FL -1

Commission of Inquiry
PARADISE DAM

PARADISE DAM COMMISSION OF INQUIRY

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TRANSCRIPT OF INTERVIEW OF FRANCISCO LOPEZ

Wednesday, 5 February 2020

Name of Witness:	**Francisco Lopez**
Date of birth:	
Current address:	
Occupation:	**Technical Principle Engineer – Dams at SMEC**
Contact details (phone/email):	
Statement taken by:	**Jane Menzies**
Also present:	**Matthew Smith - Observer** **Tom Morton – Observer** **Simon Scott – Observer** **Brock Morgan – Observer** **Rachael Murray - Observer**

MS MENZIES: So, just by way of background, you may already know this, Francisco, but so you know where you sort of fit in the picture of the Commission overall, the main things we have been tasked to look at are structural and stability issues with Paradise Dam that have been identified in engineering and technical reports over the last few years, and given your involvement in preparing some of the Technical Review Panel reports, we know that they are looking at what GHD has been doing, but obviously your work is relevant to the issues we're looking at, and ultimately we've been tasked with finding the root causes of these issues that have been latterly identified.

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FL -1

So the purpose of today's call is really to discuss the reports, those three reports that we sent through to Simon. I presume you've been - actually, I think, Simon, you confirmed that you'd sent them on, hadn't you? Is that --

MR SCOTT: That's correct, yes.

MS MENZIES: Yep. Great. So, Francisco, you've been provided with the TRP reports, numbers 1, 2 and 3.

MR LOPEZ: Yes.

MS MENZIES: And so we just want to talk about the content of those reports, in particular the sections that you prepared, and to better understand what is being discussed and any other views you may have. So, please forgive the basic nature of some of the questions, and I think it's safe to presume that you're speaking with people who have minimal technical expertise. So, to the best that you are able, if you can speak in layperson's terms, that would be very much appreciated.

MR LOPEZ: I will do my best.

MS MENZIES: Thank you. So, would you please tell us what your qualifications are and what your background in dams is?

MR LOPEZ: Yes. I'm currently technical principal for dams at SMEC. I am a civil engineer with a Masters in Earthquake Engineering. I have had 21, almost 22, years of experience in the dams area, spanning projects in four continents, different types of dams, and my main field of work is on the structural analysis of concrete dams.

MS MENZIES: You've talked about work in four continents with different types of dams. Before Paradise Dam, had you been involved with any roller compacted concrete dams?

MR LOPEZ: Yes.

MS MENZIES: And whereabouts were those?

MR LOPEZ: Colombia, Costa Rica, Dominican Republic - where else? The Philippines.

MS MENZIES: Yes. Okay.

MR LOPEZ: That I can remember.

MS MENZIES: Thank you. That's helpful. And so when did you first become involved in the Technical Review Panel for Paradise Dam?

MR LOPEZ: That was May last year.

MS MENZIES: Yes. And why were you --

MR LOPEZ: No, actually, before that. Before that. Because the workshop was in May, so, I don't know, maybe February, March, I was first involved.

MS MENZIES: Okay.

MR LOPEZ: By engagement by Sunwater.

MS MENZIES: And why were you asked to join? What particular role do you have on the TRP?

MR LOPEZ: The TRP - well, my role in the TRP is the role of any of the members of the TRP, which is to provide comments, advice, guidance in the upgrade works that are being prepared by GHD. And that will be for - I mean, there are different disciplines, so they were trying to get a balanced TRP, so they were looking at my particular background in the structural analysis of concrete dams.

MS MENZIES: Yes. And so the structural analysis of concrete dams - this is maybe too broad a question, but can you give a broad overview of the sorts of things that that work involves?

MR LOPEZ: Yes. The structural analysis of a concrete dam requires to understand whether the materials that are components of the dam are strong enough to support the demand that comes from different loads that the dam will be subject to during its usual life, which may include the water, of course; also seismic forces from earthquakes; other types of hydraulic forces that come with floods and all that. So the integrity of the materials, the capacity. One part of the design includes determining what's the capacity of the materials versus the expected demand on those materials; and the second one is the stability of the dam as a complete body, whether the geometry of the dam is such that it can withstand forces that try to slide or turn the structure.

FL -1

MS MENZIES: Yes. So is it then accurate to say, with Paradise Dam, there have been two issues that you've been looking at: firstly - well, the structural analysis, is that where the lift joint strength comes in?

MR LOPEZ: Yes. The strength of the lift joints is paramount in the structural design of the dam and the stability of the dam itself, yes.

MS MENZIES: So the lift joint, the capacity of a lift joint to withstand horizontal force is relevant to the structural analysis sort of thing you were talking about before - the ability of the materials to support the different loadings, as well as the stability of the dam as a mass, or is - I'm just trying to understand. Sorry, I will rephrase. You are talking about stability of the dam, and I understand you're looking then at the dam wall as a whole body, so whether it's going to tip over as a result, I presume, of moment forces --

MR LOPEZ: Yes.

MS MENZIES: -- or whether the whole thing will slide along the foundation?

MR LOPEZ: The stability requires the dam to be safe at any potential failure point within the dam.

MS MENZIES: Okay.

MR LOPEZ: So on an RCC dam, we need to understand what an RCC dam is, which is a concrete dam that is made of horizontal continuous layers of concrete. So we need to check that the dam is safe for stability at any particular horizontal joint created by the RCC compaction, and the dam as a whole. So we need to check for potential sliding planes within the foundation, at the interface between the concrete and the foundation rock, and within the body of the dam at any potential weak layer of RCC.

MS MENZIES: Yes, okay, thank you. That's helpful. Can we --

MR LOPEZ: I need to make a precision - I need to make a precision on something that you said.

MS MENZIES: Yes.

FL -1

MR LOPEZ: Regarding whether the lift joints need to withstand horizontal forces.

MS MENZIES: Yes.

MR LOPEZ: Well, horizontal forces and forces in any direction.

MS MENZIES: Yes, okay.

MR LOPEZ: It could be vertical forces as well.

MS MENZIES: Yes, okay, thank you. Can we turn then, please, to TRP report number 1. Do you have that in front of you, Francisco?

MR LOPEZ: Yes.

MS MENZIES: So a couple of very basic questions to start with. So page - I think it's 18. Yes, page 18 of the report has your signature, along with the three other members of the TRP at that time.

MR LOPEZ: Yes.

MS MENZIES: So we understand this is the signed report, but it has a "Draft" watermark.

MR LOPEZ: Yes.

MS MENZIES: But can you confirm that this was still the final, signed report?

MR LOPEZ: I cannot, a hundred per cent, confirm that. It's likely to be, but I cannot - I will need to go into the records and see what exactly was sent to Sunwater as final delivery, and to confirm that this is exactly the same one. It could be just a matter of that the person who delivered it forgot to removed the "Draft" watermark.

MS MENZIES: Yes.

MR LOPEZ: That could be the case. But I cannot confirm that right now.

MS MENZIES: Okay. At the end of this, as I said earlier, we will prepare a draft statement that we will send through to you, and

FL -1

there is likely to be a few drafting notes in there, things that you might like to confirm after today's interview. So we'll put a placeholder in it for things like this.

MR LOPEZ: Okay.

