Exhibit 162

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF NORTH CAROLINA

IN RE:	) No. 7:23-cv-00897
CAMP LEJEUNE WATER LITIGATION	)
This Document Relates To: ALL CASES	)

VIDEOTAPED DEPOSITION
OF
HOWARD HU, M.D., M.P.H, Sc.D.

TAKEN AT: Keller Rohrback
LOCATED AT: 1201 3rd Avenue, Suite 3200
Seattle, WA 98101

WEDNESDAY, APRIL 30, 2025
10:24 a.m. to 7:53 p.m.

REPORTED BY: Cynthia A. Kennedy, RPR, CCR
Washington CCR No. 3005

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I N D E X

In re: In re: Camp Lejeune Water Litigation
No.: 7:23-cv-00897
Date: Wednesday, April 30, 2025

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(NOTE: All quotations from exhibits are reflected in the manner in which they were read into the record and do not necessarily denote an exact quote from the document.)

BE IT REMEMBERED that on WEDNESDAY, APRIL 30, 2025, at 10:24 a.m., the VIDEOTAPED DEPOSITION of HOWARD HU, M.D., M.P.H, Sc.D., was taken before Cynthia A. Kennedy, Washington State Certified Court Reporter. The following proceedings took place:

THE VIDEOGRAPHER: We are now on the record. My name is Shreve VanZanten. I am the videographer for Golkow.

Today's date is April 30th, 2025, and the time is 10:24 a.m. Pacific Time. This is -- this video deposition is being held in Seattle, Washington, at 1201 3rd Avenue, Suite 3400.

This deposition is taken in the matter of camp Lejeune versus the United States of America for the United States District Court for the Eastern District of North Carolina.

The deponent is Dr. Howard Hu.

All counsel will be noted on the stenographic record. The court reporter is Cindie Kennedy and will now swear in the witness, and then counsel may proceed.

THE STENOGRAPHIC REPORTER: Would you raise your right hand, please?

Do you solemnly swear or affirm that

the testimony you give shall be the truth, the whole truth, and nothing but the truth?

THE WITNESS: I do.

THE COURT REPORTER: Thank you.

MS. KLIMEK: First, I'd like to state for the record we received from plaintiffs' counsel yesterday some additional studies that counsel says are materials considered by Dr. Hu. We have not had time to review these materials, and we reserve the right to reopen this deposition at a later date to address the late disclosed materials.

HOWARD HU, witness herein, having been duly sworn by the Certified Court Reporter testified under oath as follows:

EXAMINATION

BY MS. KLIMEK:

Q. Good morning, Mr. Hu -- Dr. Hu. I know I've introduced myself, but for the record, my name is Amy Klimek and I represent the United States.

Could you please state your full name for the record?

A. Howard Hu.

Q. And your current business address?

A. The University of Southern California, 1845 North Soto Street, Suite 225D, Los Angeles, California 90032.

Q. Thank you. I recognize you've been deposed before, but I'd still like to go over some preliminary deposition so we're all on the same page.

First and foremost, you understand that you just took an oath to tell the truth, correct?

A. Yes.

Q. And you understand that this is the same oath that you would take in a court, subject to the same penalties of perjury?

A. I understand.

Q. I will ask questions, and please answer them to the best of your ability. If you don't understand a question, please let me know and I can rephrase.

A. Will do.

Q. If you don't ask for a clarification on a question, I'm going to assume you understood it; is that fair?

A. Yes.

Q. Okay. During the deposition, the court reporter is going to record and transcribe everything that we say. So to make their job easier and make

sure we have a clear record, I ask that you answer everything verbally. So if it's a yes-or-no question, please answer yes or no as opposed to shaking your head yes or no.

A. Yes.

Q. Okay. In normal conversation, it's difficult that you may understand what I'm going to ask but before I can complete the question, but for the record, if you could let me complete the question so the court reporter can get it all down, and I will do the same when you answer your questions.

A. Understood.

Q. Please talk at a reasonable pace like the pace I'm speaking at now so the court reporter can get everything down.

A. Okay.

Q. Objections, during the deposition, you may hear counsel object to a question. I ask that you answer the question unless they instruct you to do otherwise.

A. Yes.

Q. Breaks, we can take a break at any time if you'd like to take a break. The only thing I ask is if there's a question pending, that you please answer the question before we take the break.

A. Yes.
Q. Is there any reason you may not be able to give truthful and accurate testimony this morning?
A. No.
Q. Any reason your memory might be impaired today?
A. No.
Q. Not currently taking any type of medications that might impair your ability to testify?
A. No.
Q. Okay. I'm going to show you and mark for Exhibit 1, this is a copy of your subpoena.
MS. KLIMEK: This one's going over here. Okay.
(Whereupon Exhibit 1 was marked for the record.)
Q. Do you recognize this document, Dr. Hu?
A. I do.
Q. And you recognize this as the subpoena notice of deposition for today?
A. I do.
Q. If you turn your attention to attachment A near the end of the document, do you recognize attachment A?
A. Yes.

Q. Did you review this production of documents request that's set forth in attachment A?

A. At one point, yes.

Q. Okay. And do you have any responsive documents to produce?

A. Not any more than have already been produced.

Q. Okay. And just walking through this, the first request starting with number 1, you have no communications from Morris Maslia or David Savitz; is that correct?

A. Correct.

Q. And number 2, all emails, letters, correspondence, text messages, conversations, chats, voice mail, technical files, other communications pertaining to Camp Lejeune from the 10 individuals listed?

A. Correct. Nothing.

Q. Have you ever had any communications with anyone outside of counsel about Camp Lejeune?

A. I served on the Board of Population and Public Health for the National Academy of Sciences about maybe 10 years ago, and we actually commissioned and reviewed the ATSDR study of Camp Lejeune. So that's my first familiarity with Camp Lejeune.

Does that --
Q. So --
A. -- answer the question?
Q. Yes. At that time, did you have communications with David Savitz?
A. No.
Q. Okay. And you're -- we're talking about the 2009?
A. Yes.
Q. Okay. Have you had any other communications with anyone, any of the other experts who have been retained in this matter?
A. The ones listed here?
Q. No. It would be some of the plaintiffs' experts.
A. At some point I talked with Dr. Dean Felsher.
Q. Okay.
A. But I can't remember if it's about this particular litigation.
Q. Okay.
A. He and I are colleagues.
Q. Okay. And then number 4, we were given -- as far as invoices, we were given some documents here today.

To your knowledge, do those represent all the invoices to date --

A. I believe so.

Q. -- for your services?

A. Sorry. Yes, I believe so.

Q. Okay. What did you do to prepare for today's deposition?

A. I reread my own reports. I reread some of the primary research articles that I referenced. I read the recent -- recent pre-publication manuscript by Xu, et al., that regards to the UK Biobank study of BTEX. And I had a meeting with plaintiffs' counsel yesterday.

Q. And was that the only time you've met in person with plaintiffs' counsel?

A. We met once in Los Angeles in person.

Q. Okay. And how long was yesterday's meeting?

A. Three hours. Three and a half hours.

Q. It was an in-person meeting?

A. Yes. And then we had lunch.

Q. And then in Los Angeles, who did you meet with? Same individuals?

A. Present company and a few other lawyers.

Q. Okay. Do you recall the names of the other

lawyers who were at that meeting?

A. I think Patrick Talan was there. And one other attorney whose name just escapes me as I'm sitting here.

Q. Okay. And was that a several-hour meeting, too?

A. Yes. And we were supposed to have lunch, but Patrick forgot to prepare it, so we didn't.

(Stenographic reporter clarification.)

THE WITNESS: Forgot to order lunch, so we didn't have lunch.

MS. KLIMEK: I think he's online. And --

MR. TALAN: I'll admit to it.

BY MS. KLIMEK:

Q. How did you first learn about this matter, the Camp Lejeune litigation?

MS. GREENWALD: Objection. Asked and answered.

A. I was contacted by Attorney Talan.

BY MS. KLIMEK:

Q. Attorney Talan. Okay.

And when did he first contact you? Do you know the date?

A. I don't recall, but maybe --
Q. A month even?
A. -- a year and a half ago or so.
Q. A year and a half ago. Okay.
(Stenographic reporter admonition.)
THE WITNESS: I'm sorry.
BY MS. KLIMEK:
Q. And were you retained in this litigation a year and a half ago?
A. Yes.
Q. Okay. And Patrick Talan was the one who retained you?
A. He was the one -- I was representing the plaintiffs, and he's the one I worked with. I wouldn't know if he officially was the entity that retained me.
Q. Okay. Did you perform any work in connection with this matter prior to executing a retainer agreement?
A. No.
Q. Okay. When you were first retained, what information were you provided with at that time?
A. Just a verbal description of the Camp Lejeune Act and the general aims of the litigation.

Q. And what were the aims of the litigation?
MS. GREENWALD: Objection. Form. It's attorney-client privilege. I mean expert privilege.
MS. KLIMEK: You're instructing him not to answer?
MS. GREENWALD: I mean, are we really going to go into conversations now that we have with our experts? I mean, I --
MS. KLIMEK: Uh-huh. Yep.
BY MS. KLIMEK:
Q. Were you provided with containment exposure levels in any way -- I'm sorry, contaminant exposure levels?
A. Well, I think once I was retained, I was provided with some reports that provided details of exposures at Camp Lejeune.
Q. Okay.
MS. KLIMEK: And again, I need to go back. Are you instructing him not to answer?
MS. GREENWALD: I am until I understand what the rules are here, but I have never seen any depositions in the past that have allowed questions about conversations between counsel and experts under the new federal rules. So if you can

explain to me why you think it's okay to ask those questions, I'm all ears.

MS. KLIMEK: Okay. We can move on.

MS. GREENWALD: All right.

BY MS. KLIMEK:

Q. Did you receive any written materials? Did you receive any written materials during that meeting?

A. Which -- which meeting? I'm sorry.

Q. This would have been the first meeting that you had when you were retained in this matter.

A. In person or by Zoom?

Q. Either.

A. Okay.

Q. Were you given -- when you were retained, were you given documentation?

A. Yes.

Q. And were you given studies, or did you get a copy of the Act, the Camp Lejeune Justice Act?

A. I can't recall if I actually received a copy of the whole Act, but I remember receiving a copy of the ATSDR report that detailed their assessment of Camp Lejeune.

Q. Okay. Was anything -- everything that you received added to -- or -- in your materials considered list that you provided?

A. I believe so.
Q. Okay. And did you provide counsel with any materials prior to your retainment?
A. Not that I'm aware of except my CV and rate sheet.
Q. Okay. Before we go further, I'd like to establish a few abbreviations that I'll be using today, and I hope that we can agree to these.
When I say "NHL," I'm referring to non-Hodgkin's lymphoma.
A. Okay.
Q. When I say "TCE," I'm referring to trichloroethylene.
A. Okay.
Q. When I say "PCE," I'm referring to tetrachloroethylene or perc -- or perchloroethylene.
A. Okay.
Q. When I say "IARC," I'm referring to the International Agency for Research in Cancer.
A. Okay.
Q. When I say "NTP," I'm referring to the U.S. Department of Health and Human Services National Toxicology Program.
A. Okay.
Q. And when I say "EPA," I'm referring to the

United States Environmental Protection --

A. Okay.

Q. -- Agency.

A. Okay.

Q. You filed two reports in this matter, correct?

A. Yes.

Q. And I'm going to go ahead and mark these two reports now as Exhibits 2 and 3. And I'll hand you copy.

(Whereupon Exhibit 2 was marked for the record.)

The first report is titled, "General Causation Expert Report of Dr. Howard Hu."

(Whereupon Exhibit 3 was marked for the record.)

And you also filed a supplemental report dated January 31st, 2005, entitled, "Supplement to December 9th, 2024 General Causation Expert Report of Dr. Howard Hu."

Correct?

A. Correct.

Q. Throughout the deposition, I'm going to be referring to your December General Causation Report as "report" And if I reference your supplemental report,

I will call it a "supplemental report."

A. Okay.

Q. Is that agreed?

A. Yes.

Q. And I would like to now turn to Appendix A of your report.

And is this a current -- most current copy of your CV?

A. Well, my CV gets updated every week or two with a new publication or presentation. So I wouldn't say it's absolutely current, but it's current as of the date on the CV, November 24, 2024.

Q. What publications have you had since December 2024 that would not be listed?

A. I'd have to go to my computer files to draw up my current CV to answer that truthfully.

Q. Could we get a copy of your current CV today?

A. Of course.

Q. Okay. Any additional educational experiences?

A. Yes.

Q. Okay. That would also be on your current CV?

A. Yes.

Q. How about testimony as an expert? Have you testified in any cases that would not be listed on the CV we were provided with?

A. I don't think I listed testimony on my CV. I think that was a separate document.

Q. I think it was Appendix B, is deposition and trial.

A. Okay. Can you repeat the question, please?

Q. Is there any additional since not reflected on this appendix -- are there any other updated where you served as an expert witness since?

A. Yes.

Q. In what case was that in?

A. It was a case brought by a group of plaintiffs against the State of Connecticut in relation to radon exposure experienced at a medium security prison in Connecticut.

Q. Okay. And is that litigation ongoing?

A. Yes.

Q. Do you know the name of the litigation?

A. Not off the top of my head.

Q. Okay. Would that be reflected on your most current CV?

A. No.

Q. Okay. We can follow up with you later for

that case.
A. Sure.
Q. Dr. Hu, do you maintain an active medical license?
A. I do.
Q. Do you see patients still?
A. Sometimes.
Q. Is your primary focus on research or patient care?
A. Research.
Q. Research. Okay.
You're not an oncologist, correct?
A. I am not.
Q. No medical training in oncology?
A. Well, as part of my internal medicine training, we rotate through a cancer service. So we do have training in oncology.
Q. Okay. Have you ever published peer-review articles specifically addressing the potential association of TCE and NHL?
A. No.
Q. Have you ever published peer-review articles specifically addressing the potential association between PCE and NHL?
A. No.

Q. Have you ever published peer-review articles specifically addressing the potential association between benzene and NHL?

A. Benzene, but not in relation to NHL.

Q. Prior to being retained in this litigation, had you ever conducted any type of research focused on the potential relationship between TCE, PCE, benzene, and NHL?

A. No.

Q. And we briefly just spoke about this, but from 2009 to 2012, you were a member of the board on the Environmental Studies and Toxicology at the National Research Council, correct?

A. Correct.

Q. And as part of that, you served as a report reviewer, correct, for the National Research Council?

A. Yes.

Q. Would you agree that reviewing those reports is a -- kind of a rigorous process being on those committees?

MS. GREENWALD: Objection. Form.

A. More or less, yes.

BY MS. KLIMEK:

Q. Okay. And I noticed on your CV, you are currently on a sabbatical; is that correct?

A. Correct.
Q. And it was a one-year sabbatical?
A. Yes.
Q. What are you doing during this one-year sabbatical?
A. Writing a lot of grants and hoping they get reviewed.
Q. Okay.
A. And doing my usual research.
Q. And the sabbatical ends in June of this year, correct?
A. Yes.
Q. And what are you doing after the sabbatical ends?
A. I'll be continuing my research, and I'll be returning to teaching.
Q. Okay. And teaching at which university?
A. University of Southern California.
Q. Okay. If you can turn to Appendix C of your report, this is a list of your consulting fees.
Is this the most current -- does this accurately reflect the fees that you are charging in this case?
A. Yes.
Q. Okay. Do you recall how much you've been

paid in preparing your reports and preparing for the deposition today?

A. Both of those things or just --

Q. Preparing your report. Let's start with that one.

A. Total? I'm just guessing, but maybe $40,000 or so.

Q. Okay. You've also been retained as a specific causation expert in this litigation in relation to two NHL plaintiffs; is that correct?

A. Two plaintiffs, and -- I don't recall specifically which cancers they had, but I have no reason to disagree with you.

Q. Okay. And have you kept your invoicing separate? So would you have invoices that relate to general causation phase and invoices that relate to the specific causation phase?

A. I'm not sure.

Q. Okay. Can you refer to your supplemental report?

On page 1 of the report, it says that you are supplementing your general causation report based on information that, quote, "recently appeared in the peer-reviewed literature that you did not have an opportunity to incorporate into your earlier report."

Did I read that correctly?

A. Yes.

Q. And the literature that we are referring to is the Camp Lejeune Cancer Incident Study con- -- is that correct?

A. Correct.

Q. When you drafted your initial December report, did you have any knowledge of the 2024 Bove Cancer Incidence Study?

A. No.

Q. How did that study come to your attention?

A. Counsel forwarded it to me.

Q. So counsel forwarded it to you after you had completed your December report, correct?

A. Correct.

Q. I'm going to hand to you your materials considered list, which we will be marking as an exhibit.

(Whereupon Exhibit 4 was marked for the record.)

Do you recognize this document?

A. I do.

Q. Does the materials considered list include all the materials you considered at the time you wrote your reports?

A. I believe so. And it also includes apparently publications I cited that I myself was involved in.

Q. Let me check something.

It's a -- 12 pages, correct?

A. Correct.

Q. Okay. I briefly asked you about this, but as far as other expert reports, you indicated that you had talked to Dr. Felsher, correct, as a colleague?

A. Yes.

Q. But did you specifically speak to him about the litigation?

MS. GREENWALD: Objection. Asked and answered.

A. Not that I recall.

BY MS. KLIMEK:

Q. In association with your general causation assignment, did you review any water contamination related reports submitted by either party?

A. I believe I did.

Q. Which reports did you review; do you recall?

A. There was a report, I believe, by Morris.

Q. Morris Maslia?

A. That's correct. And then, of course, ATSDR

had within its report a discussion of the monitoring results.

(Stenographic reporter clarification.)

THE WITNESS: Of course.

A. In ATSDR's report, it had a discussion of the monitoring results.

Q. Did you review any of the United States' expert reports? Dr. Remy Hennet? Dr. Alex Spilotopoulos?

A. Say those names again, I'm sorry.

Q. Remy Hennet and Dr. Alex Spilotopoulos.

A. Okay. Not that I recall.

Q. Okay. In rendering your general causation opinions, did you rely on any facts provided by another expert in the case?

A. Not that I recall.

Q. And did you rely on any data provided by another expert in the case?

A. Not that I recall.

Q. Since you've prepared your reports, have you reviewed any of the subsequently filed expert reports for -- in the litigation?

A. Maybe. I'm sorry, I'm trying to remember. I may have.

Q. Okay. You don't specifically recall which reports you may have reviewed?
A. No.
Q. Okay. In writing your report, did you have any assistance --
A. No.
Q. -- with writing it?
Did you copy any material directly out of any other reports?
A. I may have paraphrased them, but I don't recall outright copy and pasting.
Q. Do you recall copying any sentences directly from Dr. Mallon's leukemia report?
A. Mallon?
Q. Yes.
A. Not that I recall.
Q. Okay. So you wouldn't know why identical sentences appear in both of your reports?
A. If you can point out the actual text, that might refresh my memory.
Q. If you could turn to page 24 of your report.
A. The general (indiscernible cross talk) --
Q. General causation. Yes, sir.
And then if you could -- Dr. Mallon's

report, pages 39-40.

A. I don't have a copy of that.

Q. Okay.

MS. O'LEARY: It's right here.

A. Yes. I'm introducing Dr. Mallon's report as Exhibit 5.

(Whereupon Exhibit 5 was marked for the record.)

A. 39-40?

Q. 39. It's the conclusion, "PCE exposure at least as likely as not causes leukemia." I'm looking at that section.

Okay. And I'm starting in that second line. I'm reading from Dr. Mallon's report.

"Due, in part, to the fact that leukemia is a relatively rare disease and that other than history, there are no tools, example, biological markers, with which to assess historical and/or cumulative exposure to TCE; and even" --

MS. GJONAJ: I don't see where you're reading from.

MS. GREENWALD: I don't know.

MS. KLIMEK: Dr. Mallon's report, page 39. Dr. Timothy Mallon's report. The conclusions section.

A. Well --

MS. GREENWALD: Oh, you started in the middle.

MS. KLIMEK: Started with the second --

MS. GREENWALD: Okay.

MS. KLIMEK: Well...

A. Well, what I can say is that I have not seen this report by Dr. Mallon. And I agree there's some overlap there, but if anything -- I mean, I wrote this by myself. Perhaps Dr. Mallon looked at my report. But I can't explain other than that there -- the coincidence of being some overlap in the wording.

BY MS. KLIMEK:

Q. Okay. You're aware that Dr. David Savitz is an expert in the -- for the plaintiffs in this case, correct?

A. Yes.

Q. Is Dr. -- Dr. Savitz is an authority in the field of epidemiology, correct?

MS. GREENWALD: Objection. Form.

A. He's well-published. He's an editor in the field and is generally recognized as an authority, yes.

BY MS. KLIMEK:

Q. And in your report, you cite to two of his publications, I believe.

A. Yes.

Q. Have you cited to Dr. Savitz's works in any scientific materials that you've authored?

A. In any scientific materials? You mean like, I might -- I mean, I've published over 400 peer-reviewed articles. I might have cited some of his work.

Q. Okay. Are you familiar with any of his texts in epidemiology?

A. I believe I've seen them, even read parts of them.

Q. One of his books is "Interpreting Epidemiological Evidence: Connection (sic) Research to Applications."

Are you familiar with that publication?

A. I've seen it.

Q. Would you agree that it's a reliable authority in the field of epidemiology?

MS. GREENWALD: Objection. Form.

A. I mean, I believe it's a important contribution to epidemiology. I don't necessarily agree with everything that's in the book, but it is considered a reference in epidemiology.

BY MS. KLIMEK:

Q. Are you familiar with Dr. Savitz's book, "Interpreting Epidemiological Evidence: Strategies for Study Design and Analysis"?

A. I don't specifically recall that one.

Q. How about Dr. Savitz's book, "Epidemiology and the Law"?

A. I am not familiar with that one.

Q. Prior to this case, have you ever served as an expert witness with Dr. Savitz?

A. I believe I've been an expert witness in a case where he was on the defense side and I was on the plaintiff side.

Q. Okay. I want to go back to your report. If you could turn to page 4 of your report.

The very top of the page, you indicate that your report is being produced in response to a request for a medical expert opinion on three issues; is that correct?

A. Correct.

Q. And you list the three issues below, correct?

A. Yes.

Q. You were told that TCE, PCE, and benzene were in the water at Camp Lejeune, correct?

MS. GREENWALD: Objection. Form.

A. Correct.

BY MS. KLIMEK:

Q. Who initially told you that?

A. To my best recollection, it was Attorney Talan.

Q. On page 7 and 8 of your report, you state that it's your understanding that the water at Camp Lejeune was also contaminated with vinyl chloride, correct?

A. Yes.

Q. But you didn't offer opinions in your report on vinyl chloride, correct?

A. Correct.

Q. Okay. I'd like to ask you a few questions about the methodology that you used to arrive at your opinions.

A. Okay.

Q. On page 6 of your report, you state that to conduct your expert evaluation, you reviewed the relevant peer-reviewed scientific literature and reports of international and national agencies; is that correct?

A. Yes.

Q. How did you identify the agency reports

that you reviewed?

A. Well, I was aware of some of them even before the litigation, and then I did a search.

Q. Okay. Did plaintiffs' counsel provide you with any of the agency reports?

A. They provided me with the ATSDR report. I believe the others I dug up myself.

Q. Okay. And how did you identify with the search?

A. I usually use PubMed. I also use Google. I use some artificial intelligence search machines.

Q. And did you -- was it -- you used those resources for both agency reports and studies?

A. I'm sorry, I used those resources for --

Q. To identify --

A. -- my reports.

Q. I'm sorry. To identify relevant agency reports?

A. Yes.

Q. As well as relevant studies, correct?

A. Yes.

Q. Did you only review peer-reviewed scientific literature?

A. For the most part, yes.

Q. Okay. And then you've used the term

"relevant."

What criteria did you use to determine if a piece of literature or a study was relevant?

A. Well, it had to be focused on the subjects at hand; non-Hodgkin's lymphoma, benzene, trichloroethylene, perchloroethylene, some of the mechanistic research that might pertain to any of those relationships, as well as the epidemiology. And that's what I can think of off the top of my head.

Q. Would you be able to replicate the searches that you conducted?

MS. GREENWALD: Objection. Form.

A. Of course.

BY MS. KLIMEK:

Q. Okay. How would you be able to replicate the searches? Do you have them written down?

MS. GREENWALD: Same objection.

A. Well, I would re-interrogate the sources that I mentioned, which are online, with the search terms that are relevant. I would also add that some of the references that I identify and read as part of that search will have their own references that will sometimes lead me to additional evidence that I may not see on the primary search.

So there's a whole process that I followed,

and I could replicate it if necessary.
BY MS. KLIMEK:
Q. Okay. Did you document your search?
A. I made a list of the citations, and then I downloaded the primary articles using my access to university library systems at the University of Southern California and the University of Michigan, as necessary.
Q. Did your search terms only retrieve studies that had found a positive association with NHL?
A. No.
Q. So you reviewed studies that found no positive association with NHL?
MS. GREENWALD: Objection.
A. Well, if what you mean by positive association is -- and is what apparently is a positive association that is statistically significant or not statistically significant, correct. I viewed any study that examined the relationship in question.
BY MS. KLIMEK:
Q. Why did you not include these studies in your report?
A. Well, first of all, the studies that include negative findings, or the lack of positive findings, are also included in the systematic reviews

and meta-analyses that I reviewed. So I would not say my report ignores them. In fact, it includes them insofar as those peer-reviewed systematic reviews and meta-analyses included those results in the summary analysis.

Q. Okay. You did pull out and talk about individual studies, correct, that were not meta-analysis or part of the systematic review?

A. Mostly studies that appeared after the systematic reviews and meta-analyses as an additional information that came to light since they were published.

Q. On page 6 of your report, you state that you "evaluated each relevant study and report by looking at several factors." This would be the second sentence under the methodology.

The factors that you identified were statistical significance, potential for bias, quality of methodology, and study design. Then you say, "among other criteria."

What would the other criteria be?

A. Potential for confounding, whether they were cohort studies or case-control studies, whether there was biological monitoring that was used for exposure assessment. I could go on, but those are

just --

Q. Okay.

A. -- examples of other criteria.

Q. Did you consider statistical significance to be the most important factor?

A. Absolutely not.

Q. And did you provide an analysis for each study that you cite outside of the meta-analysis as to the factors that you rely on in your report --

MS. GREENWALD: Objection. Form.

