

## THE ALBERTA ENERGY REGULATOR

PROCEEDING ID NO. 430

IN THE MATTER OF the Responsible Energy Development Act, SA 2012, c R-17.3 and the Regulations and Rules made thereunder;

AND IN THE MATTER OF an Application to Amend Commercial Scheme Approval No. 11475 for the Kirby In Situ Oil Sands Project, KN08 and KN09 Development (Application No. 1936092)

---

AER PROCEEDING

VOLUME 1

---

Calgary, Alberta

February 6, 2024

1	TABLE OF CONTENTS		
2			
3	Description		Page
4			
5	February 6, 2023	Morning Session	4
6	Opening Remarks		5
7	Submissions by J. Jamieson		15
8	Submissions by M. Riley		20
9	Decision		22
10	Submissions by M. Riley		23
11	Submissions by J. Jamieson		28
12	Decision		30
13	Discussion		32
14	DEVIN OLLENBERGER, THOMAS BOONE, LENNON ROCHE,		36
15	MARC SCRIMSHAW, Affirmed		
16	GERARD IANNATONE, JASON LAVIGNE, SCOTT SVERDAHL,		
17	DALE WALTERS, XIANG WANG, PETER THOMSEN, SCOTT		
18	BARLAND, Sworn		
19	Direct Evidence of Canadian Natural Resources		37
20	Limited Witness Panel		
21			
22	February 6, 2023	Afternoon Session	79
23	DEVIN OLLENBERGER, THOMAS BOONE, LENNON ROCHE,		81
24	MARC SCRIMSHAW, Previously Affirmed		
25	GERARD IANNATONE, JASON LAVIGNE, SCOTT SVERDAHL,		
26	DALE WALTERS, XIANG WANG, PETER THOMSEN, SCOTT		

1	BARLAND, Previously Sworn	
2	M. Riley Cross-examines Canadian Natural	157
3	Resources Limited Witness Panel	
4	A. McLeod Cross-examines Canadian Natural	172
5	Resources Limited Witness Panel	
6	The Panel Questions the Canadian Natural	190
7	Resources Limited Witness Panel	
8	Certificate of Transcript	192
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		

1 Proceedings taken at Govier Hall, Calgary, Alberta

2

---

3 February 6, 2023 Morning Session

4

5 Cindy Chiasson Panel Chair

6 Brian Zaitlin Panel Member

7 Meg Barker Panel Member

8

9 William McClary AER Legal Counsel

10 Shannon Peddlesden AER Legal Counsel

11 Andrew Lung AER Staff

12 Denise Parsons AER Staff

13 Anastasia Stanislavski AER Staff

14 Fahad Hamdan AER Staff

15 Maryam Rahimabadi AER Staff

16 Susan Harbidge AER Staff

17 Maksim Khaferllari AER Staff

18 Felix Chiang AER Staff

19 Scott Botterill AER Staff

20 Baohong Yang AER Staff

21 Elwyn Galloway AER Staff

22

23 J.P. Jamieson For Canadian Natural

24 Resources Limited

25

26

1 M. Riley For ISH Energy Ltd.

2 A. McLeod For ISH Energy Ltd.

3

4 S. Murphy, CSR(A) Official Court Reporter

5 S. Burns, CSR(A), RPR, CRR Official Court Reporter

6

---

7 (PROCEEDINGS COMMENCED AT 9:17 AM)

8 Opening Remarks

9 COMMISSIONER CHIASSON: So a question before we start.  
10 Are we standardly leaving the door open to the foyer  
11 there? I suspect it would be a noise distraction.  
12 Thank you.

13 Good morning, and welcome to Govier Hall. Thank  
14 you for attending to participate in and observe the  
15 hearing in Proceeding 430. My name is Cindy Chiasson,  
16 and I am the hearing commissioner chairing this  
17 hearing. The other Panel Members are on my right, Meg  
18 Barker and on my left Dr. Brian Zaitlin.

19 COMMISSIONER ZAITLIN: We ask that the parties refer  
20 to us as "Commissioner Chiasson", "Commissioner  
21 Barker", and "Commissioner Zaitlin", and that you  
22 refrain from using the term "Madam Chair".

23 My colleagues and I respectfully acknowledge that  
24 we are holding this proceeding on the traditional  
25 territories of peoples of Treaty 7 region in southern  
26 Alberta, which includes the Siksika, Piikani, and

1 Tsuut'ina Nation and the Stoney Nakoda Nation, which  
2 includes the Chiniki, Bearspaw, and Wesley First  
3 Nation, Mohkinstsis, also known as the City of Calgary,  
4 is also home to Metis Nation of Alberta Region 3.

5 I want to introduce the AER staff who are  
6 assisting the panel in this proceeding. Please  
7 identify yourself when I read your names.

8 So we have Will McClary and Shannon Peddlesden of  
9 the law branch, when I read your names.

10 Andrew Lung, the hearing coordinator for this  
11 proceeding. The technical staff assisting the Panel  
12 are Susan Harbidge, Maksim Xhaferllari, Felix Chiang,  
13 Scott Botterill, Baohong Yang, and Elwyn Galloway.

14 Additional staff supporting the hearing may change  
15 throughout the week. This morning we have Denise  
16 Parsons and Fahad Hamdan from hearing services, and do  
17 we have Anastasia there as well?

18 And, Anastasia, I apologize because I remember  
19 your maiden name but not your married name. So I will  
20 correct that when I have a chance to look. The hearing  
21 panel and all the AER staff in the hearing room are  
22 wearing name tags whether they are assisting in the  
23 proceeding or observing participating. If you have  
24 questions about this proceeding, please approach the  
25 staff supporting the hearing for assistance.

26 Communications with the Hearing Panel must be on

1 the record; therefore, don't speak to Panel Members  
2 unless it is part of the hearing. We're not trying to  
3 be unfriendly, but, to be fair and transparent to the  
4 hearing parties, all communication with us must be on  
5 the record. We appreciate everyone's understanding and  
6 respect on this request.

7 In addition to AER staff, we have court reporters  
8 to transcribe the proceeding. We ask the hearing  
9 parties to be mindful of speaking slowly and not  
10 interrupting or talking over each other for the court  
11 reporter's benefit.

12 Video of the hearing is being live streamed  
13 through a link on the AER's website. We do not keep a  
14 record of videocast, and the video is not an official  
15 transcript. The court reporter will prepare the only  
16 official transcript of this hearing. To any viewers  
17 who are observing the video cast, we advise that  
18 recording or rebroadcasting of hearing audio or video  
19 is strictly prohibited, and the same applies to anyone  
20 here in the room.

21 As well, we would advise for anyone in the room  
22 that there is the possibility because you are video  
23 casting that may show up on the video, so if you have  
24 concerns please speak to hearing staff.

25 Mr. Lung, please tell us the safety procedures as  
26 well as the particulars of this proceeding and the

1 publication of the notice of hearing.

2 A. LUNG: Thank you, Commissioner  
3 Chiasson. In case there is a building alarm, listen  
4 for directions and ask -- to evacuate turn left as you  
5 evacuate Govier Hall and proceed down the stairs. The  
6 muster point is in the lobby of the Eau Claire Tower,  
7 which is across the street to the west of us.

8 In the event of a medical emergency, call 9-1-1  
9 and then alert an AER employee, who will notify  
10 building security. The first aid kits, defibrillator,  
11 and first aid extinguisher can be found by the sink in  
12 the foyer area that you came in.

13 The fire phone on this floor is located right  
14 outside of the elevator lobby. Ms. Harbidge, in the  
15 back row, is trained in first aid.

16 An AER employee will be present to assist anyone  
17 who requires support to evacuate should there be an  
18 emergency. For other emergencies, please alert any AER  
19 staff. Please note that Govier Hall is the only AER  
20 room on this floor, all other conference rooms are  
21 private, and if not booked for your use, please don't  
22 use it.

23 The subject of today's proceeding is  
24 Application 1936092. On March 11, 2022, the AER  
25 received Application 1936092 from Canadian Natural  
26 Resources Limited under Section 13(1) of the Oil Sands



1 Conservation Act and Directive 23, oil sands project  
2 applications to amend Commercial Scheme Approval  
3 Number 11475.

4 The amendment is for Pads KN08 and KN09 within --  
5 or with the addition of two SAGD drainage boxes. The  
6 statement of concern from ISH Energy Limited was  
7 received on April 8th, 2022.

8 The AER determined that the application should be  
9 set down for a hearing on May 1st, 2023. The notice of  
10 hearing and notice of scheduling of hearing are  
11 Exhibits 2.01 and 51.001 respectfully and were  
12 distributed directly to all parties.

13 The materials filed for the hearing have been  
14 marked as exhibits. The parties were sent a copy of  
15 the most recent exhibit list on February 1st, 2024.  
16 That's all, Chiasson Commissioner.

17 COMMISSIONER CHIASSON: Thank you, Mr. Lung.

18 We will now register the hearing participants.  
19 Please speak clearly and not too quickly into the  
20 microphone so the court reporters can hear you and for  
21 the video webcast. State your name for the record,  
22 spell your surname for the court reporter, and confirm  
23 the party you are representing.

24 And this piece here is applicable for the whole  
25 hearing. Technical limitations only allow five  
26 microphones to be live at any one time, and you'll see

1 we've got a multiplicity of them here. So please mute  
2 your microphone when you are finished speaking.

3 Who is representing the applicant, Canadian  
4 Natural Resources Limited?

5 J. JAMIESON: Good morning, Commissioner  
6 Chiasson. My name is JoAnn Jamieson. Jamieson is  
7 spelt J-A-M-I-E-S-O-N, and I am here representing  
8 Canadian Natural Resources Limited as the applicant in  
9 this application.

10 I do want to clarify, if I could, that seated here  
11 at the table with me are two corporate representatives.  
12 I can introduce those just for the record. So there's  
13 no co-counsel, but Maude Ramsay, spelled R-A-M-S-A-Y,  
14 is regulatory manager for Canadian Natural Resources  
15 Limited. And seated beside Ms. Ramsay is Mr. Gerard  
16 Iannattone -- Iannattone, and he is vice president of  
17 Athabasca Oil Sands for Canadian Natural. Iannattone  
18 is spelled I-A-N-N-A-T-T-O-N-E. Yes, correct. I  
19 believe those are all our comments. Thank you.

20 COMMISSIONER CHIASSON: Thank you, Ms. Jamieson. Who  
21 is representing ISH Energy Ltd.

22 M. RILEY: Good morning. My name is  
23 Marlé Riley, R-I-L-E-Y, and with me I have Andrew  
24 McLeod, McLeod, M-C-L-E-O-D, and we are counsel for ISH  
25 Energy. Thank you.

26 COMMISSIONER CHIASSON: Thank you.

1           So, Ms. Jamieson and Ms. Riley, I'm going to  
2 mention right now, if you're able to either adjust the  
3 mics to come a little closer to you or speak a little  
4 louder, 'cause I can say right now I was not hearing  
5 you as clearly as -- as I might have hoped. So thank  
6 you.

7           So I will now explain the procedures for this  
8 hearing. The Panel expects all hearing participants  
9 and observers to be respectful and civil throughout  
10 this proceeding. According to Section 21 of the  
11 Alberta Energy Regulator Rules of Practice, all  
12 witnesses must give evidence under oath or affirmation.  
13 The court reporters will provide for this when  
14 witnesses come forward to give evidence. All witnesses  
15 who are sworn or affirmed are not allowed to discuss  
16 evidence amongst themselves or with counsel or others  
17 during breaks until such time they are released by the  
18 Panel.

19           Please note that we will not be qualifying expert  
20 witnesses in this hearing. Having said that, it will  
21 be open to each party to argue what weight we should  
22 give a witness's evidence based on that witness's  
23 qualifications or other relevant factors.

24           During this hearing exhibits will be referred to  
25 and displayed on the screens in this room. To assist  
26 all participants, we ask counsel and witnesses to

1 identify each document they refer to by its exhibit  
2 number, then the relevant PDF page number within the  
3 document, and the paragraph or line number, if  
4 applicable.

5 Please pause after giving an exhibit number to  
6 give our staff time to find the relevant exhibit and  
7 then confirm that the exhibit that you requested is  
8 being displayed. It is not our staff's responsibility  
9 to guess about the exhibit if your reference is  
10 incorrect.

11 We will be following the order of presentation set  
12 out in the AER Rules of Practice. First, I will ask  
13 Canadian Natural to come forward and present its direct  
14 evidence. Canadian Natural has been allocated through  
15 mid-afternoon today to present its direct evidence;  
16 following which, ISH will begin cross-examination of  
17 Canadian Natural's witnesses. We plan to wrap up Day 1  
18 of the hearing at 4:35 PM.

19 On Wednesday, ISH will complete its  
20 cross-examination followed by any questions for  
21 Canadian Natural's witnesses by AER staff and the  
22 Panel. After this, Canadian Natural may redirect.  
23 This is scheduled to take us to mid-afternoon on  
24 Wednesday. After a break, ISH will begin its direct  
25 evidence, and we plan to wrap up Day 2 of the hearing  
26 around 5:05 PM. On Thursday, ISH will complete its

1 direct evidence followed by the start of Canadian  
2 Natural's cross-examination. We plan to conclude Day 3  
3 of the hearing at 4:50 PM.

4 On Friday morning, Canadian Natural will complete  
5 its cross-examination of ISH's witnesses and AER staff  
6 and the Panel may also question ISH. Following that,  
7 ISH may redirect and Canadian Natural may present  
8 rebuttal evidence. There will then be ISH's  
9 cross-examination of Canadian Natural on rebuttal if  
10 needed and questions by AER staff and the Panel for  
11 Canadian Natural on rebuttal, if needed.

12 After a break we will hear closing argument first  
13 from Canadian Natural and then from ISH. Our plan is  
14 to conclude the hearing around 5 PM on Friday.

15 After the hearing has concluded, we expect to  
16 issue the hearing decision within 90 days.

17 Please note that the Panel Members may be taking  
18 notes throughout the hearing. Even though we may not  
19 be making direct eye contact with you at all times,  
20 please understand that we are listening to what you are  
21 saying.

22 We request that the parties remain in the hearing  
23 room throughout the proceedings to maintain procedural  
24 fairness and in consideration of those giving their  
25 presentations. Should any of the parties require a  
26 break during the proceedings, please let me or hearing

1 services staff know. We have breaks planned for each  
2 morning and afternoon as well as a hour lunch break  
3 every day.

4 We ask that everyone present in the room ensure  
5 that your electronic devices, including telephones and  
6 computers, are set to "silent" mode through the  
7 hearing. If you must take or make a call and cannot do  
8 so at a break, please step out of Govier Hall to do so,  
9 and by "out of Govier Hall", I mean out into the  
10 hallway outside of the foyer because the sound carries.

11 As I mentioned before, recording or transmission  
12 of this hearing, other than the official transcript and  
13 AER videocast, are not permitted.

14 In our review of the exhibits filed in this  
15 proceeding, the Panel notes that there appears to have  
16 been a narrowing and focusing of the parties' position  
17 on some hearing issues. The parties can assist us by  
18 identifying matters that are not in dispute between  
19 them. In those circumstances, we strongly encourage  
20 the parties to focus their direct evidence,  
21 cross-examination, and argument on those matters that  
22 are still in contention.

23 So I understand that we have two preliminary  
24 matters to deal with. The Panel we have before us --  
25 there's the question of materials that CNRL sought to  
26 file yesterday morning, and the Panel plans to deal

1 with that first, and then we have a motion that was to  
2 adjourn that was filed by ISH this morning and  
3 depending on the -- and the Panel will look to address  
4 that after it has dealt with the first piece on the  
5 material sought to be filed by CNRL.

6 So, Ms. Jamieson, if you would like to proceed and  
7 tell the Panel a bit about this material that CNRL has  
8 sought to -- to file.

9 J. JAMIESON: Is this better audio if I move  
10 it forward?

11 COMMISSIONER CHIASSON: Yes. Thank you.

12 Submissions by J. Jamieson

13 J. JAMIESON: Yes. Thank you, Commissioner  
14 Chiasson.

15 So I'll just provide a little bit of context. The  
16 material that's in question right now is Canadian  
17 Natural's direct evidence presentation, and what we did  
18 was we put together an opening statement, and there's  
19 extensive technical evidence that's been filed in this  
20 proceeding, so the idea was to put forward a PowerPoint  
21 presentation that Canadian Natural witnesses could, you  
22 know, move through and provide both their opening  
23 comments as well a review of the technical evidence,  
24 and that was the idea.

25 We -- of course, the Panel would be aware that  
26 Canadian Natural's KN06 application went through a

1 similar full hearing process -- that one was online  
2 during COVID -- but we filed a very similar direct  
3 evidence PowerPoint presentation. There was no issue  
4 there. We filed it, gave it. There was no issue, and  
5 so we were attempting to do a very similar thing here.

6 With respect to timing, there was a couple of  
7 things. We did reach out to Mr. Lung to request a --  
8 just a sense of timing when the direct evidence  
9 presentation would need to be filed. We were advised  
10 at least 24 hours prior to, and that's what we  
11 attempted to do. So it was, of course, the weekend.  
12 We filed first thing Monday morning.

13 The -- in terms of the content of the material, we  
14 heard from Ms. Peddlesden late yesterday, just some  
15 concerns about the content of the direct evidence  
16 presentation, and she pointed out a couple, sort of,  
17 rules that we needed to be aware of. One was in terms  
18 of when we were presenting material in the slide deck  
19 to make sure that we had sourced the exhibit number,  
20 and we had done that by far for the majority of the  
21 information; however, there were a couple of places  
22 where we had combined sort of maps and figures on one  
23 slide, and so we had to go back and review and make  
24 sure we had identified, you know, both exhibits where  
25 that information -- there's no new evidence being  
26 filed, no new data, no new interpretations. It was



1 just trying to present this very complicated technical  
2 evidence in a way that could be consumed in a  
3 three-hour block, you know, by the Panel.

4         And the other thing that we had done -- again, we  
5 hadn't -- we had reached out, again, to Mr. Lung, but  
6 we hadn't yet received confirmation about whether or  
7 not there would be a laser pointer. If we had -- you  
8 know, because we didn't know whether there would be a  
9 laser pointer, we had included some, you know, colour  
10 and shading. Also there's some, you know, arrows on  
11 some of the slides and also, you know, just visual cues  
12 to sort of help the reader follow the talking points of  
13 the witnesses. So that's what we had done. We thought  
14 we were onside the rules by doing that, but given  
15 Ms. Peddlesden's correspondence, we did quickly -- the  
16 team has spent the last six to eight hours going back  
17 through making sure that there are exhibit numbers for  
18 each of the figures and maps, anything that we sort of  
19 combined on one slide to make sure that it could be  
20 tracked and -- back to the record.

21         We did remove anything that was sort of unique or  
22 outside, like, that we had -- like, visual markers that  
23 we had superimposed, with a few exceptions. There was  
24 some, you know, very light shading on a couple of  
25 images. We made that darker, that kind of thing. We  
26 also bolded.

1           So we have confirmation now that there is a mouse  
2 available that the witnesses can point to things on the  
3 slide. So we removed as much of that as we thought  
4 was, you know, practical. We have filed a revised  
5 presentation this morning. We're prepared to proceed,  
6 if that's acceptable to the Panel. We're also  
7 prepared -- the witnesses tell me that they're -- if  
8 they can't have their visual, their direct evidence,  
9 that they'll proceed by just, you know, reviewing and  
10 going through their talking points which they prepared,  
11 so if it really is a -- is a problem.

12           The question of new evidence -- I'll just speak to  
13 that, because we are aware of the rule in the -- AER's  
14 Rules of Practice about not filing new documentary  
15 evidence. There was no attempt to do that. It really  
16 was just to try to communicate very complicated  
17 technical evidence that's already been filed. We have  
18 reviewed it. We don't believe there's anything new  
19 there that can't be sourced from the record. And so  
20 the material is with the hearing coordinator, I  
21 believe, at this point. But that's really our request,  
22 if we could please proceed with this revised  
23 presentation.

24           COMMISSIONER CHIASSON:    So my understanding is that  
25 this is not a simple few-pages opening statement, that  
26 we have a slide deck that CNRL's present -- planning --

1 suggesting to present about 154 slides.

2 J. JAMIESON: Yes.

3 COMMISSIONER CHIASSON: Which is a fairly substantial  
4 matter, and if there's no new evidence, can you explain  
5 to the Panel why this could not have been provided on  
6 January -- January 23rd when CNRL -- CNRL's deadline  
7 was for filing -- filing its reply submission?

8 J. JAMIESON: Well, I think that just simply  
9 can be explained by time constraints. I mean, we were  
10 very focused on getting the reply submission in, which  
11 in itself was an extensive document. That was two  
12 weeks ago, and so then the -- the -- our witness panel  
13 went right into preparing their direct evidence.

14 I -- you know, my counsel to them -- because, in  
15 my experience, coming into a hearing with your direct  
16 evidence or your opening statement is standard, and  
17 like I say, for the KN06 proceeding, we did that in the  
18 form of the PowerPoint and because there's so much  
19 technical evidence, but it has literally taken two  
20 weeks to prepare that PowerPoint as well as the  
21 speaking points because, of course, it's a review of  
22 literally hundreds of pages of technical evidence.

23 COMMISSIONER CHIASSON: And that's not something that  
24 could have been a heads-up given to both ISH and the  
25 Panel.

26 J. JAMIESON: Yeah. I appreciate your

1 point, and, believe me, in hindsight that's exactly  
2 what we were -- what we would have done. We did not  
3 believe we were presenting anything new or novel. It's  
4 just a summary of Canadian Natural's technical  
5 evidence. The actual opening comments, I think, are  
6 less than ten slides, and then it goes into the five  
7 hearing issues as well as Dr. Boone's independent  
8 assessment, and, you know, that's -- I have no other  
9 explanation. That's the time it took to put that  
10 together.

11 COMMISSIONER CHIASSON: Okay. Thank you,  
12 Ms. Jamieson.

13 We would like to hear from Ms. Riley now. And,  
14 Ms. Riley, what we would like to hear from is not in  
15 relation to your motion. At this point we would like  
16 to hear in relation to what CNRL is seeking to put on  
17 the record.

18 Submissions by M. Riley

19 M. RILEY: Certainly. Thank you.

20 The problem that we have, in the first place, is I  
21 understand that this morning at 20 to 8, this new  
22 updated slide deck was -- was sent by email. I was not  
23 favoured with that email. I learned about that when I  
24 met with my -- with my client. Apparently it was sent  
25 to co-counsel, but I did not receive it, and I was not  
26 with him this morning.

1           So as we stand here, I have not even seen this new  
2 slide deck. The purpose of the 24 hours is to allow us  
3 to verify what is on that slide deck to go to the  
4 record, to compare what is there, to see if we have any  
5 concerns, anything that we need to tell the -- the  
6 Panel. We do not have that opportunity.

7           What is proposed now is that the slide deck be  
8 filed, and while we're listening to the evidence, we  
9 have to go to the record, see what is there, see if  
10 there is anything we want to cross-examine on, and that  
11 is wholly unfair and not within the rules.

12           There's been quite a bit of mention about what  
13 happened in the KN06 hearing. In KN06 it was a virtual  
14 hearing. The directors made provision for the filing  
15 of an opening statement. This directive in this  
16 hearing does not provide for that.

17           Ms. Jamieson also mentioned that it took two weeks  
18 to prepare. If they -- CNRL had two weeks to prepare  
19 the slide deck, surely ISH should be allowed a little  
20 bit more than an hour to have a look as well. We  
21 object to the filing of this document, and we submit  
22 that it should not be allowed at this late -- this  
23 time.

24 COMMISSIONER CHIASSON: Thank you, Ms. Riley.

25           Thank you. We're going to take a short break, and  
26 the Panel is going to step out to discuss.

1 (ADJOURNMENT)

2 Decision

3 COMMISSIONER CHIASSON: Thank you all for your  
4 patience. Actually, before we get going, just a  
5 reminder from the panelists again -- and I would point  
6 out to counsel you can pick up the mic and move it  
7 around. So adjust it on the dais. We need you to have  
8 it close to you so that it's -- so that it's coming  
9 through. So we'll do that.

10 Thank you, everyone, for your patience. The Panel  
11 has discussed, and we have determined -- we heard  
12 reference to two documents, one that CNRL filed  
13 yesterday and a revised one that they produced this  
14 morning. Neither of -- we have decided that neither of  
15 those documents will be allowed, and we've taken into  
16 consideration in making that determination the fairness  
17 to ISH in relation to how it would affect them in terms  
18 of managing -- managing in this proceeding and the lack  
19 of preparation time. CNRL has indicated to us that  
20 they are prepared to proceed without the document.

21 And the Panel would like to note that we  
22 appreciate that there was reference made by both  
23 parties to the 397 proceeding and that such matter was  
24 allowed in the 397 proceeding. We would point out,  
25 one, the 397 proceeding was a fully electronic  
26 hearing -- the first electronic hearing that the AER

1 had held because of COVID -- this is not -- and also  
2 that the 397 proceeding is not binding on this Panel or  
3 on this proceeding, and, in that vein, we would remind  
4 the parties that nothing that was on the record in 397  
5 is automatically part of this proceedings, materials,  
6 or record. So if either party is looking to  
7 incorporate and make reference to -- or want us to  
8 consider any materials that were live in 397, those are  
9 not on our -- those -- unless they've been filed by  
10 parties, they're not on our record, and you can govern  
11 yourselves accordingly in relation to that.

12 So, in that vein, we will mention that we are open  
13 to allowing CNRL to adjust before seating their witness  
14 panel. What we want to do is move on to -- we also  
15 have before us a motion from ISH this morning to  
16 adjourn. So what we want to do is move on to that.

17 So, Ms. Riley.

18 Submissions by M. Riley

19 M. RILEY: Thank you.

20 The motion by ISH engages the AER jurisdiction to  
21 make orders in respect of its own procedure to instruct  
22 parties to file further material and to adjourn matters  
23 on any terms that the Panel may deem fit. I want to be  
24 clear that before we received this presentation from  
25 CNRL that has now not been allowed to be filed we had  
26 no intention of seeking an adjournment. ISH had

1 prepared its submissions based on the record.

2 A great deal of the concerns that ISH has, and as  
3 a part of the basis of the application for adjournment,  
4 was the prejudice that stemmed from this presentation,  
5 which arguably now may be cured because the  
6 presentation is not allowed on the record; however,  
7 that does not resolve the problem.

8 What we saw in that presentation is that there is  
9 further information available specifically on the  
10 modelling that is not before the AER. It also appeared  
11 to ISH from that presentation that CNRL has changed its  
12 interpretation that is extremely relevant to the Panel  
13 and to the hearing issues.

14 The AER cannot be expected to make a decision in  
15 the vacuum of all relevant information. Specifically,  
16 ISH's problem is this: When we approach the  
17 geomechanical evidence, it was on the basis that there  
18 is nothing before the AER regarding deformation. Then  
19 we received the response to the AER's information  
20 request and the modelling again, and we had another  
21 look. Nothing in the information requests filed or  
22 responses filed dealt with the deformation issue. It  
23 is a standard model you used for caprock integrity, but  
24 it did not answer the actual issue before this Panel,  
25 and that relates to the underlying strata and what  
26 would happen to those strata while SAGD operations are



1 underway.

2 In Slide 116, we saw new information regarding the  
3 modelling, relevant information, and information that  
4 would -- would change ISH's experts' views and would  
5 also result in further questions being asked by ISH's  
6 experts. To this end, that is why ISH does not just  
7 want an adjournment. ISH is also applying for further  
8 procedural direction. ISH is requesting that the  
9 technical experts meet so that we can determine exactly  
10 where the -- this alignment between ISH and CNRL is so  
11 that we can have a focused hearing on just the issues  
12 that are still in dispute.

13 It's clear from the presentation that there is  
14 more to be seen yet and more to be said. And in the  
15 public interest, all of the relevant information should  
16 be before the Panel before the Panel makes a decision.

17 Another issue that appeared from this presentation  
18 that was not allowed is the issue of CNRL's  
19 ever-changing ask. For instance -- and you see that  
20 from our model -- or from our motion -- CNRL indicated  
21 that they seek a maximum operating pressure of five  
22 thousand five -- no -- sorry -- not MOP, a standard  
23 operating pressure of 5,500.

24 But if you look at ninety -- Slide 96, their work  
25 is still being done at 6 ,000 kPa. So it's not clear  
26 to ISH what exactly CNRL wants, and that makes it very

1 difficult to prepare for a hearing and to know what  
2 case to meet.

3 CNRL will complain about prejudice if this hearing  
4 is adjourned. We have two responses to that. Any  
5 prejudice that CNRL suffers will be financial -- and  
6 they have indicated that financial harm is not  
7 something the AER should care about -- and they are the  
8 author of their own misfortune. They have decided to  
9 file further -- well, attempted to file further  
10 evidence on the eve of this hearing. Had we not known  
11 about this further information, well, we don't know  
12 what we don't know, but now that we know about it, this  
13 allowing CNRL to file it does not make that information  
14 go away, and that is why ISH is seeking the  
15 adjournment, the directives for a technical meeting  
16 further evidence, and then ancillary relief.

17 Those are my submissions. I don't know if there's  
18 any questions.

19 COMMISSIONER CHIASSON: Yes, there are.

20 So my understanding is, from what Ms. Jamieson  
21 told us earlier, that what we disallowed had no new  
22 evidence, so what we're looking to proceed on today is  
23 all the material that's been on the record. You made  
24 reference to geomechanical modelling, the rest of it.  
25 We've had an extensive procedure in this proceeding,  
26 including extensive information requests, the last of

1 which were filed, I believe, three weeks ago. Why  
2 weren't we hearing concerns about this three weeks ago,  
3 Ms. Marlé -- Ms. Riley?

4 M. RILEY: We indicated that in our  
5 motion. We had a look at it. We saw that -- well,  
6 there's still no information about deformation. So  
7 from that, we take it that CNRL is not concerned about  
8 deformation, which is ISH's concern. We prepared for  
9 this hearing on the basis that that work was simply not  
10 done. It's not ISH's application; it's CNRL's, so CNRL  
11 has to convince this Panel that there is no concerns.

12 Now we know that there is a whole host of  
13 information that we've simply not been privy to.

14 COMMISSIONER CHIASSON: Which my understanding is not  
15 on our record.

16 M. RILEY: Indeed.

17 COMMISSIONER CHIASSON: So are you suggesting, then,  
18 that we need to adjourn this proceeding and reopen?

19 M. RILEY: Indeed that is -- that is the  
20 request. That is why we --

21 COMMISSIONER CHIASSON: And --

22 M. RILEY: -- ask that the -- and I will  
23 file the further information that there be a technical  
24 meeting of the experts and that there be further  
25 evidence filed.

26 COMMISSIONER CHIASSON: I have to say I'm struggling a

1 little bit with the concept of why this is something  
2 that is a concern that's only coming to us the morning  
3 of the hearing when we've had extensive exchanges  
4 between the parties.

5 M. RILEY: Well, the process did not  
6 allow for ISH to make any further submissions or ask  
7 any further questions of CNRL after the filing of their  
8 information responses, and, as I said, we had a look at  
9 what they filed, decided, Well, if we were to do  
10 anything more, it will result in an adjournment, and  
11 given that this work that we now see wasn't done, we  
12 would proceed on that basis.

13 COMMISSIONER CHIASSON: And -- sorry. But when  
14 would -- when would enough be enough?

15 M. RILEY: Once all of the information  
16 underlying CNRL's geomechanical modelling is on the  
17 record and before the Panel.

18 COMMISSIONER CHIASSON: So you've mentioned about  
19 deformation. Isn't that what's covered in the video  
20 evidence that was filed by ISH?

21 M. RILEY: It is ISH -- ISH's  
22 interpretation, yes.

23 COMMISSIONER CHIASSON: Okay. Just a moment. Okay.  
24 Thank you.

25 We will hear from Ms. Jamieson now.

26 Submissions by J. Jamieson

1 J. JAMIESON: Thank you, Commissioner  
2 Chiasson.

3 I want to confirm for the record that no new  
4 evidence is being presented in either of the PowerPoint  
5 presentations that are not on the record. We've --  
6 we've made a request to file it on the record, and that  
7 has not occurred.

8 In terms of new information, again, I would  
9 reiterate that what Canadian Natural was attempting to  
10 do with that direct evidence was present an extensive  
11 record in an efficient and a visually digestible way,  
12 and that's what -- so I think Ms. Riley used the term  
13 "they haven't seen this work before" or "this work has  
14 not been seen". That simply is not the case. All of  
15 this data, evaluation, assessment, you know, is all  
16 sitting on the record, either in Canadian Natural's  
17 hearing submission or in its responses to the AER,  
18 including the geomechanical modelling as well as  
19 Canadian Natural's reply submission, which is where  
20 things like deformation, Canadian -- the deformation.  
21 Those were issues that ISH had raised and Canadian  
22 Natural was addressing in its reply submission. But I  
23 don't believe there's anything new. I'm going to  
24 confer with our geomechanical experts, if I can, just  
25 to confirm, because she did point out one or two  
26 slides, and I'll just make sure there was nothing new

1 there, that it all came from either the modelling or  
2 the IR responses. If you will give me a moment.

3 Ms. Chiasson, I'm learning as we go myself, but in  
4 respect to Slide 116 that Ms. Riley referenced, this is  
5 all information that is sitting in the GeoSim modelling  
6 report, you know, the figures and the numbers, all pull  
7 from that, and then what I understand is on one bullet,  
8 they articulated the maximum confinement strata uplift,  
9 which is actually part of the GeoSim model. So it's  
10 baked into the model, if you will.

11 But, again, this is all filed on the record, and I  
12 would -- you know, my -- the Canadian Natural witnesses  
13 can speak to that point if it's an issue.

14 COMMISSIONER CHIASSON: Thank you, Ms. Jamieson.

15 So we'll take a short break. One thing, though,  
16 before we take the break that I want to make abundantly  
17 clear to both parties is that, as you've indicated,  
18 we've not allowed these -- either of these materials,  
19 these presentations, and I want the parties to  
20 understand the Panel has not seen either of the  
21 presentations. So when you're making references to the  
22 particular slides of that, we have no idea what's on  
23 there. We have not seen any of that material. Okay.  
24 We're going to take another short break.

25 (ADJOURNMENT)

26 Decision

1 COMMISSIONER CHIASSON: Okay. Thank you, all.

2 So we've considered what we've heard from both  
3 parties, and on this we have decided that we will not  
4 grant the adjournment motion brought by ISH. We heard  
5 that there is no new evidence being provided in this,  
6 so we are dealing with what has been on the record  
7 for -- some of it for some time, several months; some  
8 of it for a few weeks, but what has been on the record.

9 We know -- we heard reference to making the case.  
10 The last proceeding, 397, was a regulatory appeal,  
11 which is different than this proceeding, which is an  
12 application. In a hearing on an application, the  
13 parties can present what evidence they choose to  
14 convince us with respect to meeting application  
15 requirements and any necessary conditions that might  
16 need to be attached should we choose to approve the  
17 application. That -- parties have had ample  
18 opportunity in this to test the evidence, file motions,  
19 raise concerns, et cetera, and we would note that we  
20 have adjusted the proceeding schedule previously to  
21 adjust timelines at the request of each party. So we  
22 have accommodated in the past where it's done so, and  
23 we feel that that's sufficient.

24 We would also remind the parties that we are well  
25 aware of Rule 24(5), that argument in a hearing must be  
26 based on the evidence before the proceeding and that we

1 feel that that would safeguard against any potential  
2 prejudice together with our other procedural rules.

3 So, as such, we deny the motion, and we would look  
4 to proceed.

5 Discussion

6 COMMISSIONER CHIASSON: Ms. Jamieson, can you advise  
7 us whether or not CNRL would like some time to adjust  
8 before you seat your witness panel.

9 J. JAMIESON: Yes, Commissioner Chiasson.  
10 We would appreciate 30 minutes, if we could. That'll  
11 take us to 11:00. We could be ready to go by then.

12 I want to point out that in terms of efficiency,  
13 we might have a -- it might be clunkier, the  
14 presentation, because they're going to rely on their  
15 scripts now. They're going to try to reduce the number  
16 of exhibits that they need to be -- that need to be  
17 pulled up on the screen, but we will still ask for some  
18 visuals up on the screen so that they can speak to  
19 those maps or figures or whatever they need to, but we  
20 will absolutely endeavour to present the direct  
21 evidence within the -- within the rules and the  
22 confines of your rulings.

23 COMMISSIONER CHIASSON: Thank you.

24 And, Ms. Jamieson, just for clarity's sake, when  
25 you refer to "scripts", your clients -- I'm assuming --  
26 will be referring to -- referring to that material that



1 we've disallowed just in terms of -- as, like, speaking  
2 notes, aide-mémoire --

3 J. JAMIESON: Speaking notes, exactly.

4 COMMISSIONER CHIASSON: Yes. Okay.

5 J. JAMIESON: So they had speaking notes  
6 prepared with the slides, which -- and, again, the  
7 slides were just a compilation of all the evidence  
8 sitting on the record. So, yes, what they have, none  
9 of this is intended to be filed, but they will have  
10 their -- their materials -- their application materials  
11 in front of them and their speaking points, and now  
12 they will have -- because the exhibit numbers for their  
13 figures are sitting in their slides, so they may need  
14 to refer to those to get it up, you know, Exhibit 15.01,  
15 Tab 42, and then it can go up on the screen, but  
16 there's no intention to, you know, do anything outside  
17 of that.

18 COMMISSIONER CHIASSON: Okay. Thank you,  
19 Ms. Jamieson.

20 Ms. Riley, any concern in relation to speaking  
21 notes?

22 M. RILEY: None.

23 COMMISSIONER CHIASSON: Okay.

24 M. RILEY: Assuming that ISH has the same  
25 privilege.

26 COMMISSIONER CHIASSON: That's -- that's -- that's

1 totally fine. We fully expected something complex like  
2 this that witnesses would be making use of -- making  
3 use of notes, and we would recognize as well that it's  
4 fully open to counsel to question witnesses in relation  
5 to what they're referring to, so ...

6 All right. We will break now. We will look to  
7 reconvene at 11:00, and, during this break, the Panel  
8 will take a look at the schedule to look at where we  
9 can adjust accordingly to give people a better idea of  
10 timing going forward. So thank you, all. We will be  
11 back at 11:00.

12 (ADJOURNMENT)

13 COMMISSIONER CHIASSON: So, Mr. Lung, Ms. Jamieson,  
14 we're good to go? Thank you. Okay. Let's proceed. I  
15 will give the reminder again because we've got lots of  
16 people with lots of mics that --

17 (AUDIO DIFFICULTIES)

18 COMMISSIONER CHIASSON: That's always an eery feeling.  
19 Anyhow, just -- just -- just a reminder -- and I don't  
20 mean to be nagging; I will remind this all the way  
21 along -- we've got lots of people, lots of mics so just  
22 to remember, only five mics can be live at any one  
23 time, so it makes it a whole lot easier for everyone if  
24 you mute your mic when you're done speaking. Thank  
25 you.

26 Please proceed, Ms. Jamieson.

1 J. JAMIESON: Thank you, Commissioner  
2 Chiasson. Again, my name is JoAnn Jamieson, and I am  
3 here representing Canadian Natural in this proceeding.  
4 With me still at the table is Maude Ramsay, manager of  
5 regulatory affairs for thermal and conventional  
6 development at Canadian Natural. I'll take my cue, but  
7 I'm thinking before I introduce the Panel this would be  
8 a good time to have them sworn in or informed.

9 COMMISSIONER CHIASSON: Yes. We'll get the court  
10 reporters to deal with that.

11 Actually, while they're being sworn or affirmed, I  
12 will mention that the plan is to go till noon, which  
13 was our regular scheduled lunch break; we'll take the  
14 lunch break; and then we anticipate, given the time  
15 that we have allotted for CNRL, we would anticipate  
16 going to 3:00 to be able to -- and ideally that gets us  
17 to the end of your direct at 3, and we take a break  
18 then. So it pushes the break back a touch, but --

19 J. JAMIESON: Sure. Understood. And we did  
20 have -- we do have, like, one hour --

21 COMMISSIONER CHIASSON: Yes.

22 J. JAMIESON: -- of material --

23 COMMISSIONER CHIASSON: Yeah.

24 J. JAMIESON: -- until the break. And so I  
25 will know if Mr. Lavigne's within, you know --

26 COMMISSIONER CHIASSON: Yes.

1 J. JAMIESON: -- five minutes of finishing.

2 COMMISSIONER CHIASSON: Yeah.

3 J. JAMIESON: Maybe we can do that.

4 COMMISSIONER CHIASSON: Yes. Please let me -- let me

5 know if that's the --

6 J. JAMIESON: Okay.

7 COMMISSIONER CHIASSON: -- case. Yeah.

8 J. JAMIESON: And just on scheduling, just

9 the other point I want to make at this point, we're

10 already pretty confident that we don't need the full

11 hour -- full three hours requested for our

12 cross-examination of ISH. So that is a spot we could

13 cut back.

14 COMMISSIONER CHIASSON: Okay. Thank you. Yes.

15 J. JAMIESON: Okay.

16 COMMISSIONER CHIASSON: We'll -- we'll -- we'll -- our

17 plan is essentially to assess as we go along and see

18 how things --

19 J. JAMIESON: Okay.

20 COMMISSIONER CHIASSON: -- see how things flow.

21 J. JAMIESON: Understood.

22 COMMISSIONER CHIASSON: Thank you.

23 J. JAMIESON: Yes. If I could have the

24 court reporter swear our witnesses in, that would be

25 appreciated.

26 DEVIN OLLENBERGER, THOMAS BOONE, LENNON ROCHE,

1           MARC SCRIMSHAW, Affirmed  
2           GERARD IANNATONE, JASON LAVIGNE, SCOTT SVERDAHL,  
3           DALE WALTERS, XIANG WANG, PETER THOMSEN, SCOTT BARLAND,  
4           Sworn  
5           Direct Evidence of Canadian Natural Resources Limited  
6           Witness Panel

7           J. JAMIESON:                   Thank you, Court Reporter.

8                   So I'd like to commence by introducing the  
9           Canadian Natural witness panel. I'm going to do this  
10          in a fairly quick, abbreviated order just in the  
11          interest of time. So as I introduce each of you, if  
12          you could identify yourselves to the Panel and the  
13          other folks in the room, as well as I'm going to ask  
14          you to confirm that your curriculum vitae information  
15          is as filed on the record. All right?

16        Q    J. JAMIESON:                   So, Mr. Iannattone, I'm going  
17          to start with you. Mr. Iannattone is seated in the  
18          middle. He is vice president for the Athabasca oil  
19          sands region and the chair of the Canadian Natural's  
20          witness panel, is Canadian Natural's senior  
21          representative on the witness panel and has authority  
22          to make decisions with respect to the KN08 and KN09  
23          application?

24                   Mr. Iannattone has a bachelor of science in  
25          mechanical engineering and is a professional engineer  
26          by trade. He has over 40 years experience in the oil

1 and gas industry which includes a broad and diverse  
2 experience within the Western Canadian Basin as well as  
3 internationally.

4 Is my pace okay? A little fast. Okay. I'll slow  
5 it down. You bet.

6 Mr. Iannattone, can you please confirm for the  
7 record that your curriculum vitae as filed on the  
8 record in Exhibit 40.01 accurately sets out your  
9 professional qualifications and experience and was  
10 prepared under your direction and control?

11 A G. IANNATONE: Yes, I do.

12 J. JAMIESON: Turning now to  
13 Mr. Iannattone's right is Mr. Scott Sverdahl.  
14 Mr. Sverdahl has a bachelor of science in geophysics  
15 and is a professional geophysicist with APEGA here in  
16 Alberta, is the exploration manager for the Kirby  
17 Athabasca thermal asset.

18 Q J. JAMIESON: Mr. Sverdahl, can you please  
19 confirm that your curriculum vitae as filed on the  
20 record as Exhibit 40.01 accurately sets out your  
21 professional qualifications and experience and was  
22 prepared under your direction and control?

23 A S. SVERDAHL: Yes.

24 J. JAMIESON: Seated to Mr. Sverdahl's right  
25 is Mr. Jason Lavigne. Mr. Lavigne has a master's of  
26 science in geology and is a professional geologist by

1 trade. Mr. Lavigne was a Canadian Natural employee for  
2 11 years as a district geologist on the thermal  
3 exploration team, is now working as a senior consultant  
4 in the development of the Kirby north project.

5 Q J. JAMIESON: Mr. Lavigne, can you confirm  
6 that your curriculum vitae as filed on the record in  
7 Exhibit 40.01 accurately sets out your professional  
8 qualifications and experience and was prepared under  
9 your direction and control?

10 A J. LAVIGNE: Yes, I can.

11 J. JAMIESON: Mr. Devin Ollenberger is  
12 seated to Mr. Iannottone's left. Mr. Ollenberger is a  
13 chemical engineer with over 16 years of experience in  
14 SAGD reservoir and exploitation engineering.

15 Q J. JAMIESON: Mr. Ollenberger, can you  
16 please confirm for the record that your curriculum  
17 vitae as filed on the record as Exhibit 40.01  
18 accurately sets out your professional qualifications  
19 and experience and was prepared under your direction  
20 and control?

21 A D. OLLENBERGER: Yes, that is correct.

22 J. JAMIESON: Mr. Thomsen is to  
23 Mr. Ollenberger's left. Mr. Peter Thomsen has a  
24 bachelor of science in petroleum engineering and is a  
25 professional engineer by trade. He has experience and  
26 expertise in thermal recovery processes, exploitation,

1 and reservoir engineering, geomechanics of the oil  
2 sands formation and caprock integrity.

3 Q J. JAMIESON: Mr. Thomsen, can you please  
4 confirm that your curriculum vitae as filed on the  
5 record as Exhibit 40.01 accurately sets out your  
6 professional qualifications and experience and was  
7 prepared under your direction and control?

8 A P. THOMSEN: Yes, that is correct.

9 J. JAMIESON: Seated to Mr. Thomsen's left  
10 is Dr. Thomas Boone. Dr. Boone has a bachelor of  
11 science in civil engineering, a master's of science in  
12 structural engineering from the University of Texas,  
13 and a PhD in structural engineering from Cornell  
14 University. He has over 39 years of experience in the  
15 oil and gas industry, including extensive experience in  
16 geomechanics, hydraulic fracturing, reservoir  
17 engineering, numerical simulation modelling, heavy oil  
18 recovery processes, thermal recovery processes, pilot  
19 design and operation, reservoir surveillance, and  
20 formal risk assessment.

21 Q J. JAMIESON: Dr. Boone, can you please  
22 confirm that your curriculum vitae as filed on the  
23 record as Exhibit 40.01 accurately sets out your  
24 professional qualifications and experience and was  
25 prepared under your direction and control?

26 A T. BOONE: Yes, I can confirm.



1 Q Can you please describe what you were retained to do  
2 for Canadian Natural in this proceeding?

3 A I was retained by the independent assessment of  
4 Issues 1 to 4 for this hearing.

5 Q And can you please confirm that your independent --  
6 your initial independent report was filed as part of  
7 Canadian Natural's Hearing Submission 15.01 as  
8 Appendix 2, and you also filed a supplemental report as  
9 Exhibit 50.002 in this proceeding?

10 A Yes, that's correct.

11 Q And does your written report identify and include the  
12 data or information upon which it was based, including  
13 any factual assumptions made, research conducted, and  
14 any other data or documents relied upon?

15 A Yes, it does.

16 Q Do you have any corrections or revisions to your  
17 written evidence?

18 A No, I don't.

19 Q And please also confirm that you're providing an  
20 independent professional opinion evidence in this  
21 proceeding and that you understand your duty here is to  
22 provide evidence to the Regulator that is fair,  
23 objective, and impartial?

24 A Yes. I understand that obligation.

25 J. JAMIESON: Turning to the back row, and  
26 I'll start with Mr. Lennon Roche. He's in the far

1 corner.

2 Mr. Lennon Roche is a chemical engineer. He has  
3 17 years experience in production engineer and  
4 optimization with a focus on thermal production for the  
5 past six years.

6 Q J. JAMIESON: Mr. Roche, can you please  
7 confirm that your curriculum vitae as filed on the  
8 record as Exhibit 40.01 accurately sets out your  
9 professional qualifications and experience and was  
10 prepared under your direction and control?

11 A L. ROCHE: Yes, I confirm.

12 J. JAMIESON: Seated next to Mr. Roche's  
13 right is Mr. Dale Walters. Mr. Walters has a 'B' --  
14 bachelor of science in civil engineering as well as a  
15 master's of science in geotechnical engineering. He  
16 has over 25 years of engineering experience  
17 participating in large reservoir and geomechanical  
18 engineering studies throughout the world within a  
19 multidisciplinary team environment.

20 He is currently working with Canadian Natural as a  
21 reservoir geomechanic specialist with responsibilities  
22 for supporting all the geomechanical projects related  
23 to cyclic steam stimulation, SAGD, unconventional and  
24 carbon capture sequestration.

25 Q J. JAMIESON: Mr. Walters, can you kindly  
26 confirm that your curriculum vitae as filed on the

1 record as Exhibit 40.01 accurately sets out your  
2 professional qualifications and experience and was  
3 prepared under your direction and control?

4 A D. WALTERS: Yes, I confirm.

5 J. JAMIESON: Seated beside Mr. Walters is  
6 Mr. Marc Scrimshaw. Mr. Scrimshaw has two bachelors of  
7 sciences, one in microbiology and one in civil  
8 environmental engineering. He has over 20 years  
9 experience working in the area of regulatory  
10 applications and environmental assessments and is now  
11 the lead regulatory team member for thermal projects.

12 Q J. JAMIESON: Mr. Scrimshaw, can you please  
13 confirm that your curriculum vitae as filed on the  
14 record as Exhibit -- and I don't know. I'll have to  
15 check with Mr. Lung and provide you with a number  
16 because I don't know the most recent exhibit numbers,  
17 but I will provide you with that information -- sets  
18 out your professional qualifications and experience and  
19 was prepared under your direction and control?

20 A M. SCRIMSHAW: Yes, I confirm.

21 Q Thank you.

22 J. JAMIESON: Next we have Dr. Xiang Wang,  
23 and Dr. Xiang -- sorry -- Dr. Wang has a master's of  
24 science in structural geology and geochemistry. He  
25 also has a master of science in structural geology and  
26 rock mechanics and a PhD in geology from the University

1 of New South Wales in Sydney, Australia. He has more  
2 than 20 years of experience in multiple sedimentary  
3 basins with a variety of tectonic styles and has  
4 experience in structural geology, rock mechanics,  
5 sedimentology, geochemistry, statistics, and  
6 geomodelling and also extensive experience in  
7 interpreting image logs for Canadian Natural's thermal  
8 operations.

9 Q J. JAMIESON: Mr. Wang -- or Dr. Wang, can  
10 you kindly confirm that your curriculum vitae as filed  
11 on the record as Exhibit 48.001 accurately sets out  
12 your professional qualifications and experience and was  
13 prepared under your direction and control?

14 A X. WANG: Yes, I confirm.

15 J. JAMIESON: And next we have Mr. Scott  
16 Barland. Mr. Barland has a bachelor of science -- two  
17 bachelors of science actually, one in geology and  
18 another one in agriculture. He has -- he's also a  
19 professional geologist with the Association of  
20 Professional Engineers and Geosciences of Alberta,  
21 APEGA. He has 13 years experience in the SAGD industry  
22 as a geologist. He pioneered work at Devon Canada  
23 using GCMS analysis to identify barriers and baffles in  
24 the McMurray formation pay starting with the first 13  
25 cores analyzed by Devon Canada in 2013. To date he has  
26 analyzed or reviewed over 140 cored wells that have

1 GCMS data across it. This would be across Canadian  
2 Natural's thermal assets in Jackfish, Pike, Kirby, and  
3 Primrose areas.

4 Q J. JAMIESON: Mr. Barland, can you please  
5 confirm that your curriculum vitae as filed on the  
6 record, again as Exhibit X, accurately sets out your  
7 professional qualifications and experience and was  
8 prepared under your direction and control?

9 A S. BARLAND: Yes, I can.

10 Q Thank you.

11 Mr. Iannattone, a couple of last questions for  
12 you. Can you please confirm that Canadian Natural's  
13 written evidence, with the exception of Dr. Boone's  
14 report, was prepared under your direction and control?

15 A G. IANNATONE: Yes, it was.

16 Q And do you adopt that evidence on behalf of Canadian  
17 Natural in this proceeding?

18 A Yes, I do.

19 Q Can you confirm that Canadian Natural's evidence is  
20 accurate to the best of your knowledge and belief?

21 A I confirm.

22 Q Do you have any corrections or revisions to make to the  
23 Canadian Natural evidence?

24 A No, I don't.

25 Q Thank you.

26 J. JAMIESON: All right. And with that,

1 Commissioner Chiasson, I will turn it over to Canadian  
2 Natural's witness panel. We do have about 50 minutes  
3 of material here, so we'll try to cut it to 12 noon as  
4 best we can, and I will signal, you know, if we do need  
5 additional time, but there's a chance we'll get through  
6 it. Thank you very much.

7 COMMISSIONER CHIASSON: Okay. Thank you. Please  
8 proceed.

9 I think Mr. Lung perhaps had the exhibit number?

10 A. LUNG: That's right. For  
11 Mr. Scrimshaw and Mr. Barland's curriculum vitae, it's  
12 Exhibit 58.001.

13 J. JAMIESON: Thank you.

14 COMMISSIONER CHIASSON: Great. Thank you. Please  
15 proceed.

16 A G. IANNATONE: My name is Gerard Iannattone.  
17 I am Canadian Natural's -- sorry. Got that off all of  
18 a sudden. I'll start again.

19 I am Canadian Natural's senior representative and  
20 the chair of Canadian Natural's panel. I'm also here  
21 to speak to policy issues.

22 Good morning, Commissioner Chiasson, Baker [sic],  
23 and Zaitlin. I would like to thank the Panel for the  
24 opportunity to present our direct evidence. Canadian  
25 Natural is Canada's largest and most diverse energy  
26 company. I would like to take a moment here to read

1 our mission statement. It is to: (as read)

2 Develop people to work together to create  
3 value for the company shareholders by doing  
4 it right with fun and integrity.

5 Canadian Natural staff live the mission statement in  
6 all aspects of their work, including this hearing, by  
7 creating value for the public interest via royalty and  
8 tax payments to the Alberta and federal governments,  
9 doing it right by adhering to all governing laws and  
10 regulations as a responsible operator, being honest and  
11 humble, demonstrating integrity.

12 Canadian Natural has over 24 years of thermal  
13 development and operating experience. As part of this  
14 vast base, we have safely started up and operated over  
15 390 well pairs at our SAGD projects. Highly  
16 experienced technical and operational staff have proven  
17 Canadian Natural to be a safe SAGD operator with no  
18 incidents of lost steam to other formations during  
19 circulation startups or continuous SAGD operations.

20 Fundamental to our SAGD business is Canadian  
21 Natural's ability to contain steam chambers.

22 The KN08, KN09 pads are part of the next  
23 development phase for the Kirby north project, and  
24 these pads are expected to recover between 30 and  
25 35 million barrels. The project is an example of how  
26 Canadian Natural creates value for all Albertans

1 through positive contributions to the local, regional  
2 economies during both construction and operations with  
3 direct, indirect, and induced employment. The  
4 successful execution of this project will also deliver  
5 up to \$250 million in royalties.

6 On the flip side, value can be easily eroded by  
7 spending unnecessary dollars as the Kirby north project  
8 is in a post-payout royalty position. Every dollar  
9 spent reduces a net profit and the royalties payable by  
10 30 to 40 cents. In effect, Albertans are funding 30 to  
11 40 percent of the costs. It is Canadian Natural's  
12 responsibility, as the operator, to be as efficient as  
13 possible.

14 Mr. Lung, I would like to bring up an exhibit now.  
15 I will give you the number. It is Exhibit 01.01, PDF  
16 page 18 of 387. Thank you.

17 To provide some regional context, the following  
18 figure is a map of the Kirby north project development  
19 area and associated drainage boxes. The blue outline  
20 represents the Kirby north development area in the  
21 scheme approval, which is the red outline.

22 The grey boxes represent the KN01 to KN07 drainage  
23 boxes, which are on continuous SAGD production. The  
24 KN08, KN09 proposed boxes are outlined in red.

25 Canadian Natural respects ISH's concerns and takes  
26 them seriously. We have engaged with ISH since



1 December of 2021 prior to filing of the application and  
2 have attempted to address their concerns at every  
3 opportunity since. Obviously we were unsuccessful and  
4 are here today to demonstrate that there is a low risk  
5 to the gas resource.

6 Canadian Natural has taken and will continue to  
7 take all reasonable steps to mitigate and/or avoid any  
8 impact to the gas resource. Canadian Natural also  
9 understands that ISH is not seeking an order preventing  
10 the KN08, KN09 development, but rather is asking the  
11 Panel to impose certain conditions.

12 Draft Directive 23, Section 4.2 describes the  
13 requirements for stakeholder involvement program. The  
14 directive states that the ERCB expects applicants to  
15 respond in a meaningful way with any party that has  
16 raised a concern or has questions regarding oil sands  
17 projects and to make reasonable efforts to address  
18 concerns raised before filing the application.

19 Canadian Natural did provide ISH confidential data  
20 addressing ISH's concerns directly in the application  
21 as filed on March the 10th, 2022. ISH filed their  
22 statement of concern on April the 8th, 2022, and three  
23 rounds of extensive supplementary information requests  
24 from the AER were answered.

25 In 2023, Canadian Natural initiated two  
26 face-to-face meetings with ISH. Canadian Natural has

1           made a bona fide effort to address and resolve ISH's  
2           concerns.

3                     Mr. Lung, I'd like to bring up another exhibit.  
4           It is Exhibit 15.01, paragraph 29, PDF page 10 of 505.  
5           Okay.

6           A. LUNG:                                 Sorry, Mr. Iannattone. Can  
7           you repeat that.

8           A    G. IANNATONE:                     Can we try Tab 4 -- Tab 4,  
9           PDF 107 of 505. Yeah. There it is. Thank you.

10                    In the stratigraphic sense, there are two  
11           commercial bitumen reservoirs located below the  
12           Wabiskaw B, or more formerly known as the Kirby upper  
13           Mannville II gas pool. The red vertical bars shown on  
14           the graph here represent the gas trapped in the  
15           Wabiskaw B and also the gas trapped at the top of the  
16           Wabiskaw D.

17                    The Wabiskaw D bitumen reservoir and the McMurray  
18           Post 2 incision bitumen reservoir are shown by the  
19           vertical green bars. The KN08, KN09 proposed  
20           development is in the McMurray bitumen reservoir.

21                    From an aerial sense, it is important to note here  
22           that the Kirby Upper Mannville II gas pool overlies  
23           both the commercial McMurray and the Wabiskaw D bitumen  
24           reservoirs.

25                    Mr. Lung, I would like another slide. It is --  
26           let's see if I can get this one right. It's

1 Exhibit 50.003, Tab 3, PDF page 48 of 250. You just  
2 passed it. Yeah. Thank you. This is a complex slide,  
3 but I will walk through it as it is important to  
4 understand the gas situation in the Kirby north area.

5 There are a total of five GOBed Mannville gas  
6 pools in the Kirby area. The GOBed gas pool names --  
7 COMMISSIONER CHIASSON: Sorry -- sorry to interrupt,  
8 but just -- and I should have said this earlier on. If  
9 you're going to use acronyms, just for the record, can  
10 you explain what the acronym is first so that we're  
11 clear for the record and also for anybody who is  
12 watching on the videocast. So, for example, "GOB".

13 A G. IANNATONE: GOB, gas over bitumen. Okay.  
14 Thank you.

15 For a total of five gas over bitumen GOB Mannville  
16 gas pools in the Kirby areas. The GOB gas pool names  
17 and areas are shown in red.

18 The GOBed Kirby Upper Mannville II pool boundary,  
19 which is the subject gas pool in this hearing, is  
20 highlighted in -- oh -- in purple, yes, it is, yeah,  
21 and the Kirby north drainage boxes are outlined in  
22 black.

23 In addition to the GOBed gas pools, there are four  
24 Mannville gas pools that are allowed to produce. The  
25 producing names and the areas are shown in green, with  
26 the currently active gas wells highlighted in black

1 circles.

2 In terms of the regulatory framework, the GOB  
3 decisions gave priority and time to the bitumen  
4 development. The GOB decisions concluded there exist  
5 potential impact on bitumen recovery from the  
6 pressure-depleting effects of producing overlying gas.  
7 The decisions ordered the shut-in of the Kirby Upper  
8 Mannville II gas pool to protect the Wabiskaw D and  
9 McMurray bitumen reservoirs. Subsequently, Canadian  
10 Natural and ISH have received substantial royalty  
11 adjustment payments as compensations for direct impacts  
12 caused by the shut-in order.

13 Bitumen resources can be directly inversely  
14 affected by pressure depletion of connected gas. If  
15 containment of the steam chamber is lost, the amount of  
16 steam required will increase while the bitumen  
17 production and recovery factor will decrease, making  
18 pad economics uncompetitive for capital allocation.  
19 Ultimately, this could lead to the stranding of bitumen  
20 resource.

21 Canadian Natural requires certainty that bitumen  
22 pressure depletion will not occur before investing  
23 hundreds of millions of dollars on pad developments.

24 Pressure in the Kirby Upper Mannville II pool are  
25 already significantly pressure depleted as measured at  
26 the 10-01 well. The current declining pressures are

1 likely due to connectivity to other producing gas  
2 pools, and any further decrease in pressure is a threat  
3 to the efficient recovery of the Wabiskaw D bitumen.

4 As a joint owner of the Kirby Upper Mannville II  
5 pool, Canadian Natural shares a mutual interest in  
6 protecting the overlying gas as well as protecting the  
7 bitumen resource.

8 This protection relies on responsible operatorship  
9 of both the bitumen resource developer as well as the  
10 gas operator as required under the Oil Sands  
11 Conservation Act, the GOB order, and the Oil and Gas  
12 Conservation Act.

13 I wish to clarify here that this hearing is not  
14 about the protection of this bitumen resource from  
15 pressure depletion, but rather the reverse situation  
16 where ISH is concerned about the potential damage to  
17 the remaining gas reserves in the Kirby Upper  
18 Mannville II pool caused by SAGD operations in the  
19 McMurray Post-B2 reservoir. We are here today to  
20 present that Canadian Natural's technical evidence  
21 demonstrates that the risk to the Wabiskaw B gas  
22 resource is low due to an effective containment barrier  
23 and no evidence of fractures or faults, and Canadian  
24 Natural's evidence will also demonstrate that it's  
25 proposed mitigation and monitoring measures are  
26 reasonable in the circumstances given the nature of the

1 potential effects, practisability [sic], effectiveness,  
2 and cost benefits.

3 Mr. Lung, one more for me, please. It is  
4 Exhibit 50.003, Tab 4, PDF page 49 of 250. Thank you.

5 This is Canadian Natural's workflow. Throughout  
6 the course of the hearing, the Panel will be required  
7 to value or weigh a large amount of technical evidence.  
8 The slide highlights that the difference between  
9 directly measured data and data which requires  
10 interpretation and expertise to evaluate. In addition,  
11 the diagram illustrates no dataset is used in isolation  
12 but rather involves an integration of multiple diverse  
13 datasets and disciplines.

14 The arching arrows in blue indicate the workflow  
15 is iterative bringing various perspectives together to  
16 promote alignment. The best results note that's the  
17 overlying triangular area labelled "assessment" in the  
18 middle of the diagram are always obtained when there is  
19 a convergence of data interpretations and models that  
20 support the same conclusion.

21 Commissioner Chiasson, this concludes my opening  
22 statement. I would now wish to turn the presentation  
23 over to Canadian Natural's technical panel to address  
24 the hearing issues starting with Mr. Lavigne.

25 A J. LAVIGNE: Thank you, Mr. Iannattone. My  
26 name is Jason Lavigne, and I'm a geologist -- I'm a

1 geologist and will be addressing the first hearing  
2 issue. The first hearing issue is whether there's an  
3 effective barrier or top seal overlying the  
4 bitumen-bearing McMurray formation consisting of a  
5 deposit or series -- or aggregation of strata that is  
6 not permeable to steam over the life of the KN08 and 9  
7 box -- drainage boxes, which includes but is not  
8 limited to whether or not there are fractures in the  
9 strata between the McMurray formation and the  
10 Wabiskaw B member.

11 In this section, we will discuss the presence and  
12 characteristics of the barrier, and we will discuss the  
13 presence or absence of fractures separately in a later  
14 section.

15 Canadian Natural uses the definitions of  
16 "barriers" and "baffles" as follows: Barriers are not  
17 permeable to steam over the life of operations, while  
18 baffles interfere with and impedes the movement of  
19 steam but doesn't stop it entirely.

20 While it is well understood that the regional  
21 mudstone units may ultimately contain steam, barriers  
22 and baffles that occur within the reservoir units also  
23 significantly affect steam chamber development.  
24 Extensive operational experience since the gas over  
25 bitumen rulings show that steam is often effectively  
26 contained in heterolithic strata below the regional

1 mudstone. These aggregations of strata contain  
2 numerous barriers and baffles that work together to  
3 ensure containment of the steam chamber over the life  
4 of the operations.

5 In order to ensure efficient operations, the steam  
6 chamber must be contained within the reservoir  
7 interval. Unanticipated barriers or baffles within the  
8 reservoir zone -- and leak off into the overlying units  
9 diminish the thermal efficiency of the SAGD process and  
10 negatively affect oil recovery. The ratio of steam  
11 injected to the volume of oil produced is a key metric  
12 in evaluating the viability of potential SAGD pads, and  
13 potential loss of steam from the reservoir unit is a  
14 risk that is thoroughly assessed in advance of  
15 development.

16 To facilitate steam chamber containment, an  
17 analysis of the overlying confinement strata is  
18 critical. Characteristics of effective confinement  
19 strata include typically mudstone facies with greater  
20 than 50 percent volume of shale or V shale and the  
21 resulting low vertical permeability and units that are  
22 stratigraphically correlatable and have significant  
23 lateral extents relative to the drainage boxes. These  
24 units must also be geomechanically competent over the  
25 life of SAGD operations, which will be covered in  
26 Hearing Issue 3.



1           Because of the large capital expenditure of SAGD  
2 projects, Canadian Natural applies a multidisciplinary  
3 approach to evaluation and de-risking potential  
4 developments. This section focuses on the geo -- the  
5 geoscience component of that analysis. Canadian  
6 Natural uses wireline logs, cores, and image logs to  
7 evaluate details of reservoirs and also the confinement  
8 strata. 3D seismic helps to define and identify the  
9 continuity of both reservoir -- the reservoirs and  
10 confinement strata units and constrain key depositional  
11 edges. Geochemical analysis of oil samples taken from  
12 cores helps identify potential barriers and baffles  
13 within the reservoir and the overlying confinement  
14 strata units.

15           After steam injection has begun, temperature logs  
16 in 4D seismic are used to monitor the growth of the  
17 steam chamber. Canadian Natural employs a philosophy  
18 of continuous improvement and relies on its extensive  
19 experience in operating oil sands assets and leverages  
20 its large set of internal production analogs to help  
21 assess the results of new data and adjust its  
22 evaluation and execution strategies to ensure effective  
23 and efficient operations.

24           One tool that can be utilized to potentially  
25 proactively predict the presence of barriers and  
26 baffles within the reservoir and confinement strata

1 units prior to steaming is gas chromatography mass  
2 spectrometry, or "GCMS". This geochemical tool may  
3 also be used to help assess the potential sealing  
4 capacity of confinement strata units by indicating  
5 layers across which hydrocarbon concentration profiles  
6 change markedly. If oil concentrations were not able  
7 to equilibrate across low permeability beds or  
8 heterolithic units over geological time, it is very  
9 unlikely that steam will be able to migrate through  
10 these lower permeability zones over the life of the  
11 KN08 and -- and 9 pads.

12 When closely tied to the confinement strata  
13 stratigraphy, GCMS is an important tool in predicting  
14 the vertical rise of steam within both the reservoir  
15 and overlying confinement strata units.

16 Mr. Lung, could I please bring up Exhibit 043.002,  
17 Tab 7A, PDF page 180.

18 THE COURT REPORTER: Mr. Lavigne, can you just slow  
19 down with the terms.

20 A J. LAVIGNE: Okay. Sorry. Thank you.

21 If I could please see the figure at the bottom of  
22 the page, Mr. Lung.

23 Thank you very much.

24 Graphically depicted on the left, connected  
25 reservoirs show a gradual downward decrease in light  
26 hydrocarbons due to preferential biodegradation of

1 light hydrocarbons at the oil/water contact. In the  
2 centre, baffles are identified by bends in the downward  
3 decreasing profile. On the right, barriers show two  
4 separate downward decreasing hydrocarbon profiles that  
5 are laterally offset.

6 Canadian Natural uses a third-party vendor to  
7 conduct the analysis and follows industry standard  
8 practices for plotting the data. Wells are  
9 strategically sampled at a reasonable density based on  
10 known stratigraphic surfaces and mudstone interbeds  
11 within the reservoir and confinement strata intervals.  
12 GCMS is used as a qualitative test of stratigraphic  
13 surface and is but a part of Canadian Natural's overall  
14 evaluation program. However, when closely tied to  
15 stratigraphy and analyzed in the context of production  
16 temperature data, it has been observed that the rise of  
17 steam chambers has been halted across horizons that  
18 sometimes display relatively minor concentration  
19 changes.

20 Again, molecular diffusion and hydrocarbon  
21 biodegradation happen over geological time and  
22 geochemical indications of baffles are likely to be  
23 barriers to steam over the time scale of a SAGD  
24 operation.

25 Throughout this presentation, GCMS -- GCMS plots  
26 like this will be used to support Canadian Natural's

1 position that barriers and baffles exist in the strata  
2 between the McMurray formation reservoir and the  
3 Mannville II gas pool at the top of the Wabiskaw B.

4 Mr. Lung, could I please have up Exhibit 15.01,  
5 Tab 4, PDF page 107.

6 Thank you.

7 We will now examine the confinement strata over  
8 the KN08 and KN09 boxes in detail. Looking at the  
9 stratigraphic column in the KN08 and 9 area,  
10 bitumen-saturated intervals are shown in green,  
11 including the McMurray reservoir and the overlying  
12 Wabiskaw D sandstone. On the right-hand side of the  
13 column, note the position of the regional B2 and A2  
14 mudstones, which were defined in the regional  
15 geological study, and the mid-B1 mudstone in the -- in  
16 the dashed line defined by the KN06 decision report.  
17 Where present, these three regional mudstones have been  
18 deemed to be effective barriers to steam.

19 Over the KN08 and 9 drainage boxes, the Wabiskaw D  
20 incision cuts deeper and removes portions of the upper  
21 B1 regional sequence across the centre of the KN08 --  
22 across the centre of the KN09 box and the northern  
23 third of the KN08 drainage box. This incision never  
24 cuts down to the level of the mid-B1 mudstone, and as  
25 Canadian Natural will demonstrate, this widespread  
26 regional barrier is present over the drainage boxes.

1           North of the boxes where it cuts deeper, the  
2 Wabiskaw D incision contains thick saturated  
3 sandstones. These sandstones are flanked and overlapped  
4 by two mudstone-prone facies, the Wabiskaw D  
5 non-reservoir, and the basal upper Wab D heterolithic  
6 unit, both of which hold back gas caps.

7           To the south, over the KN08 and 9 boxes, the  
8 incision shallows, and while the basal sandstone is  
9 much thinner, the two mudstone units are present.  
10 Canadian Natural will demonstrate that, where present,  
11 these additional units would also be expected to  
12 contain steam.

13           Mr. Lung, could I please bring up -- my apologies;  
14 I'll -- one second. Sorry -- Exhibit 050.003, Tab 6,  
15 PDF page 51.

16           Thank you.

17           Graphically illustrated, an annotated seismic  
18 section with wells projected on it demonstrates the  
19 distribution of confinement strata over the KN08 and  
20 KN09 drainage boxes. Looking at the total confinement  
21 strata present, the post-B2 non-reservoir in grey shows  
22 variable thickness. The regional B1 sequence in green,  
23 including the dashed mid-B1 mudstone, is present over  
24 both boxes, where it is cut out by deeper Wabiskaw D  
25 incision just north of the KN09 drainage box. The thin  
26 A2 mudstone in red is present over the southern

1 two-thirds of the KN08 drainage box on the left.

2 The two Wabiskaw D confinement strata units in  
3 purple are undifferentiated in this diagram but can be  
4 seen to cover the entirety of both boxes where the  
5 incision shallows to the south on the left. Similarly,  
6 the thin Wabiskaw C in blue also covers the entirety of  
7 the boxes.

8 Could I please bring up Exhibit zero -- 01.01,  
9 Figure 2-19, PDF page 53.

10 That's okay. Sorry. I'll continue with this  
11 figure. This isn't exactly the one I was hoping. My  
12 mistake.

13 In the AA -- oops. Did I -- I'm sorry.

14 Q J. JAMIESON: Mr. Lavigne, if I could  
15 assist --

16 A Yeah.

17 Q -- because -- is this the one you're looking for?

18 A Yes.

19 Q It's on the same one, but the exhibit number is towards  
20 the end, I believe. It's Exhibit 15.01. That's the --  
21 or the hearing submission. Tab 9.

22 A 15.01, Tab 9, PDF page 16 -- 216? Okay. I'm going to  
23 just continue.

24 Q If that's not the right one, the next reference is  
25 right there, 219. Page 219.

26 A That's not it.

1           Okay. Last try. Could we please try page 16.

2           Okay. My apologies. I don't have the correct  
3           reference.

4           I'm sorry, Mr. Lung. Could I please have page 216  
5           of that document. My apologies for -- that -- that --  
6           that's it. Thank you very much. Sorry about the  
7           confusion.

8           I'll now describe the confinement strata units  
9           in -- in detail. The post-B2 non-reservoir unit occurs  
10          directly above the McMurray formation SAGD reservoir.  
11          This unit consists of a muddying upwards package of  
12          inclined heterolithic strata with 'V' shales greater  
13          than 50 percent.

14          Similar deposits have been well studied in  
15          outcrops of the McMurray formation north of Fort  
16          McMurray where individual mudstone beds may be traced  
17          for tens to over a hundred metres and their geometry  
18          and depositional character are well documented.

19          Could I please have Exhibit 050.003, Tab 16, PDF  
20          page 61.

21          Thank you.

22          As mentioned, point bar facies are well understood  
23          in both modern and ancient settings. The image on the  
24          right shows a section of the modern Bow River south of  
25          Strathmore, Alberta. Note the position and frequency  
26          of abandoned reaches of channel left of centre in the

1 figure. These portions of abandoned channels represent  
2 incipient mud plugs and -- as they will ultimately be  
3 filled with mudstone deposits. The effects of  
4 differential compaction on mudstone such as these will  
5 be discussed in more detail later in Canadian Natural's  
6 direct evidence. This reach of the Bow River valley  
7 bears a striking similarity to the post-B2 reservoir  
8 isopach map over the KN08 and KN09 boxes in the lower  
9 left, where mudstone abandonment plugs are highlighted  
10 in grey.

11 Note the yellow shaded area corresponds to the  
12 post-B2 incision valley. The variability in post-B2  
13 non-reservoir unit thickness is explained by the  
14 distribution of these mud plugs in relation to top set  
15 mud beds and the position of the KN08/9 drainage boxes  
16 on the inside bend of the post-B2 incision valley.

17 While the mudstone-dominated character of the  
18 post-B2 non-reservoir would, where present, be expected  
19 to contain steam, many well -- many wells contain beds  
20 that suggest that steam could be contained below this  
21 mudstone-dominated facies.

22 Could I please have Exhibit 15.01, Tab 11, PDF  
23 page 21.

24 That is not it. Oh, I'm sorry. This is the  
25 correct figure. My apologies.

26 In the 100/1-3 well, within an otherwise



1 continuous connected hydrocarbon column, an upwards --  
2 an upwards increasing shift in hydrocarbon  
3 concentrations -- sorry. Within an otherwise connected  
4 column, an upwards shift in hydrocarbon columns occurs  
5 at a high gamma ray mudstone layer at about 580 metres,  
6 which suggests the low permeability mudstone has  
7 affected the hydrocarbon concentrations in the column.  
8 Geochemistry would suggest this is a baffle rather than  
9 a barrier. Both below and above this point, the  
10 concentration profile has equilibrated and established  
11 a uniform gradient.

12 The fact that it hasn't done so at 580 metres is  
13 likely a result of lower permeability in the mudstone  
14 unit. While oil concentration profiles equilibrated  
15 over geological time, practical experience in operating  
16 SAGD reservoirs shows that in this horizon in this  
17 well, steam is most likely to be halted at this  
18 mudstone. The top -- the top of the -- the expected  
19 steam chamber top would be picked at this horizon and  
20 production forecasts would be based on its height above  
21 the injector.

22 After steaming operations have begun, temperature  
23 logs can help to understand steam chamber development.  
24 The numerous producing SAGD pads within its portfolio  
25 provide Canadian Natural with well understood analogs  
26 with which to better predict and understand complex

1 reservoirs and operational data.

2           Could I please have Exhibit 15.01, Tab 12 --  
3 yeah -- PDF 224.

4           Thank you.

5           On the left, PNX logs in the 102/6-4 well show  
6 that the steam top has been held up by mudstone-rich  
7 IHS. Increased gas saturation above the steam  
8 temperature top is due to conductive heating but steam  
9 remains contained.

10           On the right, PNX suite of logs in the 11-4 well  
11 for two thousand -- 2022 and 2023 demonstrate that a  
12 mud class breccia has been holding up steam for  
13 approximately one year. In these logs from the Kirby  
14 north Pad KN02, the year-over-year increase in gas  
15 saturation associated with the development of the steam  
16 chamber, which is at 200 degrees Celsius.

17           This nearby analog was not available at the time  
18 of the KN06 hearing. SAGD is very sensitive to  
19 vertical permeability changes, and, where present, the  
20 post-B2 non-reservoir base is effective at confining  
21 the steam chamber. The KN02 pad is in the same post-B2  
22 incision valley as the KN08 and 9 pads. The  
23 stratigraphy is virtually identical to that at KN08 and  
24 KN09, and therefore these data are useful in  
25 understanding the predicted limits to vertical steam  
26 chamber growth. The chamber is contained and will not

1 be able to rise and affect the overlying GOB zone.

2 Moving up above the post-B2 non-reservoir, the  
3 next unit in the confinement strata is the regional B1  
4 sequence and, in particular, the mid-B1 mudstone.

5 Despite the heterolithic nature of these regional  
6 sequences and variations in the relative percentages of  
7 sandstone and mudstones, the units are correlatable  
8 over the entirety of the KN08 and KN09 drainage boxes.  
9 These units contain a high visual mud index.

10 Examination of well logs and cores demonstrates  
11 that the mid-B1 mudstone can also be correlated over  
12 the adjacent KN08 and 9 boxes. Like KN06, the unit  
13 also displays some variation in facies, and, similarly,  
14 GCMS also confirms that the B1 regional sequence also  
15 contains baffles and barriers that would be expected to  
16 provide steam containment over KN08 and 9.

17 Could I please have Exhibit 050.003, Tab 5.

18 As illustrated in Canadian Natural's reply  
19 submission, these core photos from across the KN08 and  
20 9 drainage boxes demonstrate that while the lithofacies  
21 of the upper and lower B1 units are heterolithic and  
22 variable, they contain a high mudstone percentage.  
23 They also demonstrate that the mid-B1 mudstone which  
24 overlies the marine flooding surface is widespread and  
25 was deposited over the KN08 and KN09 drainage boxes.

26 My apologies. I just need one second.

1 J. JAMIESON: Commissioner Chiasson, I'm  
2 just watching the clock here. We're just past noon. I  
3 believe this witness has 15 -- 10 to 15 minutes left to  
4 go. So I'm in your hands. If you want to break for  
5 lunch, he can come back and finish up then.

6 COMMISSIONER CHIASSON: If it's about 15 minutes,  
7 let's continue and finish -- finish this piece.

8 J. JAMIESON: Thank you.

9 A J. LAVIGNE: In this figure from the reply  
10 submission, there are differences between the  
11 distribution, the mid-B1 mudstone as proposed by ISH,  
12 where the mid-B1 mudstone has been interpreted to be  
13 removed in the blue area.

14 And -- if -- if I could please have  
15 Exhibit 050.003, Tab 7.

16 Thank you.

17 As discussed in its reply submission, Canadian  
18 Natural acknowledges that the 100/01-03 well, in  
19 the well, the typical mid-B1 lithofacies is not  
20 present. At this level, an upper B1 tidal channel  
21 appears to have locally erosionally removed the mid-B1  
22 mudstone. Within this channel, a mudstone rich  
23 interbedded lithofacies has been deposited at  
24 approximately mid-B1 level.

25 The three-well cross-section in the top centre of  
26 offsetting wells demonstrates that typical mid-B1

1 mudstone facies is present in surrounding wells and  
2 that the 100/1-3 well represents an isolated tidal  
3 channel which are normal parts of tidal flat sequences.  
4 The lateral extent of this channel is small, and there  
5 is no significant down cutting through the underlying  
6 mudstone prone lower B1 sequence.

7 Can I please have Exhibit 15.01, Tab 11, PDF  
8 page 219.

9 Could we please scroll down one page. Down one  
10 more, please. One more. One more. Could I try 219,  
11 please. 218, perhaps. Yeah. That's it. Thank you.  
12 My -- my mistake. Sorry.

13 GCMS analysis in the previously mentioned well  
14 shows that this heterolithic unit may have acted as a  
15 baffle to hydrocarbon biodegradation and that the upper  
16 B1 unit contains numerous breaks in the hydrocarbon  
17 concentration profile suggesting a baffle noticed by  
18 these back stepping of values.

19 It's worth noting, as previously mentioned, that  
20 the predicted steam top in this well would occur lower  
21 at about 580. There's a well equilibrated hydrocarbon  
22 column up into the lower B1 sequence where there is a  
23 decrease in concentration, suggesting a barrier in the  
24 lower B1. Where the -- where the tidal channel has  
25 locally cut into the mid-B1 mudstone, the decrease --  
26 upwards decreasing concentration profile suggests

1 barriers or potentially baffles. But above this at the  
2 base of the Wabiskaw D, the sharp increase -- sorry --  
3 the sharp decrease in concentration profiles supports  
4 the existence of a barrier at this -- at this spot.

5 This suggests that while the channel feature has  
6 resulted in the very localized removal of the mid-B1  
7 mudstone, other baffles and a strong barrier are  
8 present above that would act to contain steam. This  
9 reinforces the concept of confinement strata where no  
10 single unit is relied to contain steam but all units  
11 work together in -- in tandem.

12 In summary, we -- we spent some time on the B1  
13 sequence and the mid-B1 mudstone. It's worthwhile to  
14 summarize the units as confinement strata before moving  
15 on to others. In summary, the facies of the regional  
16 B1 sequence consist of bioturbated heterolithic  
17 sandstones and mudstones. They are separated by the  
18 thin but laterally extensive marine mid-B1 mudstone.  
19 This mudstone can be correlated regionally over the  
20 nearby KN06 box and beyond the Kirby north initial  
21 development area several miles to the east. It can be  
22 readily identified on logs and in core.

23 In one well, the KN08 drainage box appears to have  
24 been removed by a very localized tidal channel, but  
25 GCMS data suggests that in this well baffles exist  
26 within the channel itself and there's a barrier at the

1 top of the upper B1 base of the Wabiskaw D.

2 Could I please have Exhibit 15.01, Tab 7, PDF  
3 page 193.

4 I'm sorry. Could we please have -- from the same  
5 document -- Tab 8, PDF page 198. Page 326 instead,  
6 please. Thanks for your patience, Mr. Lung.

7 The A2 mudstone has a very distinctive log --  
8 signature and easily identifiable in core. Canadian  
9 Natural has provided mapping that shows the aerial  
10 extent of the regional A2 mudstone over the KN08 and  
11 KN09 drainage boxes. It has locally been removed by  
12 the Wabiskaw D aged incision. Where present, the A2  
13 mudstone has been shown to provide a barrier separating  
14 underlying bitumen reservoirs from the overlying gas  
15 resources. But even where it has been removed, other  
16 confinement strata exist to assist in providing steam  
17 containment.

18 Moving on to the Wabiskaw D. As mentioned, it has  
19 cut down into the upper McMurray sequence over the KN08  
20 and 9 drainage boxes. It has deposited two mudstone  
21 prone units that act as confinement strata. The lowest  
22 is the Wabiskaw D non-reservoir unit.

23 Could I please have Exhibit 043.002, Tab 1E, PDF  
24 page 29.

25 Thank you.

26 In order to better understand the Wabiskaw units

1 above the KN08/KN09 drainage boxes, one must examine  
2 the Wabiskaw D more broadly in the Kirby north area.  
3 In the map on the left, thick Wabiskaw D sandstones --  
4 there is no map. Oh, thank you. In the bottom left --  
5 thick Wabiskaw D sandstones in orange exist just north  
6 of the KN08 and 9 drainage boxes. It occurs in a  
7 southwest/northeast oriented title scour that thins out  
8 over the top of the KN08/KN09 drainage boxes.

9 To understand the distribution of facies in the  
10 Wabiskaw D, Canadian Natural has submitted this  
11 geomodel slice that shows two Wabiskaw D  
12 mudstone-dominated units that onlap and drape the  
13 sandstone body. The Wabiskaw D incision does not cut  
14 as deeply, and the sandstone component thins  
15 dramatically to the south over the KN08 and KN09 boxes.  
16 Despite this, the two Wabiskaw D mudstone-prone facies  
17 are correlatable over the KN08/KN09 drainage boxes.

18 Could I please have Exhibit 15.01, Tab 16, PDF  
19 page 327.

20 Thank you.

21 The Wabiskaw D non-reservoir unit occurs in a  
22 southwest/northeast oriented -- orientation along the  
23 flank of the Wabiskaw D pay trend previously mentioned.  
24 It covers most of the KN08 box and the western  
25 two-thirds of the KN09 box. It is identified in core  
26 by a high volume of characteristically dark grey



1 mudstone and sits directly on top of the bitumen  
2 saturated Wab D sandstone.

3 Can I please have Exhibit 01.01, PDF page 142 and  
4 143. So we could start at 142, perhaps. Could I  
5 request to go to 143, please.

6 Thank you.

7 This is typical facies of the Wab D non-reservoir  
8 units. It has a visual mud index of about 60 percent.  
9 While the individual mudstone beds within the unit are  
10 laterally likely on the decimetre to metre scale, as a  
11 package -- the package as a whole is mappable over  
12 several kilometres. This unit locally holds back small  
13 gas caps in underlying -- in the underlying Wab D  
14 sandstone, which supports its potential sealing  
15 capacity.

16 Could we please go up -- sorry -- to 142. Yeah.  
17 Okay. That's okay. We can use this as well.

18 Above the Wab D non-reservoir, the basal upper  
19 Wabiskaw heterolithic unit is the highest of the  
20 Wabiskaw D confinement strata. The basal upper  
21 Wabiskaw D unit is a mudstone-prone interval similar in  
22 character to the underlying Wabiskaw D non-reservoir  
23 unit. To the north, it marks the base of a coarsening  
24 upward cycle near the top of the Wabiskaw D unit. Over  
25 the KN08/KN09 drainage boxes where the Wabiskaw D  
26 incision is thinner, it is composed predominantly of

1 dark grey mudstone with centimetre scale saturated  
2 sandstone interbeds and a visual mud index of over  
3 50 percent. Over the boxes, it sits directly on top of  
4 the Wabiskaw D non-reservoir unit where the contact is  
5 typically demarcated by concretionary cement.

6 Could I please have 15.01, PDF page 2. My  
7 apologies. Page 328. Thank you.

8 This is an isopach map of the basal upper  
9 Wabiskaw D unit, and note how it occurs in the same  
10 region where the A1 mudstone has been removed. Its  
11 high visual mudstone index suggests it would be  
12 expected to be a barrier to the vertical rise of steam.

13 Could I please have Exhibit 01.01, PDF page 370.

14 So what I'm going to do is I'm going to walk down  
15 here the -- the basal upper Wab D unit is the dark  
16 mudstones at the bottom of this slide.

17 Could we please go down to page 371?

18 Thank you.

19 This series of core photos is directly beneath the  
20 previously shown ones. The base of the basal upper  
21 Wabiskaw D heterolithic unit is marked with a red line.  
22 Note the light oil saturation in the three box -- in  
23 the three tubes of sand immediately below this. This  
24 is a good illustration of the basal upper Wab D  
25 heterolithic unit's ability to act as a barrier to  
26 steam. In this particular well, the lighter saturation

1 marks the presence of a gas cap at the top of the  
2 Wabiskaw D in this well. Note the light saturation at  
3 the top of the sand.

4       The results of the analysis in this well are  
5 significant for two reasons: Firstly, at a location  
6 where the total confinement strata is relatively thin,  
7 multiple high-quality barriers still exist. Secondly,  
8 as can be seen with the basal upper Wab D unit in this  
9 well, intervals with high V shale greater than  
10 50 percent can still be seen to contain gas caps.  
11 Units that are capable of containing gas caps would  
12 also be capable of containing steam.

13       A summary of GCMS data shows a consistent decrease  
14 in hydrocarbon compounds across the top of the McMurray  
15 to the base of the Wab D. There is strong geochemical  
16 evidence that there is a hydrodynamic barrier that has  
17 not allowed hydrocarbon concentrations to equilibrate  
18 across the base of the Wab D over geological time. It  
19 is therefore more likely than not that the barriers  
20 that exist to impede this uniform biodegradation over  
21 geological time will also prevent the passage of steam  
22 over the life of operations of KN08 and KN09 pads.

23       The Wabiskaw C is the highest interval of  
24 confinement strata units that separate bitumen from --  
25 in the McMurray formation from the gas in the  
26 Mannville II pool at the top of the Wabiskaw B.

1           Could I please have Exhibit 01.01, PDF page 370.

2           Thank you.

3           The Wabiskaw C represents a transgressive sheet of  
4 muddy sandstone with a visual mud index of about  
5 70 percent that has been nearly entirely bioturbated to  
6 the point that very few primary sedimentary structures  
7 have been preserved. In core, the bioturbation and  
8 lighter colour make it easily differentiated from the  
9 dark mudstones of the Wabiskaw D below and the intact  
10 bedding and variably saturated sandstones of the  
11 overlying Wabiskaw B. The Wabiskaw C is present over  
12 the entirety of the KN08 and 9 drainage boxes in  
13 thicknesses greater than 1 metre. The bioturbation has  
14 introduced clay into the pore throats and the resultant  
15 vertical permeability is low.

16           In summary, over the KN08 and KN09 drainage boxes,  
17 six low vertical permeability units are present in  
18 aggregate thickness of 3.9 to 14.3 metres, as  
19 discussed, while individual confinement strata units  
20 showed variable thickness and character, an aggregate  
21 package of predominantly mudstone-rich facies with low  
22 vertical permeability exists over the KN08 and KN09  
23 drainage boxes. Stratigraphic context is a very  
24 important factor in assessing a unit's ability to  
25 provide confinement of steam. GCMS analysis shows that  
26 the confinement strata units display changes in

1 hydrocarbon concentrations that suggest barriers to  
2 biodegradation over geological time that would be  
3 expected to provide steam chamber confinement over the  
4 life of the KN08 and KN09 pads. This is particularly  
5 true of the regional B1 sequence, including the mid-B1  
6 mudstone, and the Wabiskaw D, which seems to act as a  
7 barrier in virtually all wells analyzed.

8         Within the post-B2 reservoir, GCMS supports the  
9 presence of barriers and baffles near the top of the  
10 reservoir. Operational experience suggests steam will  
11 be effectively contained below the post-B2  
12 non-reservoir unit.

13         The regional mid-B1 mudstone was deposited over an  
14 area much larger than the KN08 and 9 drainage boxes.  
15 It sits in the middle of the regional B1 sequence,  
16 which contains a high volume of shale. GCMS suggests  
17 numerous barriers and baffles within this interval.

18         The regional A2 mudstone, where present, acts as a  
19 barrier. The Wabiskaw D contains two mudstone-prone  
20 units that are deposited over the area where the A2  
21 mudstone has been removed. GCMS defines a strong  
22 barrier at the base of the Wabiskaw D in all the wells  
23 analyzed, and gas caps are trapped beneath these units.  
24 The Wabiskaw C has a high 'V' shale and occurs  
25 everywhere over the drainage boxes.

26         Canadian Natural concludes that there is an

1 effective barrier or top seal over the bitumen bearing  
2 McMurray formation that would not be permeable to steam  
3 over the life of the KN08/KN09 drainage boxes.

4 Thank you for your patience as I struggled with  
5 some figures.

6 COMMISSIONER CHIASSON: Thank you, Mr. Lavigne.

7 J. JAMIESON: This would be a good time to  
8 break. I may have misspoke earlier, so that concludes  
9 addressing hearing the first part of Hearing Issue 1,  
10 and it will be Mr. Lavigne that continues when we come  
11 back from the break.

12 COMMISSIONER CHIASSON: Okay. Thank you.

13 All right. We are at 12:30. We will reconvene at  
14 1:30. We would encourage folks to -- the room won't be  
15 locked, so if you have belongings that you're concerned  
16 about security, please take them with you rather than  
17 leaving them in the room.

18

19 PROCEEDINGS ADJOURNED UNTIL 1:30 PM

20

21

22

23

24

25

26

1 Proceedings taken at Govier Hall, Calgary, Alberta

2

---

3 February 6, 2023

Afternoon Session

4

5 Cindy Chiasson

Panel Chair

6 Brian Zaitlin

Panel Member

7 Meg Barker

Panel Member

8

9 William McClary

AER Legal Counsel

10 Shannon Peddlesden

AER Legal Counsel

11 Andrew Lung

AER Staff

12 Denise Parsons

AER Staff

13 Anastasia Stanislavski

AER Staff

14 Fahad Hamdan

AER Staff

15 Maryam Rahimabadi

AER Staff

16 Susan Harbidge

AER Staff

17 Maksim Khaferllari

AER Staff

18 Felix Chiang

AER Staff

19 Scott Botterill

AER Staff

20 Baohong Yang

AER Staff

21 Elwyn Galloway

AER Staff

22

23 J.P. Jamieson

For Canadian Natural

24

Resources Limited

25

26

1 M. Riley For ISH Energy Ltd.

2 A. McLeod For ISH Energy Ltd.

3

4 S. Murphy, CSR(A) Official Court Reporter

5 S. Burns, CSR(A), RPR, CRR Official Court Reporter

6

---

7 (PROCEEDINGS COMMENCED 1:32 PM)

8 COMMISSIONER CHIASSON: Okay. Thank you, everyone.

9 So we're now back from the break, so, Ms. Jamieson,  
10 just as a time check. By my calculations, time-wise  
11 we're close to about halfway through the time allotted  
12 for CNRL's direct. Does that jive with where you're --  
13 you were expecting to be in your materials?

14 J. JAMIESON: Yeah, I -- I have to be  
15 honest. I think we're about a third of the way through  
16 our presentation, but I also know there's some  
17 opportunities to condense further in. Mr. Lavigne's  
18 and Mr. Sverdahl's is sort of the most dense part of  
19 the presentation, so I think if we can just proceed on  
20 that basis.

21 COMMISSIONER CHIASSON: Okay.

22 J. JAMIESON: We'll endeavour to --

23 COMMISSIONER CHIASSON: Okay. Let's proceed. We'll  
24 see how far we get. At the very latest, we will plan  
25 to take a break at 3:30.

26 J. JAMIESON: Understood. Thank you.



1 COMMISSIONER CHIASSON: If you don't reach the end of  
2 your evidence beforehand.

3 J. JAMIESON: Yes, that sounds good. Thank  
4 you.

5 COMMISSIONER CHIASSON: So Panel, please proceed.

6 DEVIN OLLENBERGER, THOMAS BOONE, LENNON ROCHE,  
7 MARC SCRIMSHAW, Previously Affirmed  
8 GERARD IANNATONE, JASON LAVIGNE, SCOTT SVERDAHL,  
9 DALE WALTERS, XIANG WANG, PETER THOMSEN, SCOTT BARLAND,  
10 Previously Sworn

11 A J. LAVIGNE: Thank you.

12 Thank you for this. I'm going to move up through  
13 a series of core photos. The first part of the Hearing  
14 Issue 1 dealt with the presence of barrier or an  
15 aggregation of strata expected to confine steam, and  
16 just very briefly, before we move on to the assessment  
17 of fractures in these intervals, I just wanted to move  
18 quickly up through a core.

19 This is the AA/1-3 well near the centre of the  
20 KN08 pad, and the bitumen-saturated sands at the bottom  
21 is the top of the reservoir, and this is where we would  
22 interpret -- we would predict the top of the steam  
23 chamber will be. And so there is -- there is a unit of  
24 post B2 non-reservoir. Then we move up into the more  
25 heavily bioturbated heterolithic deposits of the lower  
26 B1.

1           Could we please move up one photo or -- am I in  
2 control as well? Sorry. Or -- okay. Okay. Thank  
3 you.

4           In the bottom three tubes is the lower B1 regional  
5 sequence, which contains locally some paleosols and  
6 coals that occur near the top of that. Then we can see  
7 the regional mid-B1 mudstone. Above it in the top  
8 tubes is the -- the bioturbated deposits of the upper  
9 B1 regional sequence. And if we could go up another  
10 one, please. We pass up in through there to the top of  
11 the upper B1 sequence. We can note that it's  
12 heterolithic -- its heterolithic nature but also its  
13 relatively high V shale component. The base of the  
14 Wabiskaw D incision can be seen with the dark grey  
15 mudstones in this Wabiskaw D sandier interval.

16           Go up one more, please.

17           And then we pass into the two high V shale  
18 Wabiskaw D confinement strata units. As mentioned,  
19 this is the contact between the top Wab D non-reservoir  
20 and the basal upper heterolithic unit.

21           If we could go up another, please.

22 COMMISSIONER CHIASSON:     Actually, Mr. Lavigne, if you  
23 don't mind, one brief question. I'm not a geologist,  
24 and so this is my non-geologist -- can you just explain  
25 to me briefly what you mean by "V shale".

26 J. LAVIGNE:                     Sorry. The volume of shale,

1           so the percentage of fine grain material relative to  
2           the entire unit. So 50 percent V shale would be half  
3           shale, half sand --

4           COMMISSIONER CHIASSON:     Okay.

5           J. LAVIGNE:                   -- or mudstone.

6           COMMISSIONER CHIASSON:     Super. Thank you very much.

7    A     J. LAVIGNE:                   So the two Wabiskaw D units  
8           with a high volume of shale, high mud percentage. Then  
9           the base of the Wabiskaw C, which is the heavily  
10          bioturbated heterolithic package, and then we see the  
11          base of the Wabiskaw B.

12                 And if we could please go up another slide. We  
13                 could see abundant calcite concretions within the unit  
14                 and the lighter saturation that's starting.

15                 And if we could go up one more, please. And this  
16                 is getting up into the Mannville II gas pool that  
17                 occurs at the top of the Wabiskaw B in these lower  
18                 saturation units.

19                 So in summary, there's a sequence of multiple  
20                 units with high mudstone content and low vertical  
21                 permeability between the top of the McMurray formation  
22                 reservoir and the base -- and the Wabiskaw B, which  
23                 contains the Mannville II gas pool.

24                 Now -- now, we'll turn -- excuse me -- to the  
25                 second hearing issue -- or part of the first hearing  
26                 issue, which is the determination of whether or not

1 there are fractures in the strata between the McMurray  
2 formation and the Wabiskaw B member.

3 Canadian Natural believes it's very important to  
4 the success of a SAGD project to determine if faults  
5 and fractures are present as they represent a risk to  
6 steam containment. Any loss of steam from the SAGD  
7 chamber would be very detrimental to the efficiency of  
8 the operation and would severely negatively affect  
9 project economics.

10 Also, as previously discussed, Canadian Natural is  
11 a majority working-interest partner in the Wabiskaw B  
12 gas pool and has a common goal to protect the future  
13 production of gas resource once the SAGD bitumen  
14 operations are complete.

15 Canadian Natural has an extensive  
16 multidisciplinary workflow to identify the magnitude  
17 and locations of potential faults and fractures, not  
18 just within the confinement strata units but also  
19 within the SAGD reservoir zone, the caprock, and deeper  
20 Paleozoic sediments. This includes geological and  
21 geophysical structure mapping, 3D seismic amplitude  
22 mapping, as well as core and image log interpretation.  
23 This data is then integrated with a review of  
24 operational data such as pressure monitoring of the  
25 McMurray bottom water versus pressures observed in the  
26 gas cap and a review of lost circulation events in

1 nearby wells.

2 Post-steam, Canadian Natural also regularly  
3 reviews data for any indications of loss of steam,  
4 including loss of steam via potential faults or  
5 fractures through RST or PNX logs, 4D seismic, and  
6 continued pressure and steam balance monitoring.

7 We will now discuss the core and image log data  
8 and see how they can be used to identify faults or  
9 fractures.

10 Canadian Natural has conducted a review of its  
11 core and image log data at KN08 and 9. Well logs, core  
12 data, and image logs were reviewed from 43  
13 stratigraphic test wells in the KN08 and 9 areas. No  
14 faults or natural fractures were observed within the  
15 confinement strata intervals on 24 cored wells.  
16 Additionally no fractures were observed on 36 image  
17 logs within the confinement strata units.

18 Could I please bring up Exhibit 01.01, PDF  
19 page 272. Thank you.

20 Prior to examining Canadian Natural's core  
21 evidence, it is important to take a moment to describe  
22 the difference as observed in core between in situ  
23 natural fractures that are present at depth and induced  
24 fractures that were created by the coring process  
25 itself. Fractures are often induced by the coring  
26 process due to in situ compressional stresses in the

1 vicinity of the bottom hole. They can be distinguished  
2 from natural -- naturally occurring fractures observed  
3 in core by their distinctive shapes and  
4 characteristics. Specifically, coring-induced  
5 fractures can be characterized as petal centre line or  
6 petal line -- petal centre line fractures as per the  
7 schematic on the left. Centre line fractures wander  
8 from side to side, down the middle of the core. Petal  
9 fractures are curved and often propagate downwards  
10 towards the centre of the core where they may join  
11 centre line fractures. Vertical cracking is also  
12 commonly observed in oil sands due to degassing of the  
13 core on retrieval from depth. In contrast, natural  
14 fractures, as illustrated in the figure on the right,  
15 are plainer and usually intersect the entire core.

16       Could I please pull up Exhibit 050.003, Tab 8,  
17 page 53. Thank you.

18       In its January 2024 geology report, ISH referenced  
19 the online blog of Ogilvie 2021 and showed Figure 5B in  
20 the upper left to illustrate coring-induced petal  
21 fractures. Figure 5A, also from Ogilvie, was not shown  
22 in the submission which illustrates open coring-induced  
23 centre line fractures. It should be noted that  
24 Figure 5A bears a striking resemblance to the images of  
25 fractures ISH observed in cores over the KN08 and  
26 KN09 boxes shown on the left -- on the right.

1 Canadian Natural believes all of the fractures ISH  
2 submitted are coring induced. Furthermore both of  
3 these examples -- I'm sorry -- the two centre examples,  
4 ISH Figure 6 and ISH Figure 9, are from  
5 calcite-cemented intervals. These drilling-induced  
6 fractures in these concretions commonly happen due to  
7 an increase of weight on the bit during the drilling  
8 process in order to continue to core through these  
9 hard, dense intervals. These are not indicative of in  
10 situ natural fractures.

11 The oil seen on the fracture plains wicks into the  
12 fracture plain during the coring process and is not  
13 indicative of a natural in situ fracture network  
14 through which oil can migrate.

15 Other examples from ISH's hearing submission are  
16 shown in pairs of photos throughout the slide. In the  
17 photo pairs, the photos submitted by Canadian Natural  
18 are on the left, and the -- ISH has interpreted  
19 fractures and annotated them on the paired right-side  
20 image.

21 Note the hackily nature of the fracture plains and  
22 the similarity in appearance to the induced fractures  
23 referred to in Ogilvie Figure 5A.

24 The frequency of these fractures is very small and  
25 even if present at depth would not be indicative of a  
26 connected natural fracture network that could be a

1 pathway to steam. However, Canadian Natural reiterates  
2 that there is no evidence of natural fractures within  
3 the confinement strata interval over the KN08 and KN09  
4 drainage boxes, and the examples highlighted by ISH are  
5 coring induced.

6 Could I please have Exhibit 01.01, PDF page 273.

7 Thank you. Similarly, it would be useful to  
8 quickly describe how fractures are interpreted on image  
9 logs. Referring to the figure on the top, an image log  
10 can be thought of as an unrolled section of the  
11 wellbore surface as shown. Dipping bedding plains will  
12 appear as low amplitude sinusoids; horizontal bedding  
13 will be -- will appear horizontal and fractures will  
14 appear as high amplitude sinusoids cutting across the  
15 bedding plains of the image log.

16 An example of a fracture as seen in image logs is  
17 shown on the bottom right where a high amplitude  
18 sinusoid cuts across the low amplitude sinusoids of  
19 bedding and can be easily identified.

20 Could I please have Exhibit 15.01, Tab 25,  
21 page 339. Thank you.

22 Canadian Natural has conducted an extensive review  
23 of its image log data at KN08 and KN09 and has found no  
24 evidence of natural fractures within the confinement  
25 strata. As part of its response to AER, SIR1,  
26 Question 2, Canadian Natural supplied image logs and



1 core photos of coring-induced fractures within the  
2 various confinement strata intervals. The fractures  
3 observed in core in the AA/16-33 wells shown are coring  
4 induced. They are centre line fractures in a  
5 calcite-cemented interval in the Wabiskaw B. They're a  
6 common occurrence in oil sands cores in calcite  
7 concretions as mentioned previously.

8 The image log over this interval shows no fracture  
9 in the image in the bottom right, merely continuous  
10 bedding shown by the continuous low angle sinusoids.  
11 The fractures that can be seen in the core at the top  
12 are not seen at depth in the walls of the wellbore;  
13 therefore, they are not present at depth.

14 Could I please have Exhibit 01.01, PDF page 275.  
15 Thank you.

16 The figure on this slide is an example from this  
17 response showing a portion of the post B2 non-reservoir  
18 strata in the AA/15-34 well. As can be seen in the  
19 core photo, there are some fractures observed which are  
20 interpreted to be coring-induced petal and centre line  
21 fractures. The image log from the corresponding  
22 interval in the upper right shows continuous dipping  
23 beds expected from this muddy ISH confinement strata,  
24 but no high angle -- high amplitude sinusoid features  
25 indicative of natural fractures are present.

26 Note also the effective mud smearing on one of the

1 pads which somewhat obscures the detail in that track.  
2 Additionally sand-filled skolithos-like burrows can be  
3 seen in the core photo but not on the image log. That  
4 is because the burrows are of low density and do not  
5 occur in the walls of the wellbore. They are small  
6 with narrow apertures and are not a viable pathway for  
7 steam.

8           Could I please have Exhibit 050.003, page 55.  
9 Thank you.

10           Canadian Natural has re-examined all of the  
11 features on image logs purchased by ISH that were  
12 interpreted to be fractures as depicted in Table 1 of  
13 ISH's hearing submission. Canadian Natural interprets  
14 the majority of the fractures observed by ISH to be  
15 artifacts caused by tool marks from the imaging tool  
16 marking the wellbore walls rather than natural  
17 fractures.

18           An example of this is shown in the 1AA/11-2 well  
19 at around 436 metres within the Wabiskaw A formation,  
20 which is part of the caprock. Canadian Natural  
21 observed several linear features on the image log  
22 around 436 metres, which are characteristic of tool  
23 marks, not fractures.

24           In the higher-quality static image right of  
25 centre, note how the dark feature at about 436.5 metres  
26 is not continuous over all of the tracks, and

1 continuous horizontal bedding exists higher to the left  
2 of this dipping feature. The three pads starting  
3 second from the left on the dynamic image log show no  
4 evidence of this feature. It does not describe a  
5 sinusoid; therefore, it is not a plain and therefore it  
6 cannot be a fracture.

7 ISH purchased numerous image logs from a  
8 third-party vendor in the Kirby north area and provided  
9 a map of where the interpreted fractures were present  
10 or absent. From this review, the only well from the  
11 purchased image logs that ISH observed a fracture over  
12 the KN08/KN09 pads was in the AA/11-2 well that was  
13 just described as representing tool marks.  
14 Additionally, this fracture as interpreted by ISH was  
15 not within any of the confinement strata units but  
16 rather above the Wabiskaw B gas zone in the caprock  
17 interval.

18 Canadian Natural also reviewed the remaining  
19 fractures identified by ISH on these wells, and as per  
20 Table 1 in the Canadian Natural hearing  
21 submission as -- interpreted that none of the fractures  
22 identified within the confinement strata represent  
23 natural in situ fractures as per Table 12B in Canadian  
24 Natural's reply submission. Canadian Natural concludes  
25 that the fracture density within the confinement strata  
26 values at KN08 and KN09 based on the image log data

1 purchased by ISH is very low to nonexistent.

2 ISH had half -- a petrophysical consulting company  
3 review in detail only 2 out of the 11 image logs  
4 supplied by Canadian Natural. The -- these wells were  
5 located in the southern part of the KN08 drainage box.  
6 HEF identified only four fractures -- sorry. HEF  
7 identified only four fractures within any of the  
8 confinement strata intervals within these two wells.  
9 Canadian Natural states that this would constitute a  
10 very low fracture density within the confinement strata  
11 units if the four fractures observed were, in fact,  
12 natural. However, Canadian Natural has reviewed these  
13 four features identified by ISH in these wells and  
14 concludes they're also tool marks and not in situ  
15 fractures as per the table in Tab 9 of the reply  
16 submission.

17 Additionally, HEF had made some general statements  
18 in their hearing submission report about the fracture  
19 nature and density they had observed in these wells  
20 that are worth restating. For the AB11-34 well:  
21 (as read)

22 There are no obvious faulting indicated by  
23 the bedding data.

24 Fractures are sparse and there aren't enough  
25 of them to comment on orientation trends.

26 [For the AA/9-3 well] There is no obvious

1            faulting indicated by the bedding data.  
2            The image interval has a low-to-moderate  
3            intensity of open fracturing with a similar  
4            intensity and orientation of heel fractures.  
5            There are no observed shears or interpretable  
6            large fractures in the image.

7            Sorry. I would like to correct it in the second well.  
8            It's the AA/9-33 well. My apologies.

9            Finally, as will be discussed further in Canadian  
10           Natural's direct evidence, it is noted that the two  
11           wells selected by ISH for analysis are near the seismic  
12           feature observed as a zone of expected heterogeneity on  
13           the spectral decomposition slice provided in Canadian  
14           Natural's application. ISH did not request HEF to  
15           review the image log provided by Canadian Natural at  
16           the AD/13-34 strat well that directly penetrates this  
17           seismic feature, but it will be shown shortly in  
18           Canadian Natural's direct evidence that there are no  
19           features within the confinement strata as seen on image  
20           logs from this well.

21           In summary, Canadian Natural states from its  
22           evaluation of core and image log data at KN08 and 9 the  
23           following: No natural fractures have been observed  
24           within the confinement strata units on the 24 cores  
25           reviewed by Canadian Natural. Canadian Natural  
26           interprets all fractures observed by ISH on submitted

1 core photos as coring induced, not naturally occurring  
2 at depth. No natural fractures have been observed  
3 within the confinement strata units on 36 image logs  
4 reviewed by Canadian Natural. The majority of the  
5 fractures identified by ISH on the purchased image logs  
6 that they or HEF reviewed are interpreted by Canadian  
7 Natural to be tool marks.