MS MENZIES: The other thing is, also on page 18, there is a date there, "13 June 2016". The workshop out of which this report came was in May 2019.

MR LOPEZ: Yes.

MS MENZIES: Can you confirm that that date is incorrect, or confirm what the date ought to have been?

MR LOPEZ: Do you mean the date of the signature?

MS MENZIES: Yes. At page 18, it seems like that date might be incorrect.

MR LOPEZ: I can see a 13 June date, which seems to be a potential amount of time for releasing the Technical Review Panel report, two weeks after completion of the workshop - that sounds reasonable.

MS MENZIES: Sorry, Francisco, I'm not being very clear. The year in that date is 2016, but the --

MR LOPEZ: Oh, okay, yes, yes. Oh, that's definitely a typo. That's definitely a typo. It must be 2019.

MS MENZIES: Yes. Okay. Thank you. So then the content of this report - which parts did you help or draft, Francisco? What was the process for compiling this?

MR LOPEZ: Well, after the workshop, which involves Sunwater personnel and GHD personnel and some other people invited there, of the Technical Review Panel, at the end of the workshop we are given a private time for the Technical Review Panel members to convene and to discuss what has been presented to us during the workshop. So some notes are made by, let's say, like a person in charge of producing the first draft, in this case Peter Foster, and then Peter Foster puts this collection of ideas in a draft report that is then circulated to the rest of the panel members for their approval or for their discussion or for the addition of inputs into the report. So it is a very - it is a joint effort. So some parts of

FL -1

the report are easy to identify as where I did this part or I wrote this or this is my particular idea. Some others are not, because that came from a discussion of the whole panel, and that was collected in Peter Foster's first draft.

MS MENZIES: Yes.

MR LOPEZ: So, yes, that's the process, and that applies to all reports.

MS MENZIES: Okay, thank you. That's helpful to understand how we get to where we are. Given your expertise, we presumed that you had at least some amount of input into section 3 of this report, which starts on page 8?

MR LOPEZ: I want to make a clarity: it is not expertise, it is experience that I have.

MS MENZIES: Okay. Thank you, so I will rephrase. Based on your experience, then, Francisco, section 3.3 seems relevant to your background? It is headed "Dam" --

MR LOPEZ: Yes.

MS MENZIES: So page 8.

MR LOPEZ: We are still with the report number 1; that's correct?

MS MENZIES: Yes, that's right, yes.

MR LOPEZ: 3.1, "Background and Progress Update"?

MS MENZIES: Oh, so page 8 we are on.

MR LOPEZ: Page 8?

MS MENZIES: And it's headed, "Dam Stability" --

MR LOPEZ: So it's 3.3?

MS MENZIES: Yes.

MR LOPEZ: Not 3.1, but 3.3?

MS MENZIES: No, 3.3.

MR LOPEZ: Okay, yes.

MS MENZIES: Yes. So this is headed "Dam Stability Including RCC Shear Strength".

MR LOPEZ: Yes.

MS MENZIES: And I wanted to ask you about some particular things in this section, just to better understand what it says. So, firstly, can you recall contributing to this section?

MR LOPEZ: Yes.

MS MENZIES: Great. On page 9, so the next page, at the top of that page there is a fairly long paragraph and it has a few different things raised in it.

MR LOPEZ: Okay.

MS MENZIES: So you'll see about halfway down there is a sentence ending:

> *... the strength estimated by GHD might be a bit too conservative.*

And this is talking about the friction angles they have adopted.

MR LOPEZ: Yes.

MS MENZIES: Are you, please, able to just talk about the process GHD went through and that comment that GHD's estimate "might be a bit too conservative"?

MR LOPEZ: Well, I need to read that paragraph.

MS MENZIES: That's fine.

MR LOPEZ: Well, we are not criticising how GHD arrived to that particular conclusion. We understand why GHD established a shear strength of 37 to 38 degrees, and that's because they took samples of the dam - basically, they drilled cores that are between 100mm and 150mm, six of them. So they took a very, very small sample to characterise the whole dam. So, strictly talking, the shear strength data that came from those tests show 37 to 38 degrees.

FL -1

Now we need to put that in context. Remember, we are talking about the stability along a whole horizontal layer of RCC, which can have hundreds of X square metres in area - yep?

MS MENZIES: Yes.

MR LOPEZ: And we are characterising this with six particular holes to determine what's the assessment of the whole dam.

MS MENZIES: Yes.

MR LOPEZ: So, strictly talking from the evidence, and that's it, from the test results, the number is correct. But there are other (indistinct) factors that affect the actual shear strength of that particular layer of concrete, and that is that there is uncertainty on how the - well, these six, the six holes, they came as being unbonded. I mean the layers of RCC were not sticking together.

MS MENZIES: Yes.

MR LOPEZ: So that definitely affects the shear strength. So what we are questioning there is that it could be a bit conservative to assume that the whole layer is going to be unbonded, because the whole layer was not investigated.

MS MENZIES: Yes.

MR LOPEZ: And it is impossible to investigate the whole thing. But you have a factor of uncertainty there. So one thing is to determine what's the shear strength that comes from the tests, which is, yes, 37 to 38 degrees, but a different thing is how much you use in the analysis of the stability of the dam along the whole surface, and we are just raising the issue there.

MS MENZIES: Yes.

MR LOPEZ: We are not saying it is incorrect, but we are saying, well, you need to take into account all the factors, like if the surface is not completely horizontal, which it is not, but has some undulations, those undulations, of course, provide other issues in our shear strength.

MS MENZIES: Yes.

MR LOPEZ: Now, those factors are very, very difficult to measure, if not impossible. But what we want to bring there is that using 38 or 37 degrees, just because the six tests say that, it could be too conservative, and unless it's proven with additional studies - which we recommended later on, to continue doing more shear strength tests - well, that will be too conservative. So that's the whole idea behind it.

MS MENZIES: Yes. That's a really helpful explanation. Thank you very much for that. There has been a suggestion elsewhere to the Commission that a friction angle of 37 to 38 degrees - I can't remember the exact words, but it was something like - is not in the realms of reality, or something like that, just based on how these things normally work. I understand your point that that is what the shear strength test results were, but in terms of your experience with these dams, is a friction angle in that realm likely to be accurate, just as a general feel, a gut feel?

MR LOPEZ: Well, six tests tells that that is possible.

MS MENZIES: Yes, okay.

MR LOPEZ: Have I seen these low frictions, angles of friction before? Not that I remember.

MS MENZIES: Yes. Okay. In that paragraph, a little further down, you are talking about some of those core holes that were tested were taken vertically, and some were horizontally, and they did not follow the same testing standards.

MR LOPEZ: Yes.

MS MENZIES: And then it says that GHD acknowledges this, and they took some conservatism in the estimation.
Is there anything significant in that, for our purposes?

MR LOPEZ: Well, this is the main factor contributing to the identified deficiencies on the dam. So the shear strength is the key parameter, I believe. So every effort should be done to try and have standardised procedures, to try and get a more credible answer. Because even in the estimation of the 37 to 38 degrees, there is some statistical error, if you wish. So this is TRP number 1, so this is at the start of the project. So we are asking for more samples to be taken, and those samples to be tested with the same standards to try and avoid any potential error and to try and give

confidence to the adopted shear strength parameters. So that's - how much I can't quantify; I cannot tell you how much would the number improve or be worse, by using that standard. But do you know what a standard means? We want to be able to compare apples with apples.