BY MS. KLIMEK:

Q. -- as to those factors?

MS. GREENWALD: Okay. Objection. Form.

A. Other than what I wrote in my reports? No.

BY MS. KLIMEK:

Q. In this litigation, have you assigned the weight to the factors as you would be -- as -- I'm sorry.

In this litigation, have you assigned the weight to the -- these same factors as you would in conducting research, so outside of the litigation context?

A. I guess you could say that's roughly true.

Q. If an agency, such as IARC or the NTP, had

produced a review of the same studies and their monographs, did you consider IARC or the NTP's assessment of the study's quality and evaluation?

MS. GREENWALD: Objection. Form.

A. Can you repeat the question?

BY MS. KLIMEK:

Q. Yep. If the agency, such as IARC or NTP, had conducted a review of the same study that you cite into your report, did you consider their evaluation and assessment of the study's quality in your evaluation?

A. Yes.

Q. You did not apply the weight of the evidence approach in your report, correct?

MS. GREENWALD: Objection. Form.

A. I would disagree with that.

BY MS. KLIMEK:

Q. You assigned varying levels of importance to studies based on their design methodologies and limitations?

A. Well, I assigned relative weights to the evidence according to the so-called Bradford Hill considerations, so taking the scientific evidence as a whole.

Q. Are you familiar with the term "publication

bias"?

A. Yes.

Q. Did you account for this in your review of evidence for causation of NHL?

A. Well, once again, I reviewed the systematic reviews and meta-analyses that were done. The systematic reviews contained specific methodology for evaluating for publication bias, and I reviewed those metrics in those systematic reviews to understand the quality of the evidence.

Q. Approximately how much time did you spend doing literature searches?

A. I -- 20-plus hours. I can't really give you an estimate as I sit here today.

Q. Okay. Approximately 20-plus hours?

How much time did you spend, once they were identified, reviewing and analyzing the literature? Or is that included in that 20-plus hours?

A. That's included, yes.

Q. Okay. For animal carcinogenicity studies, did you focus on certain types of studies?

A. I looked at whatever evidence there was available. You mentioned animal studies, so whatever species of animals, whatever exposure conditions, as long as they were relevant to the subject at hand.

Q. So did you review bioassays?
A. Are you referring to things like the Ames assay, DNA mutation assays, or other in vitro assays?
Q. Essay -- bioassays that may not have been included in the IARC and NTP.
MS. GREENWALD: Objection. Form.
A. Well, I certainly tried to look at whatever experimental evidence was relevant to the subject at hand that appeared subsequent to those reports.
BY MS. KLIMEK:
Q. Do you know if any of these studies that you looked at were conducted in rat or mouse strains that could actually develop NHL?
A. I'd have to go back and look at the individual studies to remember.
Q. Okay. You've agreed that statistical significance is a factor that you look at in evaluating a study, correct?
A. It is.
Q. Okay. And you perform statistical significance testing in your published works, correct?
A. I do as one of the measures of evaluation, yes.
Q. It's important to analyze standard incident rates in study results, correct?

A. I would agree with that.
Q. And the risk ratio, odds ratio indicates the level of association observed, correct?
A. More or less, yes.
Q. 1.0 is a null hypothesis, correct?
A. That's correct.
Q. Less than 1 indicates a negative association, correct?
MS. GREENWALD: Objection. Form.
A. I'd say more or less, that's true.
BY MS. KLIMEK:
Q. What level of increased risk reflects a modest association?
MS. GREENWALD: Objection. Form.
A. I think it depends on the context.
BY MS. KLIMEK:
Q. I'll represent to you that Dr. Savitz in his book, "Epidemiology and the Law," states 1.2 is a modest association.
Would you agree with that characterization?
MS. GREENWALD: Objection. Form.
A. Again, I'd say it depends on the context.
BY MS. KLIMEK:
Q. Same question for a sizable association.
What level of increased risk reflects a

sizable association --

A. Same --

Q. -- in research?

A. -- response.

Q. I'm sorry?

A. Same response.

Q. Okay. I represent to you that Dr. Savitz has said that 2.0 is a sizable association.

Do you agree with that characterization?

MS. GREENWALD: Objection. Form.

A. Same response. I think it depends on the context.

BY MS. KLIMEK:

Q. Do you agree with the EPA's characterization of levels of risk?

MS. GREENWALD: Object. Sorry.

A. I don't specifically recall what those are.

BY MS. KLIMEK:

Q. EPA stated no evidence of a positive association. The OR is less than 1.0, being the odds ratio, OR.

Would you agree with that?

A. Yes.

Q. No evidence of a significant positive association if the OR is 1.0 but it's not significant.

MS. GREENWALD: Objection. Form.

A. Could you repeat the question?

BY MS. KLIMEK:

Q. No evidence of a significant positive association. The odds ratio is equal to 1, but it's not -- there's no statistical significance.

MS. GREENWALD: Objection. Form.

A. The first time you said 1.0.

BY MS. KLIMEK:

Q. I'm sorry, what did I say? 1.0, yes.

A. Is that what you mean?

Q. Yes.

A. Yeah, I'd agree with that.

Q. Okay. Evidence of a slight positive association, EPA has said is greater than 1, but less than 1.3.

Would you agree with that characterization as being a slight positive association?

A. It depends on the context.

Q. Okay.

A. In my view.

Q. Then they said evidence of a positive association is less than 1 point -- I'm sorry, greater than 1.30, but less than 2.

A. What? That sounds like a contradiction in

terms.
You said greater than 1.30, but less than 1.2?
Q. No, I'm sorry, less than 2.0.
A. Oh. I believe it depends on the context.
Q. Okay. Same for evidence of a moderately strong association. EPA has characterized it as 2.0 -- greater than 2.0, but less than 3.0 and significant.
A. Once again, I think it depends on the context.
Q. Okay. Would you agree that evidence of a strong association would be an odds ratio greater than 3?
MS. GREENWALD: Objection. Form. Asked and answered.
A. Again, it -- I believe it depends on context.
BY MS. KLIMEK:
Q. What is the context that...
A. Well, first of all, you haven't cited confidence intervals.
Q. Okay.
A. You've made a general statement not referring to the exact study we're talking about. If it's the study of Camp Lejeune, that's one thing, but

if it's a study of something else, if it's a case-control study of a common outcome or a rare outcome, some of my opinions would differ. So it really does depend on the context, in my view.

Q. So you would disagree with EPA's assessment?

MS. GREENWALD: Objection. Form.

A. I have no grounds to agree or disagree. I just believe that it's a general statement that lacks context.

BY MS. KLIMEK:

Q. You would agree that association is not the same as causation, correct?

A. Correct.

Q. Generating an opinion on causation is not as simple as just having a study that shows a statistically significant association between a substance and a disease, correct?

A. Correct.

Q. What are the factors that would prevent someone from concluding causation where there's a statistically significant association?

MS. GREENWALD: Objection. Form.

A. Well, first of all, it's just one study, and I don't think it's -- it is typically usual or

recommended to make any conclusion based on one study. And we haven't talked about the quality of the study, and we also haven't talked about the various considerations that need to be taken into account to render an opinion on causality. Things like biological plausibility, some of the other considerations in the so-called Bradford Hill assessment, consistency with other studies.

BY MS. KLIMEK:

Q. What do you consider to be a high-quality study?

Were you finished with your answer? I'm sorry.

A. I could go on, but I think you get the gist of it. So...

Q. I apologize.

A. So repeat the next question?

Q. What would you consider to be a high-quality study? What factors?

A. So -- well, this is, again, off the top of my head. A high-quality study would be one that was designed to optimize the understanding of the relationship between an exposure and an outcome, preferably a cohort study in which the exposure clearly is documented to precede the outcome of

interest. It would have to have sample size large enough to have statistical power to draw inference and have what could be considered significant results. It should have the appropriate controls to assess for and adjust for confounding to minimize any bias. It would have to have the appropriate methodology for the analysis of the results using the statistical methodology that's -- would be able to tease out important relationships and sub-relationships.

Those are a few of the criteria I would list.

Q. You mentioned confidence intervals.

So you're familiar with confidence intervals, correct?

A. Yes.

Q. And have you published studies that include confidence intervals?

A. Yes.

Q. Okay. Do you consistently use the same confidence intervals in your research publications?

A. I typically use the 95 percent confidence interval, which I think is the standard.

Q. And in your expert reports in the litigation context, you use the 95 percent standard also, or is --

A. I do.
Q. -- it different?
When the confidence interval includes 1, you agree that the increased risk results are not significantly significant, correct?
MS. GREENWALD: Objection. Form.
A. If statistical significance means that the -- the -- the findings cannot be assigned a probability of occurrence of less than five percent, then that's correct.
BY MS. KLIMEK:
Q. Would you agree a wider confidence interval weakens confidence that the risk estimate is accurate?
A. No, but I would say a wider confidence interval weakens the interpretation with respect to precision, not accuracy.
Q. Would you agree that a confidence interval of 0.9 to 1.1 is more precise than a confidence interval of 0.1 to 10?
MS. GREENWALD: Objection. Form.
A. Yes.
BY MS. KLIMEK:
Q. Did you limit your consideration to studies where the confidence interval was above 1?
A. No.

Q. Would you agree that magnitude above or below 1 is the strength of association in the Bradford Hill context?

A. Yes. It has meaning for that.

Q. Would you agree that in addition to strength of association, you also need the precision that you mentioned?

A. Yes.

Q. When an odds ratio increases as exposure to a chemical increases, would you agree that that -- we can be more confident that an association is present?

A. In general, yes. That's often referred to as the dose response.

Q. And the dose response is reflected in the Bradford Hill criteria as biological gradient, correct?

A. Correct.

Q. And we typically expect to see a dose response if there's causation, correct?

(Stenographic reporter clarification.)

MS. KLIMEK: Sure. The one before or this one?

THE STENOGRAPHIC REPORTER: This one.

BY MS. KLIMEK:

Q. You'd agree we typically expect to see a dose response if there's causation, correct?

A. We typically would like to see that. If the study has been designed and has the statistical power to assess for multiple levels of exposure, then you can see a dose response.

Q. Okay. You mentioned a couple different kinds of studies, and they're also reflected in your report.

You mentioned cohort study, correct?

A. Yes.

Q. There's also case-control studies?

A. Yes.

Q. Ecological studies?

A. Yes.

Q. Meta-analysis?

A. Yes.

Q. And mechanistic studies, correct?

A. Yes.

Q. Which of those five do you consider to be of greater -- greater value in the context of this litigation?

MS. GREENWALD: Objection. Form.

A. I think they all have value, and I -- I find it difficult to try to assign a -- an ordinal

ranking of the importance of those studies because it depends on the context.

BY MS. KLIMEK:

Q. Okay. Would you agree that in meta-analysis, the results -- the results of the meta and pooled analysis are largely driven by the selection of the studies and data included?

A. A meta-analysis that's just done as a meta-analysis without a prior systematic review to standardize the selection of studies for the meta-analysis is then subject to whatever selection that was used, but the studies that I find most rigorous are those that combine systematic review with the subsequent meta-analysis.

Q. Okay. Would you agree that pooling data or averaging results across studies in that meta-analysis can't overcome if there's critical limitations in the studies themselves?

A. I think pooling data that uses studies of questionable quality is a questionable exercise.

Q. Okay. Would you agree that sometimes they might be subject to exposure, misclassification, and confounding?

MS. GREENWALD: Objection to form.

A. Well, exposure misclassification is a -- a

methodological limitation that is inherent to just about any epidemiology study.

BY MS. KLIMEK:

Q. Okay.

A. It's really the degree of exposure misclassification and whether the exposure misclassification is differential versus nondifferential that really is important for the epidemiologist to consider.

Q. And you don't believe cohort studies carry more weight than case-control studies, as a general statement?

A. Well, I think in general epidemiologists like cohort studies because, as I mentioned earlier in this deposition, you can clearly see that the exposure precedes the disease. But depending on the context, if there's a very rare condition that's being -- or a relatively rare condition that's being studied, case control design might have a lot more power than a cohort study. So, again, it depends on context.

Q. We also mentioned ecological studies.

Would you agree ecological studies collect data only about a group as a whole?

A. Pretty much, but there's some hybrid studies that have some individual data, but then also

other data that's as a whole. So there's some study designs that are a little bit hard to classify as just ecological versus some other design.

Q. Would you agree that typically co-founders aren't generally gathered in ecological studies? I'm sorry, con- -- confounders.

A. Yeah.

Q. I apologize.

A. Well, ecological studies that lack individual data on potential confounders are subject to that limitation.

Q. Okay. Are you aware of the ecological fallacy?

A. Yes.

Q. You mentioned study size earlier.

All things being equal, studies with a larger number of participants are more reliable than those with small numbers; would you agree?

MS. GREENWALD: Objection. Form.

A. Well, if all other things were equal, then that's generally true.

BY MS. KLIMEK:

Q. Okay. If all things being equal, would you agree that a study that doesn't account for potential confounders is a lower quality study than one that

does account for confounders?

A. I would agree with that under the assumption that the potential confounders are truly potential confounders and not just covariates plucked out of the air.

Q. Okay. Would you consider using job titles as a proxy for exposure as a lower or higher quality than using an actual exposure measurement method?

A. I mean, I think in general that's true, but, you know, exposure measurements of what type? If it's exposures that were just taken at one point in time, that could actually introduce more misclassification than actually using job type. So it depends on context.

Q. Do you agree that self-reported exposure information is subject to potential recall bias and inaccuracies?

A. That's certainly true in case-control studies, less true for cohort studies.

Q. Would you consider using the presence of chemicals in drinking water a lower or higher quality method of exposure assessment relative to a measurement of individual exposure?

MS. GREENWALD: Objection. Form.

A. Repeat the question. I'm sorry.

BY MS. KLIMEK:

Q. Using just the presence of chemicals in drinking water, a lower or higher quality method of exposure assessments relevant to measurements of individuals.

MS. GREENWALD: Objection. Form.

A. In general, I would agree with that.

BY MS. KLIMEK:

Q. Do you agree that estimates based on residential proximity to contaminated sites do not take into account individual exposure variations?

A. I would agree with that.

Q. Okay. On page 7, you've also brought it -- mentioned it several times today, you talk about Bradford Hill?

A. Yes.

Q. Where did you learn the Bradford Hill criteria?

A. Oh, I think this is back in public health school in the 1980s.

Q. As a physician, you don't use the Bradford Hill criteria, correct?

A. Well, as an academic physician, you do consider some of the same considerations when you're trying to interpret the literature.

Q. Do you always apply the Bradford Hill criteria when you do expert litigation work?
A. When it's appropriate.
Q. When would it not be appropriate?
A. I've done expert litigation work on workers' comp cases, individual --
Q. Okay.
A. -- you know, causality, and that's where Bradford Hill is irrelevant.
Q. When you're evaluating chemical exposure, do you typically use the Bradford Hill criteria?
MS. GREENWALD: Objection to form.
A. Do you mean general causation --
BY MS. KLIMEK:
Q. Correct.
A. -- in chemical exposures? Generally, yes, I use the Bradford Hill considerations.
Q. Do you agree that the Bradford Hill considerations are meant for determining whether an observed association is causal?
A. In general, that's often how they're applied.
Q. Do you explain in your report how you weigh the Bradford Hill criteria?
A. How I weigh them... I certainly evaluated

the questions at hand using the rubric of the Bradford Hill considerations. I don't remember in my report discussing the methodology of actually using the Bradford Hill criteria -- considerations other than simply applying them and discussing the evidence in relation to them.

Q. Do you typically weigh some criteria more heavily than other considerations?

A. Of the --

Q. Bradford Hill, yes.

A. Well, obviously some of the considerations are not terribly applicable. Experimental is one of the considerations, which is not typically seen in environmental health because it would be unethical to experimentally expose human beings to a toxicant.

MS. KLIMEK: We've been going a little over an hour. Do we want to take a break or keep going?

MS. GREENWALD: It's up to you.

THE WITNESS: Keep going.

MS. KLIMEK: Keep going. Okay.

MS. O'LEARY: I'm sorry. I could use a --

MS. KLIMEK: Oh, I'm sorry.

MS. O'LEARY: -- short break.

MS. KLIMEK: I'm sorry.
THE VIDEOGRAPHER: Okay. The time is 11:34 a.m., and we're going off the record.
(Whereupon a recess was taken.)
THE VIDEOGRAPHER: The time is 11:42 a.m., and we're back on the record.
BY MS. KLIMEK:
Q. Dr. Hu, on pages 7 and 8 of your report, you have a section entitled "Standard Applied"?
A. Yes.
Q. In this section, you discuss the "least as likely as not" language from the Camp Lejeune Justice Act, correct?
A. Correct.
Q. You also quote the language of the act that a -- quote, "The CLJA's language that a plaintiff must, quote, 'show one or more relationships between the water at Camp Lejeune and the harm,' end quote, and to meet the burden of proof, a party shall produce evidence showing that the relationship between exposure to the water at Camp Lejeune and the harm is A, sufficient to conclude that a causal relationship exists; or B, sufficient to conclude that a causal relationship is not" -- I'm sorry -- "is at least as likely as not."

Did I read that correctly?

A. Yes.

Q. Did the plaintiffs' attorneys provide you with the burden and standard-of-proof section of the Camp Lejeune Justice Act?

A. Yes.

Q. Were you instructed to rely on that in your analysis?

MS. GREENWALD: Objection. Form.

A. I was instructed that that was an option I could use in my analysis.

BY MS. KLIMEK:

Q. Were you provided with a complete copy of the Camp Lejeune Justice Act?

A. I don't recall.

Q. And you're not an attorney, correct?

A. I am not.

Q. No legal training, correct?

A. Well, I have a spouse who is a lawyer, but other than osmosis, no.

Q. And you're not qualified to offer expert opinions on legal concepts, correct?

A. Correct.

Q. In any case in which you've served as a general causation expert, have you interpreted a

statute's legal causation standard?

A. No.

Q. On page 8 of your report, you compare the classification scheme used by the ATSDR in its 2017 assessment of the evidence for drinking water contaminants at Camp Lejeune and specific cancers and other diseases with the language in the Camp Lejeune Justice Act, correct?

A. Correct.

Q. And you conclude that the, quote, "Sufficient and equipoise and above categories of the ATSDR classification scheme uses the same language as the Camp Lejeune Justice Act," correct?

A. That's what it seemed to me, correct.

Q. Sufficient means the evidence is sufficient to conclude that a causal relationship exists, correct?

A. Yes.

Q. Equipoise and above means the evidence is insufficient to conclude that a causal relationship is at least as likely as not, but not sufficient to conclude that a causal relationship exists, correct?

MS. GREENWALD: Objection. Form.

A. I think you misstated that. I think you said the evidence is insufficient.

Could you repeat the question?
BY MS. KLIMEK:
Q. Sure. Equipoise and above, the evidence is sufficient to conclude that a causal relationship is at least as likely as not, but not sufficient to conclude that a causal relationship exists.
A. Correct.
Q. You then equate the Camp Lejeune Justice', at least as likely as not, burden of proof standard to the ATSDR's equipoise and above classification, correct?
A. Yes.
Q. Did anyone tell you to assume that the at least as likely as not and the equipoise and above standards are the same for purposes of your opinions?
A. Say that one more time.
Q. Sure. Were you told to assume that the at least as likely as not and the equipoise and above standards are the same for purposes of your opinion?
MS. GREENWALD: Objection to form.
A. I believe so.
BY MS. KLIMEK:
Q. Have you ever published any type of research article using the classification scheme of sufficient and equipoise?

A. Not that I recall.
Q. Have you ever written an expert report that uses this scheme?
MS. GREENWALD: Objection. Form. You mean other than this one?
BY MS. KLIMEK:
Q. Other than this one, I'm sorry.
A. Yeah, not that I recall.
Q. Have you ever read any type of scientific published article that uses equipoise and above?
A. Well, not that I recall as I sit here today.
Q. Did any of the epidemiology studies you rely on in your report use the term "equipoise" or "at least as likely as not" to describe a positive association?
A. Not that I recall.
Q. To your knowledge, is there published scientific guidance on how to apply the equipoise standard?
A. Could you repeat the question?
Q. Is there published scientific guidance on how one would apply the equipoise standard?
A. Not that I am aware of.
Q. Have you ever used the equipoise standard

for describing positive associations?
Oh. Sorry.
A. Not that I -- not that I recall.
Q. To your knowledge, has the use of the equipoise standard for describing positive associations been validated?
A. I wouldn't even know what that means or how to do it.
Q. Would you agree that the equipoise denotes a lack of consensus across the medical community?
MS. GREENWALD: Objection. Form.
A. I'm not sure it's ever been considered in the medical community.
BY MS. KLIMEK:
Q. On page 8, you state that you express some of your opinions, quote, "under a more-likely-than-not standard," which you then state, "necessarily exceeds at least as likely as not standard under the Camp Lejeune Act," correct?
A. Yes.
Q. What does more likely than not mean?
A. More than 50 percent probability.
Q. More-likely-than-not standard is different from as-likely-as-not standard, correct?
A. It would seem to be, yes.

Q. Is a more-likely-than-not standard different than a reasonable degree of medical certainty?

MS. GREENWALD: Objection. Form.

A. I think there's a certain equivalence in those terms, yes.

BY MS. KLIMEK:

Q. So hypothetically, if a study found limited evidence of a causal relationship between exposure to an agent and a certain cancer, would you say that agent is more likely than not the cause of the cancer?

MS. GREENWALD: Objection. Form.

A. Not by itself, no. I already said early in this deposition that no single study can be used to come to a conclusion regarding causality.

BY MS. KLIMEK:

Q. Have you ever testified as to the meaning of the more-likely-than-not standard?

A. I think I might have been asked the same question as you posed earlier, that is, what is your understanding of what more likely than not means? I think I might have answered that question in previous depositions or trials --

Q. Okay.

A. -- but I can't specifically recall.

Q. I'd like to turn to a general discussion of NHL.

I'm not reading from your report, but do you treat NHL patients?

A. I have in the past, yes.

Q. You have in the past.

And NHL is a type of cancer that starts in the lymphocyte cells --

A. Yes.

Q. -- is that correct?

A. Correct.

Q. And that's part of the body's immune system?

A. Yes.

Q. Is it your opinion that NHL -- I'm sorry.

It is your opinion that NHL is a rare -- is a relatively rare disease, correct?

A. Relative to some other cancers like lung cancer, breast cancer, stomach cancer, colon cancer, yes.

Q. Would you agree that while NHL is sometimes referred to as lymphoma, not all lymphomas are NHL?

A. Correct.

Q. Would you also agree that while NHL is a type of hematologic cancer, not all hematologic

cancers are NHL?

A. Correct.

Q. For example, leukemia, multiple myeloma?

A. Yes, those are examples of hematologic cancers that are not NHL.

Q. Would you agree that most causes of NHL are unknown?

MS. GREENWALD: Objection. Form.

A. It depends how you define "most causes." I think in any particular patient case of non-Hodgkin's lymphoma, it's difficult to determine what the cause is. There's been quite a bit of epidemiology research that's been done to try to understand the causes of non-Hodgkin's lymphoma, including genetic studies using genome-wide association epidemiology and studies of environmental risk factors and studies of nutritional and other lifestyle factors.

I think, you know, in general, they've shed quite a bit of light on the understanding of the etiology of non-Hodgkin's lymphoma. So that, I think, gives a -- my assessment of what we know about -- general assessment of what we know about the etiology of non-Hodgkin's lymphoma. But I would certainly agree that there's a lot more that needs to be discovered.

BY MS. KLIMEK:

Q. And there are various subtypes of NHL, correct?

A. Yes.

Q. Approximately how many subtypes are there?

A. I've discussed a few in my report. I don't know, four or five, maybe more.

Q. Four or five --

A. It's the ones that --

Q. -- different subtypes of NHL?

A. The ones I've discussed, yes.

Q. Okay. And did the subtypes of NHL -- do they vary in part based on the type of lymphocytes affected?

A. Yes.

Q. So different forms of NHL arise in different cells, correct?

A. That is what apparently seems to be the case, yes.

Q. And I think you mentioned this, subtypes of NHL generally have varying clinical behaviors?

A. Yes.

Q. Are there risk factors that are association -- associated with particular NHL subtypes that other subtypes may not have the same risk factors?

A. Well, there are risk factors that have been identified in epidemiology studies, and those seem to vary according to the different subtypes. But that doesn't necessarily mean that they all have completely distinct risk factors.

Q. And you mentioned that on -- I think it's page 9 and 11, you describe different subtypes of B-cell NHL, correct?

A. Yes, correct.

Q. Why did you select these types of B-cell NHL to specifically discuss in your report?

And it would be diffuse large B-cell, mantle cell lymphoma, marginal zone lymphoma, and chronic lymphocytic leukemia.

A. Yeah. Well, these are some of the more common non-Hodgkin's lymphoma subtypes. There are others, though. So -- but I selected these because these are among the most common.

Q. Okay. I'm sorry, I think I skipped mantle cell lymphoma is also in your report.

Based on your research and studies that you cited in your report, would you expect a single chemical to cause all subtypes of NHL?

MS. GREENWALD: Objection. Form.

A. Say that one more time.

BY MS. KLIMEK:

Q. Would you expect a single chemical to cause NHL in all of these subtypes?

MS. GREENWALD: Objection. Form.

A. I think it's possible, but it depends on the chemical.

BY MS. KLIMEK:

Q. Would you agree that over the last several decades, the definition of both NHL and its subtypes have evolved?

A. Yes.

Q. On page 11 of your report, you note that chronic lymphocytic leukemia was historically considered a leukemia, but it was reclassified in 2001 by the WHO -- by the World Health Organization as a subtype of NHL, correct?

A. Correct.

Q. You would agree that there are epidemiological studies that rely on data using the old scheme, which wouldn't align with the current WHO classification, correct?

A. Correct.

Q. Is there a standard methodology for combining different lymphoma NHL entities --

MS. GREENWALD: Objection.

BY MS. KLIMEK:

Q. -- for epidemiological research?

MS. GREENWALD: Objection. Form.

A. I'm not sure there's a standard way of doing it, but epidemiologists in general try to pay attention to the classification system that's relevant at the time that they were doing their research.

BY MS. KLIMEK:

Q. Would you agree that NHL studies face challenges that other cancer studies may not due to the change of the classification system?

MS. GREENWALD: Objection. Form.

