BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

In the Matter of:	)	
	)	
SIERRA CLUB, ENVIRONMENTAL LAW AND POLICY CENTER, PRAIRIE RIVERS NETWORK, and CITIZENS AGAINST RUINING THE ENVIRONMENT	)	
	)	**PCB 2013-015**
Complainants,	)	**(Enforcement – Water)**
	)	
v.	)	
	)	
MIDWEST GENERATION, LLC,	)	
	)	
Respondent.	)	

NOTICE OF FILING

TO: Don Brown, Clerk
Illinois Pollution Control Board
60 E. Van Buren St., Ste. 630
Chicago, Illinois 60605

Attached Service List

PLEASE TAKE NOTICE that I have filed today with the Illinois Pollution Control Board Respondent, Midwest Generation, LLC's Motion to Leave to File, *Instanter*, MWG's Amended List of Exhibits Offered for Admission and Submitted to the Illinois Pollution Control Board a copy of which is served upon you.

MIDWEST GENERATION, LLC

By: /s/ Andrew Nishioka

Dated: July 26, 2023

Jennifer T. Nijman
Kristen L. Gale
Andrew Nishioka
NIJMAN FRANZETTI LLP
10 South LaSalle Street, Suite 3400 (please note new suite no.)
Chicago, IL 60603
(312) 251-5271

BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

In the Matter of:	)	
	)	
SIERRA CLUB, ENVIRONMENTAL LAW AND POLICY CENTER, PRAIRIE RIVERS NETWORK, and CITIZENS AGAINST RUINING THE ENVIRONMENT	)	
	)	**PCB 2013-015**
Complainants,	)	**(Enforcement – Water)**
	)	
v.	)	
	)	
MIDWEST GENERATION, LLC,	)	
	)	
Respondent.	)	

MIDWEST GENERATION, LLC'S MOTION TO LEAVE TO FILE, *INSTANTER*, MWG'S AMENDED LIST OF EXHIBITS OFFERED FOR ADMISSION AND SUBMITTED TO THE ILLINOIS POLLUTION CONTROL BOARD

Pursuant to 35 Ill. Adm. Code 101.500, Respondent, Midwest Generation LLC ("MWG"), by their undersigned counsel, submit to the Hearing Officer this motion for leave to file, *instanter*, MWG's Amended List of Exhibits Offered for Admission by Midwest Generation, LLC and Submitted To The Illinois Pollution Control Board and states as follows:

1. On June 29, 2023, Respondent filed its List of Exhibits Offered For Admission By Midwest Generation, LLC and Submitted To The Illinois Pollution Control Board.

2. Inadvertently, Respondent did not include exhibits 1106 and 1107, offered for admission on May 16, 2023 during the hearing. 5/16/23, Tr., p. 8:1-2.

3. Exhibits 1106 and 1107 were admitted, without objection from Complainants. 5/16/23, Tr., p. 8:3-12.

4. True and correct copies of exhibits 1106 and 1107 were provided to the Hearing Officer and Complainants during the hearing. Copies of the exhibits are attached. See 35 Ill. Adm. Code 101.627.

5. Neither party would be prejudiced if the Hearing Officer grants Respondent's Motion to Leave to File, *Instanter*, MWG's Amended List of Exhibits Offered for Admission and Submitted to the Illinois Pollution Control Board because the parties were provided with true and correct copies and there was no objection to the admittance of the exhibits.

6. Wherefore, for the reasons above, Respondent requests that the Hearing Officer grant Respondent's Motion to Leave to File, *Instanter*, MWG's Amended List of Exhibits Offered for Admission and Submitted to the Illinois Pollution Control Board.

/s/ Andrew Nishioka
MIDWEST GENERATION, LLC

Dated: July 26, 2023

Jennifer T. Nijman
Kristen L. Gale
Andrew Nishioka
NIJMAN FRANZETTI LLP
10 South LaSalle Street, Suite 3400 (please note new suite no.)
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BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

In the Matter of:	)	
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SIERRA CLUB, ENVIRONMENTAL LAW AND POLICY CENTER, PRAIRIE RIVERS NETWORK, and CITIZENS AGAINST RUINING THE ENVIRONMENT	)	
	)	**PCB 2013-015**
Complainants,	)	**(Enforcement – Water)**
	)	
v.	)	
	)	
MIDWEST GENERATION, LLC,	)	
	)	
Respondent.	)	

AMENDED LIST OF EXHIBITS OFFERED FOR ADMISSION BY MIDWEST GENERATION, LLC AND SUBMITTED TO THE ILLINOIS POLLUTION CONTROL BOARD

Pursuant to 35 Ill. Adm. Code 101.627, Respondent, Midwest Generation, LLC, submits this amended list of exhibits offered May 15, 2023 to May 19, 2023 and June 12, 2023 to June 15, 2023, at the hearing for PCB 2013-15.