MS MENZIES: Yes.

MR LOPEZ: So that's the recommendation made here.

MS MENZIES: Yes. I understand. Thank you. This might be a bit of a tricky one. A couple of paragraphs down, the paragraph starts:

> *Current stability analysis assumes that a bilinear shear strength is applicable with a frictional strength of 37 degrees with zero cohesion --*

at a particular normal stress, and friction of 28 degrees for higher normal stresses. Are you able to break that down and just explain what that means in layperson's language?

MR LOPEZ: Well, strictly talking, that is GHD's assumption.

MS MENZIES: Yes.

MR LOPEZ: That's what they are saying. So I'm not saying - I'm basically reproducing what they say.

MS MENZIES: Yes.

MR LOPEZ: So do you want me to break down what GHD is saying?

MS MENZIES: Yes, please, if it's possible to explain it in simple terms.

MR LOPEZ: Yes. Well, this is a little bit complicated. Even in a technical, in an engineering meeting, I would be using a board to draw a graph, because basically, what this is, this is a graph, this is a bilinear graph.

MS MENZIES: Yes.

MR LOPEZ: Just imagine that in the horizontal axis you are going to have your confining pressure. So just try and think of this: if you have a mass that is laying on a very polished surface, and you

try and slide it, it will slide relatively easily. But if you put a vertical force on top of it, then to try and slide that horizontally would be more difficult, when you have a larger force. So that's what is called the confining stress.

MS MENZIES: Yes.

MR LOPEZ: So when we think of two layers of concrete, the way in which the friction reacts is proportional to that vertical force, up to a certain point. So that when you have zero cohesion, you have - when you have zero, zero force on top of it, your shear strength is zero. But when you apply 600 kilopascals of pressure vertically, then the shear strength goes up to 37 degrees, and it is a linear relationship.

MS MENZIES: Yes.

MR LOPEZ: Okay?

MS MENZIES: Yes.

MR LOPEZ: So you can define a surface to slide with that linear relationship. But, in reality, that linear relationship is not linear, it starts to be curved as the confining pressure or the vertical force increases beyond 600. So it tends to be flatter. And that's what they are saying, that after 600 kilopascals, the angle of friction is flatter, is like 28 degrees, but at that point, you start to have - and this is - I need to introduce something new. The shear strength of a surface is defined not only by the friction but also by the cohesion. So what they are saying is that after 600 kilopascals, yes, the curve is flatter, so the angle of friction goes down from 37 to 28, but you have an apparent cohesion factor there that was not present at the start, on the first part of the curve.

So I know this is a complicated thing, and even talking to a dams engineer without making a graph, it would be complicated. But I hope this is a little helpful, at least.

MS MENZIES: Thank you, that is. And we've seen those sorts of graphs that you are talking about, so I'm hoping I understand what you are saying.

The last paragraph on that page is talking about the density that has been adopted for the stability analysis - they adopt 2,400

kilograms per cubic metre - and the recommendation is that the construction reports be used to verify that assumption. Do you know if that actually was done?

MR LOPEZ: By GHD?

MS MENZIES: Yes.

MR LOPEZ: No, I don't know. I don't remember. I don't remember if they adopted it. The 2,400 is a conventional density used for concrete.

MS MENZIES: Okay.

MR LOPEZ: But when we are talking about whether the dam is passing or not, and if you have the actual information from the real thing, well, it's recommended to use it.

MS MENZIES: Yes, I see.

MR LOPEZ: Why not to use it if you have it there?

MS MENZIES: Yes, I see. Can we turn, then, to a bit further on in appendix B to this report, and it starts at page 22.

MR LOPEZ: Yes.

MS MENZIES: This was a report that you had prepared about your site visit. That's --

MR LOPEZ: Well, this is the TRP. This is the whole team visit.

MS MENZIES: Yes.

MR LOPEZ: But I documented it, so, yes, this is for all of us, but those are my - this is my contribution to the report, I guess.

MS MENZIES: Yes, okay. And it's always helpful to see pictures of things - for us, that is. So on page 24, so a couple of pages in to your report, you're talking about the core hole samples that you've seen.

MR LOPEZ: Yes. These are not at the dam site.

MS MENZIES: Oh, okay, yes. That was my next question.

Whereabouts were these? So the picture, say on the bottom of page 23 - where was that taken?

MR LOPEZ: These are cores that have been stored in a shed nearby the dam. They are not - I mean, they are from the dam, but this is some, I don't know, 300 metres on one side of the dam.

MS MENZIES: Yes, okay. And I'm not sure if it says there - oh, actually, so on page 23 there is a reference to "core hole PD 06".

MR LOPEZ: Yes. That's on the dam site.

MS MENZIES: Is that a temporal - a reference to the time they were taken? Do you know when these were taken?

MR LOPEZ: Well, as we were at the dam they were extracting these. So they came either the day before or the same day of the site visit.

MS MENZIES: Okay, great, thank you.

MR LOPEZ: So that verifies that they - the figure - the core log in page 23, this is located at the crest of the dam. We were there at the crest of the dam. While the next page ones had been stored in a shed for several days.

MS MENZIES: I see. But they are all from around that same time? So they are the ones that were taken in 2019?

MR LOPEZ: I don't know. I don't know. I don't know when they all were, the ones in page 24 and 25, were drilled, because those drilling programs, they can go for months. So I cannot tell. But all these cores are logged. So it can be tracked down exactly where they were taken from and what date and time.

MS MENZIES: Yes. Okay, thank you. For present purposes, that's fine. I have more general questions. So at the top of page 24 you say:

> *The observed conditions of this contact denote poor cleaning and preparation of the foundation during construction and may significantly impact the shear strength/sliding stability of the dam.*

Are you able to show us where that is on the photos? Is that the

photo on page 23 with the arrow?

MR LOPEZ: Yes.

MS MENZIES: And how can you see that?

MR LOPEZ: Well, you can see - well, you need to get back to the principle for design and stability of concrete dams. Concrete dams are supposed to be founded on good-condition rock. When you have the foundation that is too weathered, is too broken, you normally use other types of dams, like rock fill dams or embankment dams. In a concrete dam, you normally excavate down to good rock foundation. So what you can see here is if you imagine the top of the - or the picture on the right - on your left is the concrete, and then we have the interface with the rock where the arrow is pointing.

MS MENZIES: Yes.

MR LOPEZ: And then the next bit of rock comes on the second layer in that box, on the left, so it goes from right to left as it goes down.

MS MENZIES: Yes, I see.

MR LOPEZ: Because, of course, there - so it comes in a single - in as a single cylinder, but you cannot store it, because it will be, like, 50 metres long. So it is stored in boxes that are 1.5 metres long. So you can see that after the concrete, it becomes rock that is very fractured and is soily.

MS MENZIES: Yes.

MR LOPEZ: It is more like soil, followed - so I - maybe I can make a parallel. I think somewhere else there is a parallel with - there was a photo of a good - not here. But in an ideal situation, what you can see in those cores is that at the interface between the concrete and the rock, the rock is so sound that it looks almost like concrete - maybe a different pattern, but it looks really smooth and continuous. In this case, it is quite discontinuous. It is a type of material that you can disturb really easily. So that's not the ideal foundation for a concrete dam.

MS MENZIES: Yes, okay. All right. Thank you, that's very helpful. In the next paragraph, then, on page 24, you talk about - and I presume this is a reference to the photograph on that

page:

> *... the observed joint conditions along each core were highly variable, from very good bonding (even without bonding) to completely unbonded.*

And then you say --

MR LOPEZ: Just before you read it, while I was reviewing this, I found a typo. It's "(even without bedding)", not "bonding".

MS MENZIES: Oh, "bedding", yes, yes, I see what you are saying, yes.

MR LOPEZ: But that's my mistake. I can see now there is a typo there. Is not "bonding", "(but even without bedding)".

MS MENZIES: Yes, yes.

MR LOPEZ: Okay.

MS MENZIES: Yes, thank you.

MR LOPEZ: So can you repeat the question, after making that --

MS MENZIES: Yes. So it was simply going to be the recommendation coming out of that, then, is that:

> *... GHD should carefully consider this variability when adopting the shear strength parameters ...*

Is that part of that statistical analysis? Well, you were talking about statistical analysis because of the different types of tests before, but is that - when you are adopting a friction angle, is that where GHD has to account for this variability? How does GHD do that?

MR LOPEZ: Well, this is never an easy task and is related to the "37 degrees may be too conservative". So what we are saying here, because all those tests were for unbonded joints, so we are saying, well - and this is directly related to it. We are saying, when we look at the photos, not all the joints were unbonded. So when you have a bonded joint, you are going to have a larger shear strength than in an unbonded one. So that's a fact. So what we are saying here is, again, you cannot necessarily - well, it depends. It

FL -1

depends on the approach. One thing is the reality. The reality is the shear strength is going to be a combination of the shear strength provided by the bonded and unbonded zones of the joints. So what we are recommending is to take that into consideration where using a final shear strength for the design purposes. So that's what we are saying, which is - it goes in line with the previous comment that we discussed before.

MS MENZIES: Yes. It all ties, it all points the same direction to this recommendation of needing more samples, I presume?

MR LOPEZ: Yes.

MS MENZIES: Okay. Thank you. Moving from this, then, to appendix D to this report? So you will see the next appendix is some case studies, an article?

MR LOPEZ: Yes.

MS MENZIES: And then, if you turn further through, there is a covering letter. We lose the page numbers here, but there is a letter from you to Craig Hillier on 18 April 2019, and it's a covering letter for a report --

MR LOPEZ: Excuse me. Just excuse me for one second. Sorry.

MS MENZIES: No, that's fine.

MR LOPEZ: Yes. Please go ahead.

MS MENZIES: So this seems to be a desktop review of documents you'd been provided by Sunwater to that point; is that correct?

MR LOPEZ: It is a preliminary design report by - oh, wait, wait, wait. No, there were several documents. So those documents are mentioned here. Yes.

MS MENZIES: Yes.

MR LOPEZ: So they were provided by Sunwater, yes.

MS MENZIES: Yes. And I presume that you were - well, is it correct you helped write this report, or you did - what was the process --

MR LOPEZ: What report? I wrote the letter.

MS MENZIES: So the letter attaches the report --

MR LOPEZ: So the whole appendix, the appendix D, I wrote it.

MS MENZIES: Yes. Okay, great. Thank you. I have some questions about different parts of this letter, and so maybe if we just work through. So section 2. --

MR LOPEZ: May I put this in context, the letter?

MS MENZIES: Yes, please do.

MR LOPEZ: Well, this is the thing. We were engaged as Technical Review Panel members, but Sunwater said, "Look, the first visit is going to happen only in May. Why don't you, Francisco, have a look, a preliminary look, at what has been done before and give us your thoughts on it." So this is a sort of a task in parallel to the technical panel.

So we need to understand that what I wrote here was very preliminary and before any TRP discussions or presentations were made. I was simply given a number of documents for me to make an interpretation of what is there, without any further explanation from GHD or from anyone.

MS MENZIES: Yes, okay.

MR LOPEZ: So this is very preliminary. So, with that context, please keep it in mind.

MS MENZIES: Thank you very much. So section 2 of the report is where you go through each of the different documents you've been provided and make comments. Section 2.2 is talking about a letter of 30 December 2014 and some results of core tests.

MR LOPEZ: 2.2?

MS MENZIES: Yes.

MR LOPEZ: Sorry, 2.2 is a GHD memorandum --

MS MENZIES: No, sorry.

FL -1

MR LOPEZ: -- on dam stability.

MS MENZIES: I beg your pardon. Section 2.1.2, the page before.

MR LOPEZ: 2.1.2, TRP letter.

MS MENZIES: Yes.

MR LOPEZ: Okay, I need to make some clarity there.

MS MENZIES: Yes.

MR LOPEZ: There was a previous engaged TRP for a different and previous phase of the job. So when I'm talking about "Section 8 of TRP number 3", "TRP number 4", and all that, there were reports and letters from the previous TRP.

MS MENZIES: Yes. Thank you. So this is talking about samples that were taken in December 2014, horizontal cored holes. And is it correct that four samples were taken: three were good, the fourth not so good?

MR LOPEZ: I didn't review those cores, so I'm summarising what the previous TRP stated in that letter.

MS MENZIES: Yes, okay.

MR LOPEZ: So I cannot - so they say some were good, some were bad. I didn't see them. I'm just reporting on what I read.

MS MENZIES: Yes. I see what you are saying. So in the fourth bullet point down, this document that you were looking at suggests that a more representative interpretation of the lift joint is given by the three good samples. In your experience, is that a sound approach?

MR LOPEZ: I cannot make an opinion on that.

MS MENZIES: Thank you, that's fine.

MR LOPEZ: Because I'm not looking at the samples. So, no, I cannot make an opinion.

MS MENZIES: That's fine. Thank you. The next section down is headed "2.1.3.1". So this is talking about - and appreciating that

you didn't look at the borehole samples, you are just summarising what others have done, but there are vertical boreholes drilled in May 2015, and then testing on them was done later that year, and there is a comment that you've quoted from the report, I presume, that there is a "much higher proportion of poor quality layer boundaries" in comparison to "Enlarged Cotter Dam". Is that dam significant? Have you heard of that dam before?

MR LOPEZ: Yes.

MS MENZIES: And why is that the comparator?

MR LOPEZ: I think it is relevant for comparison because that's probably the - well, is the biggest RCC dam constructed in Australia and it is contemporary with Paradise Dam.

MS MENZIES: I see.

MR LOPEZ: So that could be the reason why they make the parallel between the two.

MS MENZIES: I see, thank you. Do you know if that was a low or a high paste RCC mix or no idea?

MR LOPEZ: My understanding - I might be wrong. My understanding is it was a high paste.

MS MENZIES: Okay. So they say there - well, it's comparing to another dam, "high proportion of poor quality layer boundaries", and then the TRP at that time goes on to suggest a peak shear strength of at least 45 degrees and a residual one also close to 45 degrees. Can you explain how that fits in with what they are looking at? Are they saying that that - what's the significance of the 45 degrees they are talking about? Are they saying that's what needs to be achieved, or what does that mean?