A. That may be true.

BY MS. KLIMEK:

Q. When you use a meta-analysis of -- or there's a meta-analysis of NHL, can you tell if studies with chronic lymphocytic leukemia were included or not?

A. In some cases, I think there was attempts to do so, but I'd have to go back and review the studies to be able to identify which have paid attention to that and which have not.

Q. For purposes of your general causation analysis, did you treat all NHL subtypes the same?

A. I'm not sure what you mean by that.

Q. You discussed generally NHL.
Does that include all of these subtypes?
MS. GREENWALD: Objection. Form.
A. I think in general it does, unless I specified otherwise.
BY MS. KLIMEK:
Q. So did you consider general causation of individual subtypes?
A. I certainly looked at studies that looked at specific subtypes, but my -- you know, the -- the question that was put in front of me was NHL as a category of disease.
Q. Would you agree mutations occur naturally during cell division?
A. They occasionally occur, yes.
Q. And then the mutations can occur -- can accumulate over time and lead to cancer without any type of chemical exposure?
A. That is theoretically possible, yes.
Q. So you would -- would you agree that a person can develop NHL without having ever been exposed to any type of chemical?
A. That is true. And I'll also point out that there are genetic factors that may dictate the body's ability to do DNA repair and avoid the mutations that

cause cancer.

Q. But certainly an individual could develop NHL without having been exposed to TCE, PCE, or benzene?

A. It's possible.

Q. Would you -- you would agree that even if a person was exposed to a toxic substance, their NHL could have been caused by some other mechanism, correct?

MS. GREENWALD: Objection. Form.

A. It's theoretically possible, yes.

BY MS. KLIMEK:

Q. And our bodies have repair mechanisms to fix DNA damage, correct?

A. Correct.

Q. And DNA repair mechanisms can fix damage from environmental exposure?

A. They can.

Q. Would you agree that repair mechanisms must be overwhelmed by a carcinogenic environmental exposure --

MS. GREENWALD: Objection.

BY MS. KLIMEK:

Q. -- before the damage progresses to cancer?

MS. GREENWALD: Objection. Form.

A. Overwhelmed in the sense that the body misses repairing the defect, yes.

BY MS. KLIMEK:

Q. What does it mean for an agent to be genotoxic?

A. It's a broad term. Basically, it means that an agent can cause the chemical changes that will result in DNA abnormalities. Chromosomal damage, base substitution, sister chromatid exchanges, there's a whole bunch of different chromosomal and DNA changes that are encapsulated in this very broad category.

Q. What does it mean for an agent to be immunotoxic?

A. To affect some arm of the immunologic system that negatively affects its function.

Q. Just because an agent may be genotoxic or immunotoxic doesn't make it a carcigen (sic), correct -- or carcinogen?

A. Good question. That's certainly true of immunotoxicity. I'm struggling right now to think of a genotoxic exposure that doesn't incrementally increase the risk for cancer. So I don't know the answer to that one.

Q. Exposure to a genotoxic agent does not necessarily lead to the development of NHL, correct?

A. Correct.

Q. Exposure to an immunotoxic agent does not necessarily lead to the development of NHL.

A. Correct.

Q. Could you please turn to page 4 of your report?

In the first paragraph of page 4, it states that you were asked to opine on whether there is a causal relationship between TCE, PCE, and or benzene in the water at Camp Lejeune in non-Hodgkin's lymphoma.

Did I read that correctly?

A. Yes.

Q. On page 42 of your report, it states that testing of water between 1980 and 1985 at Tarawa Terrace showed maximum concentration of PCE at 215 micrograms per liter, correct?

A. 215 micrograms per liter, yes.

Q. At Tarawa Terrace?

A. Yes.

Q. And at Hadnot Point, you state that sampling TCE, the maximum concentration was 1,400 micrograms per liter, correct?

A. Correct.

Q. And the PCE maximum level at Hadnot Point,

based on the sampling, was 100 micrograms per liter, correct?

A. Correct.

Q. Did you use these maximum concentrations in your causation -- general causation analysis?

A. Not that I recall.

Q. Did you consider any other concentration data in your general causation analysis?

A. You mean concentration data from the Camp Lejeune studies of water?

Q. Looked at the -- and in the studies themselves. If a study gave you concentration levels and figures, did you look at those figures?

MS. GREENWALD: Objection. Form.

A. Well, I looked at the figures that were quoted in the ATSDR report. I remember that.

BY MS. KLIMEK:

Q. But not specifically the individual epidemiological studies that you looked at?

A. I don't recall the individual Camp Lejeune studies of cancer doing a analysis of the concentrations of the contaminants in direct relationship to the incidence of cancer. All I recall is that they compared the populations who were exposed to the population that was not exposed, that's the

Camp Pendleton personnel, and that they used some metric of duration of exposure, but I don't recall them actually going over the actual levels of the contaminants.

Q. And then the individual studies not related to Camp Lejeune that you reviewed, did you note what the exposure levels were cited in those studies?

A. Wherever they were cited, yes.

Q. I'm going to hand you a copy of Dr. Maslia's report. We've already mentioned he's been retained by plaintiffs in this case, correct, Dr. Maslia?

(Whereupon Exhibit 6 was marked for the record.)

A. You did.

Q. And if you turn to page 56 of Mr. Maslia's report --

MS. GREENWALD: 26?

MS. KLIMEK: 56, I'm sorry.

A. 50 --

BY MS. KLIMEK:

Q. 56, yes.

A. 56.

Q. Table 7.10.

A. Okay.

Q. This is a "Summary of Reconstructed Simulated Values and Observed Data of Tetrachloroethane at the Water Treatment Plant for Tarawa Terrace." Correct? That's the title of this study table -- or I'm sorry, not the study, Table 7.10?

A. Yes.

Q. Do you see that the highest observed PCE concentration is 215 micrograms per liter in January of 1985? Six down.

A. I don't see that figure on this table, no.

Q. So if you go six down from the top, you see January 1985?

A. Oh, there it is. Yes.

Q. And if you go over, PCE concentration?

A. Sorry. Thank you.

Q. Oh, no, that's fine.

A. Yeah, I see it.

Q. 215 micrograms per liter, correct?

A. Correct.

Q. Did you consider exposures of less than 215 ppb's in assessing whether PCE causes NHL?

MS. GREENWALD: Objection. Form.

A. I addressed the whole issue of the dose response and the lack of a threshold as a general

consideration in my report, but I didn't specifically refer to this level.

BY MS. KLIMEK:

Q. Okay. Do you recall what specific levels of PCE exposure were discussed in some of the studies?

A. Some of which studies?

Q. The studies that you cite in your report related to PCE.

A. I have a general recollection of what they are, but certainly not a specific one right now as I sit here.

Q. Okay. If you could flip to page 86 --

A. This is still in --

Q. -- of Mr. --

A. -- Maslia?

Q. -- Maslia's report. Yes.

And if you could look at Table 7.15?

A. Okay.

Q. And this is selected, measured, and reconstructed concentrations of PCE, TCE, DCE, and vinyl chloride in benzene at Hadnot Point water treatment?

A. Yes.

Q. Do you see that the highest observed TCE concentration is 1,400 micrograms per liter? That

would have been in May 1982.

A. I see that.

Q. Do you see that many observed TCE concentrations were below 10 micrograms per liter?

A. Some of them were, yes.

Q. Did you consider a mean or other average TCE concentration in your evaluation of whether TCE at Camp Lejeune caused NHL?

MS. GREENWALD: Objection. Form.

A. Same response as I gave earlier for PCE. I discussed in general the dose response and the consideration of low levels of exposure in my generalization report, but I did not specifically refer to the concentrations measured at Camp Lejeune.

BY MS. KLIMEK:

Q. Did you consider the exposures of under 1,400 ppb in assessing whether TCE at Camp Lejeune caused NHL?

MS. GREENWALD: Objection. Form. Asked and answered.

A. Same response.

BY MS. KLIMEK:

Q. Do you recall what levels of TCE concentration exposure were discussed in the studies considered in rendering your opinions?

MS. GREENWALD: Objection. Form.

A. Same response as I made for PCE.

BY MS. KLIMEK:

Q. And you also see in Table 7.5, the only benzene detections were in November and December of 1985?

A. I see that's what's listed on the table. I just have no idea whether they actually tried to sample at other times.

Q. But you would agree, as reflected on this chart, those are the only dates mentioned for benzene, correct?

A. Correct.

Q. Did you consider a mean or other average benzene concentration in your evaluation of whether benzene at Camp Lejeune caused NHL?

MS. GREENWALD: Objection. Form.

A. Same response as for PCE and TCE.

Q. Could you please provide that response again?

MS. GREENWALD: Objection. Form.

A. In my --

MS. GREENWALD: Asked and answered.

A. In my general causation response, I did not consider the concentrations measured at Camp Lejeune,

but I did discuss the issue of dose response and potential effects at low levels of exposure.

BY MS. KLIMEK:

Q. What levels of benzene concentrations do you recall -- concentration exposures do you recall being discussed in the studies you considered in rendering your opinions?

A. Same response as before. I do recall taking note of whatever concentrations were measured in those studies, but I don't recall specifically what those concentrations were.

Q. Going back to your report on page 40, you state that the orthodox view for carcinogens that cause cancer by damaging DNA -- or I'm sorry, you state the orthodox view is for carcinogens that cause cancer by damaging DNA. There is no threshold of exposure that can be considered completely safe. Correct?

MS. GREENWALD: Objection. Form.

A. Correct.

BY MS. KLIMEK:

Q. And you reference EPA on page 41 of your report, correct, in relation to the linear non-threshold model?

A. I reference the EPA, the U.S. Nuclear

Regulatory Commission, and I also made a reference to a article that appeared from authors in Europe.

Q. Do you agree that the U.S. EPA uses the linear no-threshold model to regulate risk and not to determine causation?

A. The U.S. EPA is not in the business of determining causation, so that's a truism --

Q. So you would agree --

A. -- by itself.

Q. Okay. And as you acknowledge in your report, the no-safe-dose theory and the linear no-threshold model have been challenged and are subject of ongoing debate, correct?

A. That is true.

Q. And the Hogberg and Jarnberg 2023 study that you cite on page 40 of your report, it recognizes this debate, correct?

A. Yes.

Q. Do you agree -- do you agree that it's possible for low dose -- low doses of certain carcinogens to actually have a protective effect?

MS. GREENWALD: Objection. Form.

A. That has been alleged by some scientists, but I have not seen what I consider convincing evidence of that, and I believe that's true of many of

my colleagues in environmental health.
BY MS. KLIMEK:
Q. Is it your opinion that any level of TCE exposure can cause NHL?
A. It's my opinion that any level of exposure has an associated risk. It might be extremely small if the doses are very small, but as I've said in this report, they have the potential to initiate the kinds of changes that can eventually lead to cancer.
Q. Are there peer-reviewed studies that have found that any dose of TCE can cause NHL?
MS. GREENWALD: Objection. Form.
A. I think that's -- "any" dose is a rather broad term, so I would say, yeah, there's no -- no study that would say any dose would cause cancer.
BY MS. KLIMEK:
Q. Your report says the linear no-threshold model of dose-response relationship was developed for carcinogens that cause cancer by damaging DNA; is that correct?
A. Correct.
Q. Do you agree that the linear no-threshold model does not apply to carcinogens that do not cause cancer by damaging DNA, such as through immunosuppression -- immunosuppression?

A. I have not seen a rigorous analysis of whether immunotoxicity by itself has a dose-response relationship to the causation of cancer that could elucidate whether this is threshold or not.

Q. So you have no opinion?

A. I have no opinion.

Q. On page 32 of your report, you state that P -- quote, "PCE has been shown to be genotoxic to peripheral blood lymphocytes in vitro," correct?

I'll give you a minute to get there. Page 32.

A. Yeah, yeah. Page 32 on the top there?

Q. Yes, in the top paragraph.

A. Yes, I see that sentence of mine.

Q. Is it your opinion that the peripheral blood lymphocytes are involved in the development of NHL?

A. No, that's not my opinion. But I think that because they're available for research, they're actually quite a good model for understanding the genotoxicity of chemicals with respect to blood cells.

Q. Okay. Is there a scientific paper that supports what you just said, your opinion?

MS. GREENWALD: Objection. Form.

A. Oh, I think there's plenty of scientific

research which supports the utility of looking at changes in peripheral blood lymphocytes as a marker of DNA damage. My colleague, Dr. Karl Kelsey, at Harvard is one of the pioneers in developing that technique. But I can't quote you a paper sitting here or a textbook to cite that today.

BY MS. KLIMEK:

Q. But DNA damage is not a causation of NHL?

MS. GREENWALD: Can you repeat that? I'm sorry.

MS. KLIMEK: Come back to that in a minute. I'm sorry.

BY MS. KLIMEK:

Q. Do you agree that genotoxicity in cells that are not involved in the develop -- are not involved in the development of NHL would not suggest that PCE causes NHL?

MS. GREENWALD: Objection. Form.

A. I think that was a double negative.

Would you mind making that a -- rephrasing that?

BY MS. KLIMEK:

Q. Agree that genotoxicity in cells that are not involved in the development of NHL would not be indicative or suggest that PCE causes NHL.

MS. GREENWALD: Objection. Form.

A. I believe that the evidence that I cited here, that is, genotoxicity to peripheral blood lymphocytes, is suggestive that the chemical can cause the same kind of damage to lymphocytes in bone marrow and, therefore, be a risk factor for the development of lymphatic cancers like NHL.

BY MS. KLIMEK:

Q. And how would that work?

A. Well, these peripheral blood lymphocytes originate from the bone marrow, and they ultimately come from the pluripotential hematopoietic cells that are important for providing the B lymphocytes and T lymphocytes all over the body. So if you can show that the chemical can cause genotoxicity in the specimens of lymphocytes that are circulating, there's no reason to believe that it wouldn't be able to cause the same kind of damage in bone marrow cells. And like I said, this has been a model for trying to understand genotoxicity that's been nicely validated by a number of scientists decades ago, including my -- my colleague Dr. Kelsey at Harvard.

Q. On that same page, 32, of your report, you say, PCE exposure has also been found to be associated with primary DNA damage to the leukocytes among

workers exposed to PCE in comparison to non-exposed workers; is that correct?

A. Correct.

Q. Leukocytes are not involved in NHL, correct --

A. Correct.

Q. -- leukocytes?

On page 32 of your report, you also state, quote, "Since leukemia and lymphoma involve cells that originate in the bone marrow, damage to circulating blood cells likely indicate effects of their precursor in the bone marrow," correct?

A. Correct. And it's a reiteration of what I just discussed --

Q. Okay.

A. -- in this deposition.

Q. Logically, though, why would effects of the precursors of leukemia in the bone marrow suggest that there's also effects of precursors of NHL?

A. Because NHL originates from the pluripotential cells that are in the bone marrow.

Q. Page 32, you also state that inhalation exposure to PCE has been shown to cause mononuclear cell leukemia in rats of both sexes, correct?

A. I'm sorry, where are you?

Q. One, two, three, four, five lines up from the end.
A. Oh, from the end, okay.
Q. I'm sorry, at the end of that paragraph.
A. Oh.
Q. On page --
A. Oh, right.
Q. -- 32.
A. Right, right, right.
Q. First whole paragraph.
A. Correct.
Q. What would that have to do with genotoxicity, that finding?
A. Well, presumably, the PCA would cause mononuclear cell leukemia by causing genetic damage in these rats that were assayed by the National Toxicology Program.
Q. Why not immunosuppression?
MS. GREENWALD: Objection. Form.
A. Well, as we discussed earlier in this deposition, I'm just -- I'm not sure about the literature on pure immunosuppression. But, you know, presumably, that could also be another mechanism. So I -- I think the relevance of this statement is that PCE has been shown to cause a blood-forming cancer,

not necessarily whether it's through genotoxicity or immunotoxicity.

BY MS. KLIMEK:

Q. Your report notes that, altogether, in your opinion, the studies provide evidence supporting the biological plausibility of PCE causing NHL, correct?

A. Correct.

Q. What was the methodology for concluding that PCE causes NHL through genotoxicity based on evidence of PCE's genotoxicity in the peripheral blood lymphocytes which are not involved?

You want me to repeat the question?

A. That question seemed to ramble to me. You mind restating it?

Q. Sure. Methodology that you used for concluding that PCE causes NHL through genotoxicity, based on the evidence of PCE's genotoxicity in the peripheral blood lymphocytes, which are not involved in the development of NHL.

MS. GREENWALD: Objection. Form. I just wanted to make sure you were done. Objection. Form.

MS. KLIMEK: Okay.

A. Well, I mean, in -- on page 33, I summarized my understanding of the biological

plausibility of PCEs as a risk for NHL. And I pulled together some of the observations I made in that previous paragraph that we just discussed that included the genotoxicity seen in peripheral blood cells, as well as the animal studies that showed leukemia in rats. So I -- I feel that adequately summarized my previous discussion of the evidence.

And as such, did I answer your question?

BY MS. KLIMEK:

Q. Yeah, we may revisit it in a minute.

On page 36 of your report, you state that IARC concluded that benzene is genotoxic, immunosuppressive, and hemotox- -- hematotoxic --

MS. KLIMEK: Right?

MS. O'LEARY: (Inaudible.)

MS. KLIMEK: Yeah.

Q. -- correct?

A. Okay, let's see. We're on page 36, and you're looking at the bottom; is that right?

Q. It's I -- yes, IARC's conclusion.

A. Yes. So they conclude that the evidence, including the evidence in humans, is strong that benzene is metabolically activated to electrophilic metabolites, induces oxidative stress and associated oxidative DNA damage.

(Stenographic reporter admonition.)

THE WITNESS: I'm sorry. Okay. I mean, I'm just reading that paragraph. Counselor, should I proceed or -- it's just -- really just repetitive.

BY MS. KLIMEK:

Q. Well, IARC -- IARC concluded, correct, we've got that.

Is it your opinion that benzene's genotoxic to the lymphocytes involved in the development of NHL? Is it your opinion?

A. Yes.

Q. Based on what?

A. Based on the studies which show that it causes genotoxicity in circulating lymphocytes, and that it is widely recognized as being a model for what is likely happening in the bone marrow.

Q. And then turning to page 38 of your report, you discuss post-IARC mechanistic evidence of carcinogenicity for benzene, correct?

A. Correct.

Q. And it does not discuss post-IARC mechanistic evidence based on genotoxicity, correct?

A. This paragraph does not discuss that,

correct.

Q. So IARC concluded that the evidence of carcinogenicity of benzene for NHL is limited, although there's strong mechanistic evidence that benzene causes other cancer, correct?

A. That was their conclusion in their 2018 report, correct.

Q. And you didn't find any post-IARC mechanistic evidence that benzene causes NHL, correct?

A. No, that's not correct. And, in fact, in the preceding section, I discussed the literature in the epidemiology world that appeared subsequent to the IARC report.

Q. Right; I asked about the mechanistic evidence.

A. Oh. Other than the -- the evidence regarding chronic inflammation and immunosuppression, no, I did not come across mechanistic evidence of genotoxicity published since the 2018 IARC report.

Q. What was your methodology for concluding from the fact that benzene is genotoxic for other cancers that a linear no-threshold model is appropriate for benzene and NHL?

Sorry. Would you like me to repeat the question?

A. No, that's fine. I did not discuss the issue of low-level exposure to benzene specifically. I just discussed, as I alluded to earlier in this deposition, the issue of low-level exposures in a general sense beginning on page 40 of my report.

Q. Is it your opinion that any level of benzene exposure can cause NHL?

A. Similar to my earlier response, it is my opinion that benzene as a carcinogen theoretically can initiate the cancer-causing process at any level of exposure. Of course, the quantitative risk at such very low levels would be very low.

Q. And are there peer-reviewed studies that have found that any dose is sufficient?

A. Same --

MS. GREENWALD: Objection. Form.

A. -- response as earlier. There are no studies that can possibly test that hypothesis that any exposure can cause cancer, at least from an epidemiology point of view.

BY MS. KLIMEK:

Q. And as you're switching to PCE, is it your opinion that any level of PCE exposure can cause NHL?

A. Yes, and with the same limitations I just mentioned for benzene.

Q. Does low-dose radiation exposure produce the same results as low-dose exposure to PCE, TCE, and benzene?

A. I mean, low-dose radiation has been studied extensively, and it certainly is a genotoxic exposure. I wouldn't say that the mechanism of how radiation induces DNA damage is exactly the same as benzene, TCE, and PCE, but there's probably some similarities.

Q. What are the differences?

A. Without going back to reviewing the literature, I wouldn't be able to tell -- answer that question.

Q. Okay. I'd like to now talk about a couple of the studies that you cite on page 41 and 42. You discuss two studies that you state are specifically relevant to the association of low-level chemical exposures and reflect the situation represented at Camp Lejeune?

A. Yes.

Q. The first study, there's no citation provided, but I'm assuming this is the Aschengrau 1993 study?

MS. GREENWALD: Objection to form.

A. Yeah.

BY MS. KLIMEK:

Q. The study would be "Cancer Risk and Tetrachloroethylene-contaminated Drinking Water in Massachusetts"; is that correct?

A. Yes. And as I said in my supplement report -- I apologize for forgetting to add a citation there, but you are correct. That's the Aschengrau, et al., study.

Q. And this was a population-based case-control study, correct?

MS. KLIMEK: I'll hand you a copy in just a minute, to introduce this study as Exhibit 7.

(Whereupon Exhibit 7 was marked for the record.)

A. Do you have --

Q. Oh, I'm sorry, yes.

A. Oh, thank you.

Q. And this was a population-based case-control study using ecological data to evaluate the relationship between PCE, bladder cancer, kidney cancer, and leukemia, correct?

It's the first sentence in the abstract on --

A. Yes.

Q. No data was presented for non-Hodgkin's lymphoma, correct?

A. Hold on. Would you mind repeating the first question you asked me?

Q. This was a population-based case-control study using ecological data to evaluate the relationship between PCE, bladder cancer, kidney cancer, and leukemia, correct?

A. I'd agree with that.

Q. No data was presented for NHL, correct?

A. Correct.

Q. There was no -- this study has no measured dose data, correct?

And if you look to page 287, first full paragraph, PCE exposure estimations indicates the study grouped exposures into low and high -- low and high based on the estimated mass of PCE in milligrams that entered a given house as a solute in drinking water over a specified period of time, correct?

A. Would you mind repeating the question one more time?

Q. The study grouped exposures into low and high based on estimated mass of PCE in milligrams that entered a given house as a solute in drinking water over a specified time period, correct?

A. Not quite correct. As they stated in the data analysis section, they examined exposure both

dichotomously as ever versus never, but also as unexposed, low, and high. That is three different exposure categories.

Q. So the PCE concentration in the low-use sites in one of the -- and I'm referring to page 285. PCE concentrations in low-use sites in one of the affected water distribution systems range from 1,600 to 7,750 micrograms per liter, correct?

A. That's what was characterized as typical concentrations in the affected lines in one town at low-use sites.

Q. And as we discussed and you stated on page 42 of your report, the highest measured PCE concentrations at Tarawa Terrace was 215 micrograms a liter, correct?

A. Correct.

Q. That's an order of magnitude smaller than the low-use sites in this study, correct?

MS. GREENWALD: Objection. Form.

A. Well, that's the upper range of the range cited in that report. It's not the mean. So I'm not exactly sure what you're trying to say.

Q. Well, 215 versus 1,600 to 7,750.

MS. GREENWALD: Objection. Form. If that's a question, I just want to object to the form.

BY MS. KLIMEK:

Q. Significant difference, correct?

A. Oh. No. I'm sorry. So that's -- yeah, 250 is much lower than the range of concentrations cited in this one town.

Q. There was no statistic --

A. And --

Q. I'm sorry.

A. Yeah, at so-called low -- low-use dead-end sites.

Q. There was no statistically significant increase for any of the results, except for an exposure level above the 90th percentile, correct?

A. Would you mind repeating the question, please?

Q. There was no statistically significant increase for any of the results, except for an exposure level over the 90th percentile.

A. So... Okay, there. So assuming that by statistical significance, you mean a 95 percent confidence interval that excludes one, then you're correct.

MS. GREENWALD: I'd like to take -- talk about one more study, and then we can take a break. Does that work?

THE WITNESS: Sure.

BY MS. KLIMEK:

Q. Okay. And this is going to be the Cohn 1994 study, Drinking Water Contamidation -- "Contamination and the Incidence of Leukemia in NHL."

Do you recall that article?

A. I do.

Q. Okay.

MS. KLIMEK: We're going to mark it as an exhibit, Number 8.

(Whereupon Exhibit 8 was marked for the record.)

Q. This was also an ecological study for TCE and PCE, correct? Is that correct; it was an ecological study?

A. Yes.

Q. And on page 42 of your report, you noted that compared incidence in towns in the highest TCE stratum, greater than five micrograms a liter, to towns without detectable TCE, correct? That was the comparison?

A. Hold on.

Q. Sure.

A. Yes.

Q. And on that same page, you state that the

comparison of the two towns demonstrates an age-adjusted ratio for NHL of 1.36; is that correct, as stated in your report?

A. Correct.

Q. That risk ratio was only for women associated with the highest TCE stratum, correct?

A. Yes. Correct.

Q. The study found no association between TCE exposure in NHL in men, correct?

I'm sorry. Let me rephrase that question.

The study found no statistically significant increased ratio among men at the highest exposure level, correct?

A. Now that you've rephrased it, you are correct. I will point out, though, that the relative risk was elevated at 1.2, but the confidence interval did not exclude 1.

MS. KLIMEK: Okay. We've been going a little over another hour. Do we want to take a break?

(Indiscernible cross talk.)

THE WITNESS: What's the plan for lunch?

MS. KLIMEK: Ask Pat.

(Indiscernible cross talk.)

MS. KLIMEK: We could ask Pat.

THE WITNESS: Why not?

THE VIDEOGRAPHER: Off the record. The time is 12:51 p.m., and we're going off the record.

(Whereupon a lunch recess was taken.)

-oOo-

1:44 P.M.

-oOo-

THE VIDEOGRAPHER: The time is 1:44 p.m., and we're back on the record.

EXAMINATION (resumed)

BY MS. KLIMEK:

Q. Dr. Hu, we spoke earlier today about the National Research Council, correct?

A. Yes.

Q. And I'd like to hand you a document that we're going to mark as Exhibit 9. This is the 2009 National Research Council, published a report entitled "Contaminated Water Supplies at Camp Lejeune, Assessing Potential Health Effects."

