ENVIRONMENTAL PROTECTION AUTHORITY
BEFORE AN EXPERT CONSENTING PANEL

IN THE MATTER OF THE FAST-TRACK APPROVALS ACT 2024

AND IN THE MATTER OF AN APPLICATION BY MATAKUNUI GOLD LIMITED UNDER SECTION 42 OF THE FTAA

FOR THE BENDIGO-OPHIR GOLD PROJECT

APPLICATION NO: FTAA-2507-1089

Hearing:	Held in Monarch Room, Willeston Conference Centre, 11-15 Willeston Street, Wellington Central
Date:	15 June 2026
Panel:	Hon Matthew Muir KC (Chair) Gina Sweetman Phillip Barry Roger MacGibbon (via AVL) Peter Kensington
Counsel:	Joshua Leckie and Mia Turner, Lane Neave, for the Applicant Rob Enright and Jen Vella for Environmental Defence Society David Randal for Otago Regional Council Mike Holm and Nicole Buxeda (via AVL) for Kā Rūnaka Sally Gepp for Fish & Game
Experts:	Dr Dora Avanidou (Panel appointed technical expert) Dr Paul Weber, Ryan Burgess, Julie Palich, Jens Rekker, Dr Ian Boothroyd, Gary Smith for Applicant Prof Jennifer Webster-Brown, Dr Leanne Morgan for Environmental Defence Society Inc Dr Michael Greer, Alexandra Badenhop for Otago Regional Council Matt Dale for Kā Rūnaka

TABLE OF CONTENTS

Mr Muir: Yes, well good morning and welcome to the second week of our concurrent hearings. Today's topic is water – ground and service water. Quick introductions, since we have a number of new faces in the room today. To the panel. Matthew Muir, I'm the panel chair. To my left Peter Kengsington, landscape architect; Phil Barry, economist; Roger MacGibbon, who is expert in ecology. To my right, Gina Sweetman, planner; and the person who will put you all under the microscope today, Mr Tim Mulliner, who is himself an expert in the areas of expertise you all have. Because we have a number of new faces, including today I met for the first time our section 67 appointee, Dr Dora Avanidou. Good morning, Dr Avanidou. She's seated closest to us – closest to God – and we may confer with her during the course of the day, as she is our expert appointee, in some aspects here. So if I could just run through the expert panel today just to – so I can start putting some faces to some names. Seated next door to Dr Avanidou is - - -

Mr Rekker: Jens Rekker.

Mr Muir: Mr Rekker, thank you very much, Mr Rekker. Yes, thank you.

Ms Badenhop: Alexandra Badenhop, here on behalf of the Otago Regional Council.

Mr Muir: Right, thank you. Thank you, Alexandra.

Dr Boothroyd: Ian Boothroyd, here on behalf of the applicant.

Mr Muir: Yes, thank you, Dr Boothroyd.

Dr Morgan: Leanne Morgan, here on behalf of the Environmental Defence Society.

Mr Muir: Yes, thank you very much, Dr Morgan.

Mr Burgess: Ryan Burgess, here on behalf of the applicant.

Mr Muir: Yes, thank you, Mr Burgess.

Ms Palich: Julie Palich, here on behalf of the applicant.

Mr Muir: Thank you, Ms Palich.

Dr Weber: And Paul Weber, for the applicant.

Mr Muir: Yes, thank you, Dr Weber.

Prof Webster-Brown: Jenny Webster-Brown for EDS.

Mr Muir: Yes, thank you, Professor Webster-Brown.

Dr Greer: And Michael Greer on behalf of Otago Regional Council.

Mr Kensington: Two online.

Mr Muir: And we have two online. If you could introduce yourself. Mr Smith, is it - - -

Mr Smith: Mōrena.

Mr Muir: - - - or commonly Dr Smith or Professor Smith.

Mr Smith: Mōrena. Gary Smith on behalf of the applicant.

Mr Muir: Yes, thank you. Mr Dale.

Mr Dale: Yeah, my name is Matt Dale, on behalf of Kā Rūnaka.

Mr Muir: Thank you, Mr Dale, nice to see you again. Yes, thank you. And, Mr Smith, you're on behalf of the applicant.

Mr Smith: Sorry, yes, Gary Smith - - -

Mr Muir: Yes.

Mr Smith: - - - on behalf of the applicant, yes.

Mr Muir: Yes, thank you very much, Mr Smith. Right. No doubt counsel has advised you of the way in which we have now chosen to proceed with the concurrent hearings, which is by first identifying on the whiteboard the headline topics that we need to discuss during the course of the day. I don't know whether there has been discussion between you or whether we have to settle those now with its own little mini conference. I'm going to probably go to and ask Dr Weber whether there's been some progress, or any progress in that respect, and whether you choose to divide the day up, Dr Weber, between groundwater and surface water, or in any other way that the experts think is appropriate. Has there been an opportunity to discuss headline topics?

Dr Weber: Yeah, thank you, Commissioner. We have talked through it, and Alexandra Badenhop has a list of topics that we'd like to talk through.

Mr Muir: Yes.

Dr Weber: And also a number of items circulated by others to discuss, including the – Ms McArthur, so that could be included. It does become an extensive list of topics, which I think you might need to triage and bring down a little bit.

Mr Muir: Yes, I think we might have to. Yes, we try to consolidate this down to five or six, and yes, we understand that there are sub-topics within these. But the objective is to try and avoid going through the, in this case, the two JWSs and every single item of difference and treating that as a separate topic. So – well, look, we'll just see how we go. I'd like to try and conclude this exercise within 10 minutes at most because it's going to be a long day as it is, with a great deal of material to cover. We usually use Ms Sweetman, because she has a very fine hand, to try and identify what these topics are. Can we start with some headline topics that are not going to be contentious.

Dr Weber: Common objectives. So defining what the constituents of concern are and then identifying how we manage those through appropriate limits.

Mr Muir: Typically, it might be something we put at the end of the list. But we'll definitely – that's definitely obviously going to have to be a topic for discussion. What about some headline issues? Are we going to divide it – is it useful to divide it between groundwater and surface water? It is?

Prof Webster-Brown: Yes Sir.

Dr Weber: Yes.

Mr Muir: Right. Why don't we then talk about groundwater first and see if we can identify some headline topics here for groundwater.

Ms Badenhop: Hydrogeological characterisation.

Mr Muir: Sorry.

Ms Badenhop: Hydrogeological characterisation.

Mr Muir: Right, okay. That sounds like it's a sufficiently generic topic for me. Can we get that on the board.

Mr Rekker: Seepage capture.

Mr Muir: Seepage capture.

Ms Sweetman: Does everyone agree.

Mr Muir: We agree, JWS is – it certainly seems something that we – right. Other topics in groundwater that are relatively high level of extraction.

Morgan: Groundwater modelling.

Mr Muir: Groundwater modelling, yes.

Ms Badenhop: I think the topics that Dr Weber was referring to in terms of the overall closure objectives refers to also the potential contaminants that concern the compliance standards which come under groundwater. So those aspects all come together - - -

Mr Muir: Yes.

Ms Badenhop: And they all help with the feedback loop into each other.

Mr Muir: Yes. Well, we do understand that none of these topics is siloed.

Ms Badenhop: Yeah.

Mr Muir: Yes. Well, why don't we then put under a heading, Gina, closure, for number four.

Ms Badenhop: Another option, but this might cut across other areas as well, would be adaptive management. It's not probably groundwater specific though, so it doesn't have to come within the groundwater topic.

Mr Muir: Right. Well, why don't we just put that with a bracket around it, because our experience over the last week shows that often by the time we get to the end of these lists, we have addressed them at an earlier stage of the analysis. But if we just do it as a check, a check to make sure that we don't miss it.

Ms Badenhop: Thank you.

Mr Muir: Okay. And to what extent is my objective to discuss groundwater separately from the surface water. To what extent will there be cross-pollination between those issues. Will they – can they be dealt with, with a reasonable level of self-containment, if I can call it that.

Ms Badenhop: The complicating factor is the model for the site - - -

Mr Muir: Yes.

Ms Badenhop: - - - which has the surface water infiltrating into groundwater and how those effects are carried through.

Mr Muir: Yes, yes, yes. Well, we just have to make sure that we carry that forward into both analyses, but let's try and deal with them separately to the extent that we can, and no one should feel constrained about identifying in what areas we've got to come back to this in the context of surface water. Right. Is that a sensible order, 1 to 4 there, with which to deal with these; or should we start – is there a more logical place to start. Like, for example, with the modelling.

Ms Morgan: I think the modelling would come after hydrogeological - - -

Mr Muir: Right.

Ms Badenhop: - - - conceptualisation, Sir.

Mr Muir: I see, very good, very good. I'm happy then to run with the list that we have there and I'm going – Dr Weber, I'm going to start with you always. I recognise that you have a large team for the applicant and I'll get you to then pass over to whomever on the applicant's team is best to lead off for the applicant on these topics. But I'll go to you first.

Dr Weber: Thank you, Sir. Can I just get a clarification on regards to the list that we've created. This is just for groundwater?

Mr Muir: We're just going to have to make sure – could you pull that microphone just a little bit closer first.

Dr Weber: Sorry, I'll lean forward. So just for clarification, Sir, the list we have on the board relates to groundwater. Are we also going to consider other topics that we've discussed today now, or did you want us to jump straight into groundwater?

Mr Muir: I consider that we should just deal with the ground – to the extent that we can, and the experts agree, we should deal with groundwater as a discrete topic, recognising that there will be some over – there will be some overlap.

Dr Weber: Okay, okay.

Mr Muir: Then we will, then at a later stage in the day, we will go to surface water, and we will do exactly the same thing. And it may be that at that point you say that we've got to come back to some of the overlapping issues again. Is that alright?

Dr Weber: Yes, that makes sense.

Mr Muir: That makes sense, okay.

Mr Mulliner: Is it – does this work. Is this working?

Ms Sweetman: Yeah.

Mr Mulliner: Oh, it doesn't have a light. I wonder if it's worth going over the surface water topics now, so that we have - - -

Mr Muir: Right.

Mr Mulliner: - - - a better view of the other topics that'll carry so we don't miss anything out in the discussion. Is that a good idea?

Mr Muir: Everyone's agreed with that? We – that the whole process is as flexible as it needs to be to ensure that at final analysis, we on the panel get the best information and can interrogate as we go. Right. Can I start with the applicants again.

Dr Weber: Did we want to discuss ecological effects on the receiving environment. Is that something that you'd like to talk through, Ian?

Dr Boothroyd: Yes, I think that should be included.

Mr Muir: Right, ecological effects on the receiving environment.

ECOLOGICAL EFFECTS

Dr Weber: And that there was a list created as a team and maybe I'd invite Professor Jenny Webster-Brown to provide some topics. I think she has some that are specific that I'm happy to talk to as well.

Mr Muir: Yes. Professor Webster-Brown.

Prof Webster-Brown: One of the topics that we didn't get onto in the conferencing was the pit lakes. It would be really good to have a chance to talk about those.

Mr Muir: What, what – could you just perhaps just identify with a little more specificity. We've talked last week at one point about questions about ecotoxicity in the pit lakes. Is that one of the concerns?

Prof Webster-Brown: It is one of the concerns. The general water quality is a concern, and the fact that there'll be a large volume of water there in perpetuity as it's of very poor water quality and essentially toxic. Passive treatment systems. The order might not be right there.

Mr Muir: Yes.

Mr Weber: Could I just expand on that, Professor. Maybe we lump that as treatment which includes passive and active. I think put that together.

Mr Muir: Yes.

Prof Webster-Brown: And related to that then is the compliance standards and potential contaminants of concern.

Mr Greer: On the compliance standards, I wondered if we didn't also include ecological triggers as part of the general suite of receiving environment metrics and monitoring. We haven't managed to – we didn't manage to cover that component off in the joint witness statements, so it's an area of potential oversight.

Dr Weber: And if I could provide a point of clarification, Sir. The number four, the compliance standards containing for constituents of concern and so on, that does relate to closure objectives that I've got defined above, so that's what I was indicating before, they are tied together. As you said, maybe leave something to the end.

Mr Muir: Yes, yes. Dr Weber, can you rearrange your desk please and pull that microphone just so you don't have to lean forward quite so heavily. And do keep your voice up. And I'm going to ask every expert who contributes today, until such time as our stenographers start to recognise your voice, which I'm going to suggest all morning when you introduce – when you are about to speak, introduce yourself again please, so that the stenographers can align the comment with the identifying expert. And do spare a thought for our stenographers – highly technical information. If you get to something that is, you know, a specialist term that is unlikely to be able to be spelt easily, could you just identify that for the purposes of the record. Right. Okay. Tim, are you happy – any additional items here on surface water?

Prof Webster-Brown: Could we add that water load balance modelling please.

Mr Muir: Water load balance modelling. Are we happy with what we have? Of course this is not locking us in, in an inflexible way. We need to flush out the principal areas of difference, hear from the experts on them and then interrogate them as a panel and if any other issues emerge during the course of the day, they can just be highlighted and put on the board. It's not meant to a prescriptive process, just simply trying to put some structure around our hearing today. Okay.

Mr Enright: Sir, I did have a question - - -

Mr Muir: Yes - - -

Mr Enright: - - - a topic - - -

Mr Muir: - - - Mr Enright.

Mr Enright: - - - just about the liner or the absence of a liner. It was a question I'd like to ask at some suitable point. I'm not sure which one it would be captured under.

Mr Muir: Are we talking here about the proposed wetland on the storage containment facility or - - -

Mr Enright: Sorry, for the TSF - - -

Mr Muir: Right.

Mr Enright: - - - in the absence of a proposed liner.

Mr Muir: Liner.

Prof Webster-Brown: So for the uncaptured seepage.

Mr Enright: Uncaptured, alright, thank you, great, right.

Mr Burgess: Mr Chairman, can I add one to the bottom of the surface water list if that's possible.

Mr Muir: Yes.

Mr Burgess: That's the wetland water supply.

Mr Mulliner: We can't have any more of these, there's no more room.

Mr Muir: This will be a first if we go on to page 2 of the topics. It doesn't auger well for a, you know, a 5 o'clock finish. Okay. And having identified these topics, we're going to follow the tried and trusted format, which is that I will start with whomever among the applicant's experts' addresses wishes to address this specific topic or, if more than one, such of those experts. I will then circle round to all of the invitees and section 51 parties' experts and then before I leave those comments, I will touch base with our section 67 appointee, Dr Avanidou. Then the process will involve questions from the panel. At the conclusion of questions from the panel, I will go to counsel. There's been some advice of intention to cross-examine on some of these topics, and we permit limited and focused cross-examination. At the conclusion of that, we then come back to the panel for any issues that might have emerged out of the cross-examination that the panel requires assistance with – and we do that sequentially topic-by-topic and then at the end of it we just touch base to ensure that there is nothing else that we need that any party thinks we need to discuss. So, although I'm running five minutes late, I now want to kick off on the groundwater subject on hydrological characterisation. Dr Weber. Who's for the applicant who will speak that.

Dr Weber: Thank you, Sir. For the applicant, we'll have Mr Rekker and Mr Burgess. They'll both provide a statement.

Mr Muir: Right, thank you. Thank you, Mr Rekker.

HYDROGEOLOGICAL CHARACTERISATION:

Mr Rekker: Hydrogeological characterisation was undertaken from the inception of the mineral project. It involved a stepped process of combining gold resource drilling investigations and groundwater/hydrogeological investigations. You will hear or will you have read of packer testing. It's primarily to determine hydraulic connectivity of the consolidated rock that it was either in geotechnical or gold resource holes. The hydrogeological characterisation also included the surrounding environments, the valley floor sediments and other fluvio-glacial sediments which carry groundwater and for those hydrogeological investigations, more conventional water supply focused hydrogeological characterisation work was done, particularly at the project's proposed water supply in the south-east part corner of the Bendigo aquifer. But not excluding the valley floor sediments in the Lindis catchment such as the Ardgour aquifer and the Lindis alluvial ribbon aquifer and the Bendigo Creek itself which is alluvial floor itself. So - - -

Mr Muir: What are the principal tensions on this issue, and what's the applicant's position?

Mr Rekker: - - - the applicant's position is that the understanding of the hydrogeological characterisation is at a level adequate for the assessment of effects on the site and surrounding area effects.

Mr Muir: And, in a sentence or two, what's the principal argument against you and what's the repost?

Mr Rekker: The principal argument against is that there is a great deal of uncertainty in the collection and characterisation efforts that they're of insufficient scale and number and thereby a large enough sample of hydrogeological characteristics have not been collected.

Mr Muir: Is there validity in that?

Mr Rekker: There is always validity in that. In our profession we are always managing and coping with hydrogeological uncertainty and there is no set stop point as it were in terms of investigation and a consideration of a satisfaction of uncertainty being resolved.

Mr Muir: Could I summarise the applicant's position in saying "you can always do more, but we think we've done enough".

Mr Rekker: That's correct.

Mr Muir: Right. Very good. And the applicant was going to supplement that with some comment by - - -

Mr Rekker: Mr Burgess.

Mr Muir: Mr Burgess, thank you.

Mr Burgess: Ryan Burgess. So to build on Mr Rekker's explanation, the main aspects that really drive a lot of understanding around the characterisation from a geo watering and seepage migration point of view, the geology, which is the material type that water can move through [inaudible 00:34:29] in the distribution, the permeability or hydraulic connectivity, and this is the ability of these units to transmit water and groundwater levels, and this allows us to interpret groundwater flow directions and where groundwater will travel. And throughout the characterisation programmes through exploration geo tech programmes, there's been a number of this data collected, including over 70 test pits across the sites and hundreds of geological exploration drillholes provide us this geological information, both shallow and deep. The estimates of permeability, eight drillholes, a total of 36 estimates across the site and groundwater levels in the form of vibrating wire piezometer strings, and there's a level of those distributed – 11 of those distributed across the site. There are 33 independent sensors and so to summarise that, while we note there are some limited data gaps that plan to be filled with further investigation, so one of those specific is the hydraulic connectivity of the valley bottom alluvium and it's my opinion that the available baseline as for hydrogeological data provides a reasonable basis for understanding the hydrogeological setting within the Shepherds Creek and Rise and Shine Creek valleys, including the likelihood of draw-down pattern and mine waste storage facility seepage migration as a result of the project and, as I note, there are further hydrogeological characterisation programmes, as well as performance monitoring, installations proposed to fill these gaps and inform detailed design which is the standard practice for these large developments where there's ongoing levels of investigation to further refine and support design of project elements.

Mr Muir: So we heard from Ms McArthur last week – she was unable to attend today. She was broadly critical. She said, quote, "unequivocally more could have been done and it needed to be done", was essentially the message she wanted to leave us with. Have you have an opportunity to read her evidence or listen it?

Mr Burgess: Yes, I have. I was part of the water expert conferencing.

Mr Muir: Yes. And you say that she is, what, a Council of perfection she is pursuing, or how do you respond to that?

Mr Burgess: n a similar manner to Mr Rekker. There – in hydrogeology we fundamentally, we only sample a small size of the volume of the aquifers. That is not in question. That is not in doubt. That's just a fact of our practice. And there can always be more done and so it's about finding the right balance and the level of data put forward is sufficient to understand the risks and how to manage them.

Mr Muir: Could I perhaps go to you, Professor Webster-Brown, next.

Prof Webster-Brown: Certainly. I would just make a quick comment about an inadequately identified normal water quality perspective before handing over to our groundwater experts, if that is okay.

Mr Muir: Yes.

Prof Webster-Brown: One was the – so lack of baseline water quality data collected for the groundwaters. That makes assessment of this very difficult from here on in. I am not a groundwater modeller, and I would prefer to hand on to Dr Morgan if that is alright with you.

Mr Muir: Very good. Dr Morgan.

Dr Morgan: Thank you. So I guess broadly my position is that the hydrogeological characterisation is not at a level that's adequate for the assessment of effects, if I put it broadly to start with. And the reason I say that is that while the geology is – it's quite well described in the pits and there has been, you know, there's been a lot of holes in the vicinity of the pits and in the vicinity of the ore. Beyond that the assessment has been relatively limited.

Mr Muir: Could we just bring the microphone back a little bit closer for me.

Dr Morgan: Okay.

Mr Muir: Sorry, it's my general dilapidation and loss of hearing. Thank you.

Dr Morgan: Particularly for the, particularly for the receiving environments. So for the strains of the wetlands and also for the Ardgour aquifer there's been very little work done to characterise the aquifer materials. There's been some additional work done for the, with – from the, for the seepage assessments which Brian has – Brian talked to but broadly there's been no characterisation of water levels. And the fundamental thing when we're doing groundwater is we need to understand where the groundwater's moving. And to do that you need to drill purpose – purpose drill wells that give you the groundwater levels. And from that you then create a contour. And, you know, these contours which let you know the direction of the groundwater flow - - -

Mr Muir: All of this even more difficult in this fractured schist environment?

Dr Morgan: You'd hear the direction of groundwater flow in different directions and we're kind of missing that. So it's hard for us to say where the groundwater's moving. And when you don't know where the groundwater's moving, it's very difficult to say where the contaminant will move.

Mr Muir: And if you were in our position with the suite of powers that we have under the Act, what would you specifically be asking the applicant to provide to assuage your concerns?

Dr Morgan: I would be asking for additional monitoring wells to be installed.

Mr Muir: Additional monitoring wells - - -

Dr Morgan: - - - to be installed.

Mr Muir: I'm just going to get a list of this, if I may. Additional monitoring wells.

Dr Morgan: Additional monitoring wells.

Mr Muir: Can you be more specific about number or location?

Dr Morgan: Well, you need to have enough so that you can create what I'm calling a potentiometric surface.

Mr Muir: Yes.

Dr Morgan: potentiometric surface, to put it in context is like, it's like, you know, a land surface topography map. So we need enough points so that you can constrain the highs and the lows, and so then you can determine where the groundwater's flowing because groundwater always flows from high to low. And there has been - - -

Mr Muir: [Inaudible 00:42:02].

Dr Morgan: Yes. And there has been some of that done but primarily in the pits, in the location of the pits which is understandable because that's where all of the resource work has been done, and it's expensive to drill monitoring wells and put them in, and I accept that, for a project of this scale, I think that there's a requirement to do that extra work.

Mr Muir: Right. Additional monitoring wells is what we need, yes. And if we were to issue a request for information, or use any of the other powers that we have, what – it would never be issued with that level of generality – what are we going to specifically ask, or you believe the applicant should be specifically asked to do?

Dr Morgan: Okay. The specifics, well - - -

Mr Muir: Is there a performance standard that we can impose here?

Dr Morgan: That's a very good question, Sir, and I think that as experts we can – or as groundwater scientists, we can – we know that we need more than what's currently there. We need more in the receiving environments. We need to know in the Shepherds Creek environment whether there's, you know – we need to know whether the groundwater's moving towards it or away from it. In the – around the wetlands and especially around the Rise and Shine Creek wetlands, which are the most-high value of wetlands on the site, we need to understand how they function. In the Ardgour aquifer we need to understand where the water's held, where the water's moving there.

Mr Muir: Yes.

Dr Morgan: And the connection between the fractured rock and the receiving environments, you have this – I see that you've stopped writing all this. Should I –there's a stretch where the surface water goes to ground. And that's really important that area, and there's been limited studies done there and we need more – we need more done there. And there was recently, I understand, a new monitoring well put in there and it came up with some quite new information which was quite a surprise. So it just goes to show that with more information we're quite possibly going to find that things are quite different to how they're thought to be, to be now.

Mr Mulliner: Dr Morgan, can I just ask a question on that? So if we were to have – let's say the applicant could install those wells tomorrow - - -

Dr Morgan: Yeah.

Mr Mulliner: What sort of timeframe would you think would be sufficient to gather enough data to understand seasonal annual trends?

Dr Morgan: And that's also a good point. Obviously the longer the better for the interannual. For seasonal, a year or two. There has been – there was – within the pits, I do note that there was, and this was from the reports that I've read, I imagine there's been more done, but there were four different snapshots of groundwater levels measured in the B03 report and so that would give you some sense of the seasonality, but it wasn't – but it said it was done but it wasn't reported, so we haven't seen, we haven't seen those photographs. So, yeah, it's a couple of years ideally.

Mr Mulliner: Can I just switch back to Mr Burgess here and ask – because you mentioned this also in W101, can I just confirm this, is that – that's the location of one of the proposed compliance - - -

Mr Burgess: Correct, yes.

Mr Mulliner: - - - monitoring wells? Yeah. And when was – so that was installed recently, was it?

Mr Burgess: Installation – it was within the last few weeks, so relatively recently, yes.

Mr Mulliner: And so I refer to your item 66 on this reconvened JWS, you state you found considerably different hydrogeological conditions than anticipated. How, I guess, can you explain in what manner you found it different and how that would influence, I guess, your understanding of the connectivity [inaudible 00:46:52].

Mr Burgess: Certainly. So the original conceptualisation for how – so maybe if I back up just for the panel's benefit. So water that's within Shepherds Creek, any surface water that travels past I guess the schist bedrock mountainous area goes on to an alluvial plain that, in that creek, effectively loses all of its water into groundwater.. So then the question is where does it go once it's gone through that

process and reaches the water table? The original conceptualisation put forward, based on available information at the time, was that the main groundwater transport pathway was a relatively shallow alluvial package. So when I say shallow I mean in the sort of order of 10 to 15 metres deep below ground surface that essentially followed the creek alignment and so any water that leaks from Shepherds Creek on this alluvial plain is held within this aquifer and then migrates effectively north towards the Lindis River and the Ardgour aquifer. What entered there was a low permeability unit beneath that that held the water up, that allowed water to transport along this aquifer with this conceptualised aquifer. This new well that was intercepted placed the bedrock, instead of being 10 to 15 metres deep, it was circa-60 metres deep and the alluvial – the unconsolidated, and by that I mean sands and gravels and silts, not bedrock, package above that was consistently observed to be dry, and the water table was intercepted during drilling close to this bedrock interface at around 55 to 60 metres deep. So what that means is there's a large unsaturated zone between where the water table sits and the ground surface, and that unit geologically is a mix of angular sand swells and silts that I interpret to be a terminal rain package that's consistent with the other terraces surrounding that area and that has, I would interpret as a moderate permeability. So long story short, water that leaves or leaks through the base of Shepherds Creek travels down 50 or so metres until it hits the water table and it resides within an alluvial outwash package and that's one that has larger materials, much less fine, so it tends to be more permeable and there is further work required to confirm the – whether the flow path is still in a northerly direction or whether groundwater had moved in a more westerly direction.

Mr Muir: So this has further implications, doesn't it, in terms of the ability to intercept, under some form of adaptive management plan, contaminated waters if the observations, observation over time was that treatment options were not dealing adequately to contamination of the site. So if I could just – please understand I'm a lawyer and not an engineer.

Mr Burgess: Yeah, so - - -

Mr Muir: - - - but if you're taking a broad picture of this, if there were deficiencies, and we accepted that there were deficiencies, in terms of the modelling and these issues of hydrogeological characterisation, if we were to accept the position of Dr Morgan and really Ms McArthur last week but that it didn't really matter to the extent that there was an ability in the face of increasing contamination levels being observed in groundwater leaving the site and you could put in place, and we accepted that it was geologically and here geotechnically possible to put in place an interception, then the absence of this work, or the alleged absence of this work might not sound as importantly for us. Do you see where I'm going?

Mr Burgess: Mm-hm.

Mr Muir: But now we're suggesting that rather than dealing with the interception of groundwater at perhaps 10 to 15 metres out of Shepherds Creek, to intercept it you're going to have to be 55 metres down, is that right?

Mr Burgess: If you were attempting to intercept it at that location.

Mr Muir: At that location.

Mr Burgess: Can I expand on that?

Mr Muir: Yes.

Mr Burgess: Within the Shepherds Creek valley, you have a much more constrained hydrogeological system - - -

Mr Muir: Yes.

Mr Burgess: - - - you've probably read, right, and that's where – if I was providing advice, that's where you have, well, I guess, if I was, that's where you have performance monitoring very close to your primary systems so you have an early warning – you have an early warning of if there's any unrecovered seepage from your primary collection points and then the most logical and easiest place to intercept that seepage is the next closest point within that valley. So the main focus is collection of seepage within the valley before it leaves the valley system where it comes, as you point out, harder.

Mr Muir: Yes, harder.

Mr Burgess: Yeah.

Mr Muir: Right.

Mr Mulliner: So following on from that, so the secondary containment capture system that's sort of been briefly outlined conceptually, that doesn't change in your light based on that new information. It's still that shallow – it's still in a shallow layer in that area, is it?

Mr Burgess: Within the Shepherds Creek valley within the, you know, the core – so are familiar with SCFO1 is? It's kind of a transition – the surface water compliance site - - -

Mr Mulliner: Yes.

Mr Burgess: - - - in the Shepherds Creek area where it transitions from the sort of uplands mountains onto the glacier for the alluvial plain, right.

Mr Mulliner: Yeah.

Mr Burgess: So that's kind of the – I'm just trying to – it's not exactly that location but it's more or less the point at which the bedrock becomes deeper, based on this new monitoring well, the water table becomes deeper and so theoretically harder to collect. So upstream that point and there's kilometres of stream in valley reach

between that last point, that sort of last point where you can collect it easily, and these mine waste storage facilities. So you have within that upstream of SCO1, you have shallow ground where, we know we've measured that, and that's on the order of two to five metres deep by comparison. You have groundwater flow, groundwater levels that suggest flow from the valley sides to the valley middle, right, so that promotes, or it's favourable for seepage collection. And you have this, like I said, this long reach between where your primary collection systems are and the point at which it becomes more challenging to pick up. And so your secondary systems would be placed within that valley setting and this new monitoring well in the downstream of SCO1 doesn't change how you'd manage anything upstream of SCO1 but it would within the project site and the upland mountain system.

Mr Mulliner: So do you have confirmed geological and groundwater information at that location, at SCO1?

Mr Burgess: We have – we do not have any drilling. What we do have though is a very topographically constrained point where you can observe bedrock outcropping on this very narrow point in the valley which suggests to me, in my opinion, a relatively thin package of alluvium and bedrock relatively shallow.

Mr Mulliner: So do you think, in your opinion, it's worth getting that confirmed?

Mr Burgess: So as part of the proposed characterisation programme and indeed the performance monitoring locations, there is a specific – there has been identified – that location has been identified for groundwater performance monitoring.

Mr Mulliner: Okay, but not necessarily characterisation to absolutely confirm that it is constrained there and we haven't got a 50-metre-deep alluvium, or you don't think that's necessary?

Mr Burgess: There has been ample geotechnical investigations further upstream at that point that demonstrate unequivocally that the alluvium is five to 10 metres deep at most and even thinner further up the valley.

Mr Mulliner: Okay, thank you. I do have a related question on that but potentially we can cover that later on.

Mr Muir: So from my perspective, the message I get here is the primary and secondary treatment options which are proposed and which you consider based on the information you currently have can be more appropriately established in relatively shallow alluvium. These are going to have to work because there is really no practical tertiary option further down the valley as a result of this new information.

Mr Burgess: In my opinion, there is ample opportunity to put in a third, or a third system if needed. So these seepage interception systems, they might be 50 to 100 metres in width - - -

Mr Muir: Yes.

Mr Burgess: And you've got kilometres to deal - - -

Mr Muir: Available.

Mr Burgess: Available real estate to deal with. [Check 00:59:05]. So the first one, there's primary systems. If they, for whatever reason, don't work as well as they need to, then you step off close to it, 50 to 100 metres, install your secondary system and then if that system doesn't work, you can either upgrade it or you can place a third system if needed.

Mr Muir: Another 100 metres - - -

Mr Burgess: Yes.

Mr Muir: - - - further down before you get into 50 metres of alluvium.

Mr Burgess: Correct.

Mr Muir: Okay, thank you.

Mr Mulliner: Just before we move on to this new location, one more question. So that monitoring bore is proposed to be the groundwater monitoring bore for the project. In light of this new information, is that still valid?

Mr Burgess: Just to clarify, the compliance monitoring bore.

Mr Mulliner: The compliance monitoring bore?

Mr Burgess: Yeah. There would need to be additional monitoring wells installed to confirm the appropriate location for compliance monitoring so we can confirm the groundwater flow direction.

Mr Muir: Right. Thank you. This is sort of becoming a new hybrid model again. We're sort of doing a bit of questioning as we go. Can I come to Dr Greer.

Dr Greer: Ms Badenhop is the ORC expert on specific groundwater matters.

Mr Muir: Right, okay. Ms Badenhop.

Ms Badenhop: So I think a lot of my points have actually already been covered as such, but I do consider that it is important and that further characterisation work is completed within all of the hydro stratigraphic units as discussed in our joint groundwater JWS. The valley bottom alluvium which is within both the Shepherds Creek valley bottom and within the Rise and Shine, Clearwater Creek Bendigo Creek alluvium within the weathered bedrock and within the fractured rock that further baseline information should have been collected in terms of the levels, hydraulic properties and also water quality, all of those elements, noting that at the moment there is no baseline water quality data for the alluvium within any of the valleys within the mine site or outside the mine site until you get to the Bendigo aquifer. And there is none within the Shepherds Creek valley alluvium

and we also don't have any data within the Ardgour aquifer for water quality. In terms of properties, I think that has been quite well covered and that importance for confirming groundwater flow directions. As Mr Burgess has discussed, that that does impact on your confidence in the groundwater compliance locations recommended, noting as well that there'll be potential for groundwater to flow within the schist bedrock, albeit at a slower rate and a slower load. That is also a pathway that's not currently covered in the proposed compliance monitoring.

Mr Muir: Thank you. Mr Dale, did you wish to give any preliminary statement on this subject?

Mr Dale: Thank you, Mr Chair, no, I have nothing further to add, thank you.

Mr Muir: Right. Thank you. Are there any other experts that I need to touch base with before I just ask Dr Avanidou whether she has any statement to make at this point about these issues. Any other experts? No. Thank you. Dr Avanidou.

Dr Avanidou: Thank you. I agree that we need more hydrogeological characterisation to be undertaken. As Mrs Badenhop outlined, and Dr Morgan as well, there are some unknowns that create some uncertainty which is – will be perhaps reduced with further investigations. That's not on the groundwater level monitoring but also understanding a little bit better the hydrogeological properties that we have to deal with at the different materials that we encounter onsite and further downstream where we have those receptors.

Mr Muir: And, Dr Avanidou, just apropos the questions that I put to Dr Morgan, we have a suite of powers available to us as a panel. What would you be asking if you were inviting the panel, as you do, what would you be asking the applicant to do at this point, with as much specificity as you tell me now.

Dr Avanidou: Okay. So further investigation, groundwater investigation drilling and monitoring. So groundwater levels and hydrogeological property. If you are in rock, you may need to do packer testing but if you're in the alluvial you can do other type of tests like [inaudible (over-coughing) 01:05:51] test, stamping test to define the aquifer properties and groundwater level monitoring for actually understanding at the flow direction.

Mr Muir: Right. And no doubt you give lots of advice to others in this context. Can you give us a sum of – can you size this issue in some way for us? How long would this take?

Dr Avanidou: To install the monitoring wells and undertaking the testing - - -

Mr Muir: Yes.

Dr Avanidou: - - - you mean?

Mr Muir: Yes.

Dr Avanidou: Well, it depends on the quantity of course, but it takes – it will take a few months.

Mr Muir: It would take a few months.

Dr Avanidou: Yes. It's not a one-day exercise for sure.

Ms Sweetman: If I can just jump in on that. Are these matters that could be addressed through conditions of consent, or is this information that we need now in order to make a decision?

Dr Avanidou: In my opinion, it can be addressed in some respect with conditions of consent as long as there is a plan or a way to identify how you will deal if the investigations find out, for example, we discover through the investigations and monitoring that the conceptualisation for the modelling undertaken is not like – I'm trying to find the right word – not accurate because you cannot be accurate, but right, or in the right direction, or the effects are underestimated. So as long as there is a way to control the effect of the new information so it doesn't create problems, adverse effects, then yes, one would say that yes, you can do that with a condition of consent.

Mr Muir: It sounds like a drafting nightmare.

Dr Avanidou: I understand that, yes.

Mr Muir: nd there are so many different contingencies, there's so many different trigger points and so many different potential responses to a wide variety of contingencies.

Dr Avanidou: Ideally you will have all that earlier - - -

Mr Muir: Yes.

Dr Avanidou: - - - or yeah, and definitely before mining starts.

Ms Sweetman: To follow on, are the conditions of consent that we have in front of us at the moment sufficient to address your concerns?

Dr Avanidou: haven't reviewed the conditions of consent.

Mr Muir: Thank you very much, Dr Avanidou. Right. And I'll come back now to the panel. We have asked a number of questions as we've gone through. Additional questions from the panel on this subject?

Mr Mulliner: I'd just like to ask Mr Rekker a question regarding the new hydrogeological information from this MW101. Do you, and I go back to your assessment when you looked at the contaminant mobilisation into the Ardgour aquifer and its potential effect. Does that change your position, or would it potentially change any of your findings of that assessment?

Mr Rekker: Bear in mind that I haven't seen a copy of the bore log as yet. I've heard Ryan Burgess' account of the approximate depth and the approximate depth of

water. At the depths as I've just heard, they are within the range of depths and depths of water that I could have anticipated, that I was anticipating. The project had done some gold resource drilling within 300, 350 metres of SCO1, this bedrock gap, and found the depth to a basement of 22 metres; and then there was another gold resource drill hole which was halfway between MWO1, which is where the new information arises from, and SCO1, and it penetrated 54 metres before being abandoned because the gold resource objective was to get to bedrock. So we were aware that there was a deepening of a – and a progressive deepening at first and then a deepening to some considerable depth already and the MW101 result certainly confirmed towards the deeper side of that. But the conceptual model, the pattern of groundwater movement after the infiltration of Shepherds Creek water into this coarse alluvium of variable hydraulic connectivity, I don't consider that has changed, that the site of deepening seems to be within the Shepherds Creek alluvium rather than post the entry of the Shepherds Creek alluvium to the Ardgour aquifer. So it doesn't fundamentally challenge the conceptual model that we were running with.

Mr Mulliner: Okay.

Mr Muir: Yes.

Ms Sweetman: Can I just ask Dr Morgan and Ms Badenhop the question that I asked Dr Avanidou in terms of whether you think we have sufficient information in front of us to make a decision in respect of hydrogeological characterisations, or is this a matter that we could address through conditions of consent?

Ms Badenhop: Okay. So in our groundwater JWS we actually – we did discuss the fact that to understand the groundwater flow directions that there was further hydrogeological characterisation required to support further peer review groundwater modelling and that that was required to really understand the seepage flow directions and where compliance monitoring should be and if that found notably different effects or conceptualisation than otherwise thought in both these operational post-closure groundwater table and flow directions, then there would be a number of reports, management plans and compliance locations and a whole suite of things that needed to be updated. Now I'm not a planner. I don't know how hard that is to put into consent conditions and if you can really do that. But as it stands, as we discussed, we don't have the compliance location that we can rely on and so there might need to be then thrown in a whole bunch of additional compliance locations if you need to be able to consent to that now. That would be my initial thoughts.

Dr Morgan: My thoughts would be that given the current conceptualisation, we can't, and we don't understand a lot of things about the system, so it makes it very difficult to understand what the impacts are going to be and yet we do understand that they could be quite large, including contamination of aquifers. And so given

that, I think that it's an onus to have good information going forward for a decision.

Mr Muir: Cross-examination of any of these experts? Ms Gepp, did you?

Ms Gepp: No Sir, not on this topic.

Mr Muir: Thank you.

CROSS-EXAMINATION BY MR ENRIGHT:

Mr Enright: Yes, thank you, Sir. To Dr Avanidou, and please tell me if I am mispronouncing your name. In answer to questions from the panel, you indicated that there could be a range of problems, I think was how you described it, if the assumptions made about groundwater characterisation is wrong. Now the only definition of effects includes cumulative effects, potential effects, high probability and potential effects of low probability with high potential impact. And I just want you to step us through what those problems would be if the unknown assumptions on groundwater characterisation are indeed erroneous.

Dr Avanidou: So it will be that you are not monitoring at the right locations so you may be missing the contaminants seeping through, for example. That can be one potential issue. But if you don't have enough information or your modelling is not – doesn't have enough information to provide to answers that cannot be verified, that would be one of the things that I would say in answering your question.

Mr Enright: My understanding is that when you say contamination seeping through, is that a reference to a risk that one or both of the aquifers could be contaminated over time?

Dr Avanidou: Right. For any seepage or any contaminants that travel either through the fractured rock, which will take a long time of course to reach the aquifers, or reach the surface water of the stream which then will be a quick, a quick road to reaching the aquifers, then that's probably where you may need to have more compliance or performance monitoring as we call them here. And from the water management plan, there aren't necessarily too many and, as we discussed, for example, you may have surprises when you actually go onsite and drill and see what's underneath the soil. It's not surprising that the soil is highly heterogeneous and the hydrogeological site is complex there.

Mr Enright: And is it the case that a potential effect of low probability but high potential impact with groundwater is that there could be irreversible contamination of one of those aquifers over time if we have mischaracterised groundwater flow?

Dr Avanidou: If you are not – if you cannot monitor the contaminants before, or if you have contaminant seepage for example but you are not aware that you're losing

those contaminants towards the receiving environments, then yes, that will be a problem because you will discover them when they reach the aquifer and then it will be really difficult to do something.

Mr Enright: Thank you. Thank you, Sir.

Mr Muir: Mr Randal?

CROSS-EXAMINATION BY MR RANDAL:

Mr Randal: Thank you, Sir. I think a lot of the questions asked by the panel have picked up what I wanted to talk to Mr Burgess and Mr Rekker about, and we'll come back perhaps later in the week in the process to questions of conditions, but I think as things stand, the applicant's proposal is for the water management plan to be resubmitted within the next week or so to be approved by the panel through this process. Mr Burgess, is that your understanding of things?

Mr Burgess: It is my understanding, yes.

Mr Randal: Yes, rather than certified by the Regional Council at a later point, that's right, isn't it?

Mr Burgess: That's my understanding, yes.

Mr Randal: Are you the primary - - -

Mr Muir: The applicant is asking for and has consistently asked for that we effectively sit by the management plan, and I think there's been some indications from the panel about a lack of enthusiasm for that process.

Mr Randal: In that case, yeah, thank you, Sir, and in that case I can be reasonably brief, I think. But these matters, Mr Burgess, these matters we've been discussing this morning around characterisation of the units and flow directions and rates and performance monitoring locations, as well as compliance monitoring locations – I'm sorry, I've got that the wrong way around. Compliance monitoring locations we've been focusing on the discussion around MW101 but also the locations to monitor performance of the different capture measures. Details of all these things will reside in the water management plan, won't they, details of locations, characterisation of the – and properties of the resources and so on.

Mr Burgess: Yes, the plan to resubmit this management plan will include some of those details requested by or identified as gaps by some of the opposing expert witnesses. So things like the number of monitoring wells, the nominal depths, the screen, sorry which units these wells will be screened across or monitored, as well as a number of locations that have – will be in addition to the ones originally put forward that have come out of the expert conferencing process.

Mr Randal: Yes, but to state the obvious perhaps, the further characterisation work that we've been discussing and that you've accepted needs to be done at some

point prior to the proposal going ahead, that obviously won't be available for the next draft of the water management plan, will it?

Mr Burgess: No, it will not.

Mr Randal: And I'm sure we'll talk more about water quality as the day progresses, but, as Ms Badenhop has explained, there isn't any groundwater quality data, is there, for – in areas like the valley alluvium or in the Ardgour aquifer?

Mr Burgess: That's correct. The only groundwater quality data is related to the schist bedrock.

Mr Randal: And so while limits are proposed, water quality limits, you know, downstream limits, setting to one side the correct point at which compliance with those limits is to be measured, so while limits are proposed, we have no way of knowing, as things stand, what effect any leaching contaminants might have on the downstream receiving environment, do we, if not properly captured and treated?

Mr Burgess: Yeah, if not they are properly captured and treated, and I stress that's a large caveat, we do not have a firm understanding on the groundwater flow in the Ardgour aquifer.

Mr Randal: Yes, and I think you've accepted in the, and this is at paragraph 95 of the groundwater joint witness statement, the first one, you've accepted that more baseline information is needed to inform the future modelling and progress of this, haven't you.

Mr Burgess: Yes, that's correct.

Mr Randal: Thank you. And the panel in its fourth RFI, Request for Further Information, it sought information on various things about how the project might be able to adapt to any unexpected, you know, groundwater seepage, transport of contaminants and so on, and I think it was your evidence in response from April, I think it was, where you've set out a number of recommended further changes to conditions and so on including the commissioning of a peer review panel, periodic review and update of the 3D groundwater model over time as the project progresses, a condition that allows for triggers and actions to be determined, and your evidence, I think talked about discussing and refining specifics in a workshop with the Regional Council. But those are all future processes you thought were important to run these issues to ground, that's right, isn't it? They haven't happened yet.

Mr Burgess: No, you're correct, they have not happened to date.

Mr Randal: And in terms of a finalised perfected water management plan, you know, day one of mining beginning, all of the details of all those sorts of matters, they should properly be included in a water management plan at that time, shouldn't they?

Mr Burgess: Bear with me while I formulate my thoughts.

Mr Randal: Sure.

Mr Muir: Yes, Mr Weber, Dr Weber.

Dr Weber: Could I just make a comment on that matter?

Mr Muir: Mm-hm.

Dr Weber: Management plans are organic and they have to grow with evolving knowledge. So if new knowledge comes to hand, as from these studies that have been proposed, then that management plan would need to be updated.

Mr Muir:: And I think that position is well understood by the panel. Thank you.

Mr Randal: Thank you. But, Dr Weber, you accept that the correct location for reliably assessing compliance with limits needs to be known at that point, doesn't it?

Dr Weber: And speaking to surface water, because that's my area of expertise, we have those defined.

Mr Randal: Yes.

Dr Weber: And there's been identified groundwater locations. The exact location of those could still be refined further, but the location is down there out by somewhere – I'm struggling here – by MW01.

Mr Randal: Yeah, well, I think I probably can't take that further with you, Dr Weber. I think we've heard that that monitoring location has been established to be invalid now for groundwater, but I appreciate that's not, that's not within your area. So I'll leave it there, Sir. Thank you.

Mr Muir: Thank you very much, Mr Randal. Mr Leckie?

Mr Leckie: Nothing further that hasn't been covered, Sir.

Mr Muir: Thank you. Is there any other counsel. I haven't got any counsel. I do have Kā Rūnaka's counsel online. Ms Buxeda?

Ms Buxeda: Mōrena. There is nothing more from me on this matter. Thank you, Mr Chairman.

Mr Muir: Yes, thank you very much. Rounding back to the panel, any issues emerging out of the cross-examination that the panel would like to explore further? No, no, very good. We'll close out that topic then. Moving on to topic two, seepage capture. Who would like to address at the outset on behalf of the applicant. Dr Weber? Thank you.

SEEPAGE CAPTURE:

Dr Weber: I'll jump in, Sir. So seepage capture is an important component of any management system control mine impact water. So there's a number of mine domains that potentially could generate and will generate seepage. So that includes the engineered landforms, which we call elves. I know that may not be appropriate. It's also the TSF.

Mr Muir: Rather large elves.

Dr Weber: Yes, one of them will be rather large. There's also the TSF, and there's also the pit lakes on say form [check 01:29:43] and other minor infrastructure areas. The key thing that has always been part of our approach and our advice is to control that seepage. So if you can't control it, you can't treat it. So that's a fundamental approach. So the engineered landform is based on our advice. We don't provide detailed advice on tailings storage facilities. That's not our remit. There's engineers who do that. Just ensure there's an army of drains beneath all the facilities to bring that seepage to a few locations, ideally one. You're trying to avoid diffuse loss of water, which means that it's often much harder to capture. Hence, bring two defined points. One, monitor that seepage coming out, and that's the performance monitor proposed, so that it can then be understood and characterised and improve our models and all that sort of stuff, and then managed internally. And then at closure, that'll go to the water treatment systems. And then for the tailings storage facility, that water's managed by a variety of drains, which is beyond my area of expertise, but commonly [check 02:31:00] law, but it does report to these Shepherds sump, where the TSF and the Shepherds ELF water is captured, and that'll be re-circulated internally during the operational phase, and then eventually that'll be used – that'll be sent to the water treatment plant. So that's the high-level overview. But obviously there's issues relating to the loss of seepage beyond that system to the groundwater system, which I think is the intent of this discussion. So with regards to those discussions, I would be asking the groundwater experts to comment or provide a statement on that. Perhaps start with Mr Burgess.

Mr Muir: Yes. Mr Burgess.

Mr Burgess: Sure thing. Thank you. So we've already started to touch on seepage capture through these earlier discussions around characterisation and what that means for seepage collection. As Mr Weber outlined, these mine waste storage facilities, and I use that term to encompass both engineered landforms and TSFs collectively, have a number of design elements proposed to include, that will to – to collect seepage. The engineered landforms, so the Shepherds ELF and the Western ELF, are proposed to include a low permeability cut off toe barrier at their toe, or the most downstream extent that is cut into competent rock, which will effectively shut down flow in those shallower units. In combination with that, there are these underdrains that will intercept this – this water builds up behind

these barriers and convey those into these collection sumps for management. The Shepherds Creek valley fill, although not termed an ELF, has the potential to impact groundwater quality and has a similar system proposed with a low permeability cut-off barrier and a drain to collect water that backs up behind it. The Shrek's engineered landform is slightly different and the reason for that is that rather than being situated right in the valley bottom or the valley centre as with the Shepherds ELF and the Western ELF, it is slightly – it is positioned slightly on the southern flank of the valley. And, as a result, the design of the centre [check 1:25:30] system is slightly different. Rather than having a barrier, the proposal is to have a perimeter cut off drain that cuts into the shallow subsurface to intercept the water table and pick up any seepage that's migrating through towards the, or past the engineered landform. And then lastly there is the Shepherds tailing storage facility, and that has a number of – many number of seepage control design elements that are also in part to collect seepage, but also to manage geotechnical stability, which I won't touch on as it's not my area of expertise. But those elements include another low permeability cut off barrier beneath the embankment, upstream under drainage systems, an upstream cut off drain, as well as chimney drains through the embankment. And, as Mr Weber described, those all collect water and route them beneath the Shepherds engineered landform into the Shepherds ELF seepage collection sump for management within the mine water circuit. And the – as I described, the hydrogeological system within the upland valley system has groundwater levels relatively high on the valley sides and groundwater flow through the valley centre where the majority of these storage facilities are located that promotes and makes seepage collection favourable. And, as a contingency measure, if these, as we described, if these primary seepage collection systems I've just described are shown through performance monitoring that they are not adequately collecting seepage, additional interception systems can be employed ideally as close to the primary systems as footprint allows to enhance their – to enhance their overall performance or the overall collection. And those secondary systems will be designed based on the actual, I guess, conditions that are shown through performance monitoring. But they could include shallow cut off interception drains if there was a shallow pathway. So shallow in this context is in the region of five metres or so deep. Deeper interceptional wells that can target deeper pathways and potentially a cut off the grout curtain or a cut off wall that will enable – or that will enhance the performance of the secondary seepage interception systems, and the additional benefit that these types of systems provide is that they don't necessarily rely on a barrier. They rely on controlling the water levels such that there is a – I guess, you provide hydraulic control that can be more favourable for avoiding the migration of seepage past those locations, and it does that by creating a local low point in the water table so that your – if I can sort of create – without them your gradient is down valley. When you operate these

systems, they locally depress the water levels and you can control – if you design them appropriately, you can control them such that that water level is lower than the next down gradient point, which means you have inwards gradient, inwards groundwater gradients everywhere, which means that you are able to achieve much higher seepage collection efficiencies. And I think there's an important distinction to put between the operations and post-closure. And allow me just to go on a little bit longer. During the operations, the mine operator's there. They are – I guess there's a larger workforce onsite, and these systems can be installed relatively quickly. The larger risk is, in my opinion, is post-closure when there is less man force. or less manpower onsite, and there is the potential for the drains that are currently proposed in the under-drainage systems to block and fail. And our preliminary modelling has shown that those will lead to, or potentially lead to increases in unrecovered seepage. And so my recommendation to manage that risk is one of two ways: either for closure through all the knowledge that we gain, or that is gained over the life of mining around how the actual, rather than just relying on modelling, how the actual empirical evidence shows that groundwater is moving and transport processes are occurring that a seepage collection system primarily focused on closure that is considered that doesn't have some of these failure models around drain failure, is considered and alternative, and including that financial provision and mechanisms are made such that these secondary systems can be designed, installed and operated post-closure if monitoring is shown as they're needed.

Mr Muir: These secondary systems are actively managed. We're not talking about here passive management. You're talking about – because that's sort of almost like the third leg of the treble, isn't it?

Mr Burgess: Yes. So there are – so active management is one way. There are potentially designs that could, best put, better manage – or collect seepage more effectively passively. At this stage, I think it's too early to say reliably which one would be more beneficial, and usually you would do some sort of trade-off analysis to see overall which one – they both have their pros and cons – which one provides the most, or the most favourable outcome from a range of metrics. You might consider financial reliability or redundancy and other things like environmental outcomes and ongoing maintenance needs.

Mr Mulliner: Mr Burgess, I've got a few questions related to that. So you mentioned that the secondary interception systems would be employed if the primary systems were shown not to be appropriate. What would be the measure during operations? How would you know if they're not capturing all the seepage?

Mr Burgess: So we have these groundwater performance monitoring locations proposed that are immediately – that are immediately downgradient of the primary seepage collection systems, and those performance monitoring locations will be, or the wells are supposed to be groundwater monitoring wells. They'd be installed

at the key hydro stratigraphic units that we've identified, including the valley bottom, alluvium, the weathered bedrock, and the unweathered schist bedrock. And those will be routinely monitored with – or are proposed to be monitored with traditional groundwater sampling, as well as instrumented with continuous electrical connectivity meters. And I know, Tim, you are familiar with that, but just for the benefit of the panel, the sampling is effectively taking water out of these wells and sending it off to a lab, laboratory, to measure things like metals and metalloids so some of the key metrics or the key constituents that would signify unacceptable levels of bypass would be sulphate, and the primary reason for that is that it's relatively – transported relatively conservatively. A lot of the other metals like arsenic and iron and manganese and others can undergo geochemical reactions as they transport through mine wastes and through the groundwater systems, and so they can be attenuated and so usually from the sites I've worked at over the last 15 years around the world, the breakthrough, the first signature you get from bypass of mine waste storage facilities is sulphate. And so you will see that as an increasing trend over time. The other key parameter will be nitrate, although I note that's typically not as long lasting because it's not a function of ongoing oxidation. It's a function of how much stored nitrate salts are in the material when it's placed as a result of blasting. So there's no ongoing long-term production of them post-closure once all the mine's been placed. So usually the sampling will be at monthly to quarterly intervals. And to provide increased certainty that that temporal regime is not missing anything in between those collection points, and this is something that's been agreed through the joint conferencing as favourable, is the instrument of these performance monitoring locations with electrical conductivity / connectivity [check 01 37 13] meters that basically record or measure electrical conductivity in these wells, at your frequency of choice. So that could be 15-minute intervals, that could be hourly, that could be twice daily, for example, and what – because the, and what one can do is with enough – sorry, let me back up. There will usually be a very small correlation between sulphate concentration and electric conductivity, so that EC allows for a strong proxy, although it's not necessarily a dissolved concentration; it provides strong proxy for the inherent concentration of sulphate, in particular, between those points when you're actually sampling. Does that answer your question?

Mr Muir: So that is effectively the early warning system?

Mr Burgess: It is the early warning system, correct.

Dr Webber: Sir, can I make a comment as well, just to support what Ryan's saying about the sulphate? So the studies done at Macraes by Professor Dave Corr back in 2000 for the existing tailing facilities there identified the water that goes deep to ground, but what remained elevated in sulphate comparable to what was in the TSF, yet the arsenic was attenuated. So that was absorbed through these processes

that Ryan, that Mr Burgess has just been discussing. So supporting from the empirical data from a similar site that, you know, the front of these plumes would be identified by sulphate. And we see that in other projects very commonly that we have a very good relationship for sulphate, and for either the sulphate, nite – sorry, for sulphate and nitrate against EC. So they're good indicators.

Mr Muir: Thank you. Is there any other member of the panel of experts convened by the applicant that is wishing to address us on this issue? No.

Mr Rekker: If it pleases the Commissioner - - -

Mr Muir: Yes.

Mr Rekker: I thank Mr Burgess for his detailed description of seepage containment systems, or seepage interception systems as they're often known. I wonder if I could address the other way of looking at things. What if there is undetected or uncaptured seepage in the schist rock and that it is affected or contaminated by mine waste storage facilities or some other mine mediated process, and that's sort of unsupervised groundwater, as it were, and that it's unknown of in the operations or the post-closure setting. And I'll cast your mind back to when the panel visited the site and had a site visit, and I'll refer to the Shepherds Creek catchment in the area of the proposed mining activities. It is a steeply incised gorge-like creek couched in mostly schist rock, and it's the parent material around it. And it is, if you accept the hydrogeological reports that have been put before you, low hydraulic connectivity / conductivity [check 01:49:12], or permeability is the layperson's terms; and the inherent characteristic of low permeability, even fractured rock, is that it obeys the topographic controls around it. So low permeability settings for groundwater, you'll have rises underneath ridges in the water table, in the water level, and precipitous drops to the valley floor, and a distinct low point. So it becomes a subdued expression of the surface topography. And I think that that is highly pertinent because it gives a higher level of inherent success for these seepage collection systems, but also it means that unsupervised groundwater, this uncaptured seepage that we're concerned about, won't disobey those topographic controls. So in high permeability groundwater settings, the topographic controls can be overridden and disobeyed, but in low permeability settings, they do not. And if we turn our gaze to the Rise and Shine Creek, that is a more subdued valley, as you might recall it. But after about year eight of the proposed mine development of the RAS surface pit, the floor of Rise and Shine Creek is truncated and actually taken away, as it were, at the floor of the valley. And a pipe or flume system is substituted to maintain surface flow to the lower catchment. But that truncation also intercepts the shallow groundwater system. So there is a permanent interrupt or disjoint to the shallow groundwater system in the Rise and Shine Creek catchment. And further, I'll refer you to the Rise and Shine gold deposit, which has given rise to the planning of the Rise and Shine pit and the Rise and Shine underground workings. So they crosscut the line of both

the Rise and Shine Creek and Shepherds Creek, and they remove rock from the surface pit and from the tunnels, and that will become a permanent feature. So it's sitting across the valley system and even in the post-closure setting, the Rise and Shine lake pit has the effect of producing an artificial depression in the pre-existing water table in both of those valley systems. So I suppose what I'm sketching out here is that there are inherent controls that are long-lasting that don't rely on active human derived controls necessarily whereby, firstly, things don't – groundwater doesn't jump out of its main domain. It doesn't cross topographic divides. And it also would show a tendency to become captured by the Rise and Shine lake pit, pit lake. And as we know in the active closure and post-closure setting, that pit lake is under active and then passive management in terms of managing the water qualities of – water quality of water emerging at the access, the former access portal through the tunnel system, which is essentially the de facto sort of pseudo past hydrology that becomes established in the wake of the mining activities. So that provides a distinct point with which the managers of the post-closure setting can sample, analyse, therefore monitor the flow rate and arrange either active closure of post-closure management of those discharges. So that is the other inherent sort of state in the post-mining setting, which I believe would provide substantial reassurance that uncaptured seepage, including contaminants, would be captured.

Mr Mulliner: So, Mr Rekker, so you're saying that you think in the event there is uncaptured seepage from the primary collection system, there's very little chance of it getting past the pit lake or the RAS system?

Mr Rekker: Yes. I consider that while there isn't great flow rates flowing in these ground schist groundwater systems, they are strongly affected by hydraulic control and that of any of the things that we've considered, the greatest hydraulic control is the Shepherds Creek catchment in the original state. But subsequently, the somewhat permanent state of the pit lake acting as a low-rate groundwater well, if you were, and then that is drained sideways to the Shepherds Creek system.

Mr Mulliner: So in terms of a secondary containment system, that's further down in the – and I know it's been described I think in some of Mr Burgess' documents of near the compliance location or slightly upstream of that compliance location. Yet you would suggest that's potentially not necessary based on that understanding of the containment?

Mr Rekker: I think there are always needs for contingencies, but I think that I'm – multiple barriers are always a very good idea in situations like this.

Mr Mulliner: Okay. So in terms of the – so the risk seems to be higher in a post-closure phase when dewatering is no longer.

Mr Rekker: Yes.

Mr Mulliner: And the table's coming back up, and the people aren't on the site. So would you suggest that in terms of having these multiple barriers, you'd have your primary containment system - - -

Mr Rekker: Yes.

Mr Mulliner: - - - and then potentially your secondary naturally - - -

Mr Rekker: Inherent.

Mr Mulliner: - - - adapted containment system. But wouldn't you think it would be – would you propose that they would have a tertiary, if that's, for want of a better term, system further down within that valley to contain any other seepage that would get past that point, would you?

Mr Rekker: Indeed and I have. You know, I have provided a proposal for the – [inaudible (over-coughing) 01:57:56] of drill holes across the basement gap at the surface water monitoring site SCO1 to characterise it in the first instance, and then, having characterised what groundwater underflow potential there is to the surface water flowing through that gap, to undertake monitoring as well, performance monitoring.

Mr Mulliner: Okay. So when would you suggest that was put in place?

Mr Rekker: I would imagine immediately upon grant.

Mr Mulliner: Okay. Right, thank you.

Mr Muir: Could I now round back on the ORC experts. Ms Badenhop.

Ms Badenhop: I actually think most of what we've discussed has already covered what I consider to be important in terms of the need for further hydrogeological characterisation and groundwater flow modelling to support that. I think we made some good progress in the groundwater joint witness statement about considering a range of additional performance monitoring locations that weren't identified in the original water management plan. I can point you towards those. They were in section 62. We discussed that a range of additional performance monitoring locations were required around the true left and right abutments of the TSF, the ELF and monitoring seepage pathways through the unweathered rock from the ELF towards the RAS pit. At this stage, nothing else has been considered down gradient of the RAS pit as well and the Come in Time location, but we have discussed a range of additional locations that would certainly be helpful to provide further confidence. But again, everything goes back to that original question around hydrogeological characterisation and the need for further modelling to really understand what will occur once those groundwater levels are finally drawn down because it will be a completely different system to what currently exists.

Mr Muir: Mr Greer, do you want to add anything to that?

Mr Greer: No, my expertise is more on the effects of seepage when it enters the receiving environment.

Mr Muir: Okay. Dr Morgan.

Dr Morgan: Yeah, thank you, Sir. In terms of the uncaptured seepage, I do have concerns that it could be a significant amount of water, or volume of water and load, and I'm not convinced that the modelling to date has really been sufficient to describe that adequately. So in response to the RFI 5, there was a request for more modelling, which was done. But, in my opinion, there's high uncertainty because – and it's acknowledged in the report that there's a lack of information about hydraulic conductivity, groundwater levels, and the thicknesses of the hydro stratigraphic units. So we're coming back to the hydrogeological characterisation issue again, which leaves us with uncertainty. One thing that the report did do, which was really useful, was highlight this issue around drain failure and that that could cause more seepage; and so it's good that that's been acknowledged. Something I noticed with that is that for that modelling, a net percolation rate of 20 per cent was used rather than 50 per cent. So again, we're sort of – there's sort of some optimistic assumptions being used in that case, which is something that I picked up in the modelling. So I'm not convinced that it's minor. I have raised concerns from quite early on about this loss of containment, which I'm really glad to see has been addressed in the RFI 4. So there's some pictures around that now and they say that it's unlikely, but I would point out that that is a qualitative assessment. There hasn't been a quantitative assessment. It's repeating, you know, it's sort of saying that we've got low hydraulic conductivity and it's noting a value of 10 to the minus eight metres per second, which is coming from some of the modelling that was done, but in the seepage assessment done also by the applicant, a value of 20 times higher than that is used. So we've got these different values being used, one of which is less conservative. Just as an example of potentially not using the most conservative approach. The reason I mention that value is that it was used for the post-closure phase, as Mr Rekker was describing. The water that's in the pit, if this should occur, if containment should be lost and that the seepage moves to the pit post-closure, that water will go somewhere. And so if some of it will move through the fractured rock down gradient to CO1, and there was a calculation done for that. And that calculation used the Darcy flow equation with single values, and it used this for the hydraulic conductivity value as opposed to a range, which I would normally expect that you would have a range of values, so that we're seeing the possible worst case, but also the best case, and some kind of the medium case. And that kind of assessment flows through a lot of the work that we see. That's just an example. In terms of the idea that if there is uncaptured seepage and that there is loss of containment in the pit, the idea that it will all be captured by that pit is still not certain because we have – in reality we have a 3D flow field, and so you can't rely on that. That's sort of a two-dimensional way of looking at things but things are more complicated. We have,

you know, it's a 3D system and so that points back to the need for this updated groundwater model, which we can then use to build a solute transport model, so then we can answer these questions better.

Mr Muir: Professor Webster-Brown, did you have anything to add?

Prof Webster-Brown: On a slightly different tack, my comment was around the lack of the use of liners under these features, which would prevent seepage escaping from the ELF and TSF etcetera initially, rather than trying to capture it further downstream. And I would just alert the panel to the fact that these liners of either low permeability rock or geotextile liners are being increasingly proposed for mine sites and were required in the consent for the Waihi North. So it's not unreasonable to expect at least some rationale for not having liners beneath these features at the site.

Mr Mulliner: Professor Webster-Brown, a question on that. Is that a long-term solution, having liners, especially when during operations, I assume, the applicant will be able to manage things a lot easier and that would be when the liner is in place, I assume? Well, it's in place in perpetuity, but if that liner broke down over time, would it provide any benefit long-term?

Prof Webster-Brown: I think you've nailed it by saying they are meant to be intact on perpetuity. And they – a low permeability compacted rock liner should have a long life. It would only be lose its integrity through earthquake or some other major natural event. The geotextiles can break down at a faster rate, but they would still be protected, more protected, than not having any liner at all.

Mr Muir: Mr Dale.

Mr Dale: My expertise lies – similar to Dr Greer – much more in the receiving environment space. So I've no further comment, thank you.

Mr Muir: Better than I expected, yes. Could I come back to you, Dr Avanidou, please.

Dr Avanidou: I think the majority of things have covered but, as you would have seen in the joint witness statement, we have agreed that more investigations and more modelling is required to understand these effects. But the importance of monitoring as well is what will reduce the uncertainty; and currently we have discussed a lot of additional monitoring required, which I assume will be included in the updated water management plan and/or consent conditions to cover these uncertainties.

Mr Muir: Thank you. Additional questions from the panel of any of the experts?

Mr Barry: Could I.

Mr Muir: Yes.

Mr Barry: Just for the panel's experts – sorry, I don't have your name, but it's not so much the monitoring than it is the unsupervised seepage that we're particularly concerned about. And are you comfortable that the additional safeguards that are in the natural environment that Mr Rekker, I think it was, pointed to are going to be adequate?

Dr Avanidou: I think the engineering measures that will cover the majority of the capture, at least at the initial stage, and then the monitoring will help you understand if that is working in order to be a secondary or a third way of capturing it or restricting it. I'm not saying that other measures like liners, the use of liners, is a bad idea. It definitely is, and it's good to have more than one way of capturing the contaminants, if possible. But all these engineering systems, at some point they may fail and that's acknowledged and known. And that's where the monitoring is what you actually have to let you know that the system is working or it's not working, or you have to do more.

Mr Muir: Cross-examination? Yes, Ms Gepp.

CROSS-EXAMINATION BY MS GEPP:

Ms Gepp: If I can start with just a question for you, Dr Weber, just in terms of this untreated seepage that we are talking about. In your RFI response to the panel, you had some diagrams, some graphs showing the concentration of the various contaminants in the untreated seepage; and the concentration is very, very much higher than the sort of concentration you'd be aiming for through treatment, isn't it?

Dr Weber: Sorry, could you just clarify where those graphs come from please.

Ms Gepp: Yes, your RFI response to the panel, PDF page 44.

Dr Weber: That was the geotech RFI, is that correct?

Ms Gepp: No I think it was your initial RFI, but I'll just confirm that.

Dr Weber: Oh sorry, I see my evidence dated 17th of April. Is it paragraph 1-12 or 2-11?

Ms Gepp I'll have to check that. I've got some graphs that show concentration and year for different contaminants. Is that what you have in your - - -

Dr Weber: Apologies. We created a number of new graphs - - -

Ms Gepp: - - - yeah.

Dr Weber: - - - that were provided to explain various situations. It would be helpful to know exactly which one it is please.

Ms Gepp: Okay sure.

Dr Weber: So was it in the 1-13 evidence or the part 2-12? Is that the alpha peak seepage concentrations? And the lake - - -

Ms Gepp: eah.

Dr Weber: - - - scenarios?

Ms Gepp: Yeah.

Dr Weber: Yeah, okay. Sorry, what was the question again?

Ms Gepp: The question was just that the – so just to understand what the untreated seepage is, that the concentrations of the various contaminants is very much higher in the untreated seepage than is being aimed for in the treated seepage, isn't it?

Dr Weber: So we model the seepage rates from the engineered landforms. So that is a singular type of water, and whether it becomes treated or untreated would be a function of whether you have seepage loss. So the water going to ground would be considered, if I understand your question correctly, would be considered seepage loss. For the purpose of the modelling, you can model that conservatively and nothing would change, or you could model it and consider attenuation effects, and it would be lesser. I'm not - - -

Ms Gepp: Okay I'll try and ask it again. The stuff coming out of the features, whether it's the ELF or the tailings storage facility - - -

Dr Weber: Yes.

Ms Gepp: **- - -** the concentration of contaminants in that stuff is much higher than the concentration of contaminants post-treatment, isn't it?

Dr Weber: Yes, correct, yeah.

Ms Gepp: So when we're talking about uncaptured seepage - - -

Dr Weber: Yes.

Ms Gepp: - - - we're talking about liquid with contaminants in it that is very much higher than in the treated.

Dr Weber: Than in the treated?

Ms Gepp: Yes.

Dr Weber: So you've just clarified – our model produces one type of water, and it can be captured, or it can go to ground. And that seepage that goes to ground may have – you can model it conservatively or you can consider other attenuating factors as per the models that are available, as I mentioned earlier, about the water load.

Ms Gepp: Yeah, okay. I'm not trying to catch you out here.

Dr Weber: No, no, I was just - - -

Ms Gepp: I'm just making the point that you are when you have something that is untreated, it is very much higher in contaminants than what you're aiming to achieve through treatment, isn't it?

Dr Weber: Yes, I think you've understood.

Ms Gepp: Okay, great.

Dr Weber: Apologies.

Ms Gepp: No, that's alright.

Mr Muir: Well, one would expect it to be the case, wouldn't you, Ms Gepp, otherwise we'd be wasting an awful lot of money with treatments.

Ms Gepp: Right, yes, and that's why it was hopefully going to be a quick question. So the uncaptured and untreated seepage isn't accounted for in the water load balance model outputs, is it?

Dr Weber: No, the original assumptions was that would be a negligible effect of the – and obviously during this conferencing process, you know, there's now questions about that

Ms Gepp: Yeah.

Dr Weber: And then understanding if it does happen, how will that be managed.

Ms Gepp: Yes. So the outputs of that, if there is a change in understanding about the extent to which seepage is captured, could have potential to change the water load mass balance outputs, isn't it? So water load balance models from the output?

Dr Weber: Yeah, yeah, it would. But I think either Mr Rekker or Mr Burgess could comment on the magnitude of that because obviously the flow rates between the near surface, you know, the seepage are much lower and, therefore, you need to consider the load, and the load's a function of the flow - - -

Ms Gepp: Yes.

Dr Weber: - - - and the concentration.

Ms Gepp: Yep, okay, thank you. So moving to Mr Burgess. Were you, and you've had some discussion with Mr Mulliner, Commissioner Mulliner about this, but in the second joint witness statement at paragraph 46 where you've said that the underground mine and the Rise and Shine pit will act as local groundwater sinks, do you accept Dr Morgan's point that from there, there is the potential for that untreated seepage that has reached the underground mine, or the Rise and Shine pit to enter the wider receiving environment?

Mr Burgess: Sorry, can you just clarify. You said the second joint witness statement. Is that water or groundwater or - - -

Ms Gepp: The second water one.

Mr Burgess: - - - second. So the reconvened - - -

Ms Gepp: At 46.

Mr Muir: This is 8, 9 and 10 June.

Ms Gepp: So 10 June, reconvened geochemistry, freshwater quality, etcetera, joint witness statement at 46.

Mr Burgess: Yes, this is consistent with what Mr Rekker described.

Ms Gepp: Yeah. So at the end of it, you're the RB that's being referred to there, aren't you

Mr Burgess: Yeah.

Ms Gepp: Yeah. So at the end of that you say the Rise and Shine pit and underground mine will act as local groundwater sinks effectively intersecting seepage that migrates past primary seepage collection systems. But that shouldn't be taken as saying that it's effectively capturing all of that seepage, should it?

Mr Burgess: So that response is in – so that statement is in response to the earlier figures provided by Dr Morgan.

Ms Gepp: Yes.

Mr Burgess: So these are the figures between paragraph 42 and 43.

Ms Gepp: Yes okay. So the question was that these aren't acting as full containment facilities, are they? They can still – the uncaptured seepage can still migrate from there into the environment?

Mr Burgess: So the – in our response to the geotech RFI 4 dated 3rd June, we discuss this is a bit more detail. And so the post-closure, and I think this is an important distinction between June operations, the water level in the pit and the underground workings, I think as others have pointed out, are much lower, substantially lower than the Shepherds Creek valley as it is today. And then both those voids will flood, and the position of the RAS pit, pit lake will be largely controlled by the portal elevation of the underground workings due to their enhanced hydraulic connection once the crown pillar is rock, and that is approximately 490 metres RL or metres above sea level. In my opinion, the pit lake will still remain primarily a local groundwater sink, except where it connects to the underground workings where water then migrates through those workings and then out through the portal, and then it's managed appropriately through collection and treatment collected at the portal. And our estimates in the application were that to be around six litres per second. And bear with me while I – and then in this RFI, I make a preliminary estimate using the Darcys law on the potential for groundwater flow from the – or groundwater leakage from deep, deep groundwater leakage from the underground

workings down, down the valley. And that's, I'll just check it. I think getting the relative proportions here is important just to provide context. So this is paragraph 95 of that document. Using that calculation, the deeper – if there were to be leakage under the adopted hydraulic gradient, it would be less than 0.2 per cent of the estimated portal discharge of six litres per second, which, in my opinion, is negligible.

Ms Gepp: So is there a difference between the experts as to the extent to which the untreated seepage that finds its way into the RAS pit and underground mine will migrate into the receiving environment?

Mr Burgess: Sorry, could you please rephrase that.

Ms Gepp: Oh, I can ask it again.

Mr Burgess: Ask it again, sorry.

Ms Gepp: Is there a difference of opinion between the experts as to the extent to which that seepage that makes its way into the RAS pit and underground mine will migrate into the receiving environment?

Mr Burgess: Across the entire groundwater experts present today – actually maybe I'll back up. I don't think through joint witness or expert conferencing that we addressed the potential for, or potential in detail for offsite migration from the underground workings and pit void. I would – having said that, I would expect there to be some difference of opinion, yes.

Ms Gepp: Alright, thank you. The last question is at paragraph 47 where you refer to the secondary seepage interception systems post-closure.

Mr Burgess: Mm-hm.

Ms Gepp: We don't have any details about what they would look like at the moment, do we?

Mr Burgess: What, the secondary systems?

Ms Gepp: Yeah.

Mr Burgess: We do. I've described them in a number of documents, I've described them earlier today, and ultimately what they look like in the end – if they were to be needed, the end-product design that would follow would be dictated by the performance monitoring, identifying which pathways migrate or bypass or unrecovered seepage is migrating. And I'll just briefly reiterate some of the options available. Those could include shallow interceptor drains, deeper interceptor wells, and lower permeability cut off walls or barriers.

Ms Gepp: Do you have an idea of what the cost of those systems would be?

Mr Burgess: I do not have any reliable estimates of costs available at this time.

Ms Gepp: Okay, thank you.

Mr Muir: Yes, Mr Enright.

CROSS-EXAMINATION BY MR ENRIGHT:

Mr Enright: Thank you, Sir. Mr Burgess, just a few questions please; the first one being, do you agree with the level of principal that the volume of uncaptured and untreated seepage is important, given the large volumes and footprint, more than 200 hectares of mine waste storage facilities?

Mr Burgess: Yes, ensuring a low level of unrecovered seepage will be crucial for performing or meeting perform objectives for the project in terms of water quality.

Mr Enright: And do you accept that the assessment done of seepage, which is based on modelling, has been sub-optimal because it contains a number of unvalidated assumptions?

Mr Burgess: I disagree that it's sub-optimal. They're – as noted in the document, there are a number of adopted values used, which is standard practice for groundwater modelling and most modelling, in fact. You're never going to have every single detail that you need and you have to make some informed decision or judgment on what a reasonable input value may be. So for example – and when we have some of that uncertainty, we tend to try and account for that. And so in that document you're referring to, there are a range, or a number of scenarios, over 10 scenarios that are evaluated that include things like different permeability values, different net percolation values, so including the plan or the adopted closure net percolation rate at 20 per cent and the adopted operational net percolation rate of 50 per cent. There's different scenarios, for example, was well as – as I mentioned – the repercussions of drainage failure. So they're not – these models should not be viewed as this is what will happen. They're rather estimates of the range of potential outcomes and key features of the system that influence and are important to consider for design. And so, for example, with the Shrek's ELF models, it was clear through the modelling that sufficient interception of the water table was a key driver in how well the system performed, and that then feeds directly into the detailed design of (a) further characterisation works needed to inform that design and how deep the – any drain or trench will need to be.

Mr Enright: Thank you. So just drawing from that last point, you accept that the seepage assessment today does include a number of assumptions, or unvalidated data that will still need to be addressed? Correct?

Mr Burgess: In principle, yes.

Mr Enright: Yes.

Mr Burgess: Can I add one clarifying point, is that the recommendation is for the – that has to be incorporated into 3D groundwater modelling as recommended.

Mr Enright: Yes, and your report attached to your evidence did address certain recommendations, including 3D groundwater modelling of seepage collection systems, and also to complete hydrogeological test stations in the vicinity of each MWS to confirm shallow groundwater levels, thickness of each HSU, and hydraulic properties. Those are all recommendations made by you, and so one must infer that they are matters not currently, or information not currently available in terms of the assumptions in the seepage model.

Mr Burgess: So I think there's an important distinction between having information elsewhere from around the site that informs your understanding of how the system, how the hydrogeological system or setting is at a location where you don't have direct data, which is the standards of, standard practice for these early design and assessment works and then you identify what the key parameters, key – as I mentioned, you identify what the key properties or parts of the system are for achieving your design objectives, and then you carry out further works to refine that understanding and confirm your detailed design will meet your desired outcomes.

Mr Enright: Yes. So, I mean, just as a specific example, the bypass seepage percentages, I understand that there's a range, and you heard Dr Morgan say 20 per cent could be an optimistic figure. I mean, that's a reasonable criticism, isn't it?

Mr Burgess: So 20 per cent was for the – in the modelling scenarios, 20 per cent was for the drain failure scenario. And, as I noted, further consideration of alternative designs for closure and/or financial provisions and mechanisms should be accounted for or allowed for to manage that risk.

Mr Enright: Yes. But it's, I suppose, in principle, it confirms there is a level of present optimism in the modelling, which you've recommended can be addressed in, presumably further information and conditions, right? But if you do you accept Dr Morgan's point, we do have this uncertainty problem from, on seepage, which is a key issue?

Mr Burgess: So one thing to note is those models in that document only account for the primary seepage collection system; they do not account for any contingency secondary seepage interception that would improve any performance reported in that document. So, I guess, what I'm hearing is while I acknowledge there is uncertainty with models, there is always uncertainty, no matter how much data you have, the key consideration's identifying the risk and proposing feasible management options.

Mr Enright: And I just wonder if any, with leave, if any of the other experts wish to comment just on this topic.

Mr Muir: I'll come back at the end.

Mr Enright: Alright, thank you, Sir. So my next question, which I signalled earlier, was just around the recommendation identified by Professor Webster-Brown on a liner for the pit lake. And I'm not sure which applicant expert would best answer that question.

Mr Burgess: Sorry, I don't think it was for the pit lake. I think it was for the TSF.

Mr Enright: Okay, yeah, the TSF. Sorry.

Prof Webster-Brown: Yes, the TSF and the ELFs waste rock stacks.

Mr Enright: Sorry. It's easy to get wrong, isn't. Is that best answered by yourself or - - -

Mr Burgess: So the use of liners, it's best if – so I acknowledge that they would potentially enhance seepage recovery, although I will note that there are certainly – how can I put this? Let me rephrase that. Liners are typically the purview of the geotechnical engineers that design those facilities; and so their – any questioning, in my opinion, should be directed at those experts.

Mr Enright: Yes, but is that I think the first point you made, and I understand you can defer to other experts if you feel it's outside your area, but again, at the level of principle, the liner would address, or will provide greater certainty around the uncontrolled seepage. You did agree with that point, as I understand.

Mr Burgess: Potentially.

Mr Enright: Yes.

Mr Burgess: There are – and I think, as Mr Mulliner pointed out, they can have some limitations on their design life and so they are not necessarily a walkaway solution and still require some level of seepage control and performance monitoring. And although Professor Webster-Brown noted their increasing occurrence, that is, that is different to my experience working internationally. There is often a shift away from liners because of the limitations on their design life and how well they'll work into the post-closure period, and how you cannot necessarily rely on them operating for a long period of time.

Mr Enright: And is the question of liners something that you explored with the applicant in the early phase of the proposal?

Mr Burgess: That's a matter for the geotechnical experts who designed the facilities.

Mr Enright: Okay, thank you.

Mr Muir: Yes, Mr Enright. I push back a little on the model whereby, at the conclusion of your cross-examination of the identified person, it opens up for another round of comment by, quote, "any other expert", simply because we won't be able to manage it within the time available.

Mr Enright: Yes Sir.

Mr Muir: If there was a question that you wished to direct to a specific member of the panel of experts, I would probably accept that. Otherwise, I propose that we come back at the end to Dr Avanidou and ask whether she has any comment in relation to this, as our appointee.

Mr Enright: Yes Sir, thank you. And I'm happy to take that direction. The only question was going to be for Ms Badenhop - - -

Mr Muir: Yes.

Mr Enright: - - - with leave, just to comment on the same question around - - -

Mr Muir: Well, I will allow that. Thank you.

Mr Enright: Thank you, Sir. So that was the general topic of uncertainty in terms of the seepage modelling, that's been undertaken, which you heard some questions on.

Mr Muir: Yes.

Ms Badenhop: So I think in terms of it being a standard practice to account for a range of values within modelling, that is a valid point. I would suggest there has been ample time to collect some data within that valley alluvium, which hasn't been completed. So that would have made a good starting point from which to then assess a range of hydrogeological characteristics within that alluvium before completing the seepage model. Does that answer that question?

Mr Enright: It does. Thank you, Sir.

Mr Muir: Thank you. Now, Mr Randal, did you have any questions?

CROSS-EXAMINATION BY MR RANDAL:

Mr Randal: Very quickly, Sir. I'll try and keep it brief. Mr Burgess, hi. Building on questions that Ms Gepp and Mr Enright have asked you around financial provision, it's an interesting feature of the three joint witness statements and – of these experts but also of the geotech experts and others, the experts seem to be stressing the vital importance of financial provision being made for certain future measures. You've been talking about the design, construction, and monitoring of secondary seepage containment facilities today. But, just more broadly, there's a long list of items, aren't there, that will require ongoing financial provision to achieve water quality outcomes, aren't there? So I'm talking about during the closure and post-closure phases of the mine.

Dr Weber: Yeah.

Mr Randal: Dr Weber, it's probably a question for the three of you, including Mr Rekker.

Dr Weber: Look, I can answer that, if you like. Yes, we're looking at a project that will require management for a long time into the future after closure.

Mr Randal: Yes.

Dr Weber: We've sort of identified that there's an active closure phase, which is related to the active water treatment plant transitioning to a long-term passive closure phase where those passive treatment technologies are demonstrated as being reliable and suitable to treat that water, to achieve the water quality objectives. I think they're going to talk about active and passive treatment later on. But you need some, something that is funding that, and all the experts agree that we – that's not our area of expertise. But we do note that money will need to be made available for that through some mechanisms.

Mr Randal: Yeah. So there are bonding experts obviously in this process too. But this group of experts would inform them, wouldn't you, on the cost, the likely cost of those measures.

Dr Weber: Yes, but we haven't done a costing exercise.

Mr Randal: Yes. But that will be needed won't it, in order to set the bond?

Dr Weber: Yes, and I understand the experts in bonds have very good expertise in this area and would be quite competent at doing that.

Mr Randal: Well of course but, like I say, you would be feeding into that process?

Dr Weber: As required, of course.

Mr Randal: Yes. In terms of monitoring requirements for groundwater and surface water quality, yes.

Dr Weber: Yes. That would be prescribed in the management plan of course, yes.

Mr Randal: Monitoring of things like water and oxygen ingress into the - - -

Dr Weber: Yes.

Mr Randal: - - - mine waste storage facilities.

Dr Weber: Yes. And there's a management process to be explained in the management plans as to what that requires also.

Mr Randal: Yes.

Dr Weber: To cover it off, yes.

Mr Randal: Sludge management as well?

Dr Weber: Yes.

Mr Randal: Obviously the active, or the water treatment plant operation into the future.

Dr Weber: Yes. There's lots of things that require funds to manage those processes.

Mr Randal: Yes, thank you. And we're talking and obviously in respect of that active, the water treatment process - - -

Dr Weber: Mm-hm

Mr Randal: - - - we're talking about a very long-term future horizon. Is that the same for the other sort of measures I've just been mentioning as well?

Dr Weber: No; so like active treatment is a defined process. But as you indicated, the performance monitoring, the monitoring of the engineered landfill, so oxygen egress, you monitor that as you're building it. You get a good feel for it. You'll lessen the intensity of that monitoring. Once you come to closure and the structure is rehabilitated with a cover on top, you know your trends, there's nothing significant that's going to cause those trends to change, unless there's a material something or other that causes that engineered landfill, that waste depository to be disturbed. So there could be a backing off of that required monitoring intensity and that will be determined as a natural process within the management plans.

Mr Randal: And any issues as to capture of seepage, you know, unanticipated capture of seepage, over what sort of horizon might those materialise through the monitoring? Unspecified into the future. Could be any time?

Dr Weber: Obviously, I'm not a groundwater expert to understand those timeframes, but from listening to the group of experts over the time of the conferencing, that's a slower pathway. And again, that would be part of a load that requires treatment. So the load would be very small to put through a treatment system, but to capture that treatment may require, you know, more effort because you've got, as you've heard, interception trenches or wells and so on, the capture process. Obviously, they're valued, but that's not my area of expertise. I apologise.

Mr Randal: Right. Thanks Dr Weber.

Mr Muir: Could I ask a question emerging from that? The size of the fund necessary to sustain, potentially for a very extended period, but management of water treatment facilities, as well as all of the other ecological and other requirements moving forward, is not something that anyone should realistically be suggesting be left to some later consideration in the context of a management plan. Surely, it would have to be identified by this panel as part of a condition, wouldn't it? In which case could I remind everyone that we have got to deliver a final decision by the 28th of October, and an interim decision by probably sometime in early September. The clock is ticking. When and how can we expect, given that you will have to make input into that?

Dr Weber: Yeah, I understand the purpose of conditions. Sorry. As far as what they should be, there should be some sort of condition that clearly identifies that it's needed. But the amount that is needed is going to change with time as the project evolves, and, you know, the bonds for closure would be lesser at the start and more during the peak when there's the greatest areas of disturbance and so on. So as far as defining exactly what that is, I don't think you can do that at this point

in time. I think you can understand the quantum, and again I'd say that there's experts that can advise on those costs, including, you know, the effects of how that cost is calculated in the future because when we're looking that long out, and discount rates and net present value will come into play. So that comes down to others to decide on that as to what that discount rate is and so on. So my advice to the panel would be do you need a consent condition in place to say that a bond, you know, a bonding process should be established. I'm not sure if that's already present in the conditions.

Mr Muir: It may be something beyond the bond, which may be the long-term endowment - - -

Dr Weber: I can - - -

Mr Muir: - - - trust fund.

Dr Weber: - - - provide my comment on the purpose of it.

Mr Muir: Yes.

Dr Weber: As far as what that it is, it's difficult. Waihi has some form of trust established to manage that long-term cost.

Mr Muir: Yes.

Dr Weber: It may be that sort of vehicle.

Mr Muir: Well, that's for an active round of discussion clearly now on the part of the applicant. It's just that we have to size this at some stage in broad terms, don't we?

Dr Weber: Yes, and it'll be staged as well. You may need to define a particular stage to go through the process as to when you review that and so on. And obviously as we progress through the project, as we talk about it, some of these uncertainties decrease, and we get a lot more accurate on providing for that closure - - -

Mr Muir: Yes

Dr Weber: - - - or rehabilitation project.

Mr Muir: Very good. Can I just ask – Mr Leckie, was there any - - -

Mr Leckie: No, nothing further, Sir.

Mr Muir: - - - no, and no other cross-examination. Can I round back to the panel, and then we're going to have a cup of tea. Any questions emerging out of the cross-examination topics? And then, finally, could I then come back to Dr Avanidou. Matters that you've heard discussed in cross-examination, any final comment that you'd like to make for our benefit?

Dr Avanidou: This comes back, of course, to what we have already discussed, that there's more work needed to reduce perhaps the uncertainty that we have from the modelling presented, done so far and investigations done so far. I do think that there has to be a way that this additional work that will inform all what we have discussed, that it's quite important. Like monitoring points and monitoring requirements and/or design solution for the secondary system will have to be a secondary capture system if that is needed through - - -

Mr Muir: Secondary primary.