MR LOPEZ: No, I think what they are doing at the time is in the absence of actual shear strength tests - because they were looking at the samples; they were looking at the cores. But I think at the time no-one has tested them. So a reasonable starting point for unbonded joints - and this has been documented in several dam guidelines - is that if they are broken, an angle of friction of 45 degrees and no cohesion is a reasonable starting point for analysis.

MS MENZIES: Okay, I see, yes. So then it just seems, from just

FL -1

basic comparing numbers, if 45 degrees is a conservative starting point, when you are getting shear strength results of 37 degrees, as was later produced in some of these tests, it's a big difference?

MR LOPEZ: Well, the "conservative" - 45 degrees being "conservative" is probably their words. I don't know if it says there. I think it is a "reasonable", and being a reasonable number is not necessarily a conservative number.

MS MENZIES: I see, yes. I see. But would you still agree that there is a big difference between 45 degrees as a reasonable starting point and then results showing 37 degrees in shear strength tests?

MR LOPEZ: Well, the 45 degrees is the baseline case when you are going to start checking something, but you always need to resort to shear strength tests. So the tests came with a 38 - 35 - 37, 38 degrees, yes, and that's still okay for unbonded joints. But we know - well, we know that there has been also bonded joints, and that's why our recommendation is to be very careful not to use a particular shear strength number without considering the global, the full picture.

MS MENZIES: Yes.

MR LOPEZ: So it goes back. Those are my words. Now, what they are saying there is that use - at least 45 degrees and no cohesion, that's a very conventional assumption for unbonded lift joints.

MS MENZIES: I see, yes. Thank you. That's helpful. So when these sorts of comments are being made in May 2016, talking about proportion of poor quality layer boundaries --

MR LOPEZ: That's 2015.

MS MENZIES: 2015, yes. And then there was no sampling done - are you aware when the next lot of sampling was done by Sunwater?

MR LOPEZ: No. No, I don't know when it started, no.

MS MENZIES: Okay, thank you. Would you expect to see --

MR LOPEZ: All that is very well documented in the preliminary design report by GHD, because they made a very judicious statistical analysis of the available information regarding shear strength. So

that's well documented there. But I cannot tell when they were first tested.

MS MENZIES: Yes. Okay, thank you. Okay, my next questions were about section 2.2, which is talking about GHD's work.

MR LOPEZ: Yes.

MS MENZIES: So we've addressed my first question already, which was about adopting a sheer strength of 37 degrees. We've already talked about that.

MR LOPEZ: Yes.

MS MENZIES: A couple of pages on, so you'll see --

MR LOPEZ: Within section 2.2?

MS MENZIES: Yes, yes, still in section 2.2. It is the page that's just text, there are no pictures on this one.

MR LOPEZ: Yes, okay.

MS MENZIES: Down the bottom you will see our notation, and it ends in 0660. Can you see that?

MR LOPEZ: No. Can you repeat that?

MS MENZIES: In the bottom right-hand corner there is a notation, SUN.009.003 --

MR LOPEZ: Yes, I can see that, yes.

MS MENZIES: And it ends in 660, just to check we're on the same page.

MR LOPEZ: Yes.

MS MENZIES: Great. So I'm just wondering if you can explain one bit that I don't quite understand. In the second bullet point on that page you are talking about GHD doing a stability assessment using the January 2013 flood.

MR LOPEZ: Yes.

MS MENZIES: And because it didn't fail, I presume the factor of safety must be greater than 1?

MR LOPEZ: Yes.

MS MENZIES: And then there is a comment about:

> *... the actual dam behaviour during the flood was most likely the result of a combination of factors. For instance, in regards to the shear strength of the lowest RCC lift joint, it is possible that part or all of the joints are actually bonded, therefore there will be an important cohesion component that would contribute largely to the stability of the section.*

MR LOPEZ: Yes.

MS MENZIES: We've talked already about some of that, but can you just explain how that works? Because we've been talking about --

MR LOPEZ: Yes.

MS MENZIES: Thank you.

MR LOPEZ: We need to refer back again to uncertainty. So we have a number of very specific holes that found that some part of the joints are bonded and some are not. We already made reference to the fact that the actual shear strength would be a combination of the shear strength provided by the bonded and unbonded joints. So the situation here - and we need to introduce another concept, which is uplift, and that's the vertical pore water pressure at the dam foundation interface, or at any horizontal layer, that would push the dam up.

MS MENZIES: Yes.

MR LOPEZ: So if we get back to the basic principle of how the dam resists sliding - that is, the heavier it is, the more difficult it would be to slide it horizontally; yes?

MS MENZIES: Yes.

MR LOPEZ: So when you have a big uplift component, basically, the overall vertical force is less, because you have the weight of the

dam pushing down but you have the pressure of the water pushing up. So the effective weight of the dam would be less, therefore, it would be easier to slide along a particular horizontal layer.

MS MENZIES: Yes.

MR LOPEZ: Now, there are ways to control the magnitude of that uplift force, and that would be by providing a barrier, which is called a grout curtain, on the upstream side of the dam, combined with a membrane along the face of the dam, which is connected with this grout curtain that goes down into the foundation. So basically, you are putting a hole barrier from the crest of the dam down to several metres into the foundation rock. So that's going to prevent water to permeate and go into those layers of the dam. So that's a way to reduce the uplift force.

MS MENZIES: Yes.

MR LOPEZ: Is that concept clear?

MS MENZIES: Yes. I understand, thank you.

MR LOPEZ: Okay. Now, GHD did one particular approach to it in which this particular uplift force was set as only 20 per cent of what it would have been if it had not had that particular membrane, waterproof membrane. So they were very specific about something that is very uncertain, is difficult to measure. So normally with the uplift you use different scenarios. You say, "Well, what if the uplift is reduced to 50 per cent because of the membrane", or, "What if it's 20", or, "What if it's 80", because it is very difficult to measure.

MS MENZIES: Yes.

MR LOPEZ: In this case, when they were replicating the 2013 floods, they said, "Well, let's assume that the waterproofness of the membrane provided an uplift reduction, such as the uplift was only 20 per cent, and they said that that was their parameter.

So what I'm saying here is, what if it was not coming from the membrane only; what if the uplift was not 20, but it was maybe 80? It could have been, because no-one measured that. If that's the case, the stability of the dam should come from a combination of factors, which may include the actual shear strength friction of the dam being higher than it was assumed in that particular analysis; it

could have been from the dam bending downstream, as a beam, and then it prevents the dislodging of the monoliths of the dam. That's what I'm saying. Yes.

MS MENZIES: Yes. I understand. Can I just double-check: when you are talking about this 20 per cent, is that a conservative or an aggressive assumption? So are they saying, "Let's presume the membrane and the grout curtain are very effective, so then they effectively get rid of 80 per cent of the uplift we would otherwise have" - is that what the 20 per cent is?

MR LOPEZ: Yes, that's what it is. Whether that's aggressive or not, that depends on the confidence that you, as a designer, can be - well, the 20 per cent that they, that GHD did, or adopted, I don't know what's the rationale behind it.

MS MENZIES: Okay.

MR LOPEZ: It could be aggressive. But I'm not really sure how much was used in the design. I don't know.

MS MENZIES: I understand. Thank you. So a more basic question, then, is if you, instead of 20 per cent, adopt 80 per cent, that is effectively saying that your grout curtain and membrane are not as effective?

