T R A N S C R I P T

ENVIRONMENT, NATURAL RESOURCES AND REGIONAL DEVELOPMENT COMMITTEE

Inquiry into the CFA training college at Fiskville

Melbourne — 19 October 2015

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Professor Ravi Naidu, CEO and managing director, CRC CARE Pty Ltd.

The CHAIR — I apologise that we are running a little bit over time. Thank you for your patience. I welcome Professor Ravi Naidu from CRC CARE. There are just a few formalities before we hear your presentation. All evidence taken at this hearing is protected by parliamentary privilege as provided by the Constitution Act 1975 and the provisions of the Parliamentary Committees Act 2003 and is protected from judicial review. Any comments made outside the precinct of the hearings are not protected by parliamentary privilege. All evidence given today is being recorded, and you will be provided with a proof version of the transcript to check before it is made publicly available.

Thank you again for coming in to speak to us today. I understand that you will provide us with a 15-minute presentation and then you are happy to answer questions from committee members.

Prof. NAIDU — Thank you, Chair. The guidance that I have is that I need to present to you about the five most dangerous contaminants and also remediation technologies. While I have many slides, I will just pick slides that I will talk to.

The CHAIR — Certainly. You have given us a copy of the full slide presentation as a printout. Is that a public document? Can we put that on the website for people who are interested to look at?

Prof. NAIDU — That should be fine. I will go through it again and confirm, Chair, that everything is okay.

The CHAIR — Sure. Thank you.

Visual presentation.

Prof. NAIDU — The focus is contaminated soil and water, particularly contaminants present in the aqueous film forming foam, risks and remedial options. Just as a background introduction, our most dangerous contaminants; and treatability case studies, particularly for water and also soils contaminated with AFFF. With regard to the five most dangerous chemical contaminants, it is quite a challenging question because this will depend on which country you are in and what exposure people have been subjected to. For instance, if I was in Bangladesh, they would say arsenic is the most toxic and most dangerous contaminant because many people have died of poisoning from arsenic. You could say the same thing about arsenic in India or Taiwan or parts of China.

The contaminants that we have commonly associated with posing risk are lead, which you will find in quite a number of mining sites; chlorinated hydrocarbons, which are particularly volatile and are known to cause cancer; petroleum hydrocarbons; of course you are familiar with asbestos; and hexavalent chromium, which is found to be quite toxic. I have said could include others recent PFCs, because this is the recent Stockholm priority contaminant, and it is a contaminant that CRC CARE has been working on since 2004 and we are now seen as a global leader in AFFF.

For introduction purposes, we all know what AFFF is and the ingredients in it, particularly fluorochemicals and surfactants. Those two go together. These chemicals will particularly synthesise to manage a fire. Remember when you have fire burning it reaches temperatures of 1100 to 1200 degrees Celsius. Therefore these chemicals are thermally quite stable; they just do not break down easily, so you need very high temperatures to break down these chemicals. It is quite persistent in the environment. It is known to bioaccumulate in the food chain as well.

As I said, they are man-made substances. What I want to show you is the structure of these compounds. The dots there are carbon and fluorine. They are the strongest bonds that you could ever come across, and therefore it is not easy to break down these bonds. Even microbes do not, because if they chew and if you generate hydrofluoric acid, it will kill microbes, and so to chemically break these bonds is extremely challenging. You cannot break them at low temperature. About 1100 to 1300 degrees Celsius is what you need, so it is quite energy consuming. It has been in use since the 1940s.

As I said, it bioaccumulates in higher trophic level organisms through the aquatic food chain. We have done quite a bit of work with AFFF contaminant resources, and we have found these to bioaccumulate in grass plants and also air forms. There is a publication by Key et al, and you can see from the slide, that AFFF, once in the human system, stays there for many years. This publication states that it can be toxic to the liver and the thyroid gland and may also affect foetal and neonatal development, although there is no known case of fatalities relating to human exposure to these chemicals. We know that it reaches the environment through spillages, and we find it commonly at fire training sites.

This is an additional slide that shows two things. One 'point source' shows that where you spill contaminated wastes, you can have fairly high concentrations and it is at the point source that these can also be found in groundwater. The other is, if you use this waste water for irrigation purposes, for instance, it is very diffused contamination that you have, so it is spread across the landscape and the concentrations could be much less, but the danger there is that it can bioaccumulate in plants, for instance, and air forms and from plants and earth forms to other receptors as well.

The key thing to note is that when we started work in 2004 there was hardly anyone who knew much about PFCs. We developed methods for the analysis of PFCs. There is still a lot that is not known about PFCs. Lots of people have started to work on PFCs, but the behaviour of PFCs in the environment can vary depending on the nature of the soils that you have as well and the composition of water. Other soils can be quite different — what you have in South Australia as opposed to what you have in Darwin, for example — because of the climatic changes that we have, the weathering and nature of clay and organic matter content as well. Therefore, in some cases it can move easily into groundwater and in some cases it could be retained on the surface of soils.

Having said that, these chemicals, PFCs, also include the surfactants. Together surfactants will help PFCs move, and that is the reason why we can find these in groundwater particularly around fire training sites — if you have spillages, for instance.

This slide shows an extremely good figure. It tells you about how rapidly PFCs move in groundwater. This is not mine; it is Arcadis that came up with this, assuming that all of those contaminants that you have — petroleum hydrocarbon, polyaromatic hydrocarbon, benzene, toluene, xylene, MTBE, fluoridated hydrocarbon and PFCs. If you were to inject these at the same time in groundwater, PFCs will move much faster than all other contaminants, so PFC plumes can be much larger than other contaminant plumes. That is one of the risks that we have with PFCs. Once in groundwater it moves quite rapidly. It is not just that; it moves quite rapidly vertically as well, because of the presence of detergents in the mixture.

We have already been exposed to threshold values, so I am not going to spend much time here. It is something which CRC CARE is also developing. There are national guidance documents and all the EPAs and industries are working together with the CRC in the development of the guidance documents. As you know, CRCs are national centres of excellence.

I just want to show you that our approach to managing contamination is that we say there is a site that is potentially contaminated, we do preliminary investigation and then detailed investigation. Once you do that you go through a process of risk characterisation. Here we are looking at risks to humans from exposure, for example, and also risks to the environment. Once you know what the risk is, either you go through full-scale remediation or you know that contaminants are present but at a low level and exposure may not pose risk to the environment or to human health, in which case you want to manage the risk. That is where risk perception can be an issue, and here we need to be able to communicate with the local public as well.

There is another approach here — that is, you can take a risk-based approach and say, 'These contaminants could be tied down such that they do not pose risk', and once you tie it down it can be present in the environment. It does not move, it is not bioaccumulated and even if you ingest soil, it does not get released in the human gut. That is a risk-based approach, in which case you need to be able to communicate to the local people that chemicals present no longer pose risk, why they do not pose risk and the underlying basis for that as well. They are the two key approaches that have been used.

There are many different exposure pathways. I have not got dermal adsorption there. Dermal adsorption could potentially be one, but you need to be in water with this for a certain period as well.

I am going to move to remediation. This is an extremely challenging problem. There are many different approaches that people have come up with, and most of them do not work. As I said, in the case of photo-induced oxidation you are using ozone, for example, and you are bubbling ozone and exposing soils to ozonolysis, and it has not been found to be as effective. For thermal treatment you need to raise the temperatures to between 1100 and 1300 degrees Celsius; otherwise these compounds are really stable. There is something called adsorption, and here you are looking at activated carbon, for instance. That has the ability to soak up these contaminants, and I will show you what the disadvantages are in a minute. Membrane filtration is a cumbersome process, because if your water has solute particles, it slows down the solute particles. There is sonochemical treatment, which has not worked, and chemical immobilisation, which CRC CARE has developed, and this has won a national innovation award as well.

This one here; I have a quote from Miller 2011. They tried this process where they were using ozonation. I will read this statement:

> If Hamilton uses public funds to test Nanozox … on PFOS/PFOA, Hamilton will become a laughing stock in the scientific community.

They tried it, and it did not work. So while lots of publications are there on ozonolysis, the real field samples that you have are not as simple as mixing water with these chemicals, because pure systems are quite different from what you find in the field. What you find in the field is a mixture of a whole lot of other things as well, and that is what can slow down remediation.

As I said adsorption, people use granular activated carbon, and to some extent it is found to work, and here are some of the advantages. Firstly, it does work and it can remove up to 90 per cent of PFOS and PFOA, but there are some disadvantages in the sense that if you look at the left-hand column and the right-hand column, the left-hand column is about PFOS and the right-hand column is work done by Oliaei and Kesler, which shows that PFOA and some of the other PFCs are not taken up by GAC. Therefore, you may use GAC and remove PFOS, but the other active ingredients might just move out and be present in the water that comes out. The pace with which it removes it is quite slow as well, and therefore it could take much longer to remediate than you would like and, therefore, it can be quite expensive as well.

CRC CARE therefore came up with a nano material. This is by using naturally occurring clay. We modified the naturally occurring clay such that it has the capacity to irreversibly soak up these active ingredients and clean water and also immobilise these contaminants in soils. I will just take you through some of these. It is quite easy to develop a catalyst. I have just spoken about this. This just shows how rapidly it removes. On the left-hand side is the concentration of PFOS in water, and then time, and you can see that when you expose water that is contaminated with this material, called matCARE, it very rapidly removes it, and to levels below the actual concentration of concern.

This just shows two figures here. The lower one, the red one, is the material which people have been selling in the market, and the blue one is what CRC CARE has developed. You can see the difference in the ability for these materials to remove. This just shows a table with water that has been contaminated with PFOS, PFOA, 6:2 fluorotelomer and other chemicals present in AFFF wastewater. You can see that after-treatment concentrations are within the threshold guidelines that we expect, and these are mostly Minnesota or Dutch guidelines. We found this quite effective.

This is the technology that we have come up with. This technology has now been established at three defence sites, as you see here, a wastewater plant. It is automated now, so from the confines of your office you can see how well the technology is working. This slide shows wastewater, that is influent wastewater, and clean water that comes out. It has been found to be quite an effective and highly successful technology. I will just show you very quickly, if I can use this. So we can have this now, this is a trailer, and we can take it from site to site to remediate. That is what we have been doing, just taking it from site to site and remediating wastewater that is currently stored in tanks. This is to the satisfaction of regulators as well. We can contain the plant in shipping containers as well.

This just shows the influent concentration, which is the blue one, and the red one is the outgoing concentration. That is how good the technology is. We have so far remediated 2 million litres of wastewater for defence, and this includes also the work that we have done for Airservices at Adelaide Airport. The plant that we have built has been quite successful in remediating wastewater, and it is currently established at three defence sites, and also we have been working at the Adelaide Airport helping Airservices.

Just very quickly on the remediation of soil, here we are recognising that it is not easy to remove AFFF from soil. You could do it, but it would be a very expensive process. We are saying: why do we not convert this into a form such that it no longer poses risk? It does not move and get into groundwater, it is not bioaccumulated by earthworms and, even if a child ingests this soil, it is not posing risk. What we have done here is to come up with a material that changes the chemistry of PFOS and PFOA and other active ingredients present in the soil. Risk reduction is what we have been working on, and the risk reduction is by changing the chemistry of PFOS and PFOA. But this regulatory requirement must be fulfilled to demonstrate that you are within NEPM and OECD guidelines, which we have been doing very quickly.

I will just show you the contaminated soils that we have used for our study. These are different soils, for different contaminated soils from different defence sites. The coloured lines here are control soils, and the release of PFOS and PFOA, and where soils have been added with matCARE that we have come up with we can see there is absolutely no release of PFOS and PFOA, which is what those ones show. This here shows how rapidly it is able to convert soils from presence of active PFCs to one where it is no longer active, it does not get released. Following these studies, we took matCARE out into the field. Treated soils that have been tested with water extract and total PFCs in the soil; 12 control samples were taken before we treated the soil. Here we have been treating the soils. That [slide] shows glimpses of the fieldwork, soils that have already been treated. Then we looked at the release of these PFCs in treated soils, and you can see that once we have treated the soil, column 3 says 'BDL'. It means 'below detection limit'. You can extract the soil with water and solvents. You do not see any PFCs coming out into these extracts.

We then said , 'The best test of this is to see whether earthworms can live', because earthworms are very sensitive creatures. In the presence of contaminants they just move away from contaminated soil. What it shows here is that once the soils were treated, when we exposed this to worms, worms were happy to live in the soil and that there was no bioaccumulation of PFCs. There was no sign of avoidance in these treated soils either. This demonstrates that the process that we went through to irreversibly lock these toxic substances in soils has been achieved. This is what we call a risk-based approach. You can use this. It is no different from cereal-growing soils. Every farm soil has cadmium added through superphosphate, and we are managing cadmium by adding, for instance, lime. It locks cadmium in soils so when you grow cereals it is not bioaccumulated. If you do not add lime, you will have cereals bioaccumulating cadmium. That is the approach we have used here, although it is not lime that is used to lock PFCs; it is matCARE.

In summary, then, there are quite a number of technologies out there. Many of these do not work. The technology that we have come up with, both for water and also for soils, has worked. It is a technology that has won national awards as well.

Mr McCURDY — That can be a guide. Is that what you are saying? That can be a guide as to how successful a remediation is.

Prof. NAIDU — Yes, the presence of earthworms is, because earthworms are really sensitive. If you take a tube of soil, part of the tube is contaminated soil, the other one is clean, you put earthworms in this side, lock it and they will rush to the clean side. Earthworms are OECD test for contaminants.

The cost of remediation varies depending on the contaminant loading. It can be as low as 7 to 10 cents per litre to as much as 40 cents per litre. Sometimes you have not just PFCs but petroleum hydrocarbons as well, and that complicates it. We have still remediated that. Soil remediation can be quite cheap as well. That is a very quick presentation on PFCs, introduction as well as remediation technologies. I would be quite happy to answer questions.

The CHAIR — Thank you very much for that presentation. Of course one of the terms of reference in terms of this inquiry is about the Fiskville site and whether it is possible to decontaminate and remediate the site. Just going on from that, I am not sure if you are aware of the site. I think it is 146 hectares in size. There has been various testing in various parts of the site, and new areas have been found to have PFOS in certain infrastructure, as well as other parts of the land. Perhaps if you could just take us through, starting with step 1, how you assess an area to see whether it is suitable for decontamination and remediation and how you go about that, bearing in mind at Fiskville that there are, as you were just mentioning, complications such as various unknown chemicals as well as the PFOS and PFOA within the soil and within the water.

Prof. NAIDU — Thank you for that question. Of course the approach can vary quite a lot depending on whether you are looking at a small site or a large site. In this case we are looking at a fairly large site. Also we are looking at quite a challenging contaminant, in the sense that just from the chemistry of the composition of AFFF wastewater, we know that the composition is one which will help vertical movement of the active ingredients that are present in wastewater. Therefore you come up with a conceptual site model knowing that there is potential for these contaminants to be present in groundwater as well. So for a large acreage like that, one needs to use a standard approach. There is an Australian standard for sampling potentially contaminated sites. I was part of the committee that wrote that standard. In this case it is almost like there would be sites where you might have higher concentration and there would be sites where you have lower concentrations, so you have hotspots and non-hotspots as well. Therefore the approach that you take ought to be one that is able to delineate hotspots from the diffused contamination as well.

With the assessment, once you know the total contaminant loading we then have to go through a process of what we call risk characterisation. This characterisation must take into consideration both the ecological and environmental risks as well as risk to humans. Both of these depend on threshold concentration in the soils. One thing about Australia is that we are yet to develop special concentrations for these potential contaminants in the soil. Therefore we will be borrowing these from other countries.

If you are looking at farm soils, for instance, there could be other potential contaminants as well, including low doses of cadmium, and if people have used pesticides, we might have low doses of pesticides as well. Pesticides are organic molecules, for instance, particularly if you have organic pesticides. Therefore there could be competition between both pesticides and PFCs in soils from a binding perspective.

The CHAIR — In testing at the Fiskville site and surrounds arsenic, for example, has been found. We know that diesel and other sorts of fuels were burnt as well.

