

[Edward L. Handl, P.E.]

BEFORE THE UTAH WATER QUALITY BOARD

IN THE MATTER OF)
)
PR SPRING TAR SANDS PROJECT, GROUND)
WATER DISCHARGE PERMIT-BY-RULE)
)
No. WQ PR-11-001)
_____)

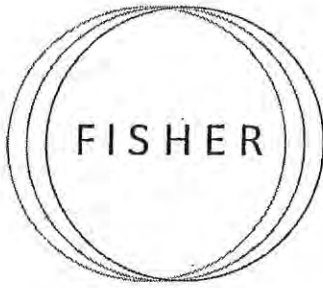
Bozeman, Montana
April 27, 2012

VIDEOTAPED DEPOSITION UPON ORAL EXAMINATION
EDWARD L. HANDL, P.E.

PREPARED FOR:

CHARLES FISHER COURT REPORTING, INC.
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May 2, 2012

Mr. Edward L. Handle, PE
JBR Environmental Consultants
121002 Browns Gulch Road
Butte, MT 59701

RE: No. WQ PR-11-001, In the Matter of PR Spring Tar Sands Project, et al.

Dear Mr. Handl:

Enclosed please find a copy of your deposition taken on April 27, 2012 along with a Deponent's Certificate and a correction sheet.

Please read the copy of your deposition and fill out the correction sheet as needed. Sign the Deponent's Certificate *and* the correction sheet before a Notary Public, and then return both documents to us within thirty (30) days of the date hereon.

The copy of the transcript is yours to keep. If you have any questions or concerns please feel free to call our office at any time.

Truly yours,

Charles Fisher Court Reporting
CFCR:lf
Enclosures

cc:
Christopher R. Hogle
Joro Walker
Rob Dubuc

In the Matter of PR Spring Tar Sands Project, et al.

Edward L. Handl, P.E.

April 27, 2012

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BEFORE THE UTAH WATER QUALITY BOARD

In the Matter of
PR Spring Tar Sands Project,
Ground Water Discharge
Permit-by-Rule

No. WQ PR-11-001

VIDEOTAPED DEPOSITION UPON ORAL EXAMINATION OF
EDWARD L. HANDLE, P.E.
VIDEO CONFERENCE

BE IT REMEMBERED, that the videotaped deposition upon oral examination of EDWARD L. HANDLE, P.E., appearing at the instance of U.S. Oil Sands, was taken at the offices of Charles Fisher Court Reporting, 503 E. Mendenhall, Bozeman, Montana, on Friday, April 27, 2012, beginning at the hour of 9:54 a.m., pursuant to the Utah Water Quality Board Rules of Procedure, before Jan M. Baldensperger, Court Reporter and Notary Public.

Appearances (Continued)

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Assistant Attorney General
160 East 300 South
Salt Lake City, Utah 84114-4870

VIDEOGRAPHER: Laura Fisher
ALSO PRESENT: Barclay Cuthbert
Dr. William Johnson

APPEARANCES

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(Mr. Machlis present in Salt Lake)
(Mr. Hogle present in Bozeman)

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Salt Lake City, Utah 84102
(Present in Salt Lake)

I N D E X

EXAMINATION OF EDWARD L. HANDL, P.E. BY: PAGE
Mr. Christopher R. Hogle, Esq. 8, 151
Ms. Joro Walker, Esq. 81, 154
Mr. Paul McConkie, Esq. 149

E X H I B I T S

DEPOSITION EXHIBITS: PAGE
Exhibit 6 Resume of Edward Handl, P.E. 8-9
Exhibit 7 Ternary Diagram. 15, 17, 19-20, 99-100
Exhibit 8 Pages 15-2 to 15-6 of Perry's Chemical Engineering Handbook 18-19, 39, 102
Exhibit 9 Ternary Phase Diagram. 22-23, 30-32, 35, 38, 42
Exhibit 10 Reference 1 - EPA On-line Tools for Site Assessment Calculation 26, 32, 42
Exhibit 11 Reference 10 - KIC Chemicals, Inc., Brazilian d-Limonene. 31-32
Exhibit 12 Reference 9 - www.inchem.org Limonene (CICADS). 34-35

I N D E X (Continued)

3 DEPOSITION EXHIBITS:		PAGE
4 Exhibit 13	Reference 5 - www.inchem.org	
5	Polycyclic aromatic hydrocarbons	
6	Section 2.2.	35-36
7 Exhibit 14	Reference 6 - www.sciencemag.org	
8	Solubility in Water of Normal	
9	C9 and C10, Alkane Hydrocarbons	36-37
10 Exhibit 15	Journal of Physical Chemistry	
11	equilibrium data.	37-38
12 Exhibit 16	Fig. 3 - Bitumen Equilibrium	
13	Between Oil & Water Phases. .	40-41
14 Exhibit 17	Reference 11 - www.inchem.org	
15	Polycyclic aromatic hydrocarbons	
16	Section 3.1.	44-45
17 Exhibit 18	Hand calculations: Different	
18	approach to Dr. Johnson's results	
19	using the same Schwarzenbach	
20	text.	74
21 Exhibit 19	Flowchart: The Ophus Process	78
22 Exhibit 20	Enhanced Concentrations of	
23	PAHs in Groundwater at a Coal	
24	Tar Site.	120
25		

1 **MS. C. FISHER:** This is the video and video
2 conference deposition of Ed Handl taken before the
3 Utah Water Quality Board, Cause No. WQ PR-11-001, in
4 the matter of PR Spring Tar Sands Project
5 Groundwater Discharge Permit-By-Rule.
6 Today is April 27, 2012. The time is
7 9:54 a.m. We are present at the offices of Fisher
8 at 503 East Mendenhall in Bozeman, Montana. The
9 court reporter is Jan Baldensperger, and the video
10 operator is Laura Fisher of Fisher Court Reporting.
11 The deposition is being taken pursuant to notice.
12 I would now ask the attorneys to identify
13 themselves and who they represent, as well as where
14 they are attending from.
15 **MR. HOGLE:** This is Chris Hogle. I am an
16 attorney for U.S. Oil Sands.
17 **MS. WALKER:** Joro Walker, attorney for Living
18 Rivers.
19 **MR. DUBUC:** Rob Dubuc, attorney for Living
20 Rivers.
21 **MR. McCONKIE:** Paul McConkie, attorney for
22 Executive Secretary.
23 **MS. C. FISHER:** The court reporter will now
24 swear the witness in.
25 (Whereupon, the witness was sworn.)

I N D E X (Continued)

3 REFERRED EXHIBITS:		PAGE
4 Exhibit 1	1/20/12 testimony of Dr.	
5	William Johnson.	33, 59
6 Exhibit 2	3/16/12 testimony of Dr.	
7	William Johnson.	59, 66
8 Exhibit 3	Pages from Schwarzenbach text	116
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		

1 WHEREUPON, the following proceedings were had
2 and testimony taken, to-wit:
3 *****
4
5 EDWARD L. HANDL, P.E.,
6 called as a witness herein, having been first duly
7 sworn, was examined and testified as follows:
8
9 EXAMINATION
10 BY MR. HOGLE:
11 Q. Please state your name.
12 A. My name is Ed Handl.
13 Q. Where do you live?
14 A. I live at 42 Ballard Lane in Whitehall,
15 Montana.
16 Q. How are you employed?
17 A. Employed by JBR Environmental
18 Consultants, based in Sandy, Utah, but my offices
19 are in Butte, Montana.
20 (Whereupon, Exhibit No. 6 was marked for
21 purposes of identification.)
22 BY MR. HOGLE:
23 Q. Mr. Handl, you're here today in this
24 matter because you've done some -- some work for
25 U.S. Oil Sands in this matter. Right now I want to

1 ask you a little bit about your -- your background,
2 your education, and your employment, but before I do
3 that, I've marked as Exhibit 6 a copy of your
4 resumé. I hand it to you, and I ask you if you
5 recognize that as your resumé.

6 A. I do, yes. This is my resumé.
7 MR. HOGLE: And then I offer Exhibit 6 as an
8 admission -- I'd move to admit Exhibit 6 as an
9 exhibit in this case.

10 BY MR. HOGLE:

11 Q. Now, tell us a little bit about your
12 educational background.

13 A. My education is a B.S. in chemical
14 engineering from Montana State University and a
15 master's of science in chemical engineering from
16 Montana State University.

17 Q. When did you get your master's?

18 A. I received my master's in 1972.

19 Q. And your B.S.?

20 A. 1970.

21 Q. All right. Now, give us your employment
22 background.

23 A. Well, I started -- my first professional
24 employment was with 3M Company. It was a summer
25 job. Then I worked for a number of different firms.

1 permitting. I've worked in pollution control. I
2 have done contamination assessments, designed and
3 constructed and started up remedial operations to
4 remediate contaminated sites.

5 I've been in business management and --
6 and managed firms. Also, I've done some safety and
7 health work and training of people for OSHA HAZWOPER
8 compliance, hazardous waste operations compliance.

9 Q. Okay. And are you a registered
10 professional engineer?

11 A. I am a registered professional engineer.
12 I was originally registered in California, and I
13 believe my registration began in about 1977, and
14 I've been registered -- then obtained reciprocity in
15 Montana. So I'm registered in Montana and
16 California.

17 Q. All right. Now, you were asked by U.S.
18 Oil Sands to perform some work for this case;
19 correct?

20 A. Yes, that's correct.

21 Q. Now, the -- the work you were asked to
22 do, is that the kind of work you do -- that you have
23 done since approximately 1988?

24 A. Yes, it's akin to that work. It -- it
25 fits in with the type of consulting and deals with

1 I -- I started with -- after -- after I worked
2 for -- that summer job, then I started my full-time
3 professional employment with Dow Chemical, worked
4 for them for a few years.

5 Then I went to work for the Montana Power
6 Company. Then Montana Power -- in several positions
7 with Montana Power -- then I left Montana Power to
8 work for a subsidiary of that company called Special
9 Resource Management, which was an
10 environmental-related firm, working in waste
11 management and environmental consulting.

12 Then we spun off from Special Resource
13 Management and formed a company that -- that I was
14 the majority owner in, and that was called Atlatl
15 Incorporated. And then Atlatl Incorporated was
16 merged into JBR Environmental Consultants in 2008,
17 and I've worked for that company since.

18 Q. Okay. When did you start for Special
19 Resource Management, approximately?

20 A. Approximately, that would have been about
21 nineteen -- I think around 1988, in that area.

22 Q. Okay. And since 1988, could you describe
23 the focus of your work?

24 A. The focus of my work has been primarily
25 environmental related. I've worked in such items as

1 the types of problems that -- that I have dealt with
2 previously.

3 Q. All right. And in your work since 1988,
4 you've dealt with real mine projects; correct?

5 A. Yes, I have. I constructed -- designed,
6 constructed, and consulted on a number of systems
7 that have resulted in actual field work.

8 Basically, a lot of my work has been
9 boots on the ground type of work, very pragmatic
10 type of work, where we've actually installed or
11 operated systems or dealt with actual client
12 problems that -- that exist from environmental
13 transport -- or environmental contamination or
14 permitting procedures and in, occasionally,
15 litigation procedures.

16 Q. And your work for projects -- if I
17 understood what you said -- sometimes it begins with
18 the design phase?

19 A. That's correct.

20 Q. Okay. And you perform calculations and
21 projections in that design phase?

22 A. I do.

23 Q. Okay. And have -- are your calculations
24 and your projections validated with actual
25 experience on the ground when the projects get up

and running?

2 A. Oh, most definitely. That's one of the
3 things I enjoy about this work is that I can get a
4 chance to design those projects and then -- and then
5 see how they conform to the design when they're
6 operating, and that's -- that's part of the closure
7 that -- that we do on our projects.

8 It's a full cycle type of a project when
9 we can design it, operate it, close down a site, and
10 complete the report. So we see the full cycle many
11 times.

12 Q. And that's been your experience since
13 approximately 1988?

14 A. Yeah, starting in 1988. Actually,
15 about -- I guess it was 1986 when I started with
16 Special Resource Management. But that's -- that's a
17 typical cycle.

18 Q. What were you asked to do for this case?

19 A. I was asked to review Dr. Johnson's
20 testimony and review his calculations and opinions
21 and offer comments and critique of -- of -- of those
22 works that he's provided.

23 Q. And what approach did you take in this
24 case?

25 A. Well, initially I reviewed Dr. Johnson's

1 work and formed some opinions regarding that work
2 and then felt that it was necessary to provide an
3 independent approach to contrast the results that --
4 that he came up with to what I felt was appropriate
5 from a -- from a different -- completely different
6 perspective.

7 Q. And what was the -- I mean, describe for
8 us the independent approach that you took.

9 A. The approach I took was a traditional
10 chemical engineering approach that starts with
11 utilization of a ternary phase diagram to model the
12 three-component liquid system that U.S. Oil Sands is
13 using to extract bitumen from the -- from the oil
14 sands, the three components being water; d-limonene,
15 which is a terpene chemical; and bitumen, which is
16 the material that they're attempting to extract from
17 the oil sands and produce as a valuable product.

18 Q. Okay. You mentioned -- just for purposes
19 of defining terms, you mentioned a ternary phase
20 diagram. What is that and why is it useful?

21 A. Well, ternary phase diagram is a diagram
22 that graphically shows the relationships between the
23 three components in -- in the liquid system. It --
24 it shows the equilibrium relationships between the
25 three chemicals.

1 In -- in our ^{TYPE} particular case, we have
2 what is called a ~~Phase 2~~ ternary diagram in which
3 there are two immiscible or partially miscible
4 phases, one phase being an oil-rich terpene phase
5 which contains the bulk of the d-limonene and the
6 bitumen, and the other phase is an aqueous phase
7 which contains very minute concentrations of
8 d-limonene and bitumen.

9 Q. Okay. And did you prepare a figure for
10 this case that shows a ternary diagram?

11 A. Yes, I -- I did. I prepared a diagram
12 that depicts a generalized ternary diagram, first of
13 all, that will describe a ~~Phase 2~~ system and --

14 Q. Before you get there --

15 A. Oh, excuse me.

16 Q. -- let me go ahead and mark it.

17 (Whereupon, Exhibit No. 7 was marked for
18 purposes of identification.)

19 BY MR. HOGLE:

20 Q. Okay. I'm handing you what's been marked
21 as Exhibit 7, and do you recognize that --

22 A. Yes. This --

23 Q. -- tell us what that is.

24 A. -- I do. This is the diagram that I
25 prepared, a hand -- hand sketch.

1 Q. Okay. Could you put that in the -- in
2 the document camera so --

3 A. Yes.

4 Q. -- we can see that. All right. And this
5 is a ternary diagram?

6 A. Yes, this is a -- this is a ternary
7 diagram -- a generalized ternary diagram for a
8 system similar to water, d-limonene and bitumen. It
9 is not the exact ternary diagram, but it represents
10 the -- the principles that -- that I would intend to
11 talk about.

12 The diagram has three apexes -- it's a
13 triangular plot -- and each apex represents a pure
14 component. For example, the lower left-hand apex of
15 the diagram represents pure water. The lower
16 right-hand apex represents pure d-limonene, and the
17 upper apex represents pure bitumen.

18 As we move away from any one of those
19 apexes, the concentration decreases for that
20 particular compound. So as I trace downward in this
21 direction, the bitumen concentration would -- would
22 decrease. And the same for the other apices.

23 So the relationship, then, is defined --
24 the relationships that we -- we want to talk about
25 are the equilibrium relationships which are formed

1 by these two lines in this Type II ternary diagram.
 2 There are two phases here: an oil-rich phase, which
 3 is represented by the line in the upper right-hand
 4 of the diagram, and then a raffinate phase, which
 5 is -- the nomenclature describes a water-rich phase.
 6 That -- that is the raffinate phase.

7 And the raffinate phase contains very
 8 dilute concentrations of the bitumen and the
 9 limonene; whereas, the extract or oil-rich phase
 10 contains very concentrated concentrations of -- of
 11 those two materials. So all possible combinations
 12 of this system in terms of any of the three
 13 components can be plotted on this diagram.

14 If we start out with a system that is --
 15 or a concentration where I'm pointing here, that
 16 actual distribution of -- of compounds will
 17 distribute between the oil-rich line and the
 18 water-rich line and be -- be able to be plotted on
 19 those two lines. So any -- anywhere that -- in this
 20 diagram -- that a -- a possible combination of those
 21 chemicals exists, they will distribute to those two
 22 lines. So that -- that forms the equilibrium
 23 relationship.

24 **Q. Okay. Now, there's a reference on this**
 25 **Exhibit 7 to a Perry 5th Edition.**

1 A. It is, from the 1973 edition.

2 **Q. Okay.**

3 **MR. HOGLE:** I move for the admission of
 4 Exhibit 8.

5 **BY MR. HOGLE:**

6 **Q. Now, on -- back to Exhibit 7, you've got**
 7 **this Phase -- this Type II ternary diagram, and**
 8 **explain to us where -- what type of mixture or what**
 9 **materials we're concerned with in this case in terms**
 10 **of post-process.**

11 A. In post-process, we're primarily
 12 interested in the raffinate phase, which is the
 13 water-rich phase, contrasting that to the oil-rich
 14 phase which is -- which is separated out for further
 15 processing and separation of the -- of the bitumen,
 16 which -- which is the product.

17 The raffinate phase is what we're
 18 concerned with in terms of the residual sands that
 19 have been washed by the process and are -- are then
 20 produced as a -- a byproduct of -- out of the
 21 process.

22 The raffinate phase will be used to
 23 describe water that could potentially come into
 24 contact with those processed sands and come in --
 25 then form an equilibrium relationship with the

1 A. Yes.

2 **Q. Does Perry -- is -- is that an**
 3 **authoritative treatise?**

4 A. Yes. Perry's Chemical Engineering
 5 Handbook is the -- the bible of chemical
 6 engineering. It's been used for -- for years and
 7 years. I was produced -- presented with my first
 8 copy of Perry's Chemical Engineering Handbook when I
 9 was a -- a junior in chemical engineering at Montana
 10 State University, and I still keep that as a
 11 keepsake. But all chemical engineers that -- that I
 12 have ever met own their own copy of Chemical
 13 Engineering -- Perry's Chemical Engineering Handbook
 14 and utilize it frequently.

15 (Whereupon, Exhibit No. 8 was marked for
 16 purposes of identification.)

17 **BY MR. HOGLE:**

18 **Q. Okay. And I'm handing you what's been**
 19 **marked as Exhibit 8, and that is -- is that**
 20 **Reference No. 2 to the expert report that you**
 21 **prepared for this case?**

22 A. It is.

23 **Q. Okay. And are those -- is -- are**
 24 **those -- excuse me -- is Exhibit 8 excerpts from the**
 25 **Perry handbook?**

1 remaining bitumen that is in those sands. That
 2 water, then, will be described by the -- the ternary
 3 diagram equilibrium line for the raffinate phase --

4 **Q. Okay.**

5 A. -- so that forms the basis of -- of
 6 making the projections.

7 **Q. And is this Figure 1 in Exhibit 7 -- is**
 8 **this to scale, or is this just meant for**
 9 **demonstration purposes?**

10 A. This is just a demonstration purpose. In
 11 actuality, the -- the components that we are dealing
 12 with in this particular case for the two phases have
 13 certain characteristics that make it difficult to
 14 actually show a -- a discernible line on the
 15 diagram.

16 For example, the oil phase is so rich in
 17 oil that it's very close to the -- the axis of the
 18 diagram. Additionally, the raffinate phase is so
 19 dilute that it is in the very, very corner of the
 20 diagram as well.

21 So this -- this Figure 1 is merely a -- a
 22 depiction of the relationships and not a -- an
 23 actual picture of what the ternary phase diagram for
 24 the system in -- in question looks like. I do have
 25 that in my report, however.

1 Q. Okay. Now, did you describe -- did you
2 complete your description of the approach that you
3 took in this case?

4 A. No. The -- the approach started out with
5 the ternary diagram and then proceeded to add
6 additional calculations and extract -- or not
7 extract -- but develop from the ternary drawing --
8 diagram an equilibrium relationship between the
9 bitumen and the water in -- in the raffinate phase.

10 And then, from that, I was able to do
11 calculations, based on other information, regarding
12 concentrations of specific chemicals in the
13 raffinate to project what real expected
14 concentrations would be in the raffinate system with
15 regard to some of the polyaromatic hydrocarbons that
16 are in question. That was then used to compare what
17 may have been an equivalent concentration from the
18 virgin sands prior to processing.

19 So I think that -- that really forms the
20 basis of -- of what I was attempting to do in my
21 contrasting analysis to what Dr. Johnson provided,
22 in that I was trying to compare the virgin sands'
23 water contact relationship with the processed sands'
24 water contact relationship.

25 Q. Okay. To the end of determining what

1 Q. Okay. Put that in the document camera
2 so...

3 A. Will I have to turn it this -- this way
4 to make it fit or --

5 Q. You can turn it any which way you like,
6 and we can --

7 A. Okay.

8 Q. -- you know, we can pan back a little
9 bit.

10 A. All right. It -- it -- it's actually
11 easiest -- can you see the whole thing that way?

12 Q. Yes.

13 A. Okay. Great.

14 Q. Okay. Before you -- before you just --
15 you go further, I would move for the admission of
16 Exhibit 9.

17 Now, I just want to make sure I -- I
18 understand. I wanted -- I wanted to back up and --
19 and sort of follow up on some of the things you
20 said.

21 You talked about performing additional
22 calculations to extract from the Type II ternary
23 diagram an equilibrium relationship between the
24 bitumen and the water in the raffinate phase.

25 A. Yes.

1 impact on the concentration in bitumen would be the
2 outcome of the U.S. Oil Sands process; right?

3 A. Yes.

4 Q. Okay. Now, you mentioned that after --
5 you started with the Type II ternary diagram, and
6 then you performed additional calculations.

7 Where did you -- what was the source for
8 your -- the equations that you used for those
9 calculations?

10 A. I -- I used the relationships from the
11 Perry's Chemical Engineering Handbook, first of all,
12 to plot out the actual ternary diagram. Now, could
13 I -- could we see that?

14 Q. Sure.

15 A. It might be easier to --

16 Q. Sure.

17 (Whereupon, Exhibit No. 9 was marked for
18 purposes of identification.)

19 BY MR. HOGLE;

20 Q. Okay. I'm handing you what's been marked
21 as Exhibit 9. Do you -- can you identify that for
22 us?

23 A. Yes. This is the actual ternary phase
24 diagram that -- that I prepared for the water,
25 d-limonene, bitumen system in this -- this matter.

1 Q. What is an equilibrium relationship, and
2 why is that a good thing to -- to -- to develop?

3 A. Well, the equilibrium relationship will
4 show the amount of bitumen compounds that are in
5 the -- in the raffinate phase as related to the
6 relative amounts of bitumen and d-limonene
7 concentrations that are in the oil phase.

8 This is important because there is
9 residual d-limonene and bitumen in the -- in the
10 residual oil sands, and thus, we are able to relate
11 what a projected concentration would be in water in
12 equilibrium contact with those processed sands.

13 Q. Okay.

14 A. So --

15 Q. And then, from there, you said you
16 performed additional calculations with information
17 regarding the specific properties of -- of
18 materials?

19 A. Yes.

20 Q. Okay. And the equations that you used
21 for those calculations, what's the source for those?

22 A. Those are -- those calculations were
23 based on solubility relationships using Raoult's
24 Law, ideal solution type of approaches for very
25 dilute solutions.

1 Q. Okay. And is that appropriate for this
2 case?

3 A. Yes, it is.

4 Q. Why?

5 A. It's appropriate because these are very
6 minute solutions -- very -- very dilute solutions,
7 and the interactions between those dissolved
8 chemicals are -- are not great.

9 And the other exhibits -- or the other
10 references that I have in my report indicate that
11 these are valid type of approaches to use for
12 looking at individual concentrations. And I believe
13 I have an EPA reference in my report that backs that
14 up.

15 Q. Okay. Is -- would that be Reference 8 to
16 your report?

17 A. I believe it is. Let me just
18 double-check here, through my materials.
19 (Witness reviewed document.) Well, it's
20 actually Reference No. 1.

21 Q. Okay. Okay.

22 A. We're looking at the effective
23 solubility --

24 Q. Okay.

25 A. -- for a -- a mixture of compounds.

1 approaches, yes.

2 Q. Now, is the approach you took the
3 accepted approach -- accepted approach in your
4 industry and in your profession?

5 A. It is. It -- the approach is actually
6 summarized in Perry's Chemical Engineering Handbook,
7 and I followed that template for -- for the
8 approach.

9 Q. Okay. Is that the same type of
10 pragmatic, real world-based approach that you take
11 in your day-to-day work?

12 A. It is.

13 Q. All right. Now, how did -- explain to us
14 in simple terms, please, for my benefit, how your --
15 you applied your approach and the outcome of your
16 approach.

17 A. Well, the approach starts out with the
18 actual construction of the ternary diagram. And in
19 order to construct the ternary diagram, we need
20 information regarding solubilities in the -- the
21 various materials, so let's start out with the --
22 the top apex of the ternary diagram.

23 There we obtained -- as described in my
24 report and referenced in my report -- a
25 concentration for dissolved bitumen in water of

1 Q. And just for the record, what is
2 Reference No. 1?

3 A. That is an EPA online tool for site
4 assessment calculations, and the -- it shows a -- an
5 equation for effective solubility as a function of
6 mole fraction and individual component solubility.

7 Q. Okay. And do you have a copy of that
8 right there --

9 A. Yes, I do.

10 Q. -- is that what you're looking at?

11 A. Yes.

12 Q. Do you mind if we -- if we mark that?

13 (Whereupon, Exhibit No. 10 was marked for
14 purposes of identification.)

15 BY MR. HOGLE:

16 Q. Okay. I've marked this Exhibit 10, and
17 I'm handing it to you. And again, is that the EPA
18 resource that you just described.

19 A. Yes.

20 MR. HOGLE: Okay. I would move for the
21 admission of Exhibit 10.

22 BY MR. HOGLE:

23 Q. Now, have you described the approaches
24 that you took to your -- to your work in this case?

25 A. In general terms, I have described the

1 6,000 milligrams per kilogram. That is one point
2 plotted on the upper -- at the upper apex on the
3 left-hand axis.

4 Then, on the other right-hand axis, we
5 have plotted the fixed point for the water
6 solubility of d-limonene. This -- this is water
7 dissolved in d-limonene. That point, then, is
8 plotted on the lower axis -- the bottom axis of the
9 diagram in the right-hand corner.

10 Those two points, then, are connected to
11 form the -- to construct the equilibrium line which
12 describes the oil-rich extract phase. This is a
13 very dilute solution in terms of -- or excuse me --
14 a very concentrated solution in terms of content of
15 d-limonene and bitumen, so it is very, very close to
16 the axis of the diagram. So it makes it almost
17 indiscernible in this case because it is so close to
18 that axis.

19 Then to construct the raffinate phase
20 line, which is in the -- the -- the lower left-hand
21 corner of the diagram, we used two points that
22 are -- that are also labeled on the diagram here.
23 On the left-hand axis of the diagram, we have
24 plotted a bitumen solubility in water that, again,
25 was taken from a range of values as described in my

report, and this is a very small or very low concentration, which is five times ten to the minus third milligrams per kilogram. That's on the left-hand axis.

Then, on the lower axis, in the left-hand corner, we have plotted a solubility point for d-limonene dissolved in water, and that is taken from the literature as 13.8 milligrams per liter. And again, it doesn't even show on the diagram. It's -- it's so small, that -- it is in this left-hand corner.

It's not -- it's important to understand that those lines exist, but it's not -- not really important for my analysis to show -- to -- to be able to show the -- the lines perfectly on this diagram because the important thing is the data that then comes from this diagram to produce the equilibrium diagram.

Q. Okay. Before you move on -- well, are you finished with this diagram?

A. I believe so.

Q. Okay. Before you move on to the next part of the application of your approach, you indicated that you used source information for the plot -- the -- the different apexes --

1 Q. Okay. And then what about the lower right apex of Exhibit 9? What is that, and what was the source material for that?

A. That is the water solubility in d-limonene, and that is the -- depicted in -- or described in my report on page 3, at the -- near the top of the page. It's the first -- or the second full sub-bullet --

9 Q. Um-hum.

A. -- water solubility in d-limonene. And I -- there were several -- or a couple of different literature values that I reviewed with regard to what was reported in Reference 4 and 10, and those values ranged from 500 to 1,000 parts per million. And I felt that a -- a value for the water solubility of 1,000 parts per million was appropriate, so I used that to plot that.

18 Q. Okay. Reference No. 4 is a communication you had with Barclay Cuthbert; correct?

A. That's correct.

21 Q. And Reference No. 10 is some information from KIC Chemicals, Inc.?

A. Yes.

(Whereupon, Exhibit No. 11 was marked for purposes of identification.)

A. Yes.

2 Q. -- what I want to make sure we understand fully the source material that you used --

A. Okay.

5 Q. -- so what was the source material for the -- what was the upper apex again, and what was the source material you used for that?

A. The -- the upper apex was a 6,000 milligram per kilogram figure -- or value based on moisture content from an analysis, and I have that documented in my -- in my report.

12 Q. What reference number is that?

A. Hang on for a second here. Bear with me while I find this --

15 Q. No problem. Take your time.

A. -- okay. Here we go. In my report, it's on page 2, the -- the second -- or the third bullet, first sub-bullet, and it is Reference 3.

19 Q. Okay. All right. And Reference 3 is the February 28, 2008, JBR Permit-By-Rule Demonstration?

A. It is, yes.

22 Q. Okay. All right. And that's the source, then, for the value on the top apex of Exhibit 9; right?

A. That's correct.

1 BY MR. HOGLE:

2 Q. I'm handing you what's been marked as Exhibit 11. Can you identify that?

A. Yes. This is the information that I received -- or obtained from the Internet website from KIC Chemicals which indicates the -- the moisture value that -- or the water content value that I was utilizing as one of the figures to make my projections.

10 Q. Okay. All right. And the reference materials -- the materials you referenced in your report and that you reference today, are all of those appropriate to rely on in this case for --

A. Yes. This is actually a commercial -- commercial value. This is -- this is a product sheet that shows the -- the range of water content.

17 Q. Okay.

18 MR. HOGLE: I would move for the admission of Exhibit 10.

20 BY MR. HOGLE:

21 Q. All right. Now, finally, in the lower left-hand apex of Exhibit 9, what is that, and what was the source of material for that?

A. Okay. On the -- the -- the lower axis of the right-hand apex, that is the d-limonene

1 solubility in -- in water, and that was -- that was
2 taken from References 8 and 9, which both agreed on
3 a solubility of 13.8 milligrams per kilogram -- or
4 milligrams per liter. Excuse me.

5 **Q. Okay. Now, identify for us what**
6 **Reference 8 is.**

7 A. Reference 8 -- Reference 8 is a -- a -- a
8 physical property reference that I obtained from the
9 Internet, from www.inchem.org, and it -- it lists
10 the water solubility of d-limonene. Excuse me. Did
11 you say 8?

12 **Q. I said 8.**

13 A. I'm sorry. I -- I --

14 **Q. You were talking about 9.**

15 A. -- I talked about -- I've got 9 here.
16 I'm sorry.

17 Reference No. 8 is an EPA reference
18 from -- from their -- one of the EPA website
19 sources, and it is www.epa.gov, and then there are
20 some other extensions to that website.

21 **Q. Okay. Do you have Dr. Johnson's January**
22 **20, 2012, testimony, which has been marked as**
23 **Exhibit 1 in this case?**

24 A. I do have that.

25 **Q. And could you turn to page 34, the last**

1 A. Yes, this is the exhibit that I was
2 previously speaking of.

3 **Q. Okay.**

4 **MR. HOGLE:** And I would move for the admission
5 of Exhibit 12.

6 **BY MR. HOGLE:**

7 **Q. Now, is there -- on the upper part of the**
8 **lower access -- apex -- excuse me -- the upper part**
9 **of the lower-left apex in Exhibit 9, there's some --**
10 **there's another reference -- or there's some --**
11 **another value; correct?**

12 A. Yes. That is the -- the bitumen
13 solubility in water. And again, that was -- the
14 value was an interpolation of values from the
15 literature, and that should be described in my
16 report as well.

17 **Q. Give us the reference.**

18 A. Bitumen solubility in water, that would
19 be on -- the last bullet on page 2 of my report
20 references 5, 6, and 7 in my reference list.

21 **Q. Okay.**

22 (Whereupon, Exhibit No. 13 was marked for
23 purposes of identification.)

24 **BY MR. HOGLE:**

25 **Q. All right. I'm handing you what's been**

1 **page? And is your Reference 8 the same as his**
2 **Reference 1?**

3 A. I can't -- I can't relate these two by
4 the information that -- that I have.

5 **Q. Let me -- let me hand you -- and I'm not**
6 **going to mark this. I'll just hand you what -- what**
7 **is Reference 8 to your report.**

8 **Based on that, does it appear to be the**
9 **same as the EPA publication on which Dr. Johnson**
10 **relied?**

11 A. (Witness reviewed document.) Well,
12 Reference 8 in Dr. Johnson's --

13 **Q. No, Reference 1.**

14 A. Reference 1. I'm sorry. Yes, that --
15 that appears to be the same --

16 **Q. Okay.**

17 A. -- document that is in Dr. Johnson's
18 report.

19 (Whereupon, Exhibit No. 12 was marked for
20 purposes of identification.)

21 **BY MR. HOGLE:**

22 **Q. Okay. And then -- and then, a second**
23 **ago, you described Reference 9. I've marked as**
24 **Exhibit 12 this document, and do you recognize that**
25 **as Reference 9 that you just described?**

1 **marked as Exhibit 13. Can you identify that?**

2 A. Yes. This is the Reference 5 that --
3 that I have used in -- in my work.

4 **Q. And what is that again?**

5 A. This -- this is a -- again, from -- from
6 the website -- the www.inchem.org website. It is a
7 listing of physical properties of -- of various
8 materials. And from -- from this listing, I was
9 able to obtain one of the values that I used to plot
10 as the -- or that I used in reference to come up
11 with the point on that diagram --

12 **Q. Okay.**

13 A. -- but one of -- one of the three --
14 three different sources.

15 **MR. HOGLE:** And I would move for the admission
16 of Exhibit 13. And you can set that aside.

17 (Whereupon, Exhibit No. 14 was marked for
18 purposes of identification.)

19 **BY MR. HOGLE:**

20 **Q. I'm handing you another document. This**
21 **one's been marked as Exhibit 14. Can you identify**
22 **that?**

23 A. Yes. This is -- this is Reference 6 that
24 I've used in my calculation, and this is from an
25 Internet source also -- www.sciencemag.org -- and it

1 is one of the -- one of the values -- wait a second
2 here -- one of the reference that I've -- references
3 that I've cited.

4 Wasn't there a second page to that?
5 Okay, yeah --

6 **Q. Well --**
7 A. -- this is -- this is it, yeah. I'm
8 sorry. There was -- there was just a single page.
9 But, yes, this is -- this is the -- this,
10 again, makes up one of the points of information
11 that I used to evaluate the chosen bitumen
12 solubility in water for -- for plotting purposes.

13 **Q. All right.**
14 **MR. HOGLE:** I'd move for the admission of
15 Exhibit 14.

16 (Whereupon, Exhibit No. 15 was marked for
17 purposes of identification.)

18 **BY MR. HOGLE:**
19 **Q. And then you mentioned one other**
20 **reference. I'm handing you what's been marked as**
21 **Exhibit 15, and please identify what that is.**

22 A. This is a compilation of liquid
23 equilibrium data from the Journal of Physical
24 Chemistry, and it -- it was also utilized in the --
25 my -- in -- in the range of values that I considered

1 A. Reference 2 in -- oh, excuse me. Exhibit
2 8 --

3 **Q. Yeah.**

4 A. -- but Reference 2 in my -- and -- can I
5 move this?

6 **Q. Yes.**

7 A. Okay. I'm going to show page 15-5 out of
8 the Perry's reference, which is Exhibit 8, and does
9 that show -- should I blow that up a little bit?

10 **Q. Yeah.**

11 A. I want to specifically look at the
12 relationship for the -- for the Type II system here,
13 and this -- this schematically shows the Type II
14 system which relates the ternary phase diagram,
15 which I'm pointing to here, to the equilibrium
16 diagram, which I'm pointing to here.

17 And what it -- what it takes to construct
18 this diagram are transferring points from the
19 equilibrium -- or from the ternary phase diagram
20 across and plotting them on the axis of the
21 equilibrium relationship.

22 And it's -- it's important to note here
23 that for -- for the Type II system, a relatively
24 straight line is generalized for the Type II ternary
25 phase diagram. And additionally, for very dilute

1 for plotting that -- that point on -- on the
2 diagram, which would be the bitumen solubility in
3 water.

4 **Q. Okay.**

5 **MR. HOGLE:** I would move for the admission of
6 Exhibit 15.

7 **BY MR. HOGLE:**

8 **Q. Now, have we identified all the source**
9 **material for the values on your diagram that's**
10 **marked as Exhibit 9?**

11 A. Yes.

12 **Q. Okay. Now -- all right. So that's part**
13 **of the -- the application of your approach. I**
14 **interrupted you to introduce and offer the source**
15 **material that you used. So please continue on with**
16 **how you applied your approach and to what end.**

17 A. Okay. Well, once -- once these -- once
18 these values are plotted on the diagram and -- and
19 documented on the diagram, then the approach is to
20 construct an equilibrium relationship that relates
21 the oil-rich and raffinate phases. And I wonder if
22 I could refer back to the Perry reference to show
23 that very quickly.

24 **Q. Sure. I think that's 7. No, it's**
25 **probably --**

1 solutions, these lines will become -- very dilute or
2 very concentrated solutions -- these lines will
3 be -- become straight, in many cases, on the ternary
4 diagram, and that will yield a relatively straight
5 equilibrium relationship here, where we relate
6 the -- the equilibrium of a -- of the bitumen
7 compound in our case to the oil and water phases or
8 the oil-rich and water-rich phases, which the
9 water-rich phase I, again, refer to as the raffinate
10 phase.

11 So that -- that is the -- the diagram
12 that -- that I will show then to be constructed from
13 the ternary diagram that -- that I started out with.

14 And the equilibrium relationship is also
15 attached to my report --

16 (Whereupon, Exhibit No. 16 was marked for
17 purposes of identification.)

18 **BY MR. HOGLE:**

19 **Q. I'm -- I'm handing you right now what's**
20 **been marked as Exhibit 16. Could you identify that?**

21 A. Yes. This is the equilibrium
22 relationship that then is extracted from the -- or
23 constructed from the data on the ternary phase
24 diagram, and it shows the percent bitumen in the
25 extract, which is the oil-rich phase, and relates

1 that to the concentration of bitumen in the
2 raffinate, which is the water-rich phase.

3 **Q. Okay. I would -- and this is a document**
4 **you prepared; correct?**

5 A. I prepared this, yes.

6 **Q. Okay.**

7 **MR. HOGLE:** And I would move for the admission
8 of Exhibit 16.

9 **BY MR. HOGLE:**

10 **Q. Now, walk us through this figure.**

11 A. Okay. The -- this is constructed in
12 the same manner as the -- as was shown in Perry's
13 Chemical Engineering Handbook.

14 So in order to construct this, I -- I --
15 the construction is described, again, in -- in my --
16 in my report. The -- directly from the equilibrium
17 relationship -- or -- or the ternary phase
18 relationship, we take the -- the point of the
19 five -- excuse me. Let me just check here -- real
20 quick here. (Witness reviewed document.)

21 From the water -- water-rich phase, we
22 take the five times ten to the minus third
23 milligrams per liter -- which is equivalent to
24 milligrams per kilogram because we're talking about
25 water, which is a density of 1,000 milligrams -- or

1 diagram are -- the relationship is described as
2 what -- what are called tie lines. And the --
3 the -- the most simple tie line is to tie the
4 equilibrium phase diagram in the ternary system for
5 the raffinate phase with that of the oil-rich phase
6 with regard to the concentration of their -- of
7 their relative amounts of bitumen.

8 So from -- directly from the diagram --
9 from the equilibrium -- or from the ternary diagram
10 at 100 percent bitumen -- basically, this is --
11 point is plotted and ties back to the -- the line at
12 five times ten to the minus third milligrams per
13 kilogram for the bitumen solubility in the water.

14 And, of course, at -- at zero
15 concentration of bitumen in the extract, where we
16 would be looking only at pure limonene, there would
17 be no concentration in the water, so we have the --
18 this -- the two points of the curve defined.

19 And then, from the relationships as I
20 previously mentioned for the dilute systems as
21 described in Perry's, the equilibrium becomes a
22 relatively straight line.

23 So then this relates the concentration of
24 bitumen in the extract to the concentration of
25 bitumen in the water-rich or raffinate phase, and

1 1,000 grams per liter -- so that -- that point is --
2 is plotted here.

3 And then the -- the corresponding point
4 would be the 100 percent bitumen in the extract --
5 or in the -- in the extract, which would be the
6 upper -- hang on for just a second here. It's been
7 a while since I looked at this. I -- could we take
8 a break for a second?

9 **Q. Yeah, let's take a break.**

10 **VIDEOGRAPHER:** We're going off the record. The
11 time now is 10:49.

12 (Off the record)

13 **VIDEOGRAPHER:** We're back on the record at
14 11:06.

15 **BY MR. HOGLE:**

16 **Q. All right. Mr. Handl, we're -- we're**
17 **still talking about the application of your approach**
18 **in this case, and walk us through the rest of your**
19 **approach after you plotted the values on**
20 **Exhibit 9. And I think you were explaining how you**
21 **took that into an equilibrium relationship as**
22 **depicted on Exhibit 10. Right?**

23 A. Right. And what I was starting to
24 explain before we took the break: The relationship
25 between the -- the two phase lines on the ternary

1 that is the equilibrium diagram that I -- that I
2 used for the -- for the basis of the -- the
3 remainder of -- of the projections I made in my
4 report.

5 Then to -- what I wanted to do was
6 compare the -- the concentration of one of the
7 polyaromatic hydrocarbons -- benzo(a)pyrene -- what
8 the concentration of that would be, estimating it
9 for the water in contact with virgin oil sands or
10 unprocessed oil sands. And in order to do that, I
11 first obtained some relative concentrations of PAHs
12 in crude petroleum in shale oil from -- or shale
13 sources from Reference 11, and -- and there were
14 ranges for those -- for the B(a)P concentrations,
15 depending on what the particular source of material
16 was. But they ranged from 3 to 192 milligrams per
17 kilogram for -- for B(a)P concentration.

18 (Whereupon, Exhibit No. 17 was marked for
19 purposes of identification.)

20 **BY MR. HOGLE:**

21 **Q. Let me go ahead and hand you a document.**
22 **That's Reference 11 to your report; correct?**

23 A. Yes.

24 **Q. Okay. And that's the document you just**
25 **described?**

1 A. Yes.

2 **Q. Okay. I would move for the admission of**
3 **Exhibit 17 which I've handed you. Go ahead and**
4 **proceed.**

5 A. So -- obviously, there's a range reported
6 in the literature, so I felt it somewhat
7 conservative to weight that range toward the high
8 end, the range being -- that -- that -- that I
9 found -- from 3 to 192 milligrams per kilogram or
10 parts per million of -- of B(a)P in the -- these
11 petroleum sources.

12 So I -- I chose a value of 150 milligrams
13 per kilogram to be conservative. And then using the
14 relationship of solubility of that compound to
15 its -- to its mole fraction, I converted the -- the
16 mole fraction and the solubility and came up with a
17 projected concentration for B(a)P in -- in the crude
18 oil sands, for -- for water that would be in contact
19 with the crude oil sands.

20 Again, this is only a projection, but
21 it -- it comes up to 5.7 times ten to the minus
22 fourth micrograms per liter. And that's -- that
23 calculation is outlined in my -- in my report.

24 Then I wanted to compare that number --
25 which is the -- basically the number one would

1 expect from rain or precipitation in contact with
2 the virgin oil sands -- I wanted to compare that
3 number to the equivalent number where rain or other
4 precipitation would be in contact with the processed
5 oil sands, and in order to do that, I needed to find
6 a percent bitumen concentration in the processed oil
7 sands, and I obtained that from a -- Reference
8 No. 3, which...

9 **Q. That's the JBR demonstration; right?**

10 A. Right. Which is the -- that was the
11 reported range of moisture content.

12 And then also, using some of the
13 d-limonene concentration as reported by Dr. Johnson
14 as 1.8 percent in the fines, along with the .84
15 percent bitumen remaining in the combined spent
16 solids -- and -- and that is from my Reference 3,
17 is -- which is that same report -- I calculated a
18 weight fraction of about 69 percent of d-limonene in
19 the bitumen. And therefore, the corresponding
20 weight fraction of -- of bitumen in that mixture
21 would be 31 percent.

22 So then -- going back to the equilibrium
23 curve -- at 31 percent bitumen in the extract phase,
24 which would be somewhere in this range, I -- I can
25 come across and relate that, through the equilibrium

1 curve, to an approximate bitumen concentration in
2 the raffinate phase of about 1.5 times ten to the
3 minus third milligrams per kilogram or parts per
4 million.

5 Then using that basic concentration value
6 for bitumen in the raffinate, I can again use the
7 relative B(a)P concentration in the petroleum
8 products which I derived before, and through a
9 similar calculation, I come up -- I -- I -- I
10 obtained a value of 2.3 times ten to the minus sixth
11 micrograms per liter for -- for the B(a)P
12 concentration -- projected B(a)P concentration in
13 the raffinate phase of the processed oil sands,
14 assuming that water was in contact with those --
15 with those sands and the water was in equilibrium.

16 So that -- that -- that made my -- made
17 the comparison complete and, I think, rigorous in --
18 in respect to that I was comparing apples for
19 apples, preprocessed conditions with post-processed
20 conditions and talking about actual projected
21 concentrations rather than orders of magnitude
22 change or a percentage change in solubilities. I'm
23 talking about actual concentrations in my analysis.

24 **Q. So just to sum, what -- what did you**
25 **compare and what was the value that you came up with**

1 **in terms of the preprocessed condition for the**
2 **actual concentrations of B(a)Ps?**

3 A. In the -- the -- the preprocessed
4 condition, the B(a)P concentration, as I -- as I
5 summed in my -- my report, I calculated 5.7 times
6 ten to the minus fourth micrograms per liter, and
7 that's from the -- in -- with water in contact with
8 the raw bitumen and comparing that to the
9 post-processed sand and fines, 2.3 times ten to the
10 minus sixth micrograms per liter. And the reason
11 for the big drop is that you've extracted much of
12 the bitumen.

13 **Q. Okay. So under your calculations, the**
14 **concentration level actually goes down --**

15 A. Yes.

16 **Q. -- through the process; right?**

17 A. Yes.

18 **Q. And Dr. Johnson opines that the**
19 **concentration levels go up by a factor of 1,500;**
20 **right?**

21 A. Yes.

22 **Q. All right.**

23 A. Well, let me -- let me just qualify that.
24 Again, I think -- I think Dr. Johnson was analyzing
25 solubilities rather than projecting actual

1 concentrations. I think -- I think that's a fair
2 statement.

3 **Q. And why is it better to do what -- what**
4 **you did and project the concentrations?**

5 A. Well, again, from a pragmatic standpoint,
6 what we're really interested in here is what is
7 present in field -- in the field, what is present in
8 the bitumen as it exists the way God put it in place
9 versus that which exists after it's been processed
10 by man.

11 Those are the two comparisons that we're
12 trying to make, so I think it's -- it's extremely
13 important to keep that in perspective and also to
14 keep in perspective that what we should be looking
15 at is as close to the bulk material data as possible
16 and not particularly making a lot of projections
17 based on, like, a proxy compound. So I think
18 it's -- I think -- I think that what I did has a --
19 a high degree of validity.

20 **Q. Okay. Now, you understand that in his**
21 **March 16 testimony, Dr. Johnson takes issue with**
22 **you --**

23 A. Yes.

24 **Q. -- and your approach?**

25 A. Yes.

1 very general, and then I'm proceeding to the
2 specifics.

3 And I -- I think that is in contrast to
4 Dr. Johnson's approach, where he starts with a
5 surrogate very specific -- or a proxy very specific
6 compound and then tries to generalize the approach
7 based on that -- that choice of -- of the proxy.

8 **Q. Well, for example, he takes issue with**
9 **your application of Raoult's Law, does he not?**

10 A. Yes.

11 **Q. And how do you respond to that?**

12 A. Well, again, these -- these are very
13 dilute -- dilute systems, and the application of --
14 of that approach is appropriate in -- in very dilute
15 solutions. And in the -- especially in the -- the
16 raffinate phase, we're -- we're talking about parts
17 per million in -- in the raffinate. So it's very
18 appropriate to use dilute solution assumptions or --
19 or models in -- in these -- in these cases of very
20 low concentrations.

21 **Q. And what -- is that what you mean by**
22 **"dilute solutions"?**

23 A. Yes. I -- I think a lot of the --
24 we'll -- we'll probably get into this in a -- in --
25 later on, but typically, the dilute solution

1 **Q. How do you respond to that?**

2 A. Well, if I could just return -- maybe
3 look at -- at some of his responses to -- to what
4 I'm saying.

5 First of all, I think that my approach
6 starts with actual data from documented sources.
7 There is a -- some discrepancy between the data, but
8 I have managed to come up with interpolated values
9 between actual published figures for most of the --
10 for most of the information that I was -- that I've
11 used in my analysis --

12 **Q. And --**

13 A. -- those are actual numbers, actual
14 concentrations.

15 **Q. And you've been conservative, have you**
16 **not?**

17 A. I've been -- I've tried to be
18 conservative in my analysis.

19 So I'm starting with -- my analysis
20 starts with a bulk concentration, a -- a large-scale
21 view of the system, and then I refine my
22 calculations and try to project what a specific
23 compound would be resultant from that analysis
24 and -- so I think -- I think I'm looking at it
25 starting with a -- a base of information that is

1 assumptions or simplifications that are used in the
2 chemical engineering theory are, you know, less --
3 less than 1 percent concentration, and -- and
4 here -- here we're way under 1 percent, so I believe
5 these dilute solution simplifications are
6 appropriate.

7 **Q. Okay. Now, other than what you've**
8 **already testified to in terms of how your approach**
9 **uses -- how you -- you -- you view your approach as**
10 **better, what other flaws -- what other significant**
11 **flaws did you find in Dr. Johnson's January 20**
12 **testimony?**

13 A. Okay. Turning, then, to -- I -- I had
14 a -- I have a number of -- of items that -- that --
15 that I think I'd like to contrast his work with --
16 with my work, and the -- the first -- the first one
17 is on -- on page 3, line -- starting on line 12 of
18 his testimony, where he is comparing an increased
19 concentration for what he calls a tar compound, an
20 increased aqueous concentration of that, and he --
21 he's -- he's comparing the -- he's -- he's making
22 the base of that comparison the pure component
23 solubility of that material.

24 And again, thinking back to the real --
25 the real world, the bitumen is not 100 percent

1 B(a)P. It is a very, very minute concentration of
2 B(a)P. So the basis of his starting comparison
3 is -- I think sets up a -- an exaggerated comparison
4 from the get-go, and I think it is somewhat
5 misleading to do that.

6 There should be -- there will be
7 insufficient B(a)P in the -- in the bitumen to
8 anywhere nearly approach the pure component
9 solubility, so I think -- I think his choice of --
10 of that starting point is -- is -- is somewhat
11 exaggerated and sets up a -- a condition that should
12 not be -- actually be compared.

13 Again, along the same line, on page --
14 page 7 of his testimony, in line -- in line No. 19,
15 he indicates that the normal solubility of
16 benzo(a)pyrene -- or B(a)P -- dissolving from solid
17 tar in water at room temperature is 1.5 micrograms
18 per liter, and that's not correct. That -- that is
19 the pure component solubility. That is not the
20 solubility that is dissolving from the tar.

21 And right above that, in the lines -- the
22 middle of his page of testimony here, he shows a
23 benzo(a)pyrene figure and some data for
24 benzo(a)pyrene, and then in lines 16 and 17, he
25 refers to perylene, which is a completely different

1 phase coefficients, we should use as close to the
2 actual extract -- extract solvent that we -- we can.

3 Octanol is an alcohol. D-limonene is
4 a -- is a hydrocarbon. There are specific
5 properties that are different between those two
6 systems, solubility being -- being one of them,
7 and -- so I think his choice of -- of that octanol,
8 again, is a -- sets up a situation that adds to a
9 compounding of errors in his analysis.

10 Those -- those are the main -- main
11 points that -- that I have -- wanted to -- to bring
12 out with -- with his analysis.

13 The -- the other thing is, starting --
14 just stepping back and looking at the big picture,
15 the first thing I did was I -- I do sort of a logic
16 test or you might call it a sniff test. Does it
17 smell rotten or not?

18 We have two extremely sparingly soluble
19 compounds, both hydrocarbons: the bitumen and the
20 d-limonene. Now, the structure of the d-limonene
21 is -- is, in -- in many cases -- or in many aspects,
22 quite similar to the structural compounds that we
23 see in the bitumen.

24 The d-limonene, which is used as a
25 solvent in -- in this case, is a monocyclic

1 chemical, and so there's a bit of inconsistency
2 in -- in what he's attempting to do here.

3 Additionally, on page -- page 8, I -- I
4 don't see any citation for where he came -- comes up
5 with the equation on line 11, and it appears to me
6 that he -- he may be double-counting solubility
7 terms there because the d-limonene, I think, is the
8 organic solvent, and then he's attempting to justify
9 additional solubility for that -- for that saturated
10 material, for that solvent liquid, and this is --
11 his attempt to justify increased solubility is
12 actually in -- in conflict with the guidance that --
13 that he uses from his own textbook on -- in the 1993
14 Schwarzenbach text, it -- on page 97 of that -- of
15 that textbook, it clearly states that for -- for
16 very dilute solutions of -- of hydrocarbons in
17 water, one hydrocarbon does not enhance -- appear to
18 enhance the solubility of -- of the other
19 hydrocarbon. So he's attempting to -- to do
20 something that his very reference says is not going
21 to occur.

22 Then on page 8 of the same -- same page,
23 I would just like to say that I don't believe that
24 octanol is a particularly good proxy for d-limonene.
25 If we're going to be looking at coefficients of --

1 hydrocarbon with some -- with some appendages on it
2 in terms of other carbon and hydrogen atoms, and it
3 has some unsaturation. This is not unlike the
4 chemicals that are in the bitumen.

5 So we have two very like systems that are
6 very dilute, and we also have the -- the guidance
7 from Schwarzenbach that the combination of dilute
8 hydrocarbons does not enhance the solubility -- the
9 mutual solubility of those hydrocarbons.

10 So from the get-go, it didn't smell right
11 to me. I don't think that -- that what he's
12 attempting to do here and what he's attempting to --
13 to show really adds up. It just doesn't make
14 logical sense. So that's part of the reason I took
15 my different approach and tried to contrast a
16 different approach to -- to what he does.

17 So I think that's -- that pretty much
18 sums up what I would have to say about his original
19 testimony.

20 **Q. Sure. And there may be some -- some**
21 **other flaws that you saw in that, but you hit the**
22 **significant ones?**

23 **A.** I think those are the most significant
24 things. I -- I did -- I did quibble over other
25 items in there that --

1 Q. Okay. Now, before we move on to his
2 March 16 testimony, I want to ask you if you have
3 any specific experience with d-limonene.

4 A. I do, yes. My -- my thesis in -- when I
5 was taking my master's courses at Montana State
6 University, I worked on terpene chemistry, and the
7 thrust of my research and my thesis was the
8 separation of terpene chemicals, and I was
9 separating a chemical called beta-phellandrene from
10 a dipentene mixture. And dipentene actually is the
11 racemic mixture of d- and l-limonene. "Racemic"
12 means two different optical rotometers that are
13 mixed together. Not -- I said -- I said
14 "rotometers." I meant rotamers.

15 The -- so I -- I -- I had a -- a fair
16 amount of experience working with those chemicals,
17 and I'm familiar with -- with a number of the other
18 terpenes that are associated with -- with that
19 particular system. That system originated from a
20 pulp product, turpentine. But I -- I am familiar
21 with it, with the chemistry involved, yes.

22 Q. Okay. Based on your experience with
23 d-limonene, in your view, would it be a -- good
24 ingredient for U.S. Oil Sands to use for their
25 operations?

1 water -- the -- the condensed water-terpene mixture.
2 So it -- it -- it is relatively volatile.

3 It is not as volatile as -- as gasoline,
4 for example, but it has a significant vapor
5 pressure. I believe it's 2 millimeters of vapor
6 pressure at -- at ambient conditions, which is about
7 25 degrees centigrade and -- so it -- it -- it
8 could evaporate.

9 Q. Um-hum.

10 A. And, in fact, in -- in my laboratory,
11 I -- I did need to keep my vessels tightly closed
12 because I would lose material through evaporation
13 otherwise.

14 Q. Okay. Let's move on to the March 16
15 testimony, which is Exhibit 2 in this case. His
16 January 20 is Exhibit 1.

17 So the March 16 testimony, what did you
18 find to be the -- the most significant flaws in
19 that?

20 A. Well, starting on -- on page 3 of his
21 testimony, I -- again, I think the -- the initial
22 flaw is in -- is a flaw in approach. I explained
23 how I went from the general to the specific.

24 Dr. Johnson's analysis assumes that
25 benzo(a)pyrene -- or B(a)P -- can be a proxy for the

1 A. Well, I -- I really think it's an
2 excellent ingredient. It's a natural chemical. It
3 is an extremely good solvent. It has a -- a
4 pleasant odor. It's not any kind of an irritating
5 odor at all. And it has a quite low, if -- if
6 nonexistence, toxicity -- human toxicity. So I
7 think it's an excellent solvent choice.

8 And it actually is -- d-limonene is
9 becoming used more and more for a lot of industrial
10 applications. And -- and, in fact, in -- in a lot
11 of garage applications, you'll find d-limonene type
12 soaps. Just last month I was using that when my
13 hands were greasy. It has a very pleasant aroma and
14 really cuts the grease, so it's an excellent
15 solvent, excellent choice. And being a natural
16 product as well, which is, you know, a very green
17 type of approach.

18 Q. And what's your experience with its
19 volatility?

20 A. In my separation of my chemicals, I -- I
21 was able to volatilize the -- the -- the dipentene
22 and the various chemicals by steam stripping with --
23 with a very small amount of -- of steam and then
24 condensing that steam by steam distillation and then
25 collecting the -- the terpenes from -- from the

1 bitumen, and at face value, that has some validity.
2 However, you -- you -- we must consider that bitumen
3 is comprised of hundreds -- I believe thousands --
4 of different individual compounds, so picking a
5 specific proxy to represent that large suite of
6 compounds in bitumen is a leap of faith.

7 I believe it's more appropriate to first
8 look at the bulk characteristics and then move to
9 the specific, rather than picking a specific proxy
10 which may not encompass the entire range of
11 chemicals --

12 Q. Um-hum.

13 A. -- and proceeding with that proxy
14 analysis.

15 But he -- he does that, and he states
16 that his -- his analysis is conservative, but I'd
17 like to introduce that I think that it could be
18 viewed as a -- a liberal estimate rather than a
19 conservative analysis.

20 Page -- on page 4, Dr. Johnson begins to
21 criticize my work, and he speaks to my report as
22 speaking only to dilution, and as I've explained,
23 that is not true. I'm speaking to the equilibrium
24 between the different phases, and my report uses the
25 published literature values for properties of the

entire mixture, which are real -- real-world information, and I document my model results in that fashion; whereas, he is relying on a -- that single proxy compound.

Then on -- turning to page 7 of -- of Dr. Johnson's March 16 testimony, he raises the -- the issue of me not summing all of the concentration of bitumen compounds in water. However, in my analysis, that is not necessary because I'm looking at bulk concentrations. All bitumen components are implicit in that bulk concentration. So I don't understand his argument there.

And again, I was able to move from the specific -- or from the general to the specific, taking that general information that included all compounds and then moving toward a specific calculation of one of those compounds that might be contained which -- which has some toxicity, and that -- those are the sorts of things that we can -- we can look at.

I was not -- I did not look at all the possible B(a)P -- or -- or all the possible polyaromatic hydrocarbons that could be emanating from that solution, but I wanted to make the example of the one that he chose and -- and square that for

1 to put -- evidently, he's trying to put words in my
2 mouth.

3 Turning to page 18 of his testimony,
4 Dr. Johnson, on -- on the entire -- through the
5 entire page here, indicates that I was not
6 accounting for some -- some of the bitumen existing
7 in solid form.

8 That's not true because in the analysis
9 method that I used, I'm looking at the -- the bulk
10 concentrations and the -- the entire system in
11 equilibrium, and I don't need to get into specific
12 calculation details that -- that he attempts to
13 employ.

14 Additionally, at this point, I -- I think
15 it's important to also bring up that bitumen
16 contains significant amounts of liquid hydrocarbons
17 as well as the solid hydrocarbons or semi-solids
18 that he -- that he purports.

19 And I know from -- from actual boots on
20 the ground experience that those liquids do exist
21 because I have personally been on two oil sand mine
22 sites near Vernal, Utah, which I visited last year
23 during the unconventional fuels symposium in Utah,
24 and I saw with my own eyes oil seeps emanating
25 from -- from those sands, so I know that a certain

1 the record, that -- that I believe his analysis was
2 flawed and that my analysis was a more appropriate
3 approach.

4 Additionally, on page 7, down in line 22,
5 he indicates that he used distribution coefficients
6 of an actual -- or of a -- of an example bitumen
7 compound between water and d-limonene, where, in
8 fact, he didn't. He used the distribution
9 coefficients based on octanol. So what he says is
10 not precise in this case.

11 And as I pointed out before, octanol has
12 specific properties, being an alcohol, that are
13 nonexistent in a hydrocarbon.

14 **Q. Like d-limonene?**

15 **A.** Such as d-limonene --

16 **Q. Right.**

17 **A.** -- yes. There are -- there are a number
18 of other misstatements in his -- in Dr. Johnson's
19 work. Another one that I'd like to point out is at
20 the bottom of page 10, line 23, where he asserts
21 that I am contending a particular activity
22 coefficient is nearly one billion.

23 I made no use of activity coefficient in
my analysis, so his -- his statement is incorrect
there. I made no such contention. And he's trying

1 portion of those oil sands do exist in liquid form,
2 and I do believe there's other documentation that
3 supports that.

4 Dr. Johnson has not accounted for --
5 when -- when he goes through his solid liquid
6 calculations and vapor pressure adjustments, he has
7 not -- he has not calculated the various fractions
8 of solid and liquid in the bitumen, and that -- that
9 is another flaw in his analysis.

10 On page 21 of his analysis, line -- line
11 12 and Equation 17, it's confusing in that
12 particular equation. I -- I think the X sub W that
13 he uses there may actually be referring to a -- a
14 solid, but he hasn't got it labeled as a -- as a
15 solid with any kind of a subscript or solid notation
16 there.

17 I -- I just raise that question. I'm
18 not -- because he doesn't show the detail of his
19 work, it's hard to follow exactly what he's trying
20 to get at there, but I think there's a question that
21 that -- that could be actually a solid designation
22 for that. And that then --

23 **Q. And why would that be significant?**

24 **A.** Well, it's significant because it can
25 lead to, as he progresses through his derivation

1 here -- first of all, it's -- it's significant to
2 try to follow -- in order to follow his derivation.
3 And secondly, if he has -- has made a -- a mistake
4 or a -- he has -- he has left an important parameter
5 out or misidentified a parameter, then -- then it
6 becomes confusing and -- and possibly sets up
7 another compounding error in his -- his analysis.

8 So I -- I -- I -- I think that that --
9 I'll just leave it there. I -- I just raise the
10 question that -- that that is -- that's not labeled
11 as to whether it's a solid or a liquid, and I think
12 it's important that it should have been done.

13 On page 24 of -- of his analysis, he's
14 getting down, now, to where he's calculating some
15 factors that -- that he will later purport to
16 increase the solubility of -- of the -- the -- of
17 the bitumen compounds, but in his -- in his
18 calculations on -- on lines -- first of all, on --
19 on -- on line 19 and 20, the -- the value that he
20 uses does not appear to correspond to the table in
21 the Schwarzenbach text that -- that he -- that he
22 refers to.

23 And the -- on line 19 specifically, the
24 delta S melt T sub M divided by R, it says it's
25 approximately 6.8 for bitumen compounds, and the --

1 And when I looked up the compounds in
2 the -- the reference that he uses on Table 4.5 on
3 page 124 and did -- did that calculation, I came up
4 with a different value for that, starting out with a
5 value of 45 for the delta S melt T sub M. And
6 that's representative of three of the compounds that
7 are also PAHs on that -- that table. So there's
8 one -- one discrepancy there.

9 Then the second discrepancy with that
10 calculation is that his -- his temperature term --
11 he indicates that he's using around 230 degrees
12 centigrade for the melting point, where the actual
13 proxy that he used is the B(a)P material. And as he
14 stated in his original testimony, the melting point
15 for -- for the -- that material is 177 degrees
16 centigrade.

17 So when you correct the -- the temp --
18 the correct temperatures -- include the correct
19 temperatures in there, it ^{raised} ~~raised~~ -- it raises -- or
20 lowers his T sub M divided by T minus 1 value to --
21 from .78 down to .52, and those two changes make a
22 dramatic change in the factor that -- that he
23 purports on the top of page 25, where he's reporting
24 a -- a 200 factor there. And if you correct that
25 calculation, it drops that down to 16.7, which is

1 the value in the table reports a value for -- for
2 similar PAH compounds of 45 for the corresponding
3 number that is input into that -- into that
4 calculation. And let me -- can I just check for a
5 second here?

6 **Q. Sure.**

7 **A. And I need to take another break too.**

8 **Q. Okay.**

9 **VIDEOGRAPHER:** We're going off the record. The
10 time now is 11:51.

11 (Off the record)

12 **VIDEOGRAPHER:** We're back on the record at
13 11:58.

14 **BY MR. HOGLE:**

15 **Q. Okay. Mr. Handl, you were explaining an**
16 **error that you saw in Dr. Johnson's March 16**
17 **testimony. It's Exhibit 2, on page 24, towards the**
18 **bottom of the page; right?**

19 **A. Yes. I was getting into the -- the value**
20 **that -- that he selected for the term in the X --**
21 **for the X exponent there on the natural -- or the --**
22 **the E, and it was -- he's got the -- a value of 6.8**
23 **for the bitumen compounds and -- which includes**
24 **the -- the term, the delta S melt, the T sub M**
25 **divided by R.**

1 greater than an order of magnitude decrease in that
2 number, which has a significant bearing on his later
3 analysis which, on page 17 -- or 27, at the top of
4 that page, he shows that 200 factor at the very top
5 of the page, where I think that -- that factor has
6 been exaggerated by the errors he's made in that
7 calculation.

8 I think that's all I would like to
9 comment on with regard to his March 16 testimony.

10 **Q. Okay. Let -- let me ask you one more**
11 **thing, though. What -- about his March 16**
12 **testimony -- you noticed his graphs in his**
13 **testimony. What's your reaction to those?**

14 **A. First of all, the -- the -- the -- the**
15 **graph that he shows here is, again, a -- a depiction**
16 **that is not scaled properly --**

17 **Q. Which one are you referring to now?**

18 **A. I'm referring to the graph on the bottom**
19 **of page 16.**

20 **Q. Okay. Why don't you use the document**
21 **camera.**

22 **A. Okay.**

23 **Q. Why don't you --**

24 **A. This has -- this has some of my other**
25 **notes that don't -- don't apply to what I'm going to**

say but --

2 Q. Okay. Here's a clean one.

3 A. Okay.

4 Q. There you go. Do you want zoom in on
5 that?

6 A. You want to zoom in on this? There.
7 First of all, the -- the scale of the --
8 of the two axes is not -- the two axes are not
9 properly scaled. And then he -- he really offers no
10 calculation to support -- well, first of all,
11 there's no scale, so the -- the line is a -- is
12 merely an arbitrarily drawn curve that -- that we --
13 apparently an arbitrarily drawn curve because he
14 doesn't show any particular calculation to -- to
15 back up the shape of that curve.

16 The -- the two points that he shows on --
17 on the graph here are, in my opinion, not -- not
18 what the point -- not -- the shape of the -- this
19 curve is not what the actual shape would be if -- if
20 the axes were properly scaled in the ternary
21 diagram. This -- this line would be much -- much
22 flatter. And I don't -- I don't see any backing for
23 the amount of curvature or the -- the height of --
24 of the curve that he has there.

25 I understand the argument that he's

1 about page numbers, are you referring to the page
2 numbers at the bottom of the page?

3 A. Yes, I am.

4 Q. Okay.

5 A. Is -- should I be referring to another --

6 Q. No, no, no, no. That's fine. I just
7 noted that there are page numbers embedded in the --

8 A. Okay.

9 Q. -- in this rough transcript, so --

10 A. Yeah, I didn't see that or I didn't
11 notice that before, but I now -- I do now.

12 Q. Yeah.

13 A. Okay. Yes, this -- this is the -- the
14 page number at the bottom of the page that -- that
15 I've been supplied with.

16 And on page 42, in the lines around 19
17 through 25 -- or 19 through 24 -- I -- I'd just like
18 to point out that in his response, I believe that
19 he's putting his own spin on the Schwarzenbach
20 statements in the text that -- I believe
21 Schwarzenbach is very clear in that he states that
22 slightly soluble compounds -- or ^{SLIGHTLY} absolutely soluble
23 hydrocarbons do not appear to enhance dissolution of
24 other hydrocarbons. That's very clear in the
25 statement, and -- and he's kind of generalizing or

1 making, but again, it is -- it is -- it is merely
2 a -- a depiction, and it's arbitrarily drawn as to
3 how far that curve would deviate from -- from the
4 straight line that he shows, neither of which are
5 actual -- actually scaled to the -- the correct
6 values.

7 Q. Okay.

8 A. The -- the end points may, in fact, be
9 correct as he cited, but the depiction is out of --
10 out of scale.

11 Q. All right. Did you have a chance to
12 review a transcript of Dr. Johnson's April 20
13 testimony?

14 A. Yes, I did.

15 Q. Do you take issue with anything that he
16 said in that testimony?

17 A. I have several -- several points that --
18 that I'd like to make.

19 Q. Okay. What are the most significant?

20 A. On page 21 of the -- of the transcript --
21 it would be on lines 10 through 16 -- I'd, again,
22 like to point out that -- that -- as I've already
23 stated -- that he -- he made no correction for the
24 fraction of bitumen that is already in liquid form.

25 Q. Just for clarity, when you're talking

1 dancing around that -- that statement in -- in the
2 Schwarzenbach text.

3 Q. Well, just for clarity, what's he talking
4 about in the testimony you've just described, in
5 sum -- in summary?

6 A. He's -- he's attempting to minimize
7 the -- the effect of -- or minimize that -- that --
8 that statement within the Schwarzenbach text, I
9 think, that -- as a generalization, and he's
10 indicating that -- that it is not appropriate for
11 the way he's looking at it, and so I -- I think
12 it's -- it's an opinion that is unsubstantiated
13 because it is very clearly stated in the -- in the
14 text.

15 Q. Okay. And --

16 A. And --

17 Q. -- you're referring to the text regarding
18 the cosolvent -- cosolvent discussion and the
19 cosolute discussion?

20 A. Yes. The one that relates back to the
21 1993 Schwarzenbach statement. I think it was on
22 page 40 --

23 Q. Ninety-seven.

24 A. Forty-seven? Was that it?

25 Q. Ninety-seven.

1 A. Yeah, page 97, where -- quote --
2 "Similarly, slightly soluble hydrocarbons present in
3 a solution do not appear to enhance the dissolution
4 of other hydrocarbons." That's directly from the
5 1993 Schwarzenbach text.

6 And then on -- I -- this is a -- a small
7 matter, but I think it -- it -- it -- it goes to
8 show intent -- or not -- not intent but maybe the --
9 the care at -- at which he approaches this -- but
10 he -- he -- at -- on page 67, line 6 through 9, he
11 erroneously states that the vapor pressure of
12 d-limonene is 2 meters, which is really erroneous.
13 It's 2 millimeters. So it's a 1,000 -- a factor of
14 1,000 different. And then misses the chance to make
15 that correction in the response to the question at
16 the bottom of page 71, line 17, continuing on to his
17 response on page 72, line 6. That's -- that's all
18 the comments I have on --

19 **Q. Okay. Now, in response to his**
20 **February 16 testimony and Dr. Johnson's April 20**
21 **testimony, did you conduct any additional**
22 **calculations?**

23 A. Yes, I -- I did. I attempted to take
24 a -- take a look at a -- a different perspective
25 from my own by -- by -- by utilizing some of the

1 information that Dr. Johnson utilized in performing
2 an independent calculation of -- of the potential
3 solubility increase as -- as he would report it for
4 a proxy compound. Not that I'm endorsing the use of
5 that proxy. I just wanted to compare -- make a
6 comparison calculation to what his results were.

7 (Whereupon, Exhibit No. 18 was marked for
8 purposes of identification.)

9 **BY MR. HOGLE:**

10 **Q. Okay. I'm handing you what I've marked**
11 **as Exhibit 18. Can you identify that for us?**

12 A. Yes. This is the calculation that I just
13 spoke of, and it's the -- my hand calculation of
14 the -- a -- a slightly different approach to
15 Dr. Johnson's results utilizing the same
16 Schwarzenbach text that -- that he does.

17 **Q. All right.**

18 **MR. HOGLE:** I move for the admission of Exhibit
19 18.

20 **BY MR. HOGLE:**

21 **Q. And why don't you put it on the document**
22 **camera there and sort of walk us through that.**

23 A. Sure. This is the first page --

24 **Q. Now, you've got it zoomed in.**

25 A. Oh, I'm sorry.

1 **Q. Yeah.**

2 A. Let's go the other way here. There you
3 go.

4 So I'm starting out with -- in -- in this
5 calculation -- with the equivalent information that
6 Dr. Johnson used in his original testimony of
7 March -- or, I guess, that was February, wasn't it?

8 **Q. January.**

9 A. January. His original January testimony,
10 January 20. So I'm -- the first two numbers that
11 I'm reciting come directly from his testimony and --
12 where he -- we're choosing, again, the
13 benzo(a)pyrene as a surrogate or a proxy for the --
14 for the bitumen. And again, I'm not endorsing this
15 approach. I am just using -- using this calculation
16 to show a contrasting method to what he presents.

17 So starting with -- with that, on the
18 third bullet then, assuming that the B(a)P is a
19 proxy for all bitumen compounds, if I utilize the
20 same values that I previously referred to in my --
21 in my report work, the spent sands would contain
22 about 1.8 parts by weight of d-limonene to .84 parts
23 by weight of bitumen. And again, we're using B(a)P
24 as a proxy for bitumen.

25 Then assuming that all that dissolves

1 together, the bitumen -- or the B(a)P or bitumen
2 dissolves into the d-limonene, I'm calculating a
3 mole fraction just by incorporating the two
4 molecular weights of those compounds, and I come up
5 with a mole fraction of .201. This would be the
6 fraction of bitumen in that solution of d-limonene
7 and bitumen.

8 **MR. HOGLE:** We're going to take a break.

9 **VIDEOGRAPHER:** We're off at 12:15.

10 (Off the record)

11 **VIDEOGRAPHER:** We're back on the record at
12 12:22.

13 **BY MR. HOGLE:**

14 **Q. All right, Mr. Handl. Just kind of**
15 **picking up where you left off with the -- you know,**
16 **assuming all the B(a)P dissolves into the**
17 **d-limonene.**

18 A. Yes. This -- we're at the bottom of the
19 first page of my demonstration calculation here. So
20 then, turning to the next page, starting with that
21 .201 mole fraction of bitumen in solution with the
22 d-limonene -- turning, then, to the second page of
23 the calculation, we can then calculate the bitumen
24 concentration in water, in equilibrium with the ⁷⁻²¹
25 d-limonene, from the relationship on Equation ⁷²¹

1 from the Schwarzenbach text. I misspelled
2 Schwarzenbach there. But that is shown -- the
3 formula is shown here, and the activity coefficient
4 is shown, and the -- that activity coefficient can
5 be approximated as 1 with regard to the statements
6 made on page 237 of Schwarzenbach.

7 And again, that deals with the ideality
8 of the hydrocarbons mixing together, which should be
9 a coefficient very close to 1.

10 So then combining the activity -- or
11 combining the two items that are -- we obtain
12 from -- from the first page -- the .201 mole
13 fraction times the -- the liquid saturated
14 solubility -- we come up with a calculated
15 solubility of 9.89 micrograms per liter for -- for
16 the approach -- a -- a similar approach to what
17 Dr. Johnson uses. But this, again, is out of the
18 Schwarzenbach text.

19 And then the solubility increase factor
20 like -- like he is utilizing in -- in -- in his
21 analysis would be comparing that increased
22 solubility to the -- to the pure component
23 solubility.

24 Dividing those two, the ratio then
25 becomes 6.51, which is the increase factor that

1 A. Yes.

2 Q. -- so if you want to zoom in there so it
3 shows up a little better. Okay.

4 Now, you have a -- you're -- you've
5 become familiar, in this case, with the de-watering
6 mechanisms that U.S. Oil Sands plans to use in its
7 operation?

8 A. Yes. I'm -- I'm -- I'm not familiar, but
9 I'm aware of them, and I understand the processes
10 that are involved.

11 Q. Okay. And are you -- are you familiar
12 with the mechanisms that they -- do you have any
13 experience with the mechanisms that they plan to
14 use?

15 A. Yes, I am familiar and experienced with
16 different types of filtration and have actually used
17 that on -- on sites. The two units that are shown
18 here are a -- a vacuum disk filter and a horizontal
19 belt filter.

20 Q. Okay. And how effective at de-watering
21 are those mechanisms?

22 A. Those are very effective. Typically,
23 they operate with a vacuum assist. So the slurry
24 enters on top of the filtration element, and the
25 liquid is pulled through the filtration element,

1 could be attributed to this method, and that's
2 vastly different than the 1,500 that -- that he
3 obtained. So I think it does point back to the
4 possibility of those -- some of those accumulative
5 errors that -- that he made in his analysis.

6 Q. Okay. And one last area I want to go
7 over with you...

8 (Whereupon, Exhibit No. 19 was marked for
9 purposes of identification.)

10 BY MR. HOGLE:

11 Q. I'm handing you what's been marked as
12 Exhibit 19. Do you -- can you identify that for us?

13 A. Yes. This is the -- the flowchart for
14 the U.S. Oil Sands process that -- that I reviewed
15 in the initial part of my work. That was supplied
16 to me. I have seen this before.

17 MR. HOGLE: And I would move for the admission
18 of Exhibit 19.

19 BY MR. HOGLE:

20 Q. Why don't -- yeah, use the document
21 camera to show that. And -- and just summarily -- I
22 mean, this will be done before your testimony is --
23 is -- is displayed, but I want to focus you in on
24 the -- the lower right-hand portion, with respect to
25 the de-watering unit --

1 leaving the -- the solid material on top of the
2 element. And then the solid material is either --
3 either -- well, it is then mechanically discharged.

4 But in the process of filtration, the
5 filter is normally operated so that as the filter
6 cake moves through the unit, the final -- the final
7 filtration step or the final filtration portion
8 of -- of the route through the unit involves
9 actually sucking air through the cake by -- by that
10 vacuum.

11 So you want -- you want the -- the vacuum
12 filter to remove the liquid and then get it to the
13 point where it's dry enough so that it's actually
14 transferring air through that filter cake. And
15 that -- that is both the case for the horizontal
16 belt filter and the -- the disk filter, as -- as
17 well as many other filtration elements.

18 Q. And when the cake or the solids come off
19 the line, how would you characterize the -- its
20 dampness or its saturation?

21 A. Well, the -- the whole object of
22 filtration is to -- to obtain a cake that is
23 handleable, so you want to remove as much of the
24 water as possible. And I'd characterize the
25 filter -- the filter cake at that point as being no

1 longer free draining. It would be -- it would still
2 have some moisture in it in terms of being a damp
3 material, but it would be well below saturation.

4 **MR. HOGLE:** No further questions at this time.

5 **MR. DUBUC:** Are you ready to go off -- let's
6 take a short break, please.

7 **MR. HOGLE:** All right.

8 **VIDEOGRAPHER:** We're going off the record at
9 12:30.

10 (Off the record)

11 **VIDEOGRAPHER:** We're back on the record at
12 12:42.

13 **EXAMINATION**

14 **BY MS. WALKER:**

15 **Q.** Thank you, Mr. Handl. Did you
16 participate in the drafting of the Permit-By-Rule
17 document?
18

19 **A.** I did not.

20 **Q.** Did you participate in the drafting of
21 the Notice of Intent?

22 **A.** I did not.

23 **Q.** Did you give anything to the agency --
24 and by "the agency," I mean the Division of Water
25 Quality -- before it made its decision in February

1 Does that ring a bell?

2 **THE WITNESS:** Was this -- is that -- let -- let
3 me just check. If it's referring to the February
4 21, 2008, attachment to Bob Bayer's letter to Mark
5 Novak, titled "Request for Permit-By-Rule
6 Determination," then the answer is yes. Otherwise,
7 the answer is no.

8 **BY MS. WALKER:**

9 **Q.** Okay. So let's call that the -- for --
10 for the time being -- the Permit-By-Rule. Okay?
11 Does that work for you?

12 **A.** Yes.

13 **Q.** Okay. So you did review that document?

14 **A.** Yes.

15 **Q.** So is your analysis in that document?

16 **A.** No.

17 **Q.** As far as you're aware, is your analysis
18 in any documents that were before the agency when it
19 made its decision in February 2011?

20 **A.** No.

21 **Q.** Does your testimony answer or attempt to
22 answer the question of whether, in your opinion,
23 d-limonene affects the solubility of the tar
24 compounds in water?

25 **A.** Yes.

1 2011?

2 **A.** No.

3 **Q.** When did you first have a role in this
4 project?

5 **A.** It was after Dr. Johnson's original
6 testimony, and I don't know the exact date, but I
7 think it would have been early February.

8 **Q.** February of what year, please?

9 **A.** This year, 2012.

10 **Q.** Does your analysis appear in that NOI,
11 the Notice of Intent?

12 **A.** I don't know.

13 **Q.** Did you review the NOI?

14 **A.** No.

15 **Q.** Does your analysis appear in the
16 Permit-By-Rule document?

17 **A.** I don't know. I don't think it does.

18 **Q.** Did you review that document?

19 **A.** I don't believe so. I -- that -- is --
20 is that the -- is that the document that Bob Bayer
21 would have...

22 **MR. HOGLE:** He's not clear on what document
23 you're referring to.

24 **MS. WALKER:** It's an exhibit to his testimony.
25 It could also be called the demonstration letter.

1 **Q.** Does the Permit-By-Rule answer the
2 question of whether d-limonene affects the
3 solubility of tar compounds in water?

4 **A.** I don't recall.

5 **Q.** Does your testimony ask the question of
6 whether d-limonene affects the solubility of the tar
7 compounds in water?

8 **A.** Yes.

9 **Q.** Is that question relevant to
10 understanding whether the processed sands are a
11 potential source of contamination?

12 **A.** Yes.

13 **Q.** So -- but you're unaware of whether the
14 Permit-By-Rule answers that question?

15 **A.** I was not asked to look at that, so I'm
16 not really aware of that.

17 **Q.** Okay. Well, would you turn to page 7 of
18 the Permit-By-Rule, please? That is an exhibit to
19 your testimony. Oh, Reference No. 3 you call it.
20 This is already an exhibit because it's part of your
21 testimony. So if you would turn to page 7, please.

22 **Okay.** So I'm reading from the -- it's
23 not the full paragraph but the last paragraph on
24 that page, and I'm going to read a statement, and
25 that is from this document, it says "The processed

tar sands would" -- "that would be disposed back into the open pit represent the material with the characteristics most likely to contaminate the water that contacts the material." Do you agree with that statement?

A. Yes.

Q. And would that statement also apply to processed sands disposed of in the waste piles?

A. Yes.

Q. Okay. So the next sentence says "Petroleum compounds associated with bitumen residual" -- "residual" -- I'm sorry -- "entrained process water, or remaining process chemical represent, in theory, potential sources of contamination." Do you agree with that sentence?

A. Yes.

Q. And does that apply to processed sands disposed of in the waste piles as well?

A. Yes.

Q. Okay. So the next sentence, which goes on to page 8, says "To further investigate this potential, lab analyses -- using Toxicity Characteristic Leaching Procedure (TCLP Method 1311) and Synthetic Precipitate Leaching Procedure (SPLP Method 8270C/3510C and GC/MS 8260B), as well as

1 summarized in that table?

2 MS. WALKER: I think you're -- I'm sorry if I -- let me restate.

4 BY MS. WALKER:

5 Q. Do these tables purport to summarize those tests?

7 A. I -- I don't know what the intent was.

8 Q. Okay. So what does this table tell us about the potential of -- what does this table tell us about the potential of the petroleum compounds associated with the bitumen residual to be a source of potential contamination? What does it tell us about that?

14 A. It appears to give some concentration values; however, there's no speciation.

16 Q. I'm sorry. Can you say what -- can tell me what "speciation" is?

18 A. I -- I -- I -- I meant the organic speciation with regard to the other hydrocarbons.

20 Q. Okay. I'm sorry. I still don't understand what "speciation" is.

22 A. Individual chemical makeup.

23 Q. So are you saying that it doesn't tell us --

25 A. Yes.

1 leaching procedures using other solvents (EPA Method 2 8015B/3545), were run on unprocessed tar sands, 3 processed sands, and processed fines,"

4 Do you agree that that's the proper way 5 to answer the question of whether the petroleum 6 compounds associated with the bitumen are a 7 potential source of contamination?

8 A. Yes, I believe those would be appropriate 9 methods.

10 Q. Okay. So I'd like to go through those 11 tests one at a time, starting with the assessment of 12 petroleum analysis and other hydrocarbons, which 13 appears in a table on page 8 and 9, but the text 14 discussing it is on page 10 and 11, with another 15 table, so if you could turn to Table 4.

16 Is it your understanding that this table 17 summarizes the results of those tests?

18 MR. HOGLE: Objection, foundation.

19 THE WITNESS: Do I need to answer or --

20 MR. HOGLE: Yes.

21 MS. WALKER: Oh, I -- I -- so you need more 22 foundation for a document that was attached to your 23 witness's testimony?

MR. HOGLE: Your question, Joro, is whether he 24 knows whether all the tests are -- test results are

1 Q. -- whether a petroleum compound --

2 A. Yes.

3 Q. Okay. I'm going to have to -- I'm going 4 to have to say the whole question. Sorry.

5 So are you telling me it doesn't tell us 6 whether the petroleum compounds associated with the 7 bitumen residue, entrained process water, or 8 remaining processed chemicals represent a potential 9 source of contamination?

10 A. No.

11 Q. No, it doesn't tell us?

12 A. That's correct.

13 Q. Okay. Thank you. So I'd like to move on 14 to the next test. This is on page 10, under the 15 heading of Volatile and Semi-Volatile Organics, and 16 it's referring to -- well, it's referring to the 17 charts on those previous pages.

18 So I'm wondering if this test tells us 19 anything about whether the petroleum compounds 20 associated with bitumen residue -- residual -- I'm 21 sorry -- entrained process water, or remaining 22 process chemicals represent a potential source of 23 contamination?

24 A. I think it speaks to that, yes.

25 Q. In what way, please?

1 A. That there is a de minimis or -- or
 2 minimal effect.
 3 Q. Does this test talk about petroleum
 4 compounds?
 5 A. Yes.
 6 Q. What does it say about petroleum
 7 compounds?
 8 A. You want me to read it back to you?
 9 Q. Sure.
 10 A. "Tar sands are comprised of bitumen,
 11 which is the non-volatile end member of the
 12 petroleum maturation process. By definition, then,
 13 bitumen contains little or no volatile or
 14 semi-volatile constituents. Therefore, it is
 15 believed that the results still indicate a
 16 de minimis effect on groundwater from volatile or
 17 semi-volatile components, particularly given the
 18 hydrogeologic settings as described below."
 19 Q. So you're saying this test tells me that
 20 tar sands are comprised of bitumen, which is a
 21 nonvolatile -- I'm sorry -- which is the nonvolatile
 22 end member of the petroleum maturation process?
 23 This test shows me that?
 24 A. I'm telling you that's what that said.
 25 That's what you --

1 testimony, argumentative.
 2 BY MS. WALKER:
 3 Q. Was it your --
 4 A. I --
 5 Q. -- was it your testimony --
 6 A. Do you want me to answer or --
 7 Q. I'm sorry. Was it --
 8 A. -- rephrase your question again. I --
 9 you're --
 10 Q. Yeah, yeah, I'll rephrase. So was it
 11 your testimony a few minutes ago that the test that
 12 resulted in the figures for oil and grease and
 13 total -- oh, PH -- total petroleum hydrocarbons --
 14 Table 4 -- okay. Let me try -- try again. Sorry.
 15 Okay.
 16 Was it your testimony earlier that the
 17 figures presented in Table 4 were not helpful to
 18 determining whether petrochemicals were a source
 19 of -- a potential source of contamination?
 20 A. I believe that's what I said.
 21 Q. Okay. So then, when I was asking you
 22 about the volatile and semi-volatile organics and
 23 the tests that were supposed to reveal those, I was
 24 asking if that test shows that tar sands are
 25 comprised of bitumen, which is the nonvolatile end

1 Q. Does the --
 2 A. -- asked me to do.
 3 Q. -- test that -- okay. I'm sorry. I'm
 4 not being clear. Does the test that they ran show
 5 that tar sands are comprised of bitumen, which is
 6 the nonvolatile end member of the petroleum
 7 maturation process?
 8 MR. HOGLE: Objection, compound. You can go
 9 ahead.
 10 THE WITNESS: I -- I don't --
 11 MS. WALKER: Does that tell us --
 12 THE WITNESS: -- see a --
 13 BY MS. WALKER:
 14 Q. Go ahead --
 15 A. Do you want --
 16 Q. -- go ahead. Sorry.
 17 A. I don't see a test for bitumen here. I
 18 do see a test for hydrocarbons, including oil and
 19 grease, and total recoverable petroleum
 20 hydrocarbons.
 21 Q. But those results were the ones you just
 22 said were not helpful in determining whether the
 23 petroleum compounds are a potential source of
 24 contamination.
 25 MR. HOGLE: Objection. It misstates the

1 member of the petroleum maturation process.
 2 So my question is: Do those tests show
 3 that? And if I understand your -- your answer, you
 4 referred back to those same oil and grease and TRPH
 5 numbers. Is that right?
 6 MR. HOGLE: Objection --
 7 THE WITNESS: Your --
 8 MR. HOGLE: -- compound.
 9 THE WITNESS: Your -- your -- your question
 10 is -- is -- is confusing, but what -- what I'd like
 11 to summarize is that these tests do not fully
 12 characterize the bitumen.
 13 BY MS. WALKER:
 14 Q. Okay. So what does a volatile and
 15 semi-volatile organic test show us?
 16 A. A volatile organic test shows the --
 17 depending on the analysis -- the specific compounds
 18 that are -- that can be readily evaporated or are
 19 volatile that are tested for in the particular test
 20 procedure applied to that material.
 21 A semi-volatile test does the same except
 22 for it quantifies the various materials that have a
 23 lower volatility that -- that, again, are part of
 24 the -- this -- the test suite. Not -- not all
 25 semi-volatile compounds nor all volatile compounds

are usually included in any one test.

2 Q. So is this the proper test to run to
3 determine if the petroleum compounds are a potential
4 source of contamination?

5 A. It would -- it would show the potential
6 for the materials that are analyzed here, yes,
7 but -- but -- let me just stop there;

8 Q. Does it rule out the petroleum compounds
9 being a potential source of contamination?

10 A. No.

11 Q. Okay. Then I'd like to go to this -- the
12 TCLP test. It's on page -- which the narrative
13 explaining that is on page 11. So I'd like to ask
14 you if this test is helpful in determining whether
15 the petroleum compounds are a potential source of
16 contamination.

17 A. Yes.

18 Q. It is helpful?

19 A. Yes.

20 Q. Does it rule out -- so do the results of
21 this test mean that the petroleum compounds are not
22 a potential source of contamination?

23 A. The -- the TCLP test does -- does not
24 speak to petroleum contamination, as described --

25 Q. Okay.

1 Q. Could one --

2 A. -- whether a test --

3 Q. -- could one --

4 A. -- be performed?

5 Q. The second: Could a test be performed?
6 Yes.

7 A. Yes.

8 Q. And does the -- do the results of any
9 such tests exist in the record as far as you know?

10 A. I can't answer that. I don't know.

11 Q. Have you seen any results of any such
12 tests on the processed fines from the PR Springs
13 site?

14 A. I have not.

15 Q. So is there any empirical data that
16 you've seen anywhere that supports your contention
17 that the presence of d-limonene will suppress the
18 transfer of PAH compounds into solution as compared
19 to the case of those same materials dissolving into
20 water from the original virgin oil sands?

21 A. Would -- would you repeat that, please?

22 Q. Okay. Just to be clear, that's a quote
23 from your testimony at page 5. So what I'm asking
24 is: Is there any empirical data that you have seen
25 anywhere that supports your contention -- and here's

1 A. -- on page 11.

2 Q. So is it fair to say that these tests
3 then, in the Permit-By-Rule, don't rule out
4 petroleum compounds as a potential source of
5 contamination?

6 A. Yes, I think that's fair.

7 Q. So what tests would rule that out?

8 A. I haven't been asked to look at that.

9 Q. Do you have any opinion on it?

10 MR. HOGLE: Objection, lacks foundation.

11 THE WITNESS: I -- I really don't have an
12 opinion on that.

13 BY MS. WALKER:

14 Q. Okay. So is there any test that would
15 test your analysis in your testimony?

16 A. Yes.

17 Q. What would that be?

18 A. It would be chemical tests to confirm the
19 bitumen content and other chemical content in the
20 two phases and relate those together.

21 Q. So you could actually run a test that
22 would determine the effect of d-limonene on the
23 solubility of the tar compounds in water?

A. Could I do that? Is that your question?
Or are you questioning --

1 where the quote from your testimony starts -- "The
2 presence of d-limonene will suppress the transfer of
3 PAH compounds into solution as compared to the case
4 of those same materials dissolving into water from
5 the original virgin oil sands"?

6 A. I have -- I have no -- not seen any
7 empirical data.

8 Q. Is there any empirical data that you've
9 seen anywhere that contradicts Dr. Johnson's
10 testimony that the presence of d-limonene will cause
11 more tar -- tar -- sorry -- will cause more tar to
12 dissolve in water than what occurs in its absence?

13 A. Yes.

14 Q. Empirical data?

15 A. What do you consider to be data?

16 Q. What do you consider to be data?

17 A. Is it -- does a textbook qualify?

18 Q. I took "data" in this question to mean
19 actual tests on actual compounds and actual
20 processed fines.

21 A. Yes, I've seen summaries of the data, but
22 I have not actually viewed the data.

23 Q. And where is that data?

24 A. The one report that I reviewed that --
25 that speaks to that is an EPA document:

1 EPA/600/M-91/009, March 1991.

2 Q. And that document was created as a result
3 of -- of actual lab tests or in-the-field tests?

4 A. That's my understanding.

5 Q. And did it deal with tar and d-limonene?

6 A. No.

7 Q. Okay. Any other data you want to refer
8 me to, please?

9 A. No.

10 Q. Is it fair to say that you're assuming,
11 for the basis of your analysis in your testimony --
12 or -- I'm sorry. I should call it your expert
13 report -- that ideal conditions exist?

14 A. Yes.

15 Q. So your analysis is based on an ideal
16 solution?

17 A. Portions of the calculations are, but the
18 analysis itself is not.

19 Q. Can you tell me which portions are based
20 on ideal solution --

21 A. Yes. When I --

22 Q. -- or -- an ideal solution or..

23 A. Okay. Yes, I -- I can -- when I made my
24 final calculations of B(a)P from the -- from the
25 bitumen dissolved in the raffinate phase, those are

1 conditions?

2 A. For dilute solutions, yes.

3 Q. Are there any dilute -- I'm sorry. Are
4 there any dilute systems -- oh, I'm sorry. Let me
5 try again.

6 Are dilute -- are dilute systems always
7 ideal?

8 A. I can't answer that.

9 Q. Is that because you don't know?

10 A. No. Because I don't -- I don't -- I'm
11 not aware of all ideal -- of all dilute solutions.
12 That was your question.

13 Q. So there could be some dilute solutions
14 of which you're not aware that are nonideal?

15 A. I don't know.

16 Q. Do you know of any kinds of dilute
17 solutions that are not ideal?

18 A. I -- I don't have the -- the knowledge to
19 answer that question.

20 Q. So when you assumed that -- well, let's
21 bring up your -- your -- your ternary diagram,
22 please. Is that the right term?

23 MR. DUBUC: Do you -- do you want it up on the
24 screen?

25 Exhibit 7. Can we get Exhibit 7 on the

1 ideal calculations.

2 Q. I'm sorry. So is that the -- the
3 exhibit -- is it 19? Is that what you're referring
4 to? Or are you referring to your testimony?

5 A. I'm referring to my report.

6 Q. Your report. So is there anything in
7 your report that does not assume ideal solution?

8 A. Yes.

9 Q. Please point that out.

10 A. All of the data that I input are actual
11 data as reported in the literature. They may or may
12 not have come from ideal solution information, but
13 they're actual data. That's one example.

14 The theory of the ternary diagram is
15 another example. The -- the approach that is
16 outlined in Perry's handbook is another example.

17 Q. So are you saying, when you did your
18 ternary analysis, that you weren't relying on an
19 ideal solution?

20 A. I was relying on the data that was
21 presented in the literature and interpreting --

22 Q. So --

23 A. -- interpreting that in accordance with
24 standard practice in Perry's hand -- handbook.

25 Q. So is standard practice to assume ideal

1 screen? Can we get Exhibit -- Exhibit 7, could we
2 get that on the screen, please?

3 BY MS. WALKER:

4 Q. Can you push it up a little, please,
5 or -- that's good --

6 A. Yeah --

7 Q. -- thank you.

8 A. -- just hold your horses.

9 Q. Okay. So on that diagram, you have an
10 arrow pointing to a point which says "Bitumen
11 solubility in water." Do you see that?

12 A. Yes.

13 Q. And you also have a point that says
14 "d-limonene solubility in water." Do you see that?

15 A. Yes.

16 Q. And so you drew a straight line between
17 those two points; is that correct?

18 A. Yes.

19 Q. And is it your understanding of
20 Dr. Johnson's testimony that he drew a curve between
21 those two points?

22 A. Yes.

23 Q. What's the basis for drawing a straight
24 line?

25 A. Perry's handbook.

1 Q. So what in Perry's handbook gives you the
2 basis for drawing a straight line?

3 A. Dilute solution assumption.

4 Q. So you're assuming that dilute solutions
5 produce straight lines?

6 A. Yes. In this case.

7 Q. All right. Are there -- in this case --

8 A. Yes.

9 Q. -- are you saying that -- and that's
10 based on what?

11 A. My education, training, and background
12 and experience.

13 Q. Is it based on testing -- data that tests
14 the points on the line?

15 A. No tests were conducted under my work.

16 Q. Okay. So when you say it's based on your
17 education and experience, are there any references
18 you can point to?

19 A. By "references," do you mean -- you mean
20 written references? Is that what you're saying?

21 I --

22 Q. Yes.

23 A. I didn't bring any with me, no.

24 Q. So does a straight line assume ideal
25 conditions?

1 MR. DUBUC: Thank you.

2 BY MS. WALKER:

3 Q. Okay. Under -- I'm going to read that
4 first -- those first couple of sentences to you.

5 "Accurate knowledge of phase-equilibrium
6 relationships is vital for quantitative

7 considerations of extraction processes. The
8 required quantities of solvent (and reflux, if used)

9 are set by these data. Also, the driving forces
10 determining rates of mass transfer are governed by

11 these thermodynamic considerations. Since
12 formulation of two stable liquid phases in contact

13 with each other is an essential requirement, at
14 least one phase is almost certain to be one in which

15 solute components behave thermodynamically in a
16 strongly non-ideal way."

17 So I'm wondering: Do we have a situation
18 in -- with our d-limonene and tar where there are

19 two stable liquid phases in contact with each other?

20 A. Is that a question?

21 Q. Yes. Do you want me to say it again?

22 A. Well, you're wondering. I don't -- I
23 don't know how to respond to your wonderment.

24 Q. Okay. In your opinion, do we have a
25 situation with our d-limonene and bitumen where we

1 A. Yes, I believe it does.

2 MR. DUBUC: Are you going to hand him this?

3 MS. WALKER: I don't know. Leave it.

4 MR. DUBUC: All right.

5 BY MS. WALKER:

6 Q. So I would like you to look at, I think,
7 what you've been calling Perry's handbook. Bible?
8 Perry's Bible?

9 MR. MACHLIS: Is that Exhibit 8?

10 BY MS. WALKER:

11 Q. Oh, Exhibit 8. If I might turn your
12 attention to -- I guess it's page 15-3, under the
13 heading Phase Equilibriums.

14 MR. DUBUC: Can we put that up on the screen,
15 please? Exhibit 8, the second page.

16 BY MS. WALKER:

17 Q. So you see that part at the bottom that
18 says "Phase Equilibriums"?

19 MR. DUBUC: Could we enhance that, please?
20 Could we zoom in on that? The bottom of that.

21 Back --

22 MS. WALKER: Right.

23 BY MS. WALKER:

Q. So the first paragraph under Phase
Equilibrinms --

1 have two stable liquid phases in contact with each
2 other?

3 A. Yes, we do.

4 Q. So in -- according to Perry's Bible,
5 then, we have a situation where at least one phase
6 is almost certain to be one in which solute
7 components have behaved thermodynamically in a
8 strongly nonideal way?

9 A. We -- we have -- we have that condition,
10 but you need to read to the bottom of that
11 paragraph.

12 Q. Well, right now let's talk about this
13 sentence. Does it mean something?

14 A. I'm sure that it does.

15 Q. Okay. So if we have -- in our situation,
16 we have two stable liquid phases in contact with
17 each other. Are you saying they're both ideal?