MR LOPEZ: Well, yes.

MS MENZIES: Okay.

MR LOPEZ: Yes, that's what it is.

MS MENZIES: I just wanted to understand how the percentages work. But I think that's helpful, thank you. I understand the point about the dam acting as a beam and so monoliths can't dislodge because of how it is acting in that fashion, but I don't understand the last point in that paragraph where you say - so back on this page, the paragraph we were just talking about:

> *... it is possible that a particular monolith had an nominal [factor of safety] of less than 1.0, but its deficit of shear strength was transferred to the adjacent monoliths via the ...*

MR LOPEZ: Okay, yes. Well, the dam is broken into monoliths,

which those - well, the way how they are broken, RCC is constructed in continuous horizontal layers, but while the concrete is still fresh, a joint breaker is induced, a piece of plastic is introduced in the concrete to create these vertical contraction joints.

MS MENZIES: Yes.

MR LOPEZ: The vertical contraction joints are not smooth. They are basically cracks, induced cracks, in the monoliths. So there will be some shear strength that prevents the sliding of one monolith with respect to the next one.

MS MENZIES: Oh, I see.

MR LOPEZ: So what I'm saying is, let's imagine that in the middle of the dam there is one particular monolith that is completely unbonded, and it would be a good candidate to slide.

MS MENZIES: Yes.

MR LOPEZ: Yes?

MS MENZIES: Yes.

MR LOPEZ: But those monoliths adjacent to the bad one, on both sides of it, they have a good shear strength resistance, or it has a good - so when the bad one tries to slide, it would need to transfer part of the - it would try, and it's like not only on the horizontal plane but also on the vertical contraction joints, and there is additional friction there.

So even if the bad one is going to try to slide, the deficit it has in terms of sliding capacity is going to be transferred to those adjacent ones that have a better sliding capacity.

MS MENZIES: Yes, okay. Is that the very purpose of those vertical joints?

MR LOPEZ: No. Concrete cracks, and that's a fact, because there is thermal reaction. So what has been shown in the past, in concrete dams technology, is that dams, they crack in a vertical way every 15 to 40 metres, depending on the mix, depending on how much heat they generate when the concrete is poured. So what we are trying to do is, instead of the dam cracking randomly, we are trying to create the cracks where we want them, so they can be controlled

and we can put water stops to prevent water to come back. So it is not too different to the concept of a sidewalk. So you have concrete and you provide contraction joints so the sidewalk doesn't look ugly, but it is cracked exactly where you want it to.

MS MENZIES: Yes. Great. Thank you very much, that's really helpful. A very easy one: a couple of pages further on you talk about the "PMPDF case" so I presume that's a reference to probable maximum --

MR LOPEZ: On 62?

MS MENZIES: Yes, that's it. So it's in the top paragraph.

MR LOPEZ: Yes.

MS MENZIES: It is a simple question: what's the difference between "probable maximum precipitation design flood" and "probable maximum flood" - PMF, compared to PMPDF?

MR LOPEZ: Well, in terms of magnitude, the PMF is much larger than the PMPDF.

MS MENZIES: Okay.

MR LOPEZ: A better description can be given by a hydrologist, which I'm not.

MS MENZIES: Okay. Yes, I understand. The graph on the bottom of that same page that we are on here - so now we're in section 2.3 and there is a graph at the bottom of the page, which I presume you did not generate - did that come out of someone else's work?

MR LOPEZ: No, that I generated.

MS MENZIES: You did generate that?

MR LOPEZ: Yes.

MS MENZIES: Can you explain what it is showing and the relevance of where the GHD and BDA plots fall?

MR LOPEZ: Yes. If you remember, I got little information at the start of the project, so I just wanted to make a comparison of the different shear strength values that have been reported to date from

FL -1

the design report and from GHD's statistical analysis of the samples, and I wanted to put that in the context of other documented shear strength measures in dams in different parts of the world. So this particular one is for similar RCC dams in Brazil, the US and Vietnam.

MS MENZIES: Yes.

MR LOPEZ: So this is not an absolute comparison, because this is - you can see it is very segmented, it is only three countries. But at least I wanted to have a starting point.

MS MENZIES: Yes.

MR LOPEZ: So what you can see, from all this collection of data, they established a regulation for the shear strength of high paste RCC, low to mid paste RCC, and low to mid paste with bedding.

So, in particular, I want to mention the low paste and low paste with bedding, because the bedding in Paradise Dam is still an issue that has been discussed. The bedding is supposed to help the bonding, to help bonding between two layers, for two reasons: one at the upstream face of the dam, to try and help the impermeability of the dam. So it is part of the system of the membrane plus the grout curtain, plus a certain amount of distance from the upstream face you have this bedding. But the other one is to help in bonding the horizontal layers when they were left to harden.

MS MENZIES: Yes.

MR LOPEZ: So when you put this mortar, that is going to help bond the two layers.

MS MENZIES: Yes.

MR LOPEZ: So there has been discussions there about how much was used in Paradise Dam and whether that was enough or not enough, but that's still in discussions, so I don't want to enter into much detail there.

MS MENZIES: Yes.

MR LOPEZ: But getting back to the graph, the blue line, which is the low to mid paste without any bedding, it is showing, well, that linear rotation there.

MS MENZIES: Yes.

MR LOPEZ: So what I wanted to do is, okay, I have information, the assumptions in the design, so that's BDA 2004, with and without bedding. So if we plot that, I think that was converted to shear strength if we had 500 kilopascals of normal stress. So I try and normalise that and plotted the BDA 2004. There were reports in the dam safety review conducted in 2016, which I am not really sure who is the author of that - it could have been GHD it could have been AECOM, I don't know - and then the one used by GHD. So I just wanted to make a comparison there. It definitely shows that even the design and the currently used values, or the ones that were used by GHD, they are relatively low with respect to that particular collection of data that has been presented.

I didn't - well, by the way, this table, the high paste, low paste, that particular graph is not my creation. I imported that from a paper from the USSD, the US Society on Dams. I'm just putting the two together.

MS MENZIES: So you are using a US Society on Dams graph but overlaying the BDA and GHD results and adopting a particular normal stress. That's your only addition to the graph?

MR LOPEZ: Yes.

MS MENZIES: Okay, I understand, thank you. Okay, thank you for that. Only probably one further question on this report - oh, sorry, there are two, actually. On the next page there is a picture, and it shows a core hole log from Paradise Dam on the left, and on the right is a sample from a dam in Brazil.

MR LOPEZ: Yes.

MS MENZIES: And you have said in the paragraph above, "Photographs of the cores tested for shear do not seem to clearly intercept any bedding mix. However, the bedding mix could be thin and difficult to identify." How likely is it that the bedding mix would be that thin and difficult to identify that you wouldn't see it, in your experience?

MR LOPEZ: That is likely.

MS MENZIES: Oh, it is likely?

MR LOPEZ: It is likely. It is likely. We have had difficulties in finding the bedding mix in any core hole from Paradise Dam, so much so that we were asking for photographs to try and verify that the bedding mix has actually been placed.

So in the picture on the left, we couldn't see any bedding mix, but it could have been - it could have been - that the location of the borehole was one out of the area of the bedding mix, because it hasn't been well defined where it was placed or not.