Have you seen this document before?

(Whereupon Exhibit 9 was marked for the record.)

A. I think so, but it's been a long time.

Q. It's not listed in your materials considered.

A. I did not consider it.

Q. Okay. If you could turn to page 1 of the document, it talks about the charge to the committee? Tab, page 1.

A. That's not Roman numeral 1, that's -- yeah,

okay. Public summary and context?

Q. Correct. And then charge to the committee, second paragraph?

A. Yes.

Q. I'm going to go ahead and read it. "The charge had several elements. One was to review the scientific evidence about the kinds of adverse health effects that could occur after exposure to TCE, PCE, and other contaminants. The second was to evaluate studies that were performed or that are underway on former residents of the base and to consider how useful it will be to conduct additional studies. The third element was to identify scientific considerations that could help the Navy set priorities on future activities. The responsibility of the committee was to address its charges in a dispassionate, expert, and unbiased way. Analyses and findings were neither subject to oversight nor influenced by the agenda of any of the entities with responsibilities for Camp Lejeune, former or current residents of Camp Lejeune, or any other entity."

Did I read that correctly?

A. You did.

Q. And then directing your attention to Roman numeral V, do you see that David Savitz is chair of

the committee?

A. I can see that at the time, yes.

Q. Okay. If you would turn to page 8 of the report.

A. Roman numeral 8?

Q. Number 8. Do you see box number 2?

A. Yes.

Q. "Categorization of Health Outcomes Reviewed in Relation to PC" -- "TCE, PCE, or Solvent Mixtures," correct?

A. Correct.

Q. Do you see the categories are, Sufficient Evidence for a Causal Relationship, Sufficient Evidence of an Association, Limited/Suggestive Evidence of an Association, Inadequate/Insufficient Evidence to Determine Whether an Association Exists, and Limited/Suggested Evidence of No Association?

A. I see those categories.

Q. And we have talked about some of those categories earlier in the deposition, correct? Sufficient evidence?

A. More or less, yes.

Q. Do you see that the National Research Council Committee, considering the Camp Lejeune water contamination with respect to TCE, PCE, and solvent

mixtures, did not list any disease in the category of Sufficient Evidence of a Causal Relationship or Sufficient Evidence of an Association?

MS. GREENWALD: Objection. Form.

A. I see that. And just note for the record that this report was published in 2009 and based on deliberations that occurred prior to that.

BY MS. KLIMEK:

Q. Do you see that NHL is listed in the "Inadequate/Insufficient Evidence to Determine Whether Association Exists"? Correct?

MS. GREENWALD: Objection. Form.

A. Correct.

BY MS. KLIMEK:

Q. You don't know what the reasoning process that the NRC committee of scientists used to place the diseases in the category is, correct?

A. I'm not privy to that.

Q. I'd now like to turn to -- this is the Bove 2014 mortality study at Camp Lejeune. This study is listed in your materials considered.

A. Okay.

MS. KLIMEK: Marked as Exhibit 10.

THE WITNESS: Thank you.

(Whereupon Exhibit 10 was marked

for the record.)

Q. The "Evaluation of mortality among marines and navy personnel exposed to contaminated drinking water at USMC base Camp Lejeune: a retrospective cohort study," correct, is the title of the study?

A. Yes, correct.

Q. And this study specifically addresses the water at issue in Camp Lejeune, correct?

A. Correct.

Q. If you look at Page 7 of this study, you'll see Table 4?

A. Yes.

Q. Titled "Standardized mortality ratios, underlying cause of death?"

A. Yes.

Q. And this is comparing the two -- Camp Pendleton to Camp Lejeune; is that correct?

A. Correct.

Q. The Marines? If you look at NHL, the SMR at Camp Lejeune is 0.68, correct?

A. Correct.

Q. At Camp Pendleton, the SMR is 0.78, correct?

A. Correct.

Q. So the SMR at Camp Lejeune is lower than

that at Camp Pendleton, correct?
A. Correct.
Q. And then it's also lower than the general population, correct?
A. Correct.
Q. If you can turn to page -- I'm sorry, to look at -- turn to page Table 5, titled, "Camp Lejeune versus Camp Pendleton: Hazardous ratio and 95 percent confidence intervals, adjusted by sex, race, rank, and education, 10-year lag," correct?
A. Correct.
Q. If you look at, for NHL, the hazardous ratio is 0.81, correct?
A. Correct.
Q. And that's comparing Camp Lejeune to Camp Pendleton, correct?
A. Correct.
Q. Does that hazardous ratio suggest an association between NHL and exposure to contaminants at Camp Lejeune for Marines?
MS. GREENWALD: Objection. Form.
A. Not per se.
BY MS. KLIMEK:
Q. Okay. Now I'm going to hand you the companion study, the Bove 2014 civilian study. Again,

this study is among the materials you considered, but not specifically mentioned in your report.

Sorry. This will be Exhibit Number 11.

(Whereupon Exhibit 11 was marked for the record.)

MS. GREENWALD: Thank you.

BY MS. KLIMEK:

Q. This study also compared Camp Lejeune cohort to Camp Pendleton cohort, correct?

A. Correct.

Q. Civilians. If we take a look at Table 3 in this study, which is on page 7, for NHL, the SMR for Camp Lejeune is 0.60, correct?

A. Correct.

Q. The SMR for Camp Pendleton is 0.70, correct?

A. Wait a minute. I'm sorry. I'm looking at the wrong thing.

What table are we looking at?

Q. I'm sorry. Table number 3, "Standardized Mortality Ratios, Underlying cause of death."

A. This is the 2014 study?

Q. 2014 Bove civilian study.

A. Right, okay. I'm looking at the right thing. But the 2000...

Q. I'm sorry. Oh, I think you've got to look at this one.
A. I'm all confused now.
MS. GREENWALD: No, we're on 11. You're on the right one. I'm sorry.
THE WITNESS: I am?
BY MS. KLIMEK:
Q. "Mortality study of civilian employees exposed to contaminated drinking water at USMC Base Camp Lejeune" --
A. Right.
Q. -- "a retrospective cohort study."
A. Right. Table 3. And --
Q. On page number 7.
A. Right.
Q. Okay. And then if you see NHL.
A. Right.
Q. And my first question was, the SMR for Camp Lejeune is 0.60 --
A. Yeah.
Q. -- correct?
A. Yes, yes. I'm sorry. The -- the type's just a little faint on this copy. But yes, I see it.
Q. The SMR for Camp Pendleton is 0.70, correct?

A. Correct.
Q. So the SMR at Camp Lejeune is lower than at Camp Pendleton, correct?
A. Yes.
Q. And lower than the general population, correct?
A. Yes.
Q. If you turn the page to page 8, Table number 4, "Camp Lejeune versus Camp Pendleton: Hazard ratios and 95 percent confidence intervals, adjusted for (sic) sex, race, occupation, and education," correct?
A. Correct.
Q. If we look at this Table 4, for -- and we -- for NHL, the hazard ratio is 0.83, comparing Camp Lejeune to Camp Pendleton, correct?
A. Correct.
Q. That hazard ratio does not suggest an association between NHL and exposure to contaminants at Camp Lejeune for civilians, correct?
A. Correct.
Q. I'd now like to turn to the 2024 Bove studies that you talk about in your report and supplemental report.
A. Okay.

Q. I'll ask you some general questions while we wait.

Bove did not use statistical significance testing to interpret his findings in these two reports, did he?

A. These ones or --

Q. No, I'm sorry, the 2024 reports that we're about to talk about.

A. That was what was quoted in his study, correct? I'll just...

MS. O'LEARY: Oh, I'm sorry, that should be 20.

THE WITNESS: Oh.

MS. GJONAJ: Yeah.

THE WITNESS: So... Oh.

MS. KLIMEK: We need to mark that as Exhibit 12.

MS. O'LEARY: Yes.

MS. KLIMEK: I'm sorry.

(Whereupon Exhibit 12 was marked for the record.)

BY MS. KLIMEK:

Q. Do you recall Dr. Bove using something called "confidence interval ratios"?

A. Yes.

Q. Can you explain to me how to calculate a confidence interval ratio?

A. It's simply the ratio of the upper bound in a confidence interval versus the lower bound.

Q. Is this a generally accepted practice in epidemiology, to use a confidence interval ratio?

A. I think it was a relatively novel way of trying to describe the precision of the effect estimates.

(Stenographic reporter clarification.)

THE WITNESS: A relatively novel way of trying to describe the precision of the estimates.

BY MS. KLIMEK:

Q. Have you ever used confidence interval ratios in any of your peer-reviewed studies?

A. I have not.

Q. Have you reviewed other peer-reviewed studies where a confidence interval ratio has been used?

A. No, I have not.

Q. On the mortality study that I handed to you, do you agree that this included 40 years of follow-up?

If you look on page number 9, 40 years of

follow-up from 1979 to 2018?

It would be the first sentence under the discussion section.

A. Yes, I see that.

Q. In the mortality study, Dr. Bove compared a Camp Lejeune cohort to a Camp Pendleton cohort again, correct?

A. Correct.

Q. And the exposures for those at Camp Lejeune were not directly measured.

They were estimates, correct?

They used base locations as a proxy for drinking water exposures?

A. Well, they used actual measurements as the basis from which to do projections.

Q. Okay. Dr. Bove assumes that those at Camp Lejeune are considered exposed, and those at Camp Pendleton are considered not exposed, is that correct?

A. Correct.

Q. Dr. Bove didn't have data on any of the health risk factors or other health factors considered, correct?

MS. GREENWALD: Objection. Form.

A. Well, he certainly had data on age and presumably sex. But other than that, he did not have

data on other covariates.
BY MS. KLIMEK:
Q. On page 43 of your report, you acknowledge that almost none of the elevated risk ratios associated with specific cancers were statistically significant, correct?
A. Hold on. Correct.
Q. That includes NHL, correct?
A. Correct.
Q. If we can jump back to the study again and look at Table number 2. It would be page number 6.
A. This is 2024 or 2014?
Q. We are -- I'm sorry. We are on the 2024 mortality study, which I believe was marked as Exhibit 12.
A. Okay. So where do you want to go again?
MS. GREENWALD: Table 2.
THE WITNESS: Table 2?
MS. GREENWALD: On page 6.
THE WITNESS: Okay.
BY MS. KLIMEK:
Q. This table is comparing Camp Pendleton cohort to the Camp Lejeune cohort underlying causes of death, correct?
A. Correct.

Q. And if you look at the row for NHL -- you've got it? Okay. The risk ratio is 0.87, correct?

A. Correct.

Q. And the observed SMR for NHL at Camp Lejeune is 0.73?

A. Correct.

Q. And Camp Pendleton, it is 0.83, correct?

A. Correct.

Q. Would you agree that this means that there was a higher percentage of Camp Pendleton cohort deaths from NHL than in the Camp Lejeune group, correct?

A. Correct.

Q. If you could turn your attention to the -- Table 3 on page 7 of the study. This is a civilian cohort for Camp Lejeune and Camp Pendleton, correct?

A. Correct.

Q. If you look roughly at the middle of the table, you will see NHL?

A. Yes.

Q. And the risk ratio is reported at 0.98, correct?

A. Correct.

Q. In the observed standard mortality ratio

for Camp Lejeune, civilians is 1.12?

A. Correct.

Q. And for Camp Pendleton, it is 1.13, correct?

A. Correct.

Q. Again, that means that a higher percentage of the civilian cohort at Camp Lejeune -- I'm sorry, at Camp Pendleton died from NHL than in comparison to Camp Lejeune, correct?

A. Correct.

Q. And there was no increased risk of NHL in the population included in Table 3, correct?

A. That -- correct.

Q. If you could turn to the next page, Table number 4. This is hazard ratio for the Marines, Navy personnel subgroup analysis of base location at Camp Lejeune versus Camp Pendleton; underlying cause of death, correct?

A. Correct.

Q. Again, if you look roughly in the middle of the table, you will see NHL?

A. Correct.

Q. The adjusted risk ratio is reported at 0.87, correct?

A. Correct.

Q. That's no indicate -- that is not indicative of a positive association, correct?
A. Correct.
Q. And turning to the last table, page -- Table number 5, on page number 10, this is a comparison of Camp Lejeune and Camp Pendleton civil workers; underlying cause of death comparison, correct?
A. Correct.
Q. Again, if you look roughly in the middle of the table, you will see NHL?
A. Yes.
Q. The adjusted hazard ratio is reported at 0.95, correct?
A. Correct.
Q. Again, no positive association, correct?
A. Correct.
Q. Attached to your study, there should be -- it's a supplemental table, Table S6. It would be the very last page, probably.
A. Oh. S6?
Q. Yes.
A. Yeah, I got it.
Q. Supplemental -- yes.
A. Yeah.

Q. This said, "Hazard ratios and 95 percent lower and upper confidence intervals for the Marines/Navy personnel subgroup analysis of base duration between '75 and '85 at Camp Lejeune with Camp Pendleton as a reference," correct --

A. Yes.

Q. -- "Underlying cause of death."

And if you look at the second page, the top quarter of the second page, you see "NHL," correct?

A. Yes.

Q. For low duration, the hazardous ratio for NHL is 1.05, correct?

A. Correct.

Q. But the confidence interval is 0.75 to 1.47, correct?

A. Correct.

Q. Not statistically significant, correct?

A. Correct.

Q. For the medium duration, the hazardous ratio is 0.98, correct?

A. Correct.

Q. No positive association there, correct?

A. Correct.

Q. For the high duration exposure, the HR is 0.72, correct?

A. Correct.
Q. Would you agree no positive association there?
A. Correct.
Q. Would you agree that the highest hazardous ratio was for the lowest duration?
A. As expressed in this table, correct.
Q. Correct. And then it decreased with the lowest hazard ratio being the highest duration, correct, 0.72?
A. Correct.
Q. So this is indicative of no dose-response relationship with respect to NHL, correct?
A. Given the limited data they have, correct.
Q. You don't mention this in your report, correct?
A. Correct.
Q. I'd like to turn now to the 2024 Cancer Incidence Study, which is discussed in your supplemental report, correct?
(Whereupon Exhibit 13 was marked for the record.)
A. Correct.
Q. There's no individualized exposure assessment performed for this study, correct?

A. Correct.
Q. If you could turn to page -- or Table 3. Did you locate Table 3?
A. Yes.
Q. Page 7.
A. Oh, yeah, I think I'm there.
Q. You've pulled some data from this table that is reported in your supplemental report, correct?
A. Yes.
Q. Table 3 shows both confidence intervals and confidence interval ratios, which we just talked about, correct?
A. Yes.
Q. And you've agreed that you have not used confidence interval ratios in either your research -- in your research, correct?
A. Correct.
Q. Not generally accepted in epidemiology to use confidence interval ratios?
MS. GREENWALD: Objection. Form.
BY MS. KLIMEK:
Q. And peer-review articles that you have seen, have you seen confidence interval ratios?
MS. GREENWALD: Objection. Form.
BY MS. KLIMEK:

Q. Intervals, I'm sorry.
A. I simply don't recall having that metric discussed in the epidemiologic literature.
Q. Table 3 lists several subtypes of NHL, correct?
A. Yes.
Q. In your supplemental report, you mentioned mantle cell and marginal zone B-cell, correct?
A. Correct.
Q. These two subtypes show adjusted hazard ratios of greater than 1.2 with confidence interval ratios of less than 3, correct?
A. Well, of 3.
Q. Excuse me?
A. Of 3.
Q. Of 3?
A. Of 3, yeah.
Q. And this was something Dr. Bove came up with, correct?
MS. GREENWALD: Objection. Form.
A. You mean the confidence incidence ratio metric?
BY MS. KLIMEK:
Q. Yes.
A. If that's what you mean, yes.

Q. You don't mention in your supplemental report NHL subtypes: follicular, diffuse large B-cell, or Burkitt, correct?
A. I'll have to go back to my report.
Q. It would be your supplemental report, I'm sorry. Which would be, I think, Exhibit 3.
A. So I mentioned the mantle cell and marginal zone B-cell lymphoma --
Q. Correct.
A. -- results.
Q. You did not mention the results for follicular, diffuse large B-cell, or Burkitt, correct?
A. I did not.
Q. None of these subtypes reflect adjusted hazard ratios of greater than 1.2 with confidence interval ratios of less than 3, correct?
Again, we're looking at follicular, diffuse large B-cell, and Burkitt subtypes of NHL.
A. Gee, it looks like the follicular lymphoma has a elevated adjusted hazard ratio with a confidence incident ratio under 3. I just forgot to mention it.
Q. The other two do not, correct?
A. Correct.
Q. Nor does NHL overall, correct?
A. Well, the adjusted hazard ratio for NHL in

general is a little above 1, 1.01, with a confidence incident ratio of 1.3.

Q. Would you consider 1.1 -- or, I'm sorry, 1.01?

MS. GREENWALD: Objection. Form.

A. What was the question?

BY MS. KLIMEK:

Q. I'm sorry, I've got to find the...

Non-Hodgkin's lymphoma is 1.01?

A. Correct.

Q. Okay. With the... No, with the adjusted hazard ratio.

A. Yes.

Q. Okay. Still looking at that same Table number 3, none of the confidence intervals listed on Table 3 for NHL or its subtypes are statistically significant, correct?

A. Well, as defined as the confidence interval will exclude one, you are correct.

Q. Would you agree this study does not support an association between NHL overall and the Marines and the water contamination at Camp Lejeune?

A. Okay. Sorry, could you repeat that question?

Q. It's for looking at NHL overall, not the

subtypes.

A. Uh-huh.

Q. This study does not support an association between NHL overall and the Marines and the water contamination at Camp Lejeune?

A. I would agree with that.

Q. If it's true that exposure to contaminated water at Camp Lejeune caused NHL, that's an assumption, then why is the adjusted hazard ratio lower in Marines, who had -- who would have been more likely to have lived on base, than the hazardous ratio for civilians who would not have lived on base?

MS. GREENWALD: Objection. Form.

A. I think you might have mixed a couple of things up. Can you repeat? You -- you -- say that question again.

BY MS. KLIMEK:

Q. Okay. The exposure to contaminated water at Camp Lejeune, if -- if it is true that exposure to contaminated water at Camp Lejeune caused NHL, then why is the adjusted hazard ratio lower in the Marines, who would have lived at Camp Lejeune, than the hazard ratio of civilians who would not have lived at Camp Lejeune?

A. I think you're --

MS. GREENWALD: Objection to form.

A. I -- I think you meant to compare Camp Lejeune with Camp Pendleton, not the military personnel and civilians, because the --

BY MS. KLIMEK:

Q. No --

A. These tables are comparing military to military, not military to civilians.

MS. KLIMEK: Okay. If you would -- supplemental report.

Q. In your supplemental report, you note that there is a slightly elevated hazard ratio for civilians, correct?

A. Oh, I see what you're doing. All right. You're looking at that last sentence rather than the tables.

Q. Yes. I'm sorry.

A. Right. Okay.

Q. And my question is why would there be a adjusted hazard ratio lower in the Marines who would have been more likely to have lived at base than the hazard ratio that you refer to in your report for civilians who would not --

A. Ah.

Q. -- have lived at the base?

A. Oh, sure. Well, I mean, there's two things. First of all, the civilians in general are older, so non-Hodgkin's lymphoma happens to be a disease that affects primarily older individuals. I believe that the median age of the development of NHL is in the late 60s, whereas the follow-up of the Marines and Navy personnel involves individuals who are much younger on average than the civilians. So the civilians simply had a longer period of time during an older age period in which to develop NHL. So that's one obvious reason why one might expect to see NHL arise in the civilian population at a point of observation when the Marines and Navy personnel simply just didn't have enough observation time when they were older.

Q. Wouldn't the age be the same for the civilian population?

MS. GREENWALD: Objection. Form.

BY MS. KLIMEK:

Q. The age average for the civilian population? I guess, do you know the age average of the civilian population?

A. Well, let's -- let's go back to some of the tables. I think that would help us understand this.

THE WITNESS: Is this it?

MS. GREENWALD: It's number 13.
THE WITNESS: Yeah, I think this is it, but I kind of already took it apart.
MS. GREENWALD: Yeah, here, let me --
THE WITNESS: So let me just see if I know. Yeah, okay --
MS. GREENWALD: -- (indiscernible cross talk) back together here.
THE WITNESS: -- this is it. Yeah, this is right. But I kind of misplaced it. Oh, here we go.

A. Okay. So in the Table 1, the age at start of follow-up is 35 in Lejeune, 35.2 in Pendleton, whereas for the civilians, it was 52.9 and 55.1. So clearly the civilians were substantially older than the military personnel.

BY MS. KLIMEK:

Q. And you're looking at which table for the civilians?

A. I'm looking at Table --

Q. 2?

A. -- 2.

Q. To your knowledge, has any authoritative body found that TCE, PCE, benzene causes mantle cell non-Hodgkin's lymphoma?

A. Not that I'm aware of.
Q. To your knowledge, has any authoritative body found that TCE, PCE, benzene cause marginal zone B-cell NHL?
A. Not to my knowledge.
Q. On page 44 of your report -- 43 and 44 of your report, where you talk about combined effects of exposure to TCE, PCE, benzene, and NHL?
A. I'll get there for that.
THE WITNESS: Anybody happen to have another paper clip so I don't mess this all up?
MS. GREENWALD: Here, you can just take this and put it over there.
THE WITNESS: Okay, thanks.
MS. GREENWALD: Sorry.
A. I'm sorry, Counselor, what page?
BY MS. KLIMEK:
Q. I'm going to discuss pages 43 and 44 of your report.
On page 44 of your report regarding the possible combined effects of exposure to TCE, PCE, benzene, and NHL?
A. Yes.
Q. You opine that the combined risk of simultaneous exposure to TCE, PCE, and benzene is more

likely than not to be at least additive, correct?

A. Correct.

Q. But you've also admitted in your report that there's lack of direct evidence of their combined effects, correct?

A. Correct.

Q. You stated that the lack of research and peer-reviewed studies that provide substantive evidence regarding the risks posed by mixtures of carcinogens has been acknowledged for a long time, correct?

A. Correct.

Q. And while you have stated that it's theoretically possible that two chemicals may interact in some way to increase the risk of NHL beyond what would be expected by summing the individual risks, isn't it also theoretically possible that chemicals interacting may have no significant -- no influence on the risk of NHL?

MS. GREENWALD: Objection. Form.

A. Well, your hypothetical -- if you're also assuming that all three have been individually shown to increase the risk of cancer, I guess my response would be, there simply isn't direct experimental or epidemiologic evidence with which to demonstrate

empirically what the combined effect would be.
BY MS. KLIMEK:
Q. You state in your report it's -- it's additionally possible that two chemicals may interact in some way that results in an overall risk of NHL that is less than the sum of the individual risks; is that correct?
A. Yes, I may -- I said that in my report.
Q. Does your report cite any direct evidence that the chemicals addressed in your report interacted in some way at Camp Lejeune that increased the risk of NHL overall?
A. No.
Q. Isn't it possible that even if an interaction occurred, that interaction may not have had an impact on the risk of NHL?
MS. GREENWALD: Objection. Form.
A. That seems general. Can you be more specific? You just said will not have an impact.
What kind of impact do you mean?
BY MS. KLIMEK:
Q. On the --
A. Multiplicative? Additive?
Q. On -- on the risk of NHL.
MS. GREENWALD: Same objection.

A. Well, I mean, as I opined in this report, given what we know about mechanisms of interaction, the expectation in this case is that the three carcinogens in a mixture would act in an additive effect in terms of increasing the risk. That's all I can say.

BY MS. KLIMEK:

Q. Would it be theoretically possible that such interaction actually decreased -- would decrease the risk of NHL?

A. Decrease below the additive risks of the three, or decrease the risk below individual risks?

Q. The additive.

A. It's possible.

Q. You've not performed any research or experiments to test the hypothesis that exposure to a mixture of TCE, PCE, and benzine is more carcinogenic than exposure to just one of these chemicals, correct?

A. I have not.

Q. Do any of the studies or agency reports cited in your report conclude that TCE, PCE, and benzene act synergistically and additively to cause cancer?

A. I don't recall if any of the agency reports even address the question of mixtures.

Q. Same question for NHL: Do any of the studies or agency reports cited in your report conclude TCE, PCE, and benzene act synergistically or additively to cause NHL?

A. I don't believe the subject has been addressed in any of those reports.

Q. When you were initially retained in this matter, were you asked to evaluate TCE, PCE, and benzene individually?

A. Yes.

Q. Then were you later asked to form an opinion based on the mixture of these chemicals?

A. Yes.

MS. GREENWALD: Objection. Form.

BY MS. KLIMEK:

Q. Do you believe that interactions may occur at specific dose ranges and may not occur at other ranges, dose ranges?

A. Theoretically, I think that would be true.

Q. Then the linear threshold model asserts that effects occur at all dose ranges, correct?

A. It basically says that there's no threshold below which some kind of effect would not be anticipated.

Q. So with the linear, no threshold wouldn't

apply, correct?

A. To what?

Q. The mixtures. We don't know the specific dose ranges and if they would have an effect at certain ranges.

MS. GREENWALD: Objection. Form.

A. Well, assuming -- I'm not sure I agree with that. I mean, assuming that you're exposed to three chemicals and each of them at a concentration greater than zero, one can assume that they'll increase the risk. It's just unclear exactly how great they would increase the risk in concert.

BY MS. KLIMEK:

Q. Turning back to your report, page 8 of your report, you present a summary of your opinions, and I want to start by asking you about the first two.

It is your opinion that TCE is a human carcinogen and that TCE more likely than not can cause NHL; is that correct?

A. Correct.

Q. Okay. On that same two -- on that same page, you state that those above two opinions are based on your review and agreement of the 2014 monograph published by IARC, correct? And your review of its underlying sources, studies on its assessment

of TCE's carcinogenicity, as well as review of IARC's assessment of TCE as a risk factor specifically for NHL, correct?

(Whereupon Exhibit 15 was marked for the record.)

A. That was one of several.

Q. Correct. We're going --

A. Yes.

Q. Number two -- second is your review and agreement with the 2015 monograph published by the NTP on its assessment of TCE's carcinogenicity, as well as your review of its underlying sources, studies, as well as review of the NTP's assessment of TCE as a risk factor, specifically for NHL, correct?

A. Correct.

Q. Then your assessment of the scientific literature that has appeared since the 2014 IARC monograph and 2015 NTP monograph, which you state provided additional evidence on TCE as a risk factor, specifically for NHL, including both toxicological and epidemiological evidence, correct?