18 A. In -- in this -- in this case of the
19 particular limonene, bitumen, and water, I believe
20 those phases are close to ideal, if not ideal.

21 Q. So does that conflict with this statement
22 here?

23 A. It -- it -- it can be resolved with that
24 statement in the context of the entire paragraph.

25 Q. Okay. I'd like to turn your attention,

1 then, to the bottom paragraph of that same column,
2 and it says "In what follows, only the simplest and
3 most commonly occurring systems are described."

4 Do you agree with that statement?

5 A. Yes.

6 Q. So is our d-limonene and tar situation a
7 simple and commonly occurring system?

8 A. I believe it to be a simple system. I
9 don't believe it to be a commonly occurring system
10 because I think this is a fairly unique system.

11 Q. So is d-limonene completely immiscible in
12 water?

13 A. No.

14 Q. So how would you describe its
15 immiscibility?

16 A. You -- you cut -- your last word cut out.
17 I wasn't sure what you said.

18 Q. How would you describe its immiscibility?

19 A. It has a very minute solubility but tends
20 to be immiscible in water.

21 Q. And how would you describe -- I'm
22 sorry -- and how would you describe the
23 immiscibility of bitumen --

24 A. It has a --

25 Q. -- in water?

1 Q. Okay. And would you describe bitumen as
2 immiscible in water?

3 A. Yes.

4 Q. So it's not more accurate to call it
5 partially immiscible?

6 A. It's -- it's a degree of -- of
7 expression, but I would consider both of those to be
8 immiscible with water.

9 Q. So by immiscible -- when you're saying
10 they're immiscible in water, are you saying they're
11 completely immiscible in water?

12 A. Define "completely immiscible," and I'll
13 tell you the answer.

14 Q. I'm asking you if, by "immiscible," you
15 mean completely immiscible.

16 A. Yes, I would say they're completely
17 immiscible. As I described before, there is some
18 solubility in the water phase, but the fluids
19 themselves are immiscible. They form a -- an
20 oil-rich -- or a layer that does not completely
21 dissolve in water, and the dissolution in the water
22 is very, very minute. I would consider them to be
23 immiscible.

24 Q. Okay. So in your report, on page 2, you
25 stated "In a Type II system" -- and by "Type II

1 A. -- it has a very low solubility in water
2 but some measurable concentration.

3 Q. Can you explain that in terms of
4 immiscibility, please?

5 A. The -- the liquid -- the liquid itself
6 forms a -- a layer or a separate phase with water;
7 therefore, it is -- it's considered, from a lay
8 standpoint, to be immiscible. But the immiscibility
9 does not always speak to the slight solubility in
10 the raffinate phase or the -- the water phase. But
11 they --

12 Q. So --

13 A. -- they --

14 Q. -- is it fair to --

15 MR. HOGLE: Hold on. He's not done yet.

16 THE WITNESS: They -- they are considered to be
17 immiscible when -- when speaking strictly of
18 miscibility.

19 BY MS. WALKER:

20 Q. Okay. Did you -- would you describe
21 d-limonene as being partially miscible in water?

22 A. I -- I would call it an immiscible fluid
23 in water.

24 Q. Immiscible? Is that what you said?

25 A. Immiscible, yes.

1 system," you're talking about the ternary phase
2 diagram -- "the two liquids used to effect the
3 extraction of the solute are only partially
4 immiscible." I'm sorry. I said that wrong. Let me
5 start over.

6 "In a Type II system, the two liquids
7 used to effect the extraction of the solute are only
8 partially miscible and the solution dissolves
9 between both phases." (As read)

10 So are you saying that -- that -- now
11 that the Type II system doesn't apply?

12 A. No.

13 Q. Okay. So it says -- if I understand your
14 testimony correctly, are you saying that a Type II
15 system is appropriate only where the compounds are
16 partially miscible?

17 A. No.

18 Q. So why did you use a Type II diagram?

19 A. Because it applies to this system.

20 Q. So why did you say in your testimony "In
21 a Type II system, the two liquids used to effect the
22 extraction of the solute are only partially miscible
23 and the solute dissolves between both phases"?

24 A. Because that's what happens. The -- the
25 term "miscibility" is not an exact term, and what I

1 meant in that paragraph was -- was I was accounting
2 for the dissolution of materials that I spoke to
3 before.

4 They are immiscible, but when you look --
5 when you talk about that immiscibility in relation
6 to the dissolution in the water phase, I was
7 allowing for the fact that there is some dissolution
8 in the water phase, but the compounds are considered
9 to be immiscible with water. It's more of a
10 semantics question.

11 Q. Okay. So in Perry's bible, on page 5-14,
12 which is the next page there -- can you have it up
13 on the document screen, please. Flip --

14 A. 5-14? I don't have a page 5-14. You'll
15 have to tell me what you're talking about. I don't
16 see 5-14.

17 Q. Well, the pages -- the next page -- so if
18 you turn the page on this Perry's Bible -- there we
19 go. That's 5-14. I don't know why it's numbered
20 that way. And then --

21 A. Where? I have no idea what she's talking
22 about.

23 Q. On the left-hand side of the page -- so
24 the first column -- in that -- just above that --
25 okay. So the first column -- can you zoom in on the

1 MR. MACHLIS: 15-4? Sorry.

2 BY MS. WALKER:

3 Q. "In Type II systems (Figure 15-2b) S is
4 partially miscible with both A and B, and a feed of
5 any proportions of A and B may be processed."

6 Oh, it's not the last sentence. Second
7 to last sentence.

8 "Raffinates lie on Curve UC, extracts on
9 WZ."

10 So what does that state -- how does that
11 statement reflect on your contention that d-limonene
12 and bitumen are immiscible?

13 A. That -- the immiscibility is what causes
14 the phases to occur. The more immiscible they are,
15 the closer they -- the closer the water -- the
16 raffinate phase will be to the apex and the more
17 highly soluble the oil phase is the closer it will
18 be to the -- to the axis on the right hand of the
19 equilibrium -- or of the ternary diagram. So it is
20 a degree of -- it is -- it is a question of degree.

21 Miscibility in this context is a somewhat
22 variable term. The system that we are looking at is
23 a lot more immiscible than the one that is
24 diagrammed in the Perry's example with regard to the
25 water phase.

1 first column, kind of in the bottom, the bottom of
2 the first paragraph?

3 A. (Witness complied.) I'm going to have to
4 take another break.

5 Q. Okay. So I'm looking --

6 MR. HOGLE: Joro --

7 MS. WALKER: -- at the last sentence in that
8 circle --

9 MR. HOGLE: -- Joro, can we take a break real
10 quick? The witness needs a break.

11 MS. WALKER: Okay.

12 VIDEOGRAPHER: We're going off the record at
13 1:34.

14 (Off the record)

15 VIDEOGRAPHER: We're back on the record at
16 1:46.

17 MR. DUBUC: Are you ready? Back on the record.
18 Sorry.

19 MS. WALKER: I'm sorry. I'm trying to eat.
20 I -- I apologize. We haven't had a lunch break.

21 BY MS. WALKER:

22 Q. Okay. I'm going to read the last
23 sentence in that first paragraph in the left column.

MR. MACHLIS: I think it's on page 15-3.

MS. WALKER: 15-4.

1 Q. So the system we're talking about is
2 more -- if I understand you correctly -- is more
3 immiscible than the diagram on page 15-3?

4 A. Yes.

5 Q. Can you flip that page over again?
6 Sorry.

7 So does it matter how you define
8 immiscibility for your analysis?

9 A. No.

10 Q. It's irrelevant?

11 A. No.

12 Q. How is it relevant?

13 A. It's relevant with regard to the amount
14 of dissolution you get of the bitumen and bitumen
15 compounds into the water phase and, as well, the
16 limonene into the water phase, so it is not
17 irrelevant.

18 Q. So are you defining miscibility, then, to
19 fit your argument, sometimes calling it partially
20 miscible and sometimes calling it immiscible?

21 A. I am not defining miscibility.

22 Q. Are you then referring to it sometimes as
23 partially miscible and partially -- I -- I'm
24 sorry -- are you referring to miscibility sometimes
25 as partially miscible and sometimes immiscible?

1 A. No, I think I've already answered that
2 question. I'm saying that miscibility is a variable
3 term that it's hard to say when a -- when a
4 system -- if we were to have a series of
5 miscibility, it would be hard to define when one
6 considers the immiscible threshold to be crossed
7 into partially miscible. It's a degree of -- it's a
8 spectrum type of an -- an approach, so it's --
9 it's -- it almost defies explanation. But it's a
10 degree of -- a -- a degree of separation.

11 Q. So how are we supposed to know what
12 you're talking about?

13 A. Listen, I guess.

14 Q. But how do we know if you're talking
15 about -- where on that spectrum you're referring to?

16 A. I'm referring to a highly immiscible
17 system, as I stated before.

18 Q. So when you say you're referring to a
19 partially miscible system, that's inaccurate?

20 A. No.

21 Q. So you're referring to both?

22 A. In my report, I -- I refer to the
23 partial immiscibility -- immiscibility with -- as
24 it -- as it relates to the dissolution of materials
25 into the respective phases. But in this system, it

1 another?

2 A. No, I don't say that.

3 Q. Okay. Are you saying, in the system we
4 have here with d-limonene and bitumen, that the
5 d-limonene and the bitumen can't affect each other?

6 A. No.

7 Q. So are you saying that the presence of
8 d-limonene in the water will affect the -- the
9 dissolving of bitumen in the water?

10 A. In -- in the entire system, it will, yes.

11 Q. In the raffinate?

12 A. The raffinate is part of that system,
13 yes.

14 Q. So you're saying the presence of
15 d-limonene in the raffinate will influence the
16 dissolving of bitumen in the water -- in the
17 raffinate?

18 A. Actually, the driving force will be the
19 other way around. The amount of limonene in the
20 oil-rich phase will -- will drive concentrations in
21 the raffinate phase.

22 Q. Okay. So I'd like to turn to Exhibit --
23 the -- the part from the textbook. What's his name?

24 DR. JOHNSON: Schwarzenbach.

25 MS. WALKER: Schwarzenbach? Which is

1 is very -- it is a very immiscible-type system.
2 That's why the large, large separation between the
3 two phase plots on the ternary diagram. That's
4 about as best as I can explain it.

5 Q. So at what degree of immiscibility is the
6 system ideal?

7 A. It is -- it is ideal with respect to the
8 dilute solutions that we have in this system. I
9 think there would be great debate as to when that
10 threshold is -- is crossed.

11 Q. So it's hard to say when a system is
12 ideal?

13 A. Again, it's a -- it's a degree of --
14 it's -- it's a degree. The -- the transition from
15 nonideal to ideal can be a gradient or a -- a -- a
16 degree.

17 Q. And yet you assume that the system was
18 ideal.

19 A. Yes. The -- for this system, I'm
20 assuming that it is ideal because of the very, very
21 dilute solutions in the water phase and the very,
22 very concentrated solutions in the oil-rich phase.

23 Q. So are you saying that in a dilute
24 system, then -- I'm sorry. Yes -- in a dilute
25 system, the -- the compounds can't affect one

1 Exhibit -- didn't we get to it? Maybe it's an
2 exhibit from -- from last week. Okay.

3 Okay. It's Exhibit 3 from last week. Do
4 you have those?

5 MR. HOGLE: Yes. He's just going to use my
6 copy. Okay, Joro?

7 MS. WALKER: Sure. Page 97. We've talked a
8 lot about this.

9 MR. HOGLE: That's it, right there (indicated).

10 THE WITNESS: Ten?

11 MR. HOGLE: Yeah. It's -- it's right in there.
12 It's open to it.

13 THE WITNESS: Oh.

14 MR. DUBUC: Can you put that on the screen,
15 please? Thank you.

16 BY MS. WALKER:

17 Q. Can you zero in a little, please, at that
18 lower paragraph?

19 A. (Witness complied.)

20 Q. Thank you. So I'm just going to read
21 a -- a statement sort of halfway down that
22 paragraph, starting with "Finally," where the little
23 mark is.

24 "Finally, if the organic chemicals are
25 present at a" -- "low enough levels (less than 10 to

1 the minus 3 volume fraction) then there is a low
2 probability of even their hydration shells
3 overlapping, we can expect no effect on the aqueous
4 activity coefficient or (liquid) solubilities." (As
5 read)

6 So is this a rule of thumb?

7 A. I -- I don't know. He's speaking of a
8 probability here, and the --

9 Q. Okay. So is it a --

10 MR. HOGLE: Were you finished with your answer?

11 THE WITNESS: He's speaking of a probability
12 and overlapping of hydration shells, which are a
13 theoretical consideration beyond what I have -- am
14 familiar with.

15 BY MS. WALKER:

16 Q. So does this statement apply to our
17 situation with d-limonene and bitumen?

18 A. The very low volume fraction portion of
19 that statement would apply.

20 Q. So does it -- are there any situations
21 where you would still see an effect on the aqueous
22 activity or on solubility?

23 A. Certainly.

24 Q. Could the situation with d-limonene and
25 bitumen be one of those?

1 temperature.

2 Q. And so, based on this statement or your
3 experience, you wouldn't expect to see an effect or
4 an increase in the dissolving of bitumen in the
5 water where the solubility of d-limonene is 13.8
6 milligrams per liter?

7 A. That's correct.

8 Q. And you're basing that statement on the
9 solubility of d-limonene in water?

10 A. Partially.

11 Q. What else?

12 A. On the solubility of d-limonene in water;
13 on the extremely low solubility of bitumen in water;
14 on the ideal solution -- dilute solution assumption;
15 and additionally, on the guidance given in
16 Schwarzenbach.

17 Q. What did you say about "ideal solution
18 situation"?

19 A. Dilute -- very dilute solutions.

20 Q. All right. And you're assuming them to
21 be ideal?

22 A. In this case, yes.

23 Q. Okay. So I have an exhibit. I don't
24 know what number -- should we just continue with our
25 numbers, or do you want letters?

1 A. No.

2 Q. So you're saying that this statement
3 rules out the possibility that d-limonene could have
4 an effect on the dissolving of bitumen in water?

5 A. No.

6 Q. So it doesn't rule it out?

7 A. No.

8 Q. So there are -- there could be -- so
9 based on this statement, d-limonene could have an
10 effect on the dissolving of bitumen in the water?

11 A. Yes.

12 Q. And that effect could be to increase the
13 concentration of bitumen in the water?

14 A. I don't think so.

15 Q. Why don't you think so?

16 A. Because it is a dilute solution, and
17 reading to the final sentence there, "Slightly
18 soluble hydrocarbons present in a solution do not
19 appear to enhance the dissolution of other
20 hydrocarbons." That doesn't rule out any effect as
21 you described it.

22 Q. So what's the solubility of d-limonene?

23 A. In what material?

24 Q. Water. I'm sorry. In water.

25 A. 13.8 milligrams per liter at room

1 MR. MACHLIS: No --

2 MR. DUBUC: No. This --

3 MR. MACHLIS: -- you can put --

4 MR. DUBUC: -- should be an exhibit for him.

5 MS. WALKER: Okay. This exhibit is called
6 "Enhanced Concentrations of PAHs in Groundwater at a
7 Coal Tar Site."

8 (Whereupon, Exhibit No. 20 was marked for
9 purposes of identification.)

10 THE WITNESS: For things like this that I have
11 not reviewed --

12 VIDEOGRAPHER: Should we go off the camera?

13 MR. HOGLE: Yeah.

14 VIDEOGRAPHER: We're off -- we'll go off the
15 record at 2:06.

16 (Off the record)

17 VIDEOGRAPHER: We're back on the record at
18 2:08.

19 MS. WALKER: I'd like to move for this to be
20 admitted as Exhibit -- I've forgotten the number
21 already.

22 MR. DUBUC: Twenty.

23 MS. WALKER: Twenty.

24 MR. HOGLE: I'd object to that. Has this been
25 provided before?

1 MS. WALKER: No.
 2 MR. HOGLE: Okay. That's the basis for my
 3 objection at this time.
 4 MS. WALKER: Well, you presented exhibits when
 5 Dr. Johnson was testifying that you hadn't provided
 6 to us.
 7 MR. HOGLE: The deadline for exchanging
 8 exhibits was after Dr. Johnson's deposition.
 9 MS. WALKER: Have you given us a list of
 10 exhibits?
 11 MR. HOGLE: Yes.
 12 MS. WALKER: When did you give it to us?
 13 MR. HOGLE: I think the 23rd is when we did
 14 that.
 15 MS. WALKER: Well, objection noted,
 16 BY MS. WALKER:
 17 Q. This article comes from a reputable
 18 journal; is that correct?
 19 A. I don't know.
 20 Q. You've never heard of the Environmental
 21 Science Technology -- Environmental Science &
 22 Technology journal?
 23 A. I believe I've heard of it. I'm not
 24 familiar with it.
 25 Q. Isn't this the top journal in your field?

1 BY MS. WALKER:
 2 Q. Do they -- are they the same or do they
 3 appear the same?
 4 A. They are the same.
 5 Q. So before we took the break, did you say
 6 that the solubility of d-limonene is 13.8 milligrams
 7 per liter?
 8 A. Yes.
 9 Q. And that that concentration was a factor
 10 in your analysis?
 11 A. Yes.
 12 Q. Okay. So I'm asking -- and that -- I'm
 13 sorry. And that that was a factor -- did you say
 14 that that was a factor in your analysis determining
 15 that d-limonene would actually suppress the
 16 solubility of bitumen in water?
 17 A. Did -- are you -- you're asking did I say
 18 that? Or what --
 19 Q. Yes.
 20 A. I think -- I think --
 21 Q. Or --
 22 A. -- it was in my report. I don't remember
 23 saying that today.
 24 Q. Okay. So do you agree with that
 25 statement then?

1 A. No.
 2 Q. What is the top journal in your field?
 3 A. My field is more chemical engineering, so
 4 I look at Chemical Engineering Progress, Chemical
 5 Engineering. I look at a variety of those type of
 6 magazines and some periodicals. I -- I don't review
 7 the scientific technology journals.
 8 Q. So are you saying that the enhanced
 9 concentrations of PAHs in groundwater at a coal tar
 10 site is not your expertise?
 11 A. Yes.
 12 Q. Okay. I'm wondering if you've heard of
 13 the Massachusetts Institute of Technology.
 14 A. Is there a question there? I have heard
 15 of it, yes.
 16 Q. I'm sorry. And I'm wondering if you
 17 could read the authors on this paper?
 18 A. Allison MacKay and Phillip Gschwend.
 19 Q. So I'm wondering -- I'm sorry. Is
 20 Phillip Gschwend also a co-author on a textbook?
 21 Organic Chemistry? Environmental Organic Chemistry?
 22 MR. HOGLE: Objection, foundation.
 23 THE WITNESS: The -- the names appear the same,
 24 yes.
 25 ///

1 A. What -- what -- read --
 2 Q. Do you want me to repeat the --
 3 A. -- read that statement back to me again,
 4 please. I -- I want to be careful how I answer
 5 this.
 6 Q. Okay. So --
 7 A. That question, rather.
 8 Q. -- is it your opinion that the solubility
 9 of d-limonene at 13.8 milligrams per liter is a
 10 factor in your conclusion that d-limonene would
 11 actually suppress the solubility of tar in water?
 12 A. Yes.
 13 Q. Okay. Is bitumen a high -- a hydrophobic
 14 organic -- a hydrophobic organic compound?
 15 A. Yes.
 16 Q. So -- and are petroleum compounds
 17 hydrophobic organic compounds?
 18 A. Yes.
 19 Q. And are PAHs hydrophobic organic
 20 compounds?
 21 A. Yes.
 22 Q. Can you tell me what PAHs are --
 23 A. Polyaromatic --
 24 Q. -- please?
 25 A. -- hydrocarbons.

1 Q. So does this paper represent actual field
 2 data?
 3 A. I don't know.
 4 Q. Would you take the time to review it so
 5 that you can answer the question?
 6 MR. HOGLE: I'm going to object and instruct
 7 the witness not to answer. This is a lengthy
 8 document -- eight pages, single spaced, both
 9 columns -- it's never been provided before, and we
 10 don't have -- time is limited.
 11 MS. WALKER: So when you provided documents to
 12 our witness -- exhibits, we had never seen them
 13 before. We didn't prevent him from answering your
 14 questions.
 15 MR. HOGLE: I don't -- I don't think I had your
 16 witness review a document like this that he had
 17 never seen before.
 18 MS. WALKER: Well, you gave us a -- you gave us
 19 an EPA document that was --
 20 MR. MACHLIS: That was your witness's
 21 testimony. The EPA document that we -- that was
 22 given in Johnson's document was -- was a document
 23 that was referenced in his testimony, wasn't it?
 24 MS. WALKER: That's not true --
 25 MR. MACHLIS: There was --

1 ahead and answer it to the best you can.
 2 THE WITNESS: No, I -- I -- I don't think it
 3 refers or relates specifically to the
 4 limonene-bitumen water system.
 5 BY MS. WALKER:
 6 Q. Why is that?
 7 A. Because the sentence that you read just
 8 says that there -- there was these increases.
 9 That's all -- that's all the information I have.
 10 Q. Okay. I'm going to read another
 11 sentence. "This suggested" -- this is just a few
 12 sentences down -- "This suggested pyrene association
 13 with humic acids. Given the decrease in groundwater
 14 total organic carbon of 4 milligrams per liter upon
 15 acidification and ultrafiltration" -- okay. Scratch
 16 that. Sorry. Hang on just a second.
 17 Okay. I'm going to try to be more
 18 helpful here and read a sentence from 1326 --
 19 MR. HOGLE: Page 1326.
 20 BY MS. WALKER:
 21 Q. -- which states that the degree -- the
 22 decrease in total organic carbon concentration of 4
 23 milligrams per liter was assumed to indicate the
 24 concentration of sorbent colloids. Does that
 25 indicate a cosolute?

1 MS. WALKER: -- this document --
 2 MR. MACHLIS: -- never mind.
 3 MR. HOGLE: Okay, guys. All right. Let --
 4 Let's -- let's continue with the examination, and we
 5 can have the debate offline.
 6 MS. WALKER: But -- so are you going to
 7 instruct him not to answer that?
 8 MR. HOGLE: That's what I am doing, yes.
 9 MS. WALKER: Then we have to have the debate.
 10 MR. HOGLE: I'm not going to change my
 11 instruction.
 12 BY MS. WALKER:
 13 Q. All right. Well, I'll read you a
 14 paragraph, the introductory paragraph to this paper.
 15 "Concentrations of polycyclic aromatic
 16 hydrocompounds (PAHs)" -- "hydrocarbons." Sorry --
 17 "in groundwater at a coal tar site were elevated by
 18 factors ranging from 3 (pyrene) to 50" -- I'm not
 19 going to say that -- "over purely dissolved
 20 concentrations."
 21 Do you think that analysis is relevant to
 22 determining whether the presence of d-limonene would
 23 influence the solubility of tar in water?
 THE WITNESS: Am I supposed to answer?
 MR. HOGLE: Objection, lacks foundation. Go

1 A. I don't believe a colloid is a solute.
 2 Q. Is humic acid a solute?
 3 A. I don't know.
 4 Q. What -- okay. So is this paper saying
 5 that there is a very low concentration of humic acid
 6 in the groundwater?
 7 MR. HOGLE: Objection, lacks foundation.
 8 THE WITNESS: I don't know what the paper says.
 9 BY MS. WALKER:
 10 Q. Okay. Can you -- can you read that
 11 paragraph, please, starting with the organic
 12 colloid -- you don't have to read it out loud.
 13 A. What -- which paragraph are you talking
 14 about?
 15 Q. Okay. It starts -- so it's the -- on
 16 page 1326, the second column. It starts with "An
 17 organic colloid."
 18 A. (Witness reviewed document.) I've
 19 scanned the paragraph.
 20 MR. DUBUC: Let's take a brief break, please.
 21 VIDEOGRAPHER: We're going off the record at
 22 2:24.
 23 (Off the record)
 24 VIDEOGRAPHER: We're back on the record at
 25 2:41.

1 MR. DUBUC: You can remove that document
2 screen, please. And can we have full screen on
3 Mr. Handl? Thank you.

4 BY MS. WALKER:

5 Q. Okay. So let's talk about a different
6 topic. I'm sure you're disappointed.

7 You estimated the solubility of bitumen
8 in water, did you not?

9 A. Yes. Oh, the --

10 Q. And in --

11 MR. HOGLE: Repeat it. Did you?

12 THE WITNESS: "Did you?"

13 MS. WALKER: I'm sorry.

14 THE WITNESS: "Did you not?" What does that
15 mean? Did you -- I did not -- I did estimate, yes.

16 BY MS. WALKER:

17 Q. And in doing so, did you state that the
18 actual makeup of bitumen will consist of hundreds to
19 thousands of different hydrocarbon molecules?

20 A. I have stated that.

21 Q. And did you choose five of those as being
22 representative of those compounds?

23 A. Yes.

24 Q. So for each of those compounds, did you
25 determine the proportion of the total of the bitumen

1 MR. HOGLE: Objection, foundation.

2 THE WITNESS: I -- I don't know the answer to
3 that.

4 BY MS. WALKER:

5 Q. Okay. Have you reviewed any documents
6 that tell you the compounds that make up the
7 bitumen?

8 A. I have seen references to some compounds
9 that are in bitumen, but in no way do I purport to
10 have seen an indication of all the compounds that
11 are in bitumen.

12 Q. So is there a test that would tell you
13 the makeup of the compounds in the bitumen?

14 A. I believe tests, plural, would be
15 appropriate.

16 Q. So did you use a proxy, then, for the
17 100 -- for the solubility of the 100 to 1,000
18 compounds?

19 A. No. I used a range of compound and then
20 made a judgment on a -- a representative figure for
21 that range. I did not use a single proxy.

22 Q. So you necessarily estimated the
23 solubility of the compounds?

24 A. Yes. I -- I -- I estimated -- I --

25 Q. And what was that --

1 that -- I'm sorry. Let me restate that.

2 And did you determine for each of those
3 compounds -- each of the five -- the proportion of
4 the total 1,000 -- 100 to 1,000 compounds they make
5 up?

6 A. No.

7 Q. So you looked at five compounds out of
8 the 100 to 1,000 without knowing the proportions of
9 those compounds in the bitumen?

10 A. Correct.

11 Q. So how did you come up with the 5
12 milligrams per liter solubility --

13 DR. JOHNSON: Micrograms.

14 BY MS. WALKER:

15 Q. -- micrograms per liter solubility?

16 A. That's explained in my report. I looked
17 at that range of compounds, and I wanted to include
18 some at the light end of the range and some at the
19 heavier end of the range, and I looked at the entire
20 range and picked some in between and weighted it
21 conservatively.

22 Q. And do we know the compounds that make up
23 the bitumen?

24 A. No.

25 Q. So that's nowhere in the record?

1 A. -- let me rephrase that. I estimated a
2 bulk solubility for bitumen. I -- I -- I did not
3 estimate the solubility for the individual compounds
4 I used. I used actual solubility figures.

5 Q. Okay. So is it fair to say that the
6 pragmatic, real world approach to determining the
7 makeup of the compounds in bitumen would be by
8 testing?

9 A. That -- that would be the preferred
10 approach.

11 Q. So this -- am I correct in saying the
12 solubility you came up with was 5 micrograms per
13 liter?

14 A. Yes.

15 Q. And do you know what figure Dr. Johnson
16 used for -- for that same solubility?

17 A. Not offhand, but I -- I think he used
18 a -- I think he -- I don't believe he estimated a --
19 a bitumen solubility. I believe he used a
20 solubility of B(a)P.

21 Q. Okay. So --

22 A. I -- I --

23 Q. -- do you know what solubility --

24 A. I -- I --

25 Q. Sorry.

A. -- think his solubility figure was already mentioned, but I -- let me just check here. I think it's in my report. It was 1.5, wasn't it? (Witness reviewed document.) I believe Dr. Johnson started with a B(a)P solubility of 1.5 micrograms per liter, so my starting solubility is more conservative than his in that it shows a higher solubility.

Q. Is that value reasonably comparable to yours?

A. Which value are you speaking of?

Q. Is 1.5 micrograms per liter close to 5 micrograms per liter?

A. It differs by 3.5.

Q. So would you expect a lower concentration based on Dr. Johnson's solubility figure or your solubility figure?

A. Dr. Johnson uses a lower solubility figure. I'm not sure I'm answering your question, though.

Q. So is the concentration calculated in water higher for a solubility of 5 micrograms per liter or 1.5 micrograms per liter?

A. It's -- it's higher for the 5.

Q. So Dr. Johnson's estimate is actually

1 representative of the entire mix.

2 Q. Didn't you both use B(a)P as your

3 representative compound?

4 A. Absolutely not.

5 Q. So on page 4 of your expert report, are

6 you estimating the concentration of B(a)P --

7 A. I do estimate the --

8 Q. -- or were you --

9 A. Is she talking again? I am estimating

10 the concentration of B(a)P, yes.

11 Q. And was that for a single compound?

12 A. It was for B(a)P, yes.

13 Q. So did this calculation include all the

14 hundreds to a thousand other compounds in bitumen?

15 A. I accounted for their presence, yes.

16 Q. How did you account for their presence?

17 A. By starting with the range of solubility

18 data that we spoke of just previously.

19 Q. So you did use B(a)P as a representative

20 compound?

21 A. Let me check back. (Witness reviewed

22 document.)

23 The compounds that I used are listed on

24 page 2 and 3 of my report, and benzo(a)pyrene was

25 one of the several compounds that I did list but not

1 more conservative than yours.

2 A. Not with regard to the calculation that

3 I'm performing because my calculation starts out

4 with a higher concentration. The -- the fact of

5 being conservative means that I am starting with a

6 higher concentration; therefore, forecasting -- the

7 basis of my calculation will be higher, and that

8 higher calculation basis would, in theory, support a

9 higher dissolved basis, which is what we're

10 contending is the problem here. So I disagree

11 with -- with that. I believe that the 5 micrograms

12 per liter is more conservative.

13 Q. Well, compared to your analysis, is,

14 then, Dr. Johnson underestimating the solubility of

15 his representative compound?

16 A. I believe that Dr. Johnson starts with a

17 handbook solubility, which should be accurate.

18 Q. Okay. I'm sorry. Compared to your

19 estimate of the solubility of the bitumen, isn't

20 Dr. Johnson underestimating the solubility of the

21 bitumen by using a lower solubility?

22 A. It's a -- it's a different approach.

23 His -- his -- his figure is lower than mine,

24 granted; but he's picking a single proxy compound,

25 where I am trying to pick a figure that is

1 the only one.

2 Q. Okay. So on page 4, though -- there,

3 were you calculating the -- were you estimating the

4 concentration of B(a)P in equilibrium contact with

5 the raw bitumen?

6 A. I was estimating the concentration of

7 B(a)P in water that was in contact with the raw

8 bitumen.

9 Q. Okay. And so does this estimate account

10 for all the 100 to 1,000 other compounds in the

11 water?

12 A. Yes, it -- it estimates the presence of

13 those compounds because of the calculation of mole

14 fraction that I performed.

15 Q. Are you saying that no other compound

16 would go into the water?

17 A. No.

18 Q. So how does this account for other

19 compounds going into the water?

20 A. It doesn't. I'm calculating it for that

21 specific compound. But in the calculation of that,

22 I incorporated the presence of the other compounds.

23 That's the specificity of my approach.

24 Q. Would other compounds dissolve in the

25 water?

1 A. Certainly.

2 **Q. How many?**

3 A. I have absolutely no idea. Hundreds to
4 thousands.

5 **Q. So doesn't your testimony at page 1**
6 **to 2 -- by that I mean this bulleted paragraph**
7 **that's indented, that goes from page 1 to 2 --**
8 **doesn't that conflict with the notion that**
9 **d-limonene will evaporate quickly from the processed**
10 **finest?**

11 A. No, I don't see that relationship.

12 **Q. So does this paragraph assume that half**
13 **of what's in solution will be d-limonene?**

14 A. For -- for purposes of the demonstration
15 that I'm -- I'm making in that first bullet, I made
16 an assumption. I'm -- I'm not talking about a real
17 world case. I'm only demonstrating the mathematics
18 of -- of the -- how the mole fractions would --
19 would distribute. I'm not indicating that that is a
20 real world example. Or real world in -- as related
21 to the specific system with -- with regard to U.S.
22 Oil Sands.

23 **Q. Okay. But is it correct to say that your**
24 **conclusion in that paragraph is that you have to**
25 **have a fair amount of d-limonene in order to**

1 college thesis work, yes.

2 **Q. Does that tell you anything relevant to**
3 **whether d-limonene will evaporate from the processed**
4 **finest?**

5 A. Yes.

6 **Q. What does it tell you?**

7 A. It speaks to the volatility of the
8 d-limonene.

9 **Q. So will it tell you how quickly that will**
10 **happen?**

11 A. No.

12 **Q. Does vapor pressure tell you how quickly**
13 **d-limonene will evaporate from the processed finest?**

14 A. It is one of the parameters that will
15 tell you that.

16 **Q. So why does vapor pressure always include**
17 **a temperature?**

18 A. Because they vary with each other.

19 **Q. In what way?**

20 A. Increased temperature increases the vapor
21 pressure.

22 **Q. So is it fair to say that a decrease in**
23 **temperature will suppress evaporation?**

24 A. It has that tendency, but the evaporation
25 is dependent on other factors as well.

1 **suppress the entry of B(a)P into the aqueous phase?**

2 A. What -- what I'm saying is that the --
3 the mole fraction of d-limonene -- whatever it is --
4 will displace proportionate amounts of the compounds
5 present in bitumen in that solution.

6 **Q. So you have to have half the d-limonene**
7 **present to suppress the entry of B(a)P into the**
8 **aqueous phase by a factor of two?**

9 A. It would -- it would decrease -- it would
10 decrease it by a factor of .5.

11 **Q. Okay. So you said that you agree -- are**
12 **you -- am I correct in saying that you agree that**
13 **d-limonene will evaporate quickly from the processed**
14 **finest?**

15 A. I -- I agree that d-limonene will tend to
16 evaporate from the processed finest. The -- the
17 quickness of that evaporation is dependent on a lot
18 of other parameters.