Dr Avanidou: Secondary primary system, if that's shown to be required. That it's something that is quantified how fast you can build it, for example, and how much you're going to be able to capture if you're not capturing the first time. You cannot fix it, for example, because there was a failure at the first – at the drain or at the pump or something like that. I do feel that, I do know that based on the understanding of the geology that we have onsite, groundwater is expected to move through the fractures if they are there and/or horizontally faster than vertically due to the nature of the material that we have onsite. From that perspective and undertaking a more comprehensive 3D groundwater model can answer some of these – help us understand these predictions and help us estimate those time intervals as much as you can through a model, but we'll always have assumptions and limitations, but it's still the best tool that we can have to help us with predictions. Now, every modeller will have a different approach, and that's why it's common practice to undertake a sensitivity analysis and try to capture those main factors that will alter the effect out of the results and then try and quantify whether those factors that are driving the differences in the results that you may have through a model. But – I kind of need to emphasise this: a robust monitoring framework and mitigation of exceeding those triggers that you may have and there may be stages that you can have is what is going to – what's the right word there? It's – justify that your assessment or your predictions are in the right ballpark and you're not off by something. And give you a way forward.

Mr Muir: Thank you very much. We're going to take about a 10-minute break if that's alright.

morning adjournment

Mr Muir: I expect that the next topic is one which, to some extent, has already been covered. What I'm going to do is a slightly different approach with this. I want to start, if I could, with the ORC experts and ask them, are there any additional issues relating to the modelling that you think we have not traversed yet that are you critical of? That's why I'm starting the other way around.

GROUNDWATER MODELLING:

Ms Badenhop: I think my perspective has been made reasonably clear in what's been done so far and in terms of the joint witness statements, noting that the

groundwater modelling completed to date has had clear objectives, and when you look at groundwater modelling, it's really important to consider the objectives to which the model was contrived, which the original modelling was with the objective of defining dewatering rates and stream depletion. Not so much for looking at overall cross-site flow directions or for a groundwater contaminant or any of those things. So that wasn't the original purpose.

Mr Muir: Yes.

Ms Badenhop: So my – I guess the important points that I think going forward are the need for that further hydrogeological – because you're going to hear me say this a lot – conceptualisation and the peer review groundwater modelling to understand long-term flow directions and contaminant transport. I think that probably is really the clearest thing that I could say to that.

Mr Muir: Thank you. Could I ask the EES experts if there's any other issue that that they had anticipated we would discuss generally under this heading that we haven't discussed earlier?

Dr Morgan: I think that covers it for me. I just would highlight that the current groundwater model does sit within a low – a class one low confidence characterisation and – but that's been covered and it will be updated, as I understand it, and I have nothing additional to add to it.

Mr Muir: Right, okay. I don't think it necessary to go back to the applicant's experts at the moment. Just on the panel, Commissioner Mulliner?

Mr Mulliner: Yeah, I just had a – it's slightly off topic but before we move off groundwater, I wanted to make sure we cover it. So there's been some talk about in terms of the groundwater take and the drawdown effects and the effects on adjoining users. And there's been some talk about there hasn't been a compliant pump test undertaken, and my question I guess is to Mr Rekker. I guess to understand what would a compliant pump take test look like and, I guess, why hasn't it been undertaken to date?

Mr Rekker: A compliant pump test, or an aquifer test in Otago has been defined but there's been a little bit of confusion as to which guideline Otago Regional Council is adhering to. At the time of the groundwater take being developed, we looked at the pumping – desired pumping rate that was sought to provide all of the different uses of groundwater at their peak consumption rate, if it coincided, and that that transpired to be approximately 110 litres per second, 3.1 million cubic litres per annum. And that obviously did not fit into the permitted activity conditioning for within the ORC Regional Plan water for a permitted activity aquifer test. I asked the applicant what they wanted to do, whether they wished to seek a groundwater take resource consent to authorise the pumping test at that flow rate. They were naturally reluctant to because there was no guarantee that it wouldn't become a permitted notification or a notified resource consent, which in

the public climate would be a problem in and of itself. So instead, I designed a set of pumping tests, two: one which was operated at just below the limit for compliance with the conditions to the permitted activity for aquifer tests for 72 hours, and it was observed with an observation well and interpreted. I understand that Ms Badenhop has considered that information from the aquifer test and is broadly comfortable with the two parameters of transmissivity and storage coefficient that were derived from that analysis. I then carried a step drawdown test over eight hours in which the two-hour peak pumping rate was at 100 litres a second, and that was in order to demonstrate the capacity of the aquifer, and the capacity of the trial production bore itself which is often important to the authorities to have undertaken. The short answer is we weren't legally, lawfully able to carry out a compliant pumping test without the possession of a separate resource consent through an uncertain process. So that was our response.

Mr Mulliner: Do you think the timing of the testing that's been taken out is important in terms of what the – I mean, obviously the aquifer is currently utilised for – in a seasonal manner. Would that have an influence on your, I guess, results, from what's been undertaken so far?

Mr Rekker: Oh, for the aquifer test. The aquifer test was carried out in July, and the groundwater levels in the Bendigo aquifer don't fluctuate as widely as elsewhere in Otago. There's essentially 1.9 to 2.1 metres worth of annual fluctuation which is relatively slight compared to other parts of the region. The groundwater level was in middling sort of level at the time of the three-day pumping test. And the reason it was conducted in winter was that there would be very, very little chance that other users would be affected by undertaking the aquifer test which is a condition of the permitted activity to authorising an aquifer test in Otago.

Mr Mulliner: kay. But do you think that if it was undertaken when – I actually don't know when the peak use is for the users and taken at the rate that is proposed by the applicant, would it, in your opinion, would there potentially be greater effects on some of those uses than what's been put forward?

Mr Rekker: Would the test have shown greater effect?

Mr Mulliner: Yes.

Mr Rekker: Perhaps. But I'm not really convinced. The saturated thickness of the Bendigo aquifer at the test site was just on 20 metres above the basement. It was a free water table, rather than a confined system; and the extent of drawdown during the three-day test was not significant, even though we were measuring it about 13 metres away from the pump bore. So the sensitivity of the system and surrounding users to the pumping of the bore at 100 litres a second did not display a great deal of sensitivity. The responses that – I do, however, acknowledge that when we're talking about authorising a long-term non-seasonal pumping system that we have a duty of some significant conservatism and that that is the reason

that I've certainly recommended that a post-grant commissioning aquifer test be undertaken. And there are concrete actions that could be taken to deal with any adverse effects on surrounding bore users arising from that commissioning test and consultation with surrounding bore users, and further investigation of their particular bore construction and geometry.

Mr Mulliner: Okay. Ms Badenhop, do you have any comments on that?

Ms Badenhop: I don't – I think, as Mr Rekker's said, in general the parameters that were identified, the aquifer properties that were identified from the pumping tests are probably adequate. The point of the longer pumping test at the maximum rate is to observe drawdown across a wider area and to determine if there are any barrier boundaries or recharge boundaries found within that system. I think it is possible to do the test and to determine if there are effects are on other users at a later date. I think it's possible for that to be conditioned. I do find it very odd that only the permitted rate was completed for a pumping test. It's not onerous to get a consent for a pumping test and the likelihood of it being notified I would have thought was extremely low. I'm not a planner but I don't see why it would have been to run a pumping test in the middle of winter when the irrigation tanks aren't operating, but I do think it is possible to put in consent conditions that allow for that commissioning test to be run and for the effects on other users to be determined and to allow for an alternative water supply if it's required. Whether or not this sets an unhealthy precedent for consents if people haven't completed their – an aquifer test under the guidelines is another question altogether, I think. Does that answer the question?

Mr Mulliner: Yes, thank you.

Mr Muir: Before we generally leave the subject of hydrogeological characterisation and the modelling, is there anyone else who wished to make any observation, on the expert panel? No. Is there any close-out cross-examination required on those combined issues? No. And no further questions from the panel. Right. We move on then to closure of objectives. Dr Greer, you've probably got quite a lot to say about this. Shall I start with you?

CLOSURE OF OBJECTIVES:

Mr Greer: Thank you. I have put my notes on this matter predominantly under the ecological - - -

Mr Muir: I see.

Mr Greer: - - - [inaudible 00:18:02] component and the surface water session.

Mr Muir: I see.

Mr Greer: But I think Professor Webster-Brown has something to talk about.

Mr Muir: Very good. Professor Webster-Brown.

Prof Webster-Brown: I've just been thrown under the bus here. We were talking at morning tea and when the moving quota objectives and effective management down to after some of the surface water measures have been discussed. So we've covered all the technical issues and can capture the total.

Mr Muir: Dealing with them generically at the end of the day?

Prof Webster-Brown: That's what I was thinking, yes – what we were thinking.

Mr Muir: That sort of sounds sensible?

Mr Mulliner: Oh yeah, I think that very much makes sense.

Mr Muir: Very good. That's exactly what we'll do then. Okay. Surface water.

SURFACE WATER:

Mr Mulliner: I think is it worth starting off the compliance standards? Does that make sense to start there? People's feelings?

Dr Weber: Yeah, could I speak to that.

Mr Mulliner: Yes, thank you.

Dr Weber: Commissioner Mulliner, I think that does make sense. Maybe if I just introduce – there was some questions about what are the contaminants of concern for this project? So maybe I frame that out and then talk through some of the – or introduce the joint witness statement paragraphs and we work through this. And then that also flowed on to some of the other questions regarding some of those other constituents of concern that we also need to talk to for clarification. So I'll start off with a general introduction.

Mr Muir: Yes, thank you, Dr Weber.

Dr Weber: And from my experience in dealing with acid and metalliferous drainage for perhaps way too long, there's three types of water quality that sit under that. So you have acid rock drainage, that's acid; you have neutral metalliferous drainage, which is a pseudo metal water is elevated in metals; and then you have saline drainage, which is really a salinity issue and high sulphate. So this project falls in the camp of neutral metalliferous drainage. We do not expect to have acid rock drainage, which is the higher risk. So the general studies. There's lots of information available from the test work that's been done. I don't think we need to talk through that today. There's also good analogue data from similar geochemical environments. Without a doubt, we would be expected to have elevated sulphate and arsenic from the deposit. We would also, from my studies in the area and new information coming to hand, we expect that nitrate to be elevated. So there was a bunch of other constituents of concern that could be elevated, which were discussed through in the joint – in the first water joint witness statement at paragraphs 55 to 59. And I'm not sure we need to talk through those unless everyone wants a refresher on those metals. There's

obviously a number of trace metals. Some of those include zinc, molybdenum, antimony. There is a list there and that's hopefully captured by the proposed consent conditions. But there's – some other things were also raised through our studies that the experts wanted you to discuss. And they were – if everyone's happy with it, maybe that's what we'd want to talk through, is those specific parameters that were discussed from paragraphs 103 to 110, which I think EDS also wanted to have raised. So I'm happy to provide some general comment on those and then pass it on to the other experts. So my first point would be the monitoring of dissolved oxygen sulphide once treatment starts. So the passive treatment can generate reducing environments, and those reducing environments are you – it's sulphate for sulphide. So if you're doing a passive treatment, you want to make sure that once you've treated it, you haven't caused a secondary contaminant. Part of that is generating a low oxygen environment. So you want to make sure that you've got low oxygen. The TSF is also likely to be reduced in oxygen, and it may contain hydrogen sulphide. So once you start active treatment, you'd just want to make sure those parameters are being adequately monitored to make sure you're not having any effect. So that was some of the advice I provided and we had a discussion.

We can continue the discussion if needed, but general agreement around that, and I support that needs to be done. There was also conversation around the monitoring of manganese and iron, and I'd support that for aesthetic purposes. The other experts could comment on whether they need / leave [check 00:23:04] for other downstream receptors. Maybe Ms Badenhop could comment on the groundwater effects there. In my studies, or the studies that our group completed, we also noted that boron was elevated. And so I've recommended performance monitoring be undertaken with this. The reason why I think it could be elevated would be it pops up in our column leach tests for the tailings as being higher than the waste rock and then also in the metallurgically testing data, we had elevated boron. And through our modelling process, we have increased that and we think it could be 0.8 to 0.825 milligrams per litre if someone were to search it, which would be getting close to some of the ANZG criteria. It's from that one domain and it's obviously not combined with other water types, so it's likely to be low. But Ms Badenhop also indicated that some of the other downstream users may require quite a low limit, and I'll let her talk to that one, if that's alright, thank you. There was discussions around mercury. I don't think mercury's an issue for this project because of the depositional style. Obviously in projects like Waihi, it is monitored closely. We haven't seen any evidence for that, but I acknowledge that it can be emotive, and there's discussions by the other experts that there should be monitoring of fish to understand whether that is going to bioaccumulate. I can't comment on that, but I do support that if does start, that would be after active and/or passive treatment starts because that's when you get the transport of these minor / mine [check 00:24:56] circuit waters. So that's my introduction.

I'm happy to take comments or carry on. Oh sorry, I did have one more. Apologies. There was also discussion around sediment monitoring, which is as per new clause D.04 new eight. I think that makes sense that if you're going to do that monitoring, that you include mercury and selenium as well, just to ensure that their transported sediment from site isn't problematic. That requires more studies to understand baseline conditions and so on. I had noted a trigger value to start doing that, based on the current consent that says if it hits – so I'm going to be, I'm a little light – whatever that limit is, then that should cause management processes. The other experts have suggested that it should be 50 per cent of that, so that you're well informed ahead; good performance monitoring to then get in and do the management steps that are required. So that's my summary of that overall part of the joint discussion. Thank you.

Mr Muir: Is it intended, Dr Weber, that any of the other experts called by the applicant are to add to that opening statement?

Dr Weber: Ms Palich may want to speak to it. She may not want to either.

Mr Muir: We'd love to hear from you.

Dr Weber: It's if there's obviously no conversation around our joint witness statements to respond to.

Mr Muir: Yes, indeed. Would you wish to address that Ms Palich?

Ms Palich: I think Paul summarised it well at the moment, but I'd be happy to speak if further discussion comes up.

Mr Muir: So, Dr Morgan, Professor Webster-Brown.

Prof Webster-Brown: I'm getting the sign. We've obviously supported the addition of these additional principal contaminants of concern to the list of things that need to be monitored onsite. I personally was supportive of also considering selenium and mercury for monitoring, because of the concerns which had been raised by others around bioaccumulation by wildlife and within the food chain. And these two metals, contaminants are bioaccumulative. They do bioaccumulate in the food chain. So you don't need high concentrations, very high concentrations in the environment before you start to see problems with bioaccumulation. So that underpinned my belief that we should include mercury and selenium as principal contaminants of concern. I think there are comments about how you would monitor them and that comes under probably compliance limit setting; and it is hard to de-couple the conversation around principal contaminants of concern from compliance limits because one dictates the other, and compliance limits have regard to how that water will be used. So there are comments that I will add, if we discuss this separately, around what other contaminants need to be added to the compliance limit list with regard to its future use, and I know Ms Badenhop has similar concerns in that regard. Otherwise, very supportive of extending the

principal contaminants of concern list to include the ones that Paul's specifically spoken of - - -

Mr Muir: Thank you.

Prof Webster-Brown: - - - both for surface water and groundwater considerations.

Mr Muir: Ms Badenhop.

Ms Badenhop: Well, I think up front, as Dr Webster-Brown's saying, that it is important to understand the feedback loop between the contaminants of concern and the compliance standards. So in the process of identifying the contaminants of concern, these were based on the proposed compliance limits at the time and the likelihood of impact based on their geochemical analysis of the metallurgically / minerology [check 00:29:50]. So what that means is if the compliance limits are changed, that assessment of the contaminants of concerns also needs to be revised. Does that make sense? So in this process, we, I suppose – in our joint witness statement the contaminants in 55 to 56 have been identified and I support those. In terms of groundwater compliance limits, these were based primarily on drinking water standards but there are also other values that could be considered which includes irrigation, water quality and livestock water quality, which we discuss more in our joint witness statement, the second one I believe, recently as well. So the values of groundwater currently aren't known within the Ardgour aquifer to determine those limits and how pumping and withdrawal of water would change those, you know, would introduce mixing to determine what the quality of water was that was extracted from that aquifer. So there is a little bit of uncertainty there in terms of what limits we're trying to achieve and what the baseline water quality is. You're frowning at me. Am I not clear yet?

Mr Mulliner: Oh no, you are.

Ms Badenhop: Am I making sense? Yes.

Mr Mulliner: Would it not be pertinent then to have compliance limits based on those values, rather than the – in terms of the water that's going into those aquifers, rather than relying on mixing on unknown qualities?

Ms Badenhop: Yeah, at this stage, because we don't know any better, I would agree with that. And it needs to also be considered at the moment that because surface water is infiltrating to groundwater and we don't know what process is occurring between those, I consider that surface water compliance limits should also meet the requirements for groundwater compliance limits to ensure that that groundwater infiltrated, particularly within the Shepherds Creek system, to ensure that groundwater isn't degraded by that infiltration of surface water such that it can't be used for possible current uses.

Mr Mulliner: So it's kind of a related question but there was a – I had a bit of misunderstanding last week when we were talking with Ms McArthur, and she

suggested that there had been agreement to shift from the 90th – this is for metals obviously - - -

Ms Badenhop: Yes.

Mr Mulliner: - - from a 90th percentile New Zealand – I forget the exact name of it - - -

Ms Badenhop: ANZG.

Mr Mulliner: - - - limit to a 95th except for in the Bendigo for arsenic. Is that correct?

Ms Badenhop: It's more or less correct. It was except for the Rise and Shine arsenic that that monitoring point there because the background levels are already too high.

Mr Mulliner: Okay. So the applicants accepted that shift from the 90th – the general shift from the 90th to the 95th limit.

Ms Badenhop: You'd have to ask the applicants as to how much agreement. The consultants - - -

Mr Mulliner: Okay.

Ms Badenhop: - - - in the room certainly seem to be generally reaching a consensus around that.

Mr Mulliner: Okay. Dr Palich.

Ms Palich: I can speak to that one, just firstly noting that I have been representing the work done by Dr Greg Ryder, who's not here, but I am speaking from my own opinions, based on my review of that work and the discussions in the room. So, with respect to you, what we were recommending that protection level get set up for surface water quality. There was two components to that: one was what is the definition of that catchment under the ANZG framework? So under that we have four different levels: 99 per cent; 95th per cent; 90th per cent; and 80th. But no one's ever really considering 80th. So we can ignore that. Dr Ryder had proposed 90th percentile across that catchment and that was on the basis that the definition for 95 per cent protection limits is defined as waterways downstream of townships for no extraction activities. Now the RSO3 point arguably is not downstream of that. The historic activities that have occurred in the Rise and Shine catchment, RSO3. So it's quite smack dab in the middle of, and that is probably why we see elevated arsenic in that area from the historic tailings that reside there, notwithstanding the catchment below the development footprint is clearly also impacted. But the rest of the water quality parameters that have been monitored during baseline assessments actually all do meet the criteria for 95 per cent. And, on that basis, we had a discussion around the fact that it might be inappropriate or may be not best practice, or really potentially not acceptable to external stakeholders to consider that it would be okay to degrade the aquifer through

release of water quality or through run-off by dropping everything down to 90th percentile when most of the other – where all of the other parameters in terms of metals etcetera within the current baseline water quality set are well below the 95 per cent criteria. So, on that basis, I think we collectively came to agreement that it would be appropriate for the RSO3 sampling point for the 95 per cent protection limits to be adopted, with the exception of for arsenic which we would never be able to achieve because the long-term data set suggests somewhere between 20 and 25 per cent of the time arsenic is already above that criteria.

Mr Mulliner: Okay. So these revised, I guess, proposed compliance limits will reflect the background water quality.

Ms Palich: Correct.

Mr Mulliner: And so going back to you, Ms Badenhop, so in terms of that aligning some of the surface water compliance limits with the groundwater limits, does that address at least some of those concerns?

Ms Badenhop: It does with respect to sulphate. Just let me – I have tabulated them here, so just let me have a little check. So the other – so with respect to molybdenum, for example, the groundwater, well, the drinking – it's not just a groundwater limit, the drinking water limit is 0.01 for molybdenum in – I'm not sure what the updated 90th percentile value was because they haven't actually been identified yet, so we haven't fully compared them.

Mr Mulliner: From memory, there's only one value - - -

Ms Palich: Yeah.

Mr Mulliner: - - - for that. There's not multiple values - - -

Ms Badenhop: Right.

Mr Mulliner: - - - provided for in ANZG.

Ms Badenhop: Right. So that was .034. So there's a difference for that and for antimony and for – I think arsenic comes out fairly similar. Sulphate is different. Sulphate – the drinking water is affected from a taste perspective once you get above 250 milligrams per litre. So that's an effect as well. There are some additional values if you start to consider irrigation, whether or not you consider a short-term or long-term irrigation water quality as well. There are other factors that start to have an effect, such as iron concentration, manganese concentration, uranium, boron. There's mercury, nickel, selenium, vanadium. There's a bunch of other parameters that you would need to consider and that have lower – that are more sensitive.

Mr Mulliner: Then you'd want to base them on the contaminants of concern, wouldn't you?

Ms Badenhop: Correct, but you need to revise the contaminants of concern based on these limits to determine if they are a contaminant of concern because the identification of the contaminants of concerns was based on the original assumption of values and compliance limits that were identified by Dr Ryder. Does that make sense, because they were compared – the expected water quality was compared to those compliance limits and therefore from that, it was identified that there would be these, be a particular suite of contaminants of concern. If you change the limits and then compare the water quality, you may come out with some additional contaminants of concern.

Mr Mulliner: Okay.

Ms Badenhop: Dr Weber can - - -

Dr Greer: Can I add something really quickly because I think it's quite important to understand the implications of this change from the 95 – 90 per cent species protection limits to the 95.

Mr Muir: For the record, this is Dr Greer.

Dr Greer: Dr Greer, sorry. It's more of a matter of practice than a fundamental change in the quality of the discharge being proposed. Dr Ryder had previously applied the 90 per cent species protection thresholds as an absolute maximum, which is a very precautionary approach to applying standards. The revised approach would allow a change to seeing the compliance limit as a 95th percentile, and because of the way water quality data are distributed, the maximum concentration of this is often many times higher than what the 95th would be. So it's not necessarily a large in the stringency of the standards. It's simply achieving alignment with the guidance documents upon which these standards are supposed to be based.

Mr Mulliner: So bouncing that discussion before, back to Dr Weber, in terms of that change in compliance standards and addressing other potential contaminants of concern, has that been considered since that discussion was undertaken?

Dr Weber: Since Thursday? No.

Mr Mulliner: Well, you had a weekend.

Dr Weber: As Ms Badenhop indicated, you know, part of our assessment was to look at the water quality standards and compare those to the baseline water quality to see what was high and what was low. That's how arsenic popped out in the Rise and Shine Creek. So we've obviously got effects there from the, you know, from the activities and from the natural mineralisation in the catchment. The other thing we do is to take, to take those water quality limits. We generally run with a variety of them and apply that to our testing procedures. Applying water quality limits to testing procedures is difficult because it's a lab sample. But it provides us context. So we take that context to consider as a line of evidence as to what

else could be elevated. So boron was a really good example. It was above the ANZG guidance on our [inaudible 00:41:19] tests. And I plotted that and I thought about it and then when it popped again in the net testing where it was .4 milligrams per litre in the process water discharge, that gives you enough evidence to say, "hey, you might want to start monitoring those". So we compared that. It's either the 90 or the 95th per cent ANZG guidelines to see if it was high or low. So we generally do that to get a feel for the risks to water quality before we get into the modelling process to make sure we're modelling the right constituents, and that's also with discussions with the likes of the ecotox experts to make sure we've got the right parameters in place. So, as Ms Badenhop said, one of the things that we may want to do is go back and check that. We could go and review that but generally, as I said, it provides guidance on what could be elevated. And irrespective of whether we picked it up or not in those early tests, if these relationships with sulphate are introduced in the model, they're carried through and they therefore provide the water quality criteria – water quality that is coming through to the proposed active aquifer feeding systems. Was it a bit too much?

Mr Mulliner: No, thank you. So I'm just trying to ascertain where – so there's obviously been some movement from the applicant to align with some of the comments in terms of the compliance values and the limits, but I guess what I'm trying to ascertain is where, exactly where is that disagreement still in terms – or are you, are we all – are all the experts now in agreement in terms of the compliance limits and standards to be applied at those surface water locations?

Dr Greer: The one matter that remains, and it was going to be the subject of some further investigation by Dr Weber, is the compliance standards for nitrate and ammonia and being sufficiently protective for periphyton growth. There were no numbers agreed to. A couple of experts agreed to a general approach, which is in the joint witness statement, but it wasn't possible at that time to come up with the numbers. So no experts have seen a revised approach yet.

Mr Mulliner: Okay. Is it worth discussing that, because I think we're trying to, I guess, focus here on points of disagreement. I don't know.

Ms Palich: I think it's probably a matter of revisiting them, as I'm not sure all those who are sitting here with potential numbers to adopt in front us. I could be wrong, but you have a nitrate number in your head now.

Dr Greer: I believe a few experts signed up to the approach of understanding what the likely nitrogen concentrations would be in the treated discharge and then setting standards based on those and implementing a periphyton monitoring and management framework to control that effect, acknowledging that predicting how periphyton growth will change under the vastly different conditions once post-closure. It's almost impossible now. So it needs to be a monitoring management approach. I believe Ms McArthur raised some concerns about that with regards

to the wording of the current placeholder condition and she noted her disagreement, I believe, with the approach: not in principle but in this very specific context.

Mr Mulliner: In terms of the – I'm just trying to envisage that the receptor, the ultimate receptor of discharge from water from site – so I guess the understanding that's been put forward in the application is generally both the Rise and Shine and the Shepherds Creek go to ground basically. So is that the understanding of all the experts?

Ms Palich: Yes, and there's a statement there at 87 in the joint witness statement that acknowledges that we have a general agreement that the more stringent of groundwater or surface water quality limits should apply to surface water in recognition that the surface water could go to groundwater and there are beneficial use risks behind that. So if the beneficial use of the groundwater had a quality criteria that was more stringent than what the surface water had, that the compliance limit would be set for the more sensitive receptor, being the groundwater.

Mr Mulliner: Okay. The reason I ask, I know this is a question back to Dr Greer. So in terms of the nitrate nitrogen and the potential impact on the receiving environment, and you mentioned periphyton growth. Is that really an issue if ultimately the receptor is the groundwater?

Dr Greer: Thank you for that. There is still, I believe, a number of kilometres between the discharge site of treated mine water and where the stream goes to ground over which period those effects can still occur, and it is standard practice to manage the effects of a discharge on periphyton, even when that discharge may be within two or three kilometres of a coastal water body. The effects are generally managed beyond the zone of reasonable mixing, which definitely does occur within Shepherds Creek. And I believe the approach in DO4 new seven is to monitor upstream of the discharge and then downstream beyond the zone of reasonable mixing. There it's not at ECO8, it's after reasonable mixing. The concentrations that are currently proposed are, I think in combination ammonia and nitrate, we'd put it close to three milligrams a litre. Given the hydrogeological changes in the river, where we're going to see less flushing events due to higher base flows in relation to flood flows, there is a good chance that that would result in a very productive system where periphyton growth would be unconstrained by flow or nutrients, which puts at risk a lot of the good work the applicant's proposing to do on their remediation.

Prof Webster-Brown: Another point of disagreement where we couldn't reach a conclusion was around mercury and selenium and how it should be monitored. And part of the disagreement there was based on the fact we weren't 100 per cent sure what the people who had expressed a worry about bioaccumulation, what

they were actually worried about, whether it was birds, fish, accumulation in plants of the river systems, or what. So there was a disconnect there.

Mr Mulliner: Okay. Is there any existing baseline data on those two elements which we know?

Prof Webster-Brown: I am not aware of any. I don't know if Otago Regional Council holds any information.

Dr Greer: No, I doubt it.

Prof Webster-Brown: I didn't think so.

Mr Muir: For the record, Dr Webster-Brown and Dr Greer.

Prof Webster-Brown: Yes.

Mr Muir: And Dr Greer, thank you.

Mr Mulliner: So, I mean, are we primarily talking here about the groundwater or the surface water, or both?

Prof Webster-Brown: I think maybe Ms McArthur noted that there is a degree of surface water connection for Bendigo Creek.

Mr Mulliner: Ephemerally.

Prof Webster-Brown: Yes, but it happens more often than it happens for Shepherds Creek was her point.

Dr Greer: I actually have comment on this because I watched the hearing the other day and I just wanted to point out that Ms McArthur's interpretation of trout probably required a bit more of an evidential basis to support the claim around connection. I noticed that she mentioned the presence of young eiver trout as evidence that there was a more frequent connection to the lower Bendigo and Clutha system. But trout can form resident populations, and mature trout of a mature size were recorded by Dr Ella Bone's [check 00:50:13] report. Trout are sexually mature; they can be sexually mature at 150 millimetres. They don't need to be nine-pound trophy fish to breed. So, yeah, it is possible that those communities are actually resident and are not recruiting from the lake. Also, the presence of young eiver trout once, even if they were migrating, would be indicative of a recent connection, not a frequent connection. That would require repeat visits to confirm. So I just wanted to flag that that line of reasoning, while it may be true, probably would be, require a bit more additional information to support it. I see Dr Boothroyd nodding his head on that front as well.

Dr Boothroyd: Yeah, I do agree with that. That's right. That certainly needs a bit more evidence to demonstrate that.

Mr Mulliner: So what would the implications be, either way, if there was more – like you start your evidence that there was a greater connection or a lesser connection, how would that, would that change anything?

Dr Boothroyd: Well, it would support the connectivity, if you like, of that system beyond our understanding of, as it was expressed today, where it goes to ground, where, in fact, perhaps that connectivity is stronger, whereas we don't think that is the case.

Dr Greer: I mean it's relevant in terms of the compliance standards that need to protect the downstream receiving environments of the lower Bendigo Creek and Clutha systems due to a surface water connection. I don't think that Ms McArthur has actually provided evidence that we need to consider that surface water connection when planning compliance standards for the immediate receiving environment. The priority there is protecting the immediate receiving environment, I think, based on the evidence we have to date.

Dr Boothroyd: And Ian Boothroyd, I should say my name. Notwithstanding that some of us did consider that a monitoring station lower down in the Bendigo and in the Lindis had merit to sort of confirm any effects in that lower components of those two systems.

Mr Mulliner: So going back, I guess, to the original question/statement around the compliance limits for nitrogen, nitrate nitrogen and ammoniacal nitrogen, there's obviously still quite a bit of disagreement there on what they should be and/or what's applicable. Is that - - -

Dr Greer: I think, sorry, Dr Greer – I think we're in a state of not just – no one's disagreed. I know that Dr Ryder had reservations about the approach used for periphyton but unfortunately was unable to attend conferencing or this hearing. At the moment, I think the experts are in a "wait and see" to see what the applicant can achieve through treatment before providing comment on the appropriate standard. I don't think there's broad disagreement. There's just not an alternative being proposed that we can agree on.