A. Correct.

Q. And consideration of the evidence in relation to the Bradford Hill considerations.

A. Correct.

Q. You read each of the underlying studies identified and considered by IARC and NTP?

A. Pretty much all of them.

Q. How did you determine what post-IARC and post-NTP monographs literature to review?

A. By reviewing the literature, through literature search, as I discussed earlier in this deposition, and then comparing the references that occurred at around the time of the reports and afterwards with the bibliography in the IARC document itself.

Q. Did you use date restrictions?

A. Well, generally yes, but there's a recognition that there are reports that were published at around the same time as the IARC report was published that were not actually reviewed by IARC because the IARC report was the result of a workshop that occurred two years earlier. So I was liberal in trying to understand what was the research around that time, as well as whatever research occurred and was published after the publication date of the IARC report.

Q. On page 11 of your report, you state that the IARC monographs program is a core element of the IARC's portfolio of activities with international

expert working groups applying rigorous procedures for the scientific review and evaluation of carcinogenic hazards, correct?

A. Correct.

Q. Is this still your opinion?

A. More or less, yes.

Q. Each monograph reviews all the pertinent epidemiology studies, cancer bioassays, experimental animals, and mechanistic and other relevant data in making an assessment, correct? In general?

A. More or less, yes.

Q. It's your opinion, as set forth on page 12 of your report, that IARC's conclusions and analysis made in the monographs are thought of as being rigorous and, in general, authoritative, with conclusions made carrying substantial weight in the scientific community, correct?

A. Yes. As, again, referent to the time when the report was published, as well as the timing of deliberations that were made that went into the report.

Q. And the monograph -- IARC monographs, they evaluate cancer hazardous -- hazards, correct?

A. Yes.

Q. And a cancer hazard, as defined by IARC, is

an agent that is capable of causing cancer under some circumstances?

A. I think that's more or less correct.

Q. While a cancer risk is an estimate of the carcinogenic effects expected from exposure to a cancer hazard; is that correct?

A. Yes.

Q. You would agree that a hazard is not the same as a risk, correct?

A. Correct.

Q. And the IARC monographs classify and evaluate cancer hazards, not risks, correct?

MS. GREENWALD: Objection. Form. Asked and answered.

A. More or less, yes.

BY MS. KLIMEK:

Q. The monographs identify cancer hazards even when the risk of the carcinogenic effects expected from the exposure to a cancer is low, correct?

MS. GREENWALD: Objection. Form.

A. As we just discussed, they're not in the business of assessing risk, which is, they're more in the business of assessing whether something's a hazard or not.

BY MS. KLIMEK:

Q. So you would agree?
A. Yes.
Q. When IARC classifies a chemical as to its likelihood of being carcinogenic to humans, the classification does not apply to all cancer types, correct?
A. I'm not sure I agree with that. Can you say that again?
Q. IARC classifies a chemical as to its likelihood of being carcinogenic to humans does not -- I'll rephrase a little bit -- does not mean that the classification indicates that the carcinogenic properties are related to all cancer types, correct?
MS. GREENWALD: Objection. Form.
A. I think you mean all cancer types and subtypes. Is that what you mean?
BY MS. KLIMEK:
Q. Sure.
A. Sort of like in our discussion of different types of NHL. Right. I would agree with that, under that context.
Q. Thank you.
And then in your report, we're talking about the 2014 IARC, which was Volume 106, that addressed the carcinogenicity of several chlorinated

agents, including TCE, correct?
A. Published in 2014, Volume 106.
Q. Correct.
A. Yes, correct.
Q. I'm not sure we need this, but we'll go ahead. This is Exhibit 14.
(Whereupon Exhibit 14 was marked for the record.)
A. Oh, that's heavy.
Q. If you flip to page 31. So on page 31, IARC classified TCE as being carcinogenic to humans based on sufficient epidemiological evidence for cancer of the kidney with mechanistic -- strong mechanistic support for studies in experimental animals and exposed humans, correct?
A. Yes, correct.
Q. The classification of TCE as carcinogenic to humans was not based on a finding of sufficient epidemiological evidence for NHL, correct?
A. Not specifically, no.
Q. In fact, the IARC working group did not find sufficient evidence between TCE and NHL, correct?
A. As they put it, they found limited evidence for an association between TCE and non-Hodgkin's lymphoma.

Q. Limited evidence for a positive association for NHL means that there was insufficient human evidence?

MS. GREENWALD: Objection. Form.

BY MS. KLIMEK:

Q. And they could not rule out chance, bias, or confounding, correct?

A. More or less correct.

Q. IARC's -- on page 185, IARC's assessment was that, quote -- I'm sorry.

A. Okay.

MS. GREENWALD: What page are you on? I'm sorry.

THE WITNESS: 185.

MS. GREENWALD: 185.

BY MS. KLIMEK:

Q. Second paragraph, second column, IARC's assessment was that there was modest positive association of NHL with exposure to TCE, were observed in several case-control studies, but the results were inconsistent overall, correct?

A. That's what's written here, correct.

Q. And while there were some indications of an exposure response relationship, these were also inconsistent and generally not statistically

significant, correct?

A. That's what's written here.

Q. What IARC has stated?

On page 158, IARC noted that the evidence for mechanisms of NHL in humans and animals -- I'm sorry, wait till you get there.

A. 158?

Q. Yes.

A. Okay.

Q. IARC noted that the evidence for mechanisms of NHL in humans and animals is limited to studies of the immune system toxicity, correct?

It's under section 4.3.3, Immune System.

A. No, I see that.

Q. Oh, okay.

A. But I think -- I believe I need to read a little bit further to answer your question.

Q. Sure.

A. Sorry to do this to you, but you mind repeating the question?

Q. Sure. IARC noted that evidence for mechanisms of NHL in humans and animals is limited to studies of the immune system toxicity.

And my question was, do you agree?

A. Okay, hold on. I'm not sure I agree with

that. I mean, in the preceding pages, in the discussion of experimental evidence of trichloroethylene, there's various references to studies that showed that trichloroethylene has effects that either pertain to genotoxicity or pertain to genotoxicity of its metabolites. So I wouldn't say that the experimental evidence is completely lacking for non-immunologic effects of TCE that pertain to biological mechanisms that could cause cancer.

Q. On page 13 of your report, you state that in reaching the conclusions -- in reaching its conclusion regarding the association between TCE and NHL, IARC independently evaluated eight cohort studies, eight case-control studies, and several meta-analysis studies, correct?

A. Okay, let's see. Where are we?

Q. Page 13 of your report.

A. Page 13. Correct.

Q. All the studies included in IARC's systematic review were occupational studies, correct?

I'll ask that question again when we have a chart in front of us, if that makes it easier.

A. Okay. Because I -- unless I specifically said that on my own report, I'd have to go through the studies to verify --

Q. Correct. Okay.
A. -- whether I agree with that.
Q. The studies that you did mention in your report, Hardell, Hansen, these would all be on -- under the strength of association, page 23, you cite to several studies. The top of page 23.
A. Okay.
Q. The Hardell, et al., 1994 study; the Hansen 2001 study; the Raaschou-Nielsen 2003 studies, and also the meta-analysis studies by Mandel, and the meta-analysis study by Scott and Jinot, 2011.
All of these studies that you mention in your report, they were all part of IARC's analysis of whether there was an association between NHL and TCE, correct?
A. I have no reason to disagree with you, but I'd have to actually go through the --
Q. Okay.
A. -- whole report to figure out if that's true.
Q. Would you agree that the studies that IARC evaluated, many of the studies, they found no association between TCE exposure and incidence of NHL?
MS. GREENWALD: Objection. Form.
A. I would agree that many of them did not

find a so-called statistically significant association between TCE and NHL.

BY MS. KLIMEK:

Q. If you can flip to page 82 through 86 of the IARC, you see a chart 2.4, case-control studies --

A. Yes.

Q. -- of NHL? And these are the studies listed.

And would you agree that the following case-control studies that are listed, starting with the Persson and Fredrikson's 1999 study, showed no statistically significant association, correct?

A. The relative risk was over 1, but the confidence interval did not exclude 1.

Q. So you would agree?

A. I would agree.

Q. If you look at the Miligi study right under it for 2006?

A. Yes.

Q. Would you also agree that there was no statistically significant association shown between NHL and TCE?

A. No, but I will point out there was a relative risk of 1.9 with a confidence interval that is close to 1.

Q. But you would agree?
A. Yes.
Q. The Seidler, et al., 2007 study?
A. Yes.
Q. Would you agree that there's no statistically significant association?
A. Not quite. I mean, at the highest exposure level, at greater than 35 parts per million years, the relative risk is 2.1 with a confidence interval of 1.0 to 4.8. So I think many of my colleagues would consider that borderline statistically significant.
Q. But would you agree with the -- the parameters we talked about earlier, it would not be statistically significant?
MS. GREENWALD: Objection. Objection.
BY MS. KLIMEK:
Q. The risk ratio is not above 1?
MS. GREENWALD: Objection. Form.
A. Well, like I said, it's borderline.
BY MS. KLIMEK:
Q. Do you know what -- do you know what 35 ppm's would be years in ppb?
A. Sure. Multiply by 1,000.
Q. So 35,000 ppm?
A. Times the number of years of exposure.

Q. Okay. Christensen study, 2013. It's the very last study on page 86.

A. Oh, 86. Okay.

Q. Would you agree that there was no -- they did not find a positive association, statistically significant?

A. Yeah, it was positive association, but it was not statistically significant.

THE WITNESS: Counselor? Can we go off the record for a second? So I'm not in a food coma, but I do have to take a bathroom break.

MS. KLIMEK: Yeah, I'm sorry. We were going to stop in a minute.

THE VIDEOGRAPHER: The time is --

MS. KLIMEK: But we're good.

THE VIDEOGRAPHER: -- 2:54 p.m. We're going off the record.

(Whereupon a recess was taken.)

THE VIDEOGRAPHER: The time is 3:06 p.m. We're back on the record.

BY MS. KLIMEK:

Q. Dr. Hu, if we could go back to the IARC Table 2.4, which is pages 82 and 86.

We were talking about some of the studies in the chart that did not show a statistically

significant risk ratio, correct?

A. Correct.

Q. I'd also like to draw your attention to the Cocco, et al, 2010 study, which is on page 83 of Table 2.4.

A. Okay.

Q. It's the very last study?

A. Yes.

Q. Again, if we look at the -- this one broke it down by different types of NHL, correct? Subtypes?

A. Correct.

Q. Okay. And we don't see a statistically significant risk ratio.

A. Right. These are all pretty small sample sizes, and none of the confidence intervals excluded 1. And -- but there were a couple of point estimates that were greater than 1.

Q. But not statistically significant risk ratio, correct?

A. Correct.

Q. Some of the studies in this chart, you mention in your report because they have a statistically significant risk ratio, correct?

One of the studies that we just reviewed, you did not mention in your report, correct?

A. So... Okay.
Q. On your report, it --
A. My recollection is that in my report, I only delved into individual studies that were not included in the IARC report, but maybe I'm wrong.
So can you point out to me where my report is?
Q. Sure. If you look at page 23, top of 23, you mention the Hardell study, correct? The Hansen study?
A. That's right.
Q. All of these studies are reflected and were evaluated by IARC, correct?
A. That's correct.
Q. Okay. And, again, the only studies mentioned in your report by name are the studies that showed a statistically significant risk ratio, correct?
A. That's correct, in this section where I'm discussing strength of association.
Q. Any other section in the TCE? Do you mention any studies that do not show a statistically significant risk ratio in any part of your TCE discussion?
A. I could have, but I left that up to the

agencies themselves.

Q. But the agencies evaluated both positive and negative studies, correct?

A. That's correct.

Q. That are reflected in this chart, correct?

A. Yes.

Q. Okay. And we just went through and identified several studies where there's no statistically significant risk ratio, correct?

A. Correct.

Q. Okay. Do you recall -- these were the case-control studies.

Do you recall reviewing the cohort studies that you mentioned?

You mentioned that you had reviewed eight, I believe, in your report?

A. Yes.

Q. If you turn to page 5152, Table 2.1 of IARC, we see the cohort studies, correct?

A. Correct.

Q. And again, on the chart 2.1, there are several studies that show no statistically significant association, correct?

A. There are some that show statistically significant elevated risks and others that did not.

Q. For example, the first one, there's not a statistically -- statistically significant risk ratio there, correct?

A. The risk is elevated at 1.56, but the confidence intervals do not exclude 1.

Q. Okay. Same with the Greenland study, maybe midway down on that same page.

No positive association, correct?

A. Correct. The risk estimate is actually less than 1.

Q. The Boice study, top of the next page, first study?

A. Yes. The risk ratio is under 1.

Q. And then the other two studies following it, the Lipworth, et al., the Radican, et al. study?

A. The risk ratios are elevated, but the confidence intervals do not exclude 1.

Q. So not statistically significant, correct?

A. Correct.

MS. GREENWALD: Objection. Form.

BY MS. KLIMEK:

Q. And, again, none of the studies that we just went over that showed no statistically significant risk ratio are mentioned in your report, correct?

A. No. Since they were summarized by the IARC report, I felt no need to go over those.

Q. But you pulled positive associations out of the IARC report, correct, and individually mentioned them?

A. Well, for a specific purpose, that is, to discuss the strength of association consideration in the Bradford Hill criteria -- Bradford Hill considerations.

Q. You would consider the Boice and the Radican studies quality studies? You discussed them in the PCE section of your report?

A. Can you remind me where I discussed them?

Q. I believe on page 28 in the PCE section of your report. Boice is maybe five lines down. Radican is the last study you talk about in that first paragraph.

A. Yes. These were studies that I thought were high quality with respect to exposure assessment methodology, but they were discussed in the context of my evaluation of PCE, not TCE.

Q. Correct, but those reports showed no TCE association. We can look at them later.

A. I have no reason to disagree with what you said, but I'd have to look at it to really make sure

that they're the same studies.

Q. I'd like to now turn to the NTP assessment of TCE.

The NTP also evaluates cancer hazardous (sic) through a multi-step process and reviews scientific evidence, correct?

A. Correct.

Q. In 2015, the NTP conducted a cancer hazard assessment of TCE, correct?

A. In 2015, they published --

Q. Published, okay.

A. -- a report, yes, on TCE as a risk factor for cancer.

Q. And that focused on three types of cancer, correct? Kidney -- kidney cancer, NHL, and liver cancer?

A. Correct.

Q. The NTP reached conclusions regarding the strength of the evidence for each of these three cancers, correct?

A. Correct.

Q. If you turn to the abstract of the NTP 8XII, this is where we see the summaries of NTP's opinion for each of the three cancers.

MS. GREENWALD: I'm sorry, what page

did you say?

MS. KLIMEK: It's the abstract. I guess it's X --

MS. GREENWALD: Roman numeral 8.

MS. KLIMEK: Yeah, Roman numeral 8.

MS. GREENWALD: Oh, Roman numeral 8.

MS. KLIMEK: I'm sorry.

MS. GREENWALD: No, no, no, no.

MS. KLIMEK: XIII. Is that 8?

MS. O'LEARY: Yes.

MS. GREENWALD: Okay.

THE WITNESS: Like Super Bowl. It's on Roman numeral...

BY MS. KLIMEK:

Q. You see that page? There you go.

A. Yes.

Q. Okay. And the NTP concluded from its hazard evaluation that there was sufficient evidence to designate PCE as a human carcinogen, correct?

A. Correct.

Q. The last sentence of the abstract -- I'm sorry.

XIII, sorry.

MS. GJONAJ: Dr. Hu, what page were you on?

THE WITNESS: Roman numeral 8 of the --
MS. GJONAJ: Okay.
THE WITNESS: -- NTP report.
MS. KLIMEK: 8 or 13? It says "abstract" at the top, correct?
MS. O'LEARY: Yes.
THE WITNESS: Yes.
MS. GREENWALD: Okay. All right. I was going too far. Thank you.
BY MS. KLIMEK:
Q. The last -- the last sentence of the abstract says, "This conclusion is based on epidemiological studies showing that TCE causes kidney cancer in humans, together with supporting evidence from toxicological" -- "toxocenic" --
A. Toxicokinetic.
Q. Thank you.
-- "and mechanistic studies demonstrating the biological plausibility of its carcinogenicity in humans," correct?
A. Correct.
Q. On page 14 of your report -- we can flip there -- you don't specifically state that the NTP based its conclusion on TCE as a human carcinogen on

the epidemiological studies showing that TCE causes kidney cancer, correct?

A. I didn't mention that specifically, but then I went on to discuss their review of -- with respect to NHL.

Q. You would agree that NTP's conclusion that TCE is a carcinogen was not based on epidemiological studies that showed that TCE causes NHL, correct?

A. As I stated, no.

Q. NTP's conclusion is that the epidemiological studies provide only limited evidence that TCE exposure causes NHL, correct?

MS. GREENWALD: Objection. Asked and answered.

BY MS. KLIMEK:

Q. If you look at page...

A. Correct.

Q. On the same page, the abstract, if you look at the NTP's conclusions in relation to kidney cancer -- which is the first one under Results and Decisions?

A. Yes.

Q. It states, "The NPT found the epidemiological studies to" -- quote, "to provide evidence of a causal relationship between exposure to

TCE and kidney cancer," correct?

A. Correct.

Q. "This was based on consistent evidence of increased risk of kidney cancer across studies with different study designs, geographical areas, and occupational settings," correct?

A. Correct.

Q. That conclusion was not reached for NHL, correct?

A. Correct. They just said it provided limited evidence based on positive association with several studies, and they also cited two meta-analyses that showed an increase with NHL.

Q. On page 108 and 109 of the NTP, it notes that their analysis included 11 cohort assay case-control studies, seven case-control studies, and two meta-analyses reporting on TCE exposure in association with NHL and related cancers, correct?

A. You're on page 109?

Q. 108, 109.

A. Oh. Oh, yes, that's correct.

Q. Okay. And like IARC, some of the studies that were included in NPT's analysis did not show statistically significant positive association, correct?

A. Correct.

Q. The Scott and Jinot, 2011, the Karami, et al., 2013, the Mendel, et al., 2006, Hardell study, 1994, Hansen, et al., 2001, Raaschou-Nielsen, 2003, and the Cocco, 2013, studies that you cite in your report were all included in NTP's analysis, correct?

I can refer you to page 130 of the NTP. It lists the Scott and Jinot study, the Karami study as being meta-analysis of TCI (sic) exposure and NHL.

A. Okay.

Q. Is that correct?

A. Yes.

Q. Would you agree that the other studies that you mentioned in your report were included in the NTP analysis, which again would be the Mendel, Hardell, Hansen, Raaschou-Nielsen, and Cocco, 2013?

A. But not the Odutola.

Q. But not the Odutola, correct. The Odutola study is the only epidemiological study you discuss in the TCE section of your report that has appeared subsequent to IARC and NTP, correct?

A. Yes.

Q. But you discuss the Karami, et al., page 18 of your report, which is part of the section on -- section D, "Literature That Has Appeared Since IARC

and NTP Reports on the Evidence Surrounding the Potential of TCE to Cause NHL," correct?

A. Say that again?

Q. You list the Karami study on page 18 of your report under a section that indicates -- it's not section 18. I'm sorry.

A. I'm sorry. This is a section that simply goes over systematic reviews and meta-analyses, not necessarily what appeared in the report or not.

Q. But if you look on page 15 of your report, the section heading D, "Literature That Has Appeared Since"; is that correct?

A. Yeah.

Q. Okay.

A. That's how it was titled.

Q. Then I want to jump back one more time to the NPT.

A. Okay.

Q. Again, to that abstract section, which would be 13, page 13, we've decided.

A. Okay.

Q. XIII.

A. Oh. Oops. Okay.

Q. It's noted that TCE most likely causes kidney cancer by its metabolism in the kidney to

genotoxic and cytotoxic GSH conjugation-derived metabolites, correct?

A. Yes.

Q. There's no discussion of any type of genotoxic or cytotoxic GSM (sic) conjugation-derived metabolites in the NHL summary, correct?

A. Not in the abstract.

Q. Okay.

A. I'd have to look at the bulk of the rest of the report, though, to see what they've discussed in terms of mechanisms that might be relevant to non-Hodgkin's lymphoma.

Q. If you flip to page 178 of the report. Page 178, section 7.2, NHL and Related Cancers, the first sentence of the third paragraph states, "The mechanisms by which TCE could cause lymphoma are largely unknown," correct?

A. That's what it says, correct.

Q. Would you agree that the NTP is indicating in that statement that any mechanism of TCE causing NHL is not genotoxic?

MS. GREENWALD: Objection. Form.

A. I'd have to go to their discussion -- actual discussion to see what they said to render opinion on that question.

BY MS. KLIMEK:

Q. If you flip one more page over to page 179 of the NTP, the last sentence in the NHL summary reads, "The mechanisms of the immunomodulation and lymphomagenesis are not completely understood, and neither the proposed model nor the potential association between TCE-induced immune effects and lymphoma have been directly tested in either humans or animals."

Do you agree?

A. Well, as I discussed on page 1920 of my report, there were some studies that I believe did not appear in either the IARC report or the NTP report that provided evidence of the potential biological mechanisms by which TCE could cause cancer.

Q. I'm sorry, which studies are you referring to?

A. Let's see.

Q. You said pages 18 and 19?

A. Of my -- I'm sorry. This is page 19 and 20 of my report.

Q. So you're saying there have been studies since then -- it's been directly tested in humans and animals since then; is that correct? Since IARC issued its report?

A. Yeah, hold on a second.
Q. I'm sorry. NTP, not IARC. I'm sorry.
A. So, yeah, I discussed the Zhang, et al., 2013 study, which does show up in the NTP bibliography, but for some reason they didn't discuss it, because it clearly, in my view, is some evidence, direct evidence, of immunotoxicity in humans. So, you know, as much as I find these reports being fairly authoritative, I think occasionally they misstate the evidence, as that -- that as an example.
Q. So that study did test directly in --
A. Yes. They tested the hypothesis that TCE exposure would be associated with markers of immune dysfunction, and they found that the exposed workers had a 17.5 percent decline in serum levels of IgG compared to the unexposed control, with a statistical significant p-value of .0002. Same thing with the serum levels of IgM, for the direct antibody levels that are about as functional an assay for immune function as you can get in human beings.
Q. Isn't it true that that's not a connection to lymphoma --
MS. GREENWALD: Objection. Form.
BY MS. KLIMEK:
Q. -- what you just read?

MS. GREENWALD: Objection. Form.

A. Well, to the extent that lymphoma may also be contributed to by immune dysfunction, it is.

BY MS. KLIMEK:

Q. Has that been tested?

MS. GREENWALD: Objection. Form.

A. Can you pose that as a complete question?

BY MS. KLIMEK:

Q. I'll have her read --

MS. KLIMEK: Could you read back what he stated, please?

(Whereupon the court reporter read back the requested record.)

Q. So I guess my question is, the connection between immune response and lymphoma from TCE, has that been tested?

A. I believe that immune dysfunction has been discussed as one of the mechanisms that may be at play in lymphoma -- the biological mechanisms of lymphoma. I can't sit here and cite chapter and verse right now, but I do believe that's true.

Q. Is the immune response you mentioned in Jinot associated with NHL?

A. The immune response I cited in what?

Q. Jinot.

A. Jinot. Help me.
Q. Page 20, I think, is what you were reading off of your report, since it --
A. Okay.
Q. -- wasn't discussed in the NTP.
A. Well, the study that I was discussing was Zhang. Zhang, et al., 2013.
Q. Oh, I'm sorry. I missed both. Yes, correct. Page 20 of your report.
A. Right. So what's the question?
Q. Is the immune response associated with -- in Zhang associated with NHL?
A. You mean, in other words, did the declines in immune function signaled by lower IgG and IgM levels -- are they mechanisms specifically associated with lymphoma? That I don't know.
Q. Okay. After reading the IARC and NTP monograms (sic) and the study's sources underlying them, you said that you concur with the evaluation made by both of these agencies, that there's limited evidence of a causal association between NHL and TCE at the time of their publication, correct?
A. Correct.
Q. Based on our early discussion about a finding, when we were talking about a finding of

limited evidence of an association between TCE and NHL, does that meet the more-likely-than-not standard --

MS. GREENWALD: Objection. Form.

BY MS. KLIMEK:

Q. -- that we spoke about earlier?

MS. GREENWALD: Objection. Form.

A. Well, when you summarize -- when I looked at all the evidence, including more recent evidence than appeared in the IARC and NTP reports, yes, I concluded that TCE exposure more likely than not is a cause of NHL.

BY MS. KLIMEK:

Q. Without the additional studies you looked at, with the conclusions of limited evidence that those two agencies stated, in your mind, does the limited evidence meet the more-likely-than-not standard?

MS. GREENWALD: Objection. Form.

A. I haven't thought of it that way, so I don't have an opinion on it. I think what is true is that the standard of -- of causation that both NTP and IARC use to make conclusions regarding causality is different than simply more likely than not. But without having directly considered your question, I

would say today I don't have an opinion on that.
BY MS. KLIMEK:
Q. Turning back to page 23 of your report, you mentioned a couple of the epidemiological studies, as well as the systematic meta-analysis study, that you say provide strong evidence of a -- strong evidence of a strong association between TCE and exposure to NHL, correct?
A. Correct.
Q. And is the strong association you refer to based on the studies' associated risk ratios?
A. As well as the fact that they were risk ratios that excluded 1.
Q. Okay. And the four individual studies that you cite, you believe those to be high-quality studies?
A. Relatively high quality, yes.
Q. And you determined the studies' quality was a factor in your opinions on causation, correct?
A. Yes.
Q. So the first study that you mention is Hardell, 1994, correct?
A. Correct.
Q. And you state that it - well, we'll get a copy of it for everybody.

MS. KLIMEK: This is Exhibit 16.

(Whereupon Exhibit 16 was marked for the record.)

Q. Dr. Hu, here's a copy of the study.

A. Thank you.

Q. And this was a Swedish population-based case-control study that evaluated TCE exposure overall and risk of NHL?

A. Correct.

Q. And as you noted in your report, Hardell reported a risk of -- for NHL among TCE-exposed subjects, which was 7.2, 95 percent confidence interval of 1.3 to 42, correct?

A. Correct.

Q. Would you agree that a confidence interval of 1.3 to 42 is relatively large and imprecise?

A. I would --

MS. GREENWALD: Objection. Form.