19 **Q. So when you were doing your steam test --**
20 **steam-stripping test, what did you conclude from**
21 **that?**

22 A. I did no such test for this work.

23 **Q. Didn't you testify about a steam test --**
24 **I'm sorry -- a steam-stripping test?**

25 A. I -- I said that I had used that in my

1 **Q. So would you expect d-limonene to**
2 **evaporate less readily from the processed finest if**
3 **the temperatures were cold?**

4 A. The -- yes, the rate of evaporation
5 should decrease with colder temperatures if the --
6 if the temperature of the -- the fine -- or the --
7 the spent material is decreased as well.

8 **Q. Okay. Do you know the relationship**
9 **between temperature and the evaporation for**
10 **d-limonene?**

11 A. No. That's dependent on a lot of other
12 parameters.

13 **Q. So, then, you don't know the effect that**
14 **temperature will have on the evaporation of**
15 **d-limonene other than to say it will decrease,**
16 **generally, with temperature?**

17 A. As I've stated, temperature -- either an
18 increase or a decrease -- will have an effect on the
19 evaporation rate, but it is not the only parameter
20 in the evaporation.

21 **Q. So is it important to know temperatures**
22 **when you're trying to determine whether d-limonene**
23 **will evaporate from the processed finest?**

24 A. Oh, absolutely.

25 **Q. Okay. Do you know the temperatures at**

1 the mine?
 2 A. No. I imagine today it's a little cool,
 3 though.
 4 Q. Do you know any -- of any data in the
 5 record that relates the temperature of -- the
 6 temperature at the mine with the -- with the
 7 evaporation of the d-limonene?
 8 A. If it's there, I have not read it.
 9 Q. Do you know the vapor pressure of
 10 d-limonene?
 11 A. The d-limonene vapor pressure is
 12 purported to be 2 millimeters at atmospheric
 13 pressure and at 25 degrees --
 14 Q. Do you know --
 15 A. -- centigrade.
 16 Q. -- do you know that compares to water?
 17 A. It is roughly ten times lower than water,
 18 I believe.
 19 Q. So what does that mean in comparison to
 20 the vapor pressure of water -- in terms of
 21 evaporation?
 22 A. It -- it will tend to evaporate
 23 relatively slower than water given all other
 24 conditions being equal.
 25 Q. And does the handling of materials affect

1 d-limonene?
 2 A. Not right off the head -- no, I don't.
 3 Q. So generally, the higher -- what does a
 4 higher vapor density mean?
 5 A. Higher vapor density is -- vapor
 6 densities are usually reported in terms of their --
 7 their bulk density with air as a basis. So if -- if
 8 a higher gas density is reported, it is usually --
 9 it -- it is always a -- heavier than air and tends
 10 to -- tends to settle if there are no mechanical --
 11 additional mechanical movements of the air in a
 12 completely still environment.
 13 Q. So what does that mean -- if it tends to
 14 settle -- in terms of evaporation?
 15 A. It doesn't really mean anything in terms
 16 of evaporation because if it's in the gas phase, it
 17 has already evaporated.
 18 Q. But how about evaporation from the pile?
 19 A. You're going to have to ask a better
 20 question so I can answer it.
 21 Q. Okay. So let's assume some of it has
 22 already evaporated but there's still some d-limonene
 23 that hasn't evaporated. So how would the vapor
 24 density of the d-limonene that has evaporated affect
 25 the evaporation of the d-limonene that hasn't

1 the degree of evaporation from the processed fines?
 2 A. Absolutely.
 3 Q. So does it matter if the fines are
 4 stacked in a pile or spread out?
 5 A. Does it matter with regard to what?
 6 Q. The rate of evaporation of d-limonene.
 7 A. Yes, I believe it would have an effect.
 8 Q. You're not sure?
 9 A. If you give me the parameters of the two
 10 piles you're speaking of, I could probably tell you;
 11 but generally, it should have an effect.
 12 Q. And so would d-limonene evaporate more
 13 slowly from a pile?
 14 A. As compared to what?
 15 Q. Sand spread out flat.
 16 A. The -- the spreading should enhance the
 17 evaporation.
 18 Q. Does vapor density affect the evaporation
 19 of d-limonene from the processed fines?
 20 A. It may or may not, depending on the
 21 velocity of air above it.
 22 Q. Does that mean wind?
 23 A. It could be wind or other movement of
 air.
 Q. Do you know the vapor density of

1 evaporated?
 2 A. Evaporation is a concentration-driven
 3 process. In the absence of mechanical transport of
 4 the air -- i.e., wind or a fan or any kind of air
 5 movement -- the evaporation will be driven by the
 6 vapor pressure and concentration gradients.
 7 If the concentration gradients are not
 8 enhanced by mechanical means, like wind or other
 9 movement, the evaporation will be slower.
 10 Temperature will increase evaporation.
 11 Surface area will increase evaporation.
 12 Q. Okay. Does the fact that d-limonene is
 13 mixed with tar affect the rate of evaporation into
 14 air?
 15 A. Yes.
 16 Q. In what way?
 17 A. The -- the mixture -- the mixture will
 18 exhibit a -- a lower vapor pressure than the pure
 19 component.
 20 Q. So are you saying the mixture will
 21 evaporate more quickly?
 22 A. No.
 23 Q. So it will evaporate less quickly?
 24 A. Yes.
 25 Q. Does the salinity in water influence the

1 effect of d-limonene on dissolving of tar in water?
 2 A. Did you say "salinity"?
 3 Q. I did.
 4 A. Yes.
 5 Q. In what way?
 6 A. Typically, ionic materials or saline
 7 materials will tend to decrease the solubility. It
 8 has a salting-out effect.
 9 Q. So you said it would decrease the
 10 solubility?
 11 A. Yes.
 12 Q. So you're saying that the presence of
 13 salinity in water would decrease the solubility of
 14 d-limonene in water?
 15 A. Yes.
 16 Q. And it would also decrease the solubility
 17 of bitumen in water?
 18 A. Yes.
 19 Q. Okay. So when Mr. Hogle asked you why
 20 you assume that we had ideal solutions, is it
 21 accurate to say -- can you hear me?
 22 A. Yes, I can --
 23 Q. I'm sorry. There's a lot of noise.
 24 A. -- hear you.
 25 Q. Okay. So when Mr. Hogle asked you why

1 A. The basis of my calculation lays the
 2 foundation for the final calculations that I make.
 3 The basis of the foundation is the
 4 ternary diagram and the relationships in it. Then I
 5 further that to the equilibrium relationship. Then
 6 I further that to specific calculation of compounds
 7 in water from the bitumen.
 8 Q. Aren't you trying to prove that the
 9 interactions between the d-limonene and the bitumen
 10 are not very great?
 11 A. No, I -- that's not the intent of what I
 12 was doing.
 13 Q. What was the intent of what you were
 14 trying to do?
 15 A. The intent was to project a comparison of
 16 a specific compound -- B(a)P -- that may be washed,
 17 in -- by water contact with the virgin oil sands and
 18 compare that to the same mechanism of washing in the
 19 processed oil sands.
 20 Q. Well, didn't you assume that the
 21 conditions were ideal because the interactions
 22 between d-limonene and tar were not great?
 23 A. No.
 24 Q. Okay. I will just review my notes for a
 25 second here, and I think I'm done, but I just want

1 you assume that we had ideal conditions, is it
 2 accurate to say that you said it was because we have
 3 dilute solutions?
 4 A. Yes. Extremely dilute solutions.
 5 Q. Okay. And then are you also saying that,
 6 as a result, the interactions are not great?
 7 A. (No audible response.)
 8 Q. Let me ask that better.
 9 A. Yes.
 10 Q. Are you saying that the inter -- the
 11 interactions between d-limonene and the bitumen are
 12 not great?
 13 A. At these very low concentrations, yes.
 14 Q. And is that the basis for assuming that
 15 the -- the line on your -- what's it called?
 16 Ternary -- is it "ternary diagram"? I'm not saying
 17 that right, am I? Oh, yeah. Ternary phase
 18 diagram -- why the line is straight?
 19 A. It is one of the bases, yes.
 20 Q. So isn't the basis for your conclusion
 21 what you are trying to prove?
 22 A. "Basis for my conclusion." No, the
 23 basis is what I'm founding the starting point of my
 24 conclusion on.
 25 Q. Can you explain that, please?

1 to check, so give me a minute, please.
 2 VIDEOGRAPHER: We're going off the record at
 3 3:17.
 4 (Off the record)
 5 VIDEOGRAPHER: We're back on the record at
 6 3:23.
 7 BY MS. WALKER:
 8 Q. Okay. So in the very beginning of your
 9 testimony, you talked about your actual field work;
 10 is that correct?
 11 A. Yes.
 12 Q. Do you place a high value on data that's
 13 taken from the field?
 14 A. Oh, yes.
 15 Q. And do you wait until projects are
 16 underway to do -- to test your design theory?
 17 A. In some cases.
 18 Q. Do you consider that a better approach?
 19 A. Better than what?
 20 Q. Do you -- do you think the best approach
 21 is to wait until projects are underway to test your
 22 design theory?
 23 A. It depends on the project. In some
 24 cases, it can't be tested until the project
 25 commences or is constructed or moved along. In

1 other cases, things can be well designed ahead of
2 time.

3 Q. So in our situation here with the PR
4 Spring mine, were there tests that could have been
5 done to determine the -- the effect of d-limonene on
6 the dissolving of bitumen?

7 A. Yes.

8 Q. And were there tests that could have been
9 done to determine the compounds that make up the
10 bitumen?

11 A. Yes.

12 MS. WALKER: Okay. Thank you.

13 EXAMINATION

14 BY MR. McCONKIE:

15 Q. Mr. Handl, thank you for hanging in there
16 with us today.

17 A. Certainly.

18 Q. I know it's been a long day, but I
19 just -- I just have a few questions.

20 For purposes of evaluating a potential
21 threat to groundwater quality, what would be the
22 purpose of evaluating chemical characteristics of
23 the processed fines?

24 A. The -- the value of that would speak

1 to -- or -- or allow you to project with greater
2 precision and detail estimates of what may occur
3 when those materials became contacted with -- with
4 water or may -- may actually lead additional
5 information toward the evaporation.

6 Q. Okay. In evaluating a potential threat
7 to groundwater, what would be considered the
8 receptor?

9 A. Well, a receptor is -- in our terminology
10 that -- that we use -- is usually a -- a -- some --
11 some sort of a downstream water -- down-gradient
12 water user that utilizes that aquifer.

13 Q. Would -- would groundwater itself be
14 considered a receptor?

15 A. Not typically in the context that --
16 that -- that I use in my work.

17 Q. What would be the purpose of determining
18 solubility of the compound residual -- of the
19 residual compound?

20 A. I'm having trouble understanding your
21 question. The solubility of residual compounds
22 would be a laboratory -- a theoretical laboratory
23 number, so the purpose of that would be whatever the
24 person had in mind that ordered that test. Maybe
25 you could rephrase the question.

1 Q. Well, let me just -- let -- let me just
2 move on.

3 You know, we -- we spent a lot of time
4 today talking about the chemical characteristics
5 of -- of processed tar sands, the residual
6 compounds, things like that. What if there were no
7 groundwater to be impacted? How might that affect
8 the -- the relevancy or the importance of what we've
9 been talking about today?

10 A. I believe it would have great -- great
11 bearing on that because with -- with no groundwater,
12 there would be no off-site transport in the
13 subsurface to be carried to what I would call
14 receptors.

15 MR. McCONKIE: Okay. That's all I have. Thank
16 you.

17 MR. HOGLE: I just have a few follow-ups.

18 EXAMINATION

19 BY MR. HOGLE:

20 Q. Mr. Handl, could you distinguish
21 miscibility from solubility?

22 A. Yes. Solubility is a -- a fixed
23 parameter that -- for a particular solute that
24 depends on the characteristics of the -- of the

1 solvent and the solute and is also a function of
2 temperature, but it is a -- a fixed parameter that
3 can be well defined.

4 Miscibility is the tendency of two fluids
5 to become dissolved within each other, and -- as
6 opposed to immiscibility, which is a tendency to
7 form two layers. And in between miscibility and
8 immiscibility is a continuum of different states
9 or -- I guess states would be the way to put it --
10 that -- or different degrees of miscibility and
11 immiscibility so that it is not a -- one specific
12 parameter like -- like solubility is.

13 Q. Okay. When you developed your ternary
14 diagram, what did you use as your basis?

15 A. The basis of my ternary diagram was
16 actual data that is reported in the literature for
17 the various materials that I found. And where I
18 could not find specific parameters, such as for
19 bitumen, I made estimates based on a range of values
20 that are representative of the compounds within that
21 mixture.

22 Q. Okay. I want to direct your attention to
23 the Permit-By-Rule Demonstration -- what's been
24 referred to as the Permit-By-Rule -- on page 10,
25 part of Table 3.

1 And my question is: Is it significant to
2 you -- is it -- is it significant to you that the
3 other hydrocarbons -- oil and grease, TRPH -- that
4 the concentration of those are substantially less in
5 the processed materials?

6 A. Yes, I think that is a very significant
7 factor. The availability of those materials is --
8 is lessened by the amount that has been removed
9 for -- during processing; and therefore, the
10 available material for transport by hydrologic
11 mechanisms or by precipitation is lessened because
12 of that lesser availability.

13 Q. And one final question: When presented
14 with the -- the operations -- the -- the planned
15 operations of the PR Spring mine, would one in your
16 field expect that d-limonene would increase water
17 solubility or concentration of PAH compounds in the
18 spent materials?

19 A. Well, the -- if -- if the -- if there
20 were no d-limonene in the spent materials, I would
21 say -- as -- as compared to the presence of
22 d-limonene in the spent materials -- I would say the
23 presence of d-limonene would tend to decrease the
24 release of -- of any materials from the -- from
25 those spent sands.

1 Q. So are you saying that for oil and grease
2 in the processed fines, 30,000 milligrams per
3 kilogram are available for transport?

4 A. That's what the table indicates, yes.

5 Q. And so for TRPH, there's 9,500 milligrams
6 per kilogram available for transport?

7 A. That looks correct.

8 MS. WALKER: Okay. Thank you. I'm done. And
9 I -- I should have said before that I really
10 appreciate how much work you've put into today. I'm
11 sorry I didn't say that before --

12 MR. HOGLE: We'll --

13 MS. WALKER: -- because I really do appreciate
14 it.

15 MR. HOGLE: We'll read and sign.

16 VIDEOGRAPHER: We're going to go off the record
17 now. The time is 3:36.

18 ---
19 (Thereupon, the deposition was concluded at
20 3:36 p.m., on Friday, April 27, 2012.)
21 ---

22 SIGNATURE REQUIRED
23
24
25

1 Q. Okay. Would you -- would one in your
2 position think that that should be something that
3 needs to be further tested?

4 A. For purposes of this -- of obtaining this
5 permit, I do not think so.

6 MR. HOGLE: Okay. No further questions.

7 MR. DUBUC: Just one second.

8 MS. WALKER: We're just moving the microphone.
9 Sorry. Okay, just a few.

10
11 EXAMINATION

12 BY MS. WALKER:

13 Q. So back to Table -- on page 11 of the
14 PR -- PBR, of the Permit-By-Rule. It's not page --
15 I'm sorry. It's on page 10, the one I want you to
16 look at.

17 THE WITNESS: I'm going to have to leave
18 shortly here.

19 BY MS. WALKER:

20 Q. Okay. So are you saying that this table
21 is instructive in determining whether petroleum
22 compounds are a potential source of contamination?

23 A. It -- it's instructive in determining
24 the -- the amount available that could be
25 transported.

1 DEPONENT'S CERTIFICATE

2
3 I, EDWARD L. HANDL, P.E., the deponent in the
4 foregoing deposition, DO HEREBY CERTIFY, that I have read
5 the foregoing - 155 - pages of typewritten material and
6 that the same is, with any changes thereon made in ink on
7 the correction sheet and signed by me, a full, true and
8 correct transcript of my oral deposition given at the time
9 and place hereinbefore mentioned.

10
11
12 EDWARD L. HANDL, P.E.

13
14 SUBSCRIBED AND SWORN TO before me this ____ day of
15 _____, 2012.
16
17
18
19

20 Notary Public State of Montana
21 Print Name _____
22 Residing in: _____
23 My Commission expires: _____

24 JB-PR Spring Tar Sands Project
25

1 CERTIFICATE

3 STATE OF MONTANA)
4 COUNTY OF GALLATIN) : ss

5 I, Jan M. Baldensperger, RFR, freelance court
6 reporter and notary public for the State of Montana, do
7 hereby certify:

8 That the witness in the foregoing deposition was by
9 me first duly sworn to testify to the truth, the whole
10 truth, and nothing but the truth in the foregoing cause;
11 that the deposition was then taken before me at the time,
12 and place herein named; that the deposition was reported
13 by me in shorthand and later transcribed into typewriting
14 under my direction, and the foregoing pages contain a true
15 record of the testimony of the witness, all done to the
16 best of my skill and ability.

17 IN WITNESS WHEREOF, I have hereunto set my hand and
18 affixed my notarial seal on this the ____ day of
19 _____, 2012.

23 Jan M. Baldensperger
24 Notary Public State of Montana
25 Residing in Bozeman, MT
My Commission expires: 1/8/2013

WORD INDEX

	12:42 (1) 81:12	1993 (3) 54:13;72:21;73:5	152:25	6.51 (1) 77:25
*	124 (1) 67:3		3.5 (1) 133:14	6.8 (2) 65:25;66:22
***** (1) 8:3	13 (3) 35:22;36:1,16	2	3:17 (1) 148:3	67 (1) 73:10
/	13.8 (6) 29:8;33:3;118:25; 119:5;123:6;124:9	2 (17) 15:2,13;18:20;30:17; 35:19;39:1,4;59:5,15; 66:17;73:12,13;107:24; 135:24;137:6,7;141:12	3:23 (1) 148:6	69 (1) 46:18
/// (1) 122:25	1311 (1) 85:23	2.3 (2) 47:10;48:9	3:36 (2) 155:17,20	
1	1326 (3) 127:18,19;128:16	208 (1) 120:15	30,000 (1) 155:2	7
1 (16) 20:7,21;25:20;26:2; 33:23;34:2,13,14;52:3,4; 59:16;67:20;77:5,9; 137:5,7	14 (3) 36:17,21;37:15	2:06 (1) 120:15	300 (1) 3:7	7 (15) 15:17,21;17:25;19:6; 20:7;35:20;38:24;53:14; 61:5;62:4;84:17,21; 99:25,25;100:1
1,000 (11) 31:14,16;41:25;42:1; 73:13,14;130:4,4,8; 131:17;136:10	15 (3) 37:16,21;38:6	2:08 (1) 120:18	31 (2) 46:21,23	71 (1) 73:16
1,500 (2) 48:19;78:2	150 (1) 45:12	2:24 (1) 128:22	34 (1) 33:25	72 (1) 73:17
1.5 (6) 47:2;53:17;133:3,5, 12,23	15-2b (1) 111:3	2:41 (1) 128:25	3M (1) 9:24	721 (1) 76:25
1.8 (2) 46:14;75:22	15-3 (3) 102:12;110:24;112:3	20 (8) 33:22;52:11;59:16; 65:19;70:12;73:20; 75:10;120:8	4	78 (1) 67:21
1:34 (1) 110:13	15-4 (2) 110:25;111:1	200 (2) 67:24;68:4	4 (10) 31:13,18;60:20;86:15; 91:14,17;127:14,22; 135:5;136:2	8
1:46 (1) 110:16	15-5 (1) 39:7	2008 (3) 10:16;30:20;83:4	4.5 (1) 67:2	8 (24) 18:15,19,24;19:4; 25:15;33:2,6,7,7,11,12, 17;34:1,7,12;39:2,8; 54:3,22;85:21;86:13; 102:9,11,15
10 (14) 26:13,16,21;31:13,21; 32:19;42:22;62:20; 70:21;86:14;88:14; 116:25;152:24;154:15	16 (15) 40:16,20;41:8;49:21; 53:24;57:2;59:14,17; 61:6;66:16;68:9,11,19; 70:21;73:20	201 (3) 76:5,21;77:12	40 (1) 72:22	8015B/3545 (1) 86:2
10:49 (1) 42:11	16.7 (1) 67:25	2011 (2) 82:1;83:19	42 (2) 8:14;71:16	8260B (1) 85:25
100 (8) 42:4;43:10;52:25; 130:4,8;131:17,17; 136:10	160 (1) 3:7	2012 (4) 7:6;33:22;82:9;155:20	45 (2) 66:2;67:5	8270C/3510C (1) 85:25
11 (9) 31:24;32:3;44:13,22; 54:5;86:14;93:13;94:1; 154:13	17 (6) 44:18;45:3;53:24; 64:11;68:3;73:16	21 (3) 64:10;70:20;83:4	5 (10) 35:20;36:2;95:23; 130:11;132:12;133:12, 22,24;134:11;138:10	84 (2) 46:14;75:22
11:06 (1) 42:14	177 (1) 67:15	22 (1) 62:4	5.7 (2) 45:21;48:5	84114-4870 (1) 3:8
11:51 (1) 66:10	18 (4) 63:3;74:7,11,19	23 (1) 62:20	50 (1) 126:18	9
11:58 (1) 66:13	19 (9) 53:14;65:19,23;71:16, 17;78:8,12,18;98:3	230 (1) 67:11	500 (1) 31:14	9 (16) 22:17,21;23:16;30:23; 31:2;32:22;33:2,14,15; 34:23,25;35:9;38:10; 42:20;73:10;86:13
12 (5) 34:19,24;35:5;52:17; 64:11	192 (2) 44:16;45:9	237 (1) 77:6	503 (1) 7:8	9,500 (1) 155:5
12:15 (1) 76:9	1970 (1) 9:20	23rd (1) 121:13	5-14 (5) 109:11,14,14,16,19	9.89 (1) 77:15
12:22 (1) 76:12	1972 (1) 9:18	24 (3) 65:13;66:17;71:17	52 (1) 67:21	9:54 (1) 7:7
12:30 (1) 81:9	1973 (1) 19:1	25 (4) 59:7;67:23;71:17; 141:13	5th (1) 17:25	97 (3) 54:14;73:1;116:7
	1977 (1) 11:13	27 (3) 7:6;68:3;155:20	6	A
	1986 (1) 13:15	28 (1) 30:20	6 (8) 8:20;9:3,7,8;35:20; 36:23;73:10,17	able (7)
	1988 (6) 10:21,22;11:23;12:3; 13:13,14	3 (15) 30:18,19;31:6;44:16; 45:9;46:8,16;52:17; 59:20;84:19;116:3; 117:1;126:18;135:24;	6,000 (2) 28:1;30:8	
	1991 (1) 97:1			

17:18;21:10;24:10; 29:15;36:9;58:21;61:13 love (3) 53:21;109:24;142:21 absence (2) 96:12;144:3 absolutely (5) 71:22;135:4;137:3; 140:24;142:2 accepted (2) 27:3,3 access (1) 35:8 accordance (1) 98:23 according (1) 104:4 account (3) 135:16;136:9,18 accounted (2) 64:4;135:15 accounting (2) 63:6;109:1 accumulative (1) 78:4 Accurate (5) 103:5;107:4;134:17; 145:21;146:2 acid (2) 128:2,5 acidification (1) 27:15 acids (1) 127:13 across (2) 39:20;46:25 activity (7) 62:21,23;77:3,4,10; 117:4,22 actual (33) 12:7,11,24;17:16; 20:23;22:12,23;27:18; 47:20;23;48:2,25;50:6,9, 13,13;55:2;62:6;63:19; 67:12;69:19;70:5;96:19, 19,19;97:3;98:10,13; 125:1;129:18;132:4; 148:9;152:16 actuality (1) 20:11 actually (25) 12:10;13:14;20:14; 23:10;25:20;27:5;32:14; 48:14;53:12;54:12; 57:10;58:8;64:13,21; 70:5;79:16;80:9,13; 94:21;96:22;115:18; 123:15;124:11;133:25; 150:4 add (1) 1:5 additional (8) 21:6;22:6;23:21;	24:16;54:9;73:21; 143:11;150:4 Additionally (6) 20:18;39:25;54:3; 62:4;63:14;119:15 adds (2) 55:8;56:13 adjustments (1) 64:6 admission (13) 9:8;19:3;23:15;26:21; 32:18;35:4;36:15;37:14; 38:5;41:7;45:2;74:18; 78:17 admit (1) 9:8 admitted (1) 120:20 affect (8) 114:25;115:5,8; 141:25;142:18;143:24; 144:13;151:7 affects (3) 83:23;84:2,6 again (37) 26:17;28:24;29:9; 30:6;35:13;36:4,5; 37:10;40:9;41:15;45:20; 47:6;48:24;49:5;51:12; 52:24;53:13;55:8;59:21; 61:13;68:15;70:1,21; 75:12,14,23;77:7,17; 91:8,14;92:23;99:5; 103:21;112:5;114:13; 124:3;135:9 agency (3) 81:23,24;83:18 ago (2) 34:23;91:11 agree (8) 85:4,15;86:4;105:4; 123:24;138:11,12,15 agreed (1) 33:2 ahead (8) 15:16;44:21;45:3; 90:9,14,16;127:1;149:1 air (10) 80:9,14;142:21,24; 143:7,9,11;144:4,4,14 akin (1) 11:24 alcohol (2) 55:3;62:12 Allison (1) 122:18 allow (1) 150:1 allowing (1) 109:7 almost (4) 28:16;103:14;104:6; 113:9	along (3) 46:14;53:13;148:25 always (4) 99:6;106:9;139:16; 143:9 ambient (1) 59:6 amount (9) 24:4;57:16;58:23; 69:23;112:13;115:19; 137:25;153:8;154:24 amounts (4) 24:6;43:7;63:16;138:4 analyses (1) 85:22 analysis (42) 21:21;29:14;30:10; 47:23;50:11,18,19,23; 55:9,12;59:24;60:14,16, 19;61:9;62:1,2,4;63:8; 64:9,10;65:7,13;68:3; 77:21;78:5;82:10,15; 83:15,17;86:12;92:17; 94:15;97:11,15,18; 98:18;112:8;123:10,14; 126:21;134:13 analyzed (1) 93:6 analyzing (1) 48:24 answered (1) 113:1 apex (15) 16:13,14,16,17;27:22; 28:2;30:6,8,23;31:2; 32:22,25;35:8,9;111:16 apexes (3) 16:12,19;29:25 apices (1) 16:22 apologize (1) 110:20 apparently (1) 69:13 appear (10) 34:8;54:17;65:20; 71:23;73:3;82:10,15; 118:19;122:23;123:3 Appearances (1) 3:1 APPEARING (1) 3:3 appears (4) 34:15;54:5;86:13; 87:14 appendages (1) 56:1 apples (2) 47:18,19 application (5) 29:23;38:13;42:17; 51:9,13 applications (2)	58:10,11 applied (3) 27:15;38:16;92:20 applies (1) 108:19 apply (6) 68:25;85:7,17;108:11; 117:16,19 appreciate (2) 155:10,13 approach (47) 13:23;14:3,8,9,10; 21:2,4;27:2,3,3,5,8,10, 15,16,17;29:23;38:13, 16,19;42:17,19;49:24; 50:5;51:4,6,14;52:8,9; 53:8;56:15,16;58:17; 59:22;62:3;74:14;75:15; 77:16,16;98:15;113:8; 132:6,10;134:22; 136:23;148:18,20 approaches (5) 24:24;25:11;26:23; 27:1;73:9 appropriate (14) 14:4;25:1,5;31:17; 32:13;51:14,18;52:6; 60:7;62:2;72:10;86:8; 108:15;131:15 approximate (1) 47:1 approximated (1) 77:5 approximately (5) 10:19,20;11:23;13:13; 65:25 April (4) 7:6;70:12;73:20; 155:20 aqueous (6) 15:6;52:20;117:3,21; 138:1,8 aquifer (1) 150:12 arbitrarily (3) 69:12,13;70:2 area (3) 10:21;78:6;144:11 argument (3) 61:12;69:25;112:19 argumentative (1) 91:1 aroma (1) 58:13 aromatic (1) 126:15 around (5) 10:21;67:11;71:16; 72:1;115:19 arrow (1) 100:10 article (1) 121:17	aside (1) 36:16 aspects (1) 55:21 asserts (1) 62:20 assessment (2) 26:4;86:11 assessments (1) 11:2 assist (1) 79:23 Assistant (1) 3:6 associated (6) 57:18;85:11;86:6; 87:11;88:6,20 association (1) 127:12 assume (9) 98:7,25;101:24; 114:17;137:12;143:21; 145:20;146:1;147:20 assumed (2) 99:20;127:23 assumes (1) 59:24 assuming (9) 47:14;75:18,25;76:16; 97:10;101:4;114:20; 119:20;146:14 assumption (3) 101:3;119:14;137:16 assumptions (2) 51:18;52:1 Atlas (2) 10:14,15 atmospheric (1) 141:12 atoms (1) 56:2 attached (2) 40:15;86:22 attachment (1) 83:4 attempt (2) 54:11;83:21 attempted (1) 73:23 attempting (8) 14:16;21:20;54:2,8, 19;56:12,12;72:6 attempts (1) 63:12 attending (1) 7:14 attention (3) 102:12;104:25;152:22 ATTORNEY (6) 3:3,6;7:16,17,19,21 attorneys (1) 7:12 attributed (1)
--	--	--	---	--

78:1 audible (1) 146:7 authoritative (1) 18:3 authors (1) 122:17 availability (2) 153:7,12 available (4) 153:10;154:24;155:3, 6 aware (5) 79:9;83:17;84:16; 99:11,14 away (1) 16:18 axes (3) 69:8,8,20 axis (13) 20:17;28:3,4,8,8,16, 18,23;29:4,5;32:24; 39:20;111:18	101:10,13,16;118:9; 119:2;133:16;152:19 bases (1) 146:19 basic (1) 47:5 Basically (3) 12:8;43:10;45:25 basing (1) 119:8 basis (20) 20:5;21:20;44:2;53:2; 97:11;100:23;101:2; 121:2;134:7,8,9;143:7; 146:14,20,22,23;147:1, 3;152:14,15 Bayer (1) 82:20 Bayer's (1) 83:4 Bear (1) 30:13 bearing (2) 68:2;151:11 became (1) 150:3 become (4) 40:1,3;79:5;152:5 becomes (3) 43:21;65:6;77:25 becoming (1) 58:9 began (1) 11:13 beginning (1) 148:8 begins (2) 12:17;60:20 BEHALF (1) 3:3 behave (1) 103:15 behaved (1) 104:7 bell (1) 83:1 below (2) 81:3;89:18 belt (2) 79:19;80:16 benefit (1) 27:14 benzoapyrene (7) 44:7;53:16,23,24; 59:25;75:13;135:24 best (3) 114:4;127:1;148:20 beta-phellandrene (1) 57:9 better (7) 49:3;52:10;79:3; 143:19;146:8;148:18,19 beyond (1)	117:13 bible (6) 18:5;102:7,8;104:4; 109:11,18 big (2) 48:11;55:14 billion (1) 62:22 bit (5) 9:1,11;23:9;39:9;54:1 bitumen (132) 14:13,15;15:6,8;16:8, 17,21;17:8;19:15;20:1; 21:9;22:1,25;23:24; 24:4,6,9;27:25;28:15,24; 35:12,18;37:11;38:2; 40:6,24;41:1;42:4;43:7, 10,13,15,24,25;46:6,15, 19,20,23;47:1,6;48:8,12; 49:8;52:25;53:7;55:19, 23;56:4;60:1,2,6;61:8, 10;62:6;63:6,15;64:8; 65:17,25;66:23;70:24; 75:14,19,23,24;76:1,1,6, 7,21,23;85:11;86:6; 87:11;88:7,20;89:10,13, 20;90:5,17;91:25;92:12; 94:19;97:25;100:10; 103:25;104:19;105:23; 107:1;111:12;112:14, 14;115:4,5,9,16;117:17, 25;118:4,10,13;119:4, 13;123:16;124:13; 129:7,18,25;130:9,23; 131:7,9,11,13;132:2,7, 19;134:19,21;135:14; 136:5,8;138:5;145:17; 146:11;147:7,9;149:6, 10;152:19 blow (1) 39:9 Board (1) 7:3 Bob (2) 82:20;83:4 boots (2) 12:9;63:19 both (11) 33:2;55:19;80:15; 104:17;107:7;108:9,23; 111:4;113:21;125:8; 135:2 bottom (14) 28:8;62:20;66:18; 68:18;71:2,14;73:16; 76:18;102:17,20; 104:10;105:1;110:1,1 Bozeman (1) 7:8 break (12) 42:8,9,24;66:7;76:8; 81:6;110:4,9,10,20; 123:5;128:20	brief (1) 128:20 bring (4) 55:11;63:15;99:21; 101:23 BS (2) 9:13,19 bulk (9) 15:5;49:15;50:20; 60:8;61:10,11;63:9; 132:2;143:7 bullet (4) 30:17;35:19;75:18; 137:15 bulleted (1) 137:6 business (1) 11:5 Butte (1) 8:19 byproduct (1) 19:20	14:4;45:16;47:25; 54:4;67:3;132:12 camera (6) 16:2;23:1;68:21; 74:22;78:21;120:12 can (63) 13:3,9;16:4;17:13; 22:21;23:5,6,8,11;32:3; 36:1,16,21;39:4;46:24; 47:6;55:2;59:25;61:19, 20;64:24;66:4;74:11; 76:23;77:4;78:12;87:16, 16;90:8;92:18;97:19,23; 99:25;100:1,4;101:18; 102:14;104:23;106:3; 109:12,25;110:9;112:5; 114:4,15;116:14,17; 117:3;120:3;124:22; 125:5;126:5;127:1; 128:10,10;129:1,2; 143:20;145:21,22; 146:25;149:1;152:3 carbon (3) 56:2;127:14,22 care (1) 73:9 careful (1) 124:4 carried (1) 151:13 case (29) 9:9;11:18;13:18,24; 15:1,10;18:21;19:9; 20:12;21:3;25:2;26:24; 28:17;32:13;33:23;40:7; 42:18;55:25;59:15; 62:10;79:5;80:15;95:19; 96:3;101:6,7;104:18; 119:22;137:17 cases (6) 40:3;51:19;55:21; 148:17,24;149:1 Cause (3) 7:3;96:10,11 causes (1) 111:13 centigrade (4) 59:7;67:12,16;141:15 certain (4) 20:13;63:25;103:14; 104:6 Certainly (3) 117:23;137:1;149:18 chance (3) 13:4;70:11;73:14 change (4) 47:22,22;67:22; 126:10 changes (1) 67:21 Characteristic (1) 85:23 characteristics (6)
B			C	
back (27) 19:6;23:8,18;38:22; 42:13;43:11;46:22; 52:24;55:14;66:12; 69:15;72:20;76:11;78:3; 81:11;85:1;89:8;92:4; 102:21;110:15,17; 120:17;124:3;128:24; 135:21;148:5;154:13 background (4) 9:1,12,22;101:11 backing (1) 69:22 backs (1) 25:13 Baldensperger (1) 7:9 Ballard (1) 8:14 BaP (32) 44:14,17;45:10,17; 47:7,11,12;48:4;53:1,2, 7,16;59:25;61:22;67:13; 75:18,23;76:1,16;97:24; 132:20;133:5;135:2,6, 10,12,19;136:4,7;138:1, 7;147:16 BaPs (1) 48:2 Barclay (2) 3:11;31:19 base (2) 50:25;52:22 based (18) 8:18;21:11;24:23; 30:9;34:8;49:17;51:7; 57:22;62:9;97:15,19;			cake (6) 80:6,9,14,18,22,25 calculate (1) 76:23 calculated (5) 46:17;48:5;64:7; 77:14;133:21 calculating (4) 65:14;76:2;136:3,20 calculation (29) 36:24;45:23;47:9; 61:17;63:12;66:4;67:3, 10,25;68:7;69:10,14; 74:2,6,12,13;75:5,15; 76:19,23;134:2,3,7,8; 135:13;136:13,21;147:1, 6 calculations (21) 12:20,23;13:20;21:6, 11;22:6,9;23:22;24:16, 21,22;26:4;48:13;50:22; 64:6;65:18;73:22;97:17, 24;98:1;147:2 California (2) 11:12,16 call (7) 55:16;83:9;84:19; 97:12;106:22;107:4; 151:13 called (9) 8:6;10:8,14;15:2;43:2; 57:9;82:25;120:5; 146:15 calling (3) 102:7;112:19,20 calls (1) 52:19 came (6)	

20:13;60:8;85:3; 149:23;151:4,25 aracterize (3) 80:19,24;92:12 charts (1) 88:17 check (6) 41:19;66:4;83:3; 133:2;135:21;148:1 chemical (28) 9:13,15;10:3;14:10, 15;18:4,5,8,9,11,12,13; 22:11;27:6;41:13;52:2; 54:1;57:9;58:2;85:13; 87:22;94:18,19;122:3,4, 4;149:23;151:4 chemicals (15) 14:25;17:21;21:12; 25:8;31:22;32:6;56:4; 57:8,16;58:20,22;60:11; 88:8,22;116:24 Chemistry (5) 37:24;57:6,21;122:21, 21 choice (5) 51:7;53:9;55:7;58:7, 15 choose (1) 129:21 choosing (1) 75:12 se (2) 45:12;61:25 chosen (1) 37:11 Chris (1) 7:15 circle (1) 110:8 citation (1) 54:4 cited (2) 37:3;70:9 City (1) 3:8 clarity (2) 70:25;72:3 clean (1) 69:2 clear (5) 71:21,24;82:22;90:4; 95:22 clearly (2) 54:15;72:13 client (1) 12:11 close (9) 13:9;20:17;28:15,17; 49:15;55:1;77:9;104:20; 133:12 ed (1) 9:11 closer (3)	111:15,15,17 closure (1) 13:6 Coal (3) 120:7;122:9;126:17 co-author (1) 122:20 coefficient (6) 62:22,23;77:3,4,9; 117:4 coefficients (4) 54:25;55:1;62:5,9 cold (1) 140:3 colder (1) 140:5 collecting (1) 58:25 college (1) 139:1 colloid (3) 128:1,12,17 colloids (1) 127:24 column (6) 105:1;109:24,25; 110:1,23;128:16 columns (1) 125:9 combination (2) 17:20;56:7 combinations (1) 17:11 combined (1) 46:15 combining (2) 77:10,11 commences (1) 148:25 commenc (1) 68:9 comments (2) 13:21;73:18 commercial (2) 32:14,15 commonly (3) 105:3,7,9 communication (1) 31:18 Company (5) 9:24;10:6,8,13,17 comparable (1) 133:9 compare (8) 21:16,22;44:6;45:24; 46:2;47:25;74:5;147:18 compared (7) 53:12;95:18;96:3; 134:13,18;142:14; 153:21 compares (1) 141:16 comparing (5)	47:18;48:8;52:18,21; 77:21 comparison (7) 47:17;52:22;53:2,3; 74:6;141:19;147:15 comparisons (1) 49:11 compilation (1) 37:22 complete (3) 13:10;21:2;47:17 completely (9) 14:5;53:25;105:11; 107:11,12,15,16,20; 143:12 compliance (2) 11:8,8 complied (2) 110:3;116:19 component (7) 16:14;26:6;52:22; 53:8,19;77:22;144:19 components (8) 14:14,23;17:13;20:11; 61:10;89:17;103:15; 104:7 compound (25) 16:20;40:7;45:14; 49:17;50:23;51:6;52:19; 61:4;62:7;74:4;88:1; 90:8;92:8;124:14; 131:19;134:15,24;135:3; 11,20;136:15,21;147:16; 150:18,19 compounding (2) 55:9;65:7 compounds (81) 17:16;24:4;25:25; 55:19,22;60:4,6;61:8,16, 17;65:17,25;66:2,23; 67:1,6;71:22;75:19; 76:4;83:24;84:3,7; 85:11;86:6;87:10;88:6, 19;89:4,7;90:23;92:17, 25,25;93:3,8,15,21;94:4, 23;95:18;96:3,19; 108:15;109:8;112:15; 114:25;124:16,17,20; 129:22,24;130:3,4,7,9, 17,22;131:6,8,10,13,18, 23;132:3,7;135:14,23, 25;136:10,13,19,22,24; 138:4;147:6;149:9; 150:21;151:6;152:20; 153:17;154:22 comprised (5) 60:3;89:10,20;90:5; 91:25 concentrated (4) 17:10;28:14;40:2; 114:22 concentration (55) 16:19,21;17:15;21:17;	22:1;24:11;27:25;29:2; 41:1;43:6,15,17,23,24; 44:6,8,17;45:17;46:6,13; 47:1,5,7,12,12;48:4,14, 19;50:20;52:3,19,20; 53:1;61:7,11;76:24; 87:14;106:2;118:13; 123:9;127:22,24;128:5; 133:15,21;134:4,6; 135:6,10;136:4,6;144:6, 7;153:4,17 concentration-driven (1) 144:2 concentrations (24) 15:7;17:8,10;21:12, 14;24:7;25:12;44:11,14; 47:21,23;48:2;49:1,4; 50:14;51:20;61:10; 63:10;115:20;120:6; 122:9;126:15,20;146:13 concerned (2) 19:9,18 conclude (1) 138:20 concluded (1) 155:19 conclusion (5) 124:10;137:24; 146:20,22,24 condensed (1) 59:1 condensing (1) 58:24 condition (4) 48:1,4;53:11;104:9 conditions (9) 47:19,20;59:6;97:13; 99:1;101:25;141:24; 146:1;147:21 conduct (1) 73:21 conducted (1) 101:15 conference (1) 7:2 confirm (1) 94:18 conflict (3) 54:12;104:21;137:8 conform (1) 13:5 confusing (3) 64:11;65:6;92:10 connected (1) 28:10 conservative (10) 45:7,13;50:15,18; 60:16,19;133:7;134:1,5, 12 conservatively (1) 130:21 consider (6) 60:2;96:15,16;107:7,	22;148:18 consideration (1) 117:13 considerations (2) 103:7,11 considered (6) 37:25;106:7,16;109:8; 150:7,14 considers (1) 113:6 consist (1) 129:18 constituents (1) 89:14 construct (6) 27:19;28:11,19;38:20; 39:17;41:14 constructed (7) 11:3;12:5,6;40:12,23; 41:11;148:25 construction (2) 27:18;41:15 Consultants (2) 8:18;10:16 consulted (1) 12:6 consulting (2) 10:11;11:25 contact (17) 19:24;21:23,24;24:12; 44:9;45:18;46:1,4; 47:14;48:7;103:12,19; 104:1,16;136:4,7;147:17 contacted (1) 150:3 contacts (1) 85:4 contain (1) 75:21 contained (1) 61:18 contains (6) 15:5,7;17:7,10;63:16; 89:13 contaminate (1) 85:3 contaminated (1) 11:4 contamination (17) 11:2;12:13;84:11; 85:15;86:7;87:12;88:9, 23;90:24;91:19;93:4,9, 16,22,24;94:5;154:22 contending (2) 62:21;134:10 content (7) 28:14;30:10;32:7,16; 46:11;94:19,19 contention (4) 62:25;95:16,25; 111:11 context (3) 104:24;111:21;150:15
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continue (3) 38:15;119:24;126:4	Cuthbert (2) 3:11;31:19	14:19;112:18,21	11:2;12:5;149:1	60:22
Continued (1) 3:1	cuts (1) 58:14	definitely (1) 13:2	detail (2) 64:18;150:2	dipentene (3) 57:10,10;58:21
continuing (1) 73:16	cycle (3) 13:8,10,17	definition (1) 89:12	details (1) 63:12	direct (1) 152:22
continuum (1) 152:8	D	degree (13) 49:19;107:6;111:20, 20;113:7,10,10;114:5, 13,14,16;127:21;142:1	Determination (1) 83:6	direction (1) 16:21
contradicts (1) 96:9	d- (1) 57:11	degrees (5) 59:7;67:11,15;141:13; 152:10	determine (7) 93:3;94:22;129:25; 130:2;140:22;149:5,9	directly (4) 41:16;43:8;73:4;75:11
contrast (4) 14:3;51:3;52:15;56:15	damp (1) 81:2	delta (3) 65:24;66:24;67:5	determining (11) 21:25;90:22;91:18; 93:14;103:10;123:14; 126:22;132:6;150:17; 154:21,23	disagree (1) 134:10
contrasting (3) 19:13;21:21;75:16	dampness (1) 80:20	demonstrating (1) 137:17	develop (2) 21:7;24:2	disappointed (1) 129:6
control (1) 11:1	dancing (1) 72:1	demonstration (8) 20:9,10;30:20;46:9; 76:19;82:25;137:14; 152:23	developed (1) 152:13	discernible (1) 20:14
converted (1) 45:15	data (30) 29:16;37:23;40:23; 49:15;50:6,7;53:23; 95:15,24;96:7,8,14,15, 16,18,21,22,23;97:7; 98:10,11,13,20;101:13; 103:9;125:2;135:18; 141:4;148:12;152:16	densities (1) 143:6	deviate (1) 70:3	Discharge (1) 7:5
cool (1) 141:2	date (1) 82:6	density (8) 41:25;142:18,25; 143:4,5,7,8,24	de-watering (3) 78:25;79:5,20	discharged (1) 80:3
copy (5) 9:3;18:8,12;26:7; 116:6	day (1) 149:19	dependent (3) 138:17;139:25;140:11	diagram (77) 14:11,20,21,21;15:2, 10,11,12,24;16:5,7,7,9, 12,15;17:1,4,13,20;19:7; 20:3,15,18,20,23;21:5,8; 22:5,12,24;23:23;27:18, 19,22;28:9,16,21,22,23; 29:9,16,17,18,20;36:11; 38:2,9,18,19;39:14,16, 18,19,25;40:4,11,13,24; 43:1,4,8,9;44:1;69:21; 98:14;99:21;100:9; 108:2,18;111:19;112:3; 114:3;146:16,18;147:4; 152:14,15	discrepancy (3) 50:7;67:8,9
corner (5) 20:19;28:9,21;29:6,11	day-to-day (1) 27:11	depending (3) 44:15;92:17;142:20	diagrammed (1) 111:24	discussing (1) 86:14
correction (2) 70:23;73:15	de (2) 89:1,16	depends (2) 148:23;151:25	different (24) 9:25;14:5,5;29:25; 31:11;36:14;53:25;55:5; 56:15,16;57:12;60:4,24; 67:4;73:14,24;74:14; 78:2;79:16;129:5,19; 134:22;152:8,10	discussion (2) 72:18,19
correctly (2) 108:14;112:2	deadline (1) 121:7	depleted (2) 31:5;42:22	differs (1) 133:14	discussion (2) 72:18,19
correspond (1) 65:20	deal (1) 97:5	depletion (4) 20:22;68:15;70:2,9	difficult (1) 20:13	disk (2) 79:18;80:16
corresponding (3) 42:3;46:19;66:2	dealing (1) 20:11	deplets (1) 15:12	dilate (1) 99:6	displace (1) 138:4
cosolute (2) 72:19;127:25	deals (2) 11:25;77:7	deposition (4) 7:2,11;121:8;155:19	dilute (37) 17:8;20:19;24:25; 25:6;28:13;39:25;40:1; 43:20;51:13,13,14,18, 22,25;52:5;54:16;56:6, 7;99:2,3,4,6,11,13,16; 101:3,4;114:8,21,23,24; 118:16;119:14,19,19; 146:3,4	displayed (1) 78:23
cosolvent (2) 72:18,18	dealt (3) 12:1,4,11	derivation (2) 64:25;65:2	dilution (1)	disposed (3) 85:1,8,18
couple (2) 31:11;103:4	debate (3) 114:9;126:5,9	derived (1) 47:8		dissolution (9) 71:23;73:3;107:21; 109:2,6,7;112:14; 113:24;118:19
course (1) 43:14	decision (2) 81:25;83:19	described (11) 10:22;14:7;15:13; 19:23;21:1;105:14,18, 21,22;106:20;107:1		dissolve (3) 96:12;107:21;136:24
courses (1) 57:5	decrease (15) 16:22;68:1;127:13,22; 138:9,10;139:22;140:5, 15,18;145:7,9,13,16; 153:23	describes (2) 17:5;28:12		dissolved (8) 25:7;27:25;28:7;29:7; 97:25;126:19;134:9; 152:5
court (3) 7:9,10,23	decreased (1) 140:7	description (1) 21:2		dissolves (5) 75:25;76:2,16;108:8, 23
created (1) 97:2	decreases (1) 16:19	design (7) 12:18,21;13:4,5,9; 148:16,22		dissolving (11) 53:16,20;95:19;96:4; 115:9,16;118:4,10; 119:4;145:1;149:6
criticize (1) 60:21	defies (1) 113:9	designation (1) 64:21		distillation (1) 58:24
critique (1) 13:21	Define (3) 107:12;112:7;113:5	designed (3)		distinguish (1) 151:21
crossed (2) 113:6;114:10	defined (3) 16:23;43:18;152:3			distribute (3) 17:17,21;137:19
crude (3) 44:12;45:17,19	defining (3)			distribution (3) 17:16;62:5,8
curvature (1) 69:23				divided (3) 65:24;66:25;67:20
curve (11) 43:18;46:23;47:1; 69:12,13,15,19,24;70:3; 100:20;111:8				Dividing (1) 77:24
cut (2) 105:16,16				Division (1)

<p>81:24 limonene (105) 14:14;15:5,8;16:8,16; 22:25;24:6,9;28:6,7,15; 29:7;31:5,10;32:25; 33:10;46:13,18;54:7,24; 55:3,20,20,24;57:3,23; 58:8,11;62:7,14,15; 73:12;75:22;76:2,6,17, 22,25;83:23;84:2,6; 94:22;95:17;96:2,10; 97:5;100:14;103:18,25; 105:6,11;106:2,1; 111:11;115:4,5,8,15; 117:17,24;118:3,9,22; 119:5,9,12;123:6,15; 124:9,10;126:22;137:9, 13,25;138:3,6,13,15; 139:3,8,13;140:1,10,15, 22;141:7,10,11;142:6, 12,19;143:1,22,24,25; 144:12;145:1,14; 146:11;147:9,22;149:5; 153:16,20,22,23 document (38) 16:2;23:1;25:19; 34:11,17,24;36:20;41:3, 20;44:21,24;61:2;68:20; 74:21;78:20;81:18; 82:16,18,20,22;83:13, 15;84:25;86:22;96:25; 7:2;109:13;125:8,16, 19,21,22,22;126:1, 128:18;129:1;133:4; 135:22 documentation (1) 64:2 documented (3) 30:11;38:19;50:6 documents (3) 83:18;125:11;131:5 done (11) 8:24;11:2,6,23;65:12; 78:22;106:15;147:25; 149:5,9;155:8 double-check (1) 25:18 double-counting (1) 54:6 Dow (1) 10:3 down (8) 13:9;48:14;62:4; 65:14;67:21,25;116:21; 127:12 down-gradient (1) 150:11 downstream (1) 150:11 downward (1) 6:20 (42) 3:12;13:19,25;21:21;</p>	<p>33:21;34:9,12,17;46:13; 48:18,24;49:21;51:4; 52:11;59:24;60:20;61:6; 62:18;63:4;64:4;66:16; 70:12;73:20;74:1,15; 75:6;77:17;82:5;96:9; 100:20;115:24;121:5,8, 130:13;132:15;133:5,16, 18,25;134:14,16,20 drafting (2) 81:17,20 draining (1) 81:1 dramatic (1) 67:22 drawing (3) 21:7;100:23;101:2 drawn (3) 69:12,13;70:2 drew (2) 100:16,20 drive (1) 115:20 driven (1) 144:5 driving (2) 103:9;115:18 drop (1) 48:11 drops (1) 67:25 dry (1) 80:13 Dubue (17) 7:19,19;81:5;99:23; 102:2,4,14,19;103:1; 110:17;116:14;120:2,4, 22;128:20;129:1;154:7 duly (1) 8:6 during (2) 63:23;153:9 <p style="text-align: center;">E</p> earlier (1) 91:16 early (1) 82:7 easier (1) 22:15 easiest (1) 23:11 East (2) 3:7;7:8 eat (1) 110:19 Ed (2) 7:2;8:12 Edition (2) 17:25;19:1 education (4) 9:2,13;101:11,17</p>	<p>educational (1) 9:12 EDWARD (1) 8:5 effect (21) 72:7;89:2,16;94:22; 108:2,7,21;117:3,21; 118:4,10,12,20;119:3; 140:13,18;142:7,11; 145:1,8;149:5 effective (4) 25:22;26:5;79:20,22 eight (1) 125:8 either (3) 80:2,3;140:17 element (3) 79:24,25;80:2 elements (1) 80:17 elevated (1) 126:17 else (1) 119:11 emanating (2) 61:23;63:24 embedded (1) 71:7 empirical (5) 95:15,24;96:7,8,14 employ (1) 63:13 employed (2) 8:16,17 employment (4) 9:2,21,24;10:3 encompass (1) 60:10 end (10) 21:25;38:16;45:8; 70:8;89:11,22;90:6; 91:25;130:18,19 endorsing (2) 74:4;75:14 engineer (2) 11:10,11 engineering (16) 9:14,15;14:10;18:4,6, 8,9,13,13;22:11;27:6; 41:13;52:2;122:3,4,5 engineers (1) 18:11 enhance (8) 54:17,18;56:8;71:23; 73:3;102:19;118:19; 142:16 Enhanced (3) 120:6;122:8;144:8 enjoy (1) 13:3 enough (2) 80:13;116:25 enters (1)</p>	<p>79:24 entire (9) 60:10;61:1;63:4,5,10; 104:24;115:10;130:19; 135:1 entrained (3) 85:12;88:7,21 entry (2) 138:1,7 environment (1) 143:12 Environmental (9) 8:17;10:11,16,25; 12:12,13;121:20,21; 122:21 environmental-related (1) 10:10 EPA (10) 25:13;26:3,17;33:17, 18;34:9;86:1;96:25; 125:19,21 EPA/600/M-91/009 (1) 97:1 equal (1) 141:24 equation (5) 26:5;54:5;64:11,12; 76:25 equations (2) 22:8;24:20 equilibrium (36) 14:24;16:25;17:22; 19:25;20:3;21:8;23:23; 24:1,3,12;28:11;29:18; 37:23;38:20;39:15,19, 21;40:5,6,14,21;41:16; 42:21;43:4,9,21;44:1; 46:22,25;47:15;60:23; 63:11;76:24;111:19; 136:4;147:5 Equilibriums (3) 102:13,18,25 equivalent (4) 21:17;41:23;46:3;75:5 erroneous (1) 73:12 erroneously (1) 73:11 error (2) 65:7;66:16 errors (3) 55:9;68:6;78:5 especially (1) 51:15 Esq (1) 3:5 essential (1) 103:13 estimate (7) 60:18;129:15;132:3; 133:25;134:19;135:7; 136:9 estimated (5)</p>	<p>129:7;131:22,24; 132:1,18 estimates (3) 136:12;150:2;152:19 estimating (5) 44:8;135:6,9;136:3,6 evaluate (1) 37:11 evaluating (3) 149:21,23;150:6 evaporate (12) 59:8;137:9;138:13,16; 139:3,13;140:2,23; 141:22;142:12;144:21, 23 evaporated (6) 92:18;143:17,22,23, 24;144:1 evaporation (26) 59:12;138:17;139:23, 24;140:4,9,14,19,20; 141:7,21;142:1,6,17,18; 143:14,16,18,25;144:2, 5,9,10,11,13;150:5 even (2) 29:9;117:2 evidently (1) 63:1 exact (3) 16:9;82:6;108:25 exactly (1) 64:19 exaggerated (3) 53:3,11;68:6 EXAMINATION (6) 8:9;81:14;126:4; 149:14;151:19;154:11 examined (1) 8:7 example (11) 16:14;20:16;51:8; 59:4;61:24;62:6;98:13, 15,16;111:24;137:20 excellent (4) 58:2,7,14,15 except (1) 92:21 excerpts (1) 18:24 exchanging (1) 121:7 excuse (8) 15:15;18:24;28:13; 33:4,10;35:8;39:1;41:19 EXECUTIVE (2) 3:3;7:22 Exhibit (81) 8:20;9:3,7,8,9;15:17, 21;17:25;18:15,19,24; 19:4,6;20:7;22:17,21; 23:16;26:13,16,21; 30:23;31:2,24;32:3,19, 22;33:23;34:19,24;35:1,</p>
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5,9,22;36:1,16,17,21; 37:15,16,21;38:6,10; 39:1,8;40:16,20;41:8; 42:20,22;44:18;45:3; 59:15,16;66:17;74:7,11, 18;78:8,12,18;82:24; 84:18,20;98:3;99:25,25; 100:1,1;102:9,11,15; 115:22;116:1,2,3; 119:23;120:4,5,8,20; 144:18	119:13;146:4 eyes (1) 63:24	17,22 final (7) 80:6,6,7;97:24; 118:17;147:2;153:13	follow (4) 23:19;64:19;65:2,2 followed (1) 27:7 following (1) 8:1 follows (2) 8:7;105:2 follow-ups (1) 151:17	fully (2) 30:3;92:11 function (2) 26:5;152:1 further (8) 19:14;23:15;81:4; 85:2;147:5,6;154:3,6
	F			G
exhibits (5) 25:9;121:4,8,10; 125:12 exist (6) 12:12;29:13;63:20; 64:1;95:9;97:13 existing (1) 63:6 exists (3) 17:21;49:8,9 expect (6) 46:1;117:3;119:3; 133:15;140:1;153:16 expected (1) 21:13 experience (11) 12:25;13:12;57:3,16, 22;58:18;63:20;79:13; 101:12,17;119:3 experienced (1) 79:15 expert (3) 18:20;97:12;135:5 expertise (1) 122:10 explain (6) 19:8;27:13;42:24; 106:3;114:4;146:25 explained (3) 59:22;60:22;130:16 explaining (3) 42:20;66:15;93:13 explanation (1) 113:9 exponent (1) 66:21 expression (1) 107:7 extensions (1) 33:20 extract (15) 14:13,16;17:9;21:6,7; 23:22;28:12;40:25;42:4, 5;43:15,24;46:23;55:2,2 extracted (2) 40:22;48:11 extraction (4) 103:7;108:3,7,22 extracts (1) 111:8 extremely (5) 49:12;55:18;58:3;	face (1) 60:1 fact (7) 58:10;59:10;62:8; 70:8;109:7;134:4; 144:12 factor (15) 48:19;67:22,24;68:4, 5;73:13;77:19,25;123:9, 13,14;124:10;138:8,10; 153:7 factors (3) 65:15;126:18;139:25 fair (9) 49:1;57:15;94:2,6; 97:10;106:14;132:5; 137:25;139:22 fairly (1) 105:10 faith (1) 60:6 familiar (8) 57:17,20;79:5,8,11,15; 117:14;121:24 fan (1) 144:4 far (3) 70:3;83:17;95:9 fashion (1) 61:3 February (8) 30:20;73:20;75:7; 81:25;82:7,8;83:3,19 feed (1) 111:4 felt (4) 14:2,4;31:15;45:6 few (6) 10:4;91:11;127:11; 149:20;151:17;154:9 field (10) 12:7;49:7,7;121:25; 122:2,3;125:1;148:9,13; 153:16 figure (15) 15:9;20:7,21;30:9; 41:10;53:23;111:3; 131:20;132:15;133:1,16, 17,19;134:23,25 figures (5) 32:8;50:9;91:12,17; 132:4 filter (10) 79:18,19;80:5,5,12,14, 16,16,25,25 filtration (8) 79:16,24,25;80:4,7,7,	find (6) 30:14;46:5;52:11; 58:11;59:18;152:18 fine (2) 71:6;140:6 fines (17) 46:14;48:9;86:3; 95:12;96:20;137:10; 138:14,16;139:4,13; 140:2,23;142:1,3,19; 149:24;155:2 finished (2) 29:20;117:10 firm (1) 10:10 firms (2) 9:25;11:6 first (32) 8:6;9:23;15:12;18:7; 22:11;30:18;31:7;44:11; 50:5;52:16,16;55:15; 60:7;65:1,18;68:14; 69:7,10;74:23;75:10; 76:19;77:12;82:3; 102:24;103:4,4;109:24, 25;110:1,2,23;137:15 Fisher (6) 3:10;7:1,7,10,10,23 fit (2) 23:4;112:19 fits (1) 11:25 five (7) 29:2;41:19,22;43:12; 129:21;130:3,7 fixed (3) 28:5;151:23;152:2 flat (1) 142:15 flatter (1) 69:22 flaw (3) 59:22,22;64:9 flawed (1) 62:2 flaws (4) 52:10,11;56:21;59:18 Flip (2) 109:13;112:5 flowchart (1) 78:13 fluid (1) 106:22 fluids (2) 107:18;152:4 focus (3) 10:23,24;78:23	form (7) 19:25;28:11;63:7; 64:1;70:24;107:19; 152:7 formed (3) 10:13;14:1;16:25 forms (4) 17:22;20:5;21:19; 106:6 formula (1) 77:3 formulation (1) 103:12 Forty-seven (1) 72:24 found (2) 45:9;152:17 foundation (9) 86:18,22;94:10; 122:22;126:25;128:7; 131:1;147:2,3 founding (1) 146:23 fourth (2) 45:22;48:6 fraction (15) 26:6;45:15,16;46:18, 20;70:24;76:3,5,6,21; 77:13;117:1,18;136:14; 138:3 fractions (2) 64:7;137:18 free (1) 81:1 frequently (1) 18:14 Friday (1) 155:20 fuels (1) 63:23 full (5) 13:8,10;31:8;84:23; 129:2 full-time (1) 10:2	garage (1) 58:11 gas (2) 143:8,16 gasoline (1) 59:3 gave (2) 125:18,18 GC/MS (1) 85:25 General (6) 3:6;26:25;51:1;59:23; 61:14,15 generalization (1) 72:9 generalize (1) 51:6 generalized (3) 15:12;16:7;39:24 generalizing (1) 71:25 generally (3) 140:16;142:11;143:3 get-go (2) 53:4;56:10 given (6) 89:17;119:15;121:9; 125:22;127:13;141:23 gives (1) 101:1 God (1) 49:8 goes (5) 48:14;64:5;73:7; 85:20;137:7 good (5) 24:2;54:24;57:23; 58:3;100:5 governed (1) 103:10 gradient (1) 114:15 gradients (2) 144:6,7 grams (1) 42:1 granted (1) 134:24 graph (3) 68:15,18;69:17 graphically (1) 14:22 graphs (1)

68:12 ease (6) 58:14;90:19;91:12; 92:4;153:3;155:1 greasy (1) 58:13 Great (9) 23:13;25:8;114:9; 146:6,12;147:10,22; 151:10,10 greater (2) 68:1;150:1 green (1) 58:16 ground (3) 12:9,25;63:20 Groundwater (12) 7:5;89:16;120:6; 122:9;126:17;127:13; 128:6;149:22;150:7,13; 151:7,11 Gschwend (2) 122:18,20 guess (5) 13:15;75:7;102:12; 113:13;152:9 guidance (3) 54:12;56:6;119:15 guys (1) 126:3	Hang (3) 30:13;42:6;127:16 hanging (1) 149:16 happen (1) 139:10 happens (1) 108:24 hard (4) 64:19;113:3,5;114:11 hazardous (1) 11:8 HAZWOPER (1) 11:7 head (1) 143:2 heading (2) 88:15;102:13 health (1) 11:7 hear (2) 145:21,24 heard (4) 121:20,23;122:12,14 heavier (2) 130:19;143:9 height (1) 69:23 helpful (5) 90:22;91:17;93:14,18; 127:18 herein (1) 8:6 Here's (2) 69:2;95:25 high (4) 45:7;49:19;124:13; 148:12 higher (12) 133:7,22,24;134:4,6,7, 8,9;143:3,4,5,8 highly (2) 111:17;113:16 hit (1) 56:21 Hogle (83) 7:15,15;8:10,22,9;7, 10;15:19;18:17;19:3,5; 22:19;26:15,20,22;32:1, 18,20;34:21;35:4,6,24; 36:15,19;37:14,18;38:5, 7;40:18;41:7,9;42:15; 44:20;66:14;74:9,18,20; 76:8,13;78:10,17,19; 81:4,7;82:22;86:18,20, 24;90:8,25;92:6,8; 94:10;106:15;110:6,9; 116:5,9,11;117:10; 120:13,24;121:2,7,11, 13;122:22;125:6,15; 126:3,8,10,25;127:19; 128:7;129:11;131:1; 145:19,25;151:17,20;	154:6;155:12,15 hold (2) 100:8;106:15 horizontal (2) 79:18;80:15 horses (1) 100:8 human (1) 58:6 humic (3) 127:13;128:2,5 hundreds (4) 60:3;129:18;135:14; 137:3 hydration (2) 117:2,12 hydrocarbon (6) 54:17,19;55:4;56:1; 62:13;129:19 hydrocarbons (24) 21:15;44:7;54:16; 55:19;56:8,9;61:23; 63:16,17;71:23,24;73:2, 4;77:8;86:12;87:19; 90:18,20;91:13;118:18, 20;124:25;126:16;153:3 hydrocompounds (1) 126:16 hydrogen (1) 56:2 hydrogeologic (1) 89:18 hydrologic (1) 153:10 hydrophobic (4) 124:13,14,17,19	144:4 II (16) 17:1;19:7;22:5;23:22; 39:12,13,23,24;107:25, 25;108:6,11,14,18,21; 111:3 imagine (1) 141:2 immiscibility (14) 105:15,18,23;106:4,8; 109:5;111:13;112:8; 113:23,23;114:5;152:6, 8,11 immiscible (31) 15:3;105:11,20;106:8, 17,22,24,25;107:2,5,8,9, 10,11,12,14,15,17,19,23; 108:4;109:4,9;111:12, 14,23;112:3,20,25; 113:6,16 immiscible-type (1) 114:1 Impact (1) 22:1 impacted (1) 151:7 implicit (1) 61:11 importance (1) 151:8 important (10) 24:8;29:12,14,16; 39:22;49:13;63:15;65:4, 12;140:21 inaccurate (1) 113:19 Inc (1) 31:22 include (4) 67:18;130:17;135:13; 139:16 included (2) 61:15;93:1 includes (1) 66:23 including (1) 90:18 inconsistency (1) 54:1 Incorporated (3) 10:15,15;136:22 incorporating (1) 76:3 incorrect (1) 62:24 increase (10) 65:16;74:3;77:19,25; 118:12;119:4;140:18; 144:10,11;153:16 increased (5) 52:18,20;54:11;77:21; 139:20 increases (2)	127:8;139:20 indented (1) 137:7 independent (3) 14:3,8;74:2 indicate (4) 25:10;89:15;127:23, 25 indicated (2) 29:24;116:9 indicates (6) 32:6;53:15;62:5;63:5; 67:11;155:4 indicating (2) 72:10;137:19 indication (1) 131:10 indiscernible (1) 28:17 individual (5) 25:12;26:6;60:4; 87:22;132:3 industrial (1) 58:9 industry (1) 27:4 influence (3) 115:15;126:23;144:25 information (17) 21:11;24:16;27:20; 29:24;31:21;32:4;34:4; 37:10;50:10,25;61:2,15; 74:1;75:5;98:12;127:9; 150:5 ingredient (2) 57:24;58:2 initial (2) 59:21;78:15 initially (1) 13:25 input (2) 66:3;98:10 installed (1) 12:10 Institute (1) 122:13 instruct (2) 125:6;126:7 instruction (1) 126:11 instructive (2) 154:21,23 insufficient (1) 53:7 intend (1) 16:10 intent (8) 73:8,8;81:21;82:11; 87:7;147:11,13,15 inter (1) 146:10 interactions (5) 25:7;146:6,11;147:9,
H		I		
half (2) 137:12;138:6 halfway (1) 116:21 hand (10) 9:4;15:25,25;34:5,6; 44:21;74:13;98:24; 102:2;111:18 Handbook (13) 18:5,8,13,25;22:11; 27:6;41:13;98:16,24; 100:25;101:1;102:7; 134:17 handed (1) 45:3 handing (11) 15:20;18:18;22:20; 26:17;32:2;35:25;36:20; 37:20;40:19;74:10; 78:11 Handl (11) 7:2;8:5,12,23;42:16; 66:15;76:14;81:16; 129:3;149:16;151:21 handleable (1) 80:23 handling (1) 41:25 hands (1) 58:13	herein (1) 8:6 Here's (2) 69:2;95:25 high (4) 45:7;49:19;124:13; 148:12 higher (12) 133:7,22,24;134:4,6,7, 8,9;143:3,4,5,8 highly (2) 111:17;113:16 hit (1) 56:21 Hogle (83) 7:15,15;8:10,22,9;7, 10;15:19;18:17;19:3,5; 22:19;26:15,20,22;32:1, 18,20;34:21;35:4,6,24; 36:15,19;37:14,18;38:5, 7;40:18;41:7,9;42:15; 44:20;66:14;74:9,18,20; 76:8,13;78:10,17,19; 81:4,7;82:22;86:18,20, 24;90:8,25;92:6,8; 94:10;106:15;110:6,9; 116:5,9,11;117:10; 120:13,24;121:2,7,11, 13;122:22;125:6,15; 126:3,8,10,25;127:19; 128:7;129:11;131:1; 145:19,25;151:17,20;	idea (2) 109:21;137:3 ideal (29) 24:24;97:13,15,20,22; 98:1,7,12,19,25;99:7,11, 17;101:24;104:17,20,20; 114:6,7,12,15,18,20; 119:14,17,21;145:20; 146:1;147:21 ideality (1) 77:7 identification (15) 8:21;15:18;18:16; 22:18;26:14;31:25; 34:20;35:23;36:18; 37:17;40:17;44:19;74:8; 78:9;120:9 identified (1) 38:8 identify (10) 7:12;22:21;32:3;33:5; 36:1,21;37:21;40:20; 74:11;78:12 ie (1)	127:8;139:20 indented (1) 137:7 independent (3) 14:3,8;74:2 indicate (4) 25:10;89:15;127:23, 25 indicated (2) 29:24;116:9 indicates (6) 32:6;53:15;62:5;63:5; 67:11;155:4 indicating (2) 72:10;137:19 indication (1) 131:10 indiscernible (1) 28:17 individual (5) 25:12;26:6;60:4; 87:22;132:3 industrial (1) 58:9 industry (1) 27:4 influence (3) 115:15;126:23;144:25 information (17) 21:11;24:16;27:20; 29:24;31:21;32:4;34:4; 37:10;50:10,25;61:2,15; 74:1;75:5;98:12;127:9; 150:5 ingredient (2) 57:24;58:2 initial (2) 59:21;78:15 initially (1) 13:25 input (2) 66:3;98:10 installed (1) 12:10 Institute (1) 122:13 instruct (2) 125:6;126:7 instruction (1) 126:11 instructive (2) 154:21,23 insufficient (1) 53:7 intend (1) 16:10 intent (8) 73:8,8;81:21;82:11; 87:7;147:11,13,15 inter (1) 146:10 interactions (5) 25:7;146:6,11;147:9,	