I just wanted - because, in theory, when you have a bedding mix, in theory, it should look as good as the one shown on the right for the Brazilian one. So it is quite clear, you can see - it is a thin line, but you can identify it, and you see the quality of the core is quite good.

MS MENZIES: Yes.

MR LOPEZ: In comparison to the very broken one that we got at Paradise Dam.

MS MENZIES: And I understand the point that this core hole might have been taken where there was no bedding mix, but, in your experience, if a sample is taken where bedding mix has been used, you should be able to see it, just like the one on the right-hand side; is that correct?

MR LOPEZ: If the sample is intact, yes. The problem is - can you get back to appendix B, page 25?

MS MENZIES: Yes.

MR LOPEZ: On the top photograph, there is a bedding mix.

MS MENZIES: Yes, I see.

MR LOPEZ: The difference here is that this borehole was drilled at an angle.

MS MENZIES: Yes.

MR LOPEZ: So you can see a more continuous bedding mix there. The problem is, when you have the vertical ones, just by the mechanical process of the beat of the drill, there is the chance that the

torque imposed there basically breaks at the bonding between the bedding mix and the RCC, and it may actually chew that particular bedding mix, so what you get there is what looks like an unbonded joint, and basically the bedding mix can disappear. So that's one of the challenges when you don't have a very good bonding condition. That's one of the challenges that you face. So it is definitely difficult to identify.

MS MENZIES: I know that there are comments in GHD's work about accounting for bonds that they think were fractured by the sampling process itself, as opposed to joints that remain intact and joints that were not bonded at all. Is it an easy process to differentiate between ones that have been broken by the sampling process and ones that were never intact? Is that difficult?

MR LOPEZ: It is difficult.

MS MENZIES: Yes, okay.

MR LOPEZ: This is probably the big question here. Because if we were able to easily identify which one is bonded, which one is not, it would be easier to make a proportion of how much cohesion you allow for in the estimation of the shear strength.

Now, there are methodologies to help with that, which are called acoustic televiewer and optical televiewer. So not only do you have the core that you extracted, but the hole in the dam, you basically put - you send a couple of exploratory tools down that are going to help visualise the condition of the joints on the dam itself.

MS MENZIES: Yes, I see.

MR LOPEZ: And there you can correlate - if you see a bad joint in the televiewer, then you can correlate that to what you have observed in your core.

MS MENZIES: Yes.

MR LOPEZ: Now, in all types of dams, or dams that don't leak - well, Paradise Dam doesn't leak much, but in dams that are subject to a lot of leakage through the joints, you can identify bad joints because you have calcite and you have a chemical deposition there at the joints, so you can identify them that way. In Paradise Dam it is more difficult, because we haven't seen many

joints at which you have active leakage or passage of water. Well, that's an ideal condition, that you don't have the water there, but it makes more difficulty in identifying these particular bedding planes or joints or broken joints.

MS MENZIES: Yes, okay. Thank you. I'm conscious I'm pushing you for time. I had one more question about this report and then I do have a couple about the other two as well, but, rest assured, not so many.

We skipped back to appendix B, but at the end of the letter we were just looking at at appendix D, at the very end of that letter it talks about possible explanations of the low shear strength.

MR LOPEZ: Yes.

MS MENZIES: So appreciating the context you provided before about when this was done, but you're talking about possible reasons, including construction methods and, I suppose, quality assurance type issues - since you prepared this report, have your views about these possible explanations changed?

MR LOPEZ: No, these are textbook explanations that need to be discarded one by one.

MS MENZIES: I see, yes.

MR LOPEZ: And I think maybe some of them have been - well, since then, some photographs were provided and some construction records, that are giving a possible explanation of the reason for the low shear strength. But at this point in time, when this was written, these are textbook hypotheses, yes.

MS MENZIES: I see, thank you. Okay. Can we turn, then, please, to the second report.

MR LOPEZ: Yes.

MS MENZIES: Which is dated 23 September 2019.

MR LOPEZ: Yes.

MS MENZIES: And on page 13 of that report is a section, section 4, "Review of Dam Stability".

FL -1

MR LOPEZ: Yes.

MS MENZIES: Did you take the lead on this section, Francisco?

MR LOPEZ: No. No, I didn't.

MS MENZIES: Who did, and did you have any input?

MR LOPEZ: Well, this is not a specific review of the dam stability done by the TRP. This is a TRP report on GHD's review of the dam stability.

MS MENZIES: Yes, I understand. So I understand that this is not the TRP doing the stability assessments themselves; you are looking at GHD's work. But who actually wrote this sort of review about this aspect of GHD's work, do you recall?

MR LOPEZ: Well, it's either Peter Foster or myself, but it could be - it could be that he collected my thoughts and put them there. But I can try and answer your questions, but I don't remember --

MS MENZIES: Okay.

MR LOPEZ: I don't think I put this together, no.

MS MENZIES: I only have one question, anyway, because we've addressed the others in the prior discussions we have had, but I wanted to ask about, on page 14, the second paragraph down, this seems to be talking about - no, let me rephrase. So it starts with:

> *"Well-defined" means a sufficient number of tests have been done on concrete core from the dam --*

to provide reasonable certainty about strength parameters. It seems to echo the ANCOLD guidelines about what angles to adopt or what factors - it might be factors of safety to adopt, actually. Can you talk about that?

MR LOPEZ: Yes, it's about the factors of safety, yes.

MS MENZIES: Yes. And so what do you understand the terms "reasonable certainty" and "sufficient number of tests" to mean?

MR LOPEZ: Can you repeat the question? The question is not clear to me.

MS MENZIES: Sorry. So this is talking about the ANCOLD approach to, as you just said, adopting a particular factor of safety, and the ANCOLD guidelines seem to use this language, and they use the terminology "sufficient number of tests" and then they say "to have strength parameters with reasonable certainty". From a lawyer's perspective, those seem to be quite vague terms, and I wondered if you had a view about exactly how many tests you might need, for instance?

MR LOPEZ: I fully agree with you, it is vague, and I think it is vague on purpose.

MS MENZIES: Okay. So --

MR LOPEZ: I think the idea - because every case is different, every dam is different. I think the idea by ANCOLD is to use engineering judgment, which is not very useful at times. When it says "sufficient number of tests", well, there is no way to put bounds on that, even on a project. I mean, what would be a sufficient number of tests? It has to do with the confidence - how many - and it goes back to this: it has to be a sufficient number of tests so the analyst and the designer feel confident that the number you are getting there is not going to be less than what you are assuming with the factor of safety being considered.

MS MENZIES: Okay. Yes. I understand. Thank you. I don't have anything - oh, sorry, just a clarification. I think you have already talked about this, but the graph on that same page, this is plotting the ANCOLD factors of safety, and there is a plot line there for 20 per cent uplift, 50 per cent uplift, 100 per cent uplift. So that ties in to what we were talking about before - for instance, those things around the membrane and the grout curtain? That's right, isn't it? That's what "uplift" there is talking about?

MR LOPEZ: It is, yes, it refers to that, yes.

MS MENZIES: Yes. Thank you. I don't have anything else on that report. And just a couple of questions on the third report, please. Can you please turn to that one.

MR LOPEZ: Yes.