Dr Boothroyd: And Ian Boothroyd. As Dr Greer's mentioned, there is a framework proposed for monitoring for that purpose for periphyton in the system with a response mechanism to that.

Mr Mulliner: Is it a new consent condition? Has it been proposed by yourself, Ian, or Dr Greer?

Dr Greer: A new seven there, for a new seven for the periphyton management response.

Mr Mulliner: Are you able to paraphrase that, Dr Greer?

Dr Greer: At the moment, it says – it's still in draft and in principle for further discussion during the hearing and conferencing. But it includes a periphyton

trigger of 50 per cent cover, or 200 milligrams a litre biomass downstream at the site, where not exceeded upstream, to trigger an investigation into the cause of that exceedance and the presumably adoption of additional water management if needed. But the condition isn't fully fleshed out to understand what that would actually look like on the ground.

Dr Weber: So I know this isn't my area of expertise, but I would make a note that in the joint witness statement, the first one, at paragraph 95, we have a comment on that where we've agreed to – I can read it out: "Update estimates on active water treatment efficiencies for nitrogenous compounds which is to support the new derivation of nitrate and ammoniacal nitrogen compliance limits for others". So that's to provide an indication of what that active water treatment plant would achieve over that active treatment period, which is currently assessed through passive treatment.

Dr Greer: So I note that in 93 as well, myself, Julie, Dr Boothroyd, and Professor Webster-Brown noted that should be limits be provided, that the framework set out in that paragraph, combined with the periphyton management response, was an appropriate way of managing effects.

Mr Muir: Dr Avanidou, did you have any comment on that? No. Thank you.

Mr Mulliner: Will those conditions and those revised compliance limits be included in the outstanding RFI? I think it's due in a week's time.

Dr Weber: I think they're meant to be.

Mr Mulliner: Okay.

Dr Weber: There needs to be discussion on that, for sure.

Mr Mulliner: Right.

Prof Webster-Brown: Could I note that there is - - -

Mr Muir: Professor Webster-Brown.

Prof Webster-Brown: Sorry, Professor Webster-Brown. There is more needed for the compliance limits discussion than what we've covered already. I think we've got other aspects to cover which could also be included in an RFI, so.

Mr Muir: [Inaudible 00:57:00] take it?

Mr Mulliner: Well, I think, as Professor Webster-Brown pointed out, then it's the performance monitoring is all – I would call that part of this discussion, not a separate discussion.

Mr Muir: Yes.

Mr Mulliner: So we can lead straight into that.

Dr Weber: Sorry, could I just ask for clarification, Commissioner Mulliner, about – what do you mean by performance in regards to water quality limits?

Mr Mulliner: Well, the water quality. There is some discussion in the performance monitoring that they would have trigger levels based on percentages of the limits. So yeah, I guess that was a question I wanted to ask, first of all is, I know that that 50 that there was a recommended condition that there would be trigger values in performance monitoring wells based on 50 per cent of the recommended compliance limits but at the time those compliance limits were based on the 90th percentile ANZG and now that seems to have shifted to a 95th, and whether those trigger values are still valid or there's been any thought about that.

Ms Palich: I think that there was a general agreement that the 50th, 50 per cent of it would be applicable except where a background was already showing that it might be above that, and that hadn't been further evaluated to identify specifically which analytes that might apply to between here and – between Thursday and today. And while I just have that, it's been raised, the concept with the additional criteria for groundwater around additional elements of concern that we hadn't – contaminants of concern that hadn't been discussed such as vanadium, and you just brought that one up in your previous statement. Just highlighting that, I think we need to be cautious that we have identified potential contaminants of concern based on the outputs from the geochemical studies, and there can be other elements that are naturally there in the environment that aren't necessarily associated with the mineralisation and the mining project that may result in a background concentration where elevated concentrations that may not meet doesn't – I haven't looked specifically because we're not actually monitoring for things like vanadium to know but one would not also generally be expecting to start monitoring for contaminants that one would not have expected to have been impacted from the mining process. But I think we should just be very, really mindful of that and consider that it's not, you know, "let's go monitor every metal in the metal suite just because there's a compliance limit sitting out there somewhere". There's no evidence between the PX ref data and the geochemical analysis to suggest that they are otherwise elevated in the actual environment because elevated concentrations could then come up just naturally without actually any impact from the mining activities.

Mr Muir: So that's Ms Palich for the record.

Mr Mulliner: So that's I guess where that identification of the potential contaminants of concern that you outlined - - -

Ms Palich: Yes, this is why we did it.

Mr Mulliner: - - - [inaudible 01:00:37].

Ms Palich: But just that that should be coming and largely driven from the geochemical stuff plus the operational activities, not from the basis of because it

could be there, or because there's a compliant – because there is a water quality criteria derived for it.

Mr Mulliner: Ms Badenhop.

Ms Badenhop: Am I able to respond that? Sorry, yeah. I certainly, just to be clear, I only listed things that were in the geochemical analysis that were identified originally in the list. So I hadn't added any into it. It was just the statement that there may or may not be an issue and there's just that feedback loop of consideration. That's all.

Ms Palich: Apologies if there was a slight misunderstanding.

Ms Badenhop: Yeah.

Ms Palich: I just noted it because vanadium wasn't part of the water quality monitoring suite, but I don't have information to comment on it.

Ms Badenhop: No, I've just got the listing of everything that Dr Weber considered in all of his different geochemical analyses, but I always listen to what he says.

Mr Muir: Yes. Dr Weber.

Dr Weber: hank you, Commissioners. Just in regards to Commissioner Mulliner's comment about the 50 per cent trigger level, there's two trigger levels that we're talking with. So for clarification, if you go to my evidence of the joint witness statement, apologies, 10th of June, that is 16(iii), that's one discussion on it, and then there's another around sediment. So the 16(iii) is around using 50 per cent of the limit to guide further investigations as a start for performance monitoring. So it provides a trigger, and that would include things like looking at increasing or decrease – or trends of some sort to see what's going on. So that gives us ample time to consider what other adaptive measures are required. And that's proposed with the compliance monitoring locations to understand those trends. But, of course, if you go all the way back up to actually monitoring the seepage, those main points, locations of poor water quality, you'll see that a lot earlier. So there's a cascade of monitoring that would facilitate that 50 per cent. And people may ask where do I get that 50 per cent from? That's based on New Zealand drinking water guidelines. That says, you know, if you wanted 50 per cent, you should do something. So that falls into a really good trigger for performance monitoring. So that's why I've noted that one. I think it's reasonable, provided you've got the performance monitoring behind it to support doing that compliance monitoring location. And then the other 50 per cent comment relates to – no, I don't want to make the consent up, but it regards the, it's regarding the sediment monitoring that is proposed as part of the new consent condition where I think the trigger was – if someone else had and read it, it would be wonderful, but it's around if you exceeded the guideline value, then you should do something, and the conversations we had about that at the conferencing was to

back that down to 50 per cent so that you can do something before it actually exceeds those limits. So I think it makes sense. That was just two comments, Commissioner Mulliner.

Mr Mulliner: And so the other side of that condition is the 50th percentile but it's also the increasing trend. So defining an increasing trend in the monitoring data, is that going to be outlined in the updated management plans compliance?

Dr Weber: Yes, I was trying to provide some reasonableness there. So like if you had a spike for whatever reason it was that went above 50 per cent, does that then cause this cascade of things to be done? If you saw you were slowly increasing towards that goal and then it went over it, well it's pretty obvious that you've got things that need to be managed and processes. So what I've said in that joint witness statement, which was copied from, oh it was probably copied from my evidence, if I remember correctly, and I can read it out, is one option to trigger that for a trigger value for adaptive management is if any PCOCs, potential constituents of concern, are within 50 per cent of the proposed compliant limit at the compliance monitoring locations with increasing trends, and I was going to reference the standards.

Mr Mulliner: But I guess the reason I ask is that increasing trend can be open to interpretation, and I wondered if it would be pertinent to really define what that is to trigger it. Would you have any comment on that?

Dr Weber: So you're saying the iometer is not appropriate? I think that could be defined. One way we've considered is that you have a suitably qualified and experienced person to look at that data, and I think, you know, part of the annual review process is it does go to the Councils, and they would have experts that can review that. Sometimes you need to take a holistic approach to not just one trend, but lots of trends.

Mr Mulliner: Okay. Have we got any comment from Ms Badenhop, or others?

Ms Badenhop: I tend to agree that it would be useful to define the type of trend analysis for that increasing means and because, you know, there is a number of layers of people that then it could go through and be misinterpreted, especially because we're talking about people 50 years in the future potentially as well reviewing reports.

Dr Greer: Just quickly. The MPCP in 2020 defines what a degrading trend is, which is helpful but not necessarily transferable to consent conditions. And it defines it as more likely than not with an invest – which is actually a statistical trend category for a start in the trend analysis tool. But it doesn't apply a magnitude of change to go with that as well. So potentially a trend category paired with a magnitude of change and the ability to delete outliers – I'm saying this mainly for Dr Weber, as he's probably going to take some of that away – would

be a sensible approach. And I think triggers could be defined quite clearly in that matter, and still having an SQEP, do a report on it.

Ms Palich: I agree with that. You know, it may be that you need, you know, three consecutive increasing trends, you know, over a period. It's going to depend a lot of monitoring frequency though, how you set that and where those statistics lie because, you know, if we're only monitoring, different monitoring frameworks – unfortunately, they're not readily on the tip of my tongue, but there's a difference between monthly monitoring, what's an increasing trend versus quarterly monitoring versus something that's only annual. So it will need to be well considered and written out, I think.

Dr Weber: Could I just jump in under there in regards to trends? Performance monitoring has monthly monitoring of water quality, but it also has continuous monitoring for flow and for EC; and, as Ryan indicated, EC is a very good indicator and I also support that [inaudible 01:08:44] sulphate and nitrate. You've got to build up a data set first to get it. That will also help understand trend analysis. It will help you define if things need to be managed adaptively. That probably also addresses one of Ms McArthur's comments yesterday about the infrequency of monitoring. Just to clarify that, if you've got monthly monitoring but you've also got continuous monitoring through EC and flow that we can understand in between that data set what the trends are. And I'll just make a comment that flow rate is also really important because it's flow times quality equals load, and if you really want to understand that total load, it requires management as well.

Ms Sweetman: Dr Weber, just looking at paragraph 19 of the 10th of June JWS and Ms McArthur's concerns there about for the lead-in time and delays, you don't therefore agree with what she said there?

Dr Weber: If I could just read it quickly.

Ms Sweetman: Sure.

Dr Weber: I think there is a number of issues tied up in that. So the first one I would address by my statement at 20. So at the start of the project, the geochemical effect's going to be lesser, and we're going to learn and we're going to start developing trends. When the risk is low, you know, the sulphate concentrations will be low, the nitrate concentrations will be low. So we'll get that data in hand. So if you stepped into it at a point in time with no information, that would be difficult because you wouldn't know if you needed a water treatment plant or not. But this project is going to gather that data as it starts up. So I'm comfortable with that, that is fine. The comment around active water treatment measure, the number of triggers proposed which we can talk about in the active and passive treatment section later on. And they were discussed and I think generally agreed on by all the experts as being suitable. I think there was

four of them in the end. Two are already in a new consent condition proposed and there's another two that come from our conferencing. Did that clarify?

Ms Sweetman: I think so.

Dr Weber: Thank you.

Mr Muir: Is there any cross-examination on the subject of the compliance limits and the contaminants of concern? Ms Gepp.

Ms Gepp: Yes Sir. I'm just looking at the time. Are you happy to carry on?

Mr Muir: Yes. Will you be five minutes or less, do you think?

CROSS-EXAMINATION BY MS GEPP:

Ms Gepp: Sure. Okay. So just picking up on the trend point, and this is something that Ms McArthur's got in her evidence, would it be necessary to include a timeframe over which the trend was being assessed in order to avoid a situation where, for example, it might be interpreted as requiring a year or more to establish a trend?

Dr Weber: So you're saying is a timeframe required to understand that trend?

Ms Gepp: I'm saying that if you don't have a – if you don't specify a timeframe, it could be open to interpretation how long you need to establish the amount of data that you need to show that there is a trend.

Dr Weber: I think it makes sense. Obviously if you had two data points, you've got a really good trend. So you need data reliability as well, and that comes with time. So if you – at the start of the project, like I said, you can have a lot of information coming in. You'll develop those trends, and that'll give you an understanding of the sensitivity of how quickly you have to make decisions. So – sorry, to explain it, if you started the project off and you've got a very slow increasing sulphate concentration, and we'll make up numbers, you know, 10 milligrams a month or 10 milligrams a year, and that was a constant, you know, over the first five years, that gives you confidence. But if something in that changes and it starts becoming a lot higher very quickly over months, that would be a trigger to me that you need to think about moving into adaptive management. I'm hearing everyone that you need to define what that – what a significant change in the trend is. I think that's fair.

Ms Gepp: With respect to nitrate or total nitrogen and the current limits proposed for nitrate and ammonia, it would also be relevant when you're considering those limits further to look at the Otago Regional Plan, schedule 15 limits that describe what is good water quality, wouldn't it?

Dr Weber: Is that discussed in – is that - - -

Ms Gepp: So that's discussed in Ms McArthur's evidence. She's set out that the nitrate nitrogen limit, for example, is .075 milligrams per litre which is very much lower than the proposed compliance limits.

Dr Weber: I think that's the general conversation we're having about what will that limit be to consider other effects beyond, you know, the – it's outside my [inaudible 01:14:44].

Ms Gepp: Yes, so perhaps it's a question for Ms Palich.

Ms Palich: We did discuss lowering limits in our JWS that were lower than the originally proposed ones. I'm just trying to find them at the moment. But yes, I think the general discussion was that the original proposals might be high and we should be looking at some other frameworks for making that decision.

Ms Gepp: Thank you. So those are going to be proposed in the 22 June conditions, are they? So that will be when we see those.

Ms Palich: I believe that would be the expectation, yes.

Ms Gepp: Thank you. Now that the 95 per cent percentile has been agreed and there's a need to work out what those limits are, there is also a need to assess whether the modelled leaching outputs, contaminant outputs, are consistent with the achievement of those limits, isn't there?

Dr Weber: So if you're saying if those limits change, then we need to re-run the models against the new limits?

Ms Gepp: Yes.

Dr Weber: Yes, that would need to be done.

Ms Gepp: Okay, thank you.

Mr Muir: And the answer was?

Dr Weber: Yes, that would need to be done so we can understand, you know, the performance of the proposed treatment systems.

Ms Gepp: And when - - -

Dr Weber: Sorry, can I correct myself? It's not the performance of the treatment systems but when would those treatment systems be able to manage the proposed concentrations to achieve the compliance limits. So if they're lower, then it may take a little longer before you transition to passive treatment, for instance.

Ms Gepp: Yes. So it's both whether you can achieve them and how long it will take to achieve them using active treatment, is that right?

Dr Weber: Sorry. The understanding is you can achieve these limits through active treatment. The period of that active treatment is a function of the efficiency of the

passive treatment system to maintain and continue to achieve those compliance limits they've set.

Ms Gepp: So have you already re-run the model to – how do you know that they can be achieved, if you haven't assessed it yet?

Dr Weber: Sorry, passive treatment or active treatment?

Ms Gepp: Well, either. The outputs, the leaching, the contaminant outputs from the model - - -

Dr Weber: So the long-term, the long-term decay in your loads – sorry, I'll say that again. The loads are turned into concentrations that decrease with time - - -

Ms Gepp: Yes.

Dr Weber: - - - and the point at which passive treatment kicks in is the point that it can achieve compliance. So if that limit is lower, it'll take longer because there's a very slow decrease in concentrations with time.

Ms Gepp: Aren't these compliance limits set in stream and need to be complied with from the outset by using active treatment?

Dr Weber: Yeah. So for, yeah. So for the active treatment, we'll manage it, treat it until the passive treatment can start.

Ms Gepp: Yeah, so whether it's active or passive treatment, the limits will be complied with.

Dr Weber: Yes, that is the intent.

Ms Gepp: Yes.

Dr Weber: And, as noted, we need to do more studies on that to validate it.

Ms Gepp: Yes, thank you.

Dr Weber: Yeah.

Ms Gepp: Thank you, those are my questions.

Dr Weber: Thank you.

Mr Muir: Mr Enright?

Mr Enright: No Sir.

Mr Muir: Mr Randal?

Mr Randal: No.

Mr Muir: And Mr Leckie?

Mr Leckie: No Sir.

Mr Muir: Right, thank you. And if I could just touch base – sorry, Mr Dale, I overlooked you the last little while. Do you have anything you wish to add?

Mr Dale: Not at this point, no. I think it's been adequately covered, thank you.

Mr Muir: Right, thank you very much. We'll take our break for lunch now and we'll just make it half an hour, if you don't mind.

luncheon adjournment

Mr Muir: Thank you. Dr Weber, should I be going to Mr Smith at this point, or start with you?

Dr Weber: Commissioner, I was just having a conversation with Professor Jenny Webster-Brown about compliance limits, and we hadn't disclosed one aspect in regards to total versus dissolved, and I believe Professor Jenny Webster-Brown might have a comment on that, if that's alright.

Mr Muir: So, Professor Webster-Brown.

Prof Webster-Brown: Yes, this could be relatively quick. The compliance limits as they are specify the dissolved metals comply with the limits that are there. You miss a lot of the trace metal emanating from the site which is being transported on suspended sediments and in other particles – particulates that are going down the river. So we did discuss it in the joint witness statement; it's paragraph 81 in the second joint witness statement. We would see the need for some kind of control compliance limits for total metals, or total metal load, or some way of controlling the sediment-bound metals going off site.

Ms Sweetman: And you agree with that, Dr Weber?

Dr Weber: I'm generally trying not to make an opinion on any of the toxicological stuff. Ms Palich?

Ms Sweetman: Ms Palich.

Ms Palich: I believe that the conversations said that those total and dissolved metals would be, should be monitored and I think there were several of us added some other conditions here, which I'll have to find, which agreed with that, but with respect to the implications for total metals on toxicological effects, they're very well defined in the ANZG, whether that is a total or a dissolved metal concentration, and that should really be the guiding, in my opinion, the guiding factor for assessing risk. And potentially our TSS guideline will help to address the other side of things because we have – I think we've also have proposed the total suspended solids limit.

Mr Muir: Sorry, you just tapered off a little bit there. Can I just understand where this is going. Can the panel expect that the total and dissolved limits will be among those proposed with the amended conditions?

Ms Palich: That was not my understanding from our conversation last week, that we would have limits for dissolved metals, but that total metals would also be monitored as part of the programme so that we could make a more semi-

qualitative assessment on potential impacts from that. But the toxicological impacts, or the ecotoxicological impacts are generally associated with the dissolved component of metals in discharge, except for a few exceptions. Do you have a comment on that, Mark?

Dr Greer: I agree that the toxicological, toxicity ones should be set on dissolved metals as that's ultimately where a [inaudible 00:04:10] might guide you. If there is a need to control total metals from the site, that should be – limits should be set specifically for that purpose in the form of a load or a total concentration. There are backstops for the immediate receiving environments in terms of total metals discharged from the site, you know, there is groundwater and surface water receiving things. So I guess what's left is really what gets through to the further downstream receiving environments, which isn't necessarily controlled directly by those compliance standards that are in there currently.

Ms Palich: I guess the additional thing is we are proposing sediment monitoring which presumably some of that total load will drop out into the sediments. And so there's a means of assessing that component in terms of its risk of what might actually be posing risk to ecological receptors subsequently as it migrates down the Shepherds and Rise and Shine catchments.

Mr Muir: Professor Webster-Brown, are you proposing hard limits for total hard, hard total limits, or is this advice of monitoring in relation to total limits sufficient to meet your concern?

Prof Webster-Brown: I'm proposing that there needs to be some control, and it currently, it could be monitored but there's no trigger point at which action should be taken. And if we want to assess this mine in terms of an output of trace metals to the environment, which I think we do, then you are missing a large proportion by not – you're not controlling a large proportion of that output by not controlling suspended sediment bound metals going offsite.

Mr Mulliner: So is there some measure – so I think the applicant's experts just described that they are willing to take total samples. Is that my understanding?

Prof Webster-Brown: Yes.

Mr Muir: So without us identifying what you now propose, trigger, some trigger limits around all of this, yes, it's all delightful to know that there are these elevated suspended, elevated levels of suspended metals. What do we do with them?

Prof Webster-Brown: Well, one of the reasons it came to my attention is arsenic is a major contaminant at this site, as you know, and that is one that binds very readily to suspended sentiments. So the load of arsenic carried off the site on suspended sentiments is likely to be high. I think that an easy way to do this would be to ask the applicant to propose an overall control on their trace metal eliminations in much the same way as they have proposed the compliance limits.

Mr Smith: I would just note, Professor Webster-Brown, that the addition in DO2 new 10 does provide for a weekly water quality analysis of total and dissolved metals. However, it doesn't mention limits, which is outside my area of expertise.

Prof Webster-Brown: I totally agree that they will be monitored, as they are monitored on most sites. But it's actually having a trigger for action is the point I'm making.

Mr Mulliner: So can I just ask a related question here. So if the compliance limits, as they are, are based on the dissolved available redaction, but how would the applicant define what that total limit would be?

Prof Webster-Brown: Well, there's quite a lot of literature around for other mine sites that have such limits. Whether they want to set a total concentration as a limit, or whether they want to look at the load of metals going off per year, per two years, that I think is something that we would need to ask the applicant for, other than dictating what's going to happen; because it has to be practical for them as well.

Mr Mulliner: Sure. Would you expect the dissolved and total concentrations of the dissolved concentrations are increasing, would you expect the total concentrations to be increasing by a similar magnitude?

Prof Webster-Brown: It does depend on the source of the contaminants. You know, if – it depends on what's driving the dissolved concentration. If it's because you've got a lot of uncontrolled seepage or silt or a sediment going into the water, then, yes, it will probably drive a higher concentration of dissolved metals as well. If it's coming out of the water treatment plant, the active water treatment plant, then clearly it's not going to have a lot of suspended sediment in it. So you wouldn't see that relationship.

Mr Mulliner: You don't think the applicant's proposed suspended sediment limits would partly address your concerns?

Prof Webster-Brown: If, and this is getting very technical, but if they characterised the suspended sediment in terms of its metal content, then, yes, you could make that leap from "this is the suspended sediment level so therefore we expect this much metal is going out on that suspended sediment".

Mr Mulliner: Okay.

Dr Greer: Just quickly. I think that there is no suspended sediment limit that applies to Rise and Shine Creek, I understand. I thought the suspended sediment limit applied to the discharge from the sediment ponds, not mine water discharge. Is that correct or not?

Prof Webster-Brown: Isn't there also a discharge from the well? So from the silt pond in the Rise and Shine catchment and there's the silt ponds downstream of this pit.

Ms Palich: So, Ms Palich, there was – you might be somewhat correct where there was a half-written condition on the new O3, the concentration of total suspended solids in the discharge from any sediment retention devices must not exceed 50 milligrams per litre, and then we had not defined the second half of that where it was proposed to say except where the background total suspended solids in the water body is greater than XX milligrams per litre. I had looked at that.

Mr Mulliner: Sorry, what condition is that?

Ms Palich: New 3.

Mr Mulliner: New 3.

? DO4.

Ms Palich: New - - -

? DO4. So you can see that.

Mr Muir: So, as a panel, we're left with Professor Webster-Brown is proposing that there needs to be an overall control on all metals in much the same way as is currently proposed in relation to dissolved metals. Does that position have traction among any other of the experts? And where are we left? Where are we left with the applicant in terms of whether that is appropriate or not?

Dr Greer: I mean, I think in terms of the immediate receiving environment, the potential for adverse effects are well covered by the sediment monitoring triggers and the – well, not well covered yet, but once they are defined, they could be. And the in-stream dissolved concentration limits. The gap is the immediate, the further downstream receiving environments which can receive all of the suspended sediment download during flood events, it could be washed downstream and deposited in the Lindis. I don't know the risk of that because that hasn't really been described to date but if, if a limit is required for that purpose, it makes sense to me for it to be a load limit because that's the effect that's being managed, not an immediate in-stream concentration limit. I think we've got the dissolved ones for the effects in the stream. If we're trying to control the load to downstream receiving environment, let's make the limit a load limit.

Mr Muir: Right. Well, I don't think that the applicant requires any further input on that. They have heard the message. Yes, Dr Weber.

Dr Weber: Thank you, Commissioner. Just to clarify, we obviously talked about that 50 per cent limit for soil. That's a new consent. That would address the load that Dr Greer talks about being deposited in the receiving environment and therefore to understand if it's elevated or not, compared to baseline conditions. So that does provide monitoring of that issue at its final depositional place, if that makes sense.

Mr Mulliner: What do you say about that Dr Greer?

Dr Greer: I don't agree just because of the way metals move in and out of sediments, and the fact that it is in its final depositional place, even the Shepherds Creek connects to the Lindis at some points during large floods, which will have a massive amount of sediment transport associated with them. So the load limit should be set to control – should be cognisant of the receiving environment's it's going into. It should, if it is set, factor in what the Lindis can take, and the risk of metals in there. But I think that that sediment monitoring is really for controlling direct effects on the immediate receiving environment, not as a proxy for load to areas further downstream.

Mr Mulliner: One more question before we move on from this. So with the current information we have from the site, do we actually understand the current loads in that respect?

Ms Palich: We have data from total and dissolved metals and to work something out from that, we'd have to do some calculations but, in theory, the data should be there to make a preliminary assessment.

Mr Muir: Dr Avanidou, did you have comment about this?

Dr Avanidou: No.

Mr Muir: Thank you. Right, treatment. Active and passive treatment options and systems. Dr Weber, should I invite Mr Smith to lead for the applicant, or do you wish to?

TREATMENT:

Dr Weber: I'd like to start off, Sir, if that's alright. I'd just like to reiterate some of the agreed triggers for when that active water treatment plant will be constructed. Two of them are already contained in the new consent condition DO.2 new eight. And it states at least 12 months before cessation of mining, or the development of a water surplus condition as predicted by the water balance modelling. And that's already been proposed in the consent conditions. And then the other two that relate to triggers that I've proposed and do need fine-tuning regarding that sediment load design that we've just been talking about, relates to poor water quality due to run-off and mine infrastructure outside of the mine circuit water and then sediment in relation to that [inaudible 00:17:23]. That's a bad sentence. Sediment in relation to elevated metals in the sediment, as discussed previously. So I'm not sure if anyone wants to comment on those or agree they're generally right. Otherwise I can carry on and talk about active and passive treatment as an introduction, or I'll hand it over to Mr Smith to talk through any questions on the active water treatment part.

Mr Muir: Well, why don't we just test that premise for a start? Anyone got any comment in relation to that? Right. Well, why don't we pass over to Mr Smith then.

Mr Smith: Good afternoon, everyone. I will start by, I think, just describing our work so everyone is aware of what we've carried out. So as part of the application, we've examined – we've carried out a literature review on suitable treatment processes for this water types that we're expecting to see at the active water treatment plant. These include chemical treatment and mineral precipitation. We also have reviewed reverse osmosis. Literature suggests that these processes can treat sulphate and metals to very low levels, which will be under the compliance limits. There is some caveats obviously. We've just previously a few minutes ago discussed the nitrate levels that we're going to have to propose. I think that was paragraph 95 of the eighth and ninth joint witness statement. So we're doing some work on that currently and, given that it was only last week, I don't have a number for that at this point.

Mr Muir: That's a function of moving the percentile levels to 95 per cent, is that right?

Mr Smith: Correct. So perhaps the – what's proposed for active treatment is we are going to carry out a series of treatment trials, and that includes a bench scale testing, which is laboratory testing of the processes to see what removals we can achieve. And then also, following on from that, we'll have pilot scales. So it's a scaled-up treatment onsite using water that – I guess I'll go back one step, sorry. So the condition new six that is being proposed within DO2, consents and conditions, states that within one year of tailings being produced, so at that point we'll start to have some representative water, these trials will get underway. And so what that should inform is a design that we can rely on for when the trigger of construction of the water treatment plant is required. I think that's my introduction and I guess if anyone has any questions.

Mr Muir: Yes, well, I'm sure there's be some more specific issues that we'll have to come back to as we open this topic up for discussion, Mr Smith. Thank you. I'm going to go to ORC at this point. Ms Badenhop, will you be leading this?

Ms Badenhop: I'm happy to ask the questions. I think the real issue with that is water treatment actually feeds back into the water load balance model, which we're going to discuss later, but given our discussion about all the different compliance limits that we're now talking about possibly meeting for both surface water and groundwater limits such as the 250 milligrams per litre of sulphate or the lower limits for molybdenum, are they all components that you're comfortable that you can meet through the active water treatment plant?

Mr Smith: Well, they certainly would. If we adopt the, which it sounds like we are, the 95th percentile compliance limits, they'll certainly have to be the treatment targets that we carried on through to our test work. Literature suggests that a lot of metals and sulphate could get well under those limits currently. So yes, I think from what we've reviewed, I would say yes.

Mr Mulliner: Can I just ask a related question there? So you refer to literature adhering to those removal rates, and I notice in your evidence some of these removal rates are up over 99 per cent. Is that literature based on actual full-scale examples, or are they more based on bench tests or pilot-scale tests?

Mr Smith: The literature I would say, depending on what you're talking about, whether you're referring to reverse osmosis or chemical precipitation, the literature around the chemical precipitation options is primarily based around pilot-scale and bench-scale style testing. The reverse osmosis, we have actual literature from the membrane suppliers what they're prepared to guarantee their removal figures will achieve. So from that point of view, we probably have more robust information regarding reverse osmosis.

Mr Mulliner: I guess the question is are there examples, in reality, where they have active treatment plants as generally described in the application where they're achieving these removal rates?

Mr Smith: Yes, from a reverse osmosis point of view. The lit – I will qualify that by saying we've, to date, carried out a literature review. I've also had experience in test work of chemical precipitation. It's covered by confidentiality, so I won't talk further to that. However, it does give me confidence that we can achieve what we're setting out to achieve.

Mr Muir: Dr Morgan, or Professor Webster-Brown, did you wish to comment on this?

Dr Morgan: Nothing from me, Sir.