8 Canadian Natural concludes from its review of core  
9 and image log data that the fracture density within the  
10 confinement strata is low to nonexistent and will not  
11 pose a risk to steaming operations at KN08 and KN09.

12 I will now introduce my colleague Mr. Scott  
13 Sverdahl, professional geophysicist, to continue with  
14 Canadian Natural's direct evidence on Hearing Issue  
15 Number 1. He will speak to Hearing Issue 1B.

16 A S. SVERDAHL: Thank you, Mr. Lavigne. I  
17 will now go through Canadian Natural's seismic  
18 evidence, along with a discussion on differential  
19 compaction and Canadian Natural's interpretation as to  
20 where the Wabiskaw B gas at KN08 and KN09 originated.  
21 We will then conclude with Canadian Natural's  
22 operational evidence showing there are no faults or  
23 open natural fractures within the confinement strata  
24 units that would be a risk to steam breakthrough.

25 Reviewing Canadian Natural's seismic data  
26 evidence, we have conducted a thorough review of its 3D

1 seismic data at KN08 and KN09, and we summarize the  
2 following: No large-scale faulting resulting from  
3 underlying salt dissolution or Paleozoic karsting is  
4 observed or expected at the project area. 3D seismic  
5 structure and attribute mapping also show no evidence  
6 of faulting within the confinement strata units.

7 Structural sags from a minor amount of  
8 differential compaction over mud-filled abandonment  
9 channels is present at KN08 and KN09. This causes some  
10 minor folding in the overlying sediments; however,  
11 faults from this amount of differential compaction is  
12 not expected nor is it observed on Canadian Natural's  
13 3D seismic. Canadian Natural disagrees with ISH's  
14 fault interpretation on a representative seismic line  
15 supplied in the application and will proceed to show  
16 why.

17 Could I have up Exhibit 01.01, PDF page 68,  
18 please. Just one moment, please. Sorry. I meant 63.  
19 Page 63. Thank you.

20 As supplied in the application, this map shows  
21 that KN08 and KN09 areas are approximately  
22 30 kilometres west from the Prairie Evaporite salt  
23 dissolution edge. The project is in a regionally  
24 tectonic stable area and faulting or other deep-seated  
25 structural events are not expected here.

26 Could we go to page 64, please. Thank you.

1           This deep seismic line through the application  
2 area extends from the Clearwater to the basement, which  
3 is just below the interpreted red beds reflector on  
4 this line. It confirms that no deep faulting is  
5 present at KN08 and KN09 from salt dissolution.

6           Canadian Natural has supplied a collage of various  
7 seismic cross-sections and attribute maps as well as  
8 depth-converted structure maps at the Wabiskaw B level  
9 and the Paleozoic level in its various submissions.  
10 These seismic interpretation products show no evidence  
11 of faulting or fracturing at KN08 and KN09, but do show  
12 some stratigraphic heterogeneities within the post B2  
13 incision SAGD reservoir trends -- start. These seismic  
14 interpretation products show no evidence of faulting or  
15 fracturing at KN08 and KN09 but do show some  
16 stratigraphic heterogeneities within the post B2  
17 incision SAGD reservoir trends, including some effects  
18 of differential compaction, which will be discussed in  
19 more detail here further.

20           Could I have Exhibit 50.003, page 58, please.

21 Thank you.

22           Canadian Natural would now like to address some  
23 differences in interpretation of faults and/or  
24 fractures with ISH on supplied representative seismic  
25 line at KN08. To start, I'll take a few moments to  
26 orient the Panel as to what is being shown on this



1 figure. The original line as supplied by Canadian  
2 Natural is on the left, and the line interpreted by  
3 ISH, with some additional annotations added by Canadian  
4 Natural, is on the right. The near vertical black  
5 lines on the right image are ISH's interpretive faults  
6 and may have also annotated some near horizontal dashed  
7 lines at or near seismic reflector events.

8 Canadian Natural placed several letters on the  
9 right figure near ISH's faults to serve as a key,  
10 namely, an 'A', 'B', or 'C'. Canadian Natural has also  
11 highlighted an interval at the top of the figure on the  
12 right in pink, which is the stratigraphic interval of  
13 the wet porous Clearwater sands that lie above the  
14 impermeable Clearwater caprock.

15 I'll now describe why Canadian Natural disagrees  
16 with ISH's fault -- fault interpretation on this  
17 seismic line.

18 We will start with the faults marked with the  
19 letter 'A' in the right-hand image. You can observe  
20 there are -- there is a significant amplitude anomaly  
21 at the Wabiskaw B VF level in between the two 'A's.  
22 This amplitude anomaly is likely due to a relatively  
23 thicker gas in the Wabiskaw B in this area relative to  
24 the remainder of the seismic line. ISH has annotated  
25 faults at both edges of this amplitude anomaly.  
26 However, gas amplitude anomalies can cause phase

1 chainage in the seismic response that can be  
2 misinterpreted as faulting.

3 Secondly, there are several faults annotated with  
4 the letter 'B'. ISH has accentuated potential offset  
5 at the locations marked with a 'B' with near horizontal  
6 dashed lines on either side of their interpretive  
7 fault traces as shown in black. When compared to the  
8 original line without the horizontal or vertical  
9 annotations, it is clear that there is only a very  
10 minor amount of structural role at the corresponding  
11 locations with no distinct breaks observed on the  
12 nearest seismic event. Canadian Natural interprets  
13 this to be subtle folding at best, not faulting.

14 ISH has also taken liberties to extend these  
15 postulated fall traces deeper down into the  
16 stratigraphy, including into the confinement strata  
17 units and further down into the McMurray. It is  
18 observed on these deeper seismic events. That  
19 structural role is not even present, let alone a  
20 distinct break on seismic reflection events. This is  
21 not evidence of faulting as speculated by ISH.

22 Thirdly, ISH has marked faults at the edges and  
23 within some observed structural sags in the McMurray  
24 SAGD interval and have extended them vertically up  
25 through the confinement strata units and beyond. These  
26 are marked with the letter 'C'.

1 Canadian Natural observes that minor structural  
2 sag at and above these locations is present to  
3 differential compaction of mud-filled abandonment  
4 plugs. Reviewing the original figure on the right at  
5 the location of these interpreted sags shows no  
6 distinct breaks at the seismic events at or above the  
7 marked letter, letter 'C', which would be indicative of  
8 faulting. It is also noted that the amount of sag  
9 diminishes with shallowing depth above the features.

10 Finally, ISH's fault interpretation has a  
11 significant number of faults extending all the way up  
12 into the zone of the Clearwater sands as marked in  
13 pink. If these faults were real and exist as open  
14 conduits for steam as ISH contends, the Wabiskaw B gas  
15 would have leaked up into the Clearwater sands a long  
16 time ago, and there would be no gas trapped within the  
17 Kirby Upper Mannville II pool.

18 In summary, Canadian Natural maintains that there  
19 is no seismic evidence of faulting at KN08 and KN09  
20 between the McMurray and Wabiskaw B gas and that ISH's  
21 seismic fault interpretation is incorrect and  
22 speculative.

23 Canadian Natural will now discuss differential  
24 compaction present at KN08 and KN09 and go through its  
25 evidence that faults or fractures have not formed  
26 within the confinement strata units as a result of this

1 compaction observed at the proposed drainage boxes.

2       Could I please have Exhibit 50-003, page 60,  
3 please. Thank you.

4       Canadian Natural observes that differential  
5 compaction at KN08 and KN09 is mostly related to areas  
6 of the post B2 incision edges and where mud-filled  
7 abandonment channel plugs within the incision exist.

8       Abandonment plugs are areas where the active  
9 channel within a river system have been cut off and  
10 subsequently filled with mud and clay sediments. This  
11 is very common in fluvial river systems. An example of  
12 this can be seen in the modern Bow River -- actually --  
13 sorry. We can see this in the modern Bow River example  
14 just outside of Calgary.

15       It is important to understand the relative  
16 positioning of abandonment plugs to the adjacent point  
17 bar sand deposits as they compact to a greater degree  
18 than the sands when buried with an -- with overlying  
19 sediment. As sediment continues to be deposited, the  
20 layers overlying the -- overlying also sag into  
21 the pression [sic] at the location of the underlying  
22 mud plug. This process is the primary mechanism of  
23 differential compaction observed at KN08 and KN09 as --  
24 as shown in the schematic in the lower left of this  
25 figure.

26       It is also important to understand the relative

1 scale of the abandonment channel plugs at KN08 and  
2 KN09. Post-B2 incision valleys at Kirby north are  
3 tributary systems on a much smaller scale than deposits  
4 at other McMurray developments, such as at Aspen, which  
5 was referenced to in Dr. Boone's October 10th, 2023,  
6 independent report.

7 Abandonment channel plugs at Kirby north,  
8 including KN08 and KN09, are visually observed to be  
9 approximately 200 to 400 metres in width and 6 to  
10 12 metres deep post-compaction. Visual inspection of  
11 the figure provided in Dr. Boone's report for Aspen  
12 where -- where some minor faulting due to differential  
13 compaction is observed shows it is a much larger  
14 McMurray channel system with abandonment plugs in the  
15 order of 700 to 1,000 metres wide and depths of 25-plus  
16 metres post-compaction.

17 Resulting amount of compaction observed over these  
18 small abandonment plugs at KN08 and KN09 is in the  
19 order of 3 to 5 metres at the Wabiskaw B level. This  
20 is considered a minor amount of structure due to  
21 compaction, and, in Canadian Natural's experience,  
22 faults or fractures are not expected from this small  
23 amount of sag, which has been confirmed by Canadian  
24 Natural's review of its seismic core data and image  
25 logs.

26 Could I get up Exhibit 50-003, PDF 62, please.

1           As you can see on this figure, Canadian Natural  
2 provided a seismic spectral decomposition slice in the  
3 2022 application, which is presented in the upper  
4 middle of this slide. There was a northeast/southwest  
5 feature noted on the map that was labelled "Area of  
6 Expected Heterogeneity", which my colleague is now  
7 pointing to. This feature is present -- this feature  
8 is present on many of Canadian Natural's other  
9 geophysical and geological mapping products, such as  
10 the seismic lines shown in the bottom right portion of  
11 this slide. On this seismic line, a structural sag on  
12 various reflectors observed -- is observed as -- and is  
13 circled in red. This sag is directly through the area  
14 of expected heterogeneity. Canadian Natural  
15 interpreted this feature to be a result of differential  
16 compaction from a mud-filled abandonment channel  
17 somewhere within the post-B2 incision reservoir.

18           This channel trend, along with other trends  
19 observed from other data sources, was incorporated into  
20 a map similar to the one shown on the upper right  
21 portion of this figure, which is -- this map is a total  
22 post-B2 non-reservoir isopach.

23           Canadian Natural decided to test the -- this  
24 interpretation to determine the exact stratigraphic  
25 level of the anomaly, as well to determine an amount of  
26 reservoir-quality sand potentially remaining underneath

1 the feature with a stratigraphic test well. You could  
2 see the location here with a red star on the spectral  
3 decomposition slice and on the map on the top right.

4 This well could also test if this area of  
5 anticipated differential compaction actually had faults  
6 or fractures within the confinement strata units by  
7 running an image log.

8 Could I please have Exhibit 050.003, PDF 62,  
9 please. Oh, this is it. Sorry. The same one, yeah.

10 Yeah. Canadian Natural drilled the 1 AD/13-34  
11 strat well, and the well logs here are on the very  
12 left. This well was drilled in February of 2022  
13 directly -- as mentioned, directly through the subject  
14 zone of expected heterogeneity at the northeast extent  
15 of the trend. As you can see on the well logs on the  
16 left, the well encountered a mud-filled abandonment  
17 plug at the top of the Bos [sic] B -- post-B2 incision  
18 reservoir as expected. A sag observed on the seismic  
19 line at the well location was confirmed to be  
20 differential compaction with 3 to 5 metres of lower  
21 structure observed through the post-B2 incision tops  
22 and up through the Wabiskaw B versus the same  
23 geological tops in the nearest offsetting wells.

24 Now I'd like PDF 63, please. Thank you.

25 This image log analysis of the 180/13-34 well  
26 confirmed that despite going through an area of

1 relatively more differential compaction compared to the  
2 other portions of the pad, there are no faults or  
3 fractures within the confinement strata units. As  
4 shown -- as shown as this -- this is -- figure in the  
5 centre of the slide. Note this was -- well was also a  
6 directional well with an inclination of around  
7 43 degrees through the confinement strata, so any  
8 vertical fractures or near vertical fractures, if  
9 present, should have been detected by the wellbore, but  
10 none were found. The only fracture event observed on  
11 the image log was significantly higher up from the top  
12 of the confinement -- confinement strata units near the  
13 Viking level.

14 In summary, this assessment confirms Canadian  
15 Natural's interpretation of differential compaction in  
16 the KN08 and KN09 areas and shows there are no fracture  
17 events present at this geophysical anomaly. The actual  
18 results prove Canadian Natural's model that  
19 differential compaction is caused by mud-filled  
20 abandonment plugs and that the magnitude of compaction  
21 is low. This conclusion is in direct contrast to ISH's  
22 postulated differential compaction model where it  
23 speculates that open faults and fractures must be  
24 present within the confinement strata due to compaction  
25 over thick channel sands. Canadian Natural's evidence  
26 does not support this theory.



1           We will now discuss Canadian Natural's evidence  
2 showing there has likely been no vertical gas migration  
3 from the McMurray to the Wabiskaw B gas thrones -- gas  
4 zones through faults and fractures.

5           Could I have Slide 65, please, of this exhibit.

6           Thank you.

7           Canadian Natural disagrees with ISH's statements  
8 that Wabiskaw B gas is only present in the KN08 and  
9 KN09 areas when overlying thick McMurray channel sands.  
10 Canadian Natural shows, as per the map in the upper  
11 right of the slide, that Wabiskaw B gas does indeed  
12 exist to the northeast of the Kirby Upper Mannville II  
13 pool. This gas exists within a smaller structural high  
14 that is away from the underlying thick McMurray post-B2  
15 incision channel trends as shown in this cross-section.

16           Can you just point ... So my colleague's pointing  
17 to the thick channel sands here and then the absence of  
18 them in the gas identified to the northeast.

19           ISH's assertion that Wabiskaw B gas only exists  
20 over thick underlying McMurray reservoir sands is  
21 incorrect.

22           Could I have page 66 from this exhibit, please.

23           Thank you.

24           ISH has also stated that the McMurray Wabiskaw B  
25 gas within the Kirby Upper Mannville II pool could have  
26 only come from degraded McMurray oil by migrating

1 vertically through preexisting open fractures and  
2 faults. Canadian Natural disagrees and postulates an  
3 alternative and more likely reason for the occurrence  
4 of Wabiskaw B gas in the KN08 and KN09 in greater Kirby  
5 north areas is that the Wabiskaw B gas is self-sourced.

6 Specifically, the Wabiskaw B gas came from the  
7 degradation of Wabiskaw B oil that was originally in  
8 place in significant volumes at Kirby north. As shown  
9 in this figure, the amount of Wabiskaw B bitumen in  
10 place within a 1-mile radius around the Kirby Upper  
11 Mannville II and Devenish Wabiskaw A pools is  
12 comparable in volume to the amount of developable  
13 McMurray bitumen volume in the existing and applied-for  
14 pads at Kirby north.

15 This is a more likely explanation for the  
16 occurrence of Wabiskaw B gas also explains why there is  
17 also gas to the northeast of the Upper Mannville II  
18 pool where there is not any significant thick McMurray  
19 post-B2 incision sands present.

20 As a side note, gas -- gas exsolved from this  
21 bitumen as a result of Wabiskaw B pressure decline also  
22 contributed to the cumulative gas production from the  
23 Kirby Mannville II and Devenish Wabiskaw A pools.

24 Some final comments on the presence of Wabiskaw B  
25 gas in and around KN08 and KN09. ISH has repeatedly  
26 asked, Where did the McMurray gas go? Canadian Natural

1 asserts that the gas generated from degraded McMurray  
2 oil likely over geological time migrated laterally away  
3 from the area updip along the post-B2 incision valley  
4 trend that carries further east into the north for  
5 several tens of kilometres, where it finally joins up  
6 with the main McMurray trunk valley system.

7         Additionally, there is no evidence of any top  
8 water and/or lean zones of low bitumen saturation at  
9 the top of the post-B2 incision sands at KN08 and KN09  
10 that might have indicated early trapping of McMurray  
11 gas that was then breached by faults or open fractures.  
12 It is more likely that faults and open fractures  
13 between the McMurray SAGD reservoir sands and the  
14 Wabiskaw B gas have just never existed as per all the  
15 other evidence shown here by Canadian Natural.

16         To conclude, we will now -- I will now describe  
17 some of Canadian Natural's operational evidence that  
18 there are no faults or open fractures that would be a  
19 risk to contaminating steam operations between the  
20 McMurray and Wabiskaw B gas.

21         Lost circulation of drilling fluids during  
22 drilling operations can be a direct indicator of faults  
23 or open fractures. Canadian Natural has observed no  
24 lost circulation events during the drilling of the 43  
25 stratigraphic test wells in the KN08 and KN09 areas and  
26 also had no loss circulation events in the recently

1 drilled 16 producer injector wellbores at offsetting  
2 KN06.

3 Could I have Exhibit 50.09, page 340, please.

4 Thank you.

5 This slide shows the pressure data at the 10-1  
6 well within the Wabiskaw B gas of the Kirby Upper  
7 Mannville II pool as well as the pressures observed  
8 within the McMurray bottom water leg at the 7-29 and  
9 12-34 wells. It would be expected that there would be  
10 no pressure differential between these zones if there  
11 were faults or an open connected fracture system  
12 between the McMurray and Wabiskaw gas zone at KN08 and  
13 KN09.

14 However, as you can see, a significant pressure  
15 differential does exist, confirming these zones are not  
16 in communication with each other. This is compelling  
17 evidence that faults and/or open connected fractures  
18 between the McMurray and Wabiskaw B gas zone at KN08  
19 and KN09 do not exist, or, in the unlikely case they do  
20 exist and remain undetected, they are closed to fluid  
21 flow.

22 In summary, Canadian Natural has shown  
23 substantial -- substantial evidence showing no faults  
24 or fractures within the confinement strata units at  
25 KN08 and KN09. We reviewed that there are -- there is  
26 no evidence of faults or fractures with the confinement

1 strata intervals on core, image log, and seismic data.  
2 We also show that differential compaction at KN08 and  
3 KN09 has not caused faults and fracture and that the  
4 Wabiskaw B gas did not likely come from the McMurray  
5 via vertical faults and fractures within the proposed  
6 drainage box areas.

7 Finally, Canadian Natural's operational and  
8 drilling data support there is most likely no faults or  
9 fractures with the confinement strata units or if they  
10 do exist, they are closed to fluid flow.

11 To close, Canadian Natural concludes that there is  
12 a low to nonexistent fracture density within the strata  
13 between the McMurray formation and the Wabiskaw B  
14 member that would pose a risk to the containment of  
15 steaming operations at KN08 and KN09.

16 This concludes Canadian Natural's direct evidence  
17 on Hearing Issue 1. I will now turn it over to  
18 Mr. Peter Thomsen to discuss Canadian Natural's direct  
19 evidence for Hearing Issue Number 3.

20 A P. THOMSEN: Good afternoon, Commissioners.

21 Thank you, Mr. Sverdahl, for explaining the  
22 geoscience evidence and showing that there are no  
23 currently open pathways through the confinement strata.  
24 Next I will present the geomechanics evaluation, which  
25 addresses the third hearing issue. It will be shown  
26 that the proposed MOPs are appropriate for confinement

1 strata containment of steam over the life of the KN08  
2 and KN09 drainage boxes.

3 Kirby north has significant field experience with  
4 starting steam circulation without fracturing. Through  
5 continuous improvement, enhanced start-up practices  
6 have been developed and used for the KN06 start-up.  
7 These enhancements will be carried forward to the KN08  
8 and KN09 start-ups.

9 There are four components to the risk -- to --  
10 mitigating components to the risk of start-up-induced  
11 hydraulic fracturing. Number 1, leakoff within the  
12 McMurray reservoir and confinement strata; Number 2, a  
13 stress contrast between the McMurray reservoir and the  
14 confinement strata; Number 3, elastic stress increases  
15 within the McMurray reservoir; and Number 4, limited  
16 rate and limited volumes injected with elevated  
17 pressures.

18 I will now address operating pressures and maximum  
19 operating pressures, "MOPs". SAGD starts with steam  
20 circulation, which lasts for approximately three to  
21 four months. Once a sufficient amount of heat has been  
22 transferred into the reservoir during circulation, the  
23 SAGD well pair is converted into gravity drainage  
24 operation. The typical SAGD operating time is  
25 approximately 10 to 15 years. During start-up,  
26 Canadian Natural will endeavour to initiate circulation

1 with bottom-hole pressures less than 5,500 kPa. Once  
2 circulation starts, the bottom-hole pressure will  
3 reduce to near the bottom water pressure. The  
4 5,500 kPa threshold pressure is to try starting  
5 circulation with bottom-hole pressures below the  
6 post-B2 reservoir sand minimum stress.

7 In the event of challenging operational  
8 circumstances, such as high emulsion pipeline  
9 pressures, it may be necessary to initiate circulation  
10 with bottom-hole pressures above 5,500 kPa and below  
11 the requested temporary MOP of 6,600 kPa. Use of  
12 elevated pressures would be for short time periods of  
13 less than 24 hours and with small volumes of injected  
14 steam, less than 180 cubic metres.

15 In the event of an operational interruption such  
16 as a power outage or a wildfire, circulation stops.  
17 Once operations can resume, circulation would need to  
18 be reinitiated, which could potentially require  
19 elevated bottom-hole pressures. Other than circulation  
20 start-ups, all other SAGD operations would be  
21 constrained by the long-term MOP.

22 The original application -- the original  
23 application requested MOP was 6,000 kPa. Underneath  
24 all of the KN08 and KN09 drainage boxes is McMurray  
25 bottom water, which has high water permeability and a  
26 hydraulically connected area much larger than the KN08

1 and KN09 drainage boxes.

2 The bottom water pressure underneath KN08 and KN09  
3 is approximately 2,600 kPa. SAGD operations will need  
4 to operate near a balanced pressure with the bottom  
5 water over the long term. Neither production from or  
6 injection into the bottom water is acceptable for  
7 extended periods of time for the bitumen resource  
8 recovery.

9 The purpose of the long-term MOP being above the  
10 bottom water pressure is operational flexibility  
11 following downtime and for wellbore issues such as  
12 scale plugging.

13 From a confinement strata integrity perspective,  
14 there are two risks to consider. The first is the  
15 short-term risk of the start-up potentially fracturing  
16 from the SAGD wells to the Wabiskaw B gas. Hydraulic  
17 fracturing is a mechanism which can create a  
18 transmissive flow path. The second risk is a long-term  
19 risk of the SAGD-induced stress changes in the  
20 confinement strata and whether this could lead to  
21 either hydraulic fracturing or shear failure in the  
22 confinement strata. The proposed SAGD operations are  
23 low risk for both of these.

24 One fracture containment mechanism is leakoff.  
25 Leakoff describes fluid flow through porous media and,  
26 specifically for the SAGD start-ups, applies to water



1 flowing within the post-B2 reservoir. Number 1, water  
2 flowing via water permeability, which occurs in the  
3 cold and undepleted McMurray oil sand. Number 2, water  
4 flowing into the McMurray bottom water, which has a  
5 leakoff capacity. In the unlikely event of hydraulic  
6 fracturing within the sand, Number 3, water flowing  
7 away from a fracture. Leakoff accommodates some  
8 injection volume and constrains potential hydraulic  
9 fracture heights. If temporary MOPs are used with  
10 small volumes, this de-risks fracturing to or through  
11 the confinement strata.

12 In the setting of the KN08 and KN09 confinement  
13 strata, stresses are a primary driver for hydraulic  
14 fracturing. A fracture pressure needs to be greater  
15 than the minimum stress for a hydraulic fracture to  
16 initiate and propagate. This extra pressure above the  
17 minimum stress is called the "net fracture pressure".  
18 A hydraulic fracture orientation depends on -- upon the  
19 orientation of the minimum stress, which can be  
20 considered as taking the path of least resistance. For  
21 the KN08 and KN09 confinement strata, the minimum  
22 stress is oriented horizontally, and this leads to  
23 hydraulic fracture orientations to be vertical and to  
24 open against the minimum horizontal stress.

25 For the confinement strata, rock strength is not a  
26 primary control of hydraulic fracture behaviour, and,

1 in fact, the low rock strength benefits the sealing of  
2 natural fractures and faults.

3 Mr. Lung, please pull up Exhibit 15.01, PDF  
4 page 96. If we could zoom into the upper Figure 6,  
5 please.

6 Within the subsurface, stresses cannot be measured  
7 directly. Instead we use diagnostic fracture injection  
8 tests, DFITs, to determine an in situ stress. In this  
9 figure is a conceptual DFIT graph of pressure versus  
10 time. During a DFIT, following the breakdown, the  
11 pressure stabilizes at a fracture propagation pressure.  
12 A fracture is open when the injection is stopped, and  
13 as the pressure declines, a point will come when the --  
14 where the fracture will close. The pressure at this  
15 point is called the "fracture closure pressure", the  
16 FCP. This is equivalent to the minimum stress.

17 DFIT-measured pressures consistently show the  
18 fracture propagation pressures to be greater than the  
19 fracture closure pressures due to the hydraulic  
20 fractures requiring additional pressure above the  
21 minimum stress, the net fracture pressure.

22 Mr. Lung, if you could please pull up  
23 Exhibit 15.01, PDF page 39, Table 1. Stresses have  
24 been characterized from DFITs, and the minimum stress  
25 gradients are 14.6 kPa per metre for the regional B1  
26 sequence and 13.1 kPa per metre for the post B2

1 reservoir sand. Please note the minimum stress  
2 gradient difference of 1.5 kPa per metre, which  
3 provides fracture containment in the unlikely event of  
4 hydraulic fracturing within the post B2 reservoir sand.  
5 This is the second fracture containment mechanism.  
6 This is consistent with the KN06 stress  
7 characterization.

8       Next, SAGD circulation will create stress  
9 increases within the post B2 reservoir sand. In the  
10 unlikely event of a hydraulic fracture within the sand,  
11 the increased pressure and temperature will create  
12 stress increases. The result of the stress increases  
13 are that in order to continue propagating a hydraulic  
14 fracture, the fracture pressure will increase through  
15 time. In a situation with a pressure limit, this will  
16 force a reduction in injection rate and can ultimately  
17 lead to a fracture closing. Elastic stress increases  
18 within the sand are the third fracture containment  
19 mechanism.

20       In Kirby north, 146 SAGD wells have been started  
21 up. These wells were assessed for indications of  
22 hydraulic fracturing. 145 out of the 146 wells  
23 conclusively initiated circulation without hydraulic  
24 fracturing of the sand. A 46 -well subset were started  
25 up with bottom-hole pressures greater than 6,000 kPa.  
26 It should be noted that the use of the elevated

1 pressure for initiating steam circulation is not a  
2 theoretical prediction, but, rather, there is a  
3 significant Kirby north experience with this type of  
4 operation.

5         The risk of fracturing the post B2 reservoir sand  
6 is low, and without initiating a hydraulic fracture  
7 within the sand, the risk of fracturing through the  
8 confinement strata is even lower. When bottom-hole  
9 pressure is -- greater than 6,000 kPa were used, it was  
10 for short time frames, typically between one to four  
11 hours, and small volumes of steam were injected,  
12 typically 1 to 10 cubic metres per well. The requested  
13 MOPs are a low likelihood for initiating hydraulic  
14 fractures within the post B2 reservoir, and this is  
15 supported by the Kirby north start-up field data.

16         The stress characterization used for this  
17 evaluation is representative for the KN08 and KN09  
18 drainage areas. This is supported by four points.  
19 Stresses tend to be regionally consistent for a given  
20 stratigraphic unit. Regionally present mud-prone  
21 heterolithic strata have consistent elastic properties  
22 which are directly related to horizontal stress  
23 gradients.

24         The commercial scale Kirby north data set of --  
25 starting up 146 wells on steam circulation does not  
26 show stress variability with either variable or low

1 fracture pressures. And, finally, significant  
2 geological structural features such as karsts are not  
3 present in the KN08 and KN09 drainage area.

4 The requested temporary MOP is low risk in part  
5 due to the short durations of less than 24 hours and  
6 minimal injection volumes of less than 180 cubic  
7 metres. Additional DFITs are not required over the  
8 KN08 and KN09 drainage areas, and Canadian Natural is  
9 not willing to conduct additional DFITs since the  
10 requested temporary MOP is low risk. Further DFITs  
11 will increase costs and may result in a further project  
12 delay. Additionally DFITs are also unlikely to change  
13 the requested MOPs.

14 The long-term operating pressure gradient will be  
15 approximately 5.5 kPa per metre, which is far below the  
16 post B2 reservoir sand minimum stress gradient of  
17 13.1 kPa per metre. The bottom water driver on SAGD  
18 operating pressure de-risks the long-term risk of  
19 hydraulic fracturing of the sand or the confinement  
20 strata. Further, the operating pressure gradient of  
21 around 5.5 kPa per metre is below the water hydrostatic  
22 head pressure gradient of 9.8 kPa per metre. Shear  
23 failure is generally considered low risk at operating  
24 pressures below the hydrostatic head of water. This is  
25 exemplified by Long Lake Pads 14 to 15 which have an  
26 MOP of the hydrostatic head of water near seismic scale

1 faults in the caprock.

2 Next we will review the geomechanical modelling.  
3 The objectives for the geomechanical modelling were to  
4 evaluate the short-term and long-term risks. For the  
5 short term, what is the potential to initiate and  
6 propagate hydraulic fracturing within the post B2  
7 reservoir sand and what is the minimum magnitude of a  
8 stress contrast to contain hydraulic fractures?

9 Specific to the long-term risk is representing  
10 SAGD-induced stress changes within the confinement  
11 strata and assessing factors of safety. The simulator  
12 used for this modelling is GeoSim, which is an  
13 AER-recognized simulator for thermal caprock integrity  
14 and is an industry standard. GeoSim features include  
15 fracture mechanics, multi-phased flow, and coupled  
16 reservoir and geomechanical modelling.

17 The methodology for evaluating the potential for  
18 start-up-induced fracturing includes consideration of  
19 the initial and the dynamic stress state, flow through  
20 effective permeability to water, and appropriate rock  
21 properties. Two locations were evaluated for potential  
22 start-up-induced fracturing: One is the location of  
23 the shallowest well, which is near the toe of KN08 12I,  
24 which is more prone to fracture initiation due to the  
25 depth.

26 The second location is where there is the shortest

1 distance between the base of the regional B1 sequence  
2 and the top of the post B2 reservoir. This is near the  
3 heel of KN08 6I. For evaluating the long-term SAGD  
4 impacts, a 2D model was extracted from the heels of the  
5 KN08 development where there is a short distance again  
6 between the regional B1 sequence and the top of the  
7 post B2 reservoir. Long-term pressure and temperature  
8 effects were predicted, which involves uplift of the  
9 overburden, including the confinement strata. The  
10 modelled stress changes within the regional B1 sequence  
11 were assessed for impacts to the tensile and shear  
12 factors of safety.

13 Finally, a 30-day period of elevated injection  
14 pressure -- of elevated injection pressures was  
15 implemented after a time period of one and five years  
16 of SAGD operation.

17 Conservative inputs have been used for many of the  
18 inputs in the modelling. Some of these conservative  
19 inputs are representing low effective permeability to  
20 water and not representing leakoff to the bottom water.  
21 For the start-up modelling, the injected fluid was cold  
22 water, which is conservative and does not include any  
23 thermal elastic effects from temperature increase.  
24 Further, only one hydraulic fracture is represented  
25 along the length of the horizontal well.

26 Low compressibility inputs have also been used.

1 As has been described earlier, four fracture  
2 containment mechanisms are represented in the  
3 modelling: Number 1, leakoff of water into the post-B2  
4 reservoir; Number 2, a stress contrast between the  
5 post-B2 reservoir and the confinement strata,  
6 specifically the regional B1 sequence; Number 3, poral  
7 elastic stress increases around a hydraulic fracture;  
8 and the fourth fracture containment mechanism is  
9 implicit with the inputs of a maximum continuous time  
10 of 24 hours with using an elevated pressure and a  
11 maximum steam rate of 180 cubic metres per day.

12 This is conservative, considering the typical use  
13 of elevated pressures above the long-term MOP is a  
14 duration of one to four hours with a volume of 1 to  
15 10 cubic metres.

16 Mr. Lung, please pull up Exhibit 46.002, page 64.

17 Please zoom in to Figure 20.

18 A. LUNG: Mr. Thomsen, could I just ask  
19 you to slow down a little bit for our court reporters.  
20 Thank you.

21 A P. THOMSEN: And zooming in on the upper  
22 figure, please.

23 The most realistic representation of the  
24 short-term risk includes the fracture containment  
25 mechanisms. This is Case Number 2, which is located at  
26 the shallowest well in the KN08 and KN09 drainage



1 boxes. Case Number 2 is modelled without a constraint  
2 on the bottom-hole pressure. In the graph of pressure  
3 versus time, the Case Number 2 green line shows a near  
4 immediate increase above 6,600 kPa. An unconstrained  
5 bottom-hole was required with the modelling in order to  
6 initiate a small fracture.

7 If you could scroll down to the next page and zoom  
8 in to Figure 22, please.

9 This image shows the geometry of the most  
10 realistic Case Number 2, which has minimal growth  
11 within the post-B2 reservoir sand of less than 2 metres  
12 in height.

13 The key finding is that with realistic modelling  
14 of the post-B2 reservoir and with a constraint of a  
15 bottom-hole pressure of 6,600 kPa, there is a low risk  
16 of fracturing the post-B2 reservoir. It is likely that  
17 a temporary MOP of 6,600 kPa will not result in  
18 fracturing of the sand.

19 In the highly unlikely event of propagating a  
20 fracture to the base of the regional B1 sequence, the  
21 stress contrast would contain a fracture below the  
22 regional B1 sequence and far below the Wabiskaw B gas.

23 Sensitivity cases have been modelled in order to  
24 evaluate fracture containment mechanisms.

25 Same exhibit, if we could go to page 71, please,  
26 and Figure 31. If you could zoom in on that, please.

1           Cases 7 to 8 were modelled in order to consider  
2 reduced minimum stress contrasts and fracture  
3 containment. Case Number 8 uses a conservatively low  
4 effective permeability to water, no bottom-hole  
5 pressure constraint, and has no elastic stress  
6 increases within the post-B2 reservoir sand. The Case  
7 Number 8 inputs use a minimum stress gradient  
8 difference of only 0.3 kPa per metre. These changes  
9 from a realistic scenario were used in order to  
10 model -- represent a fracture propagating to the base  
11 of the regional B1 sequence. On this image is the  
12 fracture size after 24 hours of injection, which shows  
13 containment within the regional B1 sequence. This  
14 shows that a minimum stress gradient difference of only  
15 0.3 kPa per metre is sufficient to contain hydraulic  
16 fractures. The regional B1 sequence has a minimum  
17 stress gradient difference of 1.5 kPa per metre.

18           Please change to PDF page 53 and zoom in to  
19 Figure 10A, the upper one.

20           For the long-term risk, a 2D cross-section was  
21 extracted from the heels of the KN08 drainage area.  
22 12 SAGD well pairs were modelled for 15 years of  
23 operation. The steam chamber pressure was set to  
24 4,000 kPa with -- removing any leakoff to the bottom  
25 water. This is conservative, considering that the  
26 bottom water pressure is 2,600 kPa.

1           Shown is a model cross-section where the shear  
2 stress level -- shown is a model cross-section showing  
3 the shear stress level, and one can also identify  
4 variable unit thicknesses which have been represented.

5           Same exhibit, please, go to page 72, Table 4.

6           Through the life of the SAGD operation, the  
7 minimum factors of safety were identified within the  
8 middle of the regional -- within the middle of the  
9 B1 sequence. The minimum shear factor of safety is  
10 1.9, and the minimum tensile factor of safety is 2.1.  
11 These are both far from the onset of failure and are  
12 above the Directive 86 shallow SAGD minimum factor of  
13 safety of 1.25. Kirby north is not within the shallow  
14 SAGD area, but this comparison is made to illustrate  
15 that the proposed operating conditions are reasonable.

16           Sensitivity cases for the long-term SAGD  
17 operations were modelled for a 30-day period of steam  
18 injection at a bottom-hole pressure of 6,000 kPa after  
19 one and five years. Due to the high compressibility of  
20 the steam chamber, there are negligible effects,  
21 impacts on confinement strata stress changes.

22           The hearing issues are focused around whether  
23 steam could communicate with the Wabiskaw B gas. This  
24 is confined to an economic risk, and there are not  
25 health, safety, or environmental consequences. For the  
26 short-term risk, a sufficient factor of safety is

1 present with the proposed operating conditions due to  
2 the limited durations and volumes for the potential use  
3 of elevated pressures, the other three fracture  
4 containment mechanisms, operational enhancements for  
5 SAGD start-ups, and Kirby north field experience of  
6 initiating steam circulation with bottom-hole pressures  
7 above 6,000 kPa without communication to the Wabiskaw B  
8 gas.

9 For the long-term risks, the factors of safety are  
10 well above the D86 minimum factor of safety of 1.25,  
11 which, again, is not applicable to Kirby north, but  
12 this comparison is made to illustrate the proposed  
13 operating conditions are not pushing the envelope.

14 In conclusion, the requested temporary MOP of  
15 6,600 kPa is low risk of fracturing through the  
16 confinement strata due to multiple fracture containment  
17 mechanisms: Number 1, leakoff within the McMurray  
18 reservoir and confinement strata; Number 2, a stress  
19 contrast between the McMurray reservoir and the  
20 confinement strata; Number 3, elastic stress increases  
21 within the McMurray reservoir; Number 4, limited rate  
22 and volume injected with elevated pressures.

23 The proposed operating conditions, including a  
24 long-term MOP of 6,000 kPa, are a low risk to the  
25 confinement strata integrity for long-term SAGD  
26 operations.

1           Regarding modifications to the requested operating  
2 limits, the originally requested MOP and temporary MOP  
3 are technically justified, as shown in the application  
4 and the written materials submitted in this hearing.

5           While not required, Canadian Natural has modified  
6 its requests. Regarding the temporary MOP, Number 1,  
7 limit the maximum continuous time to 24 hours when  
8 using bottom-hole pressures above 5,500 kPa and below  
9 the requested temporary MOP of 6,600 kPa. Number 2,  
10 limit the maximum gross steam rate to be 180 cubic  
11 metres per day when using bottom-hole pressures above  
12 5,500 kPa. Regarding the -- the MOP, reduce the MOP  
13 from 6,000 kPa to 5,500 kPa while maintaining the  
14 requested temporary MOP of 6,600 kPa for the purpose of  
15 initiating circulation.

16           While unnecessary, these modifications provide  
17 further risk mitigation and demonstrate Canadian  
18 Natural's reasonableness. Thank you for your  
19 attention, and I will now pass the presenting over to  
20 Mr. Devin Ollenberger, who will be addressing Hearing  
21 Issues Number 2, 4, and 5.

22 D. OLLENBERGER:                   Thank you, Mr. Thomsen.

23           Good afternoon, Commissioners. As mentioned  
24 earlier, my name is Devin Ollenberger, and I am the  
25 exploitation engineering manager for the Kirby north  
26 asset. Today I will be talking about Hearing Issues

1 Number 2, 4, and 5, which generally cover appropriate  
2 monitoring and observation wells; whether to approve  
3 the use of co-injection, more specifically,  
4 hydrocarbon-assisted start-up; and the thermal  
5 compatibility and/or abandonment of identified wells  
6 within or adjacent to the KN08 and KN09 pad  
7 developments.

8 I will begin my commentary with Issue Number 2.  
9 Canadian Natural plans to execute a robust monitoring  
10 strategy consisting of data collected from both gas  
11 monitoring wells and SAGD well pairs in combination  
12 with appropriate process controls and operating  
13 procedures. This strategy is demarcated into two time  
14 periods: the circulation start-up phase and the  
15 long-term SAGD operation phase. This is to ensure that  
16 the relevant differences of these two operational  
17 phases are adequately addressed. When we're available,  
18 Canadian Natural also plans on using 4D seismic data to  
19 monitor the KN08/09 development. The last such seismic  
20 shoot at Kirby north was completed in Q1 2022.  
21 Finally, Canadian Natural plans to report all relevant  
22 monitoring data as part of the AER Directive 54  
23 requirements or directly to the AER on an as-needed  
24 basis, subject to approval conditions.

25 Canadian Natural originally applied for start-up  
26 enhancements for pads KN08 and KN09 that are similar to

1 those that have been successfully executed at KN06.  
2 This includes holding a workshop at least 30 days prior  
3 to start-up, which will cover hydraulic fracturing, in  
4 situ stresses, and previous Kirby north circulation  
5 examples where temporary MOP pressures were required to  
6 establish circulation.

7 Building on the content of the workshop, the  
8 surveillance graphs that will be used to review  
9 realtime data will be modified to include clear  
10 indication of in situ stresses on bottom-hole pressure  
11 trends. During start-up, a geomechanics expert will  
12 also review the rate and pressure data for several of  
13 the initial wells on each pad to test for evidence of  
14 abnormal or unexpected fracturing behaviour.

15 One advancement that Canadian Natural proposes for  
16 KN08 and KN09 development which builds upon the  
17 start-up enhancements executed for pad KN06 is the  
18 pressure criteria utilized for pad start-up  
19 mitigations, which may need to occur during initial  
20 unloading of the SAGD well pairs.

21 Here, as Mr. Thomsen just discussed, Canadian  
22 Natural adopts Dr. Boone's suggestion that the pressure  
23 limit used prior to utilizing the temporary MOP be set  
24 at 5,500 kPa versus 6,000 kPa and less than the  
25 proposed temporary MOP of 6,600 kPa. 5,500 kPa will  
26 only be exceeded if after four hours circulation is not

1 established.

2           Again, Canadian Natural would like to reiterate  
3 that the technical evidence my colleagues have  
4 discussed this morning supports a long-term MOP of  
5 6,000 kPa. However, in light of ISH's concerns,  
6 Canadian Natural is prepared to reduce the long-term  
7 MOP to 5,500 kPa and all, accordingly, all SAGD  
8 monitoring conditions will utilize this pressure in  
9 place of the 6,000 kPa which was previously applied  
10 for. Normal operations will continue to target  
11 pressures in balance with the bottom water.

12           Canadian Natural believes that the two monitoring  
13 wells mentioned in its submission, the 10-1 well and  
14 the 100/1-3, will provide sufficient monitoring of the  
15 Kirby Upper Mannville II pool, the pool which overlies  
16 all of the KN06, KN08, and KN09 pad developments.

17           First, the 10-1 well on pad KN06 remains a  
18 suitable monitoring well for the pool, which I'll speak  
19 to more shortly.

20           In addition, the inclusion of the 100/1-3 well  
21 will provide further robustness to monitoring the Kirby  
22 Upper Mannville II pool. The well is ideally located  
23 in the heart of the SAGD pay for the KN08 pad --

24 THE COURT REPORTER:           Can I get you to slow down,  
25 please.

26 D. OLLENBERGER:                You bet.



1           -- just south of KN09 and is near three wells  
2 identified in the AER SIR Round 2 Question Number 1.  
3 The SIR was in regard to cement return volumes for the  
4 three OSE wells that were in question.

5           The 10-1 well remains a sufficient and relevant  
6 monitoring well for the Kirby Upper Mannville II pool,  
7 just as it was in August 2021 when the AER stated that  
8 it was satisfied with Canadian Natural's investigation  
9 of the well and that no remediation was required.

10          The well has been on stable pressure decline since  
11 March 30th, 2021, and has not been impacted by the  
12 initiation of SAGD operations on the KN06 pad that  
13 began in May 2023. Canadian Natural does believe that  
14 the decline in the well pressures is indicative of the  
15 depletion of the gas over bitumen gas resource in the  
16 Kirby Upper Mannville II pool.

17          In ISH's response to Canadian Natural Information  
18 Request Number 20, which is Exhibit 044.002, page 66 of  
19 95, ISH indicated that they agreed that the 10-1 well  
20 data is reliable over the last three years.

21          I will now transition to speaking on Issue  
22 Number 4, whether to approve the use of co-injection  
23 for the proposed KN08 and KN09 development.

24          First, as was stated in our submission, Canadian  
25 Natural would like to clarify that hydrocarbon agent  
26 assisted start-up is not a co-injection process, as

1 steam injection is halted prior to hydrocarbon  
2 injection.

3 In this case, typical SAGD steam circulation is  
4 conducted for 30 to 90 days before circulation is  
5 stopped and hydrocarbon is injected at a controlled  
6 rate and volume. This allows pressure to remain below  
7 MOP as hydrocarbon injection is initiated after the  
8 near wellbore region has been heated, providing  
9 additional mobility.

10 For this reason, no additional geomechanical risk  
11 is generated by hydrocarbon injection. A maximum -- a  
12 maximum hydrocarbon volume of 350 metres cubed per well  
13 pair has been requested to provide flexibility for the  
14 potential maximum length of the KN08 and KN09 well  
15 pairs and the pad scale nature of the test. The  
16 injected solvent will only occupy less than 2 percent  
17 of the pore space in the near wellbore region and is  
18 expected to stay within a 3-metre radius of the  
19 wellbore.

20 Further, given the small injected volume relative  
21 to the near wellbore fluids and xylene's  
22 full solubility in bitumen and lack of solubility in  
23 water, the solvent is expected to combine with the  
24 bitumen and be produced back in the early days of SAGD  
25 production.

26 As mentioned, injected hydrocarbon volume and

1 rates are controlled in such a way the injection  
2 pressure will stay below the approved MOP, 5,500 kPa as  
3 proposed. The temporary MOP of 6,600 kPa will not be  
4 applied to hydrocarbon-assisted start-up.

5 Of additional interest, xylene is a component in  
6 many common chemicals used in the gas production  
7 process, such as wax disbursements and demulsifiers.  
8 ISH has indicated that they use such chemicals in their  
9 gas operations in their IR response to CNRL ISH  
10 Number 34, which is Exhibit 044.05, pages 3 and 34 of  
11 62.

12 Though Canadian Natural does not support a  
13 comprehensive monitoring program for  
14 hydrocarbon-assisted start-up, such operations will be  
15 monitored closely using traditional monitoring methods  
16 such as that that was utilized previously on our pad  
17 KN01 test.

18 Finally, four other SAGD operators have also  
19 utilized hydrocarbon start-up without issue, which is  
20 why it is extremely unlikely that the  
21 hydrocarbon-assisted start-up process would impact the  
22 overlying gas resource.

23 I will now transition to discussing Issue  
24 Number 5. As per Directive 23, Section 7.8 and the  
25 requirement for well integrity in the Kirby commercial  
26 scheme approval Condition Number 13, Canadian Natural

1 has reviewed all well bores that penetrate the McMurray  
2 formation within a 300-metre buffer of the proposed  
3 KN08 and KN09 drainage boxes. Four wells were  
4 identified as thermally non-compatible following  
5 Canadian Natural's review. I will cover these wells  
6 and associated mitigation shortly.

7 Canadian Natural does require timely approval in  
8 order to gain access and execute these workovers by the  
9 end of Q1 2025 in order to progress the KN08 and KN09  
10 development pending regulatory approval. Canadian  
11 Natural maintains an implied commitment to restore  
12 production capability of the gas resource once the GOB  
13 order is lifted.

14 Canadian Natural is willing to accept ISH's  
15 recommendation and convert the 10-34 well to Wabiskaw B  
16 gas monitoring well. This will also provide a  
17 redundant gas monitoring well location within the KN08  
18 pad in addition to the 100/1-3 well. For the 10-2  
19 well, the McMurray zone will be -- sorry -- the  
20 McMurray will be zonely [sic] abandoned and the  
21 perforations into the Kirby Upper Mannville II pool  
22 will be patched, and the wellbore will be cemented to  
23 allow the uphole Grand Rapids to be returned to  
24 production.

25 The implementation of a patch is to minimize  
26 workover losses and maintain existing Kirby Upper

1 Mannville II potential, protecting our combined gas  
2 resource. The additional expense of the casing patch  
3 is \$30,000 and is above and beyond Canadian Natural's  
4 normal recommendation.

5 12-34 well was previously equipped with continuous  
6 monitoring, but pressure data ceased on November 19th,  
7 2020. The data taker and radio had failed and were  
8 repaired on August 14th, 2022. This well is now  
9 thermally compatible due to the restoration of  
10 continuous monitoring. And, finally, the 10-3 well  
11 will be abandoned.

12 Canadian Natural believes that we are in  
13 alignment -- sorry -- that alignment has been achieved  
14 with ISH's hearing submission on all four well workover  
15 proposals.

16 In ISH's hearing submission at paragraphs 141  
17 and 142, Exhibit 32.02, PDF pages 44 and 45 of 47, they  
18 stated several requested monitoring conditions and  
19 conditions of approval. Throughout our direct evidence  
20 this morning, Canadian Natural has largely discussed  
21 the major components with regard to what Canadian  
22 Natural is willing to commit to with respect to ISH's  
23 request with three exceptions that I will now touch on.

24 First, in addition to the 10-1, 100/1-3, and 10-34  
25 wells, Canadian Natural is also willing to commit to a  
26 future monitoring well location on or in the vicinity

1 of the KN09 pad development and to have that well in  
2 place prior to KN09's steaming operations in order to  
3 satisfy ISH's request of one monitoring location per  
4 pad.

5 The second item is the inclusion of surface gauges  
6 on monitoring wells. Canadian Natural actively  
7 responds to and mitigates all downhole gauge issues and  
8 therefore does not believe that surface gauges are  
9 required.

10 The final item not previously touched on is with  
11 respect to ISH's request for gas sampling. Here  
12 Canadian Natural is willing to take baseline samples  
13 from a well over the KN08/KN09 development and another  
14 sample prior to production of the GOB gas for  
15 comparison purposes.

16 Canadian Natural does not, however, support  
17 ongoing sampling over the life of the KN08/KN09  
18 development.

19 Mr. Lung, can you please bring up Exhibit 050.002,  
20 page 43, Table 4.

21 Thank you.

22 In ISH's response to Canadian Natural's  
23 Information Request Number 19, they provided estimated  
24 values of the gas resource both individually and -- and  
25 combined for the Kirby Upper Mannville II and Devenish  
26 Wabiskaw A pools. These values are provided in the

1 leftmost common of the table on your screen. Of note  
2 is that ISH used an effective date of January 1st,  
3 2024, for their economic evaluation. This date does  
4 not capture the appropriate discounting of the Kirby  
5 Upper Mannville II pool which is currently shut in  
6 under a GOB order.

7 Utilizing the values provided by ISH, Canadian  
8 Natural has provided discounted values of the gas  
9 resource assuming both 10 and 20 years delays. These  
10 are in the next two columns on your table.

11 Assuming that the Kirby Upper Mannville II pool  
12 will not be able to produce until the bitumen resource  
13 at Pads KN08 and KN09 are completed, a 20-year delay is  
14 appropriate. SAGD pads known in industry have exceeded  
15 this productive lifespan.

16 After applying appropriate discounting, the value  
17 range of the gas resource is 548,000 for the Kirby  
18 Upper Mannville II pool, and using \$5-per-million BTU  
19 gas pricing and 3 percent escalation as provided by ISH  
20 can reach up to 1.175 million using a 100 percent  
21 working interest and assuming communication of both  
22 pools. ISH's share of the Kirby Upper Mannville II  
23 pool would be 46.25 percent, and these values would  
24 also assume 100 percent of the gas resource is  
25 impacted, which is highly unlikely.

26 Mr. Lung, can you please bring up Exhibit 050.002,

1 PDF page 44, Table 5. You've just got to scroll down.

2 The table provided in Canadian Natural's reply  
3 submission as shown on the screen summarizes the  
4 estimated cost for ISH's requested monitoring and  
5 approval conditions on the left side of the table; in  
6 contrast, to the estimated costs of Canadian Natural's  
7 commitments on the right.

8 It is evident that the costs of Canadian Natural's  
9 committed monitoring, which are near-term expenses at  
10 \$1.10 million is essentially equivalent to the high-end  
11 100 percent working interest discounted value of the  
12 combined Kirby Upper Mannville II and Devenish Wabiskaw  
13 A pools of \$1.175 million and twice the value of the  
14 remaining gas in the GOB Kirby Upper Mannville II gas  
15 pool at five thousand -- \$500,048.

16 Additional monitoring measures will increase the  
17 disproportionate nature of the risk mitigation costs in  
18 comparison to the value of the gas resource. Canadian  
19 Natural's proposed mitigations and monitoring measures  
20 are reasonable under these circumstances.

21 Thank you. I would now like to hand it back to  
22 Dr. Tom Boone who has previously been --

23 COMMISSIONER CHIASSON: Actually, before you move on,  
24 Mr. Ollenberger, in relation to this Table 5 --

25 D. OLLENBERGER: Yes.

26 COMMISSIONER CHIASSON: -- just some clarification



1 here, which, I think was causing us a bit of concern  
2 ahead of the hearing. We've got 'M'. We've got 'K'  
3 showing up in the -- this -- in this table. We've got  
4 estimated --

5 D. OLLENBERGER: Sorry.

6 COMMISSIONER CHIASSON: -- cost dollars 'M'. We've  
7 got under ISH request, the second box down on the very  
8 left-hand side --

9 D. OLLENBERGER: I see that now, yes.

10 COMMISSIONER CHIASSON: -- three wells times 20K.  
11 Can you please clarify --

12 D. OLLENBERGER: I will clarify that both --

13 COMMISSIONER CHIASSON: -- for the Panel the  
14 abbreviations so that we're making sure that we're all  
15 understanding the same thing.

16 D. OLLENBERGER: Yes. We thought we had  
17 cleaned off all the Ks. Both 'M' and 'K' in this  
18 instance are \$1,000.

19 COMMISSIONER CHIASSON: Thank you.

20 D. OLLENBERGER: You're welcome. Thank you for  
21 that clarification.

22 Sorry. If there are no further questions, I will  
23 now hand over to Dr. Tom Boone as previously being  
24 introduced as Canadian Natural's independent expert  
25 witness.

26 T. BOONE: Thank you, Mr. Ollenberger.

1           Now, I'm going to be about 20 minutes and Gerard  
2           is maybe five, four?

3           COMMISSIONER CHIASSON:    Well, as we indicated, we will  
4           be having a hard stop at 3:30 for a break in any event,  
5           so --

6           J. JAMIESON:                I think we're going to make  
7           it.  There's a path forward here.

8           COMMISSIONER CHIASSON:    All right.  Thank you.

9    A    T. BOONE:                    Thank you.  Good afternoon,  
10        Hearing Commissioners.  My name is Tom Boone, and I've  
11        been engaged by CNRL to provide an independent  
12        assessment of Issues 1 to 4 with specific focus on the  
13        confining strata at KN08 and KN09.

14        Now, this presentation will summarize key points  
15        that I made in my initial and supplemental reports that  
16        I have prepared independently.  Now I'm only going to  
17        refer to figures in my supplemental report, which is  
18        Exhibit 050.003, and if it's okay, I will just refer to  
19        the PDF page numbers going forward.

20        So can I have PDF page 9, please.  Now, with  
21        respect to the first hearing issue, the approach I've  
22        taken is to conduct a comprehensive technical review of  
23        factors that may affect the containment of steam.  Now  
24        in the chart shown, I've listed a suite of parameters  
25        along with criteria for assessing each parameter.  My  
26        assessment of the parameter is in the third column,

1 which is coloured based on whether it's supportive of  
2 containment, is neutral -- supportive of containment  
3 being green, neutral being yellow, and lack of  
4 containment being red, although there are none there.