A. I would agree with that.

BY MS. KLIMEK:

Q. As noted in the study itself "Exposures were self-reported that might have been influenced by recall bias."

That's on page 2388 of the study, first sentence under the Discussion section.

A. That's true, but the authors went on to say that they conducted a validation exercise where they showed that the exposure information on the questionnaires was verifiable.

Q. If you look at Table 2 of the study, one page earlier, 2387, there were only four NHL exposure cases, correct?

A. Correct, which accounts for the wide confidence intervals.

Q. IARC also noted that the subjects could have also been exposed to phenoxy, acetic acids, and chlorophenol -- chlorophenols, but TCE solvent results were not adjusted for these exposures.

And I can pull it up.

I have to come up with the exact page cite in IARC. I'll come back to it.

A. Okay.

Q. Do you recall if the NTP monograph found the study to be of low quality?

A. Could you point me to that assessment? That would be helpful.

Q. I believe it is -- if you look on page 108 of the NTP monographs, it's listed as the lowest quality study.

A. Yes. It's in that low category, Limited

methods to consider potential confounders

Q. If you look on page 133 of the NTP.

A. Okay.

Q. I believe it's the first full sentence starting with "Limitations."

A. How far -- oh, there we go. Okay.

Q. "Limitations in study would primarily bias" -- look at the next sentence. "The high increased risk reported by Hardell, et al., should be viewed with caution because it was based on small numbers of exposed cases and controls, and this study had several methodological limitations"; is that correct?

A. That's correct.

Q. Okay. I found the reference in IARC where it talks about the Hardell study. It says, "NHL was associated with exposure to various" -- "to the phenolacetic acids, chloroforms, but TCE results were not adjusted for these exposures."

MS. GREENWALD: What page you're on?

MS. KLIMEK: I am on page 82 of IARC, Table 2.4.

BY MS. KLIMEK:

Q. It also faults the study for -- it says, "Exposure assessment was not described in detail."

Would you agree that both the NTP and IARC

found faults with the Hardell study?

A. I would agree with that.

Q. I'd like to turn your attention to the Hansen study, which is the next study you cite. Okay. This was the "Risk of cancer among workers exposed to TCE: Analysis of three Nordic cohort studies."

Actually, I'm -- I'm sorry. I'm going to -- you -- you discussed the Hansen 2001 study, correct?

Again, I'm sorry. I'm at the top of page 23. You talk about a study by Hansen, et al., 2001, that found workers exposed to TCE had an elevated standardized incident ratio of NHL of 3.5, correct?

A. Correct.

Q. Were you aware of the subsequent Hansen 2013 study that was included in NTP's 2015 analysis?

A. I can't recall.

Q. I'll hand this to you. This is -- marking it as Exhibit 17.

(Whereupon Exhibit 17 was marked for the record.)

This was a pooled cohort study with individual -- individual documented exposures to TCE in Finland, Sweden, and Denmark, and it included the 2001 Hansen cohort group. That would be in -- if you

want to see, that's in footnote 14.

Would you agree that this was what this study was about?

MS. GREENWALD: Objection. Form.

A. Yes. This is a follow-up study of the three Nordic cohorts.

BY MS. KLIMEK:

Q. If you look at the Results section on page 1, it states, in pertinent part, "We did not observe a statistically significant increased risk of NHL"; is that correct?

A. That's what they said in the abstract, but in fact, they did see a statistically significant increased relative risk for NHL among males. That is discussed on page 7, first paragraph. It just was not included in the abstract.

Q. It shows a statistically significant increased risk of NHL?

A. Yes, with a pretty tight confidence interval.

Q. Which numbers are you looking at?

A. Relative risk of 1.55, 95 percent confidence interval from 1.06 to 2.20.

Q. Do you know why the authors disregarded that in their abstract --

MS. GREENWALD: Objection. Form.
BY MS. KLIMEK:
Q. -- under summary of results?
MS. GREENWALD: Objection. Form.
A. Abstracts usually have a word limit, so authors have to pick and choose what results they put in the abstract, but to be thorough, I think it's important to look at all the results.
BY MS. KLIMEK:
Q. Would you agree, though, that that is a lower statistical rate than was found in Hansen, 2001?
A. That is true.
Q. And where they found this, the figure that you cited, that's just for men, correct?
A. Correct.
Q. I'd like to look at the Kamari (sic) meta-analysis that you also cite.
And again, Kamari was included in the NTP's analysis, correct?
A. You mean Karami?
Q. Karami, sorry.
I'll hand you a copy of the study, marked as Exhibit 18.
(Whereupon Exhibit 18 was marked for the record.)

Did you evaluate the underlying studies in this meta-analysis?

A. Many of them.

Q. In your report, did you provide any type of assessment of the studies that were reflected?

A. You mean an independent review of each of the studies included in the meta-analysis?

Q. The meta-analysis overall.

A. I think I -- I think I discussed the meta-analysis, but not the individual studies, or at least all of them.

Q. Would you agree that Hansen, 2013, and Cocco, 2013, are included in this?

A. In the NTP, yes. Not in the --

Q. No, included in the study that I've handed to you.

MS. KLIMEK: Pardon me? 18.

Q. Exhibit 18.

A. Which studies again?

Q. The Hansen, 2013, and the Cocco, 2013, are not included in this study, correct?

I think if you look at page 12, there's a couple of charts that show the studies that were included.

A. Yeah, I'm looking at it right now.

Hansen, 2013, was not in there, but if you're referring to the Cocco, 2013 study, that was, if I recall, a meta-analysis and systematic review, so that would not be included in a --

Q. Okay.

A. -- analysis like this.

Q. Would you agree that the meta-analysis -- they were not all consistent in their methodology, exposure assessments, or statistical significance, just by looking at the table, supplemental Table 1?

A. We're still on Karami?

Q. Yes. Sorry.

A. All right. Let me go back.

Q. For example, there are a variety of exposure assessments, including the urinary, biomonitoring, the JMS, company work histories versus in-person interviews, correct?

A. Yes, they had a variety of different exposure assessment methodologies across these studies. Is that what you mean?

Q. Yes.

A. Yes. True.

Q. Would you agree that all of these studies are occupational studies?

A. That's what the authors state in the paper.

I haven't -- I don't recall specifically going through all the studies to verify that they're occupational versus environmental, but that's what the authors state, and I have no reason to disagree with that.

Q. Okay. If you look at page 2 at the very bottom column, under Methods, Study identification, data extraction, and exposure assessment?

A. Yes.

Q. If you look at basically the very last sentence in there, it says -- they're talking about how they determined what studies would be included. Says, "As a result, we excluded community-based studies of TCE exposure from drinking water since the level and route of exposure differ from those found in occupational settings"; is that correct?

A. That's correct.

Q. Would you agree that the level and route of TCE exposure from drinking water differs from the level and route found in occupational settings?

MS. GREENWALD: Objection. Form.

A. I think in general, I think that's probably a truism.

BY MS. KLIMEK:

Q. Do you believe that TCE in residential water is comparable or similar to TCE in ambient air

in occupational settings?

MS. GREENWALD: Objection. Form.

A. Depends what occupation. But like I said, in general, I think that's a truism.

BY MS. KLIMEK:

Q. Have you seen other epidemiology -- epidemiology studies where this type of distinction is made?

A. I'm not sure --

Q. Where they've extracted a study because it's based on contamination in water? Or didn't include a study in the meta-analysis because of the water -- it was a water contamination study?

A. I -- I don't know. I haven't thought of that.

Q. If you look at Table 2, page 6 -- sorry, going back to the last question I asked, could you clarify whether you think drinking water is or is not comparable to ambient air in occupation studies?

MS. GREENWALD: Objection. Form. And asked and answered.

A. I mean, I -- I think in general, studies of solvents in water versus occupational studies of workers exposed to solvents relate to populations that have lower exposure. But in terms of biological

actions, what really matters is what's absorbed into the bloodstream and what the concentration might be at the target organ. So they may have relevance. It depends on the context and the kind of research you're trying to perform.

BY MS. KLIMEK:

Q. Then if you look at page -- sorry, Table 2, page 6, shows non-significant summary estimate for NHL case control.

A. You --

Q. Yes, we're on that exhibit. Exhibit 18, correct.

A. Right. So Table 2, Exhibit 18 --

Q. Page 6.

A. -- displays the relative risk associated with each one of these types of studies. And the test for heterogeneity, and test for publication bias, but the whole point of doing a meta-analysis, so you can combine them all and have much greater statistical power than individual studies alone.

Q. The risk ratio for TCE's exposed studies overall, correct?

A. You're -- you're looking at --

Q. Sorry.

A. -- Table 2, the very first row?

Q. Correct.
A. Those are TCE exposure studies that are case-control studies.
Q. Okay. Thank you.
As you note on page 19 of your report the risk estimate for cohort in case-control TCE exposure studies combined for NHL was 1.32, correct?
A. Where are you reading? I'm lost. Sorry. This is my report?
Q. Yes. Your report, page 19.
A. Oh, 19.
Q. Yes.
A. Okay. Yes, I see. Right. The combination of cohort and case-control studies combined, 19 studies, relative risk 1.32, 95 percent confidence interval 1.14 to 1.54.
Q. So would you agree, if you look at the abstract, the summary estimates for occupational TC exposure were not associated with the risk of CLL? That's in the abstract.
A. CLL?
Q. It's in the abstract of the report. It's the study. I'm sorry, not your report. The study, in the abstract section.
MS. GREENWALD: Objection. Form.

A. The -- do you have --
BY MS. KLIMEK:
Q. It's the --
A. -- Karami on you?
Q. -- Karami study, Exhibit 18.
A. Ah, it's in my hand. I'm so sorry.
Q. If you look to -- I'm sorry. If you look to the second-to-last sentence in the abstract.
A. Yes.
Q. "Summary estimates for occupational and TCE exposure were not associated with risk of HL, MM, leukemia, or CLL/SLL," correct?
A. That's correct.
Q. How do you explain the finding of a raised summary estimate for NHL but not for CLL?
A. Well, that certainly could occur by chance. It also may relate to the sample size of cases. I'd have to dig into the data and what their findings were to give you an accurate answer to that.
Q. Could it reflect that TCE exposure does not have the same effect on all NHL subtypes?
MS. GREENWALD: Objection. Form.
A. That could be in theory, but, you know, I think there's multiple other explanations, including the ones that I mentioned.

BY MS. KLIMEK:

Q. If we look at some of the studies on page 15 of the table --

A. We're still in Karami?

Q. We're still in Karami.

A. Okay. We're in the supplement?

Q. I'm sorry. Yes, supplemental Table 1.

A. Okay. Table. There we go. Okay.

Q. So at the top of the table, you see the Hansen study that we've already talked about, correct?

Or I'm sorry, we didn't talk about this Hansen study.

This is the older Hansen study, correct? The Hansen 2001?

A. Yes. And this is not the top of the table. This is actually the top of the second page --

Q. I'm sorry.

A. -- of the table.

Q. Top of the second page of the table.

A. Okay, I'm with you.

Q. Okay. You also had talked about in your report the Raaschou-Nielsen study, correct? Do you recall that? It would be on page 23.

A. Of my report.

Q. Yes. You say, "Raaschou-Nielsen, et al.,

found in a subcohort of 14,360 presumably highly exposed workers, the SIR for NHL was 1.5," correct?

A. Yes.

Q. So we see that 1.5 reflected in this supplemental chart, correct?

A. Yes.

Q. Okay. And that's -- so they're reporting on the highest level, correct?

A. Yes.

Q. With the exception of the Hansen 2001 study and the Raaschou-Nielsen 2008 study, none of the cohort studies reflect a statistically significant increased risk of NHL with TCE exposure, correct?

A. You're talking just -- referring to this supplemental Table 1?

Q. Correct. Cohort studies.

A. Well, in Bahr, et al., 2011, that was a cohort study of uranium enrichment plant workers, and the standardized mortality ratio for non-Hodgkin's lymphoma among males had a point estimate of 1.5 and a borderline confidence interval 1.0 to 2.1.

Q. But that's not statistically significant, correct, this ratio?

A. Well, I mean, I have to say the epidemiologists are not slaves to statistical

significance. As discussed throughout the epidemiologic literature, it's really important to understand the -- the actual point estimates, the confidence intervals, and to interpret the research in light of all the other evidence that there might be. So it's true it doesn't, you know, meet the less than .05. Perhaps, you know, it does -- perhaps it doesn't -- it does -- it does include 1.0. But I -- you know, I state for the record that it's really important to understand, certainly in a study like this that has right on the border its significance.

Q. And if you look at the case-control studies in the supplemental chart -- no, there's no page. It would be one, two, three, four, five -- page 6 of the chart.

A. Yeah.

Q. Do you see the Hardell study that we just -- we talked about earlier? It's the very top -- first study on page, I believe, 7. I'm sorry they're not labeled.

A. I see it.

Q. Would you agree that the odds ratio 7.2 is clearly an outlier in comparison to the other studies?

MS. GREENWALD: Objection. Form. Asked and answered.

MS. KLIMEK: Okay.

A. It is certainly the highest by far.

BY MS. KLIMEK:

Q. On page 19 of your report, you indicate that this meta-analysis -- meta-analysis, demonstrates evidence of a dose-response relationship.

A. What page are we on now?

Q. On page 19.

A. Yes.

Q. And if you look back at the study, Table 1, if you look at the cohort studies, page 4.

A. Yes.

Q. For the high-intensity studies, the risk ratio is not statistically significant, correct?

A. You're talking about the individual studies?

Q. I'm sorry, I shouldn't have referred you to the chart. On page 8 of the study, the second-to-last sentence of the summary states that, "Our meta-analysis" -- very last -- last two sentences.

A. I see it.

Q. "Our meta-analytic findings for TCE exposure and NHL risk still warrant further exploration, given the limited dose-response patterns observed in our review and the recent conclusion by

IARC that the carcinogenic evidence for TCE and NHL is limited," correct?

A. Yes.

Q. Okay.

A. That's what they wrote.

Q. We -- okay. And then flipping back to Table 1, if we're looking at the -- you see the High-Intensity Studies column? It's probably 10 rows down. Risk ratio of 1.27.

A. I might be looking at -- this is supplemental Table 1?

Q. No, I'm sorry. It's Table number 1 --

A. Oh, oh.

Q. -- page 4.

A. Okay. Sorry. Table 1, page 4.

Okay. So what was the question?

Q. High-intensity studies, the risk ratio is not significantly significant, correct?

MS. GREENWALD: Objection. Form.

BY MS. KLIMEK:

Q. About 10 rows down, it says, "high-intensity studies."

A. Well, there was one study, yes, and the relative risk was not elevated.

MS. KLIMEK: We've been going for

about an hour. Do we want to take a break? Do you want to take a break?

THE WITNESS: I can keep --

MS. KLIMEK: Five minute --

THE WITNESS: -- going if you want, but...

MS. KLIMEK: Take a five-minute break.

THE WITNESS: Okay.

THE VIDEOGRAPHER: The time is 4:20 p.m. We're going off the record.

(Whereupon a recess was taken.)

THE VIDEOGRAPHER: The time is 4:41 p.m. We're back on the record.

BY MS. KLIMEK:

Q. You also talk about a study, Cocco 2013, correct, in your TCE discussion?

A. Okay.

Q. On page 18 of your report?

Here's a copy of the study, Exhibit 19.

(Whereupon Exhibit 19 was marked for the record.)

As you noted, Cocco is a pooled study population, correct?

A. Yes. It pooled four different studies.

Q. And as stated on page 3 of the study, the

authors assessed risk of NHL and its most prevalent subtypes, DLBCL, FL, and CLL, correct?

A. Yes.

Q. And it was associated with ever (sic) exposure, and then with each category of probability, duration, top intensity level, over the work history, correct? Same sentence -- or same section?

A. Say that one more time? I'm sorry.

Q. If you look under Statistical Methods?

A. Yes.

Q. Talks about the subtypes. Then it says, "And with each category of probability, duration, top intensity level, and top frequency of TCE exposure over their work history," correct?

A. Yes, correct.

Q. And the analysis was conducted on all the exposed subjects, as well as those subjects judged to have a high probability of exposure, correct?

A. Correct.

Q. Reported estimates in the exposure response analysis estimated exposure levels in the highest exposure categories were greater than 75, or 150 -- 150 ppms, correct?

A. Let's see.

Q. It's in Table 5, I believe.

A. I'm sorry, can you repeat the question?
Q. The highest exposure categories?
A. In terms of duration, frequency, or intensity?
Q. For Table 5, intensity.
A. Is greater than 75 ppm.
Q. And the risk of NHL overall did not increase by probability of TCE exposure, nor with duration or frequency of exposure, correct?
A. I'm not sure I agree. I mean, it says right here in the table that for all the exposed, the summary estimate for NHL is 1.4. The confidence interval excludes 1, it's 0.9 to 2.1, but the summary estimate is 1.4.
Q. So it's not statistically significant, correct?
A. It doesn't exclude 1.0.
Q. With the exception of FL and CLL, there's no increased risk for any other subtypes of NHL, correct?
A. Correct.
Q. And the study only showed an increased risk of FL and CLL at the prolonged high intensity level, correct? That would be Table 5, 75 ppm we just spoke about?

A. That's with respect to exposure that's quantified in terms of intensity level, but that's not true in terms of exposure quantified in terms of duration.

Q. You're referring to... You're looking at Table 5?

A. Yes.

Q. Okay. This is intensity.

And I'm sorry, what was your answer?

A. My answer is that in terms of exposure, the odds ratios were not statistically elevated -- statistically significantly elevated by the definition of the confidence interval excluding 1 for the intensity level of greater than 75 parts per million, which is the highest intensity level.

I note that there's only nine cases of NHL and five controls in that category. But if you -- in the same table, they expressed the results in terms of a different exposure metric, which is duration of years of exposure. And here, in the second-to-highest category -- the highest category has very few subjects, but the second-to-highest category, there's an increased odds ratio for NHL of all types that's borderline significant with an odds ratio of 2.8 and a confidence interval from 1.0 to 7.8, and a odds ratio

of 3.8 for CLL, the confidence interval going from 1.0 to 14. Again, borderline statistically significant.

Q. Okay. And there were some limitations noted in the study, correct?

A. Sure. Like in any epidemiology study or even a meta-analysis, there are limitations.

Q. Only 9 percent of the study subjects were estimated to have ever -- to have never been exposed to TCE, correct? That's on page 6, first sentence of the last paragraph.

A. Yes, correct.

Q. Only 1 percent had a high probability of exposure to TCE, correct?

A. Correct.

Q. And then when we look at the highest exposure we talked about was greater than 75 ppm's -- or I'm sorry, 75 or 150 ppm's. And that's coming from Table 5 and Table 4. Table 5 is the highest intensity level, correct? We say greater than 75?

A. Yes. Greater than 75 parts per million in this particular analysis.

Q. And then we jump up. If you look at Table 4, the highest level. Greater than 150, correct?

A. Yes. This is a different analysis that includes more subjects. That is, it's not confined to

the subjects with a high probability of exposure as is true in Table 5.

Q. Would 75 ppm be converted to 75,000 ppb? Is that correct?

A. That's correct.

Q. And 150 ppm would be converted to 150,000 ppb?

A. Correct.

Q. And we have talked about the highest measured TCE concentration at Hadnot Point was 1,400 micrograms per liter, correct?

A. I have no reason to disagree. I don't remember specifically.

Q. Which would convert to 1.4 ppm, correct? I believe you used that figure on page 42 of your report.

A. Okay.

Q. Again, a significant difference?

A. Okay.

Q. Would you agree that the results of Cocco study don't offer support for the opinion that TCE exposure at concentrations of less than 75,000 ppb causes NHL?

A. I would agree that expressed as that metric of exposure, the study does not provide evidence for

that, in part because the sample size is really too small.

Q. Okay. Would you agree that the results of the study therefore do not offer support for the opinion that TCE exposure at concentrations historically present at Camp Lejeune more likely than not cause NHL?

MS. GREENWALD: Objection. Form.

A. I think this study simply provides evidence in support of the general causation question of whether TCE is capable of causing cancer in NHL, but doesn't specifically address the question of the level of exposure that's relevant to Camp Lejeune.

BY MS. KLIMEK:

Q. I'd like to turn to the next study on page 19 of your report. You mentioned this study before.

Odutola? Am I pronouncing it correctly?

A. Odutola.

Q. Odutola. I'll hand you a copy of the study. It's going to be Exhibit 20.

(Whereupon Exhibit 20 was marked for the record.)

A. Thank you.

Q. This study did not examine NHL in general or other NHL subtypes outside of FL, correct?

A. Correct.
Q. The study included a meta-analysis for multiple chemicals.
It didn't isolate TCE, correct?
A. It examined the association with chlorinated solvents, along with other exposures.
Q. But not TCE in particular, correct?
A. TCE is just one of the chlorinated solvents.
Q. So it was grouped with chlorinated solvents?
A. Correct.
Q. It did not isolate TCE, correct?
MS. GREENWALD: Objection. Form. Asked and answered.
BY MS. KLIMEK:
Q. The study showed a -- showed evidence of a positive association between FL and occupational exposure to DDE, PCBs, and exposure to any solvent and chlorinated solvent, correct?
A. Correct.
Q. I'd like to turn to another report on -- or on page 24 of your report, you talk about biological plausibility?
A. Yes.

Q. You talk about mechanistic studies.
Are those the ones that are contained that you talk about in 19 through 21 of your report?
A. Yes.
Q. I'd like to talk to you a little bit about the Deng 2013 study, "Occupational solvent exposure, genetic variation in immune genes, and the risk for NHL."
(Whereupon Exhibit 21 was marked for the record.)
A. Okay.
Q. This study was an extension of the Zhao study that you mentioned right before it, paragraph proceeding.
A. Zhao.
Q. Zhao, sorry.
And this study was included in both the NTP and the IARC analysis.
Do you recall that?
A. No, but if you can point out to me where it's included, that would refresh my memory.
Q. NTP, page 191. Exhibit 15 was NTP.
A. Right. And IARC?
Q. IARC would be page 196. That's Exhibit 14 of IARC. Page 196 lists it.

Is that correct?

A. Yeah, it's strange. One has a publication date of 2012. The other one says 2013. I'm just trying to figure out if it's the exact same study.

Q. Same title, correct?

A. Yeah.

Q. On the first page --

A. It'd be useful to see if it has the same PMID number. And that would be -- enable one to confirm that it's the exact same publication.

Q. I'm not going to refer to it --

A. Okay.

Q. -- in either publication. I was just saying that it was evaluated in both their analyses.

A. Yeah, I'm not sure. In any case, happy to review the study.

Q. This was a population-based occupational case-control study among women in Connecticut, correct?

A. Yes.

Q. The study found that women who were occupationally exposed to organic solvents versus those who were not had an increased risk for diffuse large B-cell lymphoma if they carried a certain --

A. Gene type.

Q. -- gene type, correct?
A. Correct.
Q. Women who were exposed to the organic solvents that did not carry that particular gene type did not have an increased risk for diffuse large B-cell lymphoma, correct?
A. Correct.
Q. The authors note on page 6 of the study that the findings may not be generalizable to men, correct?
A. Correct.
Q. This is the only mechanistic study that you cite that specifically addresses NHL, correct, being diffuse large B-cell lymphoma?
A. That's specific for diffuse large B-cell lymphoma?
Q. Any -- any NHL. I'm saying that's a subtype of NHL, correct?
MS. GREENWALD: Objection. Form.
A. Well, the parent study, Jiao, et al., also addressed that very topic, as I discussed on page 19 and 20.
BY MS. KLIMEK:
Q. Those two studies then, correct?
A. Correct.

Q. I'd like to introduce another study. This is also discussed on -- it's the most recent mechanistic study that you described. It starts on the bottom of page 21 of your report, Hosgood, et al.

A. Okay.

Q. This is Exhibit 22, copy of the study.

(Whereupon Exhibit 22 was marked for the record.)

If you look at page 426, Figure 1 of the Hosgood, et al., study, it shows they used a, quote, "low exposed group with exposure levels ranging from 4.3 to 9.16 ppm of TCE."

A. We're looking at Figure 1?

Q. Yes, on page 3. Figure -- yeah, it says Figure 1 on the side. It's the two little boxes on the bottom of page --

A. Right.

Q. -- 426. And you see on the side where it says, "low exposed"?

A. Yes.

Q. Okay. And a high exposed group with TCE levels ranging from 10.4 to 228.9 ppm?

A. Correct. Correct.

Q. Okay. And then on page 427, at the bottom of the left column, the author states that, "We do not

rule out the chance of false positives given the small sample size and the number of proteins assessed despite applying FDR to account for multiple testing. Hence, our results should be considered exploratory and ideally be replicated in a larger study. Our results may not be generalizable to non-occupational cohorts or occupational cohorts exposed to a different level of exposure to TCE," correct?

Did I read that correctly?

A. I'm just -- sorry. Yeah, you read that correctly.

Q. Okay. I'd like to move on and talk to you about PCE and NHL.

A. All right.

Q. So again, on page 8 of your report, you present your summary of your opinions. And your opinion on PCE is, "It is my opinion that PCE is a human carcinogen and that PCE is likely as not, if not more likely than not, can cause NHL"; is that correct?

A. Uh, I'm afraid that's a typo because I -- I didn't actually update the summary of opinions with the conclusion I made of the actual section. I think -- let's see. Let's look -- let's go to that. And I apologize for that.

So, if you look at page 34, section 2H, the

very last line says, "On the other hand, in my opinion, as reflected by my discussion based on the Bradford Hill viewpoints, enough epidemiological and mechanistic evidence exists in the scientific literature to provide support for PCE as a cause of NHL sufficient to surpass the 'at least as likely as not' standard in this case."

And I -- once again, I apologize for not propagating that final opinion through the rest of the report.

Q. So is it your opinion PCE more likely than not causes NHL?

A. Correct.

Q. And the PCE was discussed in the same monograph that the TCE was discussed, correct? 2014 monograph?

A. You mean IARC?

Q. IARC, I'm sorry. Yes.

A. Yes.

Q. So we're going to refer to it again, Exhibit 14.

A. Okay.

Q. IARC classified PCE as probably carcinogenic to humans based on sufficient evidence from animal studies, but limited evidence in humans,

correct?

A. Correct.

Q. The limited evidence for the carcinogenicity of PCE found by IARC was based on bladder cancer, not NHL, correct? It would be page 329.

A. Yes.

Q. IARC found no consistent patterns with respect to evaluating exposures to PCE and the risk of NHL, correct?

If you look at page 326, Other Cancer Sites, section 5.22.

A. Oh, there. You read that correctly.

Q. IARC found that while three cohort studies showed an increased risk for NHL, they were based on small numbers of study participants.

And I'm reading from that next page, 327.

A. Correct.

Q. IARC found the largest cohort study with the best control of potential confounders did not show an increased risk for NHL, correct?

A. That's what was written here, correct.

Q. Okay.

MS. KLIMEK: I don't know if we need to --

Q. You don't mention that study in your report, correct?

MS. GREENWALD: Objection. Form.

A. I discussed the IARC report.

Is that what you mean by "this study"?

BY MS. KLIMEK:

Q. The cohort study with the best controls and potential confounders that didn't show an increased risk for NHL.

A. Do you know which --

MS. GREENWALD: Same objection.

A. -- study that --

BY MS. KLIMEK:

Q. Yes.

A. Do you know which study that was?

Q. It's the Lynch, et al., 2006 study.

A. So I'm sorry, could you repeat the question?

Q. The question was, you did not mention the study, Lynch, et al., 2006, in your report, correct?

A. I don't think I did, no.

Q. I'm introducing Exhibit 23, which is the Lynge study, "Cancer in Persons Working in Dry Cleaning in the Nordic Countries."

(Whereupon Exhibit 23 was marked

for the record.)

And if you just look at the very beginning, the darker gray section, the abstract section in the very middle, it says, "The risks of cancer of the gastric cardia, liver, pancreas, and kidney, and non-Hodgkin's lymphoma were not significantly increased"; is that correct?

Did I read that correctly from the abstract?

A. You read that correctly.

Q. On page 25 of your report, you state that with regard to PCE and the epidemiological evidence, IARC reviewed a body of evidence, including cohort and case-control studies, as well as ecological studies, correct?

A. Correct.

Q. Do you recall reviewing the studies Anttila, Boice, Blair, Radican, Calvert, Selden? These are all studies that were reviewed by IARC?

A. Yes.

Q. And if you look on IARC Table 2.1, pages 239 to 245 are the studies.

Actually, let me see.

A. IARC page 249?

Q. I'm sorry, I misspoke. 239 to 245. Table

2.1, "Cohort studies of occupational exposure to PCE," correct?

A. I see it.

Q. And these are all the studies that IARC evaluated?

A. Yes.

Q. And you would agree that there are studies listed that do not show a positive association between PCE and NHL, correct? I should say a statistically significant positive association.

A. Well, as you first started saying, they did show some elevated risks, but they were not statistically significant as defined by the confidence interval, excluding 1.

Q. Okay.

A. By themselves.

Q. And then in your report, you acknowledge that, I believe, cohort studies showed an increased risk, but they were based on very small numbers, correct?

And if we turn to -- you state that the cohort studies showed an increased risk, but they were based on small numbers, correct? I believe it's on page 26 of your report.

A. Yes. I remember saying that in my report.

Q. And they were not statistically significant risk ratios, correct?

A. What page are you on in my report? Sorry.

Q. I'm sorry. Page 26.

A. 26. Yeah, this is my description of the IARC report.

Q. Okay. So you would agree that there were both case-control studies and cohort studies did not find a positive -- statistically significant positive association between PCE and NHL, correct?

A. So that's what was discussed in the IARC report, and then I delved deep into these individual studies on page 28 myself.

Q. Again, in your report, you don't mention any studies that did not show a significantly -- that -- yes, did not show a statistically significant association, correct?

MS. GREENWALD: Objection. Form.

A. Well, you know, once again, I referred to the NTP and the IARC reports, and also the EPA reports, which --

BY MS. KLIMEK:

Q. Okay. (Indiscernible cross talk) --

A. -- reviewed all the studies, including the negative studies, and I felt that not useful to repeat

those analyses.

Q. If you could look at page 324 of the 2'14 IARC monograph. Oh, I'm -- 2014. I'm sorry, 2014. Excuse me.

A. I'm sorry?

Q. I was correcting myself. I said 2'14. It's 2014.

A. 2014?

Q. I'm sorry. We're -- yes. Yeah, the 2014 IARC, which is what you're looking at --

A. Oh.

Q. -- right now. We're good. But I --

A. Okay.

Q. No, I would like you to look at page 324.

A. 324. Okay. Okay.

Q. If you look at the last sentence of the first -- or the second full paragraph. "Overall the evidence was not sufficiently strong to support a conclusion about mechanisms for PCE-induced carcinogenesis in cells of the immune system"; is that correct as -- did I read that correctly?

A. I'm struggling to find out exactly where you are. You're on page --

Q. Under --

A. -- 324.

Q. 324, under 4.53, Immune System.
A. The second paragraph?
Q. The last sentence in the second paragraph.
A. Okay.
Q. Yes.
A. There we go.
I see that, yes. You read that correctly.
Q. Now I'd like to switch to the NTP assessment of PCE.
MS. KLIMEK: Can we go off the record for one minute -- two minutes, please?
THE VIDEOGRAPHER: The time is 5:26 p.m. We're going off the record.
(Whereupon a recess was taken.)
THE VIDEOGRAPHER: The time is 5:27 p.m., and we're back on the record.
BY MS. KLIMEK:
Q. Can you name what's marked as Exhibit 24?
Okay, sorry.
I've handed you what we're marking as Exhibit 24.
(Whereupon Exhibit 24 was marked for the record.)
NTP conducted a report on TCE, correct?
A. TCE?

Q. PCE, I'm sorry. I just handed it to you, sir.

A. Oh, here it is.

Q. And you noted on page 26 of your report that the NTP found that PCE is reasonably anticipated to be a human carcinogen based on sufficient evidence of carcinogenicity from studies in experimental animals.

On page 26 of your report?

A. Correct.

Q. If we turn to the discussion of evidence in the NTP report on page 1 of the report under Cancer Studies -- so this is Exhibit 24 that I just handed you.

A. I'm sorry. Say that again.

Q. The exhibit that I just handed you --

A. Yes.

Q. -- if you take a look at page 1 of the report under Cancer Studies in Humans.

A. Yes.

Q. It says that "IARC 1995"...

Okay. So this is on the first column, correct?

A. Yes.

Q. Okay. "IARC 1995 concluded that there was

limited evidence for the carcinogenicity of PCE in humans, based mainly on evidence of consistent associations between PCE and esophageal cancer, cervical cancer, and NHL; however, confounding by exposure to other chemicals could not be ruled out, and the total numbers in the combined cohort studies were small."

Did I read that correctly?

A. You did.

Q. This is similar to the discussion of evidence in the 2014 IARC that we already talked about, correct?

A. Yes. But as I pointed out in my report, it was... the fact that they didn't discuss the 2014 IARC report made me question the up-to-date nature of this particular report from NTP.

Q. Turning back to your report, you also state that the 2021 NTP report does not comment on any potential association between PCE and NHL, correct?

A. Correct.

Q. Or potential impact of PCE on any specific cancer, correct?

A. Correct.

Q. I'd like to show you the EPA... This is EPA's risk evaluation for PCE, which I believe you

also discuss in your report, correct?
A. Yes.
Q. 2020 discussion.
You noted in your report on page 27 that EPA found no available studies for PCE and cancer, including NHL, that showed a dose-response relationship, correct?
You state that on page 27 of your report?
A. I did.
Q. Okay.
A. Thus, they relied on the animal bioassay to construct the dose response.
Q. On page 28 of your report, you cite to a 2022 Goodman, et al., study, Systematic Review of PCE and NHL, correct?
A. Correct.
Q. As the title indicates, this was a systematic review of the evidence relating specifically to PCE and NHL, correct?
A. Correct.
Q. You state this is the only peer-reviewed study published that you were able to find since EPA's 2020 report, correct?
A. It was, and then I went on to critique it.
Q. As you noted on page 27 of your report,

"Based on their interpretation of the studies, a review of the experimental and mechanistic data, and applying the Bradford Hill considerations, Goodman, et al., concluded that the evidence does not support an association between PCE exposure and NHL," correct?

A. That was their conclusion.

Q. When you were drafting your report, were you aware that Dr. Goodman had been retained by the United States as an expert witness?

A. I mean, I know now. I just don't recall whether I knew it when I was drafting the report or after.

Q. I'd like to turn to another one of your studies that you talk about, the Boice, 1999, "Morality among aircraft manufacturing workers."

A. Okay.

Q. And we're going to give -- hand you a copy of it. This is Exhibit Number 25.

(Whereupon Exhibit 25 was marked for the record.)

This was a retrospective cohort mortality study of the aircraft manufacturer workers employed for at least a year at a large aircraft manufacturing facility, correct?

That would be under the Methods on the very

first page, Objectives and Methods?

A. Correct.

Q. If you look at the bottom of the abstract on page 581, it says -- it reads, Workers routinely were exposed to TCE, PCE, or a mixture of solvents were not at an increased risk of total cancer, and the numbers of deaths for specific cancer sites were close to expected values. Slight to moderately increased rates of NHL were found among workers exposed to TCE or PCE, but none were significant; is that correct?

A. That's correct. And that was based on standard mortality ratios, which are a comparison with the general population. Thus, as I discussed in my report, I believe, this is subject to the healthy worker effect.

Q. So workers exposed to PCE and TCE did not experience significant increased risk rates of NHL, correct?

A. In comparison to the general population, no.

Q. If you turn to page 594 of the study, the bottom left of the page.

This would be under the PCE section, the second full paragraph on the left-hand column?

A. Yes.

Q. It reads, quote, "The rates of liver cancer and NHL were somewhat increased overall and among those with the longest durations of exposure to PCE, but none of the trends or relative risks were significant and the dose-response relations were erratic"; is that correct?

A. That's what it says.

Q. Would you agree the study concluded there was no statistically significant evidence of an association between PCE, TCE, and NHL?

A. I agree that the findings are not statistically significant, but I discuss them in my report in relation to the SMRs in comparison to years of exposure as the finding of interest.

Q. I'd like to turn to another study that you addressed, the Radican 2008 study, "Mortality of aircraft maintenance workers exposed to TCE and other hydrocarbons and chemicals: extended follow up." This will be Exhibit 26.

(Whereupon Exhibit 26 was marked for the record.)

This was a mortality study of aircraft manufacturing workers, correct?

A. Correct.

Q. If you turn to Table 7 on page 23 of the

study, you see the PCE row?
A. Yes.
Q. The study showed a hazard ratio of 2.32 for PCE and NHL for males, correct?
A. Correct.
Q. That was based on only five cases, correct?
A. Correct.
Q. And the hazard ratio was not statistically significant, correct?
A. Correct.
Q. The study also reported a HR of 2.35 per PCE and NHL for females, correct?
A. Yes.
Q. That was based on only two cases, correct?
A. Correct.
Q. Not statistically significant either, correct?
A. Correct.
Q. The study also assessed TCE and NHL, correct?
A. Yeah. Before we leave PCE, I just wanted to point out that, as I discussed in my report, the association of PCE with all lymphatic hematopoietic cancers had a hazard ratio of 1.92 that was borderline statistically significant with a confidence interval

of 1.00 to 3.69.

In answer to your question, yes, they also looked at TCE.

Q. On page 7 of the study, third -- second full paragraph. First sentence of the second full paragraph states, "Overall, our results for TCE do not provide statistically significant associations with cancer that have been reported in other studies - kidney, liver/biliary tract, cervix, and esophagus, and NHL," correct? It goes on, I'm sorry -- "multiple myeloma and Hodgkin's disease," correct?

A. This is page 7, second paragraph?

Q. Second full paragraph.

A. Second full paragraph...

Q. Starting with "overall"?

A. Overall... Oh. Oh, I'm sorry. Yeah, okay. That's -- I'm looking at the --

Q. Would you like me to read it --

A. -- first overall paragraph. Yeah, okay. Yeah, I'm there.

Q. Would you like me to read it again? I'm just asking.

A. Yeah, please.

Q. "Overall, our results for TCE do not provide statistically significant associations with

cancer that have been reported in other studies - kidney, liver/biliary tract, cervix, and esophagus, and non-Hodgkin's lymphoma, multiple myeloma, and Hodgkin's disease," correct?

Did I read that correctly?

A. You did. I just want to point out in the second sentence, "However, all of these cancers do show non-statistically significant excesses in our study, some with point estimates greater than 1.5, and, therefore, our results are not inconsistent with the literature."

I think that's a very relevant statement.

Q. I'd like to turn to another study you cite, Selden and Ahlborg, 2011 study. This is the Selden study, "Cancer morbidity in Swedish dry cleaners and laundry workers," Exhibit 27.

(Whereupon Exhibit 27 was marked for the record.)

A. Okay.

Q. You note in your report that the study found an incident rate for NHL of 2.05 in men, correct?

A. Yes.

Q. You also admit in your report that the result is, quote, "somewhat complicated by the finding

of an elevated rate of NHL among the laundry workers who were not known to have been exposed to PCE," correct --

A. -- correct.

Q. And on page 439 of the study, in the middle of the Discussion section, it says, "In addition, there was a higher than expected incidence of NHL in male workers that could not be related to PCE. Overall, no specific cancer site or type was clearly associated with PCE exposure in either gender"; is that correct?

A. That's what they wrote.

Q. I'd like to turn to your discussion of benzene. And on page 8 of your report, again, going back to where you present your summary of your opinions --

A. Okay.

Q. -- you state that "benzene is a human carcinogen, and benzene, more likely than not, can cause NHL"; is that correct?

A. That's right.

Q. Okay.

A. Okay. Which page are you on there? I'm just --

Q. I was on page 8 of your --

A. Okay. Okay. Yes.

MS. KLIMEK: We'd like to take just a 10-minute break before we switch to benzene, if that's okay.

MS. GREENWALD: Yeah.

THE WITNESS: Sure.

THE VIDEOGRAPHER: The time is 5:47 p.m., and we're going off the record.

(Whereupon a recess was taken.)

THE VIDEOGRAPHER: The time is 6:02 p.m., and we're back on the record.

BY MS. KLIMEK:

Q. For your opinions on benzene, how did you decide to rely on the benzene IARC 2018?

MS. GREENWALD: Objection to form.

A. It's just like any of the IARC reports. I consider it an important source of information and opinion based on their procedures for reviewing the literature. So, yes, I included it in my analysis.

BY MS. KLIMEK:

Q. And with the other IARCs that we've talked about, a working group would have reviewed the epidemiological studies, the animal cancer bioassays, mechanistic data to assess the carcinogenicity of benzene, correct?

A. Correct.

Q. If you look at page 297... Oh, I'm sorry. I'd like to hand you a copy of the IARC benzene report being marked as Exhibit 28.

(Whereupon Exhibit 28 was marked for the record.)

If you flip to page 297 of the report towards the very end, IARC classified benzene as being carcinogenic to humans based on sufficient evidence of an association between benzene exposure and risk of acute myeloid leukemia, correct -- in adults, correct?

A. Well, they wrote that there's sufficient evidence in humans for the carcinogenicity of benzene, and as part of the conclusion, benzene causes acute myeloid leukemia in adults.

Q. They did not find sufficient epidemiological evidence for NHL, correct? Sufficient evidence.

A. Not enough to include that in the previous statement, but they have noted positive associations.

Q. They've identified -- IARC identified overall only limited evidence for a positive association with NHL, correct?

MS. GREENWALD: Objection. Form.

A. That is one interpretation, perhaps of the

majority, but I also note in that very same section, they explicitly said a small minority of the working group considered that -- that benzene also causes NHL. So there clearly wasn't unanimity within the IARC working group on the sufficiency of the evidence regarding NHL.

BY MS. KLIMEK:

Q. But the majority found, correct, that there was not sufficient evidence in humans?

A. That would be the interpretation, yes.

Q. Do you recall if IARC previously addressed benzene in an earlier monograph?

A. I believe they did.

Q. The 2018 frequently refers to the IARC 212 monographs, Volume 100F; is that correct, what you recall?

A. I recall the same thing.

Q. Okay. And in that monograph, they also reviewed benzene and NHL, correct?

A. Yes.

Q. Do you recall them reaching the same conclusion as in this 2018 monograph?

A. I don't recall there being a small minority.

Q. But the majority reached the same

conclusion, correct?

A. I believe so, yes.

Q. Okay. If you turn to page 124 of the 2018 monograph, it says, "Adult lymphoma. This section presents the Working Group's reviews of studies of NHL and HL in adults," correct?

A. Correct.

Q. If you turn to page 132, section 2.2, "General-population studies."

A. I see it.

Q. It says, "The review included all published peer-reviewed epidemiological studies reporting a risk estimate for the association between exposure to benzene and NHL, CLL, DLBCL, follicular lymphoma, HCL, MM, ALL, or HL in study populations enrolled from the population at large, distinct from industry-based cohorts," correct?

A. You read that correctly.

Q. And earlier, we -- I was referring to, I think both of us, "FL."

And that stands for follicular lymphoma, correct?

A. Correct.

Q. So IARC's analysis of benzene and review of the studies was not confined to just CLL, correct?

A. Correct.

Q. If you flip back to page 124 of IARC and look at section 2.21, it says, "Occupational cohort studies." It notes that they looked at 21 studies on the association of NHL, including MM, and exposure to benzene in occupational cohorts were included in the IARC Monographs Volume 100F, correct?

A. Correct.

Q. And it continues to state that the purpose of the current update is to establish whether there's new studies to contribute to the causal assessment of the overall evidence, correct?

A. Correct.

Q. Do you agree that the 2018 working group examined all the pertinent studies published before and after the working group of the Volume 100F monograph?

A. Up until the most recent working group did their work, yes.

Q. Okay. On page 124, the third sentence states that this working group -- several articles on adult lymphomas included in the IARC monograph Volume 100F or published later were excluded by this working group because the exposure assessment was considered inadequate to determine whether workers were exposed

to benzene, correct?

A. You've read part of the sentence, but it continues.

Q. Or because there were -- okay. Or because there were methodological articles were focused -- are focused on mechanisms, correct?

A. Correct.

Q. Okay. Sorry about that.

In that first part that we read where they said that they excluded some studies because the exposure assessment was considered inadequate to determine whether workers were exposed to benzene.

A. I see that.

Q. Do you see, towards the very bottom of the page, one of the studies that was excluded was Mao, M-A-O, et al., 2000?

A. Yes.

Q. And if you look up at the top of the page, another study that was excluded is the Xu, et al., 2003 study.

A. I see that.

Q. You agree that in addition to conducting a review and analysis of all literature addressing a potential association between NHL and benzene, IARC also performed a meta-analysis of studies specifically

addressing CLL, correct?

A. I forget, but if you could point to me where the word -- review's at.

Q. Sure.

A. I --

Q. If you flip to page 164.

A. 164...

Q. Section 2.52, "Statistical analysis, (a) Meta-analysis."

A. I see that.

Q. Okay. So they ran a meta-analysis for AML and CLL, correct?

A. Correct.

Q. If you turn to page 165, which is the next page, you look at Figure 2.1, and then you look at Figure B, this shows the results of the meta-analysis -- hang on one second.

Okay. So this shows the results of the meta-analysis stratified by outcome assessments, correct?

A. Yes.

Q. The results show no statistically significant association between benzene exposure and NHL, correct?

MS. GREENWALD: Objection. Form.

BY MS. KLIMEK:

Q. The overall summary at the bottom? I'm looking at the 1.3 --

A. Yeah, yeah. No, I see it.

Q. Okay.

A. Yeah, I would just hasten to point out that for the study type known as incidence studies, the summary risk estimate is significant with a point estimate of 2.02 and a 95 percent confidence interval going from 1.11 to 3.70. But when the meta-analysis combined the incidence studies with the mortality studies, and the incidence and mortality studies, that's when the assembled risk estimate is 1.32, the confidence interval that -- goes from 0.97 to 1.80, and is, thus, not quite statistically significant.

Q. Okay. And I think I might have misspoken my question, but what we're looking at is CLL, correct? Not NHL overall.

A. No, CLL.

Q. Okay.

A. That's a --

Q. Yes.

A. Yeah, subtype.

Q. Then if we flip back to page 86, first full paragraph in the first column, it states, "The main

sectors where exposure assessment for benzene has been carried out for epidemiological studies are the petroleum industry, the chemical industry, and industries that use benzene in manufacturing processes," correct?

A. Correct.

Q. I want to turn to some of the studies that you talk about in your report. You cite to the Wong, W-O-N-G, et al., study in 1996.

You cite to this in page -- on page 38 of your report under Strength of Association; is that correct?

A. Yes.

Q. Make sure we have the right year on the study.

Okay. As you report in your report, it's 1987, not 1996 like I just characterized it. But it's the Wong, et al., 1987 study, correct?

A. Yes.

Q. Okay. This study was included in IARC's analysis of benzene, correct?

A. I believe so.

Q. Okay. I'm handing you a copy of this study now. It's Exhibit 29.

(Whereupon Exhibit 29 was marked

for the record.)

This is another mortality study, correct?

A. Yes.

Q. And as stated on page 382, the study studied male workers from seven chemical plants in the United States who were occupationally exposed to benzene for at least six months between 1946 and 1975, and a comparison was made with non-exposed workers from the same plants exposed for at least six months; is that correct? It's under the Methods section.

A. Yeah.

Q. On page 382.

A. Correct.

Q. On page 385 of the study, in the second column of the text, second full sentence is, "The average duration of exposure was 10 years," correct?

A. Correct.

Q. If we look at the study for NHL, no dose-response relation was detected, correct? For NHL.

I can direct you to page 392, the right-hand column. Fourth of the way down, says, "For non-Hodgkin's lymphoma, no dose-response relation was detected"; is that correct?

A. That's what was written, yes. And then it says, "When non-Hodgkin's lymphoma is combined with

leukemia, a monotonic increasing trend was seen."

Q. Correct. But just for NHL, there was no.

A. Correct.

Q. Okay. And in your report, you state that, "The authors" -- "the study found a risk ratio of 4.12."

Again, that's on page 38 of your report under Strength of Association.

A. Yes.

Q. The 4.12 risk ratio was for NHL and leukemia combined, correct?

A. Yes.

Q. You had agreed that there's evidence that benzene causes acute myeloid leukemia is greater than the evidence that benzene causes NHL, correct?

MS. GREENWALD: Objection. Form.

A. In terms of the amount of evidence, I think you have stated the record correctly.

BY MS. KLIMEK:

Q. So why would a risk ratio that includes leukemia with NHL provide any support for a conclusion that benzene causes NHL?

A. Well, as discussed by my colleague, Bernie Goldstein, who's a hematologist and a toxicologist, the mechanistic research clearly demonstrates that the

impact of benzene on the hematopoiesis and the pluripotential cells of the bone marrow are of a type that would affect the same stem cells for the lymphatic series as well as the blood-forming leukemia series. So I think that the epidemiology is relevant. It certainly is not by itself sufficient to prove anything, but it's relevant.

Q. Again, NHL as its own category did not show.

A. Correct.

Q. And the 4.12 risk ratio that you cite in your report, it was calculated based on cumulative benzene exposure greater than 720 ppm months, correct? If you -- refer you to page 392, the second column of Table 12.

Actually, that's not going to be right. It is not page -- page 390, I believe. I'm sorry. Page 390, looking at Table 12.

And, again, that's non-Hodgkin's leukemia combined, greater than 720 ppm months, correct?

A. Well, the relevance of this table also relates to the fact that there seems to be a monotonic increase in the relative risk going from the non-exposed to the next exposure category of less than 180 part-per-million months, to the next category of

180 to 719, to the next category of greater than 720, over which the relative risk increases from 1.00 to 2.71 to 2.96 to 4.12. I think that's the real relevance of this analysis.

Q. You didn't think it was important to mention that the 4.12 risk ratio was combined in HL and leukemia and was only at the 720 ppm months, the highest level?

MS. GREENWALD: Objection. Form.

A. I could have, but now I've described another characteristic for this study that's important.

BY MS. KLIMEK:

Q. Also in this study, can you show me where the -- you cite to confidence interval of -- let me find where you said -- 1.11 to 10.55?

A. I'm sorry. Where are you? Oh --

Q. I --

A. -- my report.

Q. Yes.

A. Okay.

Q. Page 38 of your report.

A. Okay.

Q. A study by Wong, et al., that found a relative risk of 4.12, 95 percent, confidence interval

1.11-10.55?

A. Yes. And you're asking where did I find that?

Q. Yes. On page 129 of IARC, it notes, "The working group noted that the results"... Oh, I'm sorry. Hang on. We've got the wrong...

A. Yeah, I'm still looking for it.

Q. Okay.

A. I'm sorry, Counselor. I know I didn't pluck it out of thin air, but I can't, at this point, tell you exactly where I got that figure from.

Q. Okay. We can move on.

The next study you talk about is a study called Hayes, et al.

You cite to it on page 38 of your report?

A. Yes.

Q. I'm handing you the Hayes study. It's Exhibit 30, "Mortality Among Benzene-Exposed Workers in China."

(Whereupon Exhibit 30 was marked for the record.)

A. Okay.

Q. You also contend that this study shows strong evidence of an association between benzene and NHL, correct?

MS. GREENWALD: Objection. Form.
BY MS. KLIMEK:
Q. You state, "Several of the individual epidemiological studies provide evidence of a strong association between benzene exposure and NHL among them," and you list the Hayes study, correct?
A. Correct.
Q. This study was discussed and evaluated by IARC working group, correct?
A. Yes.
Q. What was your assessment of the quality of the methodology and study design in this study? Do you recall?
A. Quite good.
Q. And this was a Chinese occupational cohort study, correct?
A. Correct.
Q. And it was a mortality study, correct?
A. Correct.
Q. And in this study, there's no findings specific to NHL, correct?
A. In this particular study, they lumped the hematopoietic and lymphoproliferative cancers.
Q. So it's all of them combined, correct?
A. Yes.

Q. If you look at Table 2 on page 1351 for that category, the highest relative risk ratio is the 3.1, correct?

A. Correct.

Q. And that's based on cumulative benzene exposure of 100 -- 100 to 400 ppm years, correct?

A. Correct.

Q. The risk ratio 2.0 is reported for cumulative benzene exposure of the 400-plus ppm years, correct?

A. Correct.

Q. In your report, you reported a 4.7 risk ratio, correct?

A. Yes.

Q. And where is the 4.7 reflected?

I see a 4.7 for occupational injury poisoning, but that's not --

A. No.

Q. Okay.

A. I'm sorry, Counselor. I'm struggling to find it myself. I'm wondering whether I was quoting a different study.

Q. I'd like to move on to -- the next study that you cite is the Fabbro-Perray, et al., 2001 study. Again, this is cited on page 38 of your report

under Strength of Association.

A. Okay.

Q. This is Exhibit 31.

(Whereupon Exhibit 31 was marked for the record.)

A. Thank you.

Q. You state that this study found an odds ratio of 5.7, 95 percent confidence interval, 1.4 to 23.20, correct?

A. Yes.

Q. The OR was for individuals with over 110 days of cumulative benzene exposure, correct? If you look at page 206, Table 3.

A. I'm looking at Table 3, and you said exposure metric of what?

Q. If there had been exposure where it said 810 days.

A. Oh, there it is. Yes.

Q. So what you reported were for those individuals who had 800 -- over 810 days of cumulative benzene exposure, correct?

A. Correct.

Q. Would you agree that the confidence interval of 1.40 to 23.20 is relatively wide?

A. Yes, reflecting the small sample size.

Q. Non-precise?

MS. GREENWALD: Objection. Form.

BY MS. KLIMEK:

Q. I'd like to move on to the next study you cite. This is the Xu, et al., "A Case-control Study for Assessing the Relation Between the Incidence of Malignant Lymphomas and Environmental Effects (sic) in the Sichuan Province."

This is Exhibit Number 32.

(Whereupon Exhibit 32 was marked for the record.)

As we talked about, this study was excluded from IARC's working group's evaluation because they found the exposure assessment was inadequate to determine benzene exposure, correct?

A. That was what was written, yes.

Q. Would you agree no exposure history is provided, or duration of exposure, in this study?

A. Well, the exposure was determined from information collected in face-to-face interviews with a structured questionnaire, and then the structured questionnaire was analyzed in terms of the chemical exposures. I think, without more detail, that accounts for the IARC committee rating this as low quality, because without more detail on the exposure

assessment, they felt less confidence in the exposure assessment.

Q. Would you agree some of the findings of the study are that risk factors for ML include direct contact with organic solvents, pesticides, taking aspirin, and dog raising?

If you look at chart 3.

A. Yes. No, I think what you said is true just based on the abstract.

Q. So the study says having a dog as a pet increases the risk of ML, correct?

A. In this particular study, yes.

Q. Taking aspirin increases the risk also, according to this particular study?

A. Yes.

Q. On page 5 of the study, it lists the odds ratio for benzene as 2.66 with a confidence interval of 1.86 to 7.55.

Do you see that?

A. Yes.

Q. You state on page 38 of your report that this study found an odds ratio of 2.78 with a 95 percent confidence interval of 1.68 to 14.32.

That's incorrect, right?

A. It's not terribly different. It looks

like -- feels like typos, but I don't really understand. And I'm sorry, again, Counselor, I don't understand the difference. Can't explain it right now.

Q. Again, you rely on this study as support -- as being a strong association between NHL and benzene; is that correct?

MS. GREENWALD: Objection. Form.

A. Well, even with the -- with the odds really -- odds ratio as stated, 2.66, that's fairly elevated, so that is to qualify.

BY MS. KLIMEK:

Q. As far as being a high-quality study, do you believe this to be a high-quality study?

A. I mean, I think it's -- it's not the lowest quality. It's somewhere between low and medium, but it's worth quoting.

Q. Okay. And the figure that you cite in your report, 1.68 -- the confidence interval, 1.68 to 14.32, that's a fairly wide confidence interval, correct?

A. Yes. And like I said before, it's materially different than what's in the paper, and I can't explain that other than that it's -- I must have been having a bad day at the -- at the computer and

mistyping a bunch of numbers.

Q. I'd like to turn next to the Rana, et al., 2021 study. Sorry. And I'm sorry, this is Exhibit 33.

(Whereupon Exhibit 33 was marked for the record.)

"Benzene exposure and non-Hodgkin's lymphoma: a systematic review and meta-analysis of human studies," correct?

A. Yes.

Q. When you read this study, did you also read the supplementary appendix? Had to be downloaded offline -- or online, I'm sorry.

A. I can't recall exactly how much detail I reviewed the supplementary material.

Q. It wasn't included with the study. You had to go online to get it.

A. I understand.

Q. Okay. On page 1, it states that the goal of the study was to examine the potential link between benzene exposure and the risk of NHL by evaluating an array of cohort and case-control studies, correct?

A. Correct.

Q. The author started with a preconceived hypothesis, correct, that there was an association

between benzene and NHL?

A. Well, it's the hypothesis --

MS. GREENWALD: Objection. Form.

A. -- they're trying to test.

BY MS. KLIMEK:

Q. In this study, the underlying studies, the risk ratio or the odds ratios that were incorporated into the meta-analysis were for the highest average intensity of benzene exposure, correct?

That's on page 5. The highest average intensity of benzene exposure?

A. I see that on page 5.

Q. Yes. I --

A. Fourth paragraph.

Q. -- read that correctly?

A. Yes, you read that correctly.

Q. Do you recall how the authors of this study evaluated the underlying studies, or what their criteria was for inclusion?

A. So they did an extensive search and included all peer-reviewed human cohort and case-control studies that looked at NHL and benzene exposure associations, and then they used a number of criteria to assess for methodologic quality in terms of selection of study population, comparability,

outcome, and exposures. And then they looked for some of the usual metrics when doing a meta-analysis, that is heterogeneity, publication bias. And that process resulted in reviewing 92 papers to begin with, but then eliminating a whole bunch and ending up with 28 studies, eight cohort and 20 case-control studies.

Q. So they eliminated -- they started out with 92 studies and eliminated down to -- what did you say?

A. Eliminated 64.

Q. 64 studies.

If you look at the Table 1, it talks about the studies that they've included.

Would you agree that other -- I'm sorry, I'll let you get there. Page 19.

A. Okay.

Q. Two of the studies that you've talked about are listed under cohort Hayes and Wong study.

A. This is page 17?

Q. 19, I'm sorry.

A. 19. Oh, I'm sorry.

Q. 19, Table 1.

A. All right. Okay. There's Wong and --

Q. Hayes. Would you agree that these are the only two cohort studies that show a statistically significant association?

A. How about Bassig on top?
Q. I'm sorry, Bassig, yes.
Are you familiar with the Bassig study?
A. I think I looked at it at some point.
Q. It was a study of women living in urban Shanghai, correct? Do you recall?
A. I don't specifically know.
Q. The other studies, would you agree?
A. Individually, they had confidence intervals that did not exclude 1.
Q. If we look at the case-control section, you see the Fabbro-Perray study that we discussed earlier, correct?
A. Yes.
Q. And again, that's reflecting the highest level, 5.7, greater than 810 days of benzene exposure, correct?
A. Yes.
Q. And the Xu study that we've talked about that was excluded by IARC, that is also reflected on the table, correct?
Is that correct?
A. I'm sorry. I'm just -- just give me a moment here.
So I think I solved the mystery of the

discrepant statistics we went over earlier, which is that the -- it seems like a lot of the statistics, I pulled off this table.

Q. Why would you have pulled the statistics off this table if the original reports didn't reflect that number?

A. I think that was out of convenience, and I apologize for that. But I think, you know, because they were all in one place, and I thought they would have quoted them accurately. That seems to be the case.

Q. So you would agree that this chart does not reflect the underlying --

A. Well --

Q. -- numbers in the study? Some of them, at least, that we talked about?

A. Yeah, we've got to look at some of these footnotes here. I'm trying to understand.

Oh, I see, okay.

So the studies -- in the footnote, it notes that the studies reported the odds ratio, and then they went through a statistical procedure to convert them to more of a risk ratio -- relative risk. I think that's what happened.

Q. Again, the underlying studies and the

numbers that are in your report are not reflective of the actual studies, correct?

MS. GREENWALD: Objection. Form.

A. It's reflective of the actual study results, but reported in a different metric, as demonstrated in Table 1 of this paper.

BY MS. KLIMEK:

Q. So Rana -- the authors of Rana took the numbers and changed them, correct?

A. They converted them so that they're more comparable across the studies.

Q. Okay. And you took the numbers from Table 1 and put them in your report for the --

A. That's correct.

Q. -- individual studies, correct?

A. Yes.

Q. Okay.

A. Mystery solved.

Q. You also see that on Table 1, they listed the Mao study, which was also excluded by IARC because it did not show exposure, correct?

A. Is that the study we just reviewed? No.

Q. No. It's a study we read out loud where IARC had -- had -- IARC -- or the 2018 had excluded it. I'm sorry, I think it was in the benzene report.

It had been excluded because they found that there was not an exposure assessment. That was one of the studies that we mentioned. We did Xu -- we mentioned Xu and Mao.

A. Uh-huh. Yeah. I mean, I --

Q. Okay.

A. I -- I don't argue with IARC excluding it on that basis. I just would need to look at the study myself to see if I agree with them.

Q. Would you agree that the Rana meta-analysis also reported on subsets of data from each study for different types of NHL, including diffuse large B-cell lymphoma, follicular lymphoma, chronic lymphocytic leukemia?

A. Yes.

Q. And only DLBCL had any type of statistically significant association, correct? It's page 5, Table 2.

A. Table 5. Sorry.

Q. That's all right. We can --

A. No, no, I should be able to...

Q. We can move on.

A. I've just got too many documents floating around in front of me right now.

So we're going back to Rana, and you want

to look at Table 5.

Q. It's all right. We can move on.

A. You sure?

Q. Yes. We're running out of time.

I guess the question would be, again, why would there be a statistical significant association with DLBLCL (sic), but not with FL or CLL, assuming that's what this table shows?

A. Well, there's all sorts of methodologic reasons. The easiest one would be simply sample size and power of the studies. DBC -- diffuse large cell is the most common type of NHL. So being the most common type, you'll have sufficient numbers to be able to see results that attain statistical significance if you're using confidence intervals excluding 1 as your metric.

Q. And on that -- I'm sorry. I do need -- Table 1 of the Rana analysis, it shows a study called Rinsky, et al.

Have you heard of that study?

A. Oh, yeah. I remember reading it when I was in public health school many years ago.

Q. It's a study of the Pliofilm rubber workers at three facilities in Ohio; is that correct?

A. That's correct.

Q. Are you aware that EPA believes it's the best published set of data for the evaluation of human cancer risks?

A. I don't specifically recall that, but I have no reason to argue with it.

Q. Rinsky didn't show a statistically significant association between NHL and benzene, correct, on Table 1?

A. Well, he only was dealing with five cases of NHL and exposed in five. Yeah, just five cases. So I can see why he didn't have the sample size.

Q. But there's no --

A. -- (indiscernible cross talk) much power --

Q. -- significant --

A. No.

Q. -- statistical association.

MS. KLIMEK: Okay. Can we go off the record for two minutes?

MS. GREENWALD: How much time?

THE VIDEOGRAPHER: The time -- we have seven minutes left.

MS. KLIMEK: Seven minutes left.

THE VIDEOGRAPHER: Off the record?

MS. KLIMEK: Oh, yes, I'm sorry.

THE VIDEOGRAPHER: The time is

7:08 p.m., and we're going off the record.

(Whereupon a recess was taken.)

THE VIDEOGRAPHER: The time is 7:12 p.m., and we're back on the record.

BY MS. KLIMEK:

Q. Are you familiar with the toxicological profile for benzene, the draft public comment for October 2024?

A. That was published by the ATSDR?

Q. Yes.

A. Yes.

Q. And I just want to turn your attention to page 98. This is Exhibit 35.

(Whereupon Exhibit 35 was marked for the record.)

A. I'm there.

Q. Second -- or yeah, second full paragraph, third sentence.

MS. GREENWALD: What page?

MS. KLIMEK: 98.

A. Yes.

Q. It says, quote, "Evidence for associations between benzene exposure and non-Hodgkin's lymphoma from both individuals" --

MS. GREENWALD: I don't have -- I

don't have 98. I am on 77.

MS. KLIMEK: All right. I'm sorry. 98, second full paragraph in the middle.

BY MS. KLIMEK:

Q. It says, quote, "Evidence for associations between benzene exposure and non-Hodgkin's lymphoma from both individual studies and meta-analysis are mixed. It must be noted that the available epidemiological studies are generally limited by confounding chemical exposures and methodological problems, including inadequate or lack of exposure monitoring and low statistical power due to small numbers of studies."

Did I read that correctly?

MS. GREENWALD: Objection. Form.

A. You did.

MS. KLIMEK: Thank you. That is all the questions that I have.

THE VIDEOGRAPHER: Anything further?

MS. KLIMEK: Thank you for your time.

THE VIDEOGRAPHER: The time is 7:14 p.m. We're going off the record.

(Whereupon a recess was taken.)

THE VIDEOGRAPHER: The time is 7:40 p.m., and we're back on the record.

EXAMINATION

BY MS. GREENWALD:

Q. Dr. Hu, I know it's late. I just have a couple of questions.

So --

A. Please proceed.

Q. -- you were asked about the Karami meta-analysis.

Do you remember?

A. Yes.

Q. Okay. And you were asked why that meta-analysis didn't include Hansen 2013 study.

Do you recall that?

A. Yes.

Q. Why is it that the Karami meta-analysis didn't include Hansen 2013, in your opinion?

A. The Hansen study came out, as it turns out, right after the Karami study. So there's no way the Karami investigators could have included it in their report.

Q. All right. So now I want to ask you about the discussion about the Hayes study. Okay?

A. Yes.

Q. And that was right before we took a break, right?

A. Yes.
Q. Okay. Have you reviewed, in your -- reaching your opinions in this case, more than one Hayes study?
A. Yes.
Q. Okay. And can you -- were they -- were the two Hayes studies that you reviewed, to your recollection, published at around the same time?
A. Right around the same time.
Q. Okay. How are they different?
A. One was a mortality study, and the other one was an incidence study.
Q. Okay. So -- actually, I do need a document.
If you can go back to your report, if you have it handy. It's number 2. It should be right on top.
THE STENOGRAPHIC REPORTER: It's on the bottom.
Q. It should be right on the bottom. There you go. Bottom, top? It's all the same.
A. Thank you.
Q. Okay.
A. Good move.
Q. If you can go to page 38, which we've

talked a lot about. All right?

A. Yes.

Q. All right. So I don't know if I asked you this or not already.

So you said there was more than one.

What -- what were they? What were the two different Hayes studies about? Do you remember?

A. Well, the '96 study was, I believe, the mortality study, and then the '97 study was the incidence study.

Q. Okay. And which one did you mean to cite to in your report?

A. The incidence study.

Q. Okay. So you cited to the mortality study on page 38?

A. Yes.

Q. And that's a mistake?

A. Yes.

Q. Okay. Okay. So we talked about the Rana study as well, the Rana meta-analysis before the break?

A. Yes.

Q. All right. If you -- if you want to look at it, that's fine. It's up to you if you remember.

Do you know whether in the Rana study,

those authors cited to the incidence study or the mortality study?

A. I think their citation was the mortality study.

Q. And you mentioned when you were answering questions with counsel for the government that you pulled numbers. I don't think these are exact words, but it's what my notes say, that you pulled numbers from the Rana study when you were doing some of your writing for the benzene section.

Remember that?

A. Correct.

Q. Okay. Did you review the studies that you referenced there, the individual studies, or did you just rely on what Rana said about them?

A. I reviewed the studies.

Q. Okay.

MS. KLIMEK: Objection. Form.

BY MS. GREENWALD:

Q. In reaching your opinions in this case, did you look at the totality of the evidence regarding TCE and non-Hodgkin's lymphoma as of the date of your report?

A. I did.

Q. Okay. In reaching your opinions in this

case, did you look at the totality of the evidence regarding PCE and non-Hodgkin's lymphoma as of the date of your report?

A. I did.

Q. Okay. And in reaching your opinions in this case, did you look at the totality of the evidence regarding benzene and non-Hodgkin's lymphoma as of the date of your report?

A. I did.

Q. Last question. You recently updated your materials considered list with a paper by an author named Xu.

Do you remember that?

A. Yes.

Q. Okay. Was that paper available at the time that you wrote your expert report in this case?

A. No.

Q. Why did you decide to add that paper to your materials considered list?

A. I think it's a significant paper for several different reasons. One of them is that it was a epidemiology study that took advantage of the UK Biobank, which is an enormous population-based cohort study in the United Kingdom. And they were able to connect the individual people to estimated exposures

to the so-called BTEX chemicals, which includes benzene, toluene, ethyl benzene, and xylene. And those exposures occurred at a very, very low level. And they were able to show that even at very low levels of exposure, there were detectable significant increases in cancer.

I don't think there's a study of that size, that power, that's been published before. And it's a community-based study. So for several different reasons, I think it's a very powerful study that underscores the ability of even low levels of exposure to these kinds of volatile organic compounds to cause cancer.

MS. GREENWALD: Okay. I don't have any other questions. Thank you very much.

EXAMINATION

BY MS. KLIMEK:

Q. I'd like to just follow up on the study you were just talking about, if that's okay. So -- I guess we'll give you copies. We're introducing it as Exhibit 36.

(Whereupon Exhibit 36 was marked for the record.)

What we were provided with is a journal pre-proof; is that correct?

A. Correct.
Q. And it notes on the first page that it's going to undergo additional review before it's published in its final form, correct?
A. Correct.
Q. It states that errors may be discovered which could affect the content; is that correct?
A. Correct.
Q. The copy that we received, I think, may have some of the errors. We weren't able to -- I'm not sure if you were. The first chart is not readable.
MS. GREENWALD: Objection. Form.
BY MS. KLIMEK:
Q. Are you able to read the contents of the ambient low-level BTEX and cancer risks in the first chart that's located --
A. That looks like a --
Q. -- page 1?
A. -- slide, but no. I don't think that was necessary to read and interpret the results, though.
Q. It also refers to some supplemental tables, which we weren't provided with either.
A. Okay.
Q. Some tables are missing also.

You agree?

A. It's not in this copy.

Q. Okay. And there was no individual exposure data, correct? It was done by -- annual concentrations of BTEX were estimated using the chemistry climate model, correct?

A. Well, they used that using geospatial techniques to then assign estimated exposures to people based on where they lived.

Q. The study acknowledges that the mechanisms underlying the carcinogenicity of BTEX are largely unknown, correct?

A. I think that may have been what was written, but I don't think this is a paper that was intended to be a detailed review of mechanisms underlying carcinogenesis of these chemicals.

Q. Do you agree that the paper -- the study notes in the two groups, when it compared the cases to the non-cases, that the -- I'm trying to find the language -- the -- the individuals who had reported a disease were at higher risks for certain factors such as age, obesity, and that -- it is above Table 1. There's no page numbers.

It says, "Compared to non-cases, incident cancer cases during follow-up tended to be older,

overweight, or obese, and from households with lower income, with lower education levels," correct?

A. Well, presumably those are all covariates that could be controlled for in their analysis.

Q. Do you know if they had controls for things like that, for the confounding?

A. Well, like I said, this is a cohort study, so they have a lot of individual level data on social and demographic information, including things like smoking, body mass index, weight, alcohol status, et cetera.

Q. And one of the limitations, if you look at the very last page before the citations, above the conclusion, notes, "Certain limitations should be addressed. The exposure assessment was based on residential addresses. Could not capture activity patterns of individuals. Thus, potential exposure misclassifications might exist."

A. They said that, but these are the same kinds of methodologies that are used in the many, many air pollution studies that have been done looking at air pollution and cardiovascular disease.

Q. Would you agree in the conclusion -- actually the very last sentence, "Our findings carry significant public health implications and highlight

the need for further research to corroborate these associations"? Is that correct?

MS. GREENWALD: Objection to form.

A. I think that's a general statement, and I have no reason to disagree with it.

MS. GREENWALD: You finished?

MS. KLIMEK: Yes, I'm finished. Thank you.

MS. GREENWALD: I have one more question. I'm sorry.

EXAMINATION

BY MS. GREENWALD:

Q. Can you go to the third-to-last page? It looks like this.

A. Yeah.

Q. It's that graph. It's the graph. It's this one here. I don't mean graph. I'm so sorry. It's like the (indiscernible cross talk) --

A. Oh, the one that --

Q. Yes. Okay.

A. -- is part of the --

Q. So -- so if you -- the one that counsel showed you is the second page, which is admittedly --

A. Right.

Q. -- very hard to read.

But if you go to that one, which is this -- does that appear to be the same one?

A. Yes.

Q. Okay. So can you read?

I know it's late. I know your eyes are tired. Mine are too.

Are you able to read?

You don't have to say what it is, but are you able to read "non-Hodgkin's lymphoma" pretty clearly here in this chart?

A. Let's see.

Q. It's under Multiple Myeloma.

A. Yeah, yeah. Yes.

Q. Okay. And if you read this on your computer screen, which is how you received it probably, you would be able to blow that up, right, and see it very clearly?

A. Yes.

Q. Do you want to read what the hazard ratios are for non-Hodgkin's lymphoma?

A. Well, based on 2,007 cases, the hazard ratio was 2.11 with a 95 percent confidence interval going from 1.92 to 2.30.

Q. And that's for benzene?

A. That's for benzene.

For toluene, I can read that.

For xylene --

Q. That's okay.

A. -- I can read that.

Q. That's okay.

A. But I think what we're most concerned is benzene.

MS. GREENWALD: All right. Thank you, Dr. Hu. I really appreciate your time today.

THE WITNESS: Thank you.

MS. KLIMEK: Thank you very much.

THE WITNESS: Folks --

MS. KLIMEK: Appreciate your time.

THE VIDEOGRAPHER: Okay, hold, please.

THE WITNESS: What a family.

THE VIDEOGRAPHER: The time is 7:53 p.m., and this concludes the deposition of Dr. Howard Hu. And we are going off the record.

(Whereupon the deposition of HOWARD HU, M.D., M.P.H, Sc.D. adjourned at 7:53 p.m.)

-oOo-

May 13, 2025
VIA EMAIL ONLY

WEITZ & LUXENBERG P.C.
By: Robin L. Greenwald, Esq.
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New York, NY 10003
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Re: In re: Camp Lejeune Water Litigation
No.: 7:23-cv-00897
Date: Wednesday, April 30, 2025
Deposition of: Howard Hu, M.D., M.P.H., Sc.D.

Dear Ms. Greenwald:
Attached please find a copy of the deposition transcript in the above-referenced matter. Kindly have the witness review the copy, note any corrections on the errata sheet provided within the transcript, and sign the acknowledgment page.
Please forward the errata sheet and the acknowledgement page within thirty (30) days from receipt of this letter directly to:

U.S. DEPARTMENT OF JUSTICE
CIVIL DIVISION
Allison O'Leary, Esq.
1100 L Street NW, LST 3512
Washington, DC 20005
(202) 436-6895

Please also provide a copy of the signed acknowledgment page and errata sheet to our attention for our records. The copy can be emailed to us at cs-golkow@veritext.com or mailed to our records department: 1650 Market Street, Suite 5150, Philadelphia, PA 19103.
If you should have any questions, please do not hesitate to contact us.

Sincerely,

Production Department
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cc: joseph.b.turner@usdoj.gov
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IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF NORTH CAROLINA

IN RE:	No. 7:23-cv-00897
CAMP LEJEUNE WATER LITIGATION	
This Document Relates To: ALL CASES	

I, HOWARD HU, M.D., M.P.H, Sc.D., I, state that I am the deponent in the aforesaid deposition on APRIL 30, 2025, that I have read the foregoing transcript of my deposition, and that the foregoing is a true and correct transcript of my testimony so given except as I have so indicated on the errata sheets provided herein.

I declare under the penalties of perjury of the State of Washington that the foregoing is true and correct.

_____
HOWARD HU, M.D., M.P.H, Sc.D.

No corrections (please initial) _____
Number of errata sheets submitted _____ pages

DEPOSITION ERRATA SHEET

Page No. _____ Line No. _____

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HOWARD HU, M.D., M.P.H, Sc.D.

Dated: _____

REPORTER'S CERTIFICATE

This is to certify that I, Cynthia A. Kennedy, Registered Professional Reporter and Washington Certified Court Reporter, reported the within and foregoing VIDEOTAPED DEPOSITION of HOWARD HU, M.D., M.P.H, Sc.D. On WEDNESDAY, APRIL 30, 2025;

That, prior to being examined, the witness named in the foregoing deposition was by me duly sworn pursuant to Section 30(f)(1) of the Federal Rules of Civil Procedure and the deposition is a true record of the testimony given by the witness;

That said examination was taken by me stenographically and thereafter transcribed by me or under my supervision; and that the transcript of the deposition is a full, true, and correct transcript of said witness, including all questions, answers, and objections, if any, of counsel to the best of my ability;

__X__ That the witness was requested to review the transcript and make any changes to the transcript as a result of that review pursuant to Section 30(e) of the Federal Rules of Civil Procedure.

_____ Signature is Waived

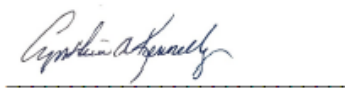
_____ The changes made by the witness are appended to the transcript.

_____ No request was made that the transcript be reviewed pursuant to Section 30(e) of the Federal Rules of Civil Procedure.

I further certify that I am not a relative or employee of counsel or any of the parties, nor am I financially interested in the outcome of the cause.

I declare under penalty of perjury under the laws of the State of California, that the foregoing is true and correct.

Witness my hand this 13th dav of Mav 2025.



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Cynthia A. Kennedy, CCR, RPR

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Federal Rules of Civil Procedure

Rule 30

(e) Review By the Witness; Changes.

(1) Review; Statement of Changes. On request by the deponent or a party before the deposition is completed, the deponent must be allowed 30 days after being notified by the officer that the transcript or recording is available in which:

(A) to review the transcript or recording; and

(B) if there are changes in form or substance, to sign a statement listing the changes and the reasons for making them.

(2) Changes Indicated in the Officer's Certificate. The officer must note in the certificate prescribed by Rule 30(f)(1) whether a review was requested and, if so, must attach any changes the deponent makes during the 30-day period.

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COMPANY CERTIFICATE AND DISCLOSURE STATEMENT

Veritext Legal Solutions represents that the foregoing transcript is a true, correct and complete transcript of the colloquies, questions and answers as submitted by the court reporter. Veritext Legal Solutions further represents that the attached exhibits, if any, are true, correct and complete documents as submitted by the court reporter and/or attorneys in relation to this deposition and that the documents were processed in accordance with our litigation support and production standards.

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