FL -1

MS MENZIES: So that is dated 9 December 2019. So there is a couple of sections I wanted to ask you about, if you were involved in writing them. So section 2 is on page 3.

MR LOPEZ: Yes.

MS MENZIES: The heading is "RCC Strength Review", and this is a discussion about the work of Tatro Hinds and what they have done looking at GHD's work. Were you involved in preparing this part of the report?

MR LOPEZ: No.

MS MENZIES: Okay, then there is probably not much --

MR LOPEZ: I was involved in the discussions, but I didn't prepare this part of the report.

MS MENZIES: Okay. If it's possible to give me some general assistance, that would be good. If you can't, that's fine. At the bottom of that page, page 3, there is the start of the last paragraph. It's talking about getting peak strength and then residual strength at different normal stresses. At a general sort of level, can you explain how that testing works and how you derive those residual strengths?

MR LOPEZ: Well, the idea is - and this is in very general terms, because I didn't see the tests being conducted.

MS MENZIES: Yes.

MR LOPEZ: And to my understanding, there are different ways of doing it, and this particular lab, they did it this way.

MS MENZIES: Yes.

MR LOPEZ: Basically, they tested a bonded sample, subjected that to a shear force, until - well, for a set vertical force, they shear the bonded sample, and then they get the force at which it fails. Well, actually, for failure, it's creating a curve of applied shear force versus displacement until it fails.

MS MENZIES: Yes.

MR LOPEZ: So once it fails, basically, you have the equivalent to

an unbonded joint, because it has already gone. So what they do is that they put another, an extra force, vertical force, and they start shearing that again. So that's going to give you the residual - I mean, the residual is the shear strength of an unbonded one. So they are using the same sample, the bonded one, to obtain the peak shear strength, and once it has failed, they say "Well, this is similar to an unbonded joint, let's put more vertical force on it and let's shear it again."

MS MENZIES: Yes, I see.

MR LOPEZ: And they repeat the shear strength on the residual one three times on the same sample.

MS MENZIES: Yes, with larger forces each time?

MR LOPEZ: With larger - well, the horizontal force, which is the shearing one, is always an increasing one, is like a pushover until it fails.

MS MENZIES: Yes.

MR LOPEZ: The vertical one has been set at three different ones.

MS MENZIES: Yes, I see.

MR LOPEZ: But you fail it - every time you fail it in shear for a sustained vertical force. The vertical force is not variable.

MS MENZIES: Yes. I see. I see. Thank you. That's very helpful. At the bottom, further down - so four lines from the bottom - this is talking about Tatro's ideas - Tatro Hinds:

> *If the testing is to represent residual strength once a dam block begins to slide on an unbonded lift it will require large displacements to define a residual strength.*

The TRP then says, "'large displacements' is a loose term". Do you recall what was being discussed there?

MR LOPEZ: At the TRP, at the meeting?

MS MENZIES: Yes, so what are those sentences talking about?

MR LOPEZ: No, the Tatro idea was exposed at the meeting, and he said it would require large displacements to find the shear strength. So he is basically doubtful that the shear strength found at the lab with this particular test is accurate enough, because a large displacement of the failed sample would be needed. But, again, the discussion in line with what you said that, as a lawyer, the ANCOLD guideline which mentions large displacements is not giving much idea of what's actually the large displacement after which the shear strength residual is actually achieved. So we are pointing towards this - it is not legislation, but let's say this, the advice - it is a very open subject. It is difficult to get whether this has to be residual strength or peak strength. It would be difficult to get that agreement, and that's still part of the discussions. Because the concept of residual shear strength for a concrete dam is not well defined in the guidelines.

MS MENZIES: Yes, okay. Thank you, that's really helpful. I have only one more question about this report. If you could please turn to page 12, this is the section headed "Dam Stability and Risk Profile".

MR LOPEZ: Yes.

MS MENZIES: Did you help with this section?

MR LOPEZ: No.

MS MENZIES: Okay, thank you. So you haven't written this, but did you have any input into figure 7.1 on page 14?

MR LOPEZ: 7.1?

MS MENZIES: Yes.

MR LOPEZ: No, that's GHD. This is extracted from GHD.

MS MENZIES: Okay.

MR LOPEZ: This is not produced by us, by the TRP.

MS MENZIES: As a general question on this report, then, Francisco, were there any sections that you prepared in report number 3? I've taken you to two, but I don't think you prepared either of them.

MR LOPEZ: No. No - well, wait. Wait. Yes, I prepared section 4

and section - yes, section 4.

MS MENZIES: Okay, thank you. Section 4 seems to be looking at the options for future works and the stability of options 2 or 3 or 3(a) as the case may be. So they are not looking at the dam as it stands now, so I wasn't intending to ask you any questions.

MR LOPEZ: No.

MS MENZIES: Okay, thank you. That's all the particular questions I had. I don't know if there is anything that springs to mind that you wanted to discuss with us in terms of what the Commission is looking at?

MR LOPEZ: Well, I would like to know what's the process looking like from this point on and whether I will be required for further steps?

MS MENZIES: Yes. So from today we will draft up this statement, we will send it through to you. It might have some placeholders for things that we couldn't quite get to the bottom of. I am counsel assisting, but senior counsel assisting is Jonathan Horton of Queen's Counsel, and he will have a look at the statement and see whether there is anything that he would like to discuss with you further and also consider whether we would like to call you as a witness at the hearings. So there are three weeks of hearings in March. The first week is up in Bundaberg and the next two weeks after that are in Brisbane. So we will let you know. I don't know, at this stage, whether we will need to call you or not, but we won't leave you lingering and we will let you know as soon as we can.

MR SMITH: Just on that point, Jane - sorry, it is Matthew here. Simon, I think, has already indicated to Rachel that Francisco will be overseas for part of the --

MS MENZIES: Yes, okay.

MR SMITH: So that should be taken into account in the event that he is asked to attend the hearings.

MS MENZIES: Yes, okay, thank you very much for raising that again. Yes, we will take that into account. Sorry, I'm just looking at one further thing, just one moment, sorry. Okay, I think that's all from us today. As I said, we will be in touch with a draft statement. We will send that through Simon, I think - that's how we

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will get it through to you, Francisco - and be grateful if you could have a look at it. If there is anything you need from us, further documents, et cetera, please let us know. But can we thank you again for being so generous with your time today.

MR LOPEZ: You are welcome. That's okay, my pleasure.

MR SMITH: I'm sorry, Jane, before we finish, is it possible - I mean, when the statement is done, is there a transcript available of the interview?

MR LOPEZ: Yes, yes, we're going to have a transcript prepared, so we can send that through as well, if you would like to see that, no problem at all.

MR SMITH: Yes, that would be great, just to make sure that what we've noted today is accurate, so that, you know, we don't waste any time - any of your time or our time. That would be great.

MS MENZIES: Yes. No problem. Will do. Okay. We will send those through. So you still want us to go through Simon - is that appropriate? Or would you prefer us to go through Matthew at Clyde & Co? We have no qualms either way. Whichever is better.

MR SCOTT: No, keep it with me, Simon, thank you.

MS MENZIES: Okay. No problem. All right. Well, thank you again for your time. We really appreciate your assistance.

MR LOPEZ: Thank you. Goodbye.

THE INTERVIEW WAS ADJOURNED ACCORDINGLY