21 interested (2) 19:12;49:6 Internet (3) 32:5;33:9;36:25 interpolated (1) 50:8 interpolation (1) 35:14 interpreting (2) 98:21,23 interrupted (1) 38:14 in-the-field (1) 97:3 into (25) 10:16;19:23;42:21; 51:24;63:11;66:3,3,19; 76:2,16;85:2;95:18,19; 96:3,4;112:15,16;113:7, 25;136:16,19;138:1,7; 144:13;155:10 introduce (2) 38:14;60:17 introductory (1) 126:14 investigate (1) 85:21 involved (2) 57:21;79:10 involves (1) 80:8 ionic (1) 145:6 irrelevant (2) 112:10,17 irritating (1) 58:4 issue (4) 49:21;51:8;61:7;70:15 items (4) 10:25;52:14;56:25; 77:11	13:19,25;33:21;34:12, 17;51:4;52:11;59:24; 61:6;62:18;66:16;70:12; 73:20;74:15;82:5;96:9; 100:20;121:8;125:22; 133:16,25 Joro (5) 7:17;86:24;110:6,9; 116:6 Journal (5) 37:23;121:18,22,25; 122:2 journals (1) 122:7 judgment (1) 131:20 junior (1) 18:9 justify (2) 54:8,11	50:20 last (13) 33:25;35:19;58:12; 63:22;78:6;84:23; 105:16;110:7,22;111:6, 7;116:2,3 later (3) 51:25;65:15;68:2 Laura (2) 3:10;7:10 Law (2) 24:24;51:9 lay (1) 106:7 layer (2) 106:6;107:20 layers (1) 152:7 lays (1) 147:1 Leaching (3) 85:23,24;86:1 lead (2) 64:25;150:4 leap (1) 60:6 least (2) 103:14;104:5 leave (3) 65:9;102:3;154:17 leaving (1) 80:1 left (4) 10:7;65:4;76:15; 110:23 left-hand (9) 16:14;28:3,20,23; 29:4,5,11;32:22;109:23 lengthy (1) 125:7 less (6) 52:2,3;116:25;140:2; 144:23;153:4 lessened (2) 153:8,11 lesser (1) 153:12 letter (2) 82:25;83:4 letters (1) 119:25 level (1) 48:14 levels (2) 48:19;116:25 liberal (1) 60:18 lie (1) 111:8 light (1) 130:18 likely (1) 85:3	limited (1) 125:10 limonene (5) 17:9;43:16;104:19; 112:16;115:19 limonene-bitumen (1) 127:4 line (37) 17:3,17,18;20:3,14; 28:11,20;39:24;43:3,11, 22;52:17,17;53:13,14, 14;54:5;62:4,20;64:10, 10;65:19,23;69:11,21; 70:4;73:10,16,17;80:19; 100:16,24;101:2,14,24; 146:15,18 lines (15) 17:1,19,22;29:13,15; 40:1,2;42:25;43:2; 53:21,24;65:18;70:21; 71:16;101:5 liquid (20) 14:12,23;37:22;54:10; 63:16;64:1,5,8;65:11; 70:24;77:13;79:25; 80:12;103:12,19;104:1, 16;106:5,5;117:4 liquids (4) 63:20;108:2,6,21 list (3) 35:20;121:9;135:25 listed (1) 135:23 Listen (1) 113:13 listing (2) 36:7,8 lists (1) 33:9 liter (25) 29:8;33:4;41:23;42:1; 45:22;47:11;48:6,10; 53:18;77:15;118:25; 119:6;123:7;124:9; 127:14,23;130:12,15; 132:13;133:6,12,13,23, 23;134:12 literature (8) 29:8;31:12;35:15; 45:6;60:25;98:11,21; 152:16 litigation (1) 12:15 little (10) 9:1,11;23:8;39:9;79:3; 89:13;100:4;116:17,22; 141:2 live (2) 8:13,14 Living (2) 7:17,19 l-limonene (1) 57:11	logic (1) 55:15 logical (1) 56:14 long (1) 149:19 longer (1) 81:1 look (13) 39:11;50:3;60:8; 61:20,21;73:24;84:15; 94:8;102:6;109:4;122:4, 5;154:16 looked (5) 42:7;67:1;130:7,16,19 looking (13) 25:12,22;26:10;43:16; 49:14;50:24;54:25; 55:14;61:9;63:9;72:11; 110:5;111:22 looks (2) 20:24;155:7 lose (1) 59:12 lot (11) 12:8;49:16;51:23; 58:9,10;111:23;116:8; 138:17;140:11;145:23; 151:3 loud (1) 128:12 low (10) 29:1;51:20;58:5; 106:1;116:25;117:1,18; 119:13;128:5;146:13 lower (18) 16:14,15;28:8,20; 29:5;31:1;32:21,24; 35:8;78:24;92:23; 116:18;133:15,18; 134:21,23;141:17; 144:18 lower-left (1) 35:9 lowers (1) 67:20 lunch (1) 110:20
J	K			
Jan (1) 7:9 January (7) 33:21;52:11;59:16; 75:8,9,9,10 JBR (4) 8:17;10:16;30:20;46:9 job (2) 9:25;10:2 Johnson (22) 3:12;21:21;34:9; 46:13;48:18,24;49:21; 60:20;63:4;64:4;74:1; 75:6;77:17;115:24; 121:5;130:13;132:15; 133:5,18;134:14,16,20 Johnson's (21)	keep (4) 18:10;49:13,14;59:11 keepsake (1) 18:11 KIC (2) 31:22;32:6 kilogram (12) 28:1;29:3;30:9;33:3; 41:24;43:13;44:17;45:9, 13;47:3;155:3,6 kind (7) 11:22;58:4;64:15; 71:25;76:14;110:1; 144:4 kinds (1) 99:16 knowing (1) 130:8 knowledge (2) 99:18;103:5 knows (1) 86:25			
	L			
	lab (2) 85:22;97:3 labeled (3) 28:22;64:14;65:10 laboratory (3) 59:10;150:22,22 lacks (3) 94:10;126:25;128:7 Lake (1) 3:8 Lane (1) 8:14 large (3) 60:5;114:2,2 large-scale (1)			
				M
				MACHLIS (8) 102:9;110:24;111:1; 120:1,3;125:20,25;126:2 MacKay (1) 122:18 magazines (1) 122:6 magnitude (2) 47:21;68:1 main (2) 55:10,10 majority (1)

10:14 akes (2) 28:16;37:10 makeup (4) 87:22;129:18;131:13; 132:7 making (5) 20:6;49:16;52:21; 70:1;137:15 man (1) 49:10 managed (2) 11:6;50:8 Management (6) 10:9,11,13,19;11:5; 13:16 manner (1) 41:12 many (6) 13:10;40:3;55:21,21; 80:17;137:2 March (10) 49:21;57:2;59:14,17; 61:6;66:16;68:9,11; 75:7;97:1 mark (5) 15:16;26:12;34:6; 83:4;116:23 marked (30) 8:20;9:3;15:17,20; 18:15,19;22:17,20; 5:13,16;31:24;32:2; 33:22;34:19,23;35:22; 36:1,17,21;37:16,20; 38:10;40:16,20;44:18; 74:7,10;78:8,11;120:8 mass (1) 103:10 Massachusetts (1) 122:13 master's (4) 9:15,17,18;57:5 material (24) 14:16;30:3,5,7;31:3; 32:23;38:9,15;44:15; 49:15;52:23;54:10; 59:12;67:13,15;80:1,2; 81:3;85:2,4;92:20; 118:23;140:7;153:10 materials (25) 17:11;19:9;24:18; 25:18;27:21;32:11,11; 36:8;92:22;93:6;95:19; 96:4;109:2;113:24; 141:25;145:6,7;150:3; 152:17;153:5,7,18,20, 22,24 mathematics (1) 137:17 matter (8) 4:8;24,25;22:25; 5:7;112:7;142:3,5 maturation (4)	89:12,22;90:7;92:1 may (15) 21:17;54:6;56:20; 60:10;64:13;70:8;98:11, 11;111:5;142:20,20; 147:16;150:2,4,4 maybe (4) 50:2;73:8;116:1; 150:24 McConkie (5) 3:5;7:21,21;149:15; 151:15 mean (17) 14:7;51:21;78:22; 81:24;93:21;96:18; 101:19,19;104:13; 107:15;129:15;137:6; 141:19;142:22;143:4,13, 15 means (3) 57:12;134:5;144:8 meant (4) 20:8;57:14;87:18; 109:1 measurable (1) 106:2 mechanical (4) 143:10,11;144:3,8 mechanically (1) 80:3 mechanism (1) 147:18 mechanisms (5) 79:6,12,13,21;153:11 melt (3) 65:24;66:24;67:5 melting (2) 67:12,14 member (4) 89:11,22;90:6;92:1 Mendenhall (1) 7:8 mentioned (6) 14:18,19;22:4;37:19; 43:20;133:2 merely (3) 20:21;69:12;70:1 merged (1) 10:16 met (1) 18:12 meters (1) 73:12 method (6) 63:9;75:16;78:1; 85:23,25;86:1 methods (1) 86:9 micrograms (15) 45:22;47:11;48:6,10; 53:17;77:15;130:13,15; 132:12;133:6,12,13,22, 23;134:11	microphone (1) 154:8 middle (1) 53:22 might (5) 22:15;55:16;61:17; 102:11;151:7 milligram (1) 30:9 milligrams (22) 28:1;29:3,8;33:3,4; 41:23,24,25;43:12; 44:16;45:9,12;47:3; 118:25;119:6;123:6; 124:9;127:14,23; 130:12;155:2,5 millimeters (3) 59:5;73:13;141:12 million (5) 31:14,16;45:10;47:4; 51:17 mind (3) 26:12;126:2;150:24 mine (7) 12:4;63:21;134:23; 141:1,6;149:4;153:15 minimal (1) 89:2 minimis (2) 89:1,16 minimize (2) 72:6,7 minus (10) 29:2;41:22;43:12; 45:21;47:3,10;48:6,10; 67:20;117:1 minute (6) 15:7;25:6;53:1; 105:19;107:22;148:1 minutes (1) 91:11 miscibility (12) 106:18;108:25; 111:21;112:18,21,24; 113:2,5;151:22;152:4,7, 10 miscible (11) 15:3;106:21;108:8,16, 22;111:4;112:20,23,25; 113:7,19 misidentified (1) 65:5 misleading (1) 53:5 misses (1) 73:14 misspelled (1) 77:1 misstatements (1) 62:18 misstates (1) 90:25 mistake (1)	65:3 mix (1) 135:1 mixed (2) 57:13;144:13 mixing (1) 77:8 mixture (11) 19:8;25:25;46:20; 57:10,11;59:1;61:1; 144:17,17,20;152:21 model (2) 14:11;61:2 models (1) 51:19 moisture (4) 30:10;32:7;46:11;81:2 mole (10) 26:6;45:15,16;76:3,5, 21;77:12;136:13; 137:18;138:3 molecular (1) 76:4 molecules (1) 129:19 monocyclic (1) 55:25 Montana (13) 7:8;8:15,19;9:14,16; 10:5,6,7,7;11:15,15; 18:9;57:5 month (1) 58:12 more (22) 58:9,9;60:7;62:2; 68:10;86:21;96:11,11; 107:4;109:9;111:14,16, 23;112:2,2;122:3; 127:17;133:7;134:1,12; 142:12;144:21 most (9) 13:2;43:3;50:9,10; 56:23;59:18;70:19;85:3; 105:3 mouth (1) 63:2 move (24) 9:8;16:18;19:3;23:15; 26:20;29:19,22;32:18; 35:4;36:15;37:14;38:5; 39:5;41:7;45:2;57:1; 59:14;60:8;61:13;74:18; 78:17;88:13;120:19; 151:2 moved (1) 148:25 movement (3) 142:23;144:5,9 movements (1) 143:11 moves (1) 80:6 moving (2)	61:16;154:8 much (6) 48:11;56:17;69:21,21; 80:23;155:10 must (1) 60:2 mutual (1) 56:9 <hr/> <p style="text-align: center;">N</p> <hr/> name (3) 8:11,12;115:23 names (1) 122:23 narrative (1) 93:12 natural (3) 58:2,15;66:21 near (2) 31:6;63:22 nearly (2) 53:8;62:22 necessarily (1) 131:22 necessary (2) 14:2;61:9 need (7) 27:19;59:11;63:11; 66:7;86:19,21;104:10 needed (1) 46:5 needs (2) 110:10;154:3 neither (1) 70:4 next (7) 29:22;76:20;85:10,20; 88:14;109:12,17 nineteen (1) 10:21 Ninety-seven (2) 72:23,25 NOI (2) 82:10,13 noise (1) 145:23 nomenclature (1) 17:5 nonexistence (1) 58:6 nonexistent (1) 62:13 nonideal (3) 99:14;104:8;114:15 non-ideal (1) 103:16 nonvolatile (4) 89:21,21;90:6;91:25 non-volatile (1) 89:11 nor (1) 92:25
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<p>normal (1) 53:15</p> <p>normally (1) 80:5</p> <p>notation (1) 64:15</p> <p>note (1) 39:22</p> <p>noted (2) 71:7;121:15</p> <p>notes (2) 68:25;147:24</p> <p>notice (4) 7:11;71:11;81:21; 82:11</p> <p>noticed (1) 68:12</p> <p>notion (1) 137:8</p> <p>Novak (1) 83:5</p> <p>nowhere (1) 130:25</p> <p>number (16) 9:25;12:6;30:12; 45:24;25:46;3;3;52:14; 57:17;62:17;66:3;68:2; 71:14;119:24;120:20; 150:23</p> <p>numbered (1) 109:19</p> <p>numbers (7) 50:13;71:1,2,7;75:10; 92:5;119:25</p>	<p>odor (2) 58:4,5</p> <p>off (24) 10:12;42:10,12;66:9, 11;76:9,10,15;80:18; 81:5,8,10;110:12,14; 120:12,14,14,16;128:21, 23;143:2;148:2,4; 155:16</p> <p>offer (3) 9:7;13:21;38:14</p> <p>offers (1) 69:9</p> <p>offhand (1) 132:17</p> <p>offices (2) 7:7;8:18</p> <p>offline (1) 126:5</p> <p>off-site (1) 151:12</p> <p>Oil (38) 7:16;8:25;11:18; 14:12,13,17;20:16,17; 22:2;24:7,10;40:7;44:9, 10,12;45:18,19;46:2,5,6; 47:13;57:24;63:21,24; 64:1;78:14;79:6;90:18; 91:12;92:4;95:20;96:5; 111:17;137:22;147:17, 19;153:3;155:1</p> <p>oil-rich (13) 15:4;17:2,9,17;19:13; 28:12;38:21;40:8,25; 43:5;107:20;114:22; 115:20</p> <p>once (3) 38:17,17,17</p> <p>one (54) 13:2;15:4;16:18;28:1; 32:8;33:18;36:9,13,13; 37:1,1,2,10,19;44:6; 45:25;52:16;54:17;55:6; 61:17,25;62:19,22;67:8, 8;68:10,17;69:2;72:20; 78:6;86:11;93:1;95:1,3; 96:24;98:13;103:14,14; 104:5,6;111:23;113:5; 114:25;117:25;135:25; 136:1;139:14;146:19; 152:11;153:13,15;154:1, 7,15</p> <p>ones (2) 56:22;90:21</p> <p>one's (1) 36:21</p> <p>online (1) 26:3</p> <p>only (11) 43:16;45:20;60:22; 105:2;108:3,7,15,22; 136:1;137:17;140:19</p> <p>open (2)</p>	<p>85:2;116:12</p> <p>operate (2) 13:9;79:23</p> <p>operated (2) 12:11;80:5</p> <p>operating (1) 13:6</p> <p>operation (1) 79:7</p> <p>operations (5) 11:3,8;57:25;153:14, 15</p> <p>operator (1) 7:10</p> <p>opines (1) 48:18</p> <p>opinion (7) 69:17;72:12;83:22; 94:9,12;103:24;124:8</p> <p>opinions (2) 13:20;14:1</p> <p>opposed (1) 152:6</p> <p>optical (1) 57:12</p> <p>order (7) 27:19;41:14;44:10; 46:5;65:2;68:1;137:25</p> <p>ordered (1) 150:24</p> <p>orders (1) 47:21</p> <p>organic (14) 54:8;87:18;92:15,16; 116:24;122:21,21; 124:14,17,19;127:14,22; 128:11,17</p> <p>Organics (2) 88:15;91:22</p> <p>orgonic (1) 124:14</p> <p>original (7) 56:18;67:14;75:6,9; 82:5;95:20;96:5</p> <p>originally (1) 11:12</p> <p>originated (1) 57:19</p> <p>OSHA (1) 11:7</p> <p>otherwise (2) 59:13;83:6</p> <p>out (34) 17:14;19:14,20;21:4; 22:12;27:17,21;39:7; 40:13;55:12;62:11,19; 65:5;67:4;70:9,10,22; 71:18;75:4;77:17;93:8, 20;94:3,7;98:9;105:16; 118:3,6,20;128:12; 130:7;134:3;142:4,15</p> <p>outcome (2) 22:2;27:15</p>	<p>outlined (2) 45:23;98:16</p> <p>over (5) 56:24;78:7;108:5; 112:5;126:19</p> <p>overlapping (2) 117:3,12</p> <p>own (6) 18:12,12;54:13;63:24; 71:19;73:25</p> <p>owner (1) 10:14</p>	<p>115:12,23;152:25</p> <p>partial (1) 113:23</p> <p>partially (15) 15:3;106:21;107:5; 108:3,8,16,22;111:4; 112:19,23,23,25;113:7, 19;119:10</p> <p>participate (2) 81:17,20</p> <p>particular (11) 15:1;16:20;20:12; 44:15;57:19;62:21; 64:12;69:14;92:19; 104:19;151:24</p> <p>particularly (3) 49:16;54:24;89:17</p> <p>parts (7) 31:14,16;45:10;47:3; 51:16;75:22,22</p> <p>Paul (2) 3:5;7:21</p> <p>PBR (1) 154:14</p> <p>PE (1) 8:5</p> <p>people (1) 11:7</p> <p>per (42) 28:1;29:3,8;30:9; 31:14,16;33:3,4;41:23, 24;42:1;43:12;44:16; 45:9,10,13,22;47:3,3,11; 48:6,10;51:17;53:18; 77:15;118:25;119:6; 123:7;124:9;127:14,23; 130:12,15;132:12;133:6, 12,13,22,23;134:12; 155:2,6</p> <p>percent (12) 40:24;42:4;43:10; 46:6,14,15,18,21,23; 52:3,4,25</p> <p>percentage (1) 47:22</p> <p>perfectly (1) 29:15</p> <p>perform (2) 11:18;12:20</p> <p>performed (5) 22:6;24:16;95:4,5; 136:14</p> <p>performing (3) 23:21;74:1;134:3</p> <p>periodicals (1) 122:6</p> <p>permit (1) 154:5</p> <p>Permit-By-Rule (13) 7:5;30:20;81:17; 82:16;83:5,10;84:1,14, 18;94:3;152:23,24; 154:14</p>
O			P	
<p>object (3) 80:21;120:24;125:6</p> <p>Objection (11) 86:18;90:8,25;92:6; 94:10;121:3,15;122:22; 126:25;128:7;131:1</p> <p>obtain (3) 36:9;77:11;80:22</p> <p>obtained (8) 11:14;27:23;32:5; 33:8;44:11;46:7;47:10; 78:3</p> <p>obtaining (1) 154:4</p> <p>obviously (1) 45:5</p> <p>occasionally (1) 12:14</p> <p>occur (3) 54:21;111:14;150:2</p> <p>occurring (3) 105:3,7,9</p> <p>occurs (1) 96:12</p> <p>octanol (5) 54:24;55:3,7;62:9,11</p>			<p>page (90) 30:17;31:6,7;33:25; 34:1;35:19;37:4,8;39:7; 52:17;53:13,14,22;54:3, 3,14,22,22;59:20;60:20, 20;61:5;62:4,20;63:3,5; 64:10;65:13;66:17,18; 67:3,23;68:3,4,5,19; 70:20;71:1,1,2,7,14,14, 16;72:22;73:1,10,16,17; 74:23;76:19,20,22;77:6, 12;84:17,21,24;85:21; 86:13,14;88:14;93:12, 13;94:1;95:23;102:12, 15;107:24;109:11,12,14, 17,18,23;110:24;112:3, 5;116:7;127:19;128:16; 135:5,24;136:2;137:5,7; 152:24;154:13,14,15</p> <p>pages (3) 88:17;109:17;125:8</p> <p>PAH (4) 66:2;95:18;96:3; 153:17</p> <p>PAHs (7) 44:11;67:7;120:6; 122:9;124:19,22;126:16</p> <p>pan (1) 23:8</p> <p>paper (5) 122:17;125:1;126:14; 128:4,8</p> <p>paragraph (19) 84:23,23;102:24; 104:11,24;105:1;109:1; 110:2,23;116:18,22; 126:14,14;128:11,13,19; 137:6,12,24</p> <p>parameter (6) 65:4,5;140:19;151:24; 152:2,12</p> <p>parameters (5) 138:18;139:14; 140:12;142:9;152:18</p> <p>part (13) 13:6;29:23;35:7,8; 38:12;56:14;78:15; 84:20;92:23;102:17;</p>	

<p>permitting (2) 11:1;12:14 rry (4) 17:25;18:2,25;38:22 Perry's (18) 18:4,8,13;22:11;27:6; 39:8;41:12;43:21;98:16, 24;100:25;101:1;102:7, 8;104:4;109:11,18; 111:24 person (1) 150:24 personally (1) 63:21 perspective (4) 14:6;49:13,14;73:24 perylene (1) 53:25 petrochemicals (1) 91:18 petroleum (27) 44:12;45:11;47:7; 85:11;86:5,12;87:10; 88:1,6,19;89:3,6,12,22; 90:6,19,23;91:13;92:1; 93:3,8,15,21,24;94:4; 124:16;154:21 PH (1) 91:13 phase (81) 12:18,21;14:11,19,21; 52:4,4,6,6,13;17:2,4,5, o,7,9;19:7,12,13,14,17, 22;20:3,16,18,23;21:9; 22:23;23:24;24:5,7; 28:12,19;39:14,19,25; 40:9,10,23,25;41:2,17, 21;42:25;43:4,5,5,25; 46:23;47:2,13;51:16; 55:1;97:25;102:13,18, 24;103:14;104:5;106:6, 10,10;107:18;108:1; 109:6,8;111:16,17,25; 112:15,16;114:3,21,22; 115:20,21;138:1,8; 143:16;146:17 phase-equilibrium (1) 103:5 phases (17) 15:4;17:2;20:12; 38:21;40:7,8;60:24; 94:20;103:12,19;104:1, 16,20;108:9,23;111:14; 113:25 Phillip (2) 122:18,20 physical (3) 33:8;36:7;37:23 pick (1) 134:25 ed (1) 30:20 picking (4)</p>	<p>60:4,9;76:15;134:24 picture (2) 20:23;55:14 pile (3) 142:4,13;143:18 piles (3) 85:8,18;142:10 pit (1) 85:2 place (2) 49:8;148:12 plan (1) 79:13 planned (1) 153:14 plans (1) 79:6 pleasant (2) 58:4,13 Please (28) 8:11;27:14;37:21; 38:15;81:6;82:8;84:18, 21;88:25;95:21;97:8; 98:9;99:22;100:2,4; 102:15,19;106:4; 109:13;116:15,17;124:4, 24;128:11,20;129:2; 146:25;148:1 plot (5) 16:13;22:12;29:25; 31:17;36:9 plots (1) 114:3 plotted (11) 17:13,18;28:2,5,8,24; 29:6;38:18;42:2,19; 43:11 plotting (3) 37:12;38:1;39:20 plural (1) 131:14 pm (1) 155:20 point (26) 28:1,5,7;29:6;36:11; 38:1;41:18;42:1,3; 43:11;53:10;62:19; 63:14;67:12,14;69:18; 70:22;71:18;78:3;80:13, 25;98:9;100:10,13; 101:18;146:23 pointed (1) 62:11 pointing (4) 17:15;39:15,16; 100:10 points (12) 28:10,21;37:10;39:18; 43:18;55:11;69:16;70:8, 17;100:17,21;101:14 pollution (1) 11:1 polyaromatic (4)</p>	<p>21:15;44:7;61:23; 124:23 polycyclic (1) 126:15 portion (4) 64:1;78:24;80:7; 117:18 Portions (2) 97:17,19 position (1) 154:2 positions (1) 10:6 possibility (2) 78:4;118:3 possible (6) 17:11,20;49:15;61:22, 22;80:24 possibly (1) 65:6 post-process (2) 19:10,11 post-processed (2) 47:19;48:9 potential (21) 74:2;84:11;85:14,22; 86:7;87:9,10,12;88:8,22; 90:23;91:19;93:3,5,9,15, 22;94:4;149:21;150:6; 154:22 potentially (1) 19:23 Power (4) 10:5;6,7,7 PR (5) 7:4;95:12;149:3; 153:15;154:14 PR-11-001 (1) 7:3 practice (2) 98:24,25 pragmatic (4) 12:9;27:10;49:5;132:6 Precipitate (1) 85:24 precipitation (3) 46:1,4;153:11 precise (1) 62:10 precision (1) 150:2 preferred (1) 132:9 prepare (1) 15:9 prepared (6) 15:11,25;18:21;22:24; 41:4,5 preprocessed (3) 47:19;48:1,3 presence (13) 95:17;96:2,10;115:7, 14;126:22;135:15,16;</p>	<p>136:12,22;145:12; 153:21,23 PRESENT (9) 3:11;7:7;49:7,7;73:2; 116:25;118:18;138:5,7 presented (5) 18:7;91:17;98:21; 121:4;153:13 presents (1) 75:16 pressure (13) 59:5,6;64:6;73:11; 139:12,16,21;141:9,11, 13,20;144:6,18 pretty (1) 56:17 prevent (1) 125:13 previous (1) 88:17 previously (5) 12:2;35:2;43:20; 75:20;135:18 primarily (2) 10:24;19:11 principles (1) 16:10 prior (1) 21:18 probability (3) 117:2,8,11 probably (3) 38:25;51:24;142:10 problem (2) 30:15;134:10 problems (2) 12:1,12 Procedure (3) 85:23,24;92:20 procedures (3) 12:14,15;86:1 proceed (1) 45:4 proceeded (1) 21:5 proceeding (2) 51:1;60:13 proceedings (1) 8:1 process (16) 19:19,21;22:2;48:16; 78:14;80:4;85:13,13; 88:7,21,22;89:12,22; 90:7;92:1;144:3 processed (31) 19:24;21:23;24:12; 46:4,6;47:13;49:9; 84:10,25;85:8,17;86:3,3; 88:8;95:12;96:20;111:5; 137:9;138:13,16;139:3, 13;140:2,23;142:1,19; 147:19;149:24;151:5; 153:5;155:2</p>	<p>processes (2) 79:9;103:7 processing (3) 19:15;21:18;153:9 produce (3) 14:17;29:17;101:5 produced (2) 18:7;19:20 product (5) 14:17;19:16;32:15; 57:20;58:16 products (1) 47:8 profession (1) 27:4 professional (4) 9:23;10:3;11:10,11 Progress (1) 122:4 progresses (1) 64:25 Project (10) 7:4;13:8;21:13;49:4; 50:22;82:4;147:15; 148:23,24;150:1 projected (4) 24:11;45:17;47:12,20 projecting (1) 48:25 projection (1) 45:20 projections (6) 12:21,24;20:6;32:9; 44:3;49:16 projects (7) 12:4,16,25;13:4,7; 148:15,21 proper (2) 86:4;93:2 properly (3) 68:16;69:9,20 properties (5) 24:17;36:7;55:5; 60:25;62:12 property (1) 33:8 proportion (2) 129:25;130:3 proportionate (1) 138:4 proportions (2) 111:5;130:8 prove (2) 146:21;147:8 provide (1) 14:2 provided (6) 13:22;21:21;120:25; 121:5;125:9,11 proxy (18) 49:17;51:5,7;54:24; 59:25;60:5,9,13;61:4; 67:13;74:4,5;75:13,19,</p>
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24;131:16,21;134:24 publication (1) 34:9 published (2) 50:9;60:25 pulled (1) 79:25 pulp (1) 57:20 pure (10) 16:13,15,16,17;43:16; 52:22;53:8,19;77:22; 144:18 purely (1) 126:19 purport (3) 65:5;87:5;131:9 purported (1) 141:12 purports (2) 63:18;67:23 purpose (4) 20:10;149:23;150:17, 23 purposes (21) 8:21;14:18;15:18; 18:16;20:9;22:18;26:14; 31:25;34:20;35:23; 36:18;37:12,17;40:17; 44:19;74:8;78:9;120:9; 137:14;149:21;154:4 pursuant (1) 7:11 push (1) 100:4 put (11) 16:1;23:1;49:8;63:1,1; 74:21;102:14;116:14; 120:3;152:9;155:10 putting (1) 71:19 pyrene (2) 126:18;127:12	quickness (1) 138:17 quite (2) 55:22;58:5 quote (3) 73:1;95:22;96:1 R Racemic (2) 57:11,11 raffinate (32) 17:4,6,7;19:12,17,22; 20:3,18;21:9,13,14; 23:24;24:5;28:19;38:21; 40:9;41:2;43:5,25;47:2, 6,13;51:16,17;97:25; 106:10;111:16;115:11, 12,15,17,21 Raffinates (1) 111:8 rain (2) 46:1,3 rained (1) 67:19 raise (2) 64:17;65:9 raises (2) 61:6;67:19 ran (1) 90:4 range (17) 28:25;32:16;37:25; 45:5,7,8;46:11,24;60:10; 130:17,18,19,20;131:19, 21;135:17;152:19 ranged (2) 31:14;44:16 ranges (1) 44:14 ranging (1) 126:18 Raoult's (2) 24:23;51:9 rate (4) 140:4,19;142:6; 144:13 rates (1) 103:10 rather (5) 47:21;48:25;60:9,18; 124:7 ratio (1) 77:24 raw (3) 48:8;136:5,7 reaction (1) 68:13 read (19) 84:24;89:8;103:3; 104:10;108:9;110:22; 116:20;117:5;122:17; 124:1,3;126:13;127:7,	10,18;128:10,12;141:8; 155:15 readily (2) 92:18;140:2 reading (2) 84:22;118:17 ready (2) 81:5;110:17 real (13) 12:4;21:13;27:10; 41:19;52:24,25;61:1,1; 110:9;132:6;137:16,20, 20 really (13) 21:19;29:13;49:6; 56:13;58:1,14;69:9; 73:12;84:16;94:11; 143:15;155:9,13 reason (2) 48:10;56:14 reasonably (1) 133:9 recall (1) 84:4 received (2) 9:18;32:5 receptor (3) 150:8,9,14 receptors (1) 151:14 reciprocity (1) 11:14 reciting (1) 75:11 recognize (3) 9:5;15:21;34:24 record (30) 26:1;42:10,12,13; 62:1;66:9,11,12;76:10, 11;81:8,10,11;95:9; 110:12,14,15,17;120:15, 16,17;128:21,23,24; 130:25;141:5;148:2,4,5; 155:16 recoverable (1) 90:19 refer (4) 38:22;40:9;97:7; 113:22 reference (47) 17:24;18:20;25:13,15, 20;26:2;30:12,18,19; 31:13,18,21;32:10,12; 33:6,7,7,8,17,17;34:1,2, 7,12,13,14,23,25;35:10, 17,20;36:2,10,23;37:2, 20;38:22;39:1,4,8;44:13, 22;46:7,16;54:20;67:2; 84:19 referenced (3) 27:24;32:11;125:23 references (8) 25:10;33:2;35:20;	37:2;101:17,19,20;131:8 referred (3) 75:20;92:4;152:24 referring (19) 64:13;68:17,18;71:1, 5;72:17;82:23;83:3; 88:16,16;98:3,4,5; 112:22,24;113:15,16,18, 21 refers (3) 53:25;65:22;127:3 refine (1) 50:21 reflect (1) 111:11 reflux (1) 103:8 regard (11) 21:15;31:12;43:6; 68:9;77:5;87:19;111:24; 112:13;134:2;137:21; 142:5 regarding (5) 14:1;21:11;24:17; 27:20;72:17 registered (5) 11:9,11,12,14,15 registration (1) 11:13 relate (5) 24:10;34:3;40:5; 46:25;94:20 related (3) 10:25;24:5;137:20 relates (8) 38:20;39:14;40:25; 43:23;72:20;113:24; 127:3;141:5 relation (1) 109:5 relationship (25) 16:23;17:23;19:25; 21:8,23,24;23:23;24:1,3; 38:20;39:12,21;40:5,14, 22;41:17,18;42:21,24; 43:1;45:14;76:25; 137:11;140:8;147:5 relationships (10) 14:22,24;16:24,25; 20:22;22:10;24:23; 43:19;103:6;147:4 relative (4) 24:6;43:7;44:11;47:7 relatively (5) 39:23;40:4;43:22; 59:2;141:23 release (1) 153:24 relevancy (1) 151:8 relevant (5) 84:9;112:12,13; 126:21;139:2	relied (1) 34:10 rely (1) 32:13 relying (3) 61:3;98:18,20 remainder (1) 44:3 remaining (5) 20:1;46:15;85:13; 88:8,21 remedial (1) 11:3 remediate (1) 11:4 remember (1) 123:22 remove (3) 80:12,23;129:1 removed (1) 153:8 repeat (3) 95:21;124:2;129:11 rephrase (4) 91:8,10;132:1;150:25 report (40) 13:10;18:20;20:25; 25:10,13,16;27:24,24; 29:1;30:11,16;31:6; 32:12;34:7,18;35:16,19; 40:15;41:16;44:4,22; 45:23;46:17;48:5;60:21, 24;74:3;75:21;96:24; 97:13;98:5,6,7;107:24; 113:22;123:22;130:16; 133:3;135:5,24 reported (8) 31:13;45:5;46:11,13; 98:11;143:6,8;152:16 reporter (2) 7:9,23 Reporting (2) 7:10;67:23 reports (1) 66:1 represent (7) 7:13;60:5;85:2,14; 88:8,22;125:1 representative (8) 67:6;129:22;131:20; 134:15;135:1,3,19; 152:20 represented (1) 17:3 represents (5) 16:9,13,15,16,17 reputable (1) 121:17 Request (1) 83:5 required (2) 103:8;155:22 requirement (1)
Q qualify (2) 48:23;96:17 Quality (3) 7:3;81:25;149:22 quantifies (1) 92:22 quantitative (1) 103:6 quantities (1) 103:8 quibble (1) 56:24 quick (2) 41:20;110:10 quickly (7) 38:23;137:9;138:13; 139:9,12;144:21,23	rate (4) 140:4,19;142:6; 144:13 rates (1) 103:10 rather (5) 47:21;48:25;60:9,18; 124:7 ratio (1) 77:24 raw (3) 48:8;136:5,7 reaction (1) 68:13 read (19) 84:24;89:8;103:3; 104:10;108:9;110:22; 116:20;117:5;122:17; 124:1,3;126:13;127:7,	recoverable (1) 90:19 refer (4) 38:22;40:9;97:7; 113:22 reference (47) 17:24;18:20;25:13,15, 20;26:2;30:12,18,19; 31:13,18,21;32:10,12; 33:6,7,7,8,17,17;34:1,2, 7,12,13,14,23,25;35:10, 17,20;36:2,10,23;37:2, 20;38:22;39:1,4,8;44:13, 22;46:7,16;54:20;67:2; 84:19 referenced (3) 27:24;32:11;125:23 references (8) 25:10;33:2;35:20;	related (3) 10:25;24:5;137:20 relates (8) 38:20;39:14;40:25; 43:23;72:20;113:24; 127:3;141:5 relation (1) 109:5 relationship (25) 16:23;17:23;19:25; 21:8,23,24;23:23;24:1,3; 38:20;39:12,21;40:5,14, 22;41:17,18;42:21,24; 43:1;45:14;76:25; 137:11;140:8;147:5 relationships (10) 14:22,24;16:24,25; 20:22;22:10;24:23; 43:19;103:6;147:4 relative (4) 24:6;43:7;44:11;47:7 relatively (5) 39:23;40:4;43:22; 59:2;141:23 release (1) 153:24 relevancy (1) 151:8 relevant (5) 84:9;112:12,13; 126:21;139:2	represent (7) 7:13;60:5;85:2,14; 88:8,22;125:1 representative (8) 67:6;129:22;131:20; 134:15;135:1,3,19; 152:20 represented (1) 17:3 represents (5) 16:9,13,15,16,17 reputable (1) 121:17 Request (1) 83:5 required (2) 103:8;155:22 requirement (1)