5 I'll briefly comment on most of these parameters  
6 using this slide and then highlight the production  
7 pressures and core assessment.

8 So, first, geology stratigraphy. As discussed by  
9 Mr. Lavigne, stratigraphic mapping shows there are  
10 multiple low permeability zones in the confinement  
11 strata at all the stratigraphic wells.

12 Core assessment. There is 24 core wells within  
13 the drainage area. All these wells have significant  
14 zones of low strength, low stiffness mudstones, where  
15 any fractures are very likely to be closed.

16 I'll comment subsequently on how the mud content  
17 will act to contain steam.

18 Microimaging logs. There is 36 microimage logs  
19 from the drainage areas with very few, if any, observed  
20 fractures in the confinement strata. Nowhere is the  
21 observed fracture frequency near the threshold that  
22 would be required for a connected pathway through the  
23 containment strata.

24 3. Seismic. There is full 3D seismic coverage of  
25 the drainage areas. No large-scale faults have been  
26 identified. Also there's no underlying salt

1 dissolution, karsting, or other such features that  
2 might contribute to faulting or local variations in the  
3 stress state. Only minor differential compaction  
4 features associated with relatively shallow mud  
5 channels have been observed.

6 GCMS. There's six wells within the KN08/KN09  
7 drainage boxes that have GCMS sampling. And all show  
8 one or more likely barriers to fluid migration within  
9 the confinement strata.

10 Analog data. The annual in situ performance  
11 presentations are available for all major SAGD projects  
12 in Alberta. They include a variety of temperature and  
13 saturation logs which can be used to ascertain if steam  
14 is migrated into the overlying confining strata. I've  
15 reviewed most of the available documents and have not  
16 found any where steam has migrated more than a few  
17 metres into the muddy confining strata.

18 Now, I'll just discuss pre-production pressures.  
19 Now, in conventional reservoir engineering, pressure  
20 monitoring is the primary tool used to assess  
21 connectivity between reservoirs. A pre-production  
22 difference -- pressure difference is definitive  
23 evidence of a barrier or a lack of communication.

24 So I requested that CNRL review its historical  
25 data for all original pressure measurements in the  
26 Kirby north area. Critically, there are two consistent

1 pre-production pressure measurements from the 1970s in  
2 the McMurray formation that also agree with more recent  
3 pre-SAGD pressure measurements. Now, plots are  
4 included in my original report. I'll just summarize  
5 briefly what the results are.

6 So the results are that the original pressure  
7 measurements in the Wabiskaw B gas zone are  
8 approximately 100 kPa above the McMurray pressure  
9 gradient. I concluded based on these measurements that  
10 over a production time scale, there's likely no  
11 hydraulic connection between the McMurray sands and the  
12 Wabiskaw B gas.

13 Now, considering post-production pressure  
14 measurements. The pressures in the Wabiskaw B gas zone  
15 were approximately 1,100 kPa shortly after gas  
16 production was shut in in 2004 due to the GOB decision.  
17 In the subsequent two decades, pressures have continued  
18 to decline to approximately 800 kPa, most likely due to  
19 nearby ongoing production.

20 However, if there was any significant hydraulic  
21 connection between the McMurray at approximately  
22 2,000 kPa and the Wabiskaw B gas zone, the gas zone  
23 pressure would have been expected to rebound after the  
24 GOB shut in due to water migration from the McMurray up  
25 to the Wabiskaw.

26 Can I have PDF page 18 now, please.

1           Now, Mr. Lavigne, previously showed you core  
2 images like the one on the screen and discussed it from  
3 a geologic perspective. However, since this issue was  
4 framed in terms of the steam migration over the  
5 lifetime of the drainage boxes were approximately 15 to  
6 20 years, it's very much a reservoir engineering and a  
7 geologic issue. I've reviewed all the core photos for  
8 all the wells available from the perspective of a  
9 reservoir engineer to assess the presence of both  
10 barriers and baffles to steam. Based on my experience,  
11 it's extremely difficult for me to imagine steam  
12 migrating through the confinement strata for any of the  
13 cores.

14           Now, SAGD is a very sensitive process, and even  
15 one single thin mudstone can act as a barrier over the  
16 life of the project. However, in order to provide a  
17 quantitative measure of the time required for steam to  
18 migrate through the confinement strata, I developed a  
19 methodology that's presented in my supplemental report.  
20 The method is tied to the standard facies definition  
21 used by most SAGD operators. It estimates steam rise  
22 rates for the different facies based on a theoretical  
23 model matched to field data, along with measured,  
24 model, and estimated permeabilities.

25           Now, the colour coding adjacent to the core in the  
26 image on the bottom of the screen there corresponds to

1 the facies definition in the table on the upper right.  
2 The facies are assigned based on visual determination  
3 of the mud content. Facies 5 shown in orange is, for  
4 practical purposes, a barrier to steam. This facies  
5 also corresponds to the confinement strata as described  
6 previously by Mr. Lavigne.

7 Based on the total thickness of the five facies in  
8 this core, the method estimates that steam would  
9 require 393 years to rise through the F5 facies. Now,  
10 this is much longer than any production time; however,  
11 it's clearly supported by the observation that there's  
12 a gas cap in the Wabiskaw D that is contained by the  
13 Wabiskaw D heterolithic and Wabiskaw C at the five  
14 facies over a geologic time scale.

15 Now, I'm also showing this well because it's  
16 located in the north of KN09 pad where the Wabiskaw D  
17 has cut into the McMurray B1, and as can be seen, the  
18 McMurray B1 mudstone, which is identified by orange in  
19 the middle at the bottom of the screen there, is  
20 relatively thin. Now, the facies -- sorry -- and then  
21 what generally is not included in CNRL's geologic  
22 assessment of the confinement strata is the F4 facies  
23 which corresponds here to 30 to 70 percent mud content.

24 An example in this well is the muddy B1 facies  
25 just below the mid-B1 mudstone that I just referenced.  
26 These facies can be described as a strong baffle to

1 steam rise.

2 Now, as shown in the table, the method estimates  
3 it would take 34 years for steam to rise through the F4  
4 facies. So, in effect, the F4 facies alone would act  
5 as a barrier to steam over the life of the drainage  
6 boxes.

7 Can I return to PDF page 9, please.

8 Now, returning to Hearing Issue 1, in summary,  
9 collectively all of the assessed parameters are  
10 supportive of the confinement strata being an effective  
11 barrier to steam. The conclusion that I've drawn from  
12 conducting my assessment is that it's very unlikely  
13 that steam will migrate through the confinement strata  
14 from the McMurray sands to the Wabiskaw B gas zones  
15 during the life of the drainage boxes. The key reasons  
16 supporting the assessment are the historical pressure  
17 measurements, the high interbedded mud content in the  
18 confinement strata, the absence of fractures in the  
19 confinement strata, the high likelihood that any  
20 fractures will be sealed, and the absence of any known  
21 occurrence of steam migration through similar  
22 confinement strata at any SAGD operations in Alberta.

23 Page 28, please. Now, before moving to Issue 2,  
24 I'll address two pertinent geomechanical concepts: the  
25 first being brittleness of the mudstones or why natural  
26 or induced fractures in the confinement strata at KN08



1 and KN09 are very likely to be closed and sealed. Now,  
2 rocks commonly behave in a brittle manner at shallow  
3 depths and in a ductile manner at greater depths. The  
4 figures shown on this page provides a clear, succinct  
5 illustration of brittle versus ductile behaviour.

6 In the top left of the figure is a typical  
7 stress/strain diagram for a triaxial test of rock.  
8 Notably, after the peak stress is reached, there's a  
9 decline in the stress with additional strain. This  
10 behaviour is termed "strained softening". It's  
11 commonly seen in most rocks at lower confining  
12 stresses. Now, it's important because it is the reason  
13 that shear fractures or faults form in most rocks as  
14 shown in the figure -- in the lower left of the figure.  
15 However, at higher confining stresses, the stress does  
16 not decline with additional strain, and induced  
17 fractures are less likely to occur.

18 Now, what is most critical from the perspective of  
19 whether the fracture is open or sealed is whether it  
20 behaves in a brittle or ductile manner, as shown on the  
21 right of the figure. Brittleness is associated with  
22 volumetric dilatancy in a laboratory test; means the  
23 test specimen expands because of the added volume of  
24 the fracture. Ductile behaviour is associated with  
25 volumetric contraction or non-dilatancy. When rock  
26 behaves in a ductile manner, the failed rock at the

1 fracture face smears along the fracture face, sealing  
2 the fracture.

3 Page 26, please. And, yes, if we can just make  
4 that figure fully visible. Thanks.

5 Dr. Chalaturnyk has provided some very useful and  
6 pertinent test data in ISH's response to CNRL's  
7 information requests. Specifically, I'm referring to  
8 the compression test data of Wabiskaw D mudstones from  
9 Suncor's MacKay River project. Test -- CTS4 is a good  
10 example of brittle or ductile behaviour, whereas CTS5  
11 is ductile or non-dilate.

12 Now, in the top figure, I've plotted the degree of  
13 dilation or contraction for the samples taken at  
14 4 percent axial strain versus the confining stress.  
15 This figure illustrates that there is a transition from  
16 brittle to ductile behaviour at approximately  
17 1,400 kPa.

18 Now, the confining stress is also the minimum  
19 effective stress in these tests. And since CNRL has  
20 measured the minimum effective stress gradient at Kirby  
21 north, the gradient can be used to estimate the depth  
22 at which behaviour will transition from brittle to  
23 ductile.

24 The figure on the bottom shows that this  
25 transition would occur at a depth of approximately  
26 140 metres. However, the confinement strata at KN08

1 and KN09 pads is at a depth of 470 metres, where the  
2 minimum effective stress is greater than 4,000 kPa.  
3 Clearly the confinement strata is in the ductile regime  
4 and, as a result, any fractures are highly likely to be  
5 closed and sealed. This also explains why there are  
6 very few fractures observed in the confinement strata  
7 at KN08 and KN09.

8 Page 31, please.

9 Now, I'll get to this table in a minute, but  
10 Dr. Chalaturnyk has speculated that there's potential  
11 for SAGD operations to induce open fractures or  
12 pathways in the confinement strata and offers  
13 centrifuge test results as evidence. However, the beam  
14 centrifuge tests were approximately scaled to a much  
15 shallower SAGD site and not scaled in any way to KN08  
16 or KN09.

17 The -- the overburdened stress in the model scales  
18 to about 500 -- scales to about 500 kPa or 50 metres of  
19 depth. This compares to the confining strata depth of  
20 approximately 450 metres at KN08 and KN09.

21 Now, not only does the model scale to very shallow  
22 depth, the overburden on top of the caprock in the  
23 model has no stiffness. Also, the material in the  
24 model simulates Clearwater caprock and not the McMurray  
25 Wabiskaw confining strata. Furthermore, the loading is  
26 mechanical and not representative of thermal SAGD

1 loading.

2 The resulting mostly tensile fractures are  
3 shallow, low stress, low confinement phenomenon. It's  
4 my opinion that these tests should not be considered  
5 when making engineering or regulatory decisions related  
6 to KN08 and KN09.

7 Now, referring to this chart here, induced shear  
8 deformations in the confining strata that are caused by  
9 SAGD operations can be very effectively identified,  
10 imaged, and quantified using multi-censored caliper  
11 surveys from SAGD wells.

12 In cyclic steam operations, it's very common to  
13 observe induced shearing this way; however, SAGD is a  
14 much gentler process, and the operations induce much  
15 less shear movement. In my supplemental report, I've  
16 included tables of casing deformations from  
17 multi-caliper logs for the Jackfish and the Kirby  
18 sites. The table for the Kirby site is shown here.  
19 While shear deformations are observed in shallower  
20 strata, none have been observed in the confinement  
21 strata. Furthermore, even if they were to occur, it's  
22 highly likely the fractures would be sealed, as  
23 discussed previously.

24 Page 24, please.

25 Now, moving on to Issues 2, 3, and 4, in my  
26 experience, the risk assessment process is an effective

1 tool for assessing the acceptability of a wide variety  
2 of operations involving steam, solvent injection, and  
3 then determining monitoring needs. In my supplemental  
4 report, I've included risk assessments that address  
5 Issues 2, 3, and 4. I've elected to use the same  
6 format as the ISH Aardwolf report to facilitate  
7 comparison. However, I've been much more specific in  
8 describing the risk, which is critical to enabling more  
9 objective evaluation of the likelihoods.

10 In the figure on the screen, the original  
11 unmitigated risks are shown in red. The final risks  
12 after consideration of mitigating factors such as  
13 monitoring and other factors specific to Kirby north  
14 are shown in green. It can be seen that all the  
15 resulting risks are in the white or low-risk category.

16 Page 23, please.

17 Now, I don't expect you to read this table, but  
18 I'll refer to it. It's in my report. Okay? The --  
19 and I'm going to address Hearing Issue 2: Is one  
20 additional monitoring well sufficient?

21 The specifics of Risk 1 in this table for steam  
22 mitigation -- for steam migration from the McMurray  
23 into the Wabiskaw B gas zone are summarized in the  
24 chart on the right. The risk scenario assumes a  
25 300-metre long subseismic open fracture results in  
26 20,000 cubic metres of steam and reaction products

1 migrating into the Wabiskaw B gas zone over the life of  
2 the drainage box.

3 Now, while ISH assumed in its risk assessment that  
4 all value of the gas zone was lost, in this more  
5 specific scenario, calculations show that only a small  
6 region of the gas zone is impacted, so only a fraction  
7 of the gas value is impaired.

8 The likelihood is difficult to estimate because  
9 there are no known occurrences of steam migration  
10 through similar confinement strata at other SAGD  
11 operations. The initial likelihood is assessed as  
12 "could happen once in the lifetime of the project".  
13 However, recognizing the confinement strata at KN08 and  
14 KN09 has very few identified fractures and the  
15 fractures are expected to be sealed, the final  
16 likelihood I've assessed to be "not during the lifetime  
17 of the project".

18 Now CNRL's surveillance program includes one  
19 existing and one additional monitoring well for the  
20 Wabiskaw B gas zone. This will be supplemented with  
21 produced water to steam ratio monitoring to assess for  
22 any significant steam loss into the gas zone. However,  
23 no likelihood credits are taken for this monitoring as  
24 its direct impact on the consequence is likely very  
25 limited. Nonetheless, the resulting risk here is  
26 assessed to be low.

1 Additional considerations are the cost of --  
2 additional monitoring is comparable to the financial  
3 risk itself, and there are no known specific locations  
4 of high concern such as a fault that might warrant  
5 additional monitoring.

6 So it's my assessment that no additional  
7 monitoring wells should be required for the purpose of  
8 mitigating steam migration through the confining  
9 strata.

10 Now, Hearing Issue 3, determination of the  
11 temporary MOP, is addressed by Risk 2 in this table.  
12 And, again, while ISH assumed that -- for this risk,  
13 that all the value of the gas zone was lost, a  
14 realistic scenario is one where only tens of cubic  
15 metres of condensed steam with no reaction products  
16 enters the gas cap through an induced fracture. The  
17 only possible consequence is that a producing gas well  
18 might require a workover at some time in the future to  
19 remove the water.

20 For this risk, there's a reliable set of data from  
21 the wells that have been -- previously been started up  
22 at Kirby, which can be used to assess the likelihood of  
23 the event. In my risk assessment, three likelihood  
24 credits are applied for leakoff barriers, stress  
25 barriers, and the proximity to a gas well. So any --  
26 any fracture would have to be near a gas well to impact

1 it.

2 The resulting risk is low, and my assessment is  
3 that the temporary MOP of 6,600 kPa should be allowed  
4 during the start-up period for KN08 and KN09 pads with  
5 the planned additional start-up mitigations. And,  
6 again, it's noteworthy that similar mitigations were  
7 applied to wells at KN06 and were effective.

8 And, now, moving on to Issue 4: Should solvent  
9 injection during start-up be approved? This is  
10 addressed by Risk 3. ISH considered the value of  
11 potentially lost solvent in the risk assessment.  
12 However, lost solvent is a consequence to CNRL and not  
13 to ISH.

14 Here I have taken the scenario to be a small  
15 volume of solvent, tens of cubic metres, not containing  
16 any reaction products enters the Wabiskaw B gas zone  
17 through a preexisting open conductive fracture. Since  
18 any solvent that might enter the gas zone will fully  
19 mix with the bitumen in the gas zone, it will be  
20 practically immobile and have no financial consequence.

21 The likelihood of the event is so low because of  
22 the very low frequency of fractures in the confining  
23 strata and the high likelihood that any fractures are  
24 closed. Hence, the resulting risk is low.

25 So it's my assessment that solvent injection  
26 should be allowed with the maximum pressure during this



1 operation being the MOP.

2 This concludes my presentation. Thank you for  
3 your attention, and I'll now hand it over to  
4 Mr. Iannattone.

5 A G. IANNATTONI: Thank you, Dr. Boone.

6 In closing, Canadian Natural's evidence  
7 demonstrates that the development of the McMurray  
8 bitumen resource at the KN08/KN09 drainage box will not  
9 impact ISH's mineral rights. You heard from  
10 Mr. Lavigne that the mud-filled facies create an  
11 effective barrier to steam with up to six intervals of  
12 confinement strata. This is not just argued but is  
13 strongly supported by Dr. Boone and in the academic  
14 literature.

15 Mr. Sverdahl confirmed no evidence of faulting or  
16 fractures are observed. The risk of breach to the  
17 confinement strata from natural fractures or faults is  
18 extremely low.

19 Mr. Thomsen's geomechanical data and analysis that  
20 was further supported by GeoSim modelling demonstrates  
21 that a 6,600 kPa temporary start-up pressure will not  
22 hydraulically fracture through the confinement strata.  
23 Having said this, Canadian Natural is prepared to  
24 modify the temporary start-up time and steam volume  
25 conditions as shown -- sorry -- and lower the requested  
26 long-term MOP to 5,500 kPa.

1           Mr. Ollenberger's evidence shows that the  
2 monitoring of the gas pool pressure at a total of four  
3 locations is more than adequate with the existing  
4 10-1 well, the 10-34, and the 1-3 well on the KN08  
5 drainage box. Also, Canadian Natural is committed to  
6 providing a future gas monitoring well on or in the  
7 vicinity of KN09 prior to the commencement of steaming.

8           Mr. Thomsen and Dr. Boone have shown that an  
9 additional DFIT is not warranted or justifiable given  
10 the cost and project timing delay.

11           Mr. Ollenberger, supported by Dr. Boone's risk  
12 assessment, concluded that hydrocarbon-assisted  
13 start-up poses no threat to the GOB gas. Also,  
14 Mr. Ollenberger has shown that Canadian Natural will  
15 make wellbores thermally compliant in a safe and  
16 efficient manner following AER directives.

17           Canadian Natural has made reasonable gas  
18 monitoring commitments. The ISH requested monitoring,  
19 which could add up to a total of \$6 million of project  
20 costs, are not justified in comparison to the  
21 discounted value of the gas pool. More importantly is  
22 that Canadian Natural is being asked to spend  
23 significant dollars today to monitor for potential  
24 damages to a low value resource that will not likely be  
25 allowed to produce for decades.

26           Canadian Natural is a majority leaseholder of the

1 GOB gas pool. Any potential impacts to the pool would  
2 not only affect ISH's gas rights but would also impact  
3 Canadian Natural's gas rights. This fact should be  
4 taken into account in the Panel's deliberations.

5 Canadian Natural recognizes its responsibility to  
6 develop the bitumen in a manner that also protects the  
7 gas resources. It is Canadian Natural's view that the  
8 technical evidence and commitments to the continued  
9 enhanced monitoring and controls demonstrates that the  
10 development and operation of the KN08/KN09 project will  
11 not impact ISH's gas rights. Additional conditions as  
12 requested by ISH will add unnecessary incremental costs  
13 and schedule delays to the project, which ultimately  
14 are significantly funded by Albertans.

15 Finally, I would like to remind the Panel that if  
16 damages occur, Canadian Natural is prepared to pay for  
17 the cleaning of the gas or connection of the gas to be  
18 burnt as fuel or pay reasonable compensation for the  
19 damage at the time when the gas production from the  
20 Kirby Upper Mannville II pool is allowed to resume.

21 Respectfully, Commissioners Chiasson, Barker, and  
22 Zaitlin, the merits of Canadian Natural's technical  
23 evidence and additional commitments warrant the  
24 approval of the KN08/KN09 development without imposing  
25 additional conditions. Thank you for your attention to  
26 Canadian Natural's direct evidence.

1 COMMISSIONER CHIASSON: Thank you.

2 We'll now break for 15 minutes 'til 3:45, at which  
3 point, unless there's anything we need to be aware of,  
4 we would look to have ISH start their  
5 cross-examination. All right? Thank you.

6 (ADJOURNMENT)

7 COMMISSIONER CHIASSON: So thank you, everyone. A  
8 couple of points just on timing for today. What we are  
9 thinking of now is to look at starting up and going  
10 'til about 5 and assessing just before 5 where we're --  
11 where we're at in -- in relation to that if that suits  
12 in terms of a spot for you to break, Ms. Riley. If  
13 not, we -- I would suggest that we may be able to go  
14 later, but we would anticipate not going any later than  
15 5:30 today at the -- at the maximum.

16 And that -- then the other piece, just to get  
17 started, is we are aware that ISH has provided in the  
18 timeline that was set out in relation to aids to cross,  
19 and we're just checking to make sure no concerns --  
20 no -- all right.

21 So Mr. Lung will mark that in. Yes?

22 A. LUNG: Yeah. We can mark in as an  
23 AQ, AQ Number 1.

24 COMMISSIONER CHIASSON: Okay. Thank you.

25 And otherwise, then, Ms. Riley, please proceed.

26 M. RILEY: Thank you very much, Panel

1 Members. I will note that we have -- with the planned  
2 timing of today, have identified one or two, maybe  
3 three topics that we can cover, and then we would like  
4 to break, and we will still finish within the time  
5 allotted, if we start tomorrow as planned.

6 COMMISSIONER CHIASSON: Thank you. So, yes, if you  
7 just let us know, then, where it -- where it suits for  
8 you to -- for you to break, then that's -- that's fine.  
9 We're glad to work with that.

10 M. RILEY: Thank you.

11 COMMISSIONER CHIASSON: Thank you.

12 M. RILEY: Very well. Mr. Lung, if you  
13 could then bring up EQ1, the first of the ISH aids to  
14 cross-examination.

15 M. Riley Cross-examines Canadian Natural Resources  
16 Limited Witness Panel

17 Q M. RILEY: And I will address the  
18 questions to Mr. -- and I apologize if I get this  
19 wrong. I always thought it was Iannattone. Apparently  
20 it's Iannattone.

21 A G. IANNATTONI: You're correct. It is  
22 Iannattone, but that's the Italian. So if you want to  
23 go with that, I'm fine with it too.

24 Q Very well.

25 So, Mr. Iannattone, you testified about the values  
26 of CNRL and specifically your mission statement the

1 first thing this morning; is that correct?

2 A That's correct.

3 Q If we look at the screen at PDF page 3, we see there a  
4 printout from Canadian Natural's website, and it  
5 essentially confirms what you said this morning, that  
6 Canadian Natural's main purpose is to develop people to  
7 work together to create value for the company's  
8 shareholders; is that correct?

9 A That's correct.

10 Q So if we go to the next page, we -- again, a printout  
11 from the company's website, and here we have CNRL's  
12 strategy. And the main message here in blue at the top  
13 of the page is "we are creating value for our  
14 shareholders"?

15 A That's what it says.

16 Q And it is fair to say that if you look at your mission  
17 statement, you look at your strategy, these things are  
18 what informs your decision-making?

19 A Sorry?

20 Q If we look at your mission statement, we look at your  
21 strategy, these are the things that inform CNRL's  
22 decision-making, at a high level?

23 A Yes, at a high level.

24 Q If we then go on and -- and we just looked at CNRL's  
25 peers. If we look at Cenovus's strategy --

26 M. RILEY: If you could just move on to

1 the next page, please, Mr. Lung.

2 Q M. RILEY: The very first thing that is  
3 part of Cenovus's strategy is top-tier safety  
4 performance and environmental, social, and governance  
5 leadership. If we scroll down and we look at Cenovus's  
6 purposes and value, they energize the world to make  
7 people's lives better. If we look at the values on the  
8 next page, they start with, "We protect what matters".  
9 So it's a bit different from CNRL's?

10 A G. IANNATONE: I wouldn't really say so. I  
11 think it's quite similar. I see that "doing it  
12 together" is on the list. You know, "making it  
13 better", "doing it right" is on the list. What you  
14 don't see on Canadian Natural's website is we have  
15 another layer of values and principles that we use  
16 internally, and, you know, we have nine core values --  
17 I'm not going to read them here, but I'll just, you  
18 know, highlight a few of them, adhere to the mission  
19 statement is important to Canadian Natural. Safety is  
20 paramount. We do it right. Way down the list,  
21 Number 5, we return real value to shareholders;  
22 humility prevails; working together really matters; and  
23 outstanding corporate citizen -- citizenship is a core  
24 value. So although that is not directly accessible to  
25 the public, it is directly accessible to every Canadian  
26 Natural employee. In fact, we take the mission

1 statement very seriously. We have mission statement  
2 meetings with every employee no matter what their  
3 position is at least once a year. So -- and at those  
4 mission statements, they are run and presentations are  
5 given by the executive team.

6 Q So that is very interesting to me because if we were to  
7 compare CNRL's general approach to monitoring with some  
8 of your industry peers, it does not look to be the  
9 same. Is that -- is that surprising to you or ...

10 A No. It's not surprising to us. We don't mold  
11 ourselves to mimic our competitors necessarily. We do  
12 what's right for us. That's the "doing it right" in  
13 the mission statement.

14 Q Doing it right for CNRL. Good.

15 We provided some industry examples in -- in -- in  
16 the evidence, and I can find you the reference if it's  
17 important to you, but the way we interpreted what  
18 CNRL's response was -- the examples that ISH provided  
19 was not really applicable to the situation; is that  
20 correct?

21 A I'm not sure what your reference to -- referencing, the  
22 examples. Which examples?

23 Q Very well. I will -- tomorrow when we get into this a  
24 bit more, I will come back to this topic.

25 One of our questions was that if CNRL owned  
26 100 percent of the gas, would it waste it in favour of



1 the bitumen production?

2 A Would it -- sorry -- be wasted? Is that what you said?

3 Q In favour of the bitumen production.

4 A No, it would not be.

5 Q If ISH was not yet to request additional monitoring,  
6 would you have undertaken the additional monitoring  
7 that you have now offered?

8 A Sorry. I'm just pulling up some notes on gas wastage.

9 Yeah. CNRL has no intention of gas wastage under  
10 any circumstances. Canadian Natural is a majority  
11 working interest owner of the GOB gas, and AER  
12 recognizes Alberta case law that, you know, bitumen  
13 rights -- mineral rights owner can extract bitumen even  
14 if it interferes with another minerals. So we would  
15 not -- we would not waste the gas. That's for sure.

16 Q That was the only question.

17 The second question was -- that you haven't  
18 answered yet -- if ISH was not here to request  
19 additional monitoring, would you have undertaken the  
20 monitoring that you have now offered in your reply?

21 A No, we wouldn't. We've gone beyond what we think is  
22 reasonable, to tell you the truth. We think one  
23 gas-monitoring well is sufficient, but we also  
24 understand that we have to accommodate ISH's request to  
25 some extent.

26 Q I see.

1 M. RILEY: Mr. Lung, if we could go to  
2 Exhibit 50.002, paragraph 13, and I did not write down  
3 the page number.

4 COMMISSIONER CHIASSON: Ms. Riley, is it possible if  
5 you either pull the mic a little closer or speak up a  
6 little more. We found that the speakers tend to be  
7 pointed towards the main room rather than us, so it --  
8 it makes it a little challenging sometimes for us to  
9 hear. Thank you.

10 M. RILEY: I believe it is on page 6.  
11 Paragraph 13. Yes.

12 Q M. RILEY: So if I can direct your  
13 attention to paragraph 13. And specifically there in  
14 the middle of the -- of the paragraph, it's a reference  
15 to the staff submission group, and there's a reference  
16 to three referenced -- the Kirby Upper Mannville II  
17 pool in potential vertical association with the  
18 Wabiskaw D valley fill and McMurray channel.

19 So the issue in -- in the GOB decisions, the  
20 underlying rationale was that there could be  
21 communication between the gas pools and the underlying  
22 bitumen zone; correct? And that could eventually -- if  
23 we produce the gas, the bitumen production would become  
24 uneconomical. That's -- that's the underlying  
25 rationale?

26 A Yes. I think I have that in my opening statement.

1 Q So how does that work with CNRL's assertion that the  
2 Wabiskaw B gas is isolated from the SAGD operations?

3 A This, I believe, was a 2003 document. You know, at the  
4 time, there was a limited amount of information. Since  
5 that time, there's been a tremendous advancement in  
6 SAGD knowledge and technology, not to mention a  
7 tremendously greater amount of information where you  
8 heard in our evidence from our geoscientist that --  
9 that we have confinement -- confinement strata that  
10 isolates -- that isolates the Wabiskaw B from the  
11 McMurray channel reservoir.

12 Q In the beginning of your evidence, you adopted all of  
13 the CNRL evidence. Did that include the application?  
14 Was the application prepared under your direction and  
15 control?

16 A Yes, it was.

17 Q What did Mr. Scrimshaw prepare?

18 A Sorry?

19 Q What did Mr. Scrimshaw prepare?

20 A Mr. Scrimshaw?

21 Q Yes. The lead application officer.

22 A What -- sorry.

23 Q Or your --

24 A I can't -- I'm sorry. Could you maybe speak a little  
25 slower and --

26 Q Certainly. So even the application was prepared under

1 your direction and control?

2 A That's correct.

3 Q Did any other panel member other than Dr. Boone have  
4 any direct involvement with any of the application  
5 material?

6 A With the application, yes. I would say Dr. Boone had  
7 no involvement, but most of the other panel members  
8 would have had some involvement for sure.

9 Q We've heard all of your evidence, and we've heard very  
10 little from most of your panel. I'm just curious what  
11 their expected role is.

12 A The back bench here is for support primarily, and we  
13 have -- if we start there with Mr. Roche, he is a -- a  
14 production expert. Dale Walters is a geomechanical  
15 expert. Specifically, Dale Walters was responsible for  
16 the geomodelling. Marc Scrimshaw is regulatory.  
17 Mr. Wang is log interpretation, image logging. The  
18 panel was introduced quite extensively. They all have  
19 a role, and they all have a reason. And, finally,  
20 Scott -- Scott Barland here is primarily focused on the  
21 GCMS -- GCMS evidence.

22 Q I was just curious because you also mentioned that  
23 Albertans pay essentially 40 percent of -- of your  
24 expenses, and it's a very extensive panel, most of whom  
25 have not given direct evidence.

26 A Yes. That -- that is a fact, but -- you know, and to

1 quite honestly say, you know, we don't want to be here;  
2 and we don't want to incur the hearing expenses. We  
3 believe it is -- it's very expensive for us. It's  
4 expensive for ISH. It's expensive for the regulatory.  
5 And I would also add given our perceived value of the  
6 gas resource, it's unjustified.

7 Q We will get into the gas values tomorrow.

8 We will now turn to the topic of GCMS data and  
9 analysis. The evidence was that CNRL uses a third body  
10 to do their analysis. Who -- who is that?

11 A Sorry. If I could have a minute. We just need to get  
12 the right person to answer this question.

13 Mr. Barland will answer this question.

14 A S. BARLAND: So Schlumberger labs does all  
15 of our GCMS analysis. They're an industry leader.  
16 They actually bought Gusher Energy or Gusher  
17 Laboratories that started -- or pioneered the GCMS  
18 analysis and have continued that same procedure.

19 Q Why do we not see a report from Schlumberger?

20 A We have several reports from Schlumberger. They have  
21 not been filed, but what we do is we take the data from  
22 them and interpret it, plot it versus depth, and  
23 interpret these concentration gradients.

24 Q So the interpretation is actually CNRL's work, it's not  
25 Schlumberger's work?

26 A Yes.

1 Q I will then -- just give me one moment. I just need my  
2 note because I don't want to misquote anyone.

3 The evidence this morning was that if oil  
4 concentrations were not able to equilibrate over  
5 geological time, it is very unlikely that steam will be  
6 able to migrate through these lower permeability zones;  
7 correct?

8 A Yes.

9 Q So my question is: Is the suggestion that geological  
10 time is equivalent to -- and I'm not clear on whether  
11 the SAGD operation is now 15 years or 25 years, but is  
12 geological time equivalent to SAGD operational time?

13 A I would say geological time is probably -- probably  
14 more -- geological time, we're talking from the time of  
15 deposition, which would have been -- in the lower  
16 McMurray would have been 120 million years ago. The  
17 SAGD lifetime of a pad would be probably 15 to  
18 20 years. So the geological time equivalents is very  
19 tough to determine.

20 Q So it's not really accurate, then, to say that because  
21 the oil concentrations were not able to equilibrate  
22 over the geological time that the steam will not be  
23 able to migrate?

24 A No. I -- I believe we would still say that that's true  
25 just because if you give something 80 or 90 million  
26 years to equilibrate and then you introduce the steam

1 over 10 or 15 years, that would be an approximation.

2 Q So what we take away from this is that the introduction  
3 of steam will change things?

4 A I don't think it would change the nature of a barrier  
5 just because they're very low permeability, and over  
6 80 million years approximately, it would still -- it's  
7 been a barrier for that long, and it still will be a  
8 barrier to steam.

9 Q Very well.

10 Let's go to Exhibit 50.01, Tab 4, PDF page 218.  
11 Here we see some of this interpreted GCMS results, and  
12 as I understand it now, this interpretation is CNRL's  
13 own work; it's not a third party's work?

14 A No, this is our own work. The concentrations you're  
15 seeing in the blue dots up there are exactly from  
16 Schlumberger's work. We're just plotting them versus  
17 depth.

18 Q I see. On the topic of those blue dots, which compound  
19 are you mapping?

20 A I believe in this well, this is phenanthrene class of  
21 compounds, so all of the phenanthrene molecules would  
22 be grouped, some individually, at each depth location,  
23 and then plotted versus that depth.

24 Q How did you decide to use those?

25 A So over the years, I've been working with GCMS data for  
26 approximately ten years, and the phenanthrenes were

1 chosen as a marker compound or a compound class of  
2 organic -- hydrocarbon molecules that do vary versus  
3 depth. If you have something that is uniform versus  
4 depth, that suggests there's no change, so no  
5 biodegradation in those. That doesn't help you  
6 determine where barriers and baffles could be.

7 Q I see. So you look for the compounds that support your  
8 outcome, and then you use those, or is there another  
9 rationale for picking a compound?

10 A You want a compound that changes versus depth so you  
11 can actually determine if those changes are meaningful.

12 Q Do you -- and in your experience, do you think that  
13 weigh zones are tighter -- zones or intervals are  
14 tighter, that it has any effect on the biodegradation  
15 of bitumen?

16 A Clarify "tighter".

17 Q Smaller, not as large. In other words, if -- if your  
18 compartment is smaller, does it have an effect on the  
19 level of biodegradation?

20 A If it was wet -- if all of these zones were wet to  
21 begin with, so they had connate water or water that was  
22 associated with them during deposition, if there was no  
23 room to remove that water, there could be more  
24 biodegradation. The bacteria live in the water.

25 Q So it does have an effect?

26 A Pardon me?



1 Q So it does have an effect?

2 A Yes. The longer that bacteria spend with water that  
3 was associated with them originally, the more  
4 biodegradation you would have.

5 Q Is this something that you considered in your  
6 interpretation?

7 A Yes. That's the whole basis of our interpretation. If  
8 you see marked changes in biodegradation in different  
9 compound classes or any compound class, that signifies  
10 that there was a layer or a barrier between those two  
11 zones.

12 Q And is an increase and a decrease a sufficient change  
13 for you to interpret a barrier?

14 A CNRL believes so.

15 Q Could you -- could you explain the rationale for that?

16 A So a decrease in concentration versus depth, viewed  
17 from the bottom up, CNRL generally looks at things from  
18 where the injector and producer would be up towards the  
19 top of the reservoir because that's the way steam  
20 would -- steam growth would occur. If we have a  
21 decrease in those concentrations, that suggests a  
22 perched or a paleo water contact that that compartment  
23 below did not talk to the compartment above.

24 The forward stepping or an increase in  
25 concentration would also suggest a lower permeability  
26 layer, preventing those two zones from equilibrating

1 over geologic time.

2 Q So explain to the Panel, please, how -- how  
3 biodegradation works. Let me ask -- give you the  
4 premise of my question.

5 As ISH understands it, biodegradation works at --  
6 you start at a high level -- relative high level, and  
7 then the value goes down up to the oil/water contact,  
8 and then it should usually increase again because there  
9 might be a barrier.

10 A Yes.

11 Q So -- so if the level going down suggests that there is  
12 a barrier, why would the level going up equate to a  
13 second barrier? Is it not -- does it not make sense  
14 that if the level keeps on going down and -- and then  
15 goes up again and then goes down further that it is  
16 still the same compartment?

17 A That's been -- I -- I would say that any lateral change  
18 in biodegradation suggests that that compartment,  
19 either above or below a lateral change, did not  
20 equilibrate across that change. So the diffusion of  
21 the oil molecules or the bacteria cannot come from that  
22 same compartment.

23 Q If we can then go to Exhibit 43.02, page 6.

24 We see here some comparisons that CNRL has made to  
25 the Weser Estuary in Germany, and I'm looking at that  
26 second paragraph there, and CNRL says there, more or

1           less the last sentence of that paragraph: (as read)  
2           In the KN08 and KN09 area, the Wabiskaw D  
3           non-reservoir facies shows a concentration of  
4           fluid muds that GCMS supports is locally a  
5           barrier to communication with the overlying  
6           units.

7           Do you see that?

8       A    It's hard for me to read at the very bottom, but I --  
9           I'm -- I'm sure if you read it to me, it would be fine.

10       Q   Well, in full disclosure, I -- I did use the acronym  
11           "GCMS".

12       A    Oh, okay.

13       Q    So do you agree that what CNRL says there is that there  
14           is a local barrier?

15       A    The nature of GCMS is it's a 1D technique. So you look  
16           at the core in that well, and it's a vertical local  
17           barrier. Lateral extents cannot be determined by GCMS.

18       Q    Can you give me one moment to confer, and then I will  
19           tell you if I have more questions for you.

20           We may have one or two more questions on GCMS, but  
21           that is most of what we wanted to cover with you.  
22           Thank you very much. My friend Mr. McLeod is now going  
23           to take over for me for a bit, and then we will see  
24           what time it is. Maybe we can squeeze in one more  
25           topic.

26       COMMISSIONER CHIASSON:   Okay. Thank you. As I said,

1 we're open to working with your timing.

2 M. RILEY: Thank you.

3 A. McLeod Cross-examines Canadian Natural Resources  
4 Limited Witness Panel

5 Q A. MCLEOD: Good afternoon. My name is  
6 Andrew McLeod, M-C-L-E-O-D, for the record.

7 I'm going to ask a few questions of Dr. Boone.  
8 And to start with, I'm curious, Dr. Boone, have you  
9 been retained by anyone other than CNRL in the last  
10 year?

11 A T. BOONE: No, not in the last year.

12 Q Very good.

13 Could we bring up Exhibit 50.01 at page 60.

14 Now, in the second paragraph there, Dr. Boone, you  
15 write that: (as read)

16 I have also consulted with CNRL technical  
17 experts to clarify specific questions and  
18 make a personal assessment of the reliability  
19 of the data.

20 Who were the technical experts that you consulted?

21 A The technical experts would include numerous people  
22 here: Mr. Thomsen, Mr. Walters, Mr. Wang,  
23 Mr. Sverdahl, Mr. Lavigne.

24 Q And are there any technical experts who you consulted  
25 in relation to your statement on page 60 here who are  
26 not present today?

1 A What's -- so Mr. Gonzales is here. He's right there.  
2 And I specifically consulted with him on this one.

3 Q Okay. And Mr. Gonzales is -- is in the audience, and  
4 he's not a sworn witness today; is that correct?

5 A As far as I know.

6 Q Okay.

7 A G. IANNATTONI: That's correct.

8 Q Now, did any of the technical experts that you  
9 consulted with write any portion of either of your  
10 reports?

11 A T. BOONE: No, they did not.

12 Q Now, you also say on paragraph -- or on page 60 here  
13 that you made an assessment of the reliability of the  
14 data, but I notice that you don't come to any  
15 conclusion about your opinion on the reliability of the  
16 data. Is that because the data was unreliable?

17 A No. That's because I -- I assessed the data to be  
18 reliable. I mean, it's -- it's a small pressure  
19 difference, at least in -- in heavy oil terms. So, I  
20 mean, it -- it -- if it had been 3 or 400 kPa, I  
21 would've said this definitively is -- or this is  
22 definitive evidence of lack of pressure communication  
23 or a barrier between the zones. But because it's small  
24 and because, you know, data like this does have some,  
25 you know, some variability, I said it was only likely.

26 Q Okay. And -- and when you say that this data has some

1           variability, does that mean that your conclusions have  
2           some degree of uncertainty?

3    A    I think that's always the case, yes.

4    Q    Okay.  Now I'll turn you to page 62 of Exhibit 50.01.  
5           And I see here that you say you have reviewed all the  
6           core photos provided in CNRL's SIR response, and you  
7           say:  (as read)

8                    I reviewed the core photos as a reservoir  
9                    engineer looking to identify the potential  
10                   for steam to migrate through the sands and  
11                   specifically I reviewed them looking for  
12                   natural fractures.

13           Now, sir, are you a reservoir engineer?

14   A    Yes, I am.

15   Q    Okay.  And -- and you're aware that part of ISH's  
16           concern has to do with the potential for induced  
17           fractures, not just natural fractures; right?

18   A    Yes.  Yeah.

19   Q    And so your review of what natural fractures existed  
20           there would not necessarily allay ISH's concerns in  
21           terms of what happens after SAGD operations start?

22   A    Correct.  That's core before -- that was acquired  
23           before operations.

24   Q    Okay.  Now, later on page 62 there, you say -- I think  
25           it's on the second paragraph under "Microimaging Logs".  
26           You say:  (as read)

1 I have met with CNRL's technical expert, who  
2 has analyzed all of the FMI logs for  
3 fractures and reviewed the process employed  
4 to identify the fractures and selected logs  
5 through the confining strata.

6 Now, Dr. Boone, who did you meet with?

7 A That would be Mr. Wang or Dr. Wang.

8 Q And did anybody else contribute to the analysis of the  
9 FMI logs?

10 A Not to my knowledge. You'd have to ask Dr. Wang.

11 Q All right.

12 Dr. Wang, did anyone else contribute to the  
13 analysis of the FMI logs?

14 A X. WANG: I'm the only --

15 Q Can you turn on your mic, sir.

16 A Okay.

17 Q And just repeat the answer to your -- to that question.

18 A Yeah, I'm the interpreter for -- for the FMI.

19 Q Very good. Thank you.

20 Now, you say that -- sorry. Dr. Boone, you say  
21 that you evaluated the FMI analysis process that CNRL  
22 uses. Now, can you tell us what qualifications you  
23 have to evaluate the FMI analysis process?

24 A T. BOONE: I'd say I'm qualified in  
25 that -- and -- and if you look at my résumé, for my  
26 last five years with ExxonMobil -- or four years, five

1 years, I was Exxon's senior reservoir engineer for  
2 enhanced oil recovery. And so I went around the world  
3 on projects everywhere providing technical reviews and  
4 evaluating them in a very similar way to what I did  
5 here -- to what I did here.

6 Now, I recognize I'm not, you know, a  
7 geophysicist, but I have some experience in the area,  
8 and I at least like to think I know of some of  
9 the right questions to ask.

10 Q All right. I'll turn you to page 63 of Exhibit 15.01.  
11 Now, right under the fifth heading there, "Seismic",  
12 you say: (as read)

13 I have reviewed the seismic cross-sections  
14 provided and noted that CNRL's geophysicists  
15 have not identified any faults.

16 Are the geophysicists who -- who evaluated those  
17 seismic cross-sections here today?

18 A Yes. Mr. Sverdahl is right there.

19 Q And --

20 A Sorry. Go ahead.

21 A S. SVERDAHL: Just to clarify, our -- our  
22 staff geophysicist is not here today but also was part  
23 of that review.

24 COMMISSIONER CHIASSON: Mr. Sverdahl, could you speak  
25 up. The Panel can't hear you.

26 A S. SVERDAHL: My apologies. Our -- CNRL's



1 geophysicist, Waiman [phonetic] Wang, is not here  
2 today.

3 Q A. MCLEOD: Okay.

4 A She was part of that review.

5 Q So aside from you and -- did you say it was Dr. Wang?

6 A Ms. Wang.

7 Q Ms. Wang.

8 So aside from you and Ms. Wang, no other CNRL  
9 geophysicists were involved in the analysis of the  
10 seismic cross-sections?

11 A No. Ms. Wang and myself were the primary geophysicists  
12 involved.

13 Q And what was the source of those seismic  
14 cross-sections, Mr. Sverdahl?

15 A They were seismic sections taken out of our seismic  
16 interpretation package called "Petrel" based on the  
17 SEG-Y data from -- from the seismic data CNRL has  
18 acquired at Kirby north.

19 Q And, Dr. -- or -- sorry -- Mr. Sverdahl, you agree that  
20 the faults or other features that may exist, they  
21 cannot be resolved through seismic imaging?

22 A Smaller scale faults cannot be resolved through seismic  
23 imaging. That is correct.

24 Q And, Dr. Boone, I believe that you made that statement  
25 in your report. You still stand behind that?

26 A T. BOONE: That's definitely true.

1 Q Thank you.

2 Now, I'll turn you to page 64 of Exhibit 15.01.  
3 Under Heading 8 there, Dr. Boone, you say: (as read)  
4 CNRL's geoscientist responsible for analysis  
5 of the Wabiskaw B gas cap has compared the  
6 pre- and post-production evaluation logs from  
7 the Wabiskaw B gas cap and seen no evidence  
8 of water invasion.

9 Sir, can you tell me -- is CNRL's geoscientist present  
10 today?

11 A No. Not the one that -- that provided that support.

12 Q Okay. And who was that who provided that support?

13 A Is it Ms. Holman? Ms. Holman.

14 Q Ms. Holman. Okay.

15 And so I guess we can't test Ms. -- Ms. Holman's  
16 evidence because she's not here. But do you agree with  
17 their conclusion that there's no evidence of water  
18 invasion?

19 A I mean, I didn't review the data specifically myself.  
20 I -- I asked the question just because it seemed to be  
21 a good question to ask: Do you have any evidence from  
22 the wells you've drilled that there is water invasion?  
23 Because that might be indicative of fluid flow through  
24 fractures. And -- and the answer was not. Although  
25 I'm going to say that's -- it would be -- it might be  
26 difficult to -- to definitively determine that from

1 just core alone.

2 Q And so I guess --

3 A And logs. I should have said "logs". I said "core",  
4 but it's -- it's log analysis.

5 Q Okay. And -- and what qualification do you have to  
6 reach that conclusion that you just did?

7 A Well, there's a reservoir engineering aspect to it,  
8 which is that -- so, you know, initially the -- the  
9 saturations before any development in the area and  
10 before -- I think this even predates gas production --  
11 is -- and I'm going to -- I think it was roughly  
12 20 percent. Okay? And don't quote me on that. But  
13 it's a relatively low number. But then the question of  
14 how much it would change is a reservoir engineering  
15 question. And so if water is invading, you have -- you  
16 have to look up and see what can that saturation be  
17 driven down to? And it's called "trapped gas  
18 saturation". And it's going to be roughly half that  
19 20 percent or so. So you could drive it down to  
20 10 percent. So you're looking for that difference  
21 between the saturations.

22 Q All right. I'll turn you to page -- oh, I guess we're  
23 already on 64. At the top of paragraph 9 there, you  
24 say: (as read)

25 I've reviewed the steam injection volumes and  
26 water production volumes for both the Kirby

1 north and Kirby south fields over the life of  
2 their operations.

3 How did you obtain that information?

4 A I went to the annual reports.

5 Q CNRL's annual reports?

6 A Yeah. Their annual in situ reports.

7 Q Okay. And has that information been provided to ISH?

8 A That's in the public domain.

9 Q Okay. Okay. I'll turn to page 66 of Exhibit 15.01.  
10 Now, you say there that based on -- sorry. It might  
11 be ...

12 The information contained in the D54 document, it  
13 appears to be essentially like a PowerPoint  
14 presentation. How are you able to do calculations  
15 based on that?

16 A I'm -- I -- I mean, there's data provided in those  
17 reports that you could use for calculations, but I'm --  
18 I'm not sure exactly what you're referring to. Is  
19 there a -- is there a line you could refer me to here,  
20 please.

21 Q Yeah. Just hang on one sec.

22 Let's turn back to page 64. Okay. So, yeah,  
23 the -- the question is: Under -- under paragraph 9  
24 there, you say that if any significant volumes of  
25 fluids were migrating out of the McMurray formation,  
26 either through the combining strata or down into the

1 bottom water zone, this would be manifested as a net  
2 loss of fluids where the rate of water production was  
3 less than the rate of steam injection. And so the  
4 question is: How did you calculate those -- those  
5 rates?

6 A So I -- I didn't calculate the rates. They are  
7 presented in plots in the D54 annual presentations that  
8 are provided. And so -- and -- and this is something  
9 that typically is always compared, is how much steam do  
10 you inject and how much water do you produce? Because,  
11 you know, you want to know where your steam is going.  
12 If you're losing it, you're losing money. And they're  
13 within 1 or 2 percent as best I could see from the --  
14 from the charts.

15 Q Okay. All right. So now I'll turn to page 66 of  
16 Exhibit 15.01. And there -- I'm having -- oh, yes.  
17 It's about -- it's in the second paragraph under the  
18 "Required Fracture Intensity". You say: (as read)

19 Based on laboratory tests that measured the  
20 fluid conductivity of fractured shale, it is  
21 conservative to assume that an open  
22 conductive natural fracture in the overlying  
23 strata in Kirby north would have a  
24 conductivity of no more than 300 MDM.

25 And -- and so I'm curious what lab you're referring to  
26 that conducted that test.

1 A So that's described in more detail in Appendix 1;  
2 right? And the references are provided --

3 Q Okay.

4 A -- in footnotes in Appendix 1. And those were papers.  
5 And it's not the shales that we're specifically dealing  
6 with. The work that's been done on this relates to  
7 shale gas and production of shale gas because that's  
8 where people worry about it most. And -- and I -- it's  
9 conservative because they'll give you a -- you can get  
10 a flow -- they've measured flow rates in these shales,  
11 but they're much stronger and stiffer than the shales  
12 we're talking about here.

13 Q Okay.

14 A And so they -- they stay open and flow.

15 Q And -- and so then there wasn't any specific laboratory  
16 testing performed in order for you to reach this --  
17 this conclusion?

18 A No.

19 Q Okay. And how is it that you reached the conclusion  
20 that the -- about the maximum conductivity?

21 A The conductivity of the fractures?

22 Q Yes.

23 A So I -- I took -- I looked at the data, and I picked a  
24 number that was in the middle of the data and was at  
25 the confining stress that's applicable to the  
26 confinement strata at KN08s and KN09.

1 Q And the data you're referring to?

2 A Is in these papers that are referenced in the appendix.

3 Q Okay. And those papers refer to production of shale  
4 gas?

5 A Well, they -- they refer -- they refer to tests that  
6 were done on samples that were actually quarried at  
7 surface from outcrops and then taken into the lab and  
8 then fractured, and then they measured the permeability  
9 of those fractures.

10 Q Right. But it's not directly relevant to -- or  
11 directly derived from the -- the geology that we're  
12 talking about here?

13 A That's correct.

14 Q As a result of that, there is some uncertainty in -- in  
15 your conclusion that the maximum conductivity would be  
16 300?

17 A Yes, there is, but I've -- I really do believe it's  
18 conservative. I think if you -- these shales here are  
19 so much weaker than the shales that were tested. Like  
20 I said earlier in my presentation, almost certainly  
21 these fractures will be closed and not conductive.

22 Q All right. I'll turn you now to page 74 of  
23 Exhibit 15.01. Now, about halfway down the page there  
24 you say: (as read)

25 Experience with SAGD has established bounds  
26 on the rates of steam rise in the Athabasca

1 oil sands.

2 Now, you're not talking about your own experience  
3 there, are you?

4 A No. I'm -- well, I mean, I have some experience, but  
5 I'm speaking more broadly of experience in the industry  
6 and what's reported in papers.

7 Q Okay. And so it's not specifically CNRL's experience,  
8 it's just the experience that you've gleaned from  
9 reading papers?

10 A To a large extent, yes.

11 Q Okay. Now, I'll turn to --

12 A. MCLEOD: Well, perhaps I'll -- I'll  
13 mention to the chair, I've got -- or, rather,  
14 Commissioner Chiasson that I've got maybe three more  
15 questions to ask on Exhibit 50. So I think I would  
16 probably be done in about 10 or 15 minutes, but I'm  
17 open to stopping now if you'd prefer.

18 COMMISSIONER CHIASSON: No. Actually, we can continue  
19 with your questions, and just for clarification, then  
20 you're proposing to essentially finish for -- for the  
21 day after those questions, or were you anticipating  
22 more questions from Ms. Riley?

23 A. MCLEOD: Let me just confer with my  
24 co-counsel, and I'll tell you.

25 COMMISSIONER CHIASSON: Thank you.

26 A. MCLEOD: Yeah. We'll conclude after



1           these last few questions for the day.

2           COMMISSIONER CHIASSON:     Sorry.

3                     Dr. Boone, did you have a question?

4           T. BOONE:                     Sorry.     Should I be facing the  
5           Panel when I answer questions?

6           COMMISSIONER CHIASSON:     Frankly, if you're using the  
7           microphone, we will be able to hear you.     So if it --  
8           whatever you're most -- whatever you're most  
9           comfortable with, but I would suggest because you've  
10          got interplay going with either Mr. McLeod or  
11          Ms. Riley, that that may be more suitable.     We'll let  
12          you know if we're having problems hearing.

13          T. BOONE:                     Okay.

14          COMMISSIONER CHIASSON:     Thank you.

15    Q     A. MCLEOD:                     I'll turn you now, sir, to  
16          Exhibit 50.003 at page 5.

17          A. MCLEOD:                     Can you scroll down a little  
18          bit there.

19    Q     A. MCLEOD:                     I thought that on this  
20          page you said something, but hang on one second while I  
21          find my reference.     Oh, yeah.     There it is.     Okay.

22                     So on the second paragraph here, after the first  
23          sentence you say:     (as read)

24                     With the support of CNRL's geoscientists, I  
25                     have classified the facies in the confinement  
26                     strata for four cored wells -- two from each

1           of the KN08 and KN09 drainage boxes -- and  
2           made a calculation of the time required steam  
3           to migrate through the confinement strata.

4           Can you confirm whether those geoscientists who support  
5           what you relied on are here today?

6    A    T. BOONE:                    Yes.  Two of them are at the  
7           end of the table down there.

8    Q    Okay.  And are there any of those geoscientists who you  
9           consulted with in -- in relation to this statement not  
10          here today?

11   A    Oh, sorry.  Colleen is -- Colleen is over here.

12   Q    Okay.  So we have one other geoscientist who is not a  
13          sworn witness; is that right?

14   A    Yeah.

15   Q    Okay.  Great.  Now, I'll turn to page 10 of  
16          Exhibit 15.03.  There you say, sir:  (as read)

17                I've reviewed the available information for  
18                this well and have concluded that it is  
19                indeed providing reliable data.

20          And I'm curious what qualifications you have to opine  
21          on the -- the reliability of that data?

22   A    Well, I'm -- I'm a reservoir engineer.  I've been  
23          involved in pilot design, pilot monitoring.  I ran the  
24          pilot programs at -- for Imperial at Cold Lake for many  
25          years, and a big part of that is assessing reliability  
26          of data that you're getting from wells.