Exhibit	Description
MWG 1106	Zarate v. Couch Docket No.: OSAH-BNR-SW-0819020-60-Miller before OSAH Georgia
MWG 1107	Tennessee Clean Water Network v. TVA. Case No. 3:15-cv-00424 January 30, 2017
MWG 1108	USEPA Presumptive Remedy for CERCLA Municipal Landfill, September 1993
MWG 1110	Water Quality Standards and Effluent Limitations for the Chicago Area Waterway System and Lower Des Plaines River, PCB R08-09, Sediment Chemistry Study (Pre-filed Testimony Dr. Burton), September 8, 2008
MWG 1111	Phase II Report, Brandon Road Interbasin Project, Kaskaskia Engineering 2022 (Army Corp of Engineers) (Excerpt)
MWG 1501	AS 2021-001, Midwest Generation LLC's Petition for Adjusted Standard and Finding of Inapplicability for the Joliet 29 Station, May 11, 2021
MWG 1502	Federal CCR Compliance Annual Groundwater Monitoring and Corrective Action Report - 2021, Joliet #29 Generating Station
MWG 1503	Map of Boring Locations, Joliet #29, Figure 1

Exhibit	Description
MWG 1504	Joliet 29 Boring Logs SB1-SB16
MWG 1505	Joliet 29 Boring Logs TW1-TW3
MWG 1506	Eurofins Joliet 29 Soil Samples East Clarifier, West Clarifier Temporary Borings
MWG 1507	Eurofins Joliet 29 Soil Samples
MWG 1508	Joliet 29 Inspection Summary Letter 2018
MWG 1509	Joliet 29 Inspection Summary Letter 2019
MWG 1510	Joliet 29 Inspection Summary Letter 2020
MWG 1511	Joliet 29 Inspection Summary Letter 2021
MWG 1512	Joliet 29 Inspection Summary Letter 2022
MWG 1513	KPRG 2021 Photos of J29 NE Area
MWG 1514	Powerton First Quarter 2015 Quarterly Report, April 24, 2015
MWG 1515	Illinois River Levels at Kingston Mines and Peoria Lock and Dam
MWG 1516	Illinois River Levels at Kingston Mines and Peoria Lock and Dam
MWG 1517	Eurofins LEAF tests for Waukegan Former Slag Area (FS Area)
MWG 1601	MWG Employee Information
MWG 1602	Lyderson, Kari, "Historic coal ash raises concerns at iconic Illinois coal plant site", Energy News, Dec. 21, 2021
MWG 1603	AS 2021-001, Recommendation of the IEPA, Joliet 29 Station, September 22, 2021
MWG 1604	AS 2021-001, Board Order, Adjusted Standard and Finding of Inapplicability for the Joliet 29 Station, May 18, 2023
MWG 1605	MWG's Response in Support of its Joliet 29 Petition for Adjusted Standard, PCB AS21-01, March 24, 2022
MWG 1606	AS 2021-002, Board Order, Adjusted Standard and Finding of Inapplicability for the Powerton Station, February 17, 2022
MWG 1607	Shealey Presentation for Testimony
MWG 1701	Expert Report on Relief and Remedy, *Sierra Club et al. v. Midwest Generation, LLC*, Weaver Consultants Group, April 2021
MWG 1702	Weaver Consulting Group Presentation for Testimony
MWG 1703	Email from J. Kunkel to F. Bugel and A. Russ attaching Meeting Minutes of meeting between J. Kunkel and F. Bugel, Aug. 20, 2014
MWG 1801	Dr. Brian Richards CV
MWG 1802	Economic Impacts of Midwest Generation Stations in Illinois, Prepared by Brian Richard, Ph.D., April 2021
MWG 1901	Expert Report *In the Matter of Sierra Club, Environmental Law and Policy Center, et al v. Midwest Generation, LLC*, PCB13-15, Prepared by Gayle Koch, April 2021 (Contains NDI – hard copies submitted)

Exhibit	Description
MWG 1902	Gayle Koch Presentation for Testimony (Contains NDI – hard copies submitted)

I certify that an accurate reproduction of the exhibits contained in the foregoing Amended List of Exhibits Offered for Admission and Submitted to the Illinois Pollution Control Board was submitted to the Illinois Pollution Control Board, Don Brown on June 29, 2023, and July 26, 2023, as required by 35 Ill. Adm. Code 101.627(c).

/s/ Andrew Nishioka
MIDWEST GENERATION, LLC

Dated: July 26, 2023

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CERTIFICATE OF SERVICE

The undersigned, an attorney, certifies that a true copy of the foregoing Notice of Filing, Respondent, Midwest Generation, LLC's Motion to Leave to File, *Instanter*, MWG's Amended List of Exhibits Offered for Admission and Submitted to the Illinois Pollution Control Board, and an accurate electronic reproduction of each exhibit was submitted on June 29, 2023, and July 26, 2023, with the following:

Don Brown, Clerk
Illinois Pollution Control Board
James R. Thompson Center
60 E. Van Buren St., Ste. 630
Chicago, Illinois 60605

and that true hard copies of the Non-Disclosable exhibits were hand-delivered to Don Brown on June 29, 2023. The Notice of Filing, Respondent, Midwest Generation, LLC's Motion to Leave to File, *Instanter*, MWG's Amended List of Exhibits Offered for Admission and Submitted to the Illinois Pollution Control Board was emailed to the parties listed on the foregoing Service List.

/s/ Andrew Nishioka

BEFORE THE OFFICE OF STATE ADMINISTRATIVE HEARINGS
STATE OF GEORGIA

EVELYN ZARATE, DEANNA WORK, STEVEN WORK, RONALD F. DOCHE, DARREK W. HAY, DAWN CAMPBELL, SANFRED L. WOOD[1] and HERB BARTLETT,	:	**Docket No.: OSAH-BNR-SW-0819020-60-Miller**
Petitioners,	:	
v.	:	
CAROL A. COUