavy ... You can see the connection with Halliburton, Cheney and the Department of Defence, because they use depleted uranium in their weaponry. It was a depleted uranium as a weighty element that's projected as, I imagine, as a shotgun pellet. You've only got that much space, so it's pretty cool stuff. If you were one of those sort of engineers, you'd be pretty proud of it. But it's there.
Ms. Jane Coram:	Thank you.
Errol Lawson:	You can ponder what happens to that stuff. What happens to that stuff, really?
Ms. Jane Coram:	Ok, thank you for that, and thank you for the reference. I'd also just like to ask your opinion I guess. You've gone to a lot of trouble to outline the process of structural failure that could lead to the well cement becoming degraded and offering a potential transport pathway from the fractured shale area to overlying aquifers, which would be probably a kilometre or more above the fracked area. As well as needing a pathway, you also need a hydraulic driver to make the fluids flow. I'm just wondering, given that the fractured shale beds are essentially being depressurized in the process of pumping out the gas, so the flow of pressure is actually going to be lowest in the shale beds, do you see that there would be a hydraulic driver for migration from the shale beds up into the aquifers?
Errol Lawson:	The two that I consider, one is capillary action. I think capillary action's important because they do have bore hole inspections looking for bore voids, and I doubt if voids would pick up the slight weakening of the bond

which gives a capillary channel. Wood is wonderful at capillary; we have big trees because of capillary action. That was one.

The other one was, once you plug a well, the gas fellows have got their money and gone home, but there's still gas down there. And so over time there's still gas being released. So there will in fact come a time ... The pressure locked in in the shale bed is no longer neutralised, it builds up. And so you do have a driver. That's why I pick 100 years, because I don't know how long it takes and nobody does. Because what is also not recognised when you're told to do the scientific inquiry and the size has mature, I talk about the engineering, the know-how, that a drilling crew would have to make the system work. No one gives credit to that.

Some crews would be very good. Some crews would have an excellent success rate of sealing, and so they'd get the jobs. Other crews would be a bit ham-fisted, they want to go home, it's Friday, five o'clock, and so it wouldn't be as good. There's hundreds of PhD theses around, including interviewing drilling crews. You can't predict because know-how, you can't capture it. It's basically test of knowledge and you can't capture that. You can watch them and you can say, "How'd you do that?" And they say, "I don't know." I teach the violin and my student last week, last Monday, was saying to me, "How did you do that?" I said, "I don't know." Then we looked at it, and I've got little grooves there from playing it for years and little grooves there. And so I always find my way back to the same position so I always play in tune. He's got to get one. That's know-how, test of knowledge, muscular memory. I don't know. That's just an example of the stuff that you can't document.

Good crews, good engineering teams, you get to know. You get to know when you've got good ones, you get to know when you've got rough ones.

Hon. Justice Rachel Pepper: Professor Priestly. Thank you.

Prof. Brian Priestly: Dr. Lawson, thank you for your submission and thank you too for putting it into the context of the risk matrix that we need to address in our inquiry.

Errol Lawson: We aim to please.

Prof. Brian Priestly: At one point you make quite a strong statement about the impact of contamination of the aquifer, saying that it could render it unsuitable for human consumption, stock watering, etc etc. Do you count, and it's the possibility that contamination, if it did occur might be at a level which would not lead to any of those outcomes?

Errol Lawson: Not with so many wells. That's why my definition of event is probability of 1 multiplied by the number of wells, which is why I kind of went through that torturous process of trying to work out the number of wells. A probability of one in a thousand multiplied by a thousand wells says it's going to happen. Is that what you-

Prof. Brian Priestly: Yeah, I'm really trying to get your views on just how those calculations might be done, so thank you.

Errol Lawson: That's why it's so important, and that's why we've been locked in our discussions and interaction with industry to the one fracking operation and how safe it is, one fracking operation, and then you say, "No, sorry, you're going to do that many, many times." Every time you do it you've got to get it through the aquifer. Balance that with the dependence of the ecosystem, including the people, on that aquifer, and I see in all the pressure on this government to go ahead, no recognition of the fact that I don't know what else the world is like, but this is one place in the world where that aquifer, or the aquifers and the rivers, are so needed for six months of the year. If it was a dam, and they could see it, I'm sure they wouldn't do it. But it's an aquifer and out of sight, and so we're not aware of it. It's a bit of a psychological problem. What you see, you don't know.

Hon. Justice Rachel Pepper: Dr. Lawson, thank you very much for the time you've given today.

Errol Lawson: Thank you.