1           And another part of it was in the KN06 hearing,  
2           but I think this is in the -- in the record for this  
3           hearing was the well test report, which as a reservoir  
4           engineer, we're trained to review well test reports and  
5           in reviewing that well test report, it gave me a lot of  
6           confidence that this well was providing reliable data.

7       Q    And -- and is it that -- that you're saying that it is  
8           presently providing reliable data or that it's always  
9           provided reliable data?

10     A    It's presently providing reliable data, and there may  
11           be some periods in the past where it didn't provide  
12           reliable data. I can't guarantee that.

13     Q    Okay.

14     A    But a lot of the data in the past is -- can definitely  
15           be interpreted and was interpreted by the well test  
16           engineer that was hired by ISH for the KN06 hearing.

17     Q    So I -- I -- I'm a bit confused about how -- how you  
18           could determine that the data was previously unreliable  
19           and then became reliable. What objective measure are  
20           you using to make that finding?

21     A    I didn't make that conclusion, by the way, that it was  
22           previously unreliable. I mean, there's some data there  
23           that -- that where you're seeing the pressures going up  
24           and down and you're wondering what might be causing  
25           that, and it would require some more in-depth review of  
26           the data, but the recent data, when you look at it,

1           when you look at the temperatures and the pressures,  
2           they're all very consistent with a well that was shut  
3           in and is -- now the pressure is recovering in the  
4           area.

5       Q    You'd agree, though, that gauge was -- for the 10-01  
6           well was broken at one point?

7       A    I -- I don't know the details on that. I believe that  
8           something to that effect is in the record, yes.

9       Q    And -- and a broken gauge, you'd agree, wouldn't  
10          provide reliable data?

11      A    Yes, I can agree with that.

12      Q    Okay. I'll turn you to Exhibit 50.003 at page 30.  
13          There you say at the second-from-last paragraph:  
14          (as read)

15                CNRL has run caliper logs on 12 wells at the  
16                Jackfish operation and 4 wells at the Kirby  
17                operation.

18          The logs have identified a total of approximately  
19          60 caisson deformations that may be associated with  
20          shear movement above the reservoir.

21                Can you confirm, sir, who collected those logs?

22      A    CNRL provided me that data. They have a database of  
23          all the logs they run and the deformations that are  
24          observed.

25      Q    And do you know if a third party collected those logs  
26          on behalf of CNRL?

1 A I'm sure they did, but I -- I can't speak to the  
2 specifics of the contract.

3 Q Okay. And so did CNRL interpret those logs before  
4 giving them to you?

5 A I -- you know, I didn't review the logs. I just asked  
6 for the data, and the data is in the tables that you  
7 see there.

8 Q Okay. But you then go on to draw the conclusion that:  
9 (as read)

10 Based on the considerations above, it is my  
11 assessment that it is unlikely that any  
12 significant shear features will be generated  
13 in the confining strata.

14 So you reached that conclusion without reviewing the  
15 logs?

16 A Well, I'm not a log analyst. I mean, the logs were  
17 analyzed and the results were tabulated, and they  
18 provided, you know, the type of deformation that was  
19 observed and the frequency of the observations. I -- I  
20 have a lot of experience reviewing logs like that for  
21 CSS operations, and in CSS operations you see a lot of  
22 deformation in the -- the caprock and the -- you know,  
23 the confinement strata above the CSS formation itself,  
24 and when you really look at these, these are very mild  
25 by comparison.

26 Q Very good. Sir, those are all of my questions for

1           today. We'll have some more for you tomorrow, I  
2           imagine, but subject to Commissioner Chiasson's  
3           comments, those are my questions for today.

4           COMMISSIONER CHIASSON: I think Commissioner Barker  
5           has one.

6           The Panel Questions the Canadian Natural Resources  
7           Limited Witness Panel

8           Q    COMMISSIONER BARKER: Thank you.

9                     Dr. Boone, just wondering, what's "CSS"? Could  
10           you just clarify what that acronym is, please?

11          A    Cyclical steam simulation.

12          Q    Okay.

13          A    Are you familiar with "cyclical steam simulation".

14          Q    Well, I just wanted to know what the acronym meant,  
15                so ...

16          A    I can expand on that, or you can just have the answer.

17          Q    That's all I need to know. Thank you very much.

18                COMMISSIONER CHIASSON: No, I think -- I believe that  
19                we are done for the day, then, and I would note that we  
20                are hoping to catch up some time tomorrow. I think  
21                there is some flex in some of our timing that may --  
22                may catch us up. So I would just remind everyone to  
23                remove any belongings you have from here in the hearing  
24                room, and parties, unless you've made arrangements that  
25                we're not aware of with the building operator, to also  
26                remove all your belongings from the breakout rooms

1 because there's no guarantee of security of any of the  
2 space.

3 And we will also remind all of the witnesses, both  
4 tables, that you're still under oath or affirmation, so  
5 do not discuss any of the evidence between yourselves,  
6 with your colleagues who are not sworn, with your  
7 counsel because you're still -- you're still in the  
8 process, and we haven't released you, so that reminder  
9 between now and when we return tomorrow morning.

10 And unless there's any other timing concerns that  
11 we're not aware of, parties, we would intend to resume  
12 back here tomorrow morning at 9:00. Any questions or  
13 concerns? No? Thank you all very much for your  
14 participation today, and we will be back tomorrow  
15 morning.

16 (WITNESSES STAND DOWN)

17

---

18 PROCEEDINGS ADJOURNED UNTIL 9:00 AM, FEBRUARY 7, 2024

19

20

21

22

23

24

25

26

1 CERTIFICATE OF TRANSCRIPT:

2

3 We, Sandie Murphy and Sandra Burns, certify that  
4 the foregoing pages are a complete and accurate  
5 transcript of the proceedings, taken down by us in  
6 shorthand and transcribed from our shorthand notes to  
7 the best of our skill and ability.

8 Dated at the City of Calgary, Province of Alberta,  
9 this 6th day of February 2024.

10

11

12

13

  
\_\_\_\_\_

14

Sandie Murphy, CSR(A)

15

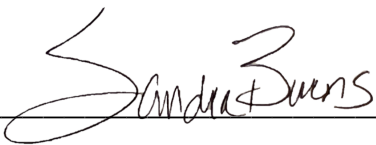
Official Court Reporter

16

17

18

19

  
\_\_\_\_\_

20

Sandra Burns, CSR(A), RPR, CRR

21

Official Court Reporter

22

23

24

25

26



	116:12 120:3,14 124:17 125:6 129:2 138:12 144:8 149:21 156:23 181:13 182:1,4	<b>11-4</b> 66:10 <b>11475</b> 9:3 <b>116</b> 25:2 30:4 <b>11:00</b> 32:11 34:7, 11 <b>12</b> 46:3 66:2 101:10 122:22 188:15 <b>12-34</b> 108:9 133:5 <b>120</b> 166:16 <b>12:30</b> 78:13 <b>12B</b> 91:23 <b>12I</b> 118:23 <b>13</b> 44:21,24 131:26 162:2,11, 13 <b>13(1)</b> 8:26 <b>13.1</b> 114:26 117:17 <b>14</b> 117:25 <b>14.3</b> 76:18 <b>14.6</b> 114:25 <b>140</b> 44:26 146:26 <b>141</b> 133:16 <b>142</b> 73:3,4,16 133:17 <b>143</b> 73:4,5 <b>145</b> 115:22 <b>146</b> 115:20,22 116:25 <b>14th</b> 133:8 <b>15</b> 68:3,6 110:25 117:25 122:22 142:5 156:2 166:11,17 167:1 184:16 <b>15.01</b> 33:14 41:7 50:4 60:4 62:20, 22 64:22 66:2 69:7 71:2 72:18 74:6 88:20 114:3, 23 176:10 178:2	180:9 181:16 183:23 <b>15.03</b> 186:16 <b>154</b> 19:1 <b>16</b> 39:13 62:22 63:1,19 72:18 108:1 <b>17</b> 42:3 <b>18</b> 48:16 141:26 <b>180</b> 58:17 111:14 117:6 120:11 125:10 <b>180/13-34</b> 103:25 <b>19</b> 134:23 <b>193</b> 71:3 <b>1936092</b> 8:24,25 <b>1970s</b> 141:1 <b>198</b> 71:5 <b>19th</b> 133:6 <b>1:30</b> 78:14,19 <b>1:32</b> 80:7 <b>1AA/11-2</b> 90:18 <b>1B</b> 94:15 <b>1D</b> 171:15 <b>1E</b> 71:23 <b>1st</b> 9:9,15 135:2	<b>2-19</b> 62:9 <b>2.01</b> 9:11 <b>2.1</b> 123:10 <b>20</b> 20:21 43:8 44:2 120:17 129:18 135:9 138:1 142:6 166:18 179:12,19 <b>20,000</b> 149:26 <b>20-year</b> 135:13 <b>200</b> 66:16 101:9 <b>2003</b> 163:3 <b>2004</b> 141:16 <b>2013</b> 44:25 <b>2020</b> 133:7 <b>2021</b> 49:1 86:19 129:7,11 <b>2022</b> 8:24 9:7 49:21,22 66:11 102:3 103:12 126:20 133:8 <b>2023</b> 9:9 49:25 66:11 79:3 101:5 129:13 <b>2024</b> 9:15 86:18 135:3 191:18 192:9 <b>2025</b> 132:9 <b>20K</b> 137:10 <b>21</b> 11:10 64:23 <b>216</b> 62:22 63:4 <b>218</b> 69:11 167:10 <b>219</b> 62:25 69:8,10 <b>22</b> 121:8 <b>224</b> 66:3 <b>23</b> 9:1 49:12 131:24 149:16 <b>23rd</b> 19:6 <b>24</b> 16:10 21:2 47:12 85:15 93:24 111:13 117:5 120:10 122:12 125:7
<hr/> <b>\$</b> <hr/>				
<b>\$1,000</b> 137:18 <b>\$1.10</b> 136:10 <b>\$1.175</b> 136:13 <b>\$250</b> 48:5 <b>\$30,000</b> 133:3 <b>\$5-per-million</b> 135:18 <b>\$500,048</b> 136:15 <b>\$6</b> 154:19	<b>1,000</b> 101:15 <b>1,100</b> 141:15 <b>1,400</b> 146:17 <b>1-3</b> 154:4 <b>1-mile</b> 106:10 <b>1.175</b> 135:20 <b>1.25</b> 123:13 124:10 <b>1.5</b> 115:2 122:17 <b>1.9</b> 123:10 <b>10</b> 50:4 68:3 110:25 116:12 120:15 135:9 167:1 179:20 184:16 186:15 <b>10-01</b> 52:26 188:5 <b>10-1</b> 108:5 128:13,17 129:5, 19 133:24 154:4 <b>10-2</b> 132:18 <b>10-3</b> 133:10 <b>10-34</b> 132:15 133:24 154:4 <b>100</b> 135:20,24 136:11 141:8 160:26 <b>100/01-03</b> 68:18 <b>100/1-3</b> 64:26 69:2 128:14,20 132:18 133:24 <b>102/6-4</b> 66:5 <b>107</b> 50:9 60:5 <b>10A</b> 122:19 <b>10th</b> 49:21 101:5 <b>11</b> 8:24 39:2 64:22 69:7 92:3			
<hr/> <b>-</b> <hr/>				
<b>-well</b> 115:24				
<hr/> <b>0</b> <hr/>				
<b>0.3</b> 122:8,15 <b>000</b> 25:25 <b>01.01</b> 48:15 62:8 73:3 74:13 76:1 85:18 88:6 89:14 95:17 <b>043.002</b> 58:16 71:23 <b>044.05</b> 131:10 <b>044.002</b> 129:18 <b>050.002</b> 134:19 135:26 <b>050.003</b> 61:14 63:19 67:17 68:15 86:16 90:8 103:8 138:18				
<hr/> <b>1</b> <hr/>				
<b>1</b> 12:17 41:4 76:13 78:9 81:14 90:12 91:20 94:15 103:10 109:17 110:11 113:1 114:23				
		<hr/> <b>2</b> <hr/>		
		<b>2</b> 12:25 41:8 50:18 74:6 88:26 92:3 110:12 113:3 120:4,25 121:1,3,10,11 124:18 125:9,21 126:1,8 129:2 130:16 144:23 148:25 149:5,19 151:11 181:13 <b>2,000</b> 141:22 <b>2,600</b> 112:3 122:26		

139:12 148:24  
**24(5)** 31:25  
**25** 42:16 88:20  
 166:11  
**25-plus** 101:15  
**250** 51:1 54:4  
**26** 146:3  
**272** 85:19  
**273** 88:6  
**275** 89:14  
**28** 144:23  
**29** 50:4 71:24  
**2D** 119:4 122:20

---

**3**


---

**3** 6:4 13:2 35:17  
 51:1 56:26  
 101:19 103:20  
 109:19 110:14  
 113:6 120:6  
 124:20 131:10  
 135:19 139:24  
 148:25 149:5  
 151:10 152:10  
 158:3 173:20

**3-metre** 130:18

**3.9** 76:18

**30** 32:10 47:24  
 48:10 95:22  
 127:2 130:4  
 143:23 188:12

**30-day** 119:13  
 123:17

**300** 181:24  
 183:16

**300-metre** 132:2  
 149:25

**30th** 129:11

**31** 121:26 147:8

**32.02** 133:17

**326** 71:5

**327** 72:19

**328** 74:7

**339** 88:21

**34** 131:10 144:3

**340** 108:3

**35** 47:25

**350** 130:12

**36** 85:16 94:3  
 139:18

**370** 74:13 76:1

**371** 74:17

**387** 48:16

**39** 40:14 114:23

**390** 47:15

**393** 143:9

**397** 22:23,24,25  
 23:2,4,8 31:10

**3:00** 35:16

**3:30** 80:25 138:4

**3:45** 156:2

**3D** 57:8 84:21  
 94:26 95:4,13  
 139:24

---

**4**


---

**4** 41:4 50:8 54:4  
 60:5 110:15  
 123:5 124:21  
 125:21 126:1  
 129:22 134:20  
 138:12 146:14  
 148:25 149:5  
 152:8 167:10  
 188:16

**4,000** 122:24  
 147:2

**4.2** 49:12

**40** 37:26 48:10,11  
 164:23

**40.01** 38:8,20  
 39:7,17 40:5,23  
 42:8 43:1

**400** 101:9 173:20

**42** 33:15

**43** 85:12 104:7  
 107:24 134:20

**43.02** 170:23

**430** 5:15

**436** 90:19,22

**436.5** 90:25

**44** 133:17 136:1

**45** 133:17

**450** 147:20

**46** 115:24

**46.002** 120:16

**46.25** 135:23

**47** 133:17

**470** 147:1

**48** 51:1

**48.001** 44:11

**49** 54:4

**4:35** 12:18

**4:50** 13:3

**4D** 57:16 85:5  
 126:18

---

**5**


---

**5** 13:14 67:17  
 101:19 103:20  
 125:21 126:1  
 131:24 136:1,24  
 143:3 156:10  
 159:21 185:16

**5,500** 25:23  
 111:1,4,10 125:8,  
 12,13 127:24,25  
 128:7 131:2  
 153:26

**5.5** 117:15,21

**50** 46:2 56:20  
 63:13 74:3 75:10  
 83:2 147:18  
 184:15

**50-003** 100:2  
 101:26

**50.002** 41:9 162:2

**50.003** 51:1 54:4  
 96:20 185:16  
 188:12

**50.01** 167:10  
 172:13 174:4

**50.09** 108:3

**500** 147:18

**505** 50:4,9

**51** 61:15

**51.001** 9:11

**53** 62:9 86:17  
 122:18

**54** 126:22

**548,000** 135:17

**55** 90:8

**58** 96:20

**58.001** 46:12

**580** 65:5,12 69:21

**5:05** 12:26

**5:30** 156:15

**5A** 86:21,24  
 87:23

**5B** 86:19

---

**6**


---

**6** 25:25 61:14  
 79:3 87:4 101:9  
 114:4 162:10  
 170:23

**6,000** 111:23  
 115:25 116:9  
 123:18 124:7,24  
 125:13 127:24  
 128:5,9

**6,600** 111:11  
 121:4,15,17  
 124:15 125:9,14  
 127:25 131:3  
 152:3 153:21

**60** 73:8 100:2  
 172:13,25 173:12  
 188:19

**61** 63:20

**62** 101:26 103:8  
 131:11 174:4,24

**63** 95:18,19  
 103:24 176:10

**64** 95:26 120:16  
 178:2 179:23  
 180:22

**65** 105:5

**66** 105:22 129:18  
 180:9 181:15

**68** 95:17

**6I** 119:3

**6th** 192:9

---

**7**


---

**7** 5:25 68:15 71:2  
 122:1 191:18

**7-29** 108:8

**7.8** 131:24

**70** 76:5 143:23

**700** 101:15

**71** 121:25

**72** 123:5

**74** 183:22

**7A** 58:17

---

**8**


---

**8** 20:21 71:5  
 86:16 122:1,3,7  
 178:3

**80** 166:25 167:6

**800** 141:18

**86** 123:12

**8th** 9:7 49:22

<b>9</b>	100:7,8,16 101:1, 7,14,18 102:16 103:16 104:20 126:5	<b>achieved</b> 133:13	117:12	<b>advised</b> 16:9
<b>9</b> 55:6 58:11 60:9, 19 61:7 62:21,22 66:22 67:12,16, 20 71:20 72:6 76:12 77:14 85:11,13 87:4 92:15 93:22 138:20 144:7 179:23 180:23	<b>abbreviated</b> 37:10	<b>acknowledge</b> 5:23	<b>address</b> 15:3 49:2,17 50:1 54:23 96:22 110:18 144:24 149:4,19 157:17	<b>AER</b> 6:5,21 7:7 8:9,16,18,19,24 9:8 12:12,21 13:5,10 14:13 22:26 23:20 24:10,14,18 26:7 29:17 49:24 79:9, 10,11,12,13,14, 15,16,17,18,19, 20,21 88:25 126:22,23 129:2, 7 154:16 161:11
<b>9-1-1</b> 8:8	<b>abbreviations</b> 137:14	<b>acknowledges</b> 68:18	<b>addressed</b> 126:17 151:11 152:10	<b>AER's</b> 7:13 18:13 24:19
<b>9.8</b> 117:22	<b>ability</b> 47:21 74:25 76:24 192:7	<b>acquired</b> 174:22 177:18	<b>addresses</b> 109:25	<b>AER- RECOGNIZED</b> 118:13
<b>90</b> 13:16 130:4 166:25	<b>abnormal</b> 127:14	<b>acronym</b> 51:10 171:10 190:10,14	<b>addressing</b> 29:22 49:20 55:1 78:9 125:20	<b>aerial</b> 50:21 71:9
<b>95</b> 129:19	<b>absence</b> 55:13 105:17 144:18,20	<b>acronyms</b> 51:9	<b>adequate</b> 154:3	<b>affairs</b> 35:5
<b>96</b> 25:24 114:4	<b>absent</b> 91:10	<b>act</b> 9:1 53:11,12 70:8 71:21 74:25 77:6 139:17 142:15 144:4	<b>adequately</b> 126:17	<b>affect</b> 22:17 55:23 56:10 67:1 84:8 138:23 155:2
<b>9:00</b> 191:12,18	<b>absolutely</b> 32:20	<b>acted</b> 69:14	<b>adhere</b> 159:18	<b>affected</b> 52:14 65:7
<b>9:17</b> 5:7	<b>abundant</b> 83:13	<b>active</b> 51:26 100:8	<b>adhering</b> 47:9	<b>affirmation</b> 11:12 191:4
<b>A</b>	<b>abundantly</b> 30:16	<b>actively</b> 134:6	<b>adjacent</b> 67:12 100:16 126:6 142:25	<b>affirmed</b> 11:15 35:11 37:1 81:7
<b>A'</b> 97:10	<b>academic</b> 153:13	<b>acts</b> 77:18	<b>adjourn</b> 15:2 23:16,22 27:18	<b>afternoon</b> 14:2 79:3 109:20 125:23 138:9 172:5
<b>A's</b> 97:21	<b>accentuated</b> 98:4	<b>actual</b> 20:5 24:24 104:17	<b>adjourned</b> 26:4 78:19 191:18	<b>aged</b> 71:12
<b>A1</b> 74:10	<b>accept</b> 132:14	<b>AD/13-34</b> 93:16 103:10	<b>adjournment</b> 22:1 23:26 24:3 25:7 26:15 28:10 30:25 31:4 34:12 156:6	<b>agent</b> 129:25
<b>A2</b> 60:13 61:26 71:7,10,12 77:18, 20	<b>acceptability</b> 149:1	<b>add</b> 154:19 155:12 165:5	<b>adjust</b> 11:2 22:7 23:13 31:21 32:7 34:9 57:21	<b>aggregate</b> 76:18, 20
<b>AA</b> 62:13	<b>acceptable</b> 18:6 112:6	<b>added</b> 97:3 145:23	<b>adjusted</b> 31:20	<b>aggregation</b> 55:5 81:15
<b>AA/1-3</b> 81:19	<b>access</b> 132:8	<b>addition</b> 7:7 9:5 51:23 54:10 128:20 132:18 133:24	<b>adjustment</b> 52:11	<b>aggregations</b> 56:1
<b>AA/11-2</b> 91:12	<b>accessible</b> 159:24,25	<b>additional</b> 6:14 46:5 61:11 97:3 114:20 117:7,9 130:9,10 131:5 133:2 136:16 145:9,16 149:20 150:19 151:1,2,5, 6 152:5 154:9 155:11,23,25 161:5,6,19	<b>adopt</b> 45:16	<b>agree</b> 141:2 171:13 177:19 178:16 188:5,9,
<b>AA/15-34</b> 89:18	<b>accommodate</b> 161:24	<b>additionally</b> 85:16 90:2 91:14 92:17 107:7	<b>adopted</b> 163:12	
<b>AA/16-33</b> 89:3	<b>accommodated</b> 31:22		<b>adopts</b> 127:22	
<b>AA/9-3</b> 92:26	<b>accommodates</b> 113:7		<b>advance</b> 56:14	
<b>AA/9-33</b> 93:8	<b>account</b> 155:4		<b>advancement</b> 127:15 163:5	
<b>Aardwolf</b> 149:6	<b>accurate</b> 45:20 166:20 192:4		<b>advise</b> 7:17,21 32:6	
<b>AB11-34</b> 92:20	<b>accurately</b> 38:8, 20 39:7,18 40:5, 23 42:8 43:1 44:11 45:6			
<b>abandoned</b> 63:26 64:1 132:20 133:11				
<b>abandonment</b> 64:9 95:8 99:3				

11	101:17,20,23	<b>anomaly</b> 97:20, 22,25 102:25 104:17	164:4,6	95:4,24 96:2
<b>agreed</b> 129:19	102:25 106:9,12	<b>anticipate</b> 35:14, 15 156:14	<b>applications</b> 9:2 43:10	97:23 102:5,13
<b>agriculture</b> 44:18	110:21 163:4,7	<b>anticipated</b> 103:5	<b>applied</b> 126:25 128:9 131:4 151:24 152:7	103:4,26 107:3 111:26 117:3 122:21 123:14 139:13 140:26 171:2 176:7 179:9 188:4
<b>ahead</b> 137:2 176:20	<b>ample</b> 31:17	<b>anticipating</b> 184:21	<b>applied-for</b> 106:13	<b>areas</b> 45:3 51:16, 17,25 85:13 95:21 100:5,8 104:16 105:9 106:5 107:25 109:6 116:18 117:8 139:19,25
<b>aid</b> 8:10,11,15	<b>amplitude</b> 84:21 88:12,14,17,18 89:24 97:20,22, 25,26	<b>APEGA</b> 38:15 44:21	<b>applies</b> 7:19 57:2 112:26	<b>arguably</b> 24:5
<b>aide-mémoire</b> 33:2	<b>analog</b> 66:17 140:10	<b>apertures</b> 90:6	<b>applying</b> 25:7 135:16	<b>argue</b> 11:21
<b>aids</b> 156:18 157:13	<b>analogous</b> 57:20 65:25	<b>apologies</b> 61:13 63:2,5 64:25 67:26 74:7 93:8 176:26	<b>appreciated</b> 36:25	<b>argued</b> 153:12
<b>alarm</b> 8:3	<b>analysis</b> 44:23 56:17 57:5,11 59:7 69:13 75:4 76:25 93:11 103:25 153:19 165:9,10,15,18 175:8,13,21,23 177:9 178:4 179:4	<b>apologize</b> 6:18 157:18	<b>approach</b> 6:24 24:16 57:3 138:21 160:7	<b>argument</b> 13:12 14:21 31:25
<b>Alberta</b> 5:26 6:4 11:11 38:16 44:20 47:8 63:25 79:1 140:12 144:22 161:12 192:8	<b>analyst</b> 189:16	<b>Apparently</b> 20:24 157:19	<b>approval</b> 9:2 48:21 126:24 131:26 132:7,10 133:19 136:5 155:24	<b>arrangements</b> 190:24
<b>Albertans</b> 47:26 48:10 155:14 164:23	<b>analyzed</b> 44:25, 26 59:15 77:7,23 175:2 189:17	<b>appeal</b> 31:10	<b>approved</b> 131:2 152:9	<b>arrows</b> 17:10 54:14
<b>alert</b> 8:9,18	<b>Anastasia</b> 6:17, 18 79:13	<b>appearance</b> 87:22	<b>approve</b> 31:16 126:2 129:22	<b>articulated</b> 30:8
<b>alignment</b> 25:10 54:16 133:13	<b>ancient</b> 63:23	<b>appeared</b> 24:10 25:17	<b>approved</b> 131:2 152:9	<b>artifacts</b> 90:15
<b>allay</b> 174:20	<b>ancillary</b> 26:16	<b>appears</b> 14:15 68:21 70:23 180:13	<b>approximately</b> 66:13 68:24 95:21 101:9 110:20,25 112:3 117:15 141:8,15, 18,21 142:5 146:16,25 147:14,20 167:6, 26 188:18	<b>as-needed</b> 126:23
<b>allocated</b> 12:14	<b>and/or</b> 49:7 96:23 107:8 108:17 126:5	<b>appendix</b> 41:8 182:1,4 183:2	<b>approach</b> 6:24 24:16 57:3 138:21 160:7	<b>ascertain</b> 140:13
<b>allocation</b> 52:18	<b>Andrew</b> 6:10 10:23 79:11 172:6	<b>applicable</b> 9:24 12:4 124:11 160:19 182:25	<b>approval</b> 9:2 48:21 126:24 131:26 132:7,10 133:19 136:5 155:24	<b>aspect</b> 179:7
<b>allotted</b> 35:15 80:11 157:5	<b>angle</b> 89:10,24	<b>applicant</b> 10:3,8	<b>approved</b> 131:2 152:9	<b>aspects</b> 47:6
<b>allowed</b> 11:15 21:19,22 22:15, 24 23:25 24:6 25:18 30:18 51:24 75:17 152:3,26 154:25 155:20	<b>annotated</b> 61:17 87:19 97:6,24 98:3	<b>applicants</b> 49:14	<b>approved</b> 131:2 152:9	<b>Aspen</b> 101:4,11
<b>allowing</b> 23:13 26:13	<b>annotations</b> 97:3 98:9	<b>application</b> 8:24, 25 9:8 10:9 15:26 24:3 27:10 31:12, 14,17 33:10 37:23 49:1,18,20 93:14 95:15,20 96:1 102:3 111:22,23 125:3 163:13,14,21,26	<b>approved</b> 131:2 152:9	<b>assertion</b> 105:19
<b>alternative</b> 106:3	<b>annual</b> 140:10 180:4,5,6 181:7	<b>applicant</b> 10:3,8	<b>approved</b> 131:2 152:9	<b>assertion</b> 163:1
<b>amend</b> 9:2	<b>anomalies</b> 97:26	<b>appeal</b> 31:10	<b>approved</b> 131:2 152:9	<b>asserts</b> 107:1
<b>amendment</b> 9:4		<b>appearance</b> 87:22	<b>approved</b> 131:2 152:9	<b>assess</b> 36:17 57:21 58:3 140:20 142:9 150:21 151:22
<b>amount</b> 52:15 54:7 95:7,11 98:10 99:8		<b>appeared</b> 24:10 25:17	<b>approved</b> 131:2 152:9	<b>assessed</b> 56:14 115:21 119:11 144:9 150:11,16, 26 173:17

**assessing** 76:24  
118:11 138:25  
149:1 156:10  
186:25

**assessment** 20:8  
29:15 40:20 41:3  
54:17 81:16  
104:14 138:12,26  
139:7,12 143:22  
144:12,16 148:26  
150:3 151:6,23  
152:2,11,25  
154:12 172:18  
173:13 189:11

**assessments**  
43:10 149:4

**asset** 38:17  
125:26

**assets** 45:2 57:19

**assigned** 143:2

**assist** 8:16 11:25  
14:17 62:15  
71:16

**assistance** 6:25

**assisted** 129:26

**assisting** 6:6,11,  
22

**association**  
44:19 162:17

**assume** 135:24  
181:21

**assumed** 150:3  
151:12

**assumes** 149:24

**assuming** 32:25  
33:24 135:9,11,  
21

**assumptions**  
41:13

**Athabasca** 10:17  
37:18 38:17  
183:26

**attached** 31:16

**attempt** 18:15

**attempted** 16:11  
26:9 49:2

**attempting** 16:5  
29:9

**attending** 5:14

**attention** 125:19  
153:3 155:25  
162:13

**attribute** 95:5  
96:7

**audience** 173:3

**audio** 7:18 15:9  
34:17

**August** 129:7  
133:8

**Australia** 44:1

**author** 26:8

**authority** 37:21

**automatically**  
23:5

**avoid** 49:7

**aware** 15:25  
16:17 18:13  
31:25 156:3,17  
174:15 190:25  
191:11

**axial** 146:14

---

## B

---

**B'** 97:10 98:4

**B1** 60:21 61:22  
67:3,14,21 68:20  
69:6,16,22,24  
70:12,16 71:1  
77:5,15 81:26  
82:4,9,11 114:25  
119:1,6,10 120:6  
121:20,22  
122:11,13,16  
123:9 143:17,18,  
24

**B2** 60:13 81:24  
89:17 96:12,16  
100:6 114:26  
115:4,9 116:5,14  
117:16 118:6  
119:2,7

**bachelor** 37:24  
38:14 39:24  
40:10 42:14  
44:16

**bachelors** 43:6  
44:17

**back** 8:15 16:23  
17:16,20 34:11  
35:18 36:13  
41:25 61:6 68:5  
69:18 73:12  
78:11 80:9  
130:24 136:21  
160:24 164:12  
180:22 191:12,14

**bacteria** 168:24  
169:2 170:21

**baffle** 65:8 69:15,  
17 143:26

**baffles** 44:23  
55:16,18,22 56:2,  
7 57:12,26 59:2,  
22 60:1 67:15  
70:1,7,25 77:9,17  
142:10 168:6

**baked** 30:10

**Baker** 46:22

**balance** 85:6  
128:11

**balanced** 112:4

**Baohong** 6:13  
79:20

**bar** 63:22 100:17

**Barker** 5:18,21  
79:7 155:21  
190:4,8

**Barland** 37:3  
44:16 45:4,9 81:9  
164:20 165:13,14

**Barland's** 46:11

**barrels** 47:25

**barrier** 53:22  
55:3,12 60:26  
65:9 69:23 70:4,  
7,26 71:13 74:12,  
25 75:16 77:7,19,  
22 78:1 81:14  
140:23 142:15  
143:4 144:5,11  
153:11 167:4,7,8  
169:10,13 170:9,  
12,13 171:5,14,  
17 173:23

**barriers** 44:23  
55:16,21 56:2,7  
57:12,25 59:3,23  
60:1,18 67:15  
70:1 75:7,19  
77:1,9,17 140:8  
142:10 151:24,25  
168:6

**bars** 50:13,19

**basal** 61:5,8  
73:18,20 74:8,15,  
20,24 75:8 82:20

**base** 47:14 66:20  
70:2 71:1 73:23  
74:20 75:15,18  
77:22 82:13 83:9,  
11,22 119:1  
121:20 122:10

**based** 11:22 24:1  
31:26 41:12 59:9  
65:20 91:26  
139:1 141:9  
142:10,22 143:2,  
7 177:16 180:10,  
15 181:19 189:10

**baseline** 134:12

**basement** 96:2

**Basin** 38:2

**basins** 44:3

**basis** 24:3,17  
27:9 28:12 80:20

126:24 169:7

**beam** 147:13

**bearing** 78:1

**bears** 64:7 86:24

**Bearspaw** 6:2

**bedding** 76:10  
88:11,12,15,19  
89:10 91:1 92:23  
93:1

**beds** 58:7 63:16  
64:15,19 73:9  
89:23 96:3

**began** 129:13

**begin** 12:16,24  
126:8 168:21

**beginning**  
163:12

**begun** 57:15  
65:22

**behalf** 45:16  
188:26

**behave** 145:2

**behaves** 145:20,  
26

**behaviour**  
113:26 127:14  
145:5,10,24  
146:10,16,22

**belief** 45:20

**believes** 84:3  
87:1 128:12  
133:12 169:14

**belongings** 78:15  
190:23,26

**bench** 164:12

**bend** 64:16

**bends** 59:2

**beneath** 74:19  
77:23

**benefit** 7:11

**benefits** 54:2  
114:1

**bet** 38:5 128:26**big** 186:25**binding** 23:2**biodegradation**58:26 59:21  
69:15 75:20 77:2  
168:5,14,19,24  
169:4,8 170:3,5,  
18**bioturbated**70:16 76:5 81:25  
82:8 83:10**bioturbation**

76:7,13

**bit** 15:7,15 21:12,20 28:1 87:7  
120:19 137:1  
159:9 160:24  
171:23 185:18  
187:17**bitumen** 50:11,17,18,20,23  
51:13,15 52:3,5,  
9,13,16,19,21  
53:3,7,9,14 55:25  
71:14 73:1 75:24  
78:1 84:13 106:9,  
13,21 107:8  
112:7 129:15  
130:22,24 135:12  
152:19 153:8  
155:6 161:1,3,12,  
13 162:22,23  
168:15**bitumen-bearing**

55:4

**bitumen-****saturated** 60:10

81:20

**black** 51:22,26

97:4 98:7

**block** 17:3**blog** 86:19**blue** 48:19 54:14

62:6 68:13

158:12 167:15,18

**body** 72:13 165:9**bolded** 17:26**bona** 50:1**booked** 8:21**Boone** 36:2640:10,21,26 81:6  
136:22 137:23,26  
138:9,10 153:5,  
13 154:8 164:3,6  
172:7,8,11,14  
173:11 175:6,20,  
24 177:24,26  
178:3 185:3,4,13  
186:6 190:9**Boone's** 20:745:13 101:5,11  
127:22 154:11**bores** 132:1**Bos** 103:17**Botterill** 6:13

79:19

**bottom** 58:2172:4 74:16 81:20  
82:4 84:25 86:1  
88:17 89:9  
102:10 108:8  
111:3,25 112:2,4,  
6,10 113:4  
117:17 119:20  
122:24,26 128:11  
142:26 143:19  
146:24 169:17  
171:8 181:1**bottom-hole**111:1,2,5,10,19  
115:25 116:8  
121:2,5,15 122:4  
123:18 124:6  
125:8,11 127:10**bought** 165:16**boundary** 51:18**bounds** 183:25**Bow** 63:24 64:6

100:12,13

**box** 55:7 60:22,2361:25 62:1 70:20,  
23 72:24,25  
74:22 92:5 109:6  
137:7 150:2  
153:8 154:5**boxes** 9:5 48:19,22,23,24 51:21  
55:7 56:23 60:8,  
19,26 61:1,7,20,  
24 62:4,7 64:8,15  
67:8,12,20,25  
71:11,20 72:1,6,  
8,15,17 73:25  
74:3 76:12,16,23  
77:14,25 78:3  
86:26 88:4 100:1  
110:2 111:24  
112:1 121:1  
132:3 140:7  
142:5 144:6,15  
186:1**branch** 6:9**breach** 153:16**breached** 107:11**break** 12:2413:12,26 14:2,8  
21:25 30:15,16,  
24 34:6,7 35:13,  
14,17,18,24 68:4  
78:8,11 80:9,25  
98:20 138:4  
156:2,12 157:4,8**breakdown**

114:10

**breakout** 190:26**breaks** 11:1714:1 69:16 98:11  
99:6**breakthrough**

94:24

**breccia** 66:12**Brian** 5:18 79:6**briefly** 81:16

82:25 139:5

141:5

**bring** 48:14 50:358:16 61:13 62:8  
85:18 134:19  
135:26 157:13  
172:13**bringing** 54:15**brittle** 145:2,5,20

146:10,16,22

**brittleness**

144:25 145:21

**broad** 38:1**broadly** 72:2

184:5

**broken** 188:6,9**brought** 31:4**BTU** 135:18**buffer** 132:2**building** 8:3,10

127:7 190:25

**builds** 127:16**bullet** 30:7**buried** 100:18**Burns** 80:5

192:3,20

**burnt** 155:18**burrows** 90:2,4**business** 47:20

---

**C**

---

**C'** 97:10 98:26

99:7

**caisson** 188:19**calcite** 83:13 89:6**calcite-cemented**

87:5 89:5

**calculate** 181:4,6**calculation**

186:2

**calculations**80:10 150:5  
180:14,17**Calgary** 6:3 79:1

100:14 192:8

**caliper** 148:10

188:15

**call** 8:8 14:7**called** 113:17114:15 177:16  
179:17**Canada** 44:22,25**Canada's** 46:25**Canadian** 8:2510:3,8,14,17  
12:13,14,17,21,  
22 13:1,4,7,9,11,  
13 15:16,21,26  
20:4 29:9,16,19,  
20,21 30:12 35:3,  
6 37:5,9,19,20  
38:2 39:1 41:2,7  
42:20 44:7 45:1,  
12,16,19,23 46:1,  
17,19,20,24 47:5,  
12,17,20,26  
48:11,25 49:6,8,  
19,25,26 52:9,21  
53:5,20,23 54:5,  
23 55:15 57:2,5,  
17 59:6,13,26  
60:25 61:10 64:5  
65:25 67:18  
68:17 71:8 72:10  
77:26 79:23 84:3,  
10,15 85:2,10,20  
87:1,17 88:1,22,  
26 90:10,13,20  
91:18,20,23,24  
92:4,9,12 93:9,  
13,15,18,21,25  
94:4,6,8,14,17,  
19,21,25 95:12,  
13 96:6,22 97:1,  
3,8,10,15 98:12  
99:1,18,23 100:4  
101:21,23 102:1,  
8,14,23 103:10  
104:14,18,25

105:1,7,10 106:2, 26 107:15,17,23 108:22 109:7,11, 16,18 110:26 117:8 125:5,17 126:9,18,21,25 127:15,21 128:2, 6,12 129:8,13,17, 24 131:12,26 132:5,7,10,14 133:3,12,20,21, 25 134:6,12,16, 22 135:7 136:2,6, 8,18 137:24 153:6,23 154:5, 14,17,22,26 155:3,5,7,16,22, 26 157:15 158:4, 6 159:14,19,25 161:10 172:3 190:6	<b>case</b> 8:3 26:2 29:14 31:9 36:7 108:19 120:25 121:1,3,10 122:3, 6 130:3 161:12 174:3 <b>cases</b> 121:23 122:1 123:16 <b>casing</b> 133:2 148:16 <b>cast</b> 7:17 <b>casting</b> 7:23 <b>catch</b> 190:20,22 <b>category</b> 149:15 <b>caused</b> 52:12 53:18 90:15 104:19 109:3 148:8 <b>causing</b> 137:1 187:24 <b>ceased</b> 133:6 <b>Celsius</b> 66:16 <b>cement</b> 74:5 129:3 <b>cemented</b> 132:22 <b>Cenovus's</b> 158:25 159:3,5 <b>centimetre</b> 74:1 <b>centre</b> 59:2 60:21,22 63:26 68:25 81:19 86:5, 6,7,10,11,23 87:3 89:4,20 90:25 104:5 <b>centrifuge</b> 147:13,14 <b>cents</b> 48:10 <b>certainty</b> 52:21 <b>CERTIFICATE</b> 192:1 <b>certify</b> 192:3 <b>cetera</b> 31:19 <b>chainage</b> 98:1	<b>chair</b> 5:22 37:19 46:20 79:5 184:13 <b>chairing</b> 5:16 <b>Chalaturnyk</b> 146:5 147:10 <b>challenging</b> 111:7 162:8 <b>chamber</b> 52:15 55:23 56:3,6,16 57:17 65:19,23 66:16,21,26 77:3 81:23 84:7 122:23 123:20 <b>chambers</b> 47:21 59:17 <b>chance</b> 6:20 46:5 <b>change</b> 6:14 25:4 58:6 117:12 122:18 167:3,4 168:4 169:12 170:17,19,20 179:14 <b>changed</b> 24:11 <b>channel</b> 63:26 68:20,22 69:3,4, 24 70:5,24,26 100:7,9 101:1,7, 14 102:16,18 104:25 105:9,15, 17 162:18 163:11 <b>channels</b> 64:1 95:9 140:5 <b>character</b> 63:18 64:17 73:22 76:20 <b>characteristic</b> 90:22 <b>characteristicall</b> <b>y</b> 72:26 <b>characteristics</b> 55:12 56:18 86:4 <b>characterization</b> 115:7 116:16	<b>characterized</b> 86:5 114:24 <b>chart</b> 138:24 148:7 149:24 <b>charts</b> 181:14 <b>check</b> 43:15 80:10 <b>checking</b> 156:19 <b>chemical</b> 39:13 42:2 <b>chemicals</b> 131:6, 8 <b>Chiang</b> 6:12 79:18 <b>Chiasson</b> 5:9,15, 20 8:3 9:16,17 10:6,20,26 15:11, 14 18:24 19:3,23 20:11 21:24 22:3 26:19 27:14,17, 21,26 28:13,18, 23 29:2 30:3,14 31:1 32:6,9,23 33:4,18,23,26 34:13,18 35:2,9, 21,23,26 36:2,4, 7,14,16,20,22 46:1,7,14,22 51:7 54:21 68:1,6 78:6,12 79:5 80:8,21,23 81:1,5 82:22 83:4,6 136:23,26 137:6, 10,13,19 138:3,8 155:21 156:1,7, 24 157:6,11 162:4 171:26 176:24 184:14, 18,25 185:2,6,14 190:4,18 <b>Chiasson's</b> 190:2 <b>Chiniki</b> 6:2 <b>choose</b> 31:13,16 <b>chosen</b> 168:1	<b>chromatography</b> 58:1 <b>Cindy</b> 5:15 79:5 <b>circled</b> 102:13 <b>circles</b> 52:1 <b>circulation</b> 47:19 84:26 107:21,24, 26 110:4,20,22, 26 111:2,5,9,16, 17,19 115:8,23 116:1,25 124:6 125:15 126:14 127:4,6,26 130:3, 4 <b>circumstances</b> 14:19 53:26 111:8 136:20 161:10 <b>citizen</b> 159:23 <b>citizenship</b> 159:23 <b>City</b> 6:3 192:8 <b>civil</b> 11:9 40:11 42:14 43:7 <b>Claire</b> 8:6 <b>clarification</b> 136:26 137:21 184:19 <b>clarify</b> 10:10 53:13 129:25 137:11,12 168:16 172:17 176:21 190:10 <b>clarity's</b> 32:24 <b>class</b> 66:12 167:20 168:1 169:9 <b>classes</b> 169:9 <b>classified</b> 185:25 <b>clay</b> 76:14 100:10 <b>cleaned</b> 137:17 <b>cleaning</b> 155:17 <b>clear</b> 23:24 25:13,25 30:17
---	--	---	--	--

51:11 98:9 127:9 145:4 166:10 <b>Clearwater</b> 96:2 97:13,14 99:12, 15 147:24 <b>client</b> 20:24 <b>clients</b> 32:25 <b>clock</b> 68:2 <b>close</b> 22:8 80:11 109:11 114:14 <b>closed</b> 108:20 109:10 139:15 145:1 147:5 152:24 183:21 <b>closely</b> 58:12 59:14 131:15 <b>closer</b> 11:3 162:5 <b>closing</b> 13:12 115:17 153:6 <b>closure</b> 114:15, 19 <b>clunkier</b> 32:13 <b>CNRL</b> 14:25 15:5,7 19:6 20:16 21:18 22:12,19 23:13,25 24:11 25:10,20,26 26:3, 5,13 27:7,10 28:7 32:7 35:15 131:9 138:11 140:24 146:19 152:12 157:26 160:14,25 161:9 163:13 165:9 169:14,17 170:24,26 171:13 172:9,16 175:21 177:8,17 188:15, 22,26 189:3 <b>CNRL's</b> 18:26 19:6 25:18 27:10 28:16 80:12 143:21 146:6 150:18 158:11, 21,24 159:9 160:7,18 163:1	165:24 167:12 174:6 175:1 176:14,26 178:4, 9 180:5 184:7 185:24 <b>co-counsel</b> 10:13 20:25 184:24 <b>co-injection</b> 126:3 129:22,26 <b>coals</b> 82:6 <b>coarsening</b> 73:23 <b>coding</b> 142:25 <b>cold</b> 113:3 119:21 186:24 <b>collage</b> 96:6 <b>colleague</b> 94:12 102:6 <b>colleague's</b> 105:16 <b>colleagues</b> 5:23 128:3 191:6 <b>collected</b> 126:10 188:21,25 <b>collectively</b> 144:9 <b>Colleen</b> 186:11 <b>colour</b> 17:9 76:8 142:25 <b>coloured</b> 139:1 <b>column</b> 60:9,13 65:1,4,7 69:22 138:26 <b>columns</b> 65:4 135:10 <b>combination</b> 126:11 <b>combine</b> 130:23 <b>combined</b> 16:22 17:19 133:1 134:25 136:12 <b>combining</b> 180:26 <b>comfortable</b> 185:9	<b>commence</b> 37:8 <b>COMMENCED</b> 5:7 80:7 <b>commencement</b> 154:7 <b>comment</b> 92:25 139:5,16 <b>commentary</b> 126:8 <b>comments</b> 10:19 15:23 20:5 106:24 190:3 <b>commercial</b> 9:2 50:11,23 116:24 131:25 <b>commissioner</b> 5:9,16,19,20,21 8:2 9:16,17 10:5, 20,26 15:11,13 18:24 19:3,23 20:11 21:24 22:3 26:19 27:14,17, 21,26 28:13,18, 23 29:1 30:14 31:1 32:6,9,23 33:4,18,23,26 34:13,18 35:1,9, 21,23,26 36:2,4, 7,14,16,20,22 46:1,7,14,22 51:7 54:21 68:1,6 78:6,12 80:8,21, 23 81:1,5 82:22 83:4,6 136:23,26 137:6,10,13,19 138:3,8 156:1,7, 24 157:6,11 162:4 171:26 176:24 184:14, 18,25 185:2,6,14 190:2,4,8,18 <b>Commissioners</b> 109:20 125:23 138:10 155:21 <b>commit</b> 133:22, 25	<b>commitment</b> 132:11 <b>commitments</b> 136:7 154:18 155:8,23 <b>committed</b> 136:9 154:5 <b>common</b> 84:12 89:6 100:11 131:6 135:1 148:12 <b>commonly</b> 86:12 87:6 145:2,11 <b>communicate</b> 18:16 123:23 <b>communication</b> 7:4 108:16 124:7 135:21 140:23 162:21 171:5 173:22 <b>Communication</b> s 6:26 <b>compact</b> 100:17 <b>compaction</b> 64:4 94:19 95:8,11 96:18 99:3,24 100:1,5,23 101:13,17,21 102:16 103:5,20 104:1,15,19,20, 22,24 109:2 140:3 <b>company</b> 46:26 47:3 92:2 <b>company's</b> 158:7,11 <b>comparable</b> 106:12 151:2 <b>compare</b> 21:4 160:7 <b>compared</b> 98:7 104:1 178:5 181:9 <b>compares</b> 147:19	<b>comparison</b> 123:14 124:12 134:15 136:18 149:7 154:20 189:25 <b>comparisons</b> 170:24 <b>compartment</b> 168:18 169:22,23 170:16,18,22 <b>compatibility</b> 126:5 <b>compatible</b> 133:9 <b>compelling</b> 108:16 <b>compensation</b> 155:18 <b>compensations</b> 52:11 <b>competent</b> 56:24 <b>competitors</b> 160:11 <b>compilation</b> 33:7 <b>complain</b> 26:3 <b>complete</b> 12:19, 26 13:4 84:14 192:4 <b>completed</b> 126:20 135:13 <b>complex</b> 34:1 51:2 65:26 <b>compliant</b> 154:15 <b>complicated</b> 17:1 18:16 <b>component</b> 57:5 72:14 82:13 131:5 <b>components</b> 110:9,10 133:21 <b>composed</b> 73:26 <b>compound</b> 167:18 168:1,9,
--	---	--	---	--



10 169:9	<b>concludes</b> 54:21 77:26 78:8 91:24 92:14 94:8 109:11,16 153:2	<b>confer</b> 29:24 171:18 184:23	<b>confining</b> 66:20 138:13 140:14,17 145:11,15 146:14,18 147:19,25 148:8 151:8 152:22 175:5 182:25 189:13	<b>conservative</b> 119:17,18,22 120:12 122:25 181:21 182:9 183:18
<b>compounds</b> 75:14 167:21 168:7	<b>conclusion</b> 54:20 104:21 124:14 144:11 173:15 178:17 179:6 182:17,19 183:15 187:21 189:8,14	<b>conference</b> 8:20	<b>confirm</b> 9:22 12:7 29:3,25 37:14 38:6,19 39:5,16 40:4,22, 26 41:5,19 42:7, 11,26 43:4,13,20 44:10,14 45:5,12, 19,21 186:4 188:21	<b>conservatively</b> 122:3
<b>comprehensive</b> 131:13 138:22	<b>conclusions</b> 174:1	<b>confidence</b> 187:6	<b>confirmation</b> 17:6 18:1	<b>consideration</b> 13:24 22:16 118:18 149:12
<b>compressibility</b> 119:26 123:19	<b>conclusively</b> 115:23	<b>confident</b> 36:10	<b>confirmed</b> 101:23 103:19,26 153:15	<b>considerations</b> 151:1 189:10
<b>compression</b> 146:8	<b>concretionary</b> 74:5	<b>confidential</b> 49:19	<b>confirming</b> 108:15	<b>considered</b> 31:2 101:20 113:20 117:23 148:4 152:10 169:5
<b>compressional</b> 85:26	<b>concretions</b> 83:13 87:6 89:7	<b>confine</b> 81:15	<b>confirms</b> 67:14 96:4 104:14 158:5	<b>consist</b> 70:16
<b>computers</b> 14:6	<b>condense</b> 80:17	<b>confined</b> 123:24	<b>confused</b> 187:17	<b>consistent</b> 75:13 115:6 116:19,21 140:26 188:2
<b>concentration</b> 58:5 59:18 65:10, 14 69:17,23,26 70:3 165:23 169:16,25 171:3	<b>condensed</b> 151:15	<b>confinement</b> 30:8 56:17,18 57:7,10,13,26 58:4,12,15 59:11 60:7 61:19,20 62:2 63:8 67:3 70:9,14 71:16,21 73:20 75:6,24 76:19,25,26 77:3 82:18 84:18 85:15,17 88:3,24 89:2,23 91:15,22, 25 92:8,10 93:19, 24 94:3,10,23 95:6 98:16,25 99:26 103:6 104:3,7,12,24 108:24,26 109:9, 23,26 110:12,14 112:13,20,22 113:11,12,21,25 116:8 117:19 118:10 119:9 120:5 123:21 124:16,18,20,25 139:10,20 140:9 142:12,18 143:5, 22 144:10,13,18, 19,22,26 146:26 147:3,6,12 148:3, 20 150:10,13 153:12,17,22 163:9 182:26 185:25 186:3 189:23	<b>consistently</b> 114:17	<b>consists</b> 63:11
<b>concentrations</b> 58:6 65:3,7 75:17 77:1 166:4,21 167:14 169:21	<b>Condition</b> 131:26	<b>conditions</b> 31:15 49:11 123:15 124:1,13,23 126:24 128:8 133:18,19 136:5 153:25 155:11,25	<b>connection</b> 141:11,21 155:17	<b>constitute</b> 92:9
<b>concept</b> 28:1 70:9	<b>conduct</b> 59:7 117:9 138:22	<b>conduct</b> 59:7 117:9 138:22	<b>connected</b> 52:14 58:24 65:1,3 87:26 108:11,17 111:26 139:22	<b>constrain</b> 57:10
<b>concepts</b> 144:24	<b>conducted</b> 41:13 85:10 88:22 94:26 130:4 181:26	<b>conditions</b> 31:15 49:11 123:15 124:1,13,23 126:24 128:8 133:18,19 136:5 153:25 155:11,25	<b>confusion</b> 63:7	<b>constrained</b> 111:21
<b>conceptual</b> 114:9	<b>conducting</b> 144:12	<b>conduct</b> 59:7 117:9 138:22	<b>connate</b> 168:21	<b>constrains</b> 113:8
<b>concern</b> 9:6 27:8 28:2 33:20 49:16, 22 137:1 151:4 174:16	<b>conductive</b> 66:8 152:17 181:22 183:21	<b>conduct</b> 59:7 117:9 138:22	<b>consequence</b> 150:24 151:17 152:12,20	<b>constraint</b> 121:1, 14 122:5
<b>concerned</b> 27:7 53:16 78:15	<b>conductivity</b> 181:20,24 182:20,21 183:15	<b>conduct</b> 59:7 117:9 138:22	<b>consequences</b> 123:25	<b>constraints</b> 19:9
<b>concerns</b> 7:24 16:15 21:5 24:2 27:2,11 31:19 48:25 49:2,18,20 50:2 128:5 156:19 174:20 191:10,13	<b>conduits</b> 99:14	<b>conduct</b> 59:7 117:9 138:22	<b>conservation</b> 9:1 53:11,12	<b>construction</b> 48:2
<b>conclude</b> 13:2,14 94:21 107:16 184:26		<b>conduct</b> 59:7 117:9 138:22		<b>consultant</b> 39:3
<b>concluded</b> 13:15 52:4 141:9 154:12 186:18		<b>conduct</b> 59:7 117:9 138:22		<b>consulted</b> 172:16,20,24 173:2,9 186:9