Prof Webster-Brown: I would have some confidence – water treatment plants are used on mine sites all the time and have to achieve certain limits, and I would imagine this is very achievable.

Mr Muir: Any cross-examination on this topic?

CROSS-EXAMINATION BY MS GEPP:

Ms Gepp: Yes Sir. I just wanted to follow up on the question of nitrates. And first of all, so, Mr Smith, Sally Gepp speaking. I'm counsel for Fish and Game. You referred to 95 of the second joint witness statement where you say you're providing updated estimates on treatment efficiencies for nitrogenous compounds to support the new derivation of nitrate and ammoniacal nitrogen compliance limits by others. And the Chair asked you if that's a function of moving to the 95th percentile, and you said correct. But the nitrogen limit is not set by reference to the 95th percentile, is it? That's - - -

Mr Smith: Sorry, no, it is not. It was discussion of a lower limit, and this is not my area of expertise, understanding. I think Dr Greer was mentioning a lower limit that's applicable to periphyton downstream.

Ms Gepp: And in terms of the effectiveness of the active water treatment for nitrates, there seemed to be a little less confidence in your report with respect to achieving low nitrate limits. Is that fair?

Mr Smith: Yes, I would say that is fair where both of the processes we're considering do have removal efficiencies for nitrates. However, I mean, because of the movement of what we have proposed in the application to what is discussed during the conferencing, I do need to go back to our process engineers and our supplier of reverse osmosis membranes and get the commentary on that to be able to respond to that question.

Ms Gepp: Thank you. And I think you're identifying in your report, B41, that's the order of magnitude study, that even with the previous nitrate limits, there would be a need for, or there would likely be a need for additional nitrate removal in addition to the water treatment plant.

Mr Smith: Potentially, yes.

Ms Gepp: Thank you. Actually, just on that, do you have an idea of the cost of the types of active treatment processes, or the water treatment plant and the other additional bolt-on processes that you've discussed?

Mr Smith: I do have an idea. However, there's quite a lot of work goes into both the capital and operational costs of these water treatment plants and they include reagents and power and various other, you know, multi disciplines for feeding into those costs. So the answer is I have an idea, but I haven't tabled that number in any of the statements so far.

Ms Gepp: Can you give me a ballpark?

Mr Smith: I'm not comfortable to do that at this stage without doing some work on it, sorry.

Ms Gepp: Alright, thank you.

Mr Muir: Mr Enright?

CROSS-EXAMINATION BY MR ENRIGHT:

Mr Enright: Yes, thank you, Dr Weber, just on passive treatment, the JWS records that further studies are required to confirm the style of passive treatment and capacity of passive treatment system to achieve the water quality limits set for the project. That's para 24 of our second statement. And Professor Webster-Brown in her written evidence raised some concerns around reliance long-term on the passive treatment systems, whether it's problematic, as she described it. Do you have any comment on examples of long-term passive treatment that's been successful in the New Zealand context over a long term, over more than 10 years.

Dr Weber: Thank you for the chance to speak to that. So passive treatment technology emerged about 40 years ago, 30 years ago. Generally, the expectation

is they last for 20, 25 years before you need to replenish the media. And that was based on observations from trials from long-term operating systems. Do they last longer than that? Well, none have run longer than that. Do they last longer than 10 years? The ones that were operating that I've been involved in constructing have gone 12 years. Sorry, I'm just guessing there.

Mr Enright: Sure.

Dr Weber: But the key, the key thing about passive treatment systems is you have to maintain them, and so you have to replenish the media. They're not a walkaway solution. As far as their performance goes, you've got to do a lot of studies to ensure that they're going to work and be reliable. And then you have to maintain that reliability. And that takes time. And I've done a lot of this, and it's site-specific and hence why I've recommended doing those trials. And I've also noted that those trials should be done five years before they're required to provide the time to do the assessment of what technology is going follow, the bench-scale testing, the pilot scale, to build a reliable plant that can then shadow along beside that active water treatment plant and transition from it to it.

Mr Enright: Yeah. And so this is a case – another one of those tensions where you're recommending it can be addressed post-grant of approval, obviously, and sometime in the future. But, I mean, do you accept Professor Webster-Brown's premises that there is some uncertainty around - - -

Dr Weber: Yeah, of course there is uncertainty, but you do need to – you have to validate these systems. If I built one of these systems with some synthetic water, there'd still be uncertainty because you'll want to know the exact, exactly how it works onsite. For instance, does it work in winter as well as it works in summer? And we discussed this in the conferencing, and the answer is no. So what does that mean? So, and the answer is well, maybe you need more organic carbon. And there's methods around that. It might be an enhanced passive treatment system where you provide organic carbon. So, yes, there's uncertainty but that can be resolved, and I'm comfortable that it can be resolved during the operating phase by doing those trials.

Mr Enright: And are you familiar with the example, the Golden Cross example?

Dr Weber: No, I'm not and I also didn't design it.

Mr Enright: It's an example Professor Webster-Brown gave, but if you're not familiar, I won't ask you about that. Thank you, Sir.

Mr Muir: Other cross-examination?

QUESTIONS FROM THE PANEL:

Mr Muir: Can I could ask please of Mr Smith. As an adjunct to the most recent reconvened geology, geotech and engineering expert conference, Professor

Lotumosa [check 00:33:15], if I have his pronunciation here correct, was unable to attend but provided a written statement. Have you had an opportunity to read that?

Mr Smith: No Sir, I haven't.

Mr Muir: Well, with that caveat, could I just take you to his discussion about the risk of "first flush events", and by way of background he refers to these as being events which occur in the project area, he says, with increasing frequency magnitude in the context of climate change, and suggests the "necessity of targeted treatment of highly concentrated first flush surges of contaminants". Is that something that you have given consideration to?

Mr Smith: Only in the fact that we are going to have surge ponds to capture that first flush, and we are also having, post-treatment, a polishing pond to have some retention time of treated water before discharge. So if there was a situation developed where the treatment plant performance wasn't as good as expected, you could re-process that water. So those ponds will have to be sized as part of a detailed design of the water treatment plant to accommodate that. But it is a question and a good question, yes.

Mr Muir: He suggests that the modelling of mine water treatment of the Shepherds TSF, as well as the ELF and the CIT backfill water is all based on constant contaminant load and hasn't specifically addressed this type of surge contaminant load.

Mr Smith: Can I pass that to Dr Weber please?

Mr Muir: Thank you. Yes, Dr Weber.

Dr Weber: Thank you, Mr Smith and Commissioner. Just to clarify, sorry, I don't have the joint witness statement in front of me.

Mr Muir: Yes.

Dr Weber: If someone could search it, we actually talked, we talked about first flush, and we had some of, you know, we had all the experts that were available there. And our understanding, I think we state that as it seems that Professor Lotumosa is misunderstanding of the issue in regards to first flush because the question provided by the panel was "what is, what is the effect, what is the effects of" I think "spill of water from the diffusion drain", if I get it right, "into that pond".

Mr Muir: Yes.

Dr Weber: And a first flush is the runoff of water from the engineered landforms and that into that one report to that facility.

Mr Muir: It may that we're at cross-purposes, but I was no less interested in what he was saying.

Dr Weber: Yes. So in regards to first flush, we've also discussed in the water joint witness statement about managing those effects. So that was on the first day, and that's when some of these management, some of these triggers have come from in regards to identifying if poor water quality is occurring and why we need to build that water treatment plant. The second one is, the other point was about the discharge from the underdrains being a first flush. I don't see that as a strong, a strong mechanism, the TSF for higher flow rates. It would be a constant concentration coming through as we have modelled. There may be an increase in the water from engineered landforms because obviously if you have a very big rainfall event, it may wet up the toes of the structures, and that water may come through the first of those underdrains. But I don't consider that a first flush. First flush to me is superficial. In regards to closure when the active water treatment plant comes on, that active water treatment plant's focused on probably pretty constant plus or minus. As I just said, some of those initial [inaudible 00:37:40] replace the ELF would require water volume. As Mr Smith indicated, there is a surge point in front of the plant that can manage those variances.

Mr Muir: He's also quite sceptical, if I could say that, of the long-term performance of any passive system in a semi-arid climate, referring to, obviously, an article of his own from 2010 about the failure of wetlands to mitigate mine water contamination as a result of seasonal droughts and then flash floods. If I could just quote, he says: "The choice of installing wetlands is questionable as a long-term solution to water management and treatment. Any installed wetland is likely to fail at some point in the semi-arid environment. In fact, current remediation efforts of mine waters emanating from historic mine sites and semi-arid terrains like southern Spain are shifting from strictly passive wetland systems to hybrid passive and subsurface flow treatment systems active water management". Now, of course, at least through an intermediate period, it's contemplated that there be active management, but he's not particularly enthusiastic about the ability to be able to transfer to passive management at any stage.

Dr Weber: Now there was a lot in that. Firstly, in regards to the arid environment, I imagine he's – I think I understand he's imagining these wetlands will dry out. So it will come down to the type of treatment system. Generally, we try to do a downflow reactor, for instance, it holds a pond of water on top. It then drains through, and once it goes through, it's treated. I would also note that these flow rates are going to be much more constant from these systems. The water load balance models demonstrate we've got that water coming in. Yes, it's an arid environment, but I don't see the loss of water being an issue; and that stuff that we'll need to consider during these trials to validate those processes. So, I've built a lot of these systems and been involved in the study and research and PhD students all [inaudible 00:40:16] over the last 20 years. I'm pretty happy with passive treatment being able to achieve these objectives.

Mr Muir: Yes.

Dr Weber: But you need to do the work.

Mr Mulliner: Can I just ask another question about the first flush?

Dr Weber: Mm-hm.

Mr Mulliner: Would that be more likely to occur in the active phase of mining, rather than closure?

Dr Weber: I'd say it's more likely to occur in the operational phase.

Mr Mulliner: So would the water be able to be contained in the mine water circuit?

Dr Weber: That is, that is an engineering control and, you know, it's proposed to contain all mine circuit water. And obviously you have runoff from these facilities that will be released due to the amount of water. We've proposed and we've been very careful to understand the potential effects from that runoff. Examples include not using pit water for dust suppression, so we don't increase the elevation of solutes. We've also realised that the solution's just not "go and build a water treatment plant". There's a lot of other levers that can be pulled that are management options. You could build some of the sediment ponds larger. Mr Torvelainen in his evidence talked about, I think it was in the water one day. I might have my water statements mixed up but he did talk about how that pond could be built larger to contain more water runoff. In that regard, that's a trigger. He talked about to go from maybe 70 to 90,000 cubes; and I apologise, those numbers are probably wrong, but it was only increasing the free board at that point by 1.5 metres, which he indicated wasn't a big thing. So there's lots of ways, Commissioner, to manage those risks before you put a water treatment plant in for that, for that runoff, you know, for the first flush.

Mr Muir: Right, thank you. That closes out that topic. I'm just going to confer with my fellow Commissioners about where we go from here. We're just trying to sort of consolidate some of the topics here. So we're going to really, we're going to focus now on topic five. But we see it as also capturing topic two, subbing the pit lakes into that, however tangentially. And then we will come back and consider topics one and six together. So the water balance load modelling and the associated pit lakes issue. What's the most efficient way of dealing with this? Should we start with you, Dr Weber?

Dr Weber: Yes, yes. Maybe if we break it down into components, and perhaps the first thing to do is talk about the model at a high level and just introduce it. So I'll get Mr Burgess just to explain the water balance, which is an important part of the model. We've had a number of conversations on that. And then I can talk to you and explain the process of how the solutes have been put into that model, in the resource terms, to understand overall effects. And as we talk through that, perhaps we can touch on each of the mine domains and we can understand the

tailings storage facility, the engineered landform and the pit void, if that makes sense.

Mr Muir: Well, what I will do is I will invite you to pull on any other member of the panel of experts assembled for the applicant to develop all the issues around these the topics, after you've introduced it, thank you.

Dr Weber: Apologies. I put a lolly in my mouth.

Mr Muir: Did you foolishly have one of those sticky lollies?

Dr Weber: Just the cheaper ones on the table.

Mr Muir: Yes, I've learnt that lesson earlier in these hearings.

WATER BALANCE MODEL:

Dr Weber: As my general introduction, the water balance model was put together by a team of professionals. That included geochemists and hydrogeologists and experienced water professionals, and we built a GoldSim model, which I'll get Mr Burgess to talk through. And to that we then did a literary review. We used our laboratory data to come up with those source terms that went into that model. And I'll talk a bit about, I'll talk about that after Mr Burgess introduces the water balance component of that, if that's alright.

Mr Muir: Yes, thank you, Mr Burgess.

Mr Burgess: So I'll just take one step back just quickly to differentiate how we modelled, or the approach to modelling between the closure and post-closure phase, and during operations. So the closure and post-closure phase modelling included a dynamic GoldSim-based model that ran at a daily timestep and accounted for all flows from mine domains as well as undisturbed or unaffected catchments and predicted what – it incorporated passive treatment and effectively predicted instream water quality at the proposed surface water compliance locations being SCO1 and RSO3. And that ran, and the simulation period was over 100 years. The operational model, as it were, was an Excel-based calculation tool that simulated – oh sorry, for water quality – simulated the discharge of mine impacted water during operations and the main – most of the, the poorest water quality, water strategy for water management is for the poorest water quality, so things like seepage, pit dewatering and those sort of high-strength sources to be retained onsite within the mine water circuit; and for lower-risk sources to be discharged offsite. And those principally include haul road runoff, as well as engineered landform of runoff through sediment control structures, although sediment control was not incorporated as part of the model.

These models considered only dissolved solutes only. That's water quality for the operations phase. Similarly, a annual water balance was calculated with Excel, or an Excel-based tool for the operational life of the mine to evaluate the water

balance conditions. So water surplus or deficit. And the need – the main strategy is to ideally be in a water deficit such as there is no need to discharge the retained water offsite. And that included flows from mine domains, including groundwaters and surface water, and evaluated two different cases, a low case and a high case. And the main conclusion was that under the – there's some uncertainty in the model results, but they sort of bracket the potential outcomes. And under the low case, the calculations suggested that the mine would be in a, or the mine water circuit would be in a deficit. Essentially, you can evaporate, inspire, evaporate sufficient amounts of water for the tailing storage facility onsite to maintain a water deficit which is consistent with the general semi-arid climate. However, with some more conservative assumptions, then there's the potential to, for the site to be in a surplus between year eight or year nine, depending on the assumptions. And that's more or less the water balance. And then I'll sort of touch quickly on the proposed, you will have had your site-wide transient water balance, the water and low balance model that's been talked about through our expert model conferencing that we'll expand – focus on the operational phase again but expand on the original work to develop another GoldSim model which will provide more detail and understanding of seasonal variability and operational site water management decisions and, ultimately, this product will become a tool for the applicant to update regularly with empirical data they collect over the life of the mine to inform their own water management planning. And I think I'll leave it there.

Dr Weber: That's where we want to talk about the low, the lower terms.

Mr Mulliner: Thank you, Mr Burgess.

Dr Weber: So to step through the load component of the water load balance model, I'll step you through the various mine domains. So the general understanding from international guidance such as the international network for acid prevention, which Commissioner Mulliner would be aware of, identifies in their latest work that 60 to 80 per cent of your load from any site comes from your waste rock dumps. And there's a real driver to change the way these traditional waste rock dumps are built to exclude the effective draw of oxygen into those dumps. And so I've stepped through that in our reports and discussed it in the expert conferencing. I've also clarified how that will be managed as a consent condition. The key objective that the applicant will take forward is to build engineered landforms.

And that's a deliberate name to acknowledge the fact that a lot of effort and cost is going into these structures to minimise the long-term cost. I probably shouldn't say cost; I should say minimise long-term liability, which is obviously the driver of cost. And that step change is needed in the industry, and this will reduce the liability in the long term, also risk from the things that we don't know could happen. So the engineered landform was modelled a number of ways. It was

firstly modelled and the models were based on analogue data scaled to other published information to understand what the maximum sulphate concentration would be on a column leach test data. The first model, which is the unconstrained waste rock dump model, would generate a sulphate concentration of sort of about 7,000 milligrams per litre sulphate, whereas the other models, we control that oxygen ingress to 20 metres or 10 metres into the shell of the dump significantly reduces that long-term oxidation in the core of the dump and, therefore, the long-term load and equal long-term liability risks. That's a pretty important thing to get right and, hence, there's an engineered landform management plan and there's a very clear explanation of how that's going to be managed, and also how we're going to monitor it to ensure that that lower oxygen environment is achieved in the core of the dump. From that we've derived water quality data that goes into the water load balance model, and it's a dynamic source term that changes with time as these dumps wet up and the load is mobilised. There's two components to the load: one is the stored oxidation products. So that's the solutes that will be flushed out. We derive that from our column leach test as to when that would happen. And then the second component is the long-term ongoing oxidation of these materials. So the materials on the outside skin of the dump carry on oxidising, carry on contributing long-term load to the underground and hence the water quality. So they've been modelled up.

I've talked through that, maybe with not so much vigour, but I have stepped through that with Professor Jenny Webster-Brown and Mr Piesse, Alexander Badenhop. And the joint witness statement at 33 considers the predictions to be reasonable. This is me reading directly from that. They note that their characterisation of the outlet discharge is based on a mix of Bendigo leaching date and analogous empirical data. They consider the water balance models needs to be updated where performance monitoring data for the seepage is available and indicates that seepage water quality is materially different to that predicted. That's my explanation for engineered landforms. Is there any comments on that or do you want me to carry on and do any other systems?

Mr Mulliner: No, thank you.

Dr Weber: So for the tailing storage facility, we obtained a source, the starting source term, and I'm going to simplify it down because I don't need to provide a lecture on it. I'm happy to talk about it later on. The initial starting water quality was from metallurgical testing of a sample that was run through the testing data by the company to understand how much gold they could get out. So we had a sample of water from that supernatant processing. It was, as I said, earlier today, it was elevated in boron, and it was elevated in a few other things like arsenic. And then we looked at the sulphate data, and the sulphate data was about, I think it was 500 milligrams per litre. And we wanted to compare it and understand what happens in a drier, arid environment where you recycle water. And Macraes has

published data, again from the works of Professor Dave Corr and Dr James Pope, and it shows that the water quality going into these structures can vary greatly. But the discharge from the bottom is about two milligrams per litre arsenic at about a thousand milligrams per litre sulphate prior to pressure oxidation. So, at Macraes, they introduced pressure oxidation. So, if you don't have it, you're just chasing the gold that can be captured by gravity. If you use pressure oxidation, acid high temperatures, you oxidise the sulphate minerals, which liberates the gold, which is called refractory gold within the particle, and you get access to that. Bendigo-Ophir isn't chasing refractory gold; they're chasing gravitational gold. So I've clicked the source terms and those trends from those that first of those curves for the storage facility to create a source term that goes into the model. So to take it from that lab data through to the empirical field data of what I would expect, I doubled the concentrations to get there because I think that's a fair way day to deal with the evaporate of recycling. And then that data is a constant term and that's probably one of the comments that was raised by Dr Lotumosa. You've got a constant iron or a constant arsenic concentration. We have, because that's how we've built that model, to understand what that water quality signature is going to be like. To be conservative, we run it at that same concentration throughout the life of the model period. So there is no decay, even after the cover system's put on, even after the process water is removed, the concentration is kept constant at that poor water quality. So that provides, I believe, a conservative assessment.

The summary statement on that by Mr Piesse, Alexandra Badenhop, Paul Weber and Jenny Webster-Brown is to consider the drive seepage water quality intent is robust and sufficiently conservative to enable assessment of operational long-term treatment requirements. But we all agree we also need ongoing performance monitoring and adaptive management updates on water load balance model that confirm those predictions are correct. So that gets introduced into the load model for that component. The other big aspect to what – I take that back. Sixty to 80 per cent of the load is from the waste rock dumps, and we're really focused on those now to bring that load down but doing them as engineered landforms.

Mr Muir: And encapsulating them effectively? That's just not the correct word.

Dr Weber: No, so - - -

Mr Muir: Reducing the opportunity for oxidation?

Dr Weber: Correct. So there's a whole lot of science and technology around that. We can do it in a – and there's a lot of other ways you can go about it, but a really good one is build it in short lifts.

Mr Muir: In short lifts?

Dr Weber: In short lifts. What I mean by that is you have a very large tip head and rocks tip off; all the big rocks roll to the bottom. And then you move out and you

do another lift and all the big rocks roll to the bottom. You're advancing that lift over a rubble layer, yes. Does that makes sense? There's your draw point through the rubble layer at the base, and if you reduce that lift height, you're not forming that segregation of materials. So therefore, instead of building a 40, 60 metre tip height, you're building much shorter ones.

Mr Muir: I see.

Dr Weber: So that's the logic but it costs more. You probably need another dozer full time; you need more surface prep, that sort of thing. But the end outcome is upfront cost but long-term reduction in liability risk. It's built better. So that's two of the delays, and the third one that Professor Jenny Webster-Brown has referred to is the pit lakes. So the pit lakes are being left as non-mine areas. They're going to have poor water quality in them. Treatment isn't planned for the pit itself because the pit is a – it's a zero, it won't spill, but it will drain down through the underground workings after the crown pillar is removed and then come out through the underground portal where it'll be adequately captured because it's all contained, except for the seepage, which I can't comment on, and then that will go to the active and the passive treatment system. One of the risks is that that water eventuates and you're reliant on passive treatment because you may not know that it is coming. But that water coming through comes through during the active treatment phase. So you have your mechanical treatment plant in place at the same time.

We've done a number of models on the pit lake. Some of them – the ones provided in was an initial model and then we were asked to provide scenarios and so we had – just recently we were able to reference other data that had built a pit lake model which we introduced into it, which increased the concentrations in that pit void and, as others have commented, it's increased the requirement for active treatment. It hasn't changed the management mechanism; all the process still remains the same, but it's pushed out that treatment period. Is that event going to happen? I think it's at the conservative end of what could happen at the pit lakes. And the reason – I did have reasons. I'll go to them, so I don't miss any out. The reasons for it is, one, when you're first filling up a pit lake, all that solute's coming out. It's coming out of the materials that are dissolved, and we used that in our model to assign that to the pit walls. So that's almost like – I'll say it like at the first flush, but it's like the first wetting up of the materials. So the concentrations are high. The second one is that that pit that was the analogue model has a whole lot of backfill in it, and that backfill will carry on generating load, and it'll also release a lot of load because of the high surface area into that pit. The third one was there's no geochemical modelling. So everything that came from this model out of the pit walls into the pit remain in solution. And things precipitate. The iron would precipitate; that would absorb other things. We don't model that because we wanted a full conservative model.

And then the fourth component of the conservatism on that model is we do not introduce a decay. So there's no decay in contaminants from those pit walls with time, and there's published information for the Brunner coal measures on the West Coast. It is an acid-forming site but there is a decrease in concentration with time. I would expect that we would see a decrease in concentration with time of those materials. So the model therefore has those levels of conservatism, which means we're maintaining a poor water quality for a very long time. The pit wall runoff doesn't consider the biogeochemical decay of nitrate because it's kept as a constant, constant source to going into the pit. We know from those studies that in a pit lake environment, that nitrogenous load decay is 20 to 30 per cent per year. That water component is fed into the model, which is then from all those mine domains, plus the other ones, there's also the surface runoff after rehabilitation which then gives us a combined water quality which is then considered for water treatment. And the way the water treatment's run is passive treatment is applied to it and at the point of passive treatment, well, the point of passive treatment achieves compliance, reverse, considering it, is the period that active treatment is required. Mr Mulliner?

Mr Mulliner: I've got a few questions. Going back to the pit lake - - -

Dr Weber: Yes.

Mr Mulliner: I know that's one of our items here and I don't know if you were a party to the ecological hearing last Friday, or if you've watched it or heard anything that came out of that, but there was a question – there was some discussion in the session there around the ecotox of the pit lakes and their potential effect on avifauna. Now the applicant's expert in that area suggested that hadn't been considered and that the water quality information was new to them, and there was some discussion about potential treatment of the pit lake. Do you have any comment about that?

Dr Weber: Firstly, it was a subject for the water conferencing. Correct me if I'm wrong, but we all agreed that wasn't our area of expertise, we're talking about avifauna. But what was agreed on and during the course of that conferencing, I went back to previous reports and pulled the published information. So it was available. It provided information on some of the larger bodies of water that might or might not be attractive for birds. And Ms McArthur noted that we may not have identified all of them, and I agree. I don't, I don't know where birds will want to go. But that water quality data was available.

Mr Mulliner: Okay. So there's potentially a connection there between yourself and the ecological expert in terms of avifauna and potential effects that needs to be made. Would that be correct?

Dr Weber: The information was available. Which experts?

Mr Mulliner: I presume the applicant's experts - - -

Dr Weber: Okay.

Mr Mulliner: - - - who are assessing the effects on avifauna. Would you agree with that?

Dr Weber: If the water quality needs to be considered by those experts.

Mr Mulliner: My take on that discussion was that they hadn't had that information to make that assessment.

Dr Weber: Okay. If that's what I'm understanding, I really can't comment whether that's right or not.

Mr Mulliner: In terms of the – so you've outlined the source terms and how they've been developed. Is there any questions from the other experts, the non-applicant experts in terms of those? My take on the JWS was there was general agreement with the development of those source terms? Is that correct?

Prof Webster-Brown: We did agree with the methods by which, which had been used in the modelling. I think our source of concern was with respect to the water load balance model. It was more about the use of average concentrations and the use of dissolved solutes. There had been no flexibility in the modelling to allow for other scenarios that might give us a feel for how bad this might get or how good this might get. We just were going entirely on the average concentrations. And there was a need also for the sensitivity analysis with the model finding out how sensitive the outputs were to variation and input data. So we're only seeing a very small part of the picture I think was where our concern lay with the water load balance model overall.

Mr Mulliner: Okay. So I guess there's two components here, isn't there? There's the water quality source terms to where's the flow component.

Prof Webster-Brown: Mm-hm.

Mr Mulliner: But, Dr Weber, in terms of the – you sort of outlined the use of the, what source terms and how they were derived. Do you think the use of average, if that's what they are, source terms is conservative enough in terms of the assessing the balance?

Dr Weber: From the TSF, I'd struggle to change it except to add in factors or even double it, for instance to get it comparable to a water type of similar sulphur content, of similar, you know, amounts of arsenic. We talked through that in the expert conferencing. That data set is based on, over that time period, and I'll make up a number, 20, 30, 40 data points, you know, over many years to me it seems reliable. And I note different projects, but they are very comparable, in my opinion. So I feel confident that if you wanted me to change it, I could but I'd struggle to make it more conservative.

Mr Mulliner: Okay. So you think increasing it would make it overly-conservative? That's what I'm hearing.

Dr Weber: Yes. And then what are we looking at there? We're looking at the longer-term effects and, you know, in the long-term, we haven't let it decrease with time. It's maintained that same concentration of an operating project with poor water quality. So I think it is conservative. We could do some higher end modelling on it and I – it sounds like, you know, everyone would have more confidence in the upper bounds and what's proposed is to build a, you know, transient water balance model to understand those flows. And then once we start getting empirical data from some of these things, we can then introduce that to understand exactly what that means about the models. But also, we can look at doing some of that scenario modelling.

Mr Mulliner: So the other part of that is, I guess, the not – another part of the load is the flow, so I guess going back to Mr Burgess in terms of that. And I know throughout your evidence, you state that you consider that it's a conservative assessment and it's potentially partly due to the conservative, or what's deemed the conservative water quality inputs. Would that be correct?

Dr Weber: Mm-hm, yeah.

Mr Mulliner: And I assume it's based on what you consider conservative flow estimates as well, would that be correct?

Mr Burgess: In short, yes. There are some elements of the inputs to those models that are more conservative than others, and others that I adjusted based on my professional experience thinking that some of them were overly-conservative. I can speak to some of those if you'd like at this point. And I note this was some of the – these were also raised through the joint witness statement and expert conferencing.

Mr Mulliner: Okay, yeah.

Mr Burgess: Bear with me while I get my notes up. So this has been sort of loosely termed as, in other communications by the experts, as water load water load balance model factors of safety. So I'm trying to speak to a variety of those topics. So the two main ones for my mind that have come up from a operation of water balance around how groundwater flows are accounted for. So Mr Rekker and his team, as we've already heard, completed groundwater modelling to estimate drawdown and groundwater inflows to the mine voids. And just taking the RAS pit as an example just to sort of illustrate the process, they estimated it at a maximum of five litres per second coming in from their modelling and recommended a factor of safety of two. And there's been some commentary from the other experts that that factor of safety was not carried forward into the water load balance, or the water balance modelling, in particular. And I'll just try and elaborate on the process to try and show that that level of, or incorporation of that,

although that effectively doesn't change the picture or the outcome. So I've noted five litres per second. Doubling that would make it 10 litres per second. Of course, the other component of pit dewatering is pit wall runoff from rainfall into the pit walls and reporting to the sump that needs management. And for our low case during the operations, we assumed a runoff coefficient of 50 per cent of annual rainfall, which takes your calculated dewatering rates to about 11 litres per second. For the high core, the high case, we did not change the groundwater flow rate, but we increased the runoff yield to 70 per cent, which takes us to 13 litres per second. If we were to increase that, if we were to double that groundwater inflow rate in a runoff coefficient of 50 percent, as per the low case, we get up to about 16 litres per second. So those are the kind of changes in magnitude we're talking about. Adopting a runoff coefficient of 50 per cent and doubling the groundwater inflow rate to 10 litres per second did not really change the overall picture of that high case. You still, we still found that in year nine the calculations suggest a water surplus and that's mainly around other satellite deposits coming online, and adding water into the mine circuits, so the Come in Time pit and the Shrek's pit. And noting that those are quite late, or relatively later in mine life and only for a relatively short duration of 12 to 14 months, compared to the RAS pit, which is effectively dewatered over the whole life of the mine.

Mr Mulliner: So what you're saying is if you were take those, I guess, recommendations or additional conservatisms into account, it wouldn't fundamentally change the water load balance models as you presented it?

Mr Burgess: That's correct, yeah. And I'll just a further note just for some context around other sites, similar to studies completed at other sites, and some of the assumptions made there, particularly around runoff coefficients. So work completed at the Macraes mine, that's publicly available. Although the runoff calculations are slightly more complex than we applied, the effect of runoff yield or annual runoff coefficient is around 14 per cent of mean annual rainfall.