Prof. NAIDU — Yes. The presence of arsenic and diesel will make assessment easy because of the analytical labs that we have. When it comes to remediation it becomes a challenge. As we have seen with water that contained petroleum hydrocarbons and PFCs, the process was initially challenging, but we have been able to remediate water and soils. There are some fragments of petroleum hydrocarbons, including diesel, that naturally biodegrade, but there will be some fragments where components will still be present in the soil. The work that CRC CARE has done of late shows that with petroleum hydrocarbons, there are some larger petroleum hydrocarbon compounds that do not pose risk. They will be sitting in the soil, they will not move and they do not pose risks because of the large molecular size, but there will be other fractions of a moderate size which could pose risk. Therefore any assessment of the site will require people who are doing assessments to make certain that the analytical lab is aware of the range of analytes that they are looking for.

Mr McCURDY — It sounds to me like there is a sliding scale in terms of remediation. Let us look at a site like Fiskville. There might be major parts of Fiskville where there is very little contamination or even zero. You are saying that there is a cost differential between where it is contaminated very heavily versus where it is not. How difficult is it to do a quote, for example, and say, ‘This is how much it will cost to clean up the site like this’? Would you do soil samples? Is it a difficult task? Can it be done?

Prof. NAIDU — The first thing to note is that if you know what contaminants are present in the soil, it is not that much of a challenge. Legacy sites are where we have challenges because you do not know the history of the site. In this case we do know the history of the site.

The second thing is that once the soils are sampled and assessed for the presence of these contaminants, you go through toxicological studies. Sometimes we might have fairly high doses of these contaminants, and when you do toxicological studies you do not find that these contaminants are impacting the most sensitive organisms like microbes, for instance, and they are not bioaccumulating. What that shows is that these chemicals are present in a form where they are not posing risk.

I will give you an example. There was a site with 17 000 milligrams per kilogram of zinc, and the initial decision was that the site was highly contaminated, but all the work that we did showed that the plants were growing happily and the microbes were not impacted. Then we found out that zinc was present in a form which was no longer posing risk. So when you go through these toxicological studies, you may be able to rule out that if you have low doses of these contaminants present, you do not need to do anything.

Mr RICHARDSON — Thank you for coming in today, Professor. I have a question about community engagement and the point that you made about a full and open discussion with the broader community. Obviously at the moment Fiskville has gone through an assessment and remediation process. I just want to touch on the process that you would expect to go through in notifying communities and local residents and stakeholders in the area and the reasonableness placed on organisations as well as the community to make an informed decision about their health and assets. My question is: what are some of your experiences with the reasonableness of that approach?

Prof. NAIDU — I will take you to 1996 and the first international conference that we organised in Australia for the Asia-Pacific region on contaminants in the Australian environment. I organised it. I remember meeting the late Dr Brian Robinson. He spoke to me about the need and how important it was to be able to sit with the local community and be as transparent as you could be about the presence of these contaminants where they posed risk and, if they do pose risk, what it is that we need to do. Therefore that was the first time somebody got up and spoke about risk communication. So from where I sit risk, communication is extremely crucial. These days particularly people just google things, and sometimes you might read things and misinterpret them. Before that happens we should be on the front foot meeting with the community and discussing it with them.

Mr RICHARDSON — Going to your point about remediation, we have heard about the challenges between departments having an environmental arm and a health arm. How does your organisation work through the environmental and health assessments in undertaking that remediation work?

Prof. NAIDU — CRC CARE is fortunate in that some of the EPAs in different states are members of CRC CARE and some are not. They all worked with CRC CARE when we developed guidance and policy documents. The other thing where we are fortunate is that every one of these guidance documents is also about human health risks. Therefore we have been able to engage with the Department of Health as well. So we work with both the Department of Health as well as the regulators. They get together around a table with us and work with them along with some of the industries that may be the cause of these contaminants.

Mr RAMSAY — Thank you for your time this morning. My question, in two parts, carries on from Mr Richardson's question in relation to the environmental audit which is being presently conducted by the EPA, and section 53V, which requires certain remediation work and also a report-back process by 2017. My question to you first is: one, given your expertise and knowledge in this area, have the EPA been working with your organisation in relation to conducting that 53V audit and remediation process; and two, in relation to those landholders who are caught outside, in this case the Fiskville facility, in relation to the samples of water and soil in relation to say, PFOS in this case, has there been a precedent where there has been compensation or legal action attached on behalf of those landholders to recompense the loss of earnings in relation to the contamination of their properties in relation to practice on those sites? One is the remediation issue with the EPA, and the second is the precedent for compensation paid. Can you provide us with some advice on that?