<b>contained</b> 55:26 56:6 64:20 66:9, 26 77:11 143:12 180:12	<b>contrast</b> 86:13 104:21 110:13 118:8 120:4 121:21 124:19 136:6	174:6,8,22 179:1, 3	<b>counsel</b> 10:24 11:16,26 19:14 22:6 34:4 79:9,10 191:7	<b>cross-examine</b> 21:10
<b>containment</b> 52:15 53:22 56:3, 16 67:16 71:17 84:6 109:14 110:1 112:24 115:3,5,18 120:2, 8,24 121:24 122:3,13 124:4, 16 138:23 139:2, 4,23	<b>contrasts</b> 122:2	<b>cored</b> 44:26 85:15 185:26	<b>couple</b> 16:6,16,21 17:24 45:11 156:8	<b>Cross-examines</b> 157:15 172:3
<b>contaminating</b> 107:19	<b>contribute</b> 140:2 175:8,12	<b>cores</b> 44:25 57:6, 12 67:10 86:25 89:6 93:24 142:13	<b>coupled</b> 118:15	<b>cross-section</b> 68:25 105:15 122:20 123:1,2
<b>contends</b> 99:14	<b>contributed</b> 106:22	<b>coring</b> 85:24,25 87:2,12 88:5 89:3 94:1	<b>court</b> 7:7,10,15 9:20,22 11:13 35:9 36:24 37:7 58:18 80:4,5 120:19 128:24 192:15,21	<b>cross-sections</b> 96:7 176:13,17 177:10,14
<b>content</b> 16:13,15 83:20 127:7 139:16 143:3,23 144:17	<b>contributions</b> 48:1	<b>coring-induced</b> 86:4,20,22 89:1, 20	<b>cover</b> 62:4 126:1 127:3 132:5 157:3 171:21	<b>CRR</b> 80:5 192:20
<b>contention</b> 14:22	<b>control</b> 38:10,22 39:9,20 40:7,25 42:10 43:3,19 44:13 45:8,14 82:2 113:26 163:15 164:1	<b>Cornell</b> 40:13	<b>coverage</b> 139:24	<b>CSR(A)</b> 80:4,5 192:14,20
<b>context</b> 15:15 48:17 59:15 76:23	<b>controlled</b> 130:5 131:1	<b>corner</b> 42:1	<b>covered</b> 28:19 56:25	<b>CSS</b> 189:21,23 190:9
<b>continence</b> 14:22	<b>controls</b> 126:12 155:9	<b>corporate</b> 10:11 159:23	<b>covers</b> 62:6 72:24	<b>CTS4</b> 146:9
<b>context</b> 15:15 48:17 59:15 76:23	<b>conventional</b> 35:5 140:19	<b>correct</b> 6:20 10:18 39:21 40:8 41:10 63:2 64:25 93:7 157:21 158:1,2,8,9 160:20 162:22 164:2 166:7 173:4,7 174:22 177:23 183:13	<b>COVID</b> 16:2 23:1	<b>CTS5</b> 146:10
<b>continue</b> 49:6 62:10,23 68:7 87:8 94:13 115:13 128:10 184:18	<b>convergence</b> 54:19	<b>corrected</b> 110:23	<b>cracking</b> 86:11	<b>cubed</b> 130:12
<b>continued</b> 85:6 141:17 155:8 165:18	<b>convert</b> 132:15	<b>corrections</b> 41:16 45:22	<b>create</b> 47:2 112:17 115:8,11 153:10 158:7	<b>cubic</b> 111:14 116:12 117:6 120:11,15 125:10 149:26 151:14 152:15
<b>continues</b> 78:10 100:19	<b>convince</b> 27:11 31:14	<b>correlatable</b> 56:22 67:7 72:17	<b>created</b> 85:24	<b>cue</b> 35:6
<b>continuity</b> 57:9	<b>coordinator</b> 6:10 18:20	<b>correlated</b> 67:11 70:19	<b>creates</b> 47:26	<b>cues</b> 17:11
<b>continuous</b> 47:19 48:23 57:18 65:1 89:9, 10,22 90:26 91:1 110:5 120:9 125:7 133:5,10	<b>copy</b> 9:14	<b>correspondence</b> 17:15	<b>creating</b> 47:7 158:13	<b>cumulative</b> 106:22
<b>contract</b> 189:2	<b>core</b> 67:19 70:22 71:8 72:25 74:19 76:7 81:13,18 84:22 85:7,11,20, 22 86:3,8,10,13, 15 87:8 89:1,3, 11,19 90:3 93:22 94:1,8 101:24 109:1 139:7,12 142:1,7,25 143:8 159:16,23 171:16	<b>cost</b> 54:2 136:4 137:6 151:1 154:10	<b>credits</b> 150:23 151:24	<b>cured</b> 24:5
<b>contraction</b> 145:25 146:13		<b>costs</b> 48:11 117:11 136:6,8, 17 154:20 155:12	<b>criteria</b> 127:18 138:25	<b>curious</b> 164:10, 22 172:8 181:25 186:20
			<b>critically</b> 140:26	<b>current</b> 52:26
			<b>critical</b> 56:18 145:18 149:8	<b>curriculum</b> 37:14 38:7,19 39:6,16 40:4,22 42:7,26 43:13 44:10 45:5 46:11
			<b>cross-</b> <b>examination</b> 12:16,20 13:2,5,9 14:21 36:12 156:5 157:14	<b>curved</b> 86:9
				<b>cut</b> 36:13 46:3 61:24 69:25 71:19 72:13 100:9 143:17
				<b>cuts</b> 60:20,24 61:1 88:18

**cutting** 69:5  
88:14

**cycle** 73:24

**cyclic** 42:23  
148:12

**cyclical** 190:11,  
13

---

**D**

---

**D54** 180:12 181:7

**D86** 124:10

**dais** 22:7

**Dale** 37:3 42:13  
81:9 164:14,15

**damage** 53:16  
155:19

**damages** 154:24  
155:16

**dark** 72:26 74:1,  
15 76:9 82:14  
90:25

**darker** 17:25

**dashed** 60:16  
61:23 97:6 98:6

**data** 16:26 29:15  
41:12,14 45:1  
49:19 54:9,19  
57:21 59:8,16  
66:1,24 70:25  
75:13 84:23,24  
85:3,7,11,12  
88:23 91:26  
92:23 93:1,22  
94:9,25 95:1  
101:24 102:19  
108:5 109:1,8  
116:15,24  
126:10,18,22  
127:9,12 129:20  
133:6,7 140:10,  
25 142:23 146:6,  
8 151:20 153:19  
165:8,21 167:25  
172:19 173:14,

16,17,24,26  
177:17 178:19  
180:16 182:23,24  
183:1 186:19,21,  
26 187:6,8,9,10,  
12,14,18,22,26  
188:10,22 189:6

**database** 188:22

**dataset** 54:11

**datasets** 54:13

**date** 44:25 135:2,  
3

**Dated** 192:8

**day** 12:17,25 13:2  
14:3 120:11  
125:11 184:21  
185:1 190:19  
192:9

**days** 13:16 127:2  
130:4,24

**de-risking** 57:3

**de-risks** 113:10  
117:18

**deadline** 19:6

**deal** 14:24,26  
24:2 35:10

**dealing** 31:6  
182:5

**dealt** 15:4 24:22  
81:14

**decades** 141:17  
154:25

**December** 49:1

**decide** 167:24

**decided** 22:14  
26:8 28:9 31:3  
102:23

**decimetre** 73:10

**decision** 13:16  
22:2 24:14 25:16  
30:26 60:16  
141:16

**decision-making**  
158:18,22

**decisions** 37:22  
52:3,4,7 148:5  
162:19

**deck** 16:18 18:26  
20:22 21:2,3,7,19

**decline** 106:21  
129:10,14 141:18  
145:9,16

**declines** 114:13

**declining** 52:26

**decomposition**  
93:13 102:2  
103:3

**decrease** 52:17  
53:2 58:25 69:23,  
25 70:3 75:13  
169:12,16,21

**decreasing** 59:3,  
4 69:26

**deem** 23:23

**deemed** 60:18

**deep** 96:1,4  
101:10

**deep-seated**  
95:24

**deeper** 60:20  
61:1,24 84:19  
98:15,18

**deeply** 72:14

**defibrillator**  
8:10

**define** 57:8

**defined** 60:14,16

**defines** 77:21

**definition** 142:20  
143:1

**definitions** 55:15

**definitive** 140:22  
173:22

**definitively**  
173:21 178:26

**deformation**  
24:18,22 27:6,8  
28:19 29:20

189:18,22

**deformations**

148:8,16,19  
188:19,23

**degassing** 86:12

**degradation**  
106:7

**degraded** 105:26  
107:1

**degree** 100:17  
146:12 174:2

**degrees** 66:16  
104:7

**delay** 117:12  
135:13 154:10

**delays** 135:9  
155:13

**deliberations**  
155:4

**deliver** 48:4

**demarcated** 74:5  
126:13

**demonstrate**  
49:4 53:24 60:25  
61:10 66:11  
67:20,23 125:17

**demonstrates**  
53:21 61:18  
67:10 68:26  
153:7,20 155:9

**demonstrating**  
47:11

**demulsifiers**  
131:7

**Denise** 6:15  
79:12

**dense** 80:18 87:9

**density** 59:9 90:4  
91:25 92:10,19  
94:9 109:12

**deny** 32:3

**depending** 15:3

**depends** 113:18

**depicted** 58:24  
90:12

**depleted** 52:25

**depletion** 52:14,  
22 53:15 129:15

**deposit** 55:5

**deposited** 67:25  
68:23 71:20  
77:13,20 100:19

**deposition**  
166:15 168:22

**depositional**  
57:10 63:18

**deposits** 63:14  
64:3 81:25 82:8  
100:17 101:3

**depth** 85:23  
86:13 87:25  
89:12,13 94:2  
99:9 118:25  
146:21,25 147:1,  
19,22 165:22  
167:17,22,23  
168:3,4,10  
169:16

**depth-converted**  
96:8

**depths** 101:15  
145:3

**derived** 183:11

**describe** 41:1  
63:8 85:21 88:8  
91:4 97:15  
107:16

**describes** 49:12  
112:25

**describing** 149:8

**design** 40:19  
186:23

**detail** 60:8 63:9  
64:5 90:1 92:3  
96:19 182:1

**details** 57:7  
188:7

<b>detected</b> 104:9	<b>DFIT-</b>	29:10 32:20	<b>discounting</b>	<b>document</b> 12:1,3
<b>determination</b>	<b>MEASURED</b>	35:17 37:5 46:24	135:4,16	19:11 21:21
22:16 83:26	114:17	48:3 52:11 64:6	<b>discuss</b> 11:15	22:20 63:5 71:5
143:2 151:10	<b>DFITS</b> 114:8,24	80:12 93:10,18	21:26 55:11,12	163:3 180:12
<b>determine</b> 25:9	117:7,9,10,12	94:14 104:21	85:7 99:23 105:1	<b>documentary</b>
84:4 102:24,25	<b>diagnostic</b> 114:7	107:22 109:16,18	109:18 140:18	18:14
114:8 166:19	<b>diagram</b> 54:11,	133:19 150:24	191:5	<b>documented</b>
168:6,11 178:26	18 62:3 145:7	155:26 162:12	<b>discussed</b> 22:11	63:18
187:18	<b>difference</b> 54:8	164:4,25	64:5 68:17 76:19	<b>documents</b>
<b>determined</b> 9:8	85:22 115:2	<b>direction</b> 25:8	84:10 93:9 96:18	22:12,15 41:14
22:11 171:17	122:8,14,17	38:10,22 39:9,19	127:21 128:4	140:15
<b>determining</b>	140:22 173:19	40:7,25 42:10	133:20 139:8	<b>dollar</b> 48:8
149:3	179:20	43:3,19 44:13	142:2 148:23	<b>dollars</b> 48:7
<b>detrimental</b> 84:7	<b>differences</b>	45:8,14 163:14	<b>discussing</b>	52:23 137:6
<b>develop</b> 47:2	68:10 96:23	164:1	131:23	154:23
155:6 158:6	126:16	<b>directional</b> 104:6	<b>discussion</b> 32:5	<b>domain</b> 180:8
<b>developable</b>	<b>differential</b> 64:4	<b>directions</b> 8:4	94:18	<b>door</b> 5:10
106:12	94:18 95:8,11	<b>directive</b> 9:1	<b>display</b> 59:18	<b>dots</b> 167:15,18
<b>developed</b> 110:6	96:18 99:3,23	21:15 49:12,14	76:26	<b>downhole</b> 134:7
142:18	100:4,23 101:12	123:12 126:22	<b>displayed</b> 11:25	<b>downtime</b>
<b>developer</b> 53:9	102:15 103:5,20	131:24	12:8	112:11
<b>development</b>	104:1,15,19,22	<b>directives</b> 26:15	<b>displays</b> 67:13	<b>downward</b> 58:25
35:6 39:4 47:13,	108:10,15 109:2	154:16	<b>disproportionate</b>	59:2,4
23 48:18,20	140:3	<b>directly</b> 9:12	136:17	<b>Draft</b> 49:12
49:10 50:20 52:4	<b>differentiated</b>	49:20 52:13 54:9	<b>dispute</b> 14:18	<b>drainage</b> 9:5
55:23 56:15	76:8	63:10 73:1 74:3,	25:12	48:19,22 51:21
65:23 66:15	<b>difficult</b> 26:1	19 93:16 102:13	<b>dissolution</b> 95:3,	55:7 56:23 60:19,
70:21 119:5	142:11 150:8	103:13 114:7	23 96:5 140:1	23,26 61:20,25
126:19 127:16	178:26	116:22 126:23	<b>distance</b> 119:1,5	62:1 64:15 67:8,
129:23 132:10	<b>DIFFICULTIES</b>	159:24,25	<b>distinct</b> 98:11,20	20,25 70:23
134:1,13,18	34:17	183:10,11	99:6	71:11,20 72:1,6,
153:7 155:10,24	<b>diffusion</b> 59:20	<b>directors</b> 21:14	<b>distinctive</b> 71:7	8,17 73:25 76:12,
179:9	170:20	<b>disagrees</b> 95:13	86:3	16,23 77:14,25
<b>developments</b>	<b>digestible</b> 29:11	97:15 105:7	<b>distinguished</b>	78:3 88:4 92:5
52:23 57:4 101:4	<b>dilatancy</b> 145:22	106:2	86:1	100:1 109:6
126:7 128:16	<b>dilation</b> 146:13	<b>disallowed</b> 26:21	<b>distraction</b> 5:11	110:2,23 111:24
<b>Devenish</b> 106:11,	<b>diminish</b> 56:9	33:1	<b>distributed</b> 9:12	112:1 116:18
23 134:25 136:12	<b>diminishes</b> 99:9	<b>disbursements</b>	<b>distribution</b>	117:3,8 120:26
<b>devices</b> 14:5	<b>dipping</b> 88:11	131:7	61:19 64:14	122:21 132:3
<b>Devin</b> 36:26	89:22 91:2	<b>disciplines</b> 54:13	68:11 72:9	139:13,19,25
39:11 81:6	<b>direct</b> 12:13,15,	<b>disclosure</b>	<b>district</b> 39:2	140:7 142:5
125:20,24	24 13:1,19 14:20	171:10	<b>diverse</b> 38:1	144:5,15 150:2
<b>Devon</b> 44:22,25	15:17 16:2,8,15	<b>discounted</b> 135:8	46:25 54:12	153:8 154:5
<b>DFIT</b> 114:9,10	18:8 19:13,15	136:11 154:21		186:1
154:9				

<b>dramatically</b> 72:15	<b>east</b> 70:21 107:4	<b>electronic</b> 14:5 22:25,26	<b>engineering</b> 37:25 39:14,24 40:1,11,12,13,17 42:14,15,16,18 43:8 125:25 140:19 142:6 148:5 179:7,14	<b>eroded</b> 48:6
<b>drape</b> 72:12	<b>Eau</b> 8:6	<b>elevated</b> 110:16 111:12,19 115:26 119:13,14 120:10,13 124:3, 22	<b>Engineers</b> 44:20	<b>erosionally</b> 68:21
<b>draw</b> 189:8	<b>economic</b> 123:24 135:3	<b>email</b> 20:22,23	<b>enhanced</b> 110:5 155:9 176:2	<b>escalation</b> 135:19
<b>drawn</b> 144:11	<b>economics</b> 52:18 84:9	<b>emergencies</b> 8:18	<b>enhancements</b> 110:7 124:4 126:26 127:17	<b>essentially</b> 36:17 136:10 158:5 164:23 180:13 184:20
<b>drilled</b> 103:10,12 108:1 178:22	<b>economies</b> 48:2	<b>emergency</b> 8:8, 18	<b>ensure</b> 14:4 56:3, 5 57:22 126:15	<b>establish</b> 127:6
<b>drilling</b> 87:7 107:21,22,24 109:8	<b>edge</b> 95:23	<b>employed</b> 175:3	<b>enter</b> 152:18	<b>established</b> 65:10 128:1 183:25
<b>drilling-induced</b> 87:5	<b>edges</b> 57:11 97:25 98:22 100:6	<b>employee</b> 8:9,16 39:1 159:26 160:2	<b>enters</b> 151:16 152:16	<b>estimate</b> 146:21 150:8
<b>drive</b> 179:19	<b>eery</b> 34:18	<b>employment</b> 48:3	<b>entire</b> 83:2 86:15	<b>estimated</b> 134:23 136:4,6 137:4 142:24
<b>driven</b> 179:17	<b>effect</b> 48:10 144:4 168:14,18, 25 169:1 188:8	<b>employs</b> 57:17	<b>entirety</b> 62:4,6 67:8 76:12	<b>estimates</b> 142:21 143:8 144:2
<b>driver</b> 113:13 117:17	<b>effective</b> 53:22 55:3 56:18 57:22 60:18 66:20 78:1 89:26 118:20 119:19 122:4 135:2 144:10 146:19,20 147:2 148:26 152:7 153:11	<b>emulsion</b> 111:8	<b>envelope</b> 124:13	<b>Estuary</b> 170:25
<b>ductile</b> 145:3,5, 20,24,26 146:10, 11,16,23 147:3	<b>effectively</b> 55:25 77:11 148:9	<b>enabling</b> 149:8	<b>environment</b> 42:19	<b>evacuate</b> 8:4,5, 17
<b>due</b> 53:1,22 58:26 66:8 85:26 86:12 87:6 97:22 101:12,20 104:24 114:19 117:5 118:24 123:19 124:1,16 133:9 141:16,18,24	<b>effectiveness</b> 54:1	<b>encountered</b> 103:16	<b>environmental</b> 43:8,10 123:25 159:4	<b>evaluate</b> 54:10 57:7 118:4 121:24 175:23
<b>duration</b> 120:14	<b>effects</b> 52:6 54:1 64:3 96:17 119:8, 23 123:20	<b>encourage</b> 14:19 78:14	<b>EQ1</b> 157:13	<b>evaluated</b> 118:21 175:21 176:16
<b>durations</b> 117:5 124:2	<b>efficiency</b> 32:12 56:9 84:7	<b>end</b> 25:6 35:17 62:20 81:1 132:9 186:7	<b>equate</b> 170:12	<b>evaluating</b> 56:12 118:17 119:3 176:4
<b>duty</b> 41:21	<b>efficient</b> 29:11 48:12 53:3 56:5 57:23 154:16	<b>endeavour</b> 32:20 80:22 110:26	<b>equilibrate</b> 58:7 75:17 166:4,21, 26 170:20	<b>evaluation</b> 29:15 57:3,22 59:14 93:22 109:24 116:17 135:3 149:9 178:6
<b>dynamic</b> 91:3 118:19	<b>effort</b> 50:1	<b>energize</b> 159:6	<b>equilibrated</b> 65:10,14 69:21	<b>Evaporite</b> 95:22
<hr/>	<b>efforts</b> 49:17	<b>energy</b> 9:6 10:21, 25 11:11 46:25 80:1,2 165:16	<b>equilibrating</b> 169:26	<b>eve</b> 26:10
<b>E</b> <hr/>	<b>elastic</b> 110:14 115:17 116:21 119:23 120:7 122:5 124:20	<b>engaged</b> 48:26 138:11	<b>equipped</b> 133:5	<b>event</b> 8:8 98:12 104:10 111:7,15 113:5 115:3,10 121:19 138:4 151:23 152:21
<b>earlier</b> 26:21 51:8 78:8 120:1 125:24 183:20	<b>effort</b> 50:1	<b>engages</b> 23:20	<b>equivalent</b> 114:16 136:10 166:10,12	
<b>early</b> 107:10 130:24	<b>efforts</b> 49:17	<b>engineer</b> 37:25 39:13,25 42:2,3 142:9 174:9,13 176:1 186:22 187:4,16	<b>equivalent</b> 114:16 136:10 166:10,12	
<b>easier</b> 34:23	<b>efforts</b> 49:17		<b>equivalent</b> 166:18	
<b>easily</b> 48:6 71:8 76:8 88:19	<b>efforts</b> 49:17		<b>ERCB</b> 49:14	

**events** 84:26  
95:25 97:7 98:18,  
20 99:6 104:17  
107:24,26  
**eventually**  
162:22  
**ever-changing**  
25:19  
**everyone's** 7:5  
**evidence** 11:12,  
14,16,22 12:14,  
15,25 13:1,8  
14:20 15:17,19,  
23 16:3,8,15,25  
17:2 18:8,12,15,  
17 19:4,13,16,19,  
22 20:5 21:8  
24:17 26:10,16,  
22 27:25 28:20  
29:4,10 31:5,13,  
18,26 32:21 33:7  
37:5 41:17,20,22  
45:13,16,19,23  
46:24 53:20,23,  
24 54:7 64:6  
75:16 81:2 85:21  
88:2,24 91:4  
93:10,18 94:14,  
18,22,26 95:5  
96:10,14 98:21  
99:19,25 104:25  
105:1 107:7,15,  
17 108:17,23,26  
109:16,19,22  
127:13 128:3  
133:19 140:23  
147:13 153:6,15  
154:1 155:8,23,  
26 160:16 163:8,  
12,13 164:9,21,  
25 165:9 166:3  
173:22 178:7,16,  
17,21 191:5  
**evident** 136:8  
**exact** 102:24

**Examination**  
67:10  
**examine** 60:7  
72:1  
**examining** 85:20  
**examples** 87:3,15  
88:4 127:5  
160:15,18,22  
**exceeded** 127:26  
135:14  
**exception** 45:13  
**exceptions** 17:23  
133:23  
**exchanges** 28:3  
**excuse** 83:24  
**execute** 126:9  
132:8  
**executed** 127:1,  
17  
**execution** 48:4  
57:22  
**executive** 160:5  
**exemplified**  
117:25  
**exhibit** 9:15 12:1,  
5,6,7,9 16:19  
17:17 33:12,14  
38:8,20 39:7,17  
40:5,23 41:9 42:8  
43:1,14,16 44:11  
45:6 46:9,12  
48:14,15 50:3,4  
51:1 54:4 58:16  
60:4 61:14 62:8,  
19,20 63:19  
64:22 66:2 67:17  
68:15 69:7 71:2,  
23 72:18 73:3  
74:13 76:1 85:18  
86:16 88:6,20  
89:14 90:8 95:17  
96:20 100:2  
101:26 103:8  
105:5,22 108:3  
114:3,23 120:16

121:25 123:5  
129:18 131:10  
133:17 134:19  
135:26 138:18  
162:2 167:10  
170:23 172:13  
174:4 176:10  
178:2 180:9  
181:16 183:23  
184:15 185:16  
186:16 188:12  
**exhibits** 9:11,14  
11:24 14:14  
16:24 32:16  
**exist** 52:4 60:1  
70:25 71:16 72:5  
75:7,20 99:13  
100:7 105:12  
108:15,19,20  
109:10 177:20  
**existed** 107:14  
174:19  
**existence** 70:4  
**existing** 106:13  
132:26 150:19  
154:3  
**exists** 76:22 91:1  
105:13,19  
**expand** 190:16  
**expands** 145:23  
**expect** 13:15  
149:17  
**expected** 24:14  
34:1 47:24 61:11  
64:18 65:18  
67:15 74:12 77:3  
81:15 89:23  
93:12 95:4,12,25  
101:22 102:6,14  
103:14,18 108:9  
130:18,23 141:23  
150:15 164:11  
**expecting** 80:13  
**expects** 11:8  
49:14

**expenditure**  
57:1  
**expense** 133:2  
**expenses** 136:9  
164:24 165:2  
**expensive** 165:3,  
4  
**experience** 19:15  
37:26 38:2,9,21  
39:8,13,19,25  
40:6,14,15,24  
42:3,9,16 43:2,9,  
18 44:2,4,6,12,21  
45:7 47:13 55:24  
57:19 65:15  
77:10 101:21  
110:3 116:3  
124:5 142:10  
148:26 168:12  
176:7 183:25  
184:2,4,5,7,8  
189:20  
**experienced**  
47:16  
**expert** 11:19  
127:11 137:24  
164:14,15 175:1  
**expertise** 39:26  
54:10  
**experts** 25:6,9  
27:24 29:24  
172:17,20,21,24  
173:8  
**experts'** 25:4  
**explain** 11:7 19:4  
51:10 82:24  
169:15 170:2  
**explained** 19:9  
64:13  
**explaining**  
109:21  
**explains** 106:16  
147:5  
**explanation** 20:9  
106:15

**exploitation**  
39:14,26 125:25  
**exploration**  
38:16 39:3  
**exsolved** 106:20  
**extend** 98:14  
**extended** 98:24  
112:7  
**extending** 99:11  
**extends** 96:2  
**extensive** 15:19  
19:11 26:25,26  
28:3 29:10 40:15  
44:6 49:23 55:24  
57:18 70:18  
84:15 88:22  
164:24  
**extensively**  
164:18  
**extent** 69:4 71:10  
103:14 161:25  
184:10  
**extents** 56:23  
171:17  
**extinguisher**  
8:11  
**extra** 113:16  
**extract** 161:13  
**extracted** 119:4  
122:21  
**extremely** 24:12  
131:20 142:11  
153:18  
**Exxon's** 176:1  
**Exxonmobil**  
175:26  
**eye** 13:19

---

**F**

---

**F4** 143:22 144:3,4  
**F5** 143:9  
**face** 146:1

<b>face-to-face</b> 49:26	13,21 99:8,19 101:12 140:2 153:15	64:1,25 68:9 86:14,19,21,24 87:4,23 88:9 89:16 97:1,9,11 99:4 100:25 101:11 102:1,21 104:4 106:9 114:4,9 120:17, 22 121:8,26 122:19 145:6,14, 21 146:4,12,15, 24 149:10	<b>find</b> 12:6 160:16 185:21	164:20
<b>facies</b> 56:19 61:4 63:22 64:21 67:13 69:1 70:15 72:9,16 73:7 76:21 142:20,22 143:1,2,3,4,7,9, 14,20,22,24,26 144:4 153:10 171:3 185:25	<b>faults</b> 53:23 84:4, 17 85:4,8,14 94:22 95:11 96:23 97:5,9,18, 25 98:3,22 99:11, 13,25 101:22 103:5 104:2,23 105:4 106:2 107:11,12,18,22 108:11,17,23,26 109:3,5,8 114:2 118:1 139:25 145:13 153:17 176:15 177:20,22	<b>figures</b> 16:22 17:18 30:6 32:19 33:13 78:5 138:17 145:4	<b>finding</b> 121:13 187:20	<b>focuses</b> 57:4
<b>facilitate</b> 56:16 149:6	<b>favour</b> 160:26 161:3	<b>file</b> 14:26 15:8 23:22 26:9,13 27:23 29:6 31:18	<b>fine</b> 34:1 83:1 157:8,23 171:9	<b>focusing</b> 14:16
<b>facing</b> 185:4	<b>favoured</b> 20:23	<b>filed</b> 9:13 14:14 15:2,5,19 16:2,4, 9,12,26 18:4,17 21:8 22:12 23:9, 25 24:21,22 27:1, 25 28:9,20 30:11 33:9 37:15 38:7, 19 39:6,17 40:4, 22 41:6,8 42:7,26 43:13 44:10 45:5 49:21 165:21	<b>finish</b> 68:5,7 157:4 184:20	<b>folding</b> 95:10 98:13
<b>fact</b> 65:12 92:11 114:1 155:3 159:26 164:26	<b>FCP</b> 114:16	<b>filing</b> 18:14 19:7 21:14,21 28:7 49:1,18	<b>finished</b> 10:2	<b>folks</b> 37:13 78:14
<b>factor</b> 52:17 76:24 123:9,10, 12,26 124:10	<b>feature</b> 70:5 90:25 91:2,4 93:12,17 102:5,7, 15 103:1	<b>fill</b> 162:18	<b>finishing</b> 36:1	<b>follow</b> 17:12
<b>factors</b> 11:23 118:11 119:12 123:7 124:9 138:23 149:12,13	<b>features</b> 89:24 90:11,21 92:13 93:19 99:9 117:2 118:14 140:1,4 177:20 189:12	<b>filled</b> 64:3 100:10	<b>fire</b> 8:13	<b>footnotes</b> 182:4
<b>factual</b> 41:13	<b>February</b> 9:15 79:3 103:12 191:18 192:9	<b>final</b> 106:24 134:10 149:11 150:15	<b>Firstly</b> 75:5	<b>force</b> 115:16
<b>Fahad</b> 6:16 79:14	<b>federal</b> 47:8	<b>finally</b> 93:9 99:10 107:5 109:7 117:1 119:13 126:21 131:18 133:10 155:15 164:19	<b>fit</b> 23:23	<b>forecasts</b> 65:20
<b>failed</b> 133:7 145:26	<b>feel</b> 31:23 32:1	<b>financial</b> 26:5,6 151:2 152:20	<b>flank</b> 72:23	<b>foregoing</b> 192:4
<b>failure</b> 112:21 117:23 123:11	<b>feeling</b> 34:18		<b>flanked</b> 61:3	<b>form</b> 19:18 145:13
<b>fair</b> 7:3 41:22 158:16	<b>Felix</b> 6:12 79:18		<b>flat</b> 69:3	<b>formal</b> 40:20
<b>fairly</b> 19:3 37:10	<b>few-pages</b> 18:25		<b>flex</b> 190:21	<b>format</b> 149:6
<b>fairness</b> 13:24 22:16	<b>fide</b> 50:1		<b>flexibility</b> 112:10 130:13	<b>formation</b> 40:2 44:24 55:4,9 60:2 63:10,15 75:25 78:2 83:21 84:2 90:19 109:13 132:2 141:2 180:25 189:23
<b>fall</b> 98:15	<b>field</b> 110:3 116:15 124:5 142:23		<b>flip</b> 48:6	<b>formations</b> 47:18
<b>familiar</b> 190:13	<b>fields</b> 180:1		<b>flooding</b> 67:24	<b>formed</b> 99:25
<b>fast</b> 38:4	<b>figure</b> 48:18 58:21 62:9,11		<b>floor</b> 8:13,20	<b>Fort</b> 63:15
<b>fault</b> 95:14 97:16 98:7 99:10,21 151:4			<b>flow</b> 36:20 108:21 109:10 112:18,25 118:15,19 178:23 182:10,14	<b>forward</b> 11:14 12:13 15:10,20 34:10 110:7 138:7,19 169:24
<b>faulting</b> 92:22 93:1 95:2,6,24 96:4,11,14 98:2,			<b>flowing</b> 113:1,2, 4,6	<b>found</b> 8:11 88:23 104:10 140:16 162:6

9,14,15,17,18,23, 26 114:7,11,12, 14,15,18,19,21 115:3,5,10,14,17, 18 116:6 117:1 118:15,24 119:24 120:1,7,8,24 121:6,20,21,24 122:2,10,12 124:3,16 139:21 145:19,24 146:1, 2 149:25 151:16, 26 152:17 153:22 181:18,22	<b>fracturing</b> 40:16 93:3 96:11,15 110:4,11 112:15, 17,21 113:6,10, 14 115:4,22,24 116:5,7 117:19 118:6,18,22 121:16,18 124:15 127:3,14 <b>framed</b> 142:4 <b>frames</b> 116:10 <b>framework</b> 52:2 <b>Frankly</b> 185:6 <b>frequency</b> 63:25 87:24 139:21 152:22 189:19 <b>Friday</b> 13:4,14 <b>friend</b> 171:22 <b>front</b> 33:11 <b>fuel</b> 155:18 <b>full</b> 16:1 36:10,11 130:22 139:24 171:10 <b>fully</b> 22:25 34:1,4 146:4 152:18 <b>fun</b> 47:4 <b>Fundamental</b> 47:20 <b>funded</b> 155:14 <b>funding</b> 48:10 <b>future</b> 84:12 133:26 151:18 154:6	24,26 52:6,8,14 53:1,6,10,11,17, 21 55:24 58:1 60:3 61:6 66:7,14 71:14 73:13 75:1, 10,11,25 77:23 83:16,23 84:12, 13,26 91:16 94:20 97:23,26 99:14,16,20 105:2,3,8,11,13, 18,19,25 106:4,5, 6,16,17,20,22,25, 26 107:1,11,14, 20 108:6,12,18 109:4 112:16 121:22 123:23 124:8 126:10 129:15 131:6,9, 22 132:12,16,17 133:1 134:11,14, 24 135:8,17,19, 24 136:14,18 141:7,12,14,15, 22 143:12 144:14 149:23 150:1,4,6, 7,20,22 151:13, 16,17,25,26 152:16,18,19 154:2,6,13,17,21 155:1,2,3,7,11, 17,19 160:26 161:8,9,11,15 162:21,23 163:2 165:6,7 178:5,7 179:10,17 182:7 183:4	69:13 70:25 75:13 76:25 77:8, 16,21 140:6,7 164:21 165:8,15, 17 167:11,25 171:4,11,15,17, 20 <b>general</b> 92:17 160:7 <b>generally</b> 117:23 126:1 143:21 169:17 <b>generated</b> 107:1 130:11 189:12 <b>gentler</b> 148:14 <b>geo</b> 57:4 <b>geochemical</b> 57:11 58:2 59:22 75:15 <b>geochemistry</b> 43:24 44:5 65:8 <b>geologic</b> 142:3,7 143:14,21 170:1 <b>geological</b> 58:8 59:21 60:15 65:15 75:18,21 77:2 84:20 102:9 103:23 107:2 117:2 166:5,9,12, 13,14,18,22 <b>geologist</b> 38:26 39:2 44:19,22 54:26 55:1 82:23 <b>geology</b> 38:26 43:24,25,26 44:4, 17 86:18 139:8 183:11 <b>geomechanic</b> 42:21 <b>geomechanical</b> 24:17 26:24 28:16 29:18,24 42:17,22 118:2,3, 16 130:10 144:24 153:19 164:14	<b>geomechanically</b> 56:24 <b>geomechanics</b> 40:1,16 109:24 127:11 <b>geometry</b> 63:17 121:9 <b>geomodel</b> 72:11 <b>geomodelling</b> 44:6 164:16 <b>geophysical</b> 84:21 102:9 104:17 <b>geophysicist</b> 38:15 94:13 176:7,22 177:1 <b>geophysicists</b> 176:14,16 177:9, 11 <b>geophysics</b> 38:14 <b>geoscience</b> 57:5 109:22 <b>Geosciences</b> 44:20 <b>geoscientist</b> 163:8 178:4,9 186:12 <b>geoscientists</b> 185:24 186:4,8 <b>Geosim</b> 30:5,9 118:12,14 153:20 <b>geotechnical</b> 42:15 <b>Gerard</b> 10:15 37:2 46:16 81:8 138:1 <b>Germany</b> 170:25 <b>give</b> 11:12,14,22 12:6 30:2 34:9,15 48:15 166:1,25 170:3 171:18 182:9 <b>giving</b> 12:5 13:24 189:4
	<b>G</b>			
122:16 139:15,20 144:18,20,26 145:13,17 147:4, 6,11 148:2,22 150:14,15 152:22,23 153:16,17 174:12,17,19 175:3,4 178:24 182:21 183:9,21	<b>gain</b> 132:8 <b>Galloway</b> 6:13 79:21 <b>gamma</b> 65:5 <b>gas</b> 38:1 40:15 49:5,8 50:13,14, 15,22 51:4,5,6, 13,15,16,19,23,	<b>gas-monitoring</b> 161:23 <b>gauge</b> 134:7 188:5,9 <b>gauges</b> 134:5,8 <b>gave</b> 16:4 52:3 187:5 <b>GCMS</b> 44:23 45:1 58:2,13 59:12,25 67:14		



**glad** 157:9  
**gleaned** 184:8  
**goal** 84:12  
**GOB** 51:12,13,  
 15,16 52:2,4  
 53:11 67:1  
 132:12 134:14  
 135:6 136:14  
 141:16,24 154:13  
 155:1 161:11  
 162:19  
**GOBED** 51:5,6,  
 18,23  
**Gonzales** 173:1,3  
**good** 5:13 10:5,22  
 34:14 35:8 46:22  
 74:24 78:7 81:3  
 109:20 125:23  
 138:9 146:9  
 160:14 172:5,12  
 175:19 178:21  
 189:26  
**govern** 23:10  
**governance**  
 159:4  
**governing** 47:9  
**governments**  
 47:8  
**Govier** 5:13 8:5,  
 19 14:8,9 79:1  
**gradient** 65:11  
 115:2 117:14,16,  
 20,22 122:7,14,  
 17 141:9 146:20,  
 21  
**gradients** 114:25  
 116:23 165:23  
**gradual** 58:25  
**grain** 83:1  
**Grand** 132:23  
**grant** 31:4  
**graph** 50:14  
 114:9 121:2

**Graphically**  
 58:24 61:17  
**graphs** 127:8  
**gravity** 110:23  
**great** 24:2 46:14  
 186:15  
**greater** 56:19  
 63:12 75:9 76:13  
 100:17 106:4  
 113:14 114:18  
 115:25 116:9  
 145:3 147:2  
 163:7  
**green** 50:19  
 51:25 60:10  
 61:22 121:3  
 139:3 149:14  
**grey** 48:22 61:21  
 64:10 72:26 74:1  
 82:14  
**gross** 125:10  
**group** 162:15  
**grouped** 167:22  
**growth** 57:16  
 66:26 121:10  
 169:20  
**guarantee**  
 187:12 191:1  
**guess** 12:9 178:15  
 179:2,22  
**Gusher** 165:16

---

## H

---

**hackily** 87:21  
**half** 83:2,3 92:2  
 179:18  
**halfway** 80:11  
 183:23  
**Hall** 5:13 8:5,19  
 14:8,9 79:1  
**hallway** 14:10  
**halted** 59:17  
 65:17 130:1

**Hamdan** 6:16  
 79:14  
**hand** 136:21  
 137:23 153:3  
**hands** 68:4  
**hang** 180:21  
 185:20  
**happen** 24:26  
 59:21 87:6  
 150:12  
**happened** 21:13  
**Harbidge** 6:12  
 8:14 79:16  
**hard** 87:9 138:4  
 171:8  
**harm** 26:6  
**head** 117:22,24,  
 26  
**heading** 176:11  
 178:3  
**heads-up** 19:24  
**health** 123:25  
**hear** 9:20 13:12  
 20:13,14,16  
 28:25 162:9  
 176:25 185:7  
**heard** 16:14  
 22:11 31:2,4,9  
 153:9 163:8  
 164:9  
**hearing** 5:15,16,  
 17 6:10,14,16,20,  
 21,25,26 7:2,4,8,  
 12,16,18,24 8:1  
 9:9,10,13,18,25  
 11:4,8,20,24  
 12:18,25 13:3,14,  
 15,16,18,22,26  
 14:7,12,17 16:1  
 18:20 19:15 20:7  
 21:13,14,16  
 22:26 24:13  
 25:11 26:1,3,10  
 27:2,9 28:3 29:17  
 31:12,25 41:4,7  
 47:6 51:19 53:13  
 54:6,24 55:1,2  
 56:26 62:21  
 66:18 78:9 81:13  
 83:25 87:15  
 90:13 91:20  
 92:18 94:14,15  
 109:17,19,25  
 123:22 125:4,20,  
 26 133:14,16  
 137:2 138:10,21  
 144:8 149:19  
 151:10 165:2  
 185:12 187:1,3,  
 16 190:23  
**heart** 128:23  
**heat** 110:21  
**heated** 130:8  
**heating** 66:8  
**heavily** 81:25  
 83:9  
**heavy** 40:17  
 173:19  
**heel** 93:4 119:3  
**heels** 119:4  
 122:21  
**HEF** 92:6,17  
 93:14 94:6  
**height** 65:20  
 121:12  
**heights** 113:9  
**held** 23:1 66:6  
**helps** 57:8,12  
**heterogeneities**  
 96:12,16  
**heterogeneity**  
 93:12 102:6,14  
 103:14  
**heterolithic**  
 55:26 58:8 61:5  
 63:12 67:5,21  
 69:14 70:16  
 73:19 74:21,25  
 81:25 82:12,20  
 83:10 116:21

143:13  
**high** 65:5 67:9,22  
 72:26 74:11 75:9  
 77:16,24 82:13,  
 17 83:8,20 88:14,  
 17 89:24 105:13  
 111:8,25 123:19  
 144:17,19 151:4  
 152:23 158:22,23  
 170:6  
**high-end** 136:10  
**high-quality**  
 75:7  
**higher** 91:1  
 104:11 145:15  
**higher-quality**  
 90:24  
**highest** 73:19  
 75:23  
**highlight** 139:6  
 159:18  
**highlighted**  
 51:20,26 64:9  
 88:4 97:11  
**highlights** 54:8  
**highly** 47:15  
 121:19 135:25  
 147:4 148:22  
**hindsight** 20:1  
**hired** 187:16  
**historical** 140:24  
 144:16  
**hold** 61:6  
**holding** 5:24  
 66:12 127:2  
**holds** 73:12  
**hole** 86:1  
**Holman** 178:13,  
 14  
**Holman's** 178:15  
**home** 6:4  
**honest** 47:10  
 80:15

<b>honestly</b> 165:1	<b>hydrocarbon-</b>	<b>identify</b> 6:7 12:1	177:21,23	66:22 71:12
<b>hoped</b> 11:5	<b>assisted</b> 126:4	37:12 41:11	<b>immediately</b>	72:13 73:26
<b>hoping</b> 62:11	131:4,14,21	44:23 57:8,12	74:23	82:14 96:13,17
190:20	154:12	84:16 85:8 123:3	<b>immobile</b> 152:20	100:6,7 101:2
<b>horizon</b> 65:16,19	<b>hydrocarbons</b>	174:9 175:4	<b>impact</b> 49:8 52:5	102:17 103:17,21
<b>horizons</b> 59:17	58:26 59:1	<b>identifying</b> 14:18	131:21 150:24	105:15 106:19
<b>horizontal</b> 88:12,	<b>hydrodynamic</b>	<b>IHS</b> 66:7	151:26 153:9	107:3,9
13 91:1 97:6	75:16	<b>II</b> 50:13,22 51:18	155:2,11	<b>inclination</b> 104:6
98:5,8 113:24	<b>hydrostatic</b>	52:8,24 53:4,18	<b>impacted</b> 129:11	<b>inclined</b> 63:12
116:22 119:25	117:21,24,26	60:3 75:26 83:16,	135:25 150:6	<b>include</b> 41:11
<b>horizontally</b>		23 99:17 105:12,	<b>impacts</b> 52:11	56:19 118:14
113:22	<b>I</b>	25 106:11,17,23	119:4,11 123:21	119:22 127:9
<b>host</b> 27:12		108:7 128:15,22	155:1	140:12 163:13
<b>hour</b> 14:2 21:20	<b>I-A-N-N-A-T-T-</b>	129:6,16 132:21	<b>impaired</b> 150:7	172:21
35:20 36:11	<b>O-N-E</b> 10:18	133:1 134:25	<b>impartial</b> 41:23	<b>included</b> 17:9
<b>hours</b> 16:10	<b>Iannattone</b>	135:5,11,18,22	<b>impede</b> 75:20	141:4 143:21
17:16 21:2 36:11	10:16,17 37:2,16,	136:12,14 155:20	<b>impedes</b> 55:18	148:16 149:4
111:13 116:11	17,24 38:6,11	162:16	<b>Imperial</b> 186:24	<b>includes</b> 5:26 6:2
117:5 120:10,14	45:11,15 46:16	<b>illustrate</b> 86:20	<b>impermeable</b>	38:1 55:7 84:20
122:12 125:7	50:6,8 51:13	123:14 124:12	97:14	118:18 120:24
127:26	54:25 81:8 153:4,	<b>illustrated</b> 61:17	<b>implementation</b>	127:2 150:18
<b>humble</b> 47:11	5 157:19,20,21,	67:18 86:14	132:25	<b>including</b> 14:5
<b>humility</b> 159:22	22,25 159:10	<b>illustrates</b> 54:11	<b>implemented</b>	26:26 29:18
<b>hundred</b> 63:17	173:7	86:22 146:15	119:15	40:15 41:12 47:6
<b>hundreds</b> 19:22	<b>Iannattone's</b>	<b>illustration</b>	<b>implicit</b> 120:9	60:11 61:23 77:5
52:23	38:13	74:24 145:5	<b>implied</b> 132:11	85:4 96:17 98:16
<b>hydraulic</b> 40:16	<b>Iannottone's</b>	<b>image</b> 44:7 57:6	<b>important</b> 50:21	101:8 119:9
110:11 112:16,21	39:12	63:23 84:22 85:7,	51:3 58:13 76:24	124:23
113:5,8,13,15,18,	<b>idea</b> 15:20,24	11,12,16 87:20	84:3 85:21	<b>inclusion</b> 128:20
23,26 114:19	30:22 34:9	88:8,9,15,16,23,	100:15,26 145:12	134:5
115:4,10,13,22,	<b>ideally</b> 35:16	26 89:8,9,21	159:19 160:17	<b>incorporate</b> 23:7
23 116:6,13	128:22	90:3,11,21,24	<b>importantly</b>	<b>incorporated</b>
117:19 118:6,8	<b>identical</b> 66:23	91:3,7,11,26 92:3	154:21	102:19
119:24 120:7	<b>identifiable</b> 71:8	93:2,6,15,19,22	<b>impose</b> 49:11	<b>incorrect</b> 12:10
122:15 127:3	<b>identified</b> 16:24	94:3,5,9 97:5,19	<b>imposing</b> 155:24	99:21 105:21
141:11,20	59:2 70:22 72:25	101:24 103:7,25	<b>improvement</b>	<b>increase</b> 52:16
<b>hydraulically</b>	88:19 91:19,22	104:11 109:1	57:18 110:5	66:14 70:2 87:7
111:26 153:22	92:6,7,13 94:5	121:9 122:11	<b>in-depth</b> 187:25	115:14 117:11
<b>hydrocarbon</b>	105:18 123:7	142:26 164:17	<b>incidents</b> 47:18	119:23 121:4
58:5 59:4,20	126:5 129:2	<b>imaged</b> 148:10	<b>incipient</b> 64:2	136:16 169:12,24
65:1,2,4,7 69:15,	132:4 139:26	<b>images</b> 17:25	<b>incision</b> 50:18	170:8
16,21 75:14,17	143:18 148:9	86:24 142:2	60:20,23 61:2,8,	<b>increased</b> 66:7
77:1 129:25	150:14 157:2	<b>imagine</b> 142:11	25 62:5 64:12,16	115:11
130:1,5,7,11,12,	176:15 188:18	190:2		<b>increases</b> 110:14
26 131:19 168:2		<b>imaging</b> 90:15		115:9,12,17

120:7 122:6 124:20	19,21 25:2,3,15 26:11,13,26 27:6, 13,23 28:8,15 29:8 30:5 37:14 41:12 43:17 49:23 129:17 134:23 146:7 163:4,7 180:3,7, 12 186:17	<b>inside</b> 64:16	54:10 84:22 94:19 95:14 96:10,14,23 97:16 99:10,21 102:24 104:15 164:17 165:24 167:12 169:6,7 177:16	<b>introduced</b> 76:14 137:24 164:18
<b>increasing</b> 65:2		<b>inspection</b> 101:10		<b>introducing</b> 37:8
<b>incremental</b> 155:12		<b>instance</b> 25:19 137:18		<b>introduction</b> 167:2
<b>incur</b> 165:2		<b>instruct</b> 23:21		<b>invading</b> 179:15
<b>independent</b> 20:7 41:3,5,6,20 101:6 137:24 138:11	<b>informed</b> 35:8	<b>intact</b> 76:9	<b>interpretations</b> 16:26 54:19	<b>invasion</b> 178:8, 18,22
<b>independently</b> 138:16	<b>informs</b> 158:18	<b>integrated</b> 84:23	<b>interpreted</b> 68:12 87:18 88:8 89:20 90:12 91:9, 14,21 94:6 96:3 97:2 99:5 102:15 160:17 167:11 187:15	<b>inversely</b> 52:13
<b>index</b> 67:9 73:8 74:2,11 76:4	<b>initial</b> 41:6 70:20 118:19 127:13,19 138:15 150:11	<b>integration</b> 54:12	<b>interpreter</b> 175:18	<b>investigation</b> 129:8
<b>indicating</b> 58:4	<b>initially</b> 179:8	<b>integrity</b> 24:23 40:2 47:4,11 112:13 118:13 124:25 131:25	<b>interpreting</b> 44:7	<b>investing</b> 52:22
<b>indications</b> 59:22 85:3 115:21	<b>initiate</b> 110:26 111:9 113:16 118:5 121:6	<b>intend</b> 191:11	<b>interpretive</b> 97:5 98:6	<b>involved</b> 177:9, 12 186:23
<b>indicative</b> 87:9, 13,25 89:25 99:7 129:14 178:23	<b>initiated</b> 49:25 115:23 130:7	<b>intended</b> 33:9	<b>interpreter</b> 175:18	<b>involvement</b> 49:13 164:4,7,8
<b>indicator</b> 107:22	<b>initiating</b> 116:1, 6,13 124:6 125:15	<b>intensity</b> 93:3,4 181:18	<b>interpreting</b> 44:7	<b>involves</b> 54:12 119:8
<b>indiction</b> 127:10	<b>initiation</b> 118:24 129:12	<b>intention</b> 23:26 33:16 161:9	<b>interpreting</b> 44:7	<b>involving</b> 149:2
<b>indirect</b> 48:3	<b>inject</b> 181:10	<b>interbedded</b> 68:23 144:17	<b>interpretive</b> 97:5 98:6	<b>IR</b> 30:2 131:9
<b>individual</b> 63:16 73:9 76:19	<b>injected</b> 56:11 110:16 111:13 116:11 119:21 124:22 130:5,16, 20,26	<b>interbeds</b> 59:10 74:2	<b>interprets</b> 90:13 93:26 98:12	<b>ISH</b> 9:6 10:21,24 12:16,19,24,26 13:6,7,13 15:2 19:24 21:19 22:17 23:15,20, 26 24:2,11 25:6, 7,8,10,26 26:14 28:6,20,21 29:21 31:4 33:24 36:12 48:26 49:9,19,21, 26 52:10 53:16 68:11 80:1,2 86:18,25 87:1,4, 18 88:4 89:23 90:11,14 91:7,11, 14,19 92:1,2,13 93:11,14,26 94:5 96:24 97:3,24 98:4,14,21,22 99:14 105:24 106:25 129:19 131:8,9 135:2,7, 19 137:7 149:6 150:3 151:12
<b>individually</b> 134:24 167:22	<b>injection</b> 57:15 112:6 113:8 114:7,12 115:16 117:6 119:13,14 122:12 123:18 130:1,2,7,11 131:1 149:2 152:9,25 179:25 181:3	<b>interest</b> 25:15 37:11 47:7 53:5 131:5 135:21 136:11 161:11	<b>interrupt</b> 51:7	
<b>induce</b> 147:11 148:14	<b>injector</b> 65:21 108:1 169:18	<b>interesting</b> 160:6	<b>interrupting</b> 7:10	
<b>induced</b> 48:3 85:23,25 87:2,22 88:5 89:4 94:1 144:26 145:16 148:7,13 151:16 174:16	<b>inputs</b> 119:17,18, 19,26 120:9 122:7	<b>interfere</b> 55:18	<b>interruption</b> 111:15	
<b>industry</b> 38:1 40:15 44:21 59:7 118:14 135:14 160:8,15 165:15 184:5		<b>interferes</b> 161:14	<b>intersect</b> 86:15	
<b>inform</b> 158:21		<b>internal</b> 57:20	<b>interval</b> 56:7 73:21 75:23 77:17 82:15 88:3 89:5,8,22 91:17 93:2 97:11,12 98:24	
<b>information</b> 16:21,25 24:9,15,		<b>internally</b> 159:16	<b>intervals</b> 59:11 60:10 75:9 81:17 85:15 87:5,9 89:2 92:8 109:1 153:11 168:13	
		<b>internationally</b> 38:3	<b>introduce</b> 6:5 10:12 35:7 37:11 94:12 166:26	
		<b>interplay</b> 185:10		
		<b>interpret</b> 81:22 165:22,23 169:13 189:3		
		<b>interpretable</b> 93:5		
		<b>interpretation</b> 24:12 28:22		

152:10,13 154:18  
155:12 156:4,17  
157:13 160:18  
161:5,18 165:4  
170:5 180:7  
187:16

**ISH's** 13:5,8  
24:16 25:4,5  
27:8,10 28:21  
48:25 49:20 50:1  
87:15 90:13  
95:13 97:5,9,16  
99:10,20 104:21  
105:7,19 128:5  
129:17 132:14  
133:14,16,22  
134:3,11,22  
135:22 136:4  
146:6 153:9  
155:2,11 161:24  
174:15,20

**isolated** 69:2  
163:2

**isolates** 163:10

**isolation** 54:11

**isopach** 64:8 74:8  
102:22

**issue** 13:16 16:3,4  
24:22,24 25:17,  
18 30:13 55:2  
56:26 78:9 81:14  
83:25,26 94:14,  
15 109:17,19,25  
126:8 129:21  
131:19,23 138:21  
142:3,7 144:8,23  
149:19 151:10  
152:8 162:19

**issues** 14:17 20:7  
24:13 25:11  
29:21 41:4 46:21  
54:24 112:11  
123:22 125:21,26  
134:7 138:12  
148:25 149:5

**Italian** 157:22  
**item** 134:5,10  
**iterative** 54:15

## J

**J-A-M-I-E-S-O-N** 10:7

**J.P.** 79:23

**Jackfish** 45:2  
148:17 188:16

**Jamieson** 10:5,6,  
20 11:1 15:6,9,  
12,13 19:2,8,26  
20:12 21:17  
26:20 28:25,26  
29:1 30:14 32:6,  
9,24 33:3,5,19  
34:13,26 35:1,2,  
19,22,24 36:1,3,  
6,8,15,19,21,23  
37:7,16 38:12,18,  
24 39:5,11,15,22  
40:3,9,21 41:25  
42:6,12,25 43:5,  
12,22 44:9,15  
45:4,26 46:13  
62:14 68:1,8 78:7  
79:23 80:9,14,22,  
26 81:3 138:6

**January** 19:6  
86:18 135:2

**Jason** 37:2 38:25  
54:26 81:8

**jive** 80:12

**Joann** 10:6 35:2

**join** 86:10

**joins** 107:5

**joint** 53:4

**jurisdiction**  
23:20

**justifiable** 154:9

**justified** 125:3  
154:20

## K

**karsting** 95:3  
140:1

**karsts** 117:2

**key** 56:11 57:10  
97:9 121:13  
138:14 144:15

**kilometres** 73:12  
95:22 107:5

**kind** 17:25

**kindly** 42:25  
44:10

**Kirby** 38:16 39:4  
45:2 47:23 48:7,  
18,20 50:12,22  
51:4,6,16,18,21  
52:7,24 53:4,17  
66:13 70:20 72:2  
91:8 99:17 101:2,  
7 105:12,25  
106:4,8,10,14,23  
108:6 110:3  
115:20 116:3,15,  
24 123:13 124:5,  
11 125:25 126:20  
127:4 128:15,21  
129:6,16 131:25  
132:21,26 134:25  
135:4,11,17,22  
136:12,14 140:26  
146:20 148:17,18  
149:13 151:22  
155:20 162:16  
177:18 179:26  
180:1 181:23  
188:16

**kits** 8:10

**KN01** 131:17

**KN02** 66:14,21

**KN06** 15:26  
19:17 21:13  
60:16 66:18  
67:12 70:20  
108:2 110:6

115:6 127:1,17  
128:16,17 129:12  
152:7 187:1,16

**KN07** 48:22

**KN08** 9:4 37:22

47:22 48:24  
49:10 50:19 55:6  
58:11 60:8,9,19,  
21,23 61:7,19  
62:1 64:8 66:22,  
23 67:8,12,16,19,  
25 70:23 71:10,  
19 72:6,15,24  
75:22 76:12,16,  
22 77:4,14 81:20  
85:11,13 86:25  
88:3,23 91:26  
92:5 93:22 94:11,  
20 95:1,9,21  
96:5,11,15,25  
99:19,24 100:5,  
23 101:1,8,18  
104:16 105:8  
106:4,25 107:9,  
25 108:12,18,25  
109:2,15 110:1,7  
111:24,26 112:2  
113:12,21 116:17  
117:3,8 118:23  
119:3,5 120:26  
122:21 126:6,26  
127:16 128:16,23  
129:23 130:14  
132:3,9,17  
135:13 138:13  
144:26 146:26  
147:7,15,20  
148:6 150:13  
152:4 154:4  
171:2 186:1