<p>103:13 search (1) 57:7 residual (10) 19:18;24:9,10;85:12; 87:11;88:20;150:18,19, 21;151:5 residue (2) 88:7,20 resolved (1) 104:23 Resource (5) 10:9,12,19;13:16; 26:18 respect (3) 47:18;78:24;114:7 respective (1) 113:25 respond (3) 50:1;51:11;103:23 response (5) 71:18;73:15,17,19; 146:7 responses (1) 50:3 rest (1) 42:18 restate (2) 87:3;130:1 result (2) 97:2;146:6 altant (1) 50:23 resulted (2) 12:7;91:12 results (11) 14:3;61:2;74:6,15; 86:17,25;89:15;90:21; 93:20;95:8,11 resumé (3) 9:4,5,6 return (1) 50:2 reveal (1) 91:23 review (10) 13:19,20;70:12;82:13, 18;83:13;122:6;125:4, 16;147:24 reviewed (12) 13:25;25:19;31:12; 34:11;41:20;78:14; 96:24;120:11;128:18; 131:5;133:4;135:21 rich (1) 20:16 ridual (1) 85:12 Right (49) 8:25;9:21;11:17;12:3; 5:4;22:2;23:10;26:8; 7:13;30:19,22,24;31:2; 32:10,21;35:25;37:13;</p>	<p>38:12;40:19;42:16,22, 23;46:9,10;48:16,20,22; 53:21;56:10;62:16; 66:18;70:11;74:17; 76:14;81:7;92:5;99:22; 101:7;102:4,22;104:12; 111:18;116:9,11; 119:20;126:3,13;143:2; 146:17 right-hand (6) 16:16;17:3;28:4,9; 32:25;78:24 rigorous (1) 47:17 ring (1) 83:1 Rivers (2) 7:18,20 Rob (1) 7:19 role (1) 82:3 room (2) 53:17;118:25 rotainers (1) 57:14 rotometers (2) 57:12,14 rotten (1) 55:17 rough (1) 71:9 roughly (1) 141:17 route (1) 80:8 rule (7) 93:8,20;94:3,7;117:6; 118:6,20 rules (1) 118:3 run (3) 86:2;93:2;94:21 running (1) 13:1</p>	<p>105:1;122:23;123:2,3,4; 132:16;147:18 sand (3) 48:9;63:21;142:15 Sands (46) 7:4,16;8:25;11:18; 14:12,14,17;19:18,24; 20:1;21:18;22:2;24:10, 12;44:9,10;45:18,19; 46:2,5,7;47:13,15;57:24; 63:25;64:1;75:21;78:14; 79:6;84:10;85:1,8,17; 86:2,3;89:10,20;90:5; 91:24;95:20;96:5; 137:22;147:17,19; 151:5;153:25 sands' (2) 21:22,23 Sandy (1) 8:18 saturated (2) 54:9;77:13 saturation (2) 80:20;81:3 saw (3) 56:21;63:24;66:16 saying (31) 50:4;87:23;89:19; 98:17;101:9,20;104:17; 107:9,10;108:10,14; 113:2;114:23;115:3,7, 14;118:2;122:8;123:23; 128:4;132:11;136:15; 138:2,12;144:20; 145:12;146:5,10,16; 154:20;155:1 scale (4) 20:8;69:7,11;70:10 scaled (4) 68:16;69:9,20;70:5 scanned (1) 128:19 schematically (1) 39:13 Schwarzenbach (17) 54:14;56:7;65:21; 71:19,21;72:2,8,21;73:5; 74:16;77:1,2,6,18; 115:24,25;119:16 science (3) 9:15;121:21,21 scientific (1) 122:7 Scratch (1) 127:15 screen (8) 99:24;100:1,2;102:14; 109:13;116:14;129:2,2 second (18) 30:13,17;31:7;34:22; 37:1,4;42:6,8;66:5;67:9; 76:22;95:5;102:15; 111:6;127:16;128:16;</p>	<p>147:25;154:7 secondly (1) 65:3 SECRETARY (2) 3:4;7:22 seeps (1) 63:24 selected (1) 66:20 semantics (1) 109:10 semi-solids (1) 63:17 Semi-Volatile (7) 88:15;89:14,17;91:22; 92:15,21,25 sense (1) 56:14 sentence (12) 85:10,15,20;104:13; 110:7,23;111:6,7; 118:17;127:7,11,18 sentences (2) 103:4;127:12 separate (1) 106:6 separated (1) 19:14 separating (1) 57:9 separation (5) 19:15;57:8;58:20; 113:10;114:2 series (1) 113:4 set (2) 36:16;103:9 sets (4) 53:3,11;55:8;65:6 settings (1) 89:18 settle (2) 143:10,14 several (5) 10:6;31:11;70:17,17; 135:25 shale (2) 44:12,12 shape (3) 69:15,18,19 sheet (1) 32:16 shells (2) 117:2,12 short (1) 81:6 shortly (1) 154:18 show (19) 20:14;24:4;29:9,14, 15;38:22;39:7,9;40:12; 56:13;64:18;69:14;73:8; 75:16;78:21;90:4;92:2,</p>	<p>15;93:5 shown (5) 41:12;77:2,3,4;79:17 shows (17) 14:22,24;15:10;26:4; 32:16;39:13;40:24; 53:22;68:4,15;69:16; 70:4;79:3;89:23;91:24; 92:16;133:7 side (1) 109:23 sign (1) 155:15 SIGNATURE (1) 155:22 significant (14) 52:10;56:22,23;59:4, 18;63:16;64:23,24;65:1; 68:2;70:19;153:1,2,6 similar (5) 16:8;47:9;55:22;66:2; 77:16 Similarly (1) 73:2 simple (4) 27:14;43:3;105:7,8 simplest (1) 105:2 simplifications (2) 52:1,5 single (6) 37:8;61:3;125:8; 131:21;134:24;135:11 site (6) 13:9;26:3;95:13; 120:7;122:10;126:17 sites (3) 11:4;63:22;79:17 situation (10) 55:8;103:17,25;104:5, 15;105:6;117:17,24; 119:18;149:3 situations (1) 117:20 sixth (2) 47:10;48:10 sketch (1) 15:25 slight (1) 106:9 slightly (4) 71:22;73:2;74:14; 118:17 slower (2) 141:23;144:9 slowly (1) 142:13 slurry (1) 79:23 small (4) 29:1,10;58:23;73:6 smell (2) 55:17;56:10</p>
S				
<p>safety (1) 11:6 saline (1) 145:6 salinity (3) 144:25;145:2,13 Salt (1) 3:8 saltling-out (1) 145:8 same (23) 16:22;27:9;34:1,9,15; 41:12;46:17;53:13; 54:22,22;74:15;75:20; 92:4,21;95:19;96:4;</p>				

sniff (1) 55:16	somewhat (4) 45:6;53:4,10;111:21	specifics (1) 51:2	19;118:2,9;119:2,8; 123:25;124:3	87:5;92:11
soaps (1) 58:12	somewhere (1) 46:24	spectrum (2) 113:8,15	statements (2) 71:20;77:5	summarized (2) 27:6;87:1
solid (12) 53:16;63:7,17;64:5,8, 14,15,15,21;65:11;80:1, 2	sorbent (1) 127:24	spent (8) 46:15;75:21;140:7; 151:3;153:18,20,22,25	states (7) 54:15;60:15;71:21; 73:11;127:21;152:8,9	summarizes (1) 86:17
solids (2) 46:16;80:18	sorry (44) 33:13,16;34:14;37:8; 74:25;85:12;87:2,16,20; 88:4,21;89:21;90:3,16; 91:7,14;96:11;97:12; 98:2,99:3,4;105:22; 108:4;110:18,19;111:1; 112:6,24;114:24; 118:24;122:16,19; 123:13;126:16;127:16; 129:13;130:1;132:25; 134:18;138:24;145:23; 154:9,15;155:11	spin (1) 71:19	steam (5) 58:22,23,24,24;138:19	summary (1) 72:5
solubilities (4) 27:20;47:22;48:25; 117:4	sort (5) 23:19;55:15;74:22; 116:21;150:11	SPLP (1) 85:24	steam-stripping (2) 138:20,24	summed (1) 48:5
solubility (97) 24:23;25:23;26:5,6; 28:6,24;29:6;31:4,10,16; 33:1,3,10;35:13,18; 37:12;38:2;43:13;45:14, 16;52:23;53:9,15,19,20; 54:6,9,11,18;55:6;56:8, 9;65:16;74:3;77:14,15, 19,22,23;83:23;84:3,6; 94:23;100:11,14; 105:19;106:1,9;107:18; 117:22;118:22;119:5,9, 12,13;123:6,16;124:8, 11;126:23;129:7; 130:12,15;131:17,23; 132:2,3,4,12,16,19,20, 23;133:1,5,6,8,16,17,18, 22;134:14,17,19,20,21; 135:17;145:7,10,13,16; 150:18,21;151:22,23; 152:12;153:17	sorts (1) 61:19	spoke (3) 74:13;109:2;135:18	step (1) 80:7	summer (2) 9:24;10:2
soluble (6) 55:18;71:22,22;73:2; 111:17;118:18	source (27) 22:7;24:21;29:24; 30:3,5,7,22;31:3;32:23; 36:25;38:8,14;44:15; 84:11;86:7;87:11;88:9, 22;90:23;91:18,19;93:4, 9,15,22;94:4;154:22	spread (2) 142:4,15	stepping (1) 55:14	summing (1) 61:7
solute (10) 103:15;104:6;108:3,7, 22,23;128:1,2;151:24; 152:1	sources (6) 33:19;36:14;44:13; 45:11;50:6;85:14	spreading (1) 142:16	still (8) 18:10;42:17;81:1; 87:20;89:15;117:21; 143:12,22	sums (1) 56:18
solution (27) 24:24;28:13,14;51:18, 25;52:5;61:24;73:3; 76:6,21;95:18;96:3; 97:16,20,22;98:7,12,19; 101:3;108:8;118:16,18; 119:14,14,17;137:13; 138:5	South (1) 3:7	Spring (3) 7:4;149:4;153:15	stop (1) 93:7	supplied (2) 71:15;78:15
solutions (20) 24:25;25:6,6;40:1,2; 51:15,22;54:16;99:2,11, 13,17;101:4;114:8,21, 22;119:19;145:20; 146:3,4	sorted (1) 125:8	Springs (1) 95:12	straight (11) 39:24;40:3,4;43:22; 70:4;100:16,23;101:2,5, 24;146:18	support (2) 69:10;134:8
solvent (9) 54:8,10;55:2,25;58:3, 7,15;103:8;152:1	sorted (1) 125:8	spun (1) 10:12	stream (1) 138:23	supports (3) 64:3;95:16,25
solvents (1) 86:1	spacing (1) 55:18	square (1) 61:25	strictly (1) 106:17	supposed (3) 91:23;113:11;126:24
sometimes (6) 12:17;112:19,20,22, 24,25	speared (1) 125:8	stacked (1) 142:4	stripping (1) 58:22	suppress (7) 95:17;96:2;123:15; 124:11;138:1,7;139:23
	spears (3) 93:24;106:9;149:25	standard (2) 98:24,25	strongly (2) 103:16;104:8	Sure (15) 22:14,16;23:17;30:2; 38:24;56:20;66:6;74:23; 89:9;104:14;105:17; 116:7;129:6;133:19; 142:8
	speaking (8) 35:2;60:22,23;106:17; 117:7,11;133:11;142:10	standpoint (2) 49:5;106:8	structural (1) 55:22	Surface (1) 144:11
	speaks (4) 60:21;88:24;96:25; 139:7	start (4) 10:18;17:14;27:21; 108:5	structure (1) 55:20	surrogate (2) 51:5;75:13
	Special (4) 10:8,12,18;13:16	started (9) 9:23;10:1,2;11:3; 13:15;21:4;22:5;40:13; 133:5	sub (5) 64:12;65:24;66:24; 67:5,20	swear (1) 7:24
	speciation (4) 87:15,17,19,21	starting (20) 13:14;42:23;50:19,25; 52:17;53:2,10;55:13; 59:20;67:4;75:4,17; 76:20;86:11;116:22; 128:11;133:6;134:5; 135:17;146:23	sub-bullet (2) 30:18;31:8	sworn (2) 7:25;8:7
	specie (23) 21:12;24:17;50:22; 51:5,5;55:4;57:3;59:23; 60:5,9,9;61:14,14,16; 62:12;63:11;92:17; 136:21;137:21;147:6, 16;152:11,18	starts (10) 14:10;27:17;50:6,20; 51:4;96:1;128:15,16; 134:3,16	subscript (1) 64:15	symposium (1) 63:23
	specifically (3) 39:11;65:23;127:3	state (7) 8:11;9:14,16;18:10; 57:5;111:10;129:17	subsidiary (1) 10:8	Synthetic (1) 85:24
	specificity (1) 136:23	stated (7) 67:14;70:23;72:13; 107:25;113:17;129:20; 140:17	substantially (1) 153:4	system (47) 14:12,23;15:13;16:8; 17:12,14;20:24;21:14; 22:25;39:12,14,23;43:4; 50:21;57:19,19;63:10; 105:7,8,9,10;107:25; 108:1,6,11,15,19,21; 111:22;112:1;113:4,17, 19,25;114:1,6,8,11,17, 19,24,25;115:3,10,12; 127:4;137:21
		statement (22) 49:2;62:24;71:25; 72:1,8,21;84:24;85:5,7; 104:21,24;105:4; 111:11;116:21;117:16,	sum (2) 47:24;72:5	systems (10) 12:6,11;43:20;51:13; 55:6;56:5;99:4,6;105:3; 111:3
			summaries (1) 96:21	
			summarily (1) 78:21	
			summarize (2)	
				T
				table (17)

65:20;66:1;67:2,7; 86:13,15,16;87:1,8,9; 91:14,17;152:25;154:13, 20;155:4	150:9	117:13;150:22	96:18;123:5	21;86:15;102:11; 104:25;109:18;115:22
tables (1) 87:5	terms (18) 14:19;17:12;19:9,18; 26:25;27:14;28:13,14; 48:1;52:8;54:7;56:2; 81:2;106:3;141:20; 143:6,14,15	theory (6) 52:2;85:14;98:14; 134:8;148:16,22	tool (1) 26:3	Turning (5) 52:13;61:5;63:3; 76:20,22
talk (6) 16:11,24;89:3;104:12; 109:5;129:5	ternary (46) 14:11,19,21;15:2,10, 12;16:5,6,7,9;17:1;19:7; 20:2,23;21:5,7;22:5,12, 23;23:22;27:18,19,22; 39:14,19,24;40:3,13,23; 41:17;42:25;43:4,9; 69:20;98:14,18;99:21; 108:1;111:19;114:3; 146:16,16,17;147:4; 152:13,15	therefore (5) 46:19;89:14;106:7; 134:6;153:9	top (10) 27:22;30:23;31:7; 67:23;68:3,4;79:24; 80:1;121:25;122:2	turpentine (1) 57:20
talked (4) 23:21;33:15;116:7; 148:9	terpene (4) 14:15;15:4;57:6,8	Thereupon (1) 155:19	topic (1) 129:6	Twenty (2) 120:22,23
talking (19) 33:14;41:24;42:17; 47:20,23;51:16;70:25; 72:3;108:1;109:15,21; 112:1;113:12,14; 128:13;135:9;137:16; 151:4,9	terpenes (2) 57:18;58:25	thermodynamic (1) 103:11	total (7) 90:19;91:13,13; 127:14,22;129:25;130:4	two (42) 15:3;17:1,2,11,19,21; 20:12;28:10,21;34:3; 42:25;43:18;49:11;55:5, 18;56:5;57:12;63:21; 67:21;69:8,8,16;75:10; 76:3;77:11,24;79:17; 94:20;100:17,21;103:12, 19;104:1,16;108:2,6,21; 114:3;138:8;142:9; 152:4,7
Tar (29) 7:4;52:19;53:17,20; 83:23;84:3,6;85:1;86:2; 89:10,20;90:5;91:24; 94:23;96:11,11,11;97:5; 103:18;105:6;120:7; 122:9;124:11;126:17, 23;144:13;145:1; 147:22;151:5	test (39) 55:16,16;86:25;88:14, 18;89:3,19,23;90:3,4,17, 18;91:11,24;92:15,16, 19,21,24;93:1,2,12,14, 21,23;94:14,15,21;95:2, 5;131:12;138:19,20,22, 23,24;148:16,21;150:24	thesis (3) 57:4,7;139:1	toward (3) 45:7;61:16;150:5	type (28) 11:25;12:9,10;13:8; 17:1;19:7,8;22:5;23:22; 24:24;25:11;27:9;39:12, 13,23,24;58:11,17; 107:25,25;108:6,11,14, 18,21;111:3;113:8; 122:5
TCLP (3) 85:23;93:12,23	tested (3) 92:19;148:24;154:3	thinking (1) 52:24	towards (1) 66:17	types (2) 12:1;79:16
Technology (4) 21:21,22;122:7,13	testified (2) 8:7;52:8	third (6) 29:3;30:17;41:22; 43:12;47:3;75:18	to-wit (1) 8:2	typical (1) 13:17
loading (2) 88:5;89:24	testify (1) 138:23	though (4) 68:1;133:20;136:2; 141:3	toxicity (4) 58:6,6;61:18;85:22	typically (4) 51:25;79:22;145:6; 150:15
tells (2) 88:18;89:19	testifying (1) 121:5	thousand (1) 135:14	trace (1) 16:20	U
temp (1) 67:17	testimony (53) 8:2;13:20;33:22; 49:21;52:12,18;53:14, 22;56:19;57:2;59:15,17, 21;61:6;63:3;66:17; 67:14;68:9,12,13;70:13, 16;72:4;73:20,21;75:6,9, 11;78:22;82:6,24;83:21; 84:5,19,21;86:23;91:1,5, 11,16;94:15;95:23;96:1, 10;97:11;98:4;100:20; 108:14,20;125:21,23; 137:5;148:9	thousand (1) 135:14	traditional (1) 14:9	UC (1) 111:8
temperature (15) 53:17;67:10;119:1; 139:17,20,23;140:6,9, 14,16,17;141:5,6; 144:10;152:2	testified (2) 8:7;52:8	thousands (3) 60:3;129:19;137:4	trailling (2) 11:7;101:11	ultrafiltration (1) 127:15
temperatures (6) 67:18,19;140:3,5,21, 25	testify (1) 138:23	threat (2) 149:22;150:6	transcript (3) 70:12,20;71:9	Um-hum (3) 31:9;59:9;60:12
template (1) 27:7	testifying (1) 121:5	three (8) 14:14,23,25;16:12; 17:12;36:13,14;67:6	transfer (3) 95:18;96:2;103:10	unaware (1) 84:13
ten (10) 29:2;41:22;43:12; 45:21;47:2,10;48:6,9; 116:10;141:17	testimony (53) 8:2;13:20;33:22; 49:21;52:12,18;53:14, 22;56:19;57:2;59:15,17, 21;61:6;63:3;66:17; 67:14;68:9,12,13;70:13, 16;72:4;73:20,21;75:6,9, 11;78:22;82:6,24;83:21; 84:5,19,21;86:23;91:1,5, 11,16;94:15;95:23;96:1, 10;97:11;98:4;100:20; 108:14,20;125:21,23; 137:5;148:9	three-component (1) 14:12	transferring (2) 39:18;80:14	unconventional (1) 63:23
tend (4) 138:15;141:22;145:7; 153:23	testing (2) 101:13;132:8	threshold (2) 113:6;114:10	transition (1) 114:14	under (7) 48:13;52:4;88:14; 101:15;102:12,24;103:3
tendency (3) 139:24;152:4,6	tests (20) 86:11,17,25;87:6; 91:23;92:2,11;94:2,7,18; 95:9,12;96:19;97:3,3; 101:13,15;131:14;149:4, 8	thrust (1) 57:7	transport (6) 12:13;144:3;151:12; 153:10;155:3,6	underestimating (2) 134:14,20
tends (4) 105:19;143:9,10,13	testified (2) 8:7;52:8	thumb (1) 117:6	transported (1) 154:25	understood (1) 12:17
term (8) 5:20,24;67:10;99:22; 108:25,25;111:22;113:3	testimony (53) 8:2;13:20;33:22; 49:21;52:12,18;53:14, 22;56:19;57:2;59:15,17, 21;61:6;63:3;66:17; 67:14;68:9,12,13;70:13, 16;72:4;73:20,21;75:6,9, 11;78:22;82:6,24;83:21; 84:5,19,21;86:23;91:1,5, 11,16;94:15;95:23;96:1, 10;97:11;98:4;100:20; 108:14,20;125:21,23; 137:5;148:9	thus (1) 24:10	TRPH (3) 92:4;153:3;155:5	underway (2) 148:16,21
terminology (1)	textbook (5) 54:13,15;96:17; 115:23;122:20	tie (3) 43:2,3,3	true (3) 60:23;63:8;125:24	unique (1) 105:10
	theoretical (2)	tightly (1) 59:11	try (6) 50:22;65:2;91:14,14; 99:5;127:17	unit (3) 78:25;80:6,8
		times (11) 13:11;29:2;41:22; 43:12;45:21;47:2,10; 48:5,9;77:13;141:17	trying (11) 21:22;49:12;62:25; 63:1;64:19;110:19; 134:25;140:22;146:21; 147:8,14	units (1) 79:17

University (4) 9:14,16;18:10;57:6 unlike (1) 56:3 unprocessed (2) 44:10;86:2 unsaturation (1) 56:3 unsubstantiated (1) 72:12 up (41) 11:3;12:25;14:4; 23:18,19;25:14;36:10; 37:10;39:9;45:16,21; 47:9,25;48:19;50:8; 53:3,11;54:4,55:8; 56:13,18;63:15;65:6; 67:1,3;69:15;76:4,15; 77:14;79:3;99:21,23; 100:4;102:14;109:12; 130:5,11,22;131:6; 132:12;149:9 upon (1) 127:14 upper (9) 16:17;17:3;28:2,2; 30:6,8;35:7,8;42:6 use (20) 25:11;47:6;51:18; 55:1;57:24;62:23;68:20; 74:4;78:20;79:6,14; 108:18;116:5;131:16, 21;135:2,19;150:10,16; 152:14 used (40) 18:6;19:22;21:16; 22:8,10;24:20;28:21; 29:24;30:3,7;31:17; 36:3,9,10,24;37:11; 38:15;44:2;50:11;52:1; 55:24;58:9;62:5,8;63:9; 67:13;75:6;79:16;103:8; 108:2,7,21;131:19; 132:4,4,16,17,19; 135:23;138:25 useful (1) 14:20 user (1) 150:12 uses (8) 52:9;54:13;60:24; 64:13;65:20;67:2;77:17; 133:18 using (13) 14:13;24:23;45:13; 46:12;47:5;58:12;67:11; 75:15,15,23;85:22;86:1; 134:21 usually (4) 93:1;143:6,8;150:10 Utah (5) 3:8;7:3,8;18;63:22,23 utilization (1)	14:11 utilize (2) 18:14;75:19 utilized (2) 37:24;74:1 utilizes (1) 150:12 utilizing (4) 32:8;73:25;74:15; 77:20 <div style="text-align: center;">V</div> vacuum (4) 79:18,23;80:10,11 valid (1) 25:11 validated (1) 12:24 validity (2) 49:19;60:1 valuable (1) 14:17 value (25) 30:9,23;31:15;32:7,7, 15;35:11,14;45:12;47:5, 10,25;60:1;65:19;66:1,1, 19,22;67:4,5,20;133:9, 11;148:12;149:25 values (16) 28:25;31:12,14;35:14; 36:9;37:1,25;38:9,18; 42:19;50:8;60:25;70:6; 75:20;87:15;152:19 vapor (18) 59:4,5;64:6;73:11; 139:12,16,20;141:9,11, 20;142:18,25;143:4,5,5, 23;144:6,18 variable (2) 111:22;113:2 variety (1) 122:5 various (6) 27:21;36:7;58:22; 64:7;92:22;152:17 vary (1) 139:18 vastly (1) 78:2 velocity (1) 142:21 Vernal (1) 63:22 versus (1) 49:9 vessels (1) 59:11 video (3) 7:1,1,9 VIDEOGRAPHER (19) 3:10;42:10,13;66:9, 12;76:9,11;81:8,11;	110:12,15;120:12,14,17; 128:2,1,24;148:2,5; 155:16 view (3) 50:21;52:9;57:23 viewed (2) 60:18;96:22 virgin (7) 21:18,22;44:9;46:2; 95:20;96:5;147:17 visited (1) 63:22 vital (1) 103:6 volatile (10) 59:2,3;88:15;89:13, 16;91:22;92:14,16,19,25 volatility (3) 58:19;92:23;139:7 volatillize (1) 58:21 volume (2) 117:1,18 <div style="text-align: center;">W</div> wait (3) 37:1;148:15,21 walk (3) 41:10;42:18;74:22 Walker (64) 7:17,17;81:15;82:24; 83:8;86:21;87:2,4; 90:11,13;91:2;92:13; 94:13;100:3;102:3,5,10, 16,22,23;103:2;106:19; 110:7,11,19,21,25; 111:2;115:25;116:7,16; 117:15;120:5,19,23; 121:1,4,9,12,15,16; 123:1;125:11,18,24; 126:1,6,9,12;127:5,20; 128:9;129:4,13,16; 130:14;131:4;148:7; 149:12;154:8,12,19; 155:8,13 washed (2) 19:19;147:16 washing (1) 147:18 waste (4) 10:10;11:8;85:8,18 Water (121) 7:3;14:14;16:8,15; 19:23;20:2;21:9,23,24; 22:24;23:24;24:11; 27:25;28:5,6,24;29:7; 31:4,10,15;32:7,16;33:1, 10;35:13,18;37:12;38:3; 40:7;41:21,25;43:13,17; 44:9;45:18;47:14,15; 48:7;53:17;54:17;59:1; 61:8;62:7;76:24;80:24;	81:24;83:24;84:3,7; 85:3,13;88:7,21;94:23; 95:20;96:4,12;100:11, 14;104:19;105:12,20,25; 106:1,6,10,21,23;107:2, 8,10,11,18,21,21;109:6, 8,9;111:15,25;112:15, 16;114:21;115:8,9,16; 118:4,10,13,24,24; 119:5,9,12,13;123:16; 124:11;126:23;127:4; 129:8;133:22;136:7,11, 16,19,25;141:16,17,20, 23;144:25;145:1,13,14, 17;147:7,17;150:4,11, 12;153:16 water-rich (8) 17:5,18;19:13;40:8,9; 41:2,21;43:25 water-terpene (1) 59:1 way (18) 23:3,5,11;49:8;52:4; 72:11;75:2;86:4;88:25; 103:16;104:8;109:20; 115:19;131:9;139:19; 144:16;145:5;152:9 website (5) 32:5;33:18,20;36:6,6 week (2) 116:2,3 weight (5) 45:7;46:18,20;75:22, 23 weighted (1) 130:20 weights (1) 76:4 weren't (1) 98:18 what's (18) 15:20;18:18;22:20; 24:21;32:2;35:25;37:20; 40:19;58:18;68:13;72:3; 78:11;100:23;115:23; 118:22;137:13;146:15; 152:23 whereas (2) 17:9;61:3 Whereupon (17) 7:25;8:1,20;15:17; 18:15;22:17;26:13; 31:24;34:19;35:22; 36:17;37:16;40:16; 44:18;74:7;78:8;120:8 Whitehall (1) 8:14 whole (3) 23:11;80:21;88:4 William (1) 3:12 wind (4) 142:22,23;144:4,8	within (3) 72:8;152:5,20 without (1) 130:8 witness (35) 7:24,25;8:6;25:19; 34:11;41:20;83:2;86:19; 90:10,12;92:7,9;94:11; 106:16;110:3,10;116:10, 13,19;117:11;120:10; 122:23;125:7,12,16; 126:24;127:2;128:8,18; 129:12,14;131:2;133:4; 135:21;154:17 witness's (2) 86:23;125:20 wonder (1) 38:21 wondering (6) 88:18;103:17,22; 122:12,16,19 wonderment (1) 103:23 word (1) 105:16 words (1) 63:1 work (36) 8:24;10:5,8,23,24; 11:7,18,21,22,24;12:3,7, 8,9,10,16;13:3;14:1,1, 26;24;27:11;36:3;52:15, 16;60:21;62:19;64:19; 75:21;78:15;83:11; 101:15;138:22;139:1; 148:9;150:16;155:10 worked (7) 9:25;10:1,3,17,25; 11:1;57:6 working (2) 10:10;57:16 works (1) 13:22 world (6) 52:25;61:1;132:6; 137:17,20,20 world-based (1) 27:10 WQ (1) 7:3 written (1) 101:20 wrong (1) 108:4 wwwepagov (1) 33:19 wwwinchemorg (2) 33:9;36:6 wwwsciencemagorg (1) 36:25 WZ (1) 111:9
---	---	---	---	---

Y				
year (3) 63:22;82:8,9				
years (3) 10:4;18:6,7				
yield (1) 40:4				
Z				
zero (2) 43:14;116:17				
zoom (5) 69:4,6;79:2;102:20; 109:25				
zoomed (1) 74:24				