Prof. NAIDU — Yes, if the question is about remediation issues with regard to Fiskville, we have not been working on this with the EPA.

Mr RAMSAY — You have?

Prof. NAIDU — We have not been invited to do that. With the second one, I have not seen any compensation or any legal action so far.

Mr RAMSAY — Can I put a question the other way then. You would be familiar with the process the EPA is going through, particularly with 53V. Do you believe that process will provide some outcome in relation to ongoing use of that facility? 2017 is the time frame, so we assume we have got two years. Do you have any confidence that the remediation work being done will provide confidence that the facility could be used in the future?

Prof. NAIDU — I see EPA Victoria as one of the most progressive EPAs in Australia, and I have confidence.

Mr RAMSAY — Have confidence in what?

Prof. NAIDU — In the EPA being able to deliver within the time line that they have suggested.

Mr RAMSAY — Do you have any commentary you would like to make in relation to those landholders who have been impacted by past history in relation to use of chemicals and foam affecting their properties and then having significant impost on their livability and income-earning capacity?

Prof. NAIDU — This reminds me of a presentation I made in 2008. There are a couple of things about contaminants. One is that if you have contaminants in your backyard or if somebody identifies contaminants on your farm, for instance, the first thing that goes to people's minds is the impact of such contaminants or chemicals on their health and their children's health. That is the first thing. The second thing is about the impact it has on property values. Even if the first two are demonstrated by experts to be of no risk, the third one plays a very significant role in what is called stigma. What it means is that the impact of those chemicals on properties would be driven by the stigma that has been created because the property has been potentially shown to have contaminants associated with it.

Mr RAMSAY — Okay. I think I will leave it there. Thanks.

Ms WARD — Thank you very much for coming today. I am interested in what you were talking about with remediation. We have heard that with some sites PFOS can go down to 11 metres as it continually gets pushed down. Are you able to remediate to that level, or are you aware of remediation occurring down to that level?

Prof. NAIDU — I am not aware of any site where PFOS or PFOA that is present in groundwater is being remediated. There are several different approaches to remediating groundwater. One can be quite expensive and is what we call pump and treat. You are pumping it, passing it through a reactor and then pumping it back into the groundwater, into the aquifer. The other is known as permeable reactive barrier, which is when we know the groundwater is moving in a particular direction, and therefore you can place a permeable barrier which allows water to pass through. Through the process, as it passes through the barrier, the barrier is made of a material which removes PFOS and PFOA, and that is much cheaper than pumping and treating. Having said that, we have a site where we are doing pump and treat and the pump is not driven by normal electricity — it is driven by a solar panel — so it makes it somewhat cheaper as well. So it is possible.

Ms WARD — With the sites you are remediating, what has brought about the need to remediate those sites? What has prompted the choice that the pollution is too high and it needs to be fixed?

Prof. NAIDU — The sites that we are remediating have chlorinated hydrocarbons present as contaminants. One thing about chlorinated hydrocarbons is that they can be present as volatiles, so they migrate upwards. If they migrate upwards, they can be present as volatiles in buildings, for instance, and the concentration of chlorinated hydrocarbons exceeds the guidance values. Therefore there is a requirement that we remediate those sites.

Ms WARD — With the plume that we saw at Oakey, it is 4 kilometres long, I think Nigel was saying. How do you remediate something like that that is just continuing to move outwards?

Prof. NAIDU — I would suggest an active and passive remediation. Passive remediation is when you place a barrier. Active remediation is one where you are using natural solar energy to pass water through a reactor system that removes contaminants, and that can really accelerate remediation.

Ms WARD — Are you aware of any way of getting PFOS out of human bodies?

Prof. NAIDU — No, I am not aware of any ways of getting PFOS out of human bodies. The key thing about organic contaminants and inorganic contaminants is that with organic contaminants, once it goes into your system it can be taken up in fatty tissues. Once it is in fatty tissues, it is quite hard to remove it, which is different, for instance, from lead and other metals, or you can use collating agents.

The CHAIR — Thank you so much, Professor Naidu, for coming in and speaking to us today and giving up your time so that we can have a greater understanding of the decontamination and remediation processes.

Prof. NAIDU — Thank you very much, Chair. Thank you for the opportunity.