**KN08/09** 126:19

**KN08/9** 64:15

**KN08/KN09**

72:1,8,17 73:25  
78:3 91:12  
134:13,17 140:6  
153:8 155:10,24

**KN08S** 182:26

**KN09** 9:4 37:22  
47:22 48:24  
49:10 50:19 60:8,  
22 61:20,25 64:8  
66:24 67:8,25  
71:11 72:15,25  
75:22 76:16,22  
77:4 86:26 88:3,  
23 91:26 94:11,  
20 95:1,9,21  
96:5,11,15 99:19,  
24 100:5,23  
101:2,8,18  
104:16 105:9  
106:4,25 107:9,  
25 108:13,19,25  
109:3,15 110:2,8  
111:24 112:1,2  
113:12,21 116:17  
117:3,8 120:26  
126:6,26 127:16  
128:16 129:1,23  
130:14 132:3,9  
134:1 135:13  
138:13 143:16  
145:1 147:1,7,16,  
20 148:6 150:14  
152:4 154:7  
171:2 182:26  
186:1

**KN09's** 134:2

**KNO1** 48:22

**knowledge** 45:20  
163:6 175:10

**kpa** 25:25 111:1,  
4,10,11,23 112:3  
114:25,26 115:2,  
25 116:9 117:15,  
17,21,22 121:4,  
15,17 122:8,15,  
17,24,26 123:18  
124:7,15,24  
125:8,9,12,13,14  
127:24,25 128:5,  
7,9 131:2,3  
141:8,15,18,22

146:17 147:2,18 152:3 153:21,26 173:20 <b>Ks</b> 137:17	68:9 78:6,10 81:8,11 82:22,26 83:5,7 94:16 139:9 142:1 143:6 153:10 172:23 <b>Lavigne's</b> 35:25 80:17 <b>law</b> 6:9 161:12 <b>laws</b> 47:9 <b>layer</b> 65:5 159:15 169:10,26 <b>layers</b> 58:5 100:20 <b>lead</b> 43:11 52:19 112:20 115:17 163:21 <b>leader</b> 165:15 <b>leadership</b> 159:5 <b>leads</b> 113:22 <b>leak</b> 56:8 <b>leaked</b> 99:15 <b>leakoff</b> 110:11 112:24,25 113:5, 7 119:20 120:3 122:24 124:17 151:24 <b>lean</b> 107:8 <b>learned</b> 20:23 <b>learning</b> 30:3 <b>leaseholder</b> 154:26 <b>leaving</b> 5:10 78:17 <b>left</b> 5:18 8:4 39:12,23 40:9 58:24 62:1,5 63:26 64:9 66:5 68:3 72:3,4 86:7, 20,26 87:18 91:1, 3 97:2 100:24 103:12,16 136:5 145:6,14	<b>left-hand</b> 137:8 <b>leftmost</b> 135:1 <b>leg</b> 108:8 <b>Legal</b> 79:9,10 <b>length</b> 119:25 130:14 <b>Lennon</b> 36:26 41:26 42:2 81:6 <b>let alone</b> 98:19 <b>letter</b> 97:19 98:4, 26 99:7 <b>letters</b> 97:8 <b>level</b> 60:24 68:20, 24 96:8,9 97:21 101:19 102:25 104:13 123:2,3 158:22,23 168:19 170:6,11,12,14 <b>leverages</b> 57:19 <b>liberties</b> 98:14 <b>lie</b> 97:13 <b>life</b> 55:6,17 56:3, 25 58:10 75:22 77:4 78:3 110:1 123:6 134:17 142:16 144:5,15 150:1 180:1 <b>lifespan</b> 135:15 <b>lifetime</b> 142:5 150:12,16 166:17 <b>lifted</b> 132:13 <b>light</b> 17:24 58:25 59:1 74:22 75:2 128:5 <b>lighter</b> 74:26 76:8 83:14 <b>likelihood</b> 116:13 144:19 150:8,11,16,23 151:22,23 152:21,23 <b>likelihoods</b> 149:9 <b>limit</b> 115:15 125:7,10 127:23	<b>limitations</b> 9:25 <b>limited</b> 8:26 9:6 10:4,8,15 37:5 55:8 79:24 110:15,16 124:2, 21 150:25 157:16 163:4 172:4 190:7 <b>limits</b> 66:25 125:2 <b>linear</b> 90:21 <b>lines</b> 97:5,7 98:6 102:10 <b>link</b> 7:13 <b>list</b> 9:15 159:12, 13,20 <b>listed</b> 138:24 <b>listen</b> 8:3 <b>listening</b> 13:20 21:8 <b>literally</b> 19:19,22 <b>literature</b> 153:14 <b>lithofacies</b> 67:20 68:19,23 <b>live</b> 7:12 9:26 23:8 34:22 47:5 168:24 <b>lives</b> 159:7 <b>loading</b> 147:25 148:1 <b>lobby</b> 8:6,14 <b>local</b> 48:1 140:2 171:14,16 <b>localized</b> 70:6,24 <b>locally</b> 68:21 69:25 71:11 73:12 82:5 171:4 <b>located</b> 8:13 50:11 92:5 120:25 128:22 143:16 <b>location</b> 75:5 99:5 100:21 103:2,19 118:22, 26 132:17 133:26 134:3 167:22 <b>locations</b> 84:17 98:5,11 99:2 118:21 151:3 154:3 <b>locked</b> 78:15 <b>log</b> 71:7 84:22 85:7,11 88:9,15, 23 89:8,21 90:3, 21 91:3,26 93:15, 22 94:9 103:7,25 104:11 109:1 164:17 179:4 189:16 <b>logging</b> 164:17 <b>logs</b> 44:7 57:6,15 65:23 66:5,10,13 67:10 70:22 85:5, 11,12,17 88:9,16, 26 90:11 91:7,11 92:3 93:20 94:3,5 101:25 103:11,15 139:18 140:13 148:17 174:25 175:2,4,9,13 178:6 179:3 188:15,18,21,23, 25 189:3,5,15,16, 20 <b>long</b> 99:15 112:5 117:25 149:25 167:7 <b>long-term</b> 111:21 112:9,18 117:14,18 118:4, 9 119:3,7 120:13 122:20 123:16 124:9,24,25 126:15 128:4,6 153:26 <b>longer</b> 143:10 169:2 <b>looked</b> 158:24 182:23
--	--	--	--

**losing** 181:12  
**loss** 56:13 84:6  
85:3,4 107:26  
150:22 181:2  
**losses** 132:26  
**lost** 47:18 52:15  
84:26 107:21,24  
150:4 151:13  
152:11,12  
**lot** 34:23 187:5,14  
189:20,21  
**lots** 34:15,16,21  
**louder** 11:4  
**low** 49:4 53:22  
56:21 58:7 65:6  
76:15,17,21  
83:20 88:12,18  
89:10 90:4 92:1,  
10 94:10 104:21  
107:8 109:12  
112:23 114:1  
116:6,13,26  
117:4,10,23  
119:19,26 121:15  
122:3 124:15,24  
139:10,14 148:3  
150:26 152:2,21,  
22,24 153:18  
154:24 167:5  
179:13  
**low-risk** 149:15  
**low-to-moderate**  
93:2  
**lower** 58:10 64:8  
65:13 67:21 69:6,  
20,22,24 81:25  
82:4 83:17  
100:24 103:20  
116:8 145:11,14  
153:25 166:6,15  
169:25  
**lowest** 71:21  
**lunch** 14:2 35:13,  
14 68:5

**Lung** 6:10 7:25  
8:2 9:17 16:7  
17:5 34:13 43:15  
46:9,10 48:14  
50:3,6,25 54:3  
58:16,22 60:4  
61:13 63:4 71:6  
79:11 114:3,22  
120:16,18 134:19  
135:26 156:21,22  
157:12 159:1  
162:1

---

**M**

---

**M'** 137:2,6  
**M-C-L-E-O-D**  
10:24 172:6  
**Mackay** 146:9  
**Madam** 5:22  
**made** 17:25  
21:14 22:22  
26:23 29:6 41:13  
50:1 92:17  
123:14 124:12  
138:15 154:17  
170:24 173:13  
177:24 186:2  
190:24  
**magnitude** 84:16  
104:20 118:7  
**maiden** 6:19  
**main** 107:6  
158:6,12 162:7  
**maintain** 13:23  
132:26  
**maintaining**  
125:13  
**maintains** 99:18  
132:11  
**major** 133:21  
140:11  
**majority** 16:20  
84:11 90:14 94:4  
154:26 161:10

**make** 14:7 16:19,  
23 17:19 23:7,21  
24:14 26:13 28:6  
29:26 30:16 36:9  
37:22 45:22  
49:17 76:8 138:6  
146:3 154:15  
156:19 159:6  
170:13 172:18  
187:20,21  
**makes** 25:16,26  
34:23 162:8  
**making** 13:19  
17:17 22:16  
30:21 31:9 34:2  
52:17 137:14  
148:5 159:12  
**Maksim** 6:12  
79:17  
**manager** 10:14  
35:4 38:16  
125:25  
**managing** 22:18  
**manifested**  
181:1  
**manner** 145:2,3,  
20,26 154:16  
155:6  
**Mannville** 50:13,  
22 51:5,15,18,24  
52:8,24 53:4,18  
60:3 75:26 83:16,  
23 99:17 105:12,  
25 106:11,17,23  
108:7 128:15,22  
129:6,16 132:21  
133:1 134:25  
135:5,11,18,22  
136:12,14 155:20  
162:16  
**map** 48:18 64:8  
72:3,4 74:8 91:9  
95:20 102:5,20,  
21 103:3 105:10  
**mappable** 73:11

**mapping** 71:9  
84:21,22 95:5  
102:9 139:9  
167:19  
**maps** 16:22 17:18  
32:19 96:7,8  
**Marc** 37:1 43:6  
81:7 164:16  
**March** 8:24  
49:21 129:11  
**marine** 67:24  
70:18  
**mark** 156:21,22  
**marked** 9:14  
74:21 97:18 98:5,  
22,26 99:7,12  
169:8  
**markedly** 58:6  
**marker** 168:1  
**markers** 17:22  
**marking** 90:16  
**marks** 73:23 75:1  
90:15,23 91:13  
92:14 94:7  
**Marlé** 10:23 27:3  
**married** 6:19  
**Maryam** 79:15  
**mass** 58:1  
**master** 43:25  
**master's** 38:25  
40:11 42:15  
43:23  
**matched** 142:23  
**material** 15:5,7,  
16 16:13,18  
18:20 23:22  
26:23 30:23  
32:26 35:22 46:3  
83:1 147:23  
164:5  
**materials** 9:13  
14:25 23:5,8  
30:18 33:10  
80:13 125:4

**matter** 19:4  
22:23 160:2  
**matters** 14:18,  
21,24 23:22  
159:8,22  
**Maude** 10:13  
35:4  
**maximum** 25:21  
30:8 110:18  
120:9,11 125:7,  
10 130:11,12,14  
152:26 156:15  
182:20 183:15  
**Mcclary** 6:8 79:9  
**McLeod** 10:24  
80:2 171:22  
172:3,5,6 177:3  
184:12,23,26  
185:10,15,17,19  
**McMurray**  
44:24 50:17,20,  
23 52:9 53:19  
55:4,9 60:2,11  
63:10,15,16  
71:19 75:14,25  
78:2 83:21 84:1,  
25 98:17,23  
99:20 101:4,14  
105:3,9,14,20,24,  
26 106:13,18,26  
107:1,6,10,13,20  
108:8,12,18  
109:4,13 110:12,  
13,15 111:24  
113:3,4 124:17,  
19,21 132:1,19,  
20 141:2,8,11,21,  
24 143:17,18  
144:14 147:24  
149:22 153:7  
162:18 163:11  
166:16 180:25  
**MDM** 181:24  
**meaningful**  
49:15 168:11

<b>means</b> 145:22	<b>mentioned</b> 14:11 21:17 28:18 63:22 69:13,19 71:18 72:23 82:18 89:7 103:13 125:23 128:13 130:26 164:22	<b>microphones</b> 9:26	<b>minimal</b> 117:6 121:10	<b>mobility</b> 130:9
<b>meant</b> 95:18 190:14	<b>merits</b> 155:22	<b>mics</b> 11:3 34:16, 21,22	<b>minimize</b> 132:25	<b>mode</b> 14:6
<b>measure</b> 142:17 187:19	<b>message</b> 158:12	<b>mid-afternoon</b> 12:15,23	<b>minimum</b> 111:6 113:15,17,19,21, 24 114:16,21,24 115:1 117:16 118:7 122:2,7,14, 16 123:7,9,10,12 124:10 146:18,20 147:2	<b>model</b> 24:23 25:20 30:9,10 104:18,22 119:4 122:10 123:1,2 142:23,24 147:17,21,23,24
<b>measured</b> 52:25 54:9 114:6 142:23 146:20 181:19 182:10 183:8	<b>met</b> 20:24 175:1	<b>mid-b1</b> 60:15,24 61:23 67:4,11,23 68:11,12,19,21, 24,26 69:25 70:6, 13,18 77:5,13 82:7 143:25	<b>minor</b> 59:18 95:7,10 98:10 99:1 101:12,20 140:3	<b>modelled</b> 119:10 121:1,23 122:1, 22 123:17
<b>measurements</b> 140:25 141:1,3,7, 9,14 144:17	<b>method</b> 142:20 143:8 144:2	<b>middle</b> 37:18 54:18 77:15 86:8 102:4 123:8 143:19 162:14 182:24	<b>minute</b> 147:9 165:11	<b>modelling</b> 24:10, 20 25:3 26:24 28:16 29:18 30:1, 5 40:17 118:2,3, 12,16 119:18,21 120:3 121:5,13 153:20
<b>measures</b> 53:25 136:16,19	<b>methodology</b> 118:17 142:19	<b>migrate</b> 58:9 87:14 142:18 144:13 166:6,23 174:10 186:3	<b>minutes</b> 32:10 36:1 46:2 68:3,6 138:1 156:2 184:16	<b>models</b> 54:19
<b>mechanical</b> 37:25 147:26	<b>methods</b> 131:15	<b>migrated</b> 107:2 140:14,16	<b>misfortune</b> 26:8	<b>modern</b> 63:23,24 100:12,13
<b>mechanics</b> 43:26 44:4 118:15	<b>Metis</b> 6:4	<b>migrating</b> 105:26 142:12 150:1 180:25	<b>misinterpreted</b> 98:2	<b>modifications</b> 125:1,16
<b>mechanism</b> 100:22 112:17,24 115:5,19 120:8	<b>metre</b> 73:10 76:13 114:25,26 115:2 117:15,17, 21,22 122:8,15, 17	<b>migration</b> 105:2 140:8 141:24 142:4 144:21 149:22 150:9 151:8	<b>misquote</b> 166:2	<b>modified</b> 125:5 127:9
<b>mechanisms</b> 120:2,25 121:24 124:4,17	<b>metres</b> 63:17 65:5,12 76:18 90:19,22,25 101:9,10,15,16, 19 103:20 111:14 116:12 117:7 120:11,15 121:11 125:11 130:12 140:17 146:26 147:1,18,20 149:26 151:15 152:15	<b>mild</b> 189:24	<b>mission</b> 47:1,5 157:26 158:16,20 159:18,26 160:1, 4,13	<b>modify</b> 153:24
<b>media</b> 112:25	<b>metric</b> 56:11	<b>miles</b> 70:21	<b>misspoke</b> 78:8	<b>Mohkinstsis</b> 6:3
<b>medical</b> 8:8	<b>mic</b> 22:6 34:24 162:5 175:15	<b>million</b> 47:25 48:5 135:20 136:10,13 154:19 166:16,25 167:6	<b>mistake</b> 62:12 69:12	<b>mold</b> 160:10
<b>meet</b> 25:9 26:2 175:6	<b>microbiology</b> 43:7	<b>millions</b> 52:23	<b>mitigate</b> 49:7	<b>molecular</b> 59:20
<b>meeting</b> 26:15 27:24 31:14	<b>microimage</b> 139:18	<b>mimic</b> 160:11	<b>mitigates</b> 134:7	<b>molecules</b> 167:21 168:2 170:21
<b>meetings</b> 49:26 160:2	<b>Microimaging</b> 139:18 174:25	<b>mind</b> 82:23	<b>mitigating</b> 110:10 149:12 151:8	<b>moment</b> 28:23 30:2 46:26 85:21 95:18 166:1 171:18
<b>Meg</b> 5:17 79:7	<b>microphone</b> 9:20 10:2 185:7	<b>mindful</b> 7:9	<b>mitigation</b> 53:25 125:17 132:6 136:17 149:22	<b>moments</b> 96:25
<b>member</b> 43:11 55:10 79:6,7 84:2 109:14 164:3		<b>mineral</b> 153:9 161:13	<b>mitigations</b> 127:19 136:19 152:5,6	<b>Monday</b> 16:12
<b>members</b> 5:17 7:1 13:17 157:1 164:7		<b>minerals</b> 161:14	<b>mix</b> 152:19	<b>money</b> 181:12
<b>mention</b> 11:2 21:12 23:12 35:12 163:6 184:13				<b>monitor</b> 57:16 126:19 154:23
				<b>monitored</b> 131:15
				<b>monitoring</b> 53:25 84:24 85:6

126:2,9,11,22 128:8,12,14,18, 21 129:6 131:13, 15 132:16,17 133:6,10,18,26 134:3,6 136:4,9, 16,19 140:20 149:3,13,20 150:19,21,23 151:2,5,7 154:2, 6,18 155:9 160:7 161:5,6,19,20 186:23 <b>months</b> 31:7 110:21 <b>MOP</b> 25:22 111:11,21,23 112:9 117:4,10, 26 120:13 121:17 124:14,24 125:2, 6,9,12,14 127:5, 23,25 128:4,7 130:7 131:2,3 151:11 152:3 153:1,26 <b>MOPS</b> 109:26 110:19 113:9 116:13 117:13 <b>morning</b> 5:13 6:15 10:5,22 13:4 14:2,26 15:2 16:12 18:5 20:21, 26 22:14 23:15 28:2 46:22 128:4 133:20 158:1,5 166:3 191:9,12, 15 <b>motion</b> 15:1 20:15 23:15,20 25:20 27:5 31:4 32:3 <b>motions</b> 31:18 <b>mouse</b> 18:1 <b>move</b> 15:9,22 22:6 23:14,16 81:12,16,17,24	82:1 136:23 158:26 <b>movement</b> 55:18 148:15 188:20 <b>moving</b> 67:2 70:14 71:18 144:23 148:25 152:8 <b>mud</b> 64:2,14,15 66:12 67:9 73:8 74:2 76:4 83:8 89:26 100:10,22 139:16 140:4 143:3,23 144:17 <b>mud-filled</b> 95:8 99:3 100:6 102:16 103:16 104:19 153:10 <b>mud-prone</b> 116:20 <b>muddy</b> 76:4 89:23 140:17 143:24 <b>muddying</b> 63:11 <b>muds</b> 171:4 <b>mudstone</b> 55:21 56:1,19 59:10 60:15,24 61:9,23, 26 63:16 64:3,4,9 65:5,6,13,18 67:4,11,22,23 68:11,12,22 69:1, 6,25 70:7,13,18, 19 71:7,10,13,20 73:1,9 74:1,10,11 77:6,13,18,21 82:7 83:5,20 142:15 143:18,25 <b>mudstone-</b> <b>dominated</b> 64:17,21 72:12 <b>mudstone-prone</b> 61:4 72:16 73:21 77:19	<b>mudstone-rich</b> 66:6 76:21 <b>mudstones</b> 60:14,17 67:7 70:17 74:16 76:9 82:15 139:14 144:25 146:8 <b>multi-caliper</b> 148:17 <b>multi-censored</b> 148:10 <b>multi-phased</b> 118:15 <b>multidisciplinary</b> 42:19 57:2 84:16 <b>multiple</b> 44:2 54:12 75:7 83:19 124:16 139:10 <b>multiplicity</b> 10:1 <b>Murphy</b> 80:4 192:3,14 <b>muster</b> 8:6 <b>mute</b> 10:1 34:24 <b>mutual</b> 53:5 <hr/> <b>N</b> <hr/> <b>nagging</b> 34:20 <b>Nakoda</b> 6:1 <b>names</b> 6:7,9 51:6, 16,25 <b>narrow</b> 90:6 <b>narrowing</b> 14:16 <b>Nation</b> 6:1,3,4 <b>natural</b> 8:25 10:4,8,14,17 12:13,14,22 13:4, 7,9,11,13 15:21 29:9,22 30:12 35:3,6 37:5,9 39:1 41:2 42:20 45:17,23 46:25 47:5,12,17,26	48:25 49:6,8,19, 25,26 52:10,21 53:5 55:15 57:2, 6,17 59:6 60:25 61:10 65:25 68:18 71:9 72:10 77:26 79:23 84:3, 10,15 85:2,10,14, 23 86:2,13 87:1, 10,13,17,26 88:1, 2,22,24,26 89:25 90:10,13,16,20 91:18,20,23,24 92:4,9,12 93:15, 21,23,25 94:2,4, 7,8,23 95:13 96:6,22 97:2,4,8, 10,15 98:12 99:1, 18,23 100:4 102:1,14,23 103:10 105:7,10 106:2,26 107:15, 23 108:22 109:11 110:26 114:2 117:8 125:5 126:9,18,21,25 127:15,22 128:2, 6,12 129:13,17, 25 131:12,26 132:7,11,14 133:12,20,22,25 134:6,12,16 135:8 144:25 153:17,23 154:5, 14,17,22,26 155:5,16 157:15 159:19,26 161:10 172:3 174:12,17, 19 181:22 190:6 <b>Natural's</b> 12:17, 21 13:2 15:17,26 20:4 29:16,19 37:19,20 41:7 44:7 45:2,12,19 46:2,17,19,20 47:21 48:11 53:20,24 54:5,23	59:13,26 64:5 67:18 85:20 91:24 93:10,14, 18 94:14,17,19, 21,25 95:12 101:21,24 102:8 104:15,18,25 105:1 107:17 109:7,16,18 125:18 129:8 132:5 133:3 134:22 136:2,6,8, 19 137:24 153:6 155:3,7,22,26 158:4,6 159:14 <b>naturally</b> 86:2 94:1 <b>nature</b> 53:26 67:5 82:12 87:21 92:19 130:15 136:17 167:4 171:15 <b>near-term</b> 136:9 <b>nearby</b> 66:17 70:20 85:1 141:19 <b>nearest</b> 98:12 103:23 <b>necessarily</b> 160:11 174:20 <b>needed</b> 13:10,11 16:17 <b>negatively</b> 56:10 84:8 <b>negligible</b> 123:20 <b>net</b> 48:9 113:17 114:21 181:1 <b>network</b> 87:13, 26 <b>neutral</b> 139:2,3 <b>ninety</b> 25:24 <b>noise</b> 5:11 <b>non-compatible</b> 132:4
--	---	---	--	--



<b>non-dilatancy</b> 145:25	54:16 60:13 63:25 64:11 74:9, 22 75:2 82:11 87:21 89:26 90:25 104:5 106:20 115:1 135:1 157:1 166:2 190:19		145:17 146:25 148:21 155:16 169:20	137:5,9,12,16,20, 26 154:11,14
<b>non-dilate</b> 146:11		<hr/> <b>O</b> <hr/>	<b>occurred</b> 29:7	<b>Ollenberger's</b> 39:23 154:1
<b>non-geologist</b> 82:24	<b>noted</b> 86:23 93:10 99:8 102:5 115:26 176:14	<b>oath</b> 11:12 191:4	<b>occurrence</b> 89:6 106:3,16 144:21	<b>ongoing</b> 134:17 141:19
<b>non-reservoir</b> 61:5,21 63:9 64:13,18 66:20 67:2 71:22 72:21 73:7,18,22 74:4 77:12 81:24 82:19 89:17 102:22 171:3	<b>notes</b> 13:18 14:15 33:2,3,5,21 34:3 161:8 192:6	<b>object</b> 21:21	<b>occurrences</b> 150:9	<b>onlap</b> 72:12
<b>Nonetheless</b> 150:25	<b>noteworthy</b> 152:6	<b>objective</b> 41:23 149:9 187:19	<b>occurring</b> 86:2 94:1	<b>onlapped</b> 61:3
<b>nonexistent</b> 92:1 94:10 109:12	<b>notice</b> 8:1 9:9,10 173:14	<b>objectives</b> 118:3	<b>occurs</b> 63:9 65:4 72:6,21 74:9 77:24 83:17 113:2	<b>online</b> 16:1 86:19
<b>noon</b> 35:12 46:3 68:2	<b>noticed</b> 69:17	<b>obligation</b> 41:24	<b>October</b> 101:5	<b>onset</b> 123:11
<b>normal</b> 69:3 128:10 133:4	<b>notify</b> 8:9	<b>obscures</b> 90:1	<b>offered</b> 161:7,20	<b>onside</b> 17:14
<b>north</b> 39:4 47:23 48:7,18,20 51:4, 21 61:1,25 63:15 66:14 70:20 72:2, 5 73:23 91:8 101:2,7 106:5,8, 14 107:4 110:3 115:20 116:3,15, 24 123:13 124:5, 11 125:25 126:20 127:4 140:26 143:16 146:21 149:13 177:18 180:1 181:23	<b>noting</b> 69:19	<b>observation</b> 126:2 143:11	<b>offers</b> 147:12	<b>oops</b> 62:13
<b>northeast</b> 103:14 105:12,18 106:17	<b>November</b> 133:6	<b>observations</b> 189:19	<b>officer</b> 163:21	<b>open</b> 5:10 11:21 23:12 34:4 86:22 93:3 94:23 99:13 104:23 106:1 107:11,12,18,23 108:11,17 109:23 113:24 114:12 145:19 147:11 149:25 152:17 172:1 181:21 182:14 184:17
<b>northeast/ southwest</b> 102:4	<b>number</b> 9:3 12:2, 3,5 16:19 32:15 43:15 46:9 48:15 62:19 94:15 99:11 109:19 110:11,12,14,15 113:1,3,6 120:3, 4,6,25 121:1,3,10 122:3,7 124:17, 18,20,21 125:6,9, 21 126:1,8 129:2, 18,22 131:10,24, 26 134:23 156:23 159:21 162:3 179:13 182:24	<b>observed</b> 59:16 84:25 85:14,16, 22 86:2,12,25 89:3,19 90:14,21 91:11 92:11,19 93:5,12,23,26 94:2 95:4,12 98:11,18,23 100:1,23 101:8, 13,17 102:12,19 103:18,21 104:10 107:23 108:7 139:19,21 140:5 147:6 148:19,20 153:16 188:24 189:19	<b>official</b> 7:14,16 14:12 80:4,5 192:15,21	<b>opening</b> 5:8 15:18,22 18:25 19:16 20:5 21:15 54:21 162:26
<b>northern</b> 60:22	<b>numbers</b> 17:17 30:6 33:12 43:16 138:19	<b>observers</b> 11:9	<b>offset</b> 59:5 98:4	<b>operate</b> 112:4
<b>Notably</b> 145:8	<b>numerical</b> 40:17	<b>observes</b> 99:1 100:4	<b>offsetting</b> 68:26 103:23 108:1	<b>operated</b> 47:14
<b>note</b> 8:19 11:19 13:17 22:21 31:19 50:21	<b>numerous</b> 56:2 65:24 69:16 77:17 91:7 172:21	<b>observing</b> 6:23 7:17	<b>Ogilvie</b> 86:19,21 87:23	<b>operating</b> 25:21, 23 47:13 57:19 65:15 110:18,19, 24 117:14,18,20, 23 123:15 124:1, 13,23 125:1 126:12
		<b>obtain</b> 180:3	<b>oil</b> 8:26 9:1 10:17 37:18,26 40:1,15, 17 49:16 53:10, 11 56:10,11 57:11,19 58:6 65:14 74:22 86:12 87:11,14 89:6 105:26 106:7 107:2 113:3 166:3,21 170:21 173:19 176:2 184:1	<b>operation</b> 40:19 59:24 84:8 110:24 116:4 119:16 122:23 123:6 126:15 153:1 155:10 166:11 188:16,17
		<b>obtained</b> 54:18	<b>oil/water</b> 59:1 170:7	<b>operational</b> 47:16 55:24 66:1
		<b>obvious</b> 92:22,26	<b>Ollenberger</b> 36:26 39:11,12, 15,21 81:6 125:20,22,24 128:26 136:24,25	
		<b>occupy</b> 130:16		
		<b>occur</b> 52:22 55:22 69:20 82:6 90:5 127:19		

77:10 84:24 94:22 107:17 109:7 111:7,15 112:10 124:4 126:16 166:12 <b>operations</b> 24:26 44:8 47:19 48:2 53:18 55:17 56:4, 5,25 57:23 65:22 75:22 84:14 94:11 107:19,22 109:15 111:17,20 112:3,22 123:17 124:26 128:10 129:12 131:9,14 134:2 144:22 147:11 148:9,12, 14 149:2 150:11 163:2 174:21,23 180:2 189:21 <b>operator</b> 47:10, 17 48:12 53:10 190:25 <b>operators</b> 131:18 142:21 <b>operatorship</b> 53:8 <b>opine</b> 186:20 <b>opinion</b> 41:20 148:4 173:15 <b>opportunities</b> 80:17 <b>opportunity</b> 21:6 31:18 46:24 49:3 <b>optimization</b> 42:4 <b>orange</b> 72:5 143:3,18 <b>order</b> 12:11 37:10 49:9 52:12 53:11 56:5 71:26 87:8 101:15,19 115:13 121:5,23 122:1,9 132:8,9, 13 134:2 135:6	142:16 182:16 <b>ordered</b> 52:7 <b>orders</b> 23:21 <b>organic</b> 168:2 <b>orient</b> 96:26 <b>orientation</b> 72:22 92:25 93:4 113:18,19 <b>orientations</b> 113:23 <b>oriented</b> 72:7,22 113:22 <b>original</b> 97:1 98:8 99:4 111:22 140:25 141:4,6 149:10 <b>originally</b> 106:7 125:2 126:25 169:3 <b>originated</b> 94:20 <b>OSE</b> 129:4 <b>outage</b> 111:16 <b>outcome</b> 168:8 <b>outcrops</b> 63:15 183:7 <b>outline</b> 48:19,21 <b>outlined</b> 48:24 51:21 <b>outstanding</b> 159:23 <b>overburden</b> 119:9 147:22 <b>overburdened</b> 147:17 <b>overlies</b> 50:22 67:24 128:15 <b>overlying</b> 52:6 53:6 54:17 55:3 56:8,17 57:13 58:15 60:11 67:1 71:14 76:11 95:10 100:18,20 105:9 131:22 140:14 171:5	181:22 <b>owned</b> 160:25 <b>owner</b> 53:4 161:11,13 <hr/> <b>P</b> <hr/> <b>pace</b> 38:4 <b>package</b> 63:11 73:11 76:21 83:10 177:16 <b>pad</b> 52:18,23 66:14,21 81:20 104:2 126:6 127:13,17,18 128:16,17,23 129:12 130:15 131:16 132:18 134:1,4 143:16 166:17 <b>pads</b> 9:4 47:22,24 56:12 58:11 65:24 66:22 75:22 77:4 90:1 91:2,12 106:14 117:25 126:26 135:13,14 147:1 152:4 <b>pages</b> 19:22 131:10 133:17 192:4 <b>pair</b> 110:23 130:13 <b>paired</b> 87:19 <b>pairs</b> 47:15 87:16,17 122:22 126:11 127:20 130:15 <b>paleo</b> 169:22 <b>paleosols</b> 82:5 <b>Paleozoic</b> 84:20 95:3 96:9 <b>panel</b> 5:17 6:6, 11,21,26 7:1 11:8,18 12:22	13:6,10,17 14:15, 24,26 15:3,7,25 17:3 18:6 19:5, 12,25 21:6,26 22:10,21 23:2,14, 23 24:12,24 25:16 27:11 28:17 30:20 32:8 34:7 35:7 37:6,9, 12,20,21 46:2,20, 23 49:11 54:6,23 79:5,6,7 81:5 96:26 137:13 155:15 156:26 157:16 164:3,7, 10,18,24 170:2 172:4 176:25 185:5 190:6,7 <b>Panel's</b> 155:4 <b>panelists</b> 22:5 <b>papers</b> 182:4 183:2,3 184:6,9 <b>paragraph</b> 12:3 50:4 162:2,11,13, 14 170:26 171:1 172:14 173:12 174:25 179:23 180:23 181:17 185:22 188:13 <b>paragraphs</b> 133:16 <b>parameter</b> 138:25,26 <b>parameters</b> 138:24 139:5 144:9 <b>paramount</b> 159:20 <b>Pardon</b> 168:26 <b>Parsons</b> 6:16 79:12 <b>part</b> 7:2 23:5 24:3 30:9 41:6 47:13,22 59:13 78:9 80:18 81:13 83:25 88:25	90:20 92:5 117:4 126:22 159:3 174:15 176:22 177:4 186:25 187:1 <b>participants</b> 9:18 11:8,26 <b>participate</b> 5:14 <b>participating</b> 6:23 42:17 <b>participation</b> 191:14 <b>particulars</b> 7:26 <b>parties</b> 5:19 7:4,9 9:12,14 13:22,25 14:17,20 22:23 23:4,10,22 28:4 30:17,19 31:3,13, 17,24 190:24 191:11 <b>parties'</b> 14:16 <b>partner</b> 84:11 <b>parts</b> 69:3 <b>party</b> 9:23 11:21 23:6 31:21 49:15 188:25 <b>party's</b> 167:13 <b>pass</b> 82:10,17 125:19 <b>passage</b> 75:21 <b>passed</b> 51:2 <b>past</b> 31:22 42:5 68:2 187:11,14 <b>patch</b> 132:25 133:2 <b>patched</b> 132:22 <b>path</b> 112:18 113:20 138:7 <b>pathway</b> 88:1 90:6 139:22 <b>pathways</b> 109:23 147:12 <b>patience</b> 22:4,10 71:6 78:4
--	---	--	--	---

<b>pause</b> 12:5	19,20 181:13	<b>Petrel</b> 177:16	<b>places</b> 16:21	<b>points</b> 17:12
<b>pay</b> 44:24 72:23 128:23 155:16,18 164:23	<b>percentage</b> 67:22 83:1,8	<b>petroleum</b> 39:24	<b>plain</b> 87:12 91:5	18:10 19:21
<b>payable</b> 48:9	<b>percentages</b> 67:6	<b>petrophysical</b> 92:2	<b>plainer</b> 86:15	33:11 116:18
<b>payments</b> 47:8 52:11	<b>perched</b> 169:22	<b>phase</b> 47:23 97:26 126:14,15	<b>plains</b> 87:11,21 88:11,15	138:14 156:8
<b>PDF</b> 12:2 48:15 50:4,9 51:1 54:4 58:17 60:5 61:15 62:9,22 63:19 64:22 66:3 69:7 71:2,5,23 72:18 73:3 74:6,13 76:1 85:18 88:6 89:14 95:17 101:26 103:8,24 114:3, 23 122:18 133:17 136:1 138:19,20 141:26 144:7 158:3 167:10	<b>perforations</b> 132:21	<b>phases</b> 126:17	<b>plan</b> 12:17,25 13:2,13 35:12 36:17 80:24	<b>policy</b> 46:21
<b>peak</b> 145:8	<b>performance</b> 140:10 159:4	<b>Phd</b> 40:13 43:26	<b>planned</b> 14:1 152:5 157:1,5	<b>pool</b> 50:13,22 51:6,16,18,19 52:8,24 53:5,18 60:3 75:26 83:16, 23 84:12 99:17 105:13,25 106:18 108:7 128:15,18, 22 129:6,16 132:21 135:5,11, 18,23 136:15 154:2,21 155:1, 20 162:17
<b>Peddlesden</b> 6:8 16:14 79:10	<b>performed</b> 182:16	<b>phenanthrene</b> 167:20,21	<b>planning</b> 18:26	<b>pools</b> 51:6,16,23, 24 53:2 106:11, 23 134:26 135:22 136:13 162:21
<b>Peddlesden's</b> 17:15	<b>period</b> 119:13,15 123:17 152:4	<b>phenanthrenes</b> 167:26	<b>plans</b> 14:26 126:9,18,21	<b>poral</b> 120:6
<b>peers</b> 158:25 160:8	<b>periods</b> 111:12 112:7 126:14 187:11	<b>phenomenon</b> 148:3	<b>plot</b> 165:22	<b>pore</b> 76:14 130:17
<b>pending</b> 132:10	<b>permeabilities</b> 142:24	<b>philosophy</b> 57:17	<b>plots</b> 59:25 141:3 181:7	<b>porous</b> 97:13 112:25
<b>penetrate</b> 132:1	<b>permeability</b> 56:21 58:7,10 65:6,13 66:19 76:15,17,22 83:21 111:25 113:2 118:20 119:19 122:4 139:10 166:6 167:5 169:25 183:8	<b>phone</b> 8:13	<b>plotted</b> 146:12 167:23	<b>portfolio</b> 65:24
<b>penetrates</b> 93:16	<b>permeable</b> 55:6, 17 78:2	<b>phonetic</b> 177:1	<b>plotting</b> 59:8 167:16	<b>portion</b> 89:17 102:10,21 173:9
<b>people</b> 34:9,16,21 47:2 158:6 172:21 182:8	<b>permitted</b> 14:13	<b>photo</b> 82:1 87:17 89:19 90:3	<b>plug</b> 100:22 103:17	<b>portions</b> 60:20 64:1 104:2
<b>people's</b> 159:7	<b>person</b> 165:12	<b>photos</b> 67:19 74:19 81:13 87:16,17 89:1 94:1 142:7 174:6, 8	<b>plugging</b> 112:12	<b>pose</b> 94:11 109:14
<b>peoples</b> 5:25	<b>personal</b> 172:18	<b>pick</b> 22:6	<b>plugs</b> 64:2,9,14 99:4 100:7,8,16 101:1,7,14,18 104:20	<b>poses</b> 154:13
<b>perceived</b> 165:5	<b>perspective</b> 112:13 142:3,8 145:18	<b>picked</b> 65:19 182:23	<b>PM</b> 12:18,26 13:3,14 78:19 80:7	<b>position</b> 14:16 48:8 60:1,13 63:25 64:15 160:3
<b>percent</b> 48:11 56:20 63:13 73:8 74:3 75:10 76:5 83:2 130:16 135:19,20,23,24 136:11 143:23 146:14 160:26 164:23 179:12,	<b>perspectives</b> 54:15	<b>pick</b> 22:6	<b>PNX</b> 66:5,10 85:5	<b>positioning</b> 100:16
	<b>pertinent</b> 144:24 146:6	<b>picking</b> 168:9	<b>point</b> 8:6 18:2,21 20:1,15 22:5,24 29:25 30:13 32:12 36:9 63:22 65:9 76:6 100:16 105:16 114:13,15 156:3 188:6	<b>positive</b> 48:1
	<b>petal</b> 86:5,6,8,20 89:20	<b>piece</b> 9:24 15:4 68:7 156:16	<b>pointed</b> 16:16 162:7	<b>possibility</b> 7:22
	<b>Peter</b> 37:3 39:23 81:9 109:18	<b>Piikani</b> 5:26	<b>pointer</b> 17:7,9	<b>post</b> 50:18 81:24 89:17 96:12,16 100:6 114:26
		<b>Pike</b> 45:2	<b>pointing</b> 102:7 105:16	
		<b>pilot</b> 40:18 186:23,24		
		<b>pink</b> 97:12 99:13		
		<b>pioneered</b> 44:22 165:17		
		<b>pipeline</b> 111:8		
		<b>place</b> 20:20 106:8,10 128:9 134:2		

115:4,9 116:5,14 117:16 118:6 119:2,7	<b>Practice</b> 11:11 12:12 18:14	<b>preparing</b> 19:13	<b>president</b> 10:16 37:18	<b>previous</b> 127:4
<b>post-b2</b> 53:19 61:21 63:9 64:7, 12,16,18 66:20, 21 67:2 77:8,11 101:2 102:17,22 103:17,21 105:14 106:19 107:3,9 111:6 113:1 120:3,5 121:11, 14,16 122:6	<b>practices</b> 59:8 110:5	<b>presence</b> 55:11, 13 57:25 75:1 77:9 81:14 106:24 142:9	<b>pression</b> 100:21	<b>previously</b> 31:20 69:13,19 72:23 74:20 81:7,10 84:10 89:7 128:9 131:16 133:5 134:10 136:22 137:23 142:1 143:6 148:23 151:21 187:18,22
<b>post-compaction</b> 101:10,16	<b>practisability</b> 54:1	<b>present</b> 8:16 12:13,15 13:7 14:4 17:1 18:26 19:1 29:10 31:13 32:20 46:24 53:20 60:17,26 61:9,10,21,23,26 64:18 66:19 68:20 69:1 70:8 71:12 76:11,17 77:18 84:5 85:23 87:25 89:13,25 91:9 95:9 96:5 98:19 99:2,24 102:7,8 104:9,17, 24 105:8 106:19 109:24 116:20 117:3 124:1 172:26 178:9	<b>pressure</b> 25:21, 23 52:14,22,24, 25 53:2,15 84:24 85:6 106:21 108:5,10,14 111:2,3,4 112:2, 4,10 113:14,16, 17 114:9,11,13, 14,15,20,21 115:11,14,15 116:1,9 117:14, 18,20,22 119:7, 14 120:10 121:2, 15 122:5,23,26 123:18 127:10, 12,18,22 128:8 129:10 130:6 131:2 133:6 140:19,22,25 141:1,3,6,8,13,23 144:16 152:26 153:21 154:2 173:18,22 188:3	<b>pricing</b> 135:19
<b>post-payout</b> 48:8	<b>predates</b> 179:10	<b>presentation</b> 12:11 15:17,21 16:3,9,16 18:5,23 23:24 24:4,6,8,11 25:13,17 32:14 54:22 59:25 80:16,19 138:14 153:2 180:14 183:20	<b>primarily</b> 164:12,20	<b>primarily</b> 76:6 100:22 113:13,26 140:20 177:11
<b>post-production</b> 141:13 178:6	<b>predict</b> 57:25 65:26 81:22	<b>presented</b> 29:4 102:3 142:19 181:7	<b>pressure-depleting</b> 52:6	<b>Primrose</b> 45:3
<b>Post-steam</b> 85:2	<b>predicted</b> 66:25 69:20 119:8	<b>presentations</b> 13:25 29:5 30:19, 21 140:11 160:4 181:7	<b>pressures</b> 52:26 84:25 108:7 110:17,18,19 111:1,5,9,10,12, 19 114:17,18,19 115:25 117:1,24 119:14 120:13 124:3,6,22 125:8, 11 127:5 128:11 129:14 139:7 140:18 141:14,17 187:23 188:1	<b>principles</b> 159:15
<b>postulated</b> 98:15 104:22	<b>predicting</b> 58:13	<b>presenting</b> 16:18 20:3 125:19	<b>preventing</b> 49:9 169:26	<b>printout</b> 158:4, 10
<b>postulates</b> 106:2	<b>prediction</b> 116:2	<b>presently</b> 187:8, 10		<b>prior</b> 16:10 49:1 58:1 85:20 127:2, 23 130:1 134:2, 14 154:7
<b>potentially</b> 57:24 70:1 102:26 111:18 112:15 152:11	<b>predominantly</b> 73:26 76:21	<b>preserved</b> 76:7		<b>priority</b> 52:3
<b>power</b> 111:16	<b>preexisting</b> 106:1 152:17			<b>private</b> 8:21
<b>Powerpoint</b> 15:20 16:3 19:18, 20 29:4 180:13	<b>prefer</b> 184:17			<b>privilege</b> 33:25
<b>practical</b> 18:4 65:15 143:4	<b>preferential</b> 58:26			<b>privity</b> 27:13
<b>practically</b> 152:20	<b>prejudice</b> 24:4 26:3,5 32:2			<b>proactively</b> 57:25
	<b>preliminary</b> 14:23			<b>problem</b> 18:11 20:20 24:7,16
	<b>premise</b> 170:4			<b>problems</b> 185:12
	<b>preparation</b> 22:19			<b>procedural</b> 13:23 25:8 32:2
	<b>prepare</b> 7:15 19:20 21:18 26:1 163:17,19			<b>procedure</b> 23:21 26:25 165:18
	<b>prepared</b> 18:5,7, 10 22:20 24:1 27:8 33:6 38:10, 22 39:8,19 40:7, 25 42:10 43:3,19 44:13 45:8,14 128:6 138:16 153:23 155:16 163:14,26			<b>procedures</b> 7:25 11:7 126:13
				<b>proceed</b> 8:5 15:6 18:5,9,22 22:20 26:22 28:12 32:4 34:14,26 46:8,15

80:19,23 81:5 95:15 156:25 <b>proceeding</b> 5:15, 24 6:6,11,23,24 7:8,26 8:23 11:10 14:15 15:20 19:17 22:18,23, 24,25 23:2,3 26:25 27:18 31:10,11,20,26 35:3 41:2,9,21 45:17 <b>proceedings</b> 5:7 13:23,26 23:5 78:19 79:1 80:7 191:18 192:5 <b>process</b> 16:1 28:5 56:9 85:24,26 87:8,12 100:22 126:12 129:26 131:7,21 142:14 148:14,26 175:3, 21,23 191:8 <b>processes</b> 39:26 40:18 <b>produce</b> 51:24 135:12 154:25 162:23 181:10 <b>produced</b> 22:13 56:11 130:24 150:21 <b>producer</b> 108:1 169:18 <b>producing</b> 51:25 52:6 53:1 65:24 151:17 <b>production</b> 42:3, 4 48:23 52:17 57:20 59:15 65:20 84:13 106:22 112:5 130:25 131:6 132:12,24 134:14 139:6 141:10,16, 19 143:10 155:19 161:1,3 162:23	164:14 179:10,26 181:2 182:7 183:3 <b>productive</b> 135:15 <b>products</b> 96:10, 14 102:9 149:26 151:15 152:16 <b>professional</b> 37:25 38:9,15,21, 26 39:7,18,25 40:6,24 41:20 42:9 43:2,18 44:12,19,20 45:7 94:13 <b>profile</b> 59:3 65:10 69:17,26 <b>profiles</b> 58:5 59:4 65:14 70:3 <b>profit</b> 48:9 <b>program</b> 49:13 59:14 131:13 150:18 <b>programs</b> 186:24 <b>progress</b> 132:9 <b>prohibited</b> 7:19 <b>project</b> 9:1 39:4 47:23,25 48:4,7, 18 84:4,9 95:4,23 117:11 142:16 146:9 150:12,17 154:10,19 155:10,13 <b>projected</b> 61:18 <b>projects</b> 42:22 43:11 47:15 49:17 57:2 140:11 176:3 <b>promote</b> 54:16 <b>prone</b> 69:6 71:21 118:24 <b>propagate</b> 86:9 113:16 118:6 <b>propagating</b>	115:13 121:19 122:10 <b>propagation</b> 114:11,18 <b>properties</b> 116:21 118:21 <b>proposals</b> 133:15 <b>proposed</b> 21:7 48:24 50:19 53:25 68:11 100:1 109:5,26 112:22 123:15 124:1,12,23 127:25 129:23 131:3 132:2 136:19 <b>proposes</b> 127:15 <b>proposing</b> 184:20 <b>protect</b> 52:8 84:12 159:8 <b>protecting</b> 53:6 133:1 <b>protection</b> 53:8, 14 <b>protects</b> 155:6 <b>prove</b> 104:18 <b>proven</b> 47:16 <b>provide</b> 11:13 15:15,22 21:16 41:22 43:15,17 48:17 49:19 65:25 67:16 71:13 76:25 77:3 125:16 128:14,21 130:13 132:16 138:11 142:16 187:11 188:10 <b>provided</b> 19:5 31:5 71:9 91:8 93:13,15 101:11 102:2 134:23,26 135:7,8,19 136:2 146:5 156:17 160:15,18 174:6	176:14 178:11,12 180:7,16 181:8 182:2 187:9 188:22 189:18 <b>providing</b> 41:19 71:16 130:8 154:6 176:3 186:19 187:6,8, 10 <b>Province</b> 192:8 <b>provision</b> 21:14 <b>proximity</b> 151:25 <b>public</b> 25:15 47:7 159:25 180:8 <b>publication</b> 8:1 <b>pull</b> 30:6 86:16 114:3,22 120:16 162:5 <b>pulled</b> 32:17 <b>pulling</b> 161:8 <b>purchased</b> 90:11 91:7,11 92:1 94:5 <b>purple</b> 51:20 62:3 <b>purpose</b> 21:2 112:9 125:14 151:7 158:6 <b>purposes</b> 134:15 143:4 159:6 <b>pushes</b> 35:18 <b>pushing</b> 124:13 <b>put</b> 15:18,20 20:9,16	44:12 45:7 175:22 186:20 <b>qualified</b> 175:24 <b>qualifying</b> 11:19 <b>qualitative</b> 59:12 <b>quantified</b> 148:10 <b>quantitative</b> 142:17 <b>quarried</b> 183:6 <b>question</b> 5:9 13:6 14:25 15:16 18:12 34:4 82:23 88:26 129:2,4 161:16,17 165:12,13 166:9 170:4 175:17 178:20,21 179:13,15 180:23 181:4 185:3 <b>questions</b> 6:24 12:20 13:10 25:5 26:18 28:7 45:11 49:16 137:22 157:18 160:25 171:19,20 172:7, 17 176:9 184:15, 19,21,22 185:1,5 189:26 190:3,6 191:12 <b>quick</b> 37:10 <b>quickly</b> 9:19 17:15 81:18 88:8 <b>quote</b> 179:12
<hr/> <b>Q</b> <hr/>				
<hr/> <b>Q1</b> 126:20 132:9 <b>qualification</b> 179:5 <b>qualifications</b> 11:23 38:9,21 39:8,18 40:6,24 42:9 43:2,18				
<hr/> <b>R</b> <hr/>				
<b>R-A-M-S-A-Y</b> 10:13 <b>R-I-L-E-Y</b> 10:23 <b>radio</b> 133:7 <b>radius</b> 106:10 130:18 <b>Rahimabadi</b> 79:15				

<b>raise</b> 31:19	<b>reading</b> 184:9	9 23:4,6,10 24:1, 6 26:23 27:15 28:17 29:3,5,6, 11,16 30:11 31:6, 8 33:8 37:15 38:7,8,20 39:6, 16,17 40:5,23 42:8 43:1,14 44:11 45:6 51:9, 11 172:6 187:2 188:8	143:25 162:16 183:2	11 52:2 132:10 148:5 164:16 165:4
<b>raised</b> 29:21 49:16,18	<b>ready</b> 32:11	<b>real</b> 99:13 159:21	<b>references</b> 30:21 182:2	<b>reinforces</b> 70:9
<b>Ramsay</b> 10:13,15 35:4	<b>realistic</b> 120:23 121:10,13 122:9 151:14	<b>realtime</b> 127:9	<b>referencing</b> 160:21	<b>reinitiated</b> 111:18
<b>ran</b> 186:23	<b>reason</b> 106:3 130:10 145:12 164:19	<b>reasonable</b> 49:7, 17 53:26 59:9 123:15 136:20 154:17 155:18 161:22	<b>referred</b> 11:24 87:23	<b>reiterate</b> 29:9 128:2
<b>range</b> 135:17	<b>reasonableness</b> 125:18	<b>recovery</b> 39:26 40:18 52:5,17 53:3 56:10 112:8 176:2	<b>referring</b> 32:26 34:5 88:9 146:7 148:7 180:18 181:25 183:1	<b>reiterates</b> 88:1
<b>Rapids</b> 132:23	<b>reasons</b> 75:5 144:15	<b>recover</b> 47:24	<b>reflection</b> 98:20	<b>related</b> 42:22 100:5 116:22 148:5
<b>rate</b> 110:16 115:16 120:11 124:21 125:10 127:12 130:6 181:2,3	<b>rebound</b> 141:23	<b>recovering</b> 188:3	<b>reflector</b> 96:3 97:7	<b>relates</b> 24:25 182:6
<b>rates</b> 131:1 142:22 181:5,6 182:10 183:26	<b>rebroadcasting</b> 7:18	<b>recovery</b> 39:26 40:18 52:5,17 53:3 56:10 112:8 176:2	<b>reflectors</b> 102:12	<b>relation</b> 20:15,16 22:17 23:11 33:20 34:4 64:14 136:24 156:11,18 172:25 186:9
<b>ratio</b> 56:10 150:21	<b>rebuttal</b> 13:8,9, 11	<b>red</b> 48:21,24 50:13 51:17 61:26 74:21 96:3 102:13 103:2 139:4 149:11	<b>refrain</b> 5:22	<b>relative</b> 56:23 67:6 83:1 97:23 100:15,26 130:20 170:6
<b>rationale</b> 162:20, 25 168:9 169:15	<b>receive</b> 20:25	<b>redirect</b> 12:22 13:7	<b>regard</b> 129:3 133:21	<b>released</b> 11:17 191:8
<b>ray</b> 65:5	<b>received</b> 8:25 9:7 17:6 23:24 24:19 52:10	<b>reduce</b> 32:15 111:3 125:12 128:6	<b>regime</b> 147:3	<b>relevant</b> 11:23 12:2,6 24:12,15 25:3,15 126:16, 21 129:5 183:10
<b>re-examined</b> 90:10	<b>recent</b> 9:15 43:16 141:2 187:26	<b>reduced</b> 122:2	<b>region</b> 5:25 6:4 37:19 74:10 130:8,17 150:6	<b>reliability</b> 172:18 173:13,15 186:21,25
<b>reach</b> 16:7 64:6 81:1 135:20 179:6 182:16	<b>recently</b> 107:26	<b>reduces</b> 48:9	<b>regional</b> 48:1,17 55:20,26 60:13, 14,17,21,26 61:22 67:3,5,14 70:15 71:10 77:5, 13,15,18 82:4,7,9 114:25 119:1,6, 10 120:6 121:20, 22 122:11,13,16 123:8	<b>reliable</b> 129:20 151:20 173:18 186:19 187:6,8,9, 10,12,19 188:10
<b>reaches</b> 63:26	<b>recognize</b> 34:3 176:6	<b>reduction</b> 115:16	<b>register</b> 9:18	<b>relied</b> 41:14 70:10 186:5
<b>reaction</b> 149:26 151:15 152:16	<b>recognizes</b> 155:5 161:12	<b>redundant</b> 132:17	<b>regular</b> 35:13	<b>relief</b> 26:16
<b>read</b> 6:7,9 46:26 47:1 92:21 149:17 159:17 171:1,8,9 172:15 174:7,26 176:12 178:3 179:24 181:18 183:24 185:23 186:16 188:14 189:9	<b>recognizing</b> 150:13	<b>refer</b> 5:19 12:1 32:25 33:14 138:17,18 149:18 180:19 183:3,5	<b>regularly</b> 85:2	<b>relies</b> 53:8 57:18
<b>reaches</b> 63:26	<b>recommendatio n</b> 132:15 133:4	<b>reference</b> 12:9 22:12,22 23:7 26:24 31:9 62:24 63:3 160:16,21 162:14,15 185:21	<b>regulations</b> 47:10	<b>rely</b> 32:14
<b>reaction</b> 149:26 151:15 152:16	<b>reconvene</b> 34:7 78:13	<b>referenced</b> 30:4 86:18 101:5	<b>Regulator</b> 11:11 41:22	<b>remain</b> 13:22 108:20 130:6
<b>read</b> 6:7,9 46:26 47:1 92:21 149:17 159:17 171:1,8,9 172:15 174:7,26 176:12 178:3 179:24 181:18 183:24 185:23 186:16 188:14 189:9	<b>record</b> 7:1,5,14 9:21 10:12 17:20 18:19 20:17 21:4,		<b>regulatory</b> 10:14 31:10 35:5 43:9,	