Mr Muir: You include rainfall, but you need what, total precipitation including snowfall? You know you've got all these benches and these pits that will accumulate a lot of snow - - -

Mr Burgess: Yes.

Mr Muir: - - - from time to time.

Mr Burgess: Yes, implicitly. Snowfall is not, snowfall varies – the amount of snowfall can vary substantially from year to year, so some years it'll be a large proportion of the total precipitation, but other years it will, rainfall will be the predominant amount.

Mr Muir: But your calculations are assuming total precipitation, correct?

Mr Burgess: Yeah. So taking that, so if I was to assume a runoff yield of 20 per cent and double the groundwater inflow rate, so that's 10 litres per second, we end up calculating a dewatering rate of around 12 litres per second for the RAS pit. So you can kind of see that there's a reasonable amount of conservatism built into the assumptions around runoff, even if we haven't directly used that factor safety of two, compared to other comparable sites and models in the region, and that when we take these more conservative approach, a more conservative approach, they don't fundamentally change the outcome of the modelling.

The other groundwater related assumption that I think's worth touching on here is the underground workings. So again, Mr Rekker and his team estimated the amount of the dewatering requirements for the underground workings with an equation, an approach that's known as the Goodman equation which is a relatively simplified way of estimating tunnel inflow, inflow to underground workings. There's a wide appreciation within practitioners, and this comes through in available literature, including [inaudible] 2001 and Moon and Fernandez 2010, that because of the formulation of the assumptions under that that equation uses, that ends up being relatively conservative to what is actually measured from tunnel drainage. So, for example, the Goodman equation assumes a constant head of infinite source, it could be a lake above your tunnel. It does not account for any drawdown nor any changes in the stress rate, the rock stress regime that can change the permeability around a tunnel. And it also assumes that the network of underground workings are linear beneath this big lake or constant head. So it doesn't account for this tunnel geometry that spirals around with the interacting, interactions it might have.

And I also note that this 30 litres per second that was calculated with this equation is approximately double the average flow of Shepherds Creek. So a long story short, there's – the product of the calculation has suggested that there's more water being able to take out from this pipe schist bedrock than the average flow down the creek. So, from that, I conclude that it's a relatively conservative estimate and provides first order magnitude estimate only. And so, for that reason, I rationalised the assessment based on available literature that took into account, based on Moon and Fernandez 2010 drawdown and the change in the stress regime around a tunnel that reduces the, effectively provides a lower permeability skin around a tunnel and that takes that down by about 30 per cent or more to around nine litres per second. And to sort of tie this off, and then moving forward, we have this site-wide transient water load balance model that's proposed under the new condition 6D, sorry, 6A, schedule 2, to build upon some of the work we've done and refine the understanding around the site water balance and some of the water management logic that the operators will follow and support detailed design around water storage requirements onsite.

Mr Muir: Could I come back to the ODC, the experts called by ODC, Ms Badenhop.

Ms Badenhop: So in terms of – there's obviously been a lot of ground covered, so I'm just trying to pick which bits to actually respond to. Firstly, in terms of this operational water load balance, which was the spreadsheet model that we were just talking about, so that – I think one of the issues with that is that there are – there is a range of values but not what you'd call a worst-case scenario presented, so when that water surplus might occur. So because it's done on a yearly – that's a yearly timestep model and spreadsheet. It's using average rainfall and average precipitation to come to those conclusions and probably doesn't test the full range of conditions. And so there's that sort of question around quantity. When does that surplus occur and can we be prepared for it, which also just sort of a related point of where it ties into the condition we proposed, well that Dr Weber was proposing for when active treatment might commence and one of those could be that it would – I'm just trying to find the right part. So that was the condition 14 of the second joint witness statement. So it would occur when there was a development of surplus mine impacted water in the mine circuit water that could not be stored in a tailings storage facility. But it could also be prompted when there was poor water quality due to runoff from mine infrastructure areas outside of the mine water circuit. So this modelling, as Mr Burgess said, is done in two separate buckets. So there's that internal mine water circuit, which is we're questioning when that becomes a surplus and if that was an issue in terms of prompting active water treatment. And then there's the second bucket which is that sufficient runoff of impacted water, and there could be a point where if that water is found to be poorer, that either you have to be building active treatment in a hurry or you have to be incorporating that into the mine water circuit at the same time. And that's probably an additional risk that hasn't been overlaid. So that's for that component. I think that's probably my first. Does anyone want to talk to that part? Does that make sense?

In terms of the water quality source terms, yeah, we've discussed those, as Dr Weber said, in our joint witness statements that in general they were considered to be appropriate, based on the information that was available and that it's very important within that process to continue to collect that performance monitoring data so that we actually are not just working off what has been anticipated based on empirical models but that we are actually measuring what is coming out of the system. But within that, we need to recognise that some of those source terms might not peak for 27 years. I think you said the Shepherds ELF poorest water quality could come 27 years forward. So we've got a long timeframe that we need to be considering that those peak loads might occur in. So there's just a range of – we just need to understand this sort of – we guess we need this transient water load balance model to be updated, based on the current understanding, you know, of the water that's actually coming out of the system. But that is also not then the

peak load that we were anticipating. Does that make sense? Alright. I've silenced everyone.

Mr Muir: Cross-examination on this topic? My apologies.

Prof Webster-Brown: That's okay. I was just going to support the comments around it perhaps not being a conservative approach in every instance with the flow elements of that model. I had some concerns around that, and it has been addressed, many of them. But one of them that wasn't mentioned was the climate change scenarios. So in SSPA 24.5 was used which, as I understand it, is a moderate changing scenario which is not necessarily conservative.

Mr Mulliner: Do you have any comment on that Mr Burgess?

Mr Burgess: Yes, I think – so first, I'll come back to climate change, if I may, and just add some additional context around this site water balance surplus deficit question, and one thing I failed to identify was the, I guess, some of the contingencies available to us, right. So these models, this model for the operational phase and a sense of water balance provides us a range of potential outcomes and you can argue whether they're worst case or not. But I'd point out that worst case isn't always that helpful because you end up in a very low probability space, and what I mean by that is you have to – the likelihood of all these sort of bad, or poorer assumptions sort of materialising jointly reduces your, how probable that occurrence might be. And we have a number of engineering controls available to us, or the project does, should the water balance, should the site become transitioned into a long-term water balance, and when I – I stress long-term because what can happen at these sites, particularly around the TSF is that there can be these large rainfall events and the geotechnical engineers, they talk about how long it takes for the site to recover from large water surplus. So you can have a lot of rainfall, and then how long does it take till you get back into a deficit again, because you have – so we've stressed this now, right. So our annual rainfall at site is around 500 millimetres per year.

Mr Muir: I thought about four, 400.

Mr Burgess: So that's down at Lake Clearwater, which is on the flat area and sort of like quite sort of similar to Cromwell. Once you get - - -

Mr Muir: Elevation?

Mr Burgess: - - - elevation correct, yeah, you get up to around five, 500, give or take, millimetres per year. So it's slightly more rainfall. The potential evaporation is around double that. So you certainly have an evaporative capacity there from a climatic energy balance point of view, and some of the engineering controls that have been put forward to mitigate any potential water surpluses include – so the use of evaporation cannons. That will basically allow you to enhance evaporation on somewhere like the TSF, and they've been used in – and the minimum

considered, I can't guarantee that they've been used in New Zealand, but they're used in other - - -

Mr Muir: That basically converts solid body water into - - -

Mr Burgess: Vapour.

Mr Muir: - - - vapour.

Mr Burgess: Yeah, yeah, and so because you're just increasing the surface area of any sort of water droplet, that can increase that. There's also the opportunity to increase water storage capacity onsite, if that was needed, and the last - - -

Mr Muir: What, by adding freeboard?

Mr Burgess: Potentially, is one option, or alternative water storages. And the last fail-safe is this active water treatment plant to start being able to treat and discharge this water that's built up. So those are some of the key contingency measures we need to keep in mind as ways the project will be able to manage water surpluses going into operations. So that's that point I just wanted to make there before I move onto climate change. And I want to quickly switch here just to make this point clear that the operational period only being sort of 10 years, the climate change has been incorporated into this long-term post-closure model that simulates a hundred years, 100 years out, right, and if you're going to imagine climate change, it's going to be more of an influence over that time period than the decade or so of 10 to 15 years of the operational period. So we adopted the – what's sort of in layman's terms called the middle of the road climate scenario, this SSPA 4.5 that effectively represents minimal changes to carbon dioxide production in the atmosphere from anthropogenic sources. There is a more optimistic case where there's – curbs our emissions, right, and this is SSPA 2.5; and then there's a more pessimistic scenario was SSPA 7.5 that, I guess, continuation and even worse, I guess, CO2 production and discharge to the atmosphere. And for rainfall, the available information from the Ministry of Environment suggests for this middle of the road scenario that rainfall will increase by approximately seven per cent annually; for this pessimistic case, the 7.5 scenario, the rainfall might increase to approximately 11 per cent. And so what that means for the model is that there is - - -

Mr Muir: Adding 50 mil.

Mr Burgess: - - - effectively, yeah, and one thing to keep in mind is that for our infiltration into our mine waste storage facilities, the adopted net percolation rate, which is another sort of topic that we might get onto, is 20 per cent. And you effectively – if you were to back-calculate what that extra 50 mils means in terms of what your net percolation rate will be, how much water goes through, that ends of being 19 to 18, a net percolation rate of 19 to 18 per cent. So effectively the same as 20. The other thing to note that although that additional rainfall would

drive additional mine-impacted waterflows and therefore loads, concentration's being held the same, there is also equally, at least in the model, increase the amount of flow from the undisturbed areas that provide dilution. So on balance, you're increasing both by the same proportion; you would expect similar outcomes basically at the downstream point of SCO1.

Mr Muir: Thank you.

Mr Burgess: And so, for that reason, it is my opinion that including a more conservative climate change scenario would not materially alter the outcomes of the modelling provided in the substantive application.

Mr Mulliner: ust on that note, I just point out what JWS this is, in the original JWS for this topic, I note that Mr Torvelainen talks about that sediment ponds for operation will be designed for the RCP 8.5 scenario. So for the period 2031 to 2050. So does that contradict slightly what you're saying?

Mr Burgess: Yeah, I guess technically it's – technically it's different. So with these predictions, you have a baseline, a reference period from which you sort of project this percentage change forward, and the tools available to us project out at different time periods, different periods and time in the future. So there's this one that's around the 2030s and, long story short, the effects or the amount of CO_2 is increasing or that the implications usually increase the longer you look out. So the first one's the 2030s, which is effectively here, depending on your considerations. The next one I believe is around 2060 or something like that. And then the next one, which is what we did, which is depending – irrespective of what scenario you use, the longer you look out, or the longer projection out, the greater the impact. The one we used is around 2090 effectively. So it's the longest lead, or the longest, the furthest out projection for any given scenario. And I can't comment directly beyond what Mr Torvelainen has indicated in his, in that statement of evidence. However, I will note there is a general difference of consideration between what climate change scenario and time period you might adopt for a design criteria for a water management infrastructure versus what you actually adopt as a forward simulation model, which is what this water balance modelling is trying to achieve. And lastly, to tie this off, some of you may be aware that this specific scenario, RCP 8.5, have actually now – the recent guidance from the International Panel for Climate Change no longer believes that 8.5 scenario to be credible and view it as extremely conservative.

Mr Muir: It's only in the last few weeks I've read that, isn't it?

Mr Burgess: Yes, correct.

Mr Muir: Dr Avanidou, is there any matter that's emerged from this discussion that you thought you should be advising the panel on?

Dr Avanidou: I haven't reviewed the water balance model. My only comment is, for example, on those groundwater contributions to the water balance model, and I would only comment on the method of the Goodman equation to estimate tunnel inflows. So that's widely used. But literature has actually showed that in some cases that you may overestimate inflow, but you also underestimate inflows because the value of inflow, using Goodman's equation, yes, there are some conservatives, but it will largely depend on the value of the hydraulic conductivity that you're using. And if your value of hydraulic conductivity that you're using in that equation represents the unfractured hydraulic conductivity of a rock and not fractures, from that perspective, you may underestimate the flows. Now I suspect in that water balance modelling, the groundwater inflows may not be the driving of the balance in the water balance modelling feature. I don't know what percentage of that is. But it's something to consider in perhaps future modelling.

Mr Muir: Mr Burgess?

Mr Burgess: So as part of the – I'm not a geotechnical rock mechanics engineer but the situation that's been described is where, purely through the mining method, you can enhance the permeability or the hydraulic connectivity / conductivity [check 01:42:10] of the overlying rock mass due to changes in the stress regime.

Mr Muir: By lifting overburden and, you know, the results of blasting and all these sorts of things?

Mr Burgess: Yeah, effectively. And that has been a matter for discussion as part of the geotechnical experts. So I can't comment on - - -

Mr Muir: We'll be hearing from them tomorrow.

Mr Burgess: - - - yeah, the exact sort of – my understanding from speaking, discussions with them, is that situation is unlikely in their opinion.

Mr Muir: Right. Thank you. Could I could back to the panel.

Mr Mulliner: I've just got one further note on the water balance load model and it probably – well, I'm not saying that it will lead into that discussion now, but it leads into the wetland. A question came up in the ecology session last week when we were talking about wetlands, and the question was raised that what will the contaminants [inaudible (over-coughing) 01:43:47] model inform the success of the wetlands and their perpetuity in terms of supplying water. Is that a component of the balance model?

Mr Burgess: So at this stage, myself and my team have been commissioned to evaluate the water balance of those wetlands or those constructed wetlands at the top of the TSF, which will be completed separately, purposely separately at this stage in a separate GoldSim model effectively. And that will be submitted for the 22nd of – before the cutoff, the 22nd of June 2026, to inform your decision-making.

Mr Mulliner: Thank you.

Mr Burgess: Can I – I'll just expand on that and just talk about some of the hydrology behind that. So these, when we look at the hydrology of the Shepherds Creek catchment, and this comes through very clearly in the work Mr Rekker has provided, is that at SCO1, effectively the valley outlet, there's a few monitoring stations. There's SCO1 and then there's ones perhaps halfway up the valley, that are Jean Creek, JCO1, and SO2 which is further up Shepherds Creek. And long story short, there is effectively no difference in the combined flow of Jean Creek and Shepherds Creek halfway up Shepherds Creek and what's observed at SCO1. And so the implication is the majority of the flow that's generated within the whole catchment comes from upstream of the SCO2 monitoring point and we can tie that conceptually to the large number of seeps or seepages that have been mapped on the northern side of the Shepherds Creek valley providing a reasonable amount of flow through that part of the upper part of the catchment. And then effectively there's minimal change downstream of that. And then when we get to the TSF, the level of the TSF or the diversion drain that streaks around it is below the position of a lot of the, almost of all of those seepages. So all of those valley-side seepages will still be reporting to this diversion channel during operations and once the TSF is at its final elevation. And just to put some – just the size of this catchment area. So at the TSF abutment where there is planned to be a bund and weir arrangement, or a mount to try and develop this constructive wetland, it'll back up water behind it and hold water there. The catchment upstream at that point is around 600 hectares, give or take. The tailings facility itself is around 60 hectares; and the proposed constructive wetland is around six hectares, to try and put that sort of in proportional magnitude. So there's a relatively large upstream catchment available to be routed and provide water to this constructed wetland. And the modelling work that we'll complete in the next week, it is already underway, in fact, will look at the variability in pond level and when the, if there are any, if there's material risks of that pond sort of drying out in prolonged dry periods.

Mr Muir: Okay. We'll just try and quarantine that issue and deal with it, I think. Do you want to engage with it not or - - -

Mr MacGibbon: I think if I can. It sounds like you're doing work, so there's not much point in discussing it further. I think if you're doing it, and I'm going to ask you to take into consideration the design parameters that have been established by the ecologists for this wetland. And I just remind you that .5 hectares of that wetland is open water; two hectares of it is permanently wet and that means either water at the surface or above the surface 12 months of the year; and the remaining 40 hectares needs to stay wet for the whole year, so damp soils at least. So I think if you could do that modelling with that target in mind, that will give us a lot of information about whether this wetland is able to be built or not.

Mr Burgess: Yes, thank you. We have certainly been guided by the ecology and wetland experts with those parameters in mind.

Mr MacGibbon: Right, thank you.

Ms Sweetman: Just jumping on that as well, looking at the ecology effects management JWS, all those experts on that also agreed it was appropriate that there's hydrological information for all the other wetlands within the DDF as well. So is work underway on that?

Mr Burgess: So just to clarify, the other wetlands within the DDF?

Ms Sweetman: Yes. So not just the to-be constructed one but the existing ones as well.

Mr MacGibbon: Perhaps if I can just help a little bit there. There are three others at least that are going to be refurbished or – I think they call them the Ardgour Terrace Wetland, Lower Shepherds Wetland, and there's a process plant wetlands as well. But the first two mentioned, I think looking at the hydrology for those and making sure it's going to be sustained or improved, otherwise again, the question about whether those wetlands can be created or - - -

Mr Burgess: I can't comment on those. Those have not been defined within our scope to date, but they could potentially be included in this evaluation.

Ms Sweetman: You may want to go and talk to your ecologists.

Mr Burgess: Yeah. I think I will – I think it'd be worth pointing out here some of the measures that will be carried forward to provide certainty, right, this will. Whatever we do now will only be an initial assessment that will need to be validated by a mixture of performance monitoring. So principally, in my mind, that includes monitoring flow up where these wetlands are actually going to be constructed, particularly this upstream one because although we have some flow measurements halfway down the creek, I think, to provide certainty, it would best to have an ongoing flow monitoring data further up where we're actually going to be managing the water to produce these, to construct these wetlands. And the other recommendation I'd make is to, where practicable, start early trials early in mine life as possible to evaluate empirically with the field scale trials and then we can translate the designs into real world outcomes.

Ms Sweetman: And is what you've just said reflected in the conditions, or it will be reflected in the conditions on 22nd of June?

Mr Burgess: I'm not aware that it is in the current conditions. It's quite a sort of emerging topic in the last sort of week through some of these conferencings between water experts and ecologists. But I can certainly, I certainly plan to discuss the inclusion of those within conditions to provide certainty of outcome with the relevant parties.

Mr MacGibbon: Just one more thing there too. Does your modelling include, factor in evapotranspiration?

Mr Burgess: Yes, it certainly will.

Mr MacGibbon: Great. Thank you.

Mr Muir: So counsel, if we could just – we've sort of grafted on to item five, item six here. Let's just take a touchpoint now about any cross-examination, and then we'll come finally back to the ecological effects on the receiving environment, albeit that we have in part touched on that in the context of, for example, the existing wetlands. Right. Ms Gepp.

Ms Gepp: Yes, I have cross-examination, Sir.

Mr Muir: Thank you. Who's this directed to?

CROSS-EXAMINATION BY MS GEPP:

Ms Gepp: I'll start with, given we've been talking about ecotoxicity, I might ask a question of Dr Weber first of all, which is whether the – one of the questions that the ecologists were asking themselves is whether your appendix A, water quality in the wetlands on the tailing storage facility factored in potential interaction with underlying tailing storage facility material.

Dr Weber: Thank you for that. That relates to the joint witness statement provided for water on day two - - -

Ms Gepp: Yes.

Dr Weber: - - - which was the document I pulled together during that conference. So I had flagged how I had created those source terms with the other experts, and the conversation was all I had provided was the baseline water quality as an indication of what that could be. I think there might be a note in the table, but I may have missed it, but it would not consider or – how do I phrase that? It was an assumption that the risks for poor water quality coming from the tailings wasn't going to effect that water quality in the wetland. If there's an effect on that water quality in the wetland, that would need to be assessed through further studies.

Ms Gepp: Okay. So that's assumed at the moment?

Dr Weber: Absolutely.

Ms Gepp: Okay, thank you. And then, Mr Burgess, so the ecologists - - -

Dr Weber: Sorry, maybe just to clarify, that's the assumption. But if there's an engineered control put in place, like some sort of liner or something, then that would prevent the migration of poor water quality. Other than that, it would still be a reasonable assumption. But those studies would need to be done.

Ms Gepp: Okay. And it would have to maintain wetland – it would have to enable wetland hydrology to be maintained, any of those engineered measures.

Dr Weber: Outside my skill set but - - -

Ms Gepp: Right. Okay. Mr Burgess, the ecologists, or one of the ecologists said that based on Dr Weber's appendix A, so she had considered that appendix A, and she said the arsenic level of the RAS pit lake is projected to reach .1 milligrams per litre and in the TSF camp pond 8.6 milligrams per litre, and those values are above the livestock drinking water guidelines which they were using as proxy, which is .025 milligrams per litre for arsenic. So on that basis, it appears that there is an unresolved issue with respect to ecotoxicity that needs to be worked through between the – sorry, it's probably a question for you actually, Dr Weber, sorry, that there is an unresolved issue that needs to be worked through in some way because at the moment, this water is – the ecologists have said this is toxic for wildlife, having looked at your appendix A.

Dr Weber: Yes.

Mr Muir: Technically, it is toxic for domestic animals and chickens, is that right, but you're making some – we're making the assumption that it would be toxic for wildlife generally.

Ms Gepp: Well, that's what I understand the ecologists to be doing and that's why they've relied on that. It's not my assumption. It's what they have relied on. So that would be an issue that would need to be addressed through managing that water in some way, wouldn't it?

Dr Weber: It needs a management mechanism I think but just – I think you mentioned 8.6 milligrams for arsenic.

Ms Gepp: Mm.

Dr Weber: That seems a little high but then I can't check that on the fly. But irrespective, it sounds like it's higher than the limits that you're concerned with, so that's a moot point. And then that specific pond isn't a large pond, and if you're worried about birds getting in there, you could probably put a net over it. But that's just me speaking badly about how to manage those factors.

Mr Muir: Can we just back up? So what's been identified there is toxicity levels in livestock, presumably for the reason of introduction into the human food chain, is that right, Ms Gepp, just remind me. And we have got obviously an issue about perhaps edible waterfowl that might land on either of these major waterbodies that are occurring and whether they might be introduced to the human food chain. But I didn't understand that those were standards of toxicity to the wildlife itself, that they were going to die, for example, if those limits were exceeded.

Ms Gepp: Well, the starting sentence says, "RT considers the potential effect of ecotoxicity on indigenous wildlife, particularly avifauna, has not been addressed". So I think it is addressing birds more generally, not just ducks that might be eaten

by people, but the ecologists also recognise the limits, limitations of their expertise and that they are not ecotoxicologists - - -

Mr Muir: Yes, yes.

Ms Gepp: - - - capable of recommending particular limits.

Mr Muir: Yes, I definitely appreciate that; so it's something that we've got to come back to?

Ms Gepp: Yes. So I'm just trying to test with the water quality expert for the applicant how that can be progressed - - -

Mr Muir: Yes.

Ms Gepp: - - - given that has been identified by the ecologists as an issue. So I guess I just put that over to you, Dr Weber.

Dr Weber: Yes. Obviously that's poor water quality within the mine water circuit, that particular example of yours. And so, yeah, that's an issue and it needs further consideration and management.

Ms Gepp: Yeah. So is that the case with the RAS pit lake?

Dr Weber: Have the avifauna experts considered - - -

Ms Gepp: Yes.

Dr Weber: - - - that's a problem?

Ms Gepp: Yes.

Dr Weber: We've provided the water quality.

Ms Gepp: So it's just an effect on birds that we just have to live with?

Dr Weber: Sorry, I don't really, I don't really go beyond a lot of the effects, that's not my area of expertise.

Ms Gepp: No, no, I'm not asking you to. I'm asking you about how this – they've identified that it is an issue.

Dr Weber: Yes.

Ms Gepp: Do you see a way of addressing that, from a water management perspective?

Dr Weber: Okay, thank you for the clarification. So there's a number of options that you could look at. One of them as that purely evidences and what is the constituent of concern that is elevated. If it's arsenic, that could be treated with ferric chloride. If there's other constituents, maybe oxidation. At the end of the day, it's considered a non-use mining area, and the water quality was going to be managed through the treatment system, as opposed to the underground water systems.

Ms Gepp: So the RAS pit lake's going to be treated?

Dr Weber: I see that's a management option but how would I manage that? I would build better models to actually understand that from empirical information and noting that the RAS pit lake doesn't occur for, doesn't occur till the closure period. So we can get more information on what that actual water quality would be. That would provide them with a better understanding. Sorry, it would then provide the ecologists with a better understanding of the water quality and where it needs to be managed. Given the [inaudible 2:01:31] consider other options as to how it could be managed.

Ms Gepp: It's something that the panel needs to know now though to understand what the potential effects on avifauna and what potential controls might need to be put in place through conditions, isn't it?

Dr Weber: I think, and again this is something that you'd want to under – you'd definitely need more information on it. I would suggest that information will be available once the project starts. The examples I would – the information I would want is pit wall runoff of quality from the various materials to understand what that water running into the pit would be, and that will help inform the actual expected water quality for closure once that system – once that actual data, and that can be done well before closure. And as per the new consent condition, I can't remember which one it is, but it's a recommendation to do a detailed pit lake model. It includes nutrient cycling and so on. Once that model's done, I think you can then think about what are the risks, and how do you manage it.

Ms Gepp: You need to do an effects assessment though, don't you, and understand what the effect is as well. And, at the moment, we don't have the information to do that, other than to know that it's been identified as an issue.

Dr Weber: But if there's potential – so the ecologists are saying they're potential effects?

Ms Gepp: Yes. Yeah, okay. The water load balance model, one of the issues that had been identified by Ms McArthur is that in the substantive application, you had peak solute concentration predicted in about year 27 in the Mine Waste Management Limited Mine Impacted Water Overview report - - -

Dr Weber: Mm-hm.

Ms Gepp: - - - and active treatment in about year 50. And then in your response, RFI 2, you added recent data from Macraes which showed higher solute concentrations and pit wall runoff - - -

Dr Weber: Mm-hm.

Ms Gepp: - - - and this saw the maximum annual load correspond to year 85 from year 27.

Dr Weber: Mm-hm.

Ms Gepp: In this latest joint witness statement, you've said that the active treatment is required until year 50, and you haven't discussed that earlier year 85 in evidence.

Dr Weber: I think I noted that it was longer as well, or longer. The year 85 is basically a conservative model, and I've talked through those four reasons for that. A lot of that, it would be the extreme end of what that water quality would be. As mentioned earlier, it doesn't change the management process. It would just mean the management process would take longer or be required for longer.

Ms Gepp: So how do we know that – so this has just used recent updated data from Macraes. How do we know that that's – on what basis do you say that's conservative when it's simply taking information that's been learned from Macraes?

Dr Weber: Because we were involved in building that report but we couldn't use it because it wasn't publicly available and, as per my evidence maybe an hour ago, I explained four reasons why that is conservative.

Mr Muir: Without interrupting your flow I hope, Ms Gepp, we would like to take a small break if we could.

Ms Gepp: Certainly.

Mr Muir: Thank you. 10 minutes.

afternoon adjournment

Mr Muir: Ms Gepp, I cut you off. Ms Gepp.

Ms Gepp: Thank you. Dr Weber, just to finish off on this issue about the peak solute concentrations. So you've got a change from year 50 to year 85, or sorry, a change from year 27 to year 85 for the peak solute load with just one change in one variable. So does that mean that it's possible for the load, the magnitude of the load or the peak year to be different to what's predicted if other inputs are changed in the same way?

Dr Weber: The peak load's driven by the seepage from the engineered landforms. As indicated, that's the dominant source of load. The change in the flow from the pit lakes is less but obviously, in this instance, moves out significantly by 30 years or something like that, for that conservative model.

Ms Gepp: Fifty years?

Dr Weber: Fifty to 85, mm-hm.

Ms Gepp: Okay, thank you. And then the last question is on a different topic, and it possibly doesn't come under this topic, but it's just come on the issue of bioaccumulation. At 106(d), there's a disagreement between Kate McArthur and

Matthew Dale, and Michael Greer and Julie Palich. So if I could just ask you, Dr Palich, whether – so this is the issue about whether tissue monitoring is needed.

Ms Palich: Yes.

Ms Gepp: And so Ms McArthur and Mr Dale have recommended that tissue sampling occurs, but you have disagreed with this because it wouldn't be possible to attribute it to this entity. That's not the only consideration though in considering whether a certain monitoring regime should be adopted, is it?

Ms Palich: Sorry, I think your reference and mine are a little misaligned here. I'm just trying to find it.

Ms Gepp: So, it's in the first – it's in the eighth and ninth joint witness statement. First.

? So that's D, is it?

Ms Gepp: 106(d), 106(d)(1).

? So total mercury and selenium.

Ms Palich: It is. It's not that I'm fully opposed to tissue sampling within the Shepherds Creek or RAS Creek catchments. It's the point that there's a bit of a – by the time you get to the Lindis and Bendigo Creek, you can't have tracked, you know, where those fish come from and what other contributions are there. So when you're looking at taking it all the way out to that potential receiving environment, noting that surface water will have submerged and resurfaced by the time it hits the Lindis and any of those things, it doesn't – you could do it but you would never be able to categorically collate any impacts back to mining operations because there are many other surface water bodies and pathways that can feed into the Lindis and Bendigo Creek.

Ms Gepp: Is that the case for those particular contaminants, for mercury and selenium? Is that something that's going to be coming from elsewhere?

Ms Palich: I haven't had a broader look at the broader catchment area to see what the land uses are to be able to comment on that.

Ms Gepp: Thank you. Thank you, those are my questions.

Mr Muir: Mr Enright.

CROSS-EXAMINATION BY MR ENRIGHT:

Mr Enright: Yes, thank you, just a couple of questions on pit lakes. And, Dr Weber, the primary question relates to whether alternatives to pit lakes were considered or recommended by you, or members of the applicant team who are present today. And, you know, particularly in light of your quite helpful summary at the start, I think it's agreed it's the pit lakes will have poor water quality, seepage will not be

contained because there's no liner proposed, and there's no treatment *per se* for the pit lakes.

Dr Weber: Mm-hm.

Mr Enright: Those kind of material factors seem to suggest that alternatives to the pit lake should have been looked at or could have been looked at in the interests of water quality at least and putting to one side geotechnical engineering considerations. What's your view on that?

Dr Weber: Our scope was to model the water balance model with the pit lake as a non-use mining area, which we've done. The water quality indicates that it's poor but as far as it being closed out as a non-use mining area, the water quality isn't going to be suitable for recreating, and you would never have people recreating in a pit like that because of health and safety issues. So I wasn't involved in the auctioneering side of things, but the general understanding is that's one of the things that knocks it on the head.

Mr Enright: Yes. So two points from your answer: the first is that you were given a brief, essentially, which involved the use of pit lakes by the client rather than a *carte blanche* approach, is that fair, based on your own notes?

Dr Weber: Yes. We had a defined approach which was "here is the pit" - - -

Mr Enright: Yeah. And, sorry.

Dr Weber: - - - noting of course that that was the model because of the health and safety risks for the, and it being a non-use mining area.

Mr Enright: And at the level of first principles, if we were talking about underground mining here, the water quality issues associated with pit lakes simply wouldn't arise in the first place, is that fair?

Dr Weber: I don't understand that question.

Mr Muir: Well, it's self-evident really. If there wasn't a pit, there wouldn't be a pit water problem.

Dr Weber: That's right.

Mr Enright: So the Chair's helpfully answered my question. Yes, thank you, those are my questions.

Prof Webster-Brown: Could I make a comment just for clarity here?

Mr Muir: Yes, yes, just one moment. Can I just – did it emerge out of that question or is it - - -

Prof Webster-Brown: Yes.

Mr Muir: - - - more general? Very good.

Prof Webster-Brown: I've been trying to get pit lakes in front of people for a long time. This is a real risk for the site of having this vast volume of water. It's over three million tonnes I think by my calculation of very, very high arsenic water staying on the site forever in perpetuity. It is not just a problem for ducks that may land on the lake. It's a perception problem, for one thing, for the local community of having a vast body of toxic water now in that catchment that requires fencing forever, maintenance of that fencing forever. I am surprised that alternatives to creating a pit lake were not considered by the applicant. It has been considered for other sites. Golden Cross was mentioned earlier as a place where passive treatment had failed, but they also breached their pit, so that it didn't form a pit lake specifically to avoid the problems that we have with pit lakes keeping toxic water on the site for the foreseeable future. So I don't expect an answer to that. I just wanted to make sure that the panel was aware we're talking really high arsenic waters here.

Mr Muir: Is it inevitable that those arsenic levels would remain at that elevated state forever? Aren't there treatment options for the arsenic?

Prof Webster-Brown: Modelling suggests, and the most recent modelling suggested the arsenic would be even higher than the .1 that Sally mentioned. The modelling suggests it would remain high for a hundred years, which is as far out as the modelling went. Treatment can take care of it temporarily. You add iron, it binds to the iron and drops down - - -

Mr Muir: It drops down.

Prof Webster-Brown: - - - further into the lake. But lakes undergo what's called lake turnover. They mix at various times of the year where the deeper waters come back up to the surface. So it doesn't necessarily address the arsenic problems in the longer term.

Mr Muir: Commissioner Mulliner, do you have any views about that? Any questions that might assist us?

Mr Mulliner: The only question would be if, in terms of managing that risk is treatment a viable option, in situ in the pit lake, if required.

Prof Webster-Brown: Dr Weber.

Dr Weber: One of the things we did look at during this modelling process was using the pit void, the pit lake as part of the water management infrastructure. So some of the auctioneering we took on that is our water load balance model was to send water from Shepherds ELF, and I think TSF 3 too, to that pit lake. The benefit of that is that it would contribute to passive treatment in that pit void by the removal of nitrogenous compounds. From the studies we've done, we know we will decrease nitrate concentrations by 20 to 30 per cent per year. So there will

also be contributions to arsenic and iron removal in that facility. That is an option that may be explored, could be explored, may not be explored. Yeah.

Mr Muir: Right, okay. Let's just make sure that we haven't missed out any cross-examination. Mr Randal, did you have any?

CROSS-EXAMINATION BY MR RANDAL:

Mr Randal: Yes Sir, briefly, thank you. Some questions for Mr Burgess. Thanks, Mr Burgess, for talking to us about scenarios in which, you know, additional rainfall might be expected due to climate change effects. And I think you explained that in a high rainfall scenario, you know, sensitivity testing of the model as it stands isn't needed for a number of reasons you set out, including additional dilution provided by clean water sources effectively. I'd like to ask you about the net percolation rate assumed in the model. I think in the application documents, I think this is appendix K to the report BO6C, there's a statement that 30 to 50 per cent net percolation was expected, given the ground conditions, materials available at the site. But the model uses a 20 per cent rate for net percolation, doesn't it?

Mr Burgess: Yes, it does, and perhaps you'll allow me to elaborate on that. So in that document you're referring to, we completed a desktop assessment of the main factors that control net percolation and your primary factor is your climatic energy balance. Basically, do you have enough potential evaporation to remove water that lands, that infiltrates or lands on the surface of your facility and stays within that upper active zone effectively, the depth of the roots to allow the plants to evapotranspire it away. So that's your primary control. And then there's a few other factors including material properties. The finer grain your materials are, the higher the propensity they have to retain water, which means that when infiltrates goes into that soil, that stays there for longer and can be evapotranspired away if there is the energy balance to do so. Then there's another, I guess you might call it secondary factors, including the vegetation type, slope and aspect. And that's basically the position of the landforms relative to where the sun might shine. If they're facing to the north, they'll get more evaporation, potential evaporation than if they were facing the south. Those last three, like I say, are general secondary and our assessment concluded they were not materially different between the different landforms. So those first two ones are the key factors: the climatic energy balance and the material properties of the rehabilitated landforms. And, as you point out, based on global guidance documents that are very general in nature, they basically classify climate types. I'm going to butcher the name, the Köppen-Geiger, that's not even the right – forgive me – but basically between, they classify it globally, it's a global classification of the climate and based on that, they then look at, this is the INAP 2017 document. They then provide a conceptual cover or cover design guidance.

Mr Muir: Well, let's just try and make it a little bit tighter, if you wouldn't mind, Mr Burgess.

Mr Burgess: They classify the net percolation ranges that you can expect based on different rehabilitation types, and for the Bendigo-Ophir project, the proposed rehabilitation covered is what's called a storm release which is covered, so a system type which is where rainfalls can infiltrate into the cover system but then can – a portion of it percolates down into the mine waste and then a portion is evapotranspired way.

Mr Muir: Yes.

Mr Burgess: And the ranges, based on that guidance document, they were again, globally and partitioned the climate classification into a relatively coarse band. So, for example, at this, at Bendigo, they classified it as a temperate with a – essentially, a form of temperate climate, rather than a semi-arid climate. And then that gave you a range between 20 and 50 per cent, sorry, 30 and 50 per cent of the mean annual rainfall or precipitation, as you just pointed out. In that document, we also point out there's empirical publicly available evidence from Macraes which use, are in essentially the same climatic setting with essentially the same rehabilitation style. So this is 20, 20, 200 millimetres of soil, topsoil, underlain by approximately 300 millimetres of weathered rock, brown rock as it's sort of colloquially called, and based on empirically measured data that's publicly available, that estimate came out at around 20 per cent of the mean annual rainfall or precipitation. So we had a – long story short, we had global international literature that provided us a range. We then looked at what was publicly available for sites nearby and we selected that 20 per cent on the basis that it's informed by a very good analogue, as good as a good analogue as you can really expect for these types of situations; and the other thing to note is that as part of one of the current consent conditions is to establish trials. So these are rehabilitation trials to demonstrate that 20 per cent is achievable. There are other engineering measures or enhancements to this rehabilitation surface that can be employed if needed to reduce the net percolation down to an acceptable level. So one way to do that is to have, include a lower permeability layer that allows more of the water to stay in the active zone, to allow it to transpire away from the mine waste. So, long story short, there's field trials planned as part of the consent conditions and there are engineering solutions to achieve that criteria if that is the closure objectives or is there to meet closure objectives.

Mr Muir: Mr Randal.

Mr Randal: Thanks, Mr Burgess. So yeah, a starting range of 30 to 50 and then you've looked at those other sources, as you say, and analogue examples, landed on a rate of 20 per cent. Can you just explain to the panel, and sorry, you've also explained that tests are required to confirm that assumption, validate that

assumption, and that's proposed for later on in the process. In the meantime, could you just explain to the panel what, or how sensitive your model is to that input. So say that you go to the other end of the range of conservatism, assume a 50 per cent net percolation rate, what would that look onsite and what contingencies are there to deal with that if it were to occur?

Mr Burgess: So to try and cut this as short or make it sort of as concise as possible - - -

Mr Muir: Yes, I'm just conscious of the time and I don't want to be here beyond half past five, if at all possible.

Mr Burgess: - - - an increase in net percolation would lead to an increase in the volume of seepage. Assuming the concentration's the same, that would lead to an increase in load; and the way that would effectively be managed post-closure would be longer active treatment process. So it would push out the duration of active treatment.

Mr Randal: So from 85, wherever we're at, to - - -

Mr Muir: Well, the duration or the peak?

Mr Burgess: I defer to Dr Weber on the peak, but at a minimum, the duration.

Mr Randal: Thank you, Sir.

Mr Muir: Dr Weber, do you have any comment about peak?

Dr Weber: Yeah, just to clarify peak. The peak is pinned to the current observed trends for the waste rock stats, which is a function of height. So we wouldn't be seeing the change in peak; we'd be seeing - - -

Mr Muir: Peak would remain at 85 years?

Dr Weber: No, no, no.

Mr Muir: I'm not talking about peak load; I'm talking when – at what year will we be dealing with the maximum load?

Dr Weber: Peak concentrations - - -

Mr Muir: Peak concentrations.

Dr Weber: - - - still remains at 27 years.

Mr Muir: Twenty-seven?

Dr Weber: - - - which is the peak, which is where the loads have come through from engineered landforms. There would just be - - -

Mr Muir: Didn't I understand that that had now been changed to 85, not 27?

Dr Weber: No.

Mr Muir: What have I missed, I'm sorry.

Dr Weber: Eighty-five is the – 27 is the peak concentration - - -

Mr Muir: Concentration, yes.

Dr Weber: - - - that would be treated due to the higher load from the engineered landforms.

Mr Muir: Yes, 27 at peak concentration, yes.

Dr Weber: And 85 would be the longer treatment period, 85 years, due to that conservative scenario where we have a very - - -

Mr Muir: Eighty-five years in active management?

Dr Weber: Well, active treatment.

Mr Muir: Yes.

Dr Weber: We have a very poor pit lake, it's modelled conservatively. Sorry, just to clarify, the concentration is not the same, but there would be more of it because you've got more flow.

Mr Muir: More flow. So on that, it would be – the peak remains the same in year 27 but there could be in excess of 85 years of active management, is that right?

Dr Weber: Yes, because the load - - -

Mr Muir: Yes.

Dr Weber: - - - coming out of those facilities, there's more of it, more of it, so less other water coming in such as from the rest of the catchment, which will be diluted down. So, you know, better water quality from other mine facilities and so on.

Mr Muir: Mr Randal?

Mr Randal: Thank you, Sir. No more questions.

Mr Muir: No, no further questions. Mr Leckie?

Mr Leckie: No questions, Sir, no.

Mr Muir: Any further cross-examination from anyone? I don't know that we've got anyone online at the moment. Right. Now, I need your assistance at this point. My understanding is we've got to address ecological effects on the receiving environment to the extent that we haven't already. Why don't I mix this up a little bit and go to the experts called for ORC to identify what they see as the issues here. Yes.

ECOLOGICAL EFFECTS:

Dr Greer: So I've just five points that I'm going to absolutely blast through and then if there's questions, you can ask them, so I don't touch on things that don't need to be touched on. The first point is that there hasn't been a fulsome effects assessment provided with the application.

Mr Muir: There hasn't been a fulsome, sorry?

Dr Greer: Effects assessment - - -

Mr Muir: Yes.

Dr Greer: - - - provided with the application that considers the discharge, hydrological changes and stream works as a package. There is enough information there for individual experts to form their own opinions, but I don't consider the panel is yet to see anything from the applicant which puts forward their position on that. In terms of what those effects are, I consider that the proposed water quality limits should be protective from toxicity effects in all receiving environments including those, including the Lake Lindis and Bendigo Creek.

Mr Muir: When you say protective, you mean no worse than currently?

Dr Greer: No. There will be a degradation in water quality and potentially a small increase in toxicity risk, the magnitude of which depends on the specific receiving environment. There's already an arsenic toxicity risk in the Rise and Shine Creek so the potential - - -

Mr Muir: It's there already, yes.

Dr Greer: - - - is lower there. So therefore in terms of the discharge effects, the risk really comes from uncaptured seepage, the probability of which I can't comment on because that's outside the scope of my evidence. So the real risk comes from that nitrate and ammonia concentrations which we talked about earlier being needs and being managed for periphyton growth, and it appears that that condition, that issue is being actively resolved by the applicant's consultants, Sir, in the coming days and weeks. So I don't think we need to comment on that further, unless you've got additional questions on that. But if those limits can't be satisfactorily addressed, amended, there is potential for significant adverse ecological effects to arise, particularly in the Shepherds Creek where there's a compounding risk associated with the hydrogeological changes reducing the frequency of flushing, flushing flows. And I think one thing to be cognisant of is that both creeks will look fundamentally different from what they to do today under this. I mean, they will be constructed, less so Rise and Shine Creek, but they'll have vastly greater flows and different water qualities. So I think they'll, or there's a good chance that they will have better ecological metrics than what we measured today, but they will be different.

Mr Muir: Thank you. Dr Morgan and Professor Webster-Brown, could I invite your comment at this point please. Is there anything you wish to add?

Prof Webster-Brown: Neither of us are ecologists, Sir - - -

Mr Muir: Yes.

Prof Webster-Brown: - - - but we would note that there has been very little ecological effects assessment done on freshwater systems.

Mr Muir: Yes. Mr Dale.

Mr Dale: Yes, thank you, Mr Chair. Yes, firstly, I'll try and get through this quite quickly. So I concur with Dr Greer around the lack of assessment of surface water quality and ecology outstream of the mine envelope, so the downstream receiving waters such as the Lindis and the Clutha Mata-Au. It's my understanding the applicant is intending to address this, which will be welcomed. Some others have been addressed earlier on around adhering to the 95th percentile protection limits, so I won't take that any further. Also, I just wanted to note around the stream diversion reclamation and diversion into new constructed channels. The applicant's proposing to remove about, just over seven kilometres of creek and although this will be, you know, the new creek diversions will be rehabilitated, there is a period where that will, you know, there's a lag between when that rehabilitation – with the impact and when that rehabilitation will come into effect; and I feel it hasn't been addressed in the application, and - - -

Mr Muir: Addressed in what way?

Mr Dale: Addressed as far as the assessment and effects, of effects, and then included in the compensation, the offset and compensation package. So there is a period there where we are in between states essentially where we have an open channel with very little ecological values and that seven kilometres of stream that no longer exists. And following on from that, and I'm also very aware of my obligations under the Expert Witness Code of Conduct, so I'm going to be very careful here because this is an interdisciplinary issue where, you know, a natural stream has an inherent value, and moving away from that state has an impact or an effect. As an ecologist, I concur with Dr Greer that a lot of the ecological measures with improved base flows, for example, might actually be an improvement, or might increase. But I believe that there is a cultural value and a landscape natural character value that I haven't seen addressed. And it's not my position to comment on a weighting to that value, but I feel that those are pieces of information that the panel hasn't had the opportunity to get some insights from the appropriate experts in that field. And so, again, very aware of my obligations under the Expert Code of Conduct, so I won't take that any further, but perhaps that is something that can be followed up on with the appropriate experts at a later date.

Mr Muir: Yes, thank you. So we come back then to the applicant's experts. Dr Webber.

Dr Weber: Thank you. I wasn't ready to provide a concluding statement, but, Ian, would you like to add anything for quality?

Dr Boothroyd: If I may, your Honour comment on some of these matters.

Mr Muir: Yes.

Dr Boothroyd: Ian Boothroyd speaking. So understanding those five components that Dr Greer's addressed, I do agree that there hasn't been that fulsome assessment of effects on surface water quality, particularly in the downstream receiving environment. However, I do think that now that we have agreed on the compliance standards, that would give some protection to those downstream aquatic, to aquatic life. That's been sufficiently addressed to give that protection to that aquatic life. We've discussed the nitrate ammonia matter, and I think we've formulated a pathway through that; and that included some monitoring of the periphyton and algae downstream, and also in the Lindis River and the Bendigo Creek to give some comfort, I guess, to the community with regard to the effects in those environments, with a response mechanism in the condition to that as well. With regard to the ecologically different, I do agree that hydrologically it might be different, in the joint statement. My view is that the communities, the ecological functionality of those new realigned water courses will nevertheless be drawn from the communities of the organisms that are currently there and they're not going to be dramatically different. Other things can't really get there in that same, through any clear pathway, noting that there were no fish in those systems at the site itself because of that truncation of flow into groundwater that we discussed earlier. So whilst they might look different to the visual eye, functionality-wise, they'll be drawn from the same community of animals and plants that live there and will provide for that.

I do disagree with Mr Dale in that in the effects assessment that we have done for the realignment of the watercourse, sometimes called diversions, I tend to, I prefer them as a realignment. And there is a lag from the day that you liven those new channels; you switch one off and you turn one on, if you like, but we provided quite substantial compensation in the Bendigo Creek through some of the rehabilitation and removal of willows and improvements to that water course to uplift that ecologically in – well, aquatic ecologically at least as a means of balancing that lag time before that realigned water course finds the improvements that we excepted to deliver.

Mr Muir: Are there any questions from the panel?

QUESTIONS FROM THE PANEL:

Mr MacGibbon: So, Mr Boothroyd, just to get to understand what you're saying, that willow work will be done prior to the stream diversion, is that what you said?

Mr Boothroyd: Well, it maybe at least at the same time or start at the same time.

Mr MacGibbon: Okay.

Mr Boothroyd: Just from the staging of these processes.

Mr MacGibbon: Thank you.

Mr Kensington: Thank you, Dr Boothroyd, I've just got a question of clarification of something you said earlier which relates to what you're talking about now. Did you mention earlier that there was going to be two new monitoring points put in place, is thar right?

Mr Boothroyd: Yes, we talked about that at the conferencing. So one was in the Lindis River and one in the Bendigo Creek downstream.

Mr Kensington: Have those locations been confirmed and will we get that information coming through on the 22nd?

Mr Boothroyd: We've been informed that they have not been confirmed at this stage.

Mr Kensington: Right. Because do they have to go on private property or - - -

Mr Boothroyd: I don't know the answer to that question in terms of the land ownership.

Mr Kensington: We'll see what comes through on the 22nd.

Mr Boothroyd: Yes.

Dr Greer: So I think the sites have been confirmed for the purposes of water quality monitoring. It is the Lindis River at Ardgour Road, which is also an ORC monitoring site; and then I cannot quite remember – oh, Bendigo Creek at BCL water level recorder, I believe, is the other site, which is Bendigo Creek Limited.

Mr Mulliner: So they're existing monitoring sites, is that - - -

Dr Greer: They were, I believe added as one of the new conditions in this condition suite lodged with the section 53 comment responses by the applicant.

Mr Mulliner: Oh okay, but not in existing sites existing in the conditions?

Dr Greer: ORC site is existing and is, I'm just about to have a look at it, so it's intermittently monitored. They've retired it a couple of times, but it exists now but I don't think that the applicant is necessarily proposing to piggyback off that monitoring.

Mr Mulliner: But there's potentially some baseline monitoring data already?

Dr Greer: Yes, there is definitely periphyton, macroinvertebrates and water quality monitoring data at the Lindis River site, and Mr Rekker I believe has summarised the water quality data in one of those memos.

Mr Rekker: Yes. So in terms of solutes, ammoniacal nitrogen and nitrate nitrogen were the sole SOE determinants that the Otago Regional Council had to be monitoring over the four to five years of doing SOE at this site at Lindis and Ardgour Road. The Bendigo Creek position for downstream monitoring is the same site as Bendigo Station Limited, and Shine Irrigation have a flow monitoring site which is for their residual monitoring, flow monitoring of their take upstream of the creek itself.

Mr Mulliner: Okay. Just to confirm, these sites wouldn't be – we're not suggesting these are compliance monitoring sites, they're just purely for aquatic monitoring.

Mr Rekker: Correct, yeah, they're not compliant sites, no.

Dr Greer: There was a disagreement of that in the joint witness statement, I believe, Ms McArthur and potentially Professor Webster-Brown considering that should act as compliance sites or at least have triggers attached to them.

Mr Mulliner: Do you want to comment on that Professor Webster-Brown?

Prof Webster-Brown: I'm struggling to remember what I said. It's paragraph 63 in the second joint witness statement. It was myself, and Julie considered monitoring in the Lindis and Bendigo Creeks best sits outside the compliance monitoring programme as proposed condition D4 at new six. So I think we didn't actually make a statement around whether it would need to be compliance monitoring. Ah, we did, in the previous one.

Ms Palich: Yes, we said it could be used as a performance site but would not be appropriate as a compliance monitoring site.

Prof Webster-Brown: Thank you. Yeah, no, we didn't come down on the side of compliance monitoring.

Mr Mulliner: Okay, and you agree that it shouldn't be a monitoring site, is that correct?

Prof Webster-Brown: It should be monitoring but not compliance monitoring.

Mr Mulliner: Yes.

Dr Boothroyd: I agree with that as well. And also, just for your reference, in my evidence in response to your section 53 feedback, I do give a commentary on the ecology, if you like, in that receiving environment, briefly, which may help address that matter of assessing the effects in the receiving environment.

Mr Muir: Any cross-examination on this topic? No. Could I round back to Dr Avanidou. Any comment?

Dr Avanidou: No.

Mr Muir: No, right, thank you. Now, where does that leave us? Have we covered off one way or another all the topics that you identified.

Dr Weber: We probably haven't really discussed active management.

ACTIVE MANAGEMENT:

Mr Muir: Not really. We've skirted around the edges of it. Right, let's then identify it as our next topic. Would you like to lead off, Dr Weber, or someone from your team that you can identify.

Dr Weber: I'll lead off.

Mr Muir: Thank you.

Dr Weber: So as previously indicated in the joint witness statement, I noted at the start of the project that geochemical risks are low and will increase in time, which enables observance of trends. We talked about those trends and how we need to come up with some sort of guidance on that, so that we can identify the management procedures that are required, which gives us the time to learn. I'd just briefly touch on the fact that, from my experience, adaptive management in these projects is a common thread. It's acknowledged by the International Network of Acid Prevention, which covers off things such a neutral metalliferous drainage. It's also identified as a mechanism within the GISTM, the Global Industry Standard on Tailings Management. So it's a recognised tool. I think that we all understand that. In regards to how that management is enacted, that comes through the management plans. The ELF and the water management plans specifically that I've been involved with have been developed to manage key risks. So those risks have been tabulated in those documents, along with a number of potential controls. So, one example was around if there's a water surplus, which we do, and Mr Burgess talked about a variety of controls; and there's others. Ms McArthur in the first water JWS at 14 notes she'd like to see triggers within the management plan that relate to surface runoff and seepage. This was also an issue raised by EDS in their memo, 10th of June. I agree with that. It makes sense. And we've talked through other triggers for surface water runoff and the need to consider what those triggers would be. They should be included in the management plan. So that would be an update, I would expect. We have talked through those. Other triggers for lesser risks need to be identified as required prior to the operations commencing. Like anything, they should be reviewed annually to make sure they still remain current, and that will be part of the annual review process.

I note, over the course of this hearing, that there are key studies and processes that are needed for effective management are discussed, and we have proposed conditions around those. I believe they all contribute to a significant reduction in uncertainty in the early phase of the project when we put engineering controls in place to manage those risks. The key ones that have been talked to include condition D.04 new two. It relates to oxygen ingress. Sorry, I need to wear my reading glasses: new 21. There's a one after that, which relates to oxygen ingress. That's a key tool that is needed to ensure the engineered landforms are built to perform like they're expected to.

We've talked through the trigger for the water treatment plant, noting that triggers for that should include closure, water surplus, sediment and water quality. Two of those are already captured in D.02 new eight, but the other two need to be added to it. We also have updates to the transient water balance model which has been

proposed as D.04 new 6A. There is also, although it's not my area of expertise, there's also a new groundwater model proposed, which is new 6B.

There's the trials that are proposed to understand new percolation rates; and there's guidance around a number of these proposed studies as to when they should be done and generally they're going to be done early, so that it informs the adaptive management process and management options. There's also trials on the active water treatment plant. During conferencing, the experts agreed that there should also be trials undertaken on passive treatment, and a timeframe was talked to on that, which was within five years of them being needed. And there's also studies to be undertaken on the pit lake to develop a model for closure to understand that facility in more detail as we go through this process. And the lesser risks not consented will be managed by the management plans. That would be my summary on the high level on adaptive management, I think, going to this.

Mr Muir: So, Dr Greer, what holes are left in that?

Dr Greer: So I can only limit my scope of my evidence to theoretically what the adaptive management plan could contain. Ms Badenhop provided the advice for the ORC on the remainder of the matters.

Mr Muir: I see. Right. We'll go to Ms Badenhop first.

Ms Badenhop: Yeah. I think, yeah, we have had a lot of discussion around adaptive management and all the things that we need to see in the water management plan and the additional elements that would need to be included into conditions. The water management plan that was submitted with the substantive application wasn't considered to be fit for purpose. It lacked timeframes and there were a lot of elements that needed updating in terms of triggers and locations and a whole range of parameters. There are a lot of – as I said, we've discussed a lot of additional things. So it's really hard to review how that will be incorporated now until it's all put together in one package. But there was certainly a lot of work that needed to be done. I mean, we've definitely made progress on that. That's probably the best I can say about it without a clear document in front of me now that says that we CAN capture it all, because all the – even the new conditions that are in there are still not finished in terms of what the triggers will be.

Mr Muir: No. That's why we called for a sort of a compendious up to date approach, so we've got one document, one set of documents to work with. Is there something that that you wanted to address at a conceptual level, Dr Greer?

Dr Greer: No, the limit of my agreement was simply that a good adaptive management plan would include triggers.

Mr Muir: Yes, we understand that. Thank you. Did Professor Webster-Brown or Dr Morgan wish to comment on this?

Dr Morgan: Yes Sir, I would.

Mr Muir: Thank you, Dr Morgan.

Dr Morgan: I'd like to re-state some of the concerns that I made in my evidence.

Mr Muir: Yes.

Dr Morgan: So – and those are around a body, and a growing body of literature, groundwater-specific literature, that sets out conditions under which adaptive management is poorly suited relating to groundwater and the effects to groundwater. And there's two conditions that particularly matter here; and that's when you have long load times and when the impact can be irreversible. So, as you'll be aware, adaptive management depends on the feedback loop that you can close. So you need to be able to detect a change and then you need to be able to act on it before that harm becomes irreversible. That requires that the lag between the activity, or the source, and a detectable effect, it needs to be short, and it needs to be bounded. And here I would argue that it's neither. More data would help us characterise that, but it hasn't been shown to be either of those things. Contamination from onsite may take years to reach the monitoring bore and by the time that it's detected, the contamination is already established and effectively permanent if it gets into the aquifers. Also for this site, the source keeps producing with peak loads in the order of decades which is potentially well beyond the mine life. There's also no baseline water quality for the Ardgour aquifer which adaptive management requires, so that we can detect deviation from baselines. So given the high, often irreversible cost of groundwater contamination, groundwater scientists are increasingly urging the application of precautionary principles in the context of groundwater management. That means being proactive effectively and being cautious. And that's even if the scientific evidence is inconclusive. In practice, this approach points to applicants needing to demonstrate that contamination won't occur and this hasn't been done to date, given the uncertainties. So many uncertainties do remain about the effects on groundwater and the connected surface water, and they need to be resolved. And just finally, so what can be said I think is that the evidence does point to considerable potential for groundwater contamination that hasn't yet been shown that that can be avoided.

Mr Mulliner: I have a quick question on that. So, from memory, I think the applicant's outlined performance monitoring wells in the underlying schist and in the alluviums down – I haven't got the exact words here, but as close as possible to every ELF, correct me if I'm wrong, to, I guess, detect early on. Does that not appease some of your concerns in terms of that long-term probability?

Dr Morgan: I can see your argument there, and if they're correctly situated, that will certainly help. But I'm still concerned that we don't understand the flow pattern on the site well enough to be able to say that, until we have the groundwater

models and the groundwater flow model and transport model, which has been identified as being needed.

Mr Mulliner: So you say we need that modelling first and then the location of the performance monitoring wells, that's what you're saying, isn't it?

Mr Muir: Mr Dale, did you have a comment on this?

Mr Dale: Not a specific comment on the points that have just raised, no, but I do have a couple of other things I'd briefly like to speak to.

Mr Muir: Right.

Mr Dale: If now is an appropriate time?

Mr Muir: Yes, yes. We are sort of in wrap-up mode, so if there's any select points you haven't addressed please.

Mr Dale: So there's nothing new and groundbreaking but just reiterating the need for an independent advisory group to support any adaptive management frameworks and also advise on key – the adherence or otherwise to key consent conditions.

Mr Muir: Yes.

Mr Dale: And also stress that something stronger than purely advisory would be my recommendation there, you know, in the sense that that advice can't be ignored. And just following on from that, again touching on something that's been brought up previously, is the need for a non-wasting endowment fund to support the long-term and, you know, in fact, intergenerational management of effects that is going to need to happen post mine closure. Everything else though I think is adequately covered in the joint witness statement or has been covered by other experts today. Thank you.

Mr Muir: Thank you, Mr Dale. Is there anything else on the subject of adaptive management that any of the experts wish to raise? Yes. I'll come back to Dr Avanidou at the very end. No. Doctor?

Dr Avanidou: Not with the comments. These have been discussed excessively at the joint witness statement and with the experts today, so nothing more to add on that.

Mr Muir: Thank you. Thank you so much, Dr Avanidou. From the panel, any questions? Any cross-examination on the subject of adaptive management? Very good. Is there any other topic that we should be discussing, this being our last opportunity to do so today? No. Well, on that basis, we will record the hearing as closed. Could I thank all of the experts who have appeared before the panel today for your professionalism and considerable assistance as we've navigated all of these topics. I've wondered over the last week whether any other business is being done in the entire country, given the fact that seemingly every outstanding expert has been represented before us over these last few days and the next few.

But you have all greatly assisted us in what is an exceedingly complex and difficult piece of decision-making. Thank you again; and my thanks to counsel also for being so well behaved on the cross-examination front. See you all tomorrow at nine – not all of you – counsel, at 9.30.

Hearing adjourned