<b>remainder</b> 97:24	149:4,6,18	<b>requested</b> 12:7	103:18 105:20	<b>respectfully</b> 5:23
<b>remaining</b> 53:17	165:19 177:25	36:11 111:11,23	107:13 110:12,	9:11 155:21
91:18 102:26	187:3,5	116:12 117:4,10,	13,15,22 111:6	<b>respects</b> 48:25
136:14	<b>reported</b> 184:6	13 124:14 125:1,	113:1 115:1,4,9	<b>respond</b> 49:15
<b>remains</b> 66:9	<b>reporter</b> 7:15	2,9,14 130:13	116:5,14 117:16	<b>responds</b> 134:7
128:17 129:5	9:22 36:24 37:7	133:18 136:4	118:7,16 119:2,7	<b>response</b> 24:19
<b>Remarks</b> 5:8	58:18 80:4,5	140:24 153:25	120:4,5 121:11,	88:25 89:17 98:1
<b>remediation</b>	128:24 192:15,21	154:18 155:12	14,16 122:6	129:17 131:9
129:9	<b>reporter's</b> 7:11	<b>requesting</b> 25:8	124:18,19,21	134:22 146:6
<b>remember</b> 6:18	<b>reporters</b> 7:7	<b>requests</b> 24:21	140:19 142:6,9	160:18 174:6
34:22	9:20 11:13 35:10	26:26 49:23	163:11 169:19	<b>responses</b> 24:22
<b>remind</b> 23:3	120:19	125:6 146:7	174:8,13 176:1	26:4 28:8 29:17
31:24 34:20	<b>reports</b> 138:15	<b>require</b> 13:25	179:7,14 186:22	30:2
155:15 190:22	165:20 173:10	111:18 132:7	187:3 188:20	<b>responsibilities</b>
191:3	180:4,5,6,17	143:9 151:18	<b>reservoir-</b>	42:21
<b>reminder</b> 22:5	187:4	187:25	<b>quality</b> 102:26	<b>responsibility</b>
34:15,19 191:8	<b>represent</b> 48:22	<b>required</b> 52:16	<b>reservoirs</b> 50:11,	12:8 48:12 155:5
<b>removal</b> 70:6	50:14 64:1 84:5	53:10 54:6 117:7	24 52:9 57:7,9	<b>responsible</b>
<b>remove</b> 17:21	91:22 122:10	121:5 125:5	58:25 65:16 66:1	47:10 53:8
151:19 168:23	<b>representation</b>	127:5 129:9	71:14 140:21	164:15 178:4
190:23,26	120:23	134:9 139:22	<b>resistance</b>	<b>rest</b> 26:24
<b>removed</b> 18:3	<b>representative</b>	142:17 151:7	113:20	<b>restating</b> 92:20
68:13,21 70:24	37:21 46:19	181:18 186:2	<b>resolve</b> 24:7 50:1	<b>restoration</b>
71:11,15 74:10	95:14 96:24	<b>requirement</b>	<b>resolved</b> 177:21,	133:9
77:21	116:17 147:26	131:25	22	<b>restore</b> 132:11
<b>removes</b> 60:20	<b>representatives</b>	<b>requirements</b>	<b>resource</b> 49:5,8	<b>result</b> 25:5 28:10
<b>removing</b> 122:24	10:11	31:15 49:13	52:20 53:7,9,14,	65:13 99:26
<b>reopen</b> 27:18	<b>represented</b>	126:23	22 84:13 112:7	102:15 106:21
<b>repaired</b> 133:8	119:24 120:2	<b>requires</b> 8:17	129:15 131:22	115:12 117:11
<b>repeat</b> 50:7	123:4	52:21 54:9	132:12 133:2	121:17 147:4
175:17	<b>representing</b>	<b>requiring</b> 114:20	134:24 135:9,12,	183:14
<b>repeatedly</b>	9:23 10:3,7,21	<b>research</b> 41:13	17,24 136:18	<b>resultant</b> 76:14
106:25	35:3 91:13 118:9	<b>resemblance</b>	153:8 154:24	<b>resulted</b> 70:6
<b>reply</b> 19:7,10	119:19,20	86:24	165:6	<b>resulting</b> 56:21
29:19,22 67:18	<b>represents</b> 48:20	<b>reserves</b> 53:17	<b>resources</b> 8:26	95:2 101:17
68:9,17 91:24	69:2 76:3	<b>reservoir</b> 39:14	10:4,8,14 37:5	148:2 149:15
92:15 136:2	<b>request</b> 7:6 13:22	40:1,16,19 42:17,	52:13 71:15	150:25 152:2,24
161:20	16:7 18:21 24:20	21 50:17,18,20	79:24 155:7	<b>results</b> 54:16
<b>report</b> 30:6 41:6,	27:20 29:6 31:21	53:19 55:22 56:6,	157:15 172:3	57:21 75:4
8,11 45:14 60:16	73:5 93:14	8,13 57:9,13,26	190:6	104:18 141:5,6
86:18 92:18	129:18 133:23	58:14 59:11 60:2,	<b>respect</b> 7:6 16:6	147:13 149:25
101:6,11 126:21	134:3,11,23	11 63:10 64:7	23:21 30:4 31:14	167:11 189:17
138:17 141:4	137:7 161:5,18,	77:8,10 81:21	37:22 133:22	<b>resume</b> 111:17
142:19 148:15	24	83:22 84:19	134:11 138:21	155:20 191:11
		96:13,17 102:17	<b>respectful</b> 11:9	

**retained** 41:1,3  
172:9  
**retrieval** 86:13  
**return** 129:3  
144:7 159:21  
191:9  
**returned** 132:23  
**returning** 144:8  
**reverse** 53:15  
**review** 14:14  
15:23 16:23  
19:21 84:23,26  
85:10 88:22  
91:10 92:3 93:15  
94:8,26 101:24  
118:2 127:8,12  
132:5 138:22  
140:24 174:19  
176:23 177:4  
178:19 187:4,25  
189:5  
**reviewed** 18:18  
44:26 85:12  
91:18 92:12  
93:25 94:4,6  
108:25 132:1  
140:15 142:7  
174:5,8,11 175:3  
176:13 179:25  
186:17  
**reviewing** 18:9  
94:25 99:4 187:5  
189:14,20  
**reviews** 85:3  
176:3  
**revised** 18:4,22  
22:13  
**revisions** 41:16  
45:22  
**rich** 68:22  
**right-hand** 60:12  
97:19  
**right-side** 87:19  
**rights** 153:9  
155:2,3,11

161:13  
**Riley** 10:22,23  
11:1 20:13,14,18,  
19 21:24 23:17,  
18,19 27:3,4,16,  
19,22 28:5,15,21  
29:12 30:4 33:20,  
22,24 80:1  
156:12,25,26  
157:10,12,15,17  
158:26 159:2  
162:1,4,10,12  
172:2 184:22  
185:11  
**rise** 58:14 59:16  
67:1 74:12  
142:21 143:9  
144:1,3 183:26  
**risk** 40:20 49:4  
53:21 56:14 84:5  
94:11,24 107:19  
109:14 110:9,10  
112:15,18,19,23  
116:5,7 117:4,10,  
18,23 118:9  
120:24 121:15  
122:20 123:24,26  
124:15,24 125:17  
130:10 136:17  
148:26 149:4,8,  
21,24 150:3,25  
151:3,11,12,20,  
23 152:2,10,11,  
24 153:16 154:11

**risks** 112:14  
118:4 124:9  
149:11,15  
**river** 63:24 64:6  
100:9,11,12,13  
146:9  
**robust** 126:9  
**robustness**  
128:21  
**Roche** 36:26  
41:26 42:2,6,11  
81:6 164:13

**Roche's** 42:12  
**rock** 43:26 44:4  
113:25 114:1  
118:20 145:7,25,  
26  
**rocks** 145:2,11,13  
**role** 98:10,19  
164:11,19  
**room** 6:21 7:20,  
21 8:20 11:25  
13:23 14:4 37:13  
78:14,17 162:7  
168:23 190:24  
**rooms** 8:20  
190:26  
**roughly** 179:11,  
18  
**Round** 129:2  
**rounds** 49:23  
**row** 8:15 41:25  
**royalties** 48:5,9  
**royalty** 47:7 48:8  
52:10  
**RPR** 80:5 192:20  
**RST** 85:5  
**rule** 18:13 31:25  
**rules** 11:11 12:12  
16:17 17:14  
18:14 21:11 32:2,  
21  
**rulings** 32:22  
55:25  
**run** 160:4 188:15,  
23  
**running** 103:7  
**résumé** 175:25

---

## S

---

**safe** 47:17 154:15  
**safeguard** 32:1  
**safely** 47:14

**safety** 7:25  
118:11 119:12  
123:7,9,10,13,25,  
26 124:9,10  
159:3,19  
**sag** 99:2,8 100:20  
101:23 102:11,13  
103:18  
**SAGD** 9:5 24:26  
39:14 42:23  
44:21 47:15,17,  
19,20 48:23  
53:18 56:9,12,25  
57:1 59:23 63:10  
65:16,24 66:18  
84:4,6,13,19  
96:13,17 98:24  
107:13 110:19,  
23,24 111:20  
112:3,16,22,26  
115:8,20 117:17  
119:3,16 122:22  
123:6,12,14,16  
124:5,25 126:11,  
15 127:20 128:7,  
23 129:12 130:3,  
24 131:18 135:14  
140:11 142:14,21  
144:22 147:11,  
15,26 148:9,11,  
13 150:10 163:2,  
6 166:11,12,17  
174:21 183:25  
**SAGD-  
INDUCED**  
112:19 118:10  
**sags** 95:7 98:23  
99:5  
**sake** 32:24  
**salt** 95:3,22 96:5  
139:26  
**sample** 134:14  
**sampled** 59:9  
**samples** 57:11  
134:12 146:13  
183:6

**sampling** 134:11,  
17 140:7  
**sand** 74:23 75:3  
83:3 100:17  
102:26 111:6  
113:3,6 115:1,4,  
9,10,18,24 116:5,  
7 117:16,19  
118:7 121:11,18  
122:6  
**sand-filled** 90:2  
**Sandie** 192:3,14  
**sandier** 82:15  
**Sandra** 192:3,20  
**sands** 8:26 9:1  
10:17 37:19 40:2  
49:16 53:10  
57:19 81:20  
86:12 89:6 97:13  
99:12,15 100:18  
104:25 105:9,17,  
20 106:19 107:9,  
13 141:11 144:14  
174:10 184:1  
**sandstone** 60:12  
61:8 67:7 72:13,  
14 73:2,14 74:2  
76:4  
**sandstones** 61:3  
70:17 72:3,5  
76:10  
**satisfied** 129:8  
**satisfy** 134:3  
**saturated** 61:2  
73:2 74:1 76:10  
**saturation** 66:7,  
15 74:22,26 75:2  
83:14,18 107:8  
140:13 179:16,18  
**saturation**  
179:9,21  
**scale** 59:23 73:10  
74:1 101:1,3  
112:12 116:24  
117:26 130:15



141:10 143:14 147:21 177:22	<b>scroll</b> 69:9 121:7 136:1 159:5 185:17	12,18,20 99:6,19, 21 101:24 102:2, 10,11 103:18 109:1 117:26 126:18,19 139:24 176:11,13,17 177:10,13,15,17, 21,22	14:1 <b>Session</b> 79:3	<b>shear</b> 112:21 117:22 119:11 123:1,3,9 145:13 148:7,15,19 188:20 189:12
<b>scaled</b> 147:14,15	<b>seal</b> 55:3 78:1		<b>set</b> 9:9 12:11 14:6 57:20 64:14 116:24 122:23 127:23 151:20 156:18	<b>shearing</b> 148:13
<b>scales</b> 147:17,18	<b>sealed</b> 144:20 145:1,19 147:5 148:22 150:15		<b>sets</b> 38:8,20 39:7, 18 40:5,23 42:8 43:1,17 44:11 45:6	<b>shears</b> 93:5
<b>scenario</b> 122:9 149:24 150:5 151:14 152:14	<b>sealing</b> 58:3 73:14 114:1 146:1	<b>selected</b> 93:11 175:4	<b>setting</b> 113:12	<b>sheet</b> 76:3
<b>schedule</b> 31:20 34:8 155:13	<b>seat</b> 32:8	<b>self-sourced</b> 106:5	<b>settings</b> 63:23	<b>shift</b> 65:2,4
<b>scheduled</b> 12:23 35:13	<b>seated</b> 10:10,15 37:17 38:24 39:12 40:9 42:12 43:5	<b>senior</b> 37:20 39:3 46:19 176:1	<b>severely</b> 84:8	<b>shoot</b> 126:20
<b>scheduling</b> 9:10 36:8	<b>seating</b> 23:13	<b>sense</b> 16:8 50:10, 21 170:13	<b>shaded</b> 64:11	<b>short</b> 21:25 30:15,24 111:12 116:10 117:5 118:5 119:5
<b>schematic</b> 86:7 100:24	<b>sec</b> 180:21	<b>sensitive</b> 66:18 142:14	<b>shading</b> 17:10,24	<b>short-term</b> 112:15 118:4 120:24 123:26
<b>scheme</b> 9:2 48:21 131:26	<b>second-from-last</b> 188:13	<b>Sensitivity</b> 121:23 123:16	<b>shale</b> 56:20 75:9 77:16,24 82:13, 17,25,26 83:2,3,8 181:20 182:7 183:3	<b>shortest</b> 118:26
<b>Schlumberger</b> 165:14,19,20	<b>section</b> 8:26 11:10 49:12 55:11,14 57:4 61:18 63:24 88:10 131:24	<b>sentence</b> 171:1 185:23	<b>shales</b> 63:12 182:5,10,11 183:18,19	<b>shorthand</b> 192:6
<b>Schlumberger's</b> 165:25 167:16	<b>sections</b> 177:15	<b>separate</b> 59:4 75:24	<b>shallow</b> 123:12, 13 140:4 145:2 147:21 148:3	<b>shortly</b> 93:17 128:19 132:6 141:15
<b>science</b> 37:24 38:14,26 39:24 40:11 42:14,15 43:24,25 44:16, 17	<b>security</b> 8:10 78:16 191:1	<b>separated</b> 70:17	<b>shallower</b> 147:15 148:19	<b>show</b> 7:23 55:25 58:25 59:3 66:5 91:3 95:5,15 96:10,11,14,15 109:2 114:17 116:26 140:7 150:5
<b>sciences</b> 43:7	<b>sediment</b> 100:19	<b>separately</b> 55:13	<b>shallowest</b> 118:23 120:26	<b>showed</b> 76:20 86:19 142:1
<b>Scott</b> 6:13 37:2,3 38:13 44:15 79:19 81:8,9 94:12 164:20	<b>sedimentary</b> 44:2 76:6	<b>separating</b> 71:13	<b>shallowing</b> 99:9	<b>showing</b> 89:17 94:22 105:2 108:23 109:22 123:2 137:3 143:15
<b>scour</b> 72:7	<b>sedimentology</b> 44:5	<b>sequence</b> 60:21 61:22 67:4,14 69:6,22 70:13,16 71:19 77:5,15 82:5,9,11 83:19 114:26 119:1,6, 10 120:6 121:20, 22 122:11,13,16 123:9	<b>shallows</b> 61:8 62:5	<b>shown</b> 50:13,18 51:17,25 60:10 71:13 74:20 86:21,26 87:16 88:11,17 89:3,10 90:18 93:17 96:26 98:7 100:24 102:10,20 104:4 105:15
<b>screen</b> 32:17,18 33:15 135:1 136:3 142:2,26 143:19 149:10 158:3	<b>sediments</b> 84:20 95:10 100:10	<b>sequences</b> 67:6 69:3	<b>Shannon</b> 6:8 79:10	
<b>screens</b> 11:25	<b>seek</b> 25:21	<b>sequestration</b> 42:24	<b>shapes</b> 86:3	
<b>Scrimshaw</b> 37:1 43:6,12,20 46:11 81:7 163:17,19, 20 164:16	<b>seeking</b> 20:16 23:26 26:14 49:9	<b>series</b> 55:5 74:19 81:13	<b>share</b> 135:22	
<b>scripts</b> 32:15,25	<b>SEG-Y</b> 177:17	<b>serve</b> 97:9	<b>shareholders</b> 47:3 158:8,14 159:21	
	<b>seismic</b> 57:8,16 61:17 84:21 85:5 93:11,17 94:17, 25 95:1,4,13,14 96:1,7,10,13,24 97:7,17,24 98:1,	<b>services</b> 6:16	<b>shares</b> 53:5	
			<b>sharp</b> 70:2,3	

106:8 107:15	102:20 126:26	<b>size</b> 122:12	<b>sought</b> 14:25	189:2
108:22 109:25	144:21 150:10	<b>skill</b> 192:7	15:5,8	<b>specimen</b> 145:23
123:1,2 125:3	152:6 159:11	<b>skolithos-like</b>	<b>sound</b> 14:10	<b>spectral</b> 93:13
136:3 138:24	176:4	90:2	<b>sounds</b> 81:3	102:2 103:2
143:3 144:2	<b>similarity</b> 64:7	<b>slice</b> 72:11 93:13	<b>source</b> 177:13	<b>spectrometry</b>
145:4,14,20	87:22	102:2 103:3	<b>sourced</b> 16:19	58:2
148:18 149:11,14	<b>similarly</b> 62:5	<b>slide</b> 16:18,23	18:19	<b>speculated</b> 98:21
153:25 154:8,14	67:13 88:7	17:19 18:3,26	<b>sources</b> 102:19	147:10
<b>shows</b> 61:21	<b>simple</b> 18:25	20:22 21:2,3,7,19	<b>south</b> 44:1 61:7	<b>speculates</b>
63:24 65:16	<b>simply</b> 19:8 27:9,	25:2,24 30:4	62:5 63:24 72:15	104:23
69:14 71:9 72:11	13 29:14	50:25 51:2 54:8	129:1 180:1	<b>speculative</b>
75:13 76:25 89:8,	<b>simulates</b> 147:24	74:16 83:12	<b>southern</b> 5:25	99:22
22 95:20 99:5	<b>simulation</b> 40:17	87:16 89:16	61:26 92:5	<b>spell</b> 9:22
101:13 104:16	190:11,13	102:4,11 104:5	<b>southwest/</b>	<b>spelled</b> 10:13,18
105:10 108:5	<b>simulator</b>	105:5,11 108:5	<b>northeast</b> 72:7,	<b>spelt</b> 10:7
121:3,9 122:12,	118:11,13	139:6	22	<b>spend</b> 154:22
14 139:9 146:24	<b>single</b> 70:10	<b>slides</b> 17:11 19:1	<b>space</b> 130:17	169:2
154:1 171:3	142:15	20:6 29:26 30:22	191:2	<b>spending</b> 48:7
<b>shut</b> 135:5	<b>sink</b> 8:11	33:6,7,13	<b>sparse</b> 92:24	<b>spent</b> 17:16 48:9
141:16,24 188:2	<b>sinusoid</b> 88:18	<b>slow</b> 38:4 58:18	<b>speak</b> 7:1,24 9:19	70:12
<b>shut-in</b> 52:7,12	89:24 91:5	120:19 128:24	11:3 18:12 30:13	<b>spot</b> 36:12 70:4
<b>sic</b> 46:22 54:1	<b>sinusoids</b> 88:12,	<b>slower</b> 163:25	32:18 46:21	156:12
100:21 103:17	14,18 89:10	<b>slowly</b> 7:9	94:15 128:18	<b>squeeze</b> 171:24
132:20	<b>sir</b> 129:2,3 174:6,	<b>small</b> 69:4 73:12	162:5 163:24	<b>stabilizes</b> 114:11
<b>side</b> 48:6 60:12	13 175:15 178:9	87:24 90:5	176:24 189:1	<b>stable</b> 95:24
86:8 98:6 106:20	185:15 186:16	101:18,22 111:13	<b>speakers</b> 162:6	129:10
136:5 137:8	188:21 189:26	113:10 116:11	<b>speaking</b> 7:9	<b>staff</b> 6:5,11,14,
<b>signal</b> 46:4	<b>SIR1</b> 88:25	121:6 130:20	10:2 19:21 33:1,	21,25 7:7,24 8:19
<b>signature</b> 71:8	<b>site</b> 147:15	150:5 152:14	3,5,11,20 34:24	12:6,21 13:5,10
<b>significant</b> 56:22	148:18	173:18,23	129:21 184:5	14:1 47:5,16
69:5 75:5 97:20	<b>sites</b> 148:18	<b>smaller</b> 101:3	<b>specialist</b> 42:21	79:11,12,13,14,
99:11 106:8,18	<b>sits</b> 73:1 74:3	105:13 168:17,18	<b>specific</b> 118:9	15,16,17,18,19,
108:14 110:3	77:15	177:22	138:12 149:7,13	20,21 162:15
116:3 117:1	<b>sitting</b> 29:16 30:5	<b>smearing</b> 89:26	150:5 151:3	176:22
139:13 141:20	33:8,13	<b>smears</b> 146:1	172:17 182:15	<b>staff's</b> 12:8
150:22 154:23	<b>situ</b> 85:22,26	<b>social</b> 159:4	<b>specifically</b> 24:9,	<b>stairs</b> 8:5
180:24 189:12	87:10,13 91:23	<b>softening</b> 145:10	15 86:4 106:6	<b>stakeholder</b>
<b>significantly</b>	92:14 114:8	<b>solubility</b> 130:22	112:26 120:6	49:13
52:25 55:23	127:4,10 140:10	<b>solvent</b> 130:16,23	126:3 146:7	<b>stand</b> 21:1
104:11 155:14	180:6	149:2 152:8,11,	157:26 162:13	177:25 191:16
<b>signifies</b> 169:9	<b>situation</b> 51:4	12,15,18,25	164:15 173:2	<b>standard</b> 19:16
<b>Siksika</b> 5:26	53:15 115:15	<b>sort</b> 16:16,22	174:11 178:19	24:23 25:22 59:7
<b>silent</b> 14:6	160:19	17:12,18,21	182:5 184:7	118:14 142:20
<b>similar</b> 16:1,2,5		80:18	<b>specifics</b> 149:21	
63:14 73:21 93:3				

<b>standardly</b> 5:10	177:24 186:9	<b>steaming</b> 58:1 65:22 94:11 109:15 134:2 154:7	108:24 109:1,9, 12,23 110:1,12, 14 112:13,20,22 113:11,13,21,25 116:8,21 117:20 118:11 119:9 120:5 123:21 124:16,18,20,25 138:13 139:11, 20,23 140:9,14, 17 142:12,18 143:5,22 144:10, 13,18,19,22,26 146:26 147:3,6, 12,19,25 148:8, 20,21 150:10,13 151:9 152:23 153:12,17,22 163:9 175:5 180:26 181:23 182:26 185:26 186:3 189:13,23	<b>strength</b> 113:25 114:1 139:14
<b>Stanislavski</b> 79:13	<b>statements</b> 92:17 105:7 160:4	<b>stemmed</b> 24:4	113:11,13,21,25 116:8,21 117:20 118:11 119:9 120:5 123:21 124:16,18,20,25 138:13 139:11, 20,23 140:9,14, 17 142:12,18 143:5,22 144:10, 13,18,19,22,26 146:26 147:3,6, 12,19,25 148:8, 20,21 150:10,13 151:9 152:23 153:12,17,22 163:9 175:5 180:26 181:23 182:26 185:26 186:3 189:13,23	<b>stress</b> 110:13,14 111:6 112:19 113:15,17,19,22, 24 114:8,16,21, 24 115:1,6,8,12, 17 116:16,22,26 117:16 118:8,10, 19 119:10 120:4, 7 121:21 122:2,5, 7,14,17 123:2,3, 21 124:18,20 140:3 145:8,9,15 146:14,18,19,20 147:2,17 148:3 151:24 182:25
<b>star</b> 103:2	<b>states</b> 49:14 92:9 93:21	<b>step</b> 14:8 21:26	113:11,13,21,25 116:8,21 117:20 118:11 119:9 120:5 123:21 124:16,18,20,25 138:13 139:11, 20,23 140:9,14, 17 142:12,18 143:5,22 144:10, 13,18,19,22,26 146:26 147:3,6, 12,19,25 148:8, 20,21 150:10,13 151:9 152:23 153:12,17,22 163:9 175:5 180:26 181:23 182:26 185:26 186:3 189:13,23	<b>stress/strain</b> 145:7
<b>start</b> 5:9 13:1 37:17 41:26 46:18 73:4 96:13, 25 97:18 156:4 157:5 159:8 164:13 170:6 172:8 174:21	<b>static</b> 90:24	<b>stepping</b> 69:18 169:24	113:11,13,21,25 116:8,21 117:20 118:11 119:9 120:5 123:21 124:16,18,20,25 138:13 139:11, 20,23 140:9,14, 17 142:12,18 143:5,22 144:10, 13,18,19,22,26 146:26 147:3,6, 12,19,25 148:8, 20,21 150:10,13 151:9 152:23 153:12,17,22 163:9 175:5 180:26 181:23 182:26 185:26 186:3 189:13,23	<b>stresses</b> 85:26 113:13 114:6,23 116:19 127:4,10 145:12,15
<b>start-up</b> 110:5,6, 25 112:15 116:15 119:21 126:4,14, 25 127:3,11,17, 18 129:26 131:4, 14,19,21 152:4,5, 9 153:21,24 154:13	<b>stay</b> 130:18 131:2 182:14	<b>steps</b> 49:7	113:11,13,21,25 116:8,21 117:20 118:11 119:9 120:5 123:21 124:16,18,20,25 138:13 139:11, 20,23 140:9,14, 17 142:12,18 143:5,22 144:10, 13,18,19,22,26 146:26 147:3,6, 12,19,25 148:8, 20,21 150:10,13 151:9 152:23 153:12,17,22 163:9 175:5 180:26 181:23 182:26 185:26 186:3 189:13,23	<b>strictly</b> 7:19
<b>start-up-induced</b> 110:10 118:18,22	<b>steam</b> 42:23 47:18,21 52:15, 16 55:6,17,19,21, 23,25 56:3,5,10, 13,16 57:15,17 58:9,14 59:17,23 60:18 61:12 64:19,20 65:17, 19,23 66:6,7,8, 12,15,21,25 67:16 69:20 70:8, 10 71:16 74:12, 26 75:12,21 76:25 77:3,10 78:2 81:15,22 84:6 85:3,4,6 88:1 90:7 94:24 99:14 107:19 110:1,4,19 111:14 116:1,11, 25 120:11 122:23 123:17,20,23 124:6 125:10 130:1,3 138:23 139:17 140:13,16 142:4,10,11,17, 21 143:4,8 144:1, 3,5,11,13,21 148:12 149:2,21, 22,26 150:9,21, 22 151:8,15 153:11,24 166:5, 22,26 167:3,8 169:19,20 174:10 179:25 181:3,9, 11 183:26 186:2 190:11,13	<b>stiffer</b> 182:11	113:11,13,21,25 116:8,21 117:20 118:11 119:9 120:5 123:21 124:16,18,20,25 138:13 139:11, 20,23 140:9,14, 17 142:12,18 143:5,22 144:10, 13,18,19,22,26 146:26 147:3,6, 12,19,25 148:8, 20,21 150:10,13 151:9 152:23 153:12,17,22 163:9 175:5 180:26 181:23 182:26 185:26 186:3 189:13,23	<b>striking</b> 64:7 86:24
<b>start-ups</b> 110:8 111:20 112:26 124:5	<b>stop</b> 55:19 138:4	<b>stopped</b> 114:12 130:5	113:11,13,21,25 116:8,21 117:20 118:11 119:9 120:5 123:21 124:16,18,20,25 138:13 139:11, 20,23 140:9,14, 17 142:12,18 143:5,22 144:10, 13,18,19,22,26 146:26 147:3,6, 12,19,25 148:8, 20,21 150:10,13 151:9 152:23 153:12,17,22 163:9 175:5 180:26 181:23 182:26 185:26 186:3 189:13,23	<b>strong</b> 70:7 75:15 77:21 143:26
<b>started</b> 47:14 115:20,24 151:21 156:17 165:17	<b>stopping</b> 184:17	<b>stopping</b> 184:17	113:11,13,21,25 116:8,21 117:20 118:11 119:9 120:5 123:21 124:16,18,20,25 138:13 139:11, 20,23 140:9,14, 17 142:12,18 143:5,22 144:10, 13,18,19,22,26 146:26 147:3,6, 12,19,25 148:8, 20,21 150:10,13 151:9 152:23 153:12,17,22 163:9 175:5 180:26 181:23 182:26 185:26 186:3 189:13,23	<b>stronger</b> 182:11
<b>starting</b> 44:24 54:24 83:14 91:2 110:4 111:4 116:25 156:9	<b>stops</b> 111:16	<b>stops</b> 111:16	113:11,13,21,25 116:8,21 117:20 118:11 119:9 120:5 123:21 124:16,18,20,25 138:13 139:11, 20,23 140:9,14, 17 142:12,18 143:5,22 144:10, 13,18,19,22,26 146:26 147:3,6, 12,19,25 148:8, 20,21 150:10,13 151:9 152:23 153:12,17,22 163:9 175:5 180:26 181:23 182:26 185:26 186:3 189:13,23	<b>strongly</b> 14:19 153:13
<b>starts</b> 110:19 111:2	<b>strain</b> 145:9,16 146:14	<b>strained</b> 145:10	113:11,13,21,25 116:8,21 117:20 118:11 119:9 120:5 123:21 124:16,18,20,25 138:13 139:11, 20,23 140:9,14, 17 142:12,18 143:5,22 144:10, 13,18,19,22,26 146:26 147:3,6, 12,19,25 148:8, 20,21 150:10,13 151:9 152:23 153:12,17,22 163:9 175:5 180:26 181:23 182:26 185:26 186:3 189:13,23	<b>structural</b> 40:12, 13 43:24,25 44:4 95:7,25 98:10,19, 23 99:1 102:11 105:13 117:2
<b>startups</b> 47:19	<b>stranding</b> 52:19	<b>stranding</b> 52:19	113:11,13,21,25 116:8,21 117:20 118:11 119:9 120:5 123:21 124:16,18,20,25 138:13 139:11, 20,23 140:9,14, 17 142:12,18 143:5,22 144:10, 13,18,19,22,26 146:26 147:3,6, 12,19,25 148:8, 20,21 150:10,13 151:9 152:23 153:12,17,22 163:9 175:5 180:26 181:23 182:26 185:26 186:3 189:13,23	<b>structure</b> 84:21 95:5 96:8 101:20 103:21
<b>state</b> 9:21 118:19 140:3	<b>strat</b> 93:16 103:11	<b>strat</b> 93:16 103:11	113:11,13,21,25 116:8,21 117:20 118:11 119:9 120:5 123:21 124:16,18,20,25 138:13 139:11, 20,23 140:9,14, 17 142:12,18 143:5,22 144:10, 13,18,19,22,26 146:26 147:3,6, 12,19,25 148:8, 20,21 150:10,13 151:9 152:23 153:12,17,22 163:9 175:5 180:26 181:23 182:26 185:26 186:3 189:13,23	<b>structures</b> 76:6
<b>stated</b> 105:24 129:7,24 133:18	<b>strata</b> 24:25,26 30:8 55:5,9,26 56:1,17,19 57:8, 10,14,26 58:4,12, 15 59:11 60:1,7 61:19,21 62:2 63:8,12 67:3 70:9,14 71:16,21 73:20 75:6,24 76:19,26 81:15 82:18 84:1,18 85:15,17 88:3,25 89:2,18,23 91:15, 22,25 92:8,10 93:19,24 94:3,10, 23 95:6 98:16,25 99:26 103:6 104:3,7,12,24	<b>strat</b> 93:16 103:11	113:11,13,21,25 116:8,21 117:20 118:11 119:9 120:5 123:21 124:16,18,20,25 138:13 139:11, 20,23 140:9,14, 17 142:12,18 143:5,22 144:10, 13,18,19,22,26 146:26 147:3,6, 12,19,25 148:8, 20,21 150:10,13 151:9 152:23 153:12,17,22 163:9 175:5 180:26 181:23 182:26 185:26 186:3 189:13,23	<b>struggled</b> 78:4
<b>statement</b> 9:6 15:18 18:25 19:16 21:15 47:1, 5 49:22 54:22 157:26 158:17,20 159:19 160:1,13 162:26 172:25	<b>street</b> 8:7	<b>street</b> 8:7	113:11,13,21,25 116:8,21 117:20 118:11 119:9 120:5 123:21 124:16,18,20,25 138:13 139:11, 20,23 140:9,14, 17 142:12,18 143:5,22 144:10, 13,18,19,22,26 146:26 147:3,6, 12,19,25 148:8, 20,21 150:10,13 151:9 152:23 153:12,17,22 163:9 175:5 180:26 181:23 182:26 185:26 186:3 189:13,23	<b>struggling</b> 27:26
			113:11,13,21,25 116:8,21 117:20 118:11 119:9 120:5 123:21 124:16,18,20,25 138:13 139:11, 20,23 140:9,14, 17 142:12,18 143:5,22 144:10, 13,18,19,22,26 146:26 147:3,6, 12,19,25 148:8, 20,21 150:10,13 151:9 152:23 153:12,17,22 163:9 175:5 180:26 181:23 182:26 185:26 186:3 189:13,23	<b>studied</b> 63:14
			113:11,13,21,25 116:8,21 117:20 118:11 119:9 120:5 123:21 124:16,18,20,25 138:13 139:11, 20,23 140:9,14, 17 142:12,18 143:5,22 144:10, 13,18,19,22,26 146:26 147:3,6, 12,19,25 148:8, 20,21 150:10,13 151:9 152:23 153:12,17,22 163:9 175:5 180:26 181:23 182:26 185:26 186:3 189:13,23	<b>studies</b> 42:18

<b>study</b> 60:15	129:5 149:20	150:20	<b>Sverdahl's</b> 38:24	125:26 166:14
<b>styles</b> 44:3	161:23 169:12	<b>supplied</b> 88:26	80:18	182:12 183:12
<b>subject</b> 8:23	<b>suggest</b> 64:20	92:4 95:15,20	<b>swear</b> 36:24	184:2
51:19 103:13	65:8 77:1 156:13	96:6,24 97:1	<b>sworn</b> 11:15	<b>tandem</b> 70:11
126:24 190:2	169:25 185:9	<b>support</b> 8:17	35:8,11 37:4	<b>target</b> 128:10
<b>submission</b> 19:7,	<b>suggesting</b> 19:1	54:20 59:26	81:10 173:4	<b>tax</b> 47:8
10 29:17,19,22	27:17 69:17,23	104:26 109:8	186:13 191:6	<b>team</b> 17:16 39:3
41:7 62:21 67:19	<b>suggestion</b>	131:12 134:16	<b>Sydney</b> 44:1	42:19 43:11
68:10,17 86:22	127:22 166:9	164:12 168:7	<b>system</b> 100:9	160:5
87:15 90:13	<b>suggests</b> 65:6	178:11,12 185:24	101:14 107:6	<b>technical</b> 6:11
91:21,24 92:16,	69:26 70:5,25	186:4	108:11	9:25 15:19,23
18 128:13 129:24	74:11 77:10,16	<b>supported</b>	<b>systems</b> 100:11	17:1 18:17 19:19,
133:14,16 136:3	168:4 169:21	116:15,18 143:11	101:3	22 20:4 25:9
162:15	170:11,18	153:13,20 154:11		26:15 27:23
<b>submissions</b>	<b>suitable</b> 128:18	<b>supporting</b> 6:14,	<b>T</b>	47:16 53:20 54:7,
15:12 20:18	185:11	25 42:22 144:16		23 128:3 138:22
23:18 24:1 26:17	<b>suite</b> 66:10	<b>supportive</b>	<b>Tab</b> 33:15 50:8	155:8,22 172:16,
28:6,26 96:9	138:24	139:1,2 144:10	51:1 54:4 58:17	20,21,24 173:8
<b>submit</b> 21:21	<b>suits</b> 156:11	<b>supports</b> 70:3	60:5 61:14 62:21,	175:1 176:3
<b>submitted</b> 72:10	157:7	73:14 77:8 128:4	22 63:19 64:22	<b>technically</b> 125:3
87:2,17 93:26	<b>summarize</b>	171:4	66:2 67:17 68:15	<b>technique</b> 171:15
125:4	70:14 95:1	<b>surely</b> 21:19	69:7 71:2,5,23	<b>technology</b> 163:6
<b>subseismic</b>	138:14 141:4	<b>surface</b> 59:13	72:18 86:16	<b>tectonic</b> 44:3
149:25	<b>summarized</b>	67:24 88:11	88:20 92:15	95:24
<b>subsequent</b>	149:23	134:5,8 183:7	167:10	<b>telephones</b> 14:5
141:17	<b>summarizes</b>	<b>surfaces</b> 59:10	<b>table</b> 10:11 35:4	<b>temperature</b>
<b>subsequently</b>	136:3	<b>surname</b> 9:22	90:12 91:20,23	57:15 59:16
52:9 100:10	<b>summary</b> 20:4	<b>surprising</b> 160:9,	92:15 114:23	65:22 66:8
139:16	70:12,15 75:13	10	123:5 134:20	115:11 119:7,23
<b>subset</b> 115:24	76:16 83:19	<b>surrounding</b>	135:1,10 136:1,2,	140:12
<b>substantial</b> 19:3	93:21 99:18	69:1	5,24 137:3 143:1	<b>temperatures</b>
52:10 108:23	104:14 108:22	<b>surveillance</b>	144:2 147:9	188:1
<b>subsurface</b> 114:6	144:8	40:19 127:8	148:18 149:17,21	<b>temporary</b>
<b>subtle</b> 98:13	<b>Suncor's</b> 146:9	150:18	151:11 186:7	111:11 113:9
<b>success</b> 84:4	<b>Super</b> 83:6	<b>surveys</b> 148:11	<b>tables</b> 148:16	117:4,10 121:17
<b>successful</b> 48:4	<b>superimposed</b>	<b>Susan</b> 6:12 79:16	189:6 191:4	124:14 125:2,6,9,
<b>successfully</b>	17:23	<b>suspect</b> 5:11	<b>tabulated</b> 189:17	14 127:5,23,25
127:1	<b>supplemental</b>	<b>Sverdahl</b> 37:2	<b>tags</b> 6:22	131:3 151:11
<b>succinct</b> 145:4	41:8 138:15,17	38:13,14,18,23	<b>taker</b> 133:7	152:3 153:21,24
<b>sudden</b> 46:18	142:19 148:15	81:8 94:13,16	<b>takes</b> 48:25	<b>ten</b> 20:6 167:26
<b>suffers</b> 26:5	149:3	109:21 153:15	<b>taking</b> 13:17	<b>tend</b> 116:19
<b>sufficient</b> 31:23	<b>supplementary</b>	172:23 176:18,	113:20	162:6
110:21 122:15	49:23	21,24,26 177:14,	<b>talk</b> 169:23	<b>tens</b> 63:17 107:5
123:26 128:14	<b>supplemented</b>	19	<b>talking</b> 7:10	151:14 152:15

**tensile** 119:11  
123:10 148:2  
**term** 5:22 29:12  
112:5 118:5  
**termed** 145:10  
**terms** 16:13,17  
22:17 23:23 29:8  
32:12 33:1 52:2  
58:19 142:4  
156:12 173:19  
174:21  
**territories** 5:25  
**test** 31:18 59:12  
85:13 102:23  
103:1,4 107:25  
127:13 130:15  
131:17 145:7,22,  
23 146:6,8,9  
147:13 178:15  
181:26 187:3,4,5,  
15  
**tested** 183:19  
**testified** 157:25  
**testing** 182:16  
**tests** 114:8  
146:19 147:14  
148:4 181:19  
183:5  
**Texas** 40:12  
**That'll** 32:10  
**theoretical** 116:2  
142:22  
**theory** 104:26  
**thermal** 35:5  
38:17 39:2,26  
40:18 42:4 43:11  
44:7 45:2 47:12  
56:9 118:13  
119:23 126:4  
147:26  
**thermally** 132:4  
133:9 154:15  
**thick** 61:2 72:3,5  
104:25 105:9,14,  
17,20 106:18

**thicker** 97:23  
**thickness** 61:22  
64:13 76:18,20  
143:7  
**thicknesses**  
76:13 123:4  
**thin** 61:25 62:6  
70:18 75:6  
142:15 143:20  
**thing** 16:5,12  
17:4,25 30:15  
137:15 158:1  
159:2  
**things** 16:7 18:2  
29:20 36:18,20  
158:17,21 167:3  
169:17  
**thinking** 35:7  
156:9  
**thinner** 61:9  
73:26  
**thins** 72:7,14  
**third-party** 59:6  
91:8  
**Thirdly** 98:22  
**Thomas** 36:26  
40:10 81:6  
**Thomsen** 37:3  
39:22,23 40:3,8  
81:9 109:18,20  
120:18,21 125:22  
127:21 154:8  
172:22  
**Thomsen's** 40:9  
153:19  
**thought** 17:13  
18:3 88:10  
137:16 157:19  
185:19  
**thousand** 25:22  
66:11 136:15  
**threat** 53:2  
154:13  
**three-hour** 17:3

**three-well** 68:25  
**threshold** 111:4  
139:21  
**throats** 76:14  
**thrones** 105:3  
**Thursday** 12:26  
**tidal** 68:20 69:2,  
3,24 70:24  
**tied** 58:12 59:14  
142:20  
**tighter** 168:13,  
14,16  
**til** 156:2,10  
**till** 35:12  
**time** 9:26 11:17  
12:6 19:9 20:9  
21:23 22:19 31:7  
32:7 34:23 35:8,  
14 37:11 46:5  
52:3 58:8 59:21,  
23 65:15 66:17  
70:12 75:18,21  
77:2 78:7 80:10,  
11 99:16 107:2  
110:24 111:12  
112:7 114:10  
115:15 116:10  
119:15 120:9  
121:3 125:7  
126:13 141:10  
142:17 143:10,14  
151:18 153:24  
155:19 157:4  
163:4,5 166:5,10,  
12,13,14,18,22  
170:1 171:24  
186:2 190:20  
**time-wise** 80:10  
**timeline** 156:18  
**timelines** 31:21  
**timely** 132:7  
**times** 13:19  
137:10  
**timing** 16:6,8  
34:10 154:10

156:8 157:2  
172:1 190:21  
191:10  
**title** 72:7  
**today** 12:15  
26:22 49:4 53:19  
125:26 154:23  
156:8,15 157:2  
172:26 173:4  
176:17,22 177:2  
178:10 186:5,10  
190:1,3 191:14  
**today's** 8:23  
**toe** 118:23  
**told** 26:21  
**Tom** 136:22  
137:23 138:10  
**tomorrow** 157:5  
160:23 165:7  
190:1,20 191:9,  
12,14  
**tool** 57:24 58:2,13  
90:15,22 91:13  
92:14 94:7  
140:20 149:1  
**top** 50:15 55:3  
60:3 64:14 65:18,  
19 66:6,8 68:25  
69:20 71:1 72:8  
73:1,24 74:3  
75:1,3,14,26 77:9  
78:1 81:21,22  
82:6,7,10,19  
83:17,21 88:9  
89:11 97:11  
103:3,17 104:11  
107:7,9 119:2,6  
145:6 146:12  
147:22 158:12  
169:19 179:23  
**top-tier** 159:3  
**topic** 160:24  
165:8 167:18  
171:25  
**topics** 157:3

**tops** 103:21,23  
**total** 51:5,15  
61:20 75:6  
102:21 143:7  
154:2,19 188:18  
**totally** 34:1  
**touch** 35:18  
133:23  
**touched** 134:10  
**tough** 166:19  
**Tower** 8:6  
**traced** 63:16  
**traces** 98:7,15  
**track** 90:1  
**tracked** 17:20  
**tracks** 90:26  
**trade** 37:26 39:1,  
25  
**traditional** 5:24  
131:15  
**trained** 8:15  
187:4  
**transcribe** 7:8  
**transcribed**  
192:6  
**transcript** 7:15,  
16 14:12 192:1,5  
**transferred**  
110:22  
**transgressive**  
76:3  
**transition** 129:21  
131:23 146:15,  
22,25  
**transmission**  
14:11  
**transmissive**  
112:18  
**transparent** 7:3  
**trapped** 50:14,15  
77:23 99:16  
179:17

**trapping** 107:10

**Treaty** 5:25

**tremendous**

163:5

**tremendously**

163:7

**trend** 72:23

102:18 103:15

107:4

**trends** 92:25

96:13,17 102:18

105:15 127:11

**triangular** 54:17

**triaxial** 145:7

**tributary** 101:3

**true** 77:5 166:24

177:26

**trunk** 107:6

**truth** 161:22

**Tsuut'ina** 6:1

**tubes** 74:23 82:4,

8

**turn** 8:4 46:1

54:22 83:24

109:17 165:8

174:4 175:15

176:10 178:2

179:22 180:9,22

181:15 183:22

184:11 185:15

186:15 188:12

**Turning** 38:12

41:25

**two-thirds** 62:1

72:25

**type** 116:3 189:18

**typical** 68:19,26

73:7 110:24

120:12 130:3

145:6

**typically** 56:19

74:5 116:10,12

181:9

---

**U**

---

**ultimately** 52:19

55:21 64:2

115:16 155:13

**Unanticipated**

56:7

**uncertainty**

174:2 183:14

**uncompetitive**

52:18

**unconstrained**

121:4

**unconventional**

42:23

**undepleted**

113:3

**underlying**

24:25 28:16 69:5

71:14 73:13,22

95:3 100:21

105:14,20 139:26

162:20,21,24

**underneath**

102:26 111:23

112:2

**understand**

13:20 14:23

20:21 30:7,20

41:21,24 51:4

65:23,26 71:26

72:9 100:15,26

161:24 167:12

**understanding**

7:5 18:24 26:20

27:14 66:25

137:15

**understands**

49:9 170:5

**understood**

35:19 36:21

55:20 63:22

65:25 80:26

**undertaken**

161:6,19

**underway** 25:1

**undetected**

108:20

**undifferentiated**

62:3

**uneconomical**

162:24

**unexpected**

127:14

**unfair** 21:11

**unfriendly** 7:3

**uniform** 65:11

75:20 168:3

**unique** 17:21

**unit** 56:13 61:6

63:9,11 64:13

65:14 67:3,12

69:14,16 70:10

71:22 72:21 73:9,

12,19,21,23,24

74:4,9,15,21 75:8

77:12 81:23

82:20 83:2,13

116:20 123:4

**unit's** 74:25

76:24

**units** 55:21,22

56:8,21,24 57:10,

14 58:1,4,8,15

61:9,11 62:2 63:8

67:7,9,21 70:10,

14 71:21,26

72:12 73:8 75:11,

24 76:17,19,26

77:20,23 82:18

83:7,18,20 84:18

85:17 91:15

92:11 93:24 94:3,

24 95:6 98:17,25

99:26 103:6

104:3,12 108:24

109:9 171:6

**University**

40:12,14 43:26

**unjustified** 165:6

**unloading**

127:20

**unmitigated**

149:11

**unnecessary**

48:7 125:16

155:12

**unreliable**

173:16 187:18,22

**unrolled** 88:10

**unsuccessful**

49:3

**updated** 20:22

**updip** 107:3

**uphole** 132:23

**uplift** 30:8 119:8

**upper** 50:12,22

51:18 52:7,24

53:4,17 60:20

61:5 67:21 68:20

69:15 71:1,19

73:18,20 74:8,15,

20,24 75:8 82:8,

11,20 86:20

89:22 99:17

102:3,20 105:10,

12,25 106:10,17

108:6 114:4

120:21 122:19

128:15,22 129:6,

16 132:21,26

134:25 135:5,11,

18,22 136:12,14

143:1 155:20

162:16

**upward** 73:24

**upwards** 63:11

65:1,2,4 69:26

**utilize** 128:8

**utilized** 57:24

127:18 131:16,19

**utilizing** 127:23

135:7

---

**V**

---

**vacuum** 24:15

**valley** 64:6,12,16

66:22 107:3,6

162:18

**valleys** 101:2

**values** 69:18

91:26 134:24,26

135:7,8,23

157:25 159:7,15,

16 165:7

**variability** 64:12

116:26 173:25

174:1

**variable** 61:22

67:22 76:20

116:26 123:4

**variably** 76:10

**variation** 67:13

**variations** 67:6

140:2

**variety** 44:3

140:12 149:1

**vary** 168:2

**vast** 47:14

**vein** 23:3,12

**vendor** 59:6 91:8

**verify** 21:3

**versus** 84:25

103:22 114:9

121:3 127:24

145:5 146:14

165:22 167:16,23

168:2,3,10

169:16

**vertical** 50:13,19

56:21 58:14

66:19,25 74:12

76:15,17,22

83:20 86:11 97:4

98:8 104:8 105:2  
109:5 113:23  
162:17 171:16  
**vertically** 98:24  
106:1  
**VF** 97:21  
**viability** 56:12  
**viable** 90:6  
**vice** 10:16 37:18  
**vicinity** 86:1  
133:26 154:7  
**video** 7:12,14,17,  
18,22,23 9:21  
28:19  
**videocast** 7:14  
14:13 51:12  
**view** 155:7  
**viewed** 169:16  
**viewers** 7:16  
**views** 25:4  
**Viking** 104:13  
**virtual** 21:13  
**virtually** 66:23  
77:7  
**visible** 146:4  
**visual** 17:11,22  
18:8 67:9 73:8  
74:2,11 76:4  
101:10 143:2  
**visually** 29:11  
101:8  
**visuals** 32:18  
**vitae** 37:14 38:7,  
19 39:6,17 40:4,  
22 42:7,26 43:13  
44:10 45:5 46:11  
**volume** 56:11,20  
72:26 77:16  
82:26 83:8  
106:12,13 113:8  
120:14 124:22  
130:6,12,20,26  
145:23 152:15  
153:24

**volumes** 106:8  
110:16 111:13  
113:10 116:11  
117:6 124:2  
129:3 179:25,26  
180:24  
**volumetric**  
145:22,25

---

**W**

---

**Wab** 61:5 73:2,7,  
13,18 74:15,24  
75:8,15,18 82:19  
**Wabiskaw**  
50:12,15,16,17,  
23 52:8 53:3,21  
55:10 60:3,12,19  
61:2,4,24 62:2,6  
70:2 71:1,12,18,  
22,26 72:2,3,5,  
10,11,13,16,21,23  
73:19,20,21,22,  
24,25 74:4,9,21  
75:2,23,26 76:3,  
9,11 77:6,19,22,  
24 82:14,15,18  
83:7,9,11,17,22  
84:2,11 89:5  
90:19 91:16  
94:20 96:8 97:21,  
23 99:14,20  
101:19 103:22  
105:3,8,11,19,24  
106:4,5,6,7,9,11,  
16,21,23,24  
107:14,20 108:6,  
12,18 109:4,13  
112:16 121:22  
123:23 124:7  
132:15 134:26  
136:12 141:7,12,  
14,22,25 143:12,  
13,16 144:14  
146:8 147:25  
149:23 150:1,20  
152:16 162:18

163:2,10 171:2  
178:5,7  
**Waiman** 177:1  
**Wales** 44:1  
**walk** 51:3 74:14  
**walls** 89:12 90:5,  
16  
**Walters** 37:3  
42:13,25 43:4,5  
81:9 164:14,15  
172:22  
**wander** 86:7  
**Wang** 37:3  
43:22,23 44:9,14  
81:9 164:17  
172:22 175:7,10,  
12,14 177:1,5,6,  
7,8,11  
**wanted** 81:17  
171:21 190:14  
**warrant** 151:4  
155:23  
**warranted** 154:9  
**wastage** 161:8,9  
**waste** 160:26  
161:15  
**wasted** 161:2  
**watching** 51:12  
68:2  
**water** 84:25  
107:8 108:8  
111:3,25 112:2,5,  
6,10,26 113:1,2,  
3,4,6 117:17,21,  
24,26 118:20  
119:20,22 120:3  
122:4,25,26  
128:11 130:23  
141:24 150:21  
151:19 168:21,  
23,24 169:2,22  
178:8,17,22  
179:15,26 181:1,  
2,10

**wax** 131:7  
**weaker** 183:19  
**wearing** 6:22  
**webcast** 9:21  
**website** 7:13  
158:4,11 159:14  
**Wednesday**  
12:19,24  
**week** 6:15  
**weekend** 16:11  
**weeks** 19:12,20  
21:17,18 27:1,2  
31:8  
**weigh** 54:7  
168:13  
**weight** 11:21  
87:7  
**wellbore** 88:11  
89:12 90:5,16  
104:9 112:11  
130:8,17,19,21  
132:22  
**wellbores** 108:1  
154:15  
**wells** 44:26 51:26  
59:8 61:18 64:19  
68:26 69:1 77:7,  
22 85:1,13,15  
89:3 91:19 92:4,  
8,13,19 93:11  
103:23 107:25  
108:9 112:16  
115:20,21,22  
116:25 126:2,5,  
11 127:13 128:13  
129:1,4 132:3,5  
133:25 134:6  
137:10 139:11,  
12,13 140:6  
142:8 148:11  
151:7,21 152:7  
178:22 185:26  
186:26 188:15,16  
**Weser** 170:25

**Wesley** 6:2  
**west** 8:7 95:22  
**western** 38:2  
72:24  
**wet** 97:13 168:20  
**white** 149:15  
**wholly** 21:11  
**wicks** 87:11  
**wide** 101:15  
149:1  
**widespread**  
60:25 67:24  
**width** 101:9  
**wildfire** 111:16  
**William** 79:9  
**wireline** 57:6  
**witness's** 11:22  
**witnesses** 11:12,  
14,20,26 12:17,  
21 13:5 15:21  
17:13 18:2,7  
30:12 34:2,4  
36:24 191:3,16  
**wondering**  
187:24 190:9  
**words** 168:17  
**work** 25:24 27:9  
28:11 29:13  
44:22 47:2,6 56:2  
70:11 157:9  
158:7 163:1  
165:24,25  
167:13,14,16  
182:6  
**workflow** 54:5,  
14 84:16  
**working** 39:3  
42:20 43:9  
135:21 136:11  
159:22 161:11  
167:25 172:1  
**working-interest**  
84:11

**workover** 132:26  
133:14 151:18

**workovers** 132:8

**works** 170:3,5

**workshop** 127:2,  
7

**world** 42:18  
159:6 176:2

**worry** 182:8

**worth** 69:19  
92:20

**worthwhile**  
70:13

**would've** 173:21

**wrap** 12:17,25

**write** 162:2  
172:15 173:9

**written** 41:11,17  
45:13 125:4

**wrong** 157:19

---

**X**

---

**Xhaferllari** 6:12  
79:17

**Xiang** 37:3  
43:22,23 81:9

**xylene** 131:5

**xylene's** 130:21

---

**Y**

---

**Yang** 6:13 79:20  
**year** 66:13 160:3  
172:10,11

**year-over-year**  
66:14

**years** 37:26 39:2,  
13 40:14 42:3,5,  
16 43:8 44:2,21  
47:12 110:25  
119:15 122:22  
123:19 129:20  
135:9 142:6

143:9 144:3  
166:11,16,18,26  
167:1,6,25,26  
175:26 176:1  
186:25

**yellow** 64:11  
139:3

**yesterday** 14:26  
16:14 22:13

---

**Z**

---

**Zaitlin** 5:18,19,  
21 46:23 79:6  
155:22

**zone** 56:8 67:1  
84:19 91:16  
93:12 99:12  
103:14 108:12,18  
132:19 141:7,14,  
22 149:23 150:1,  
4,6,20,22 151:13  
152:16,18,19  
162:22 181:1

**zonely** 132:20

**zones** 58:10  
105:4 107:8  
108:10,15  
139:10,14 144:14  
166:6 168:13,20  
169:11,26 173:23

**zoom** 114:4  
120:17 121:7,26  
122:18

**zooming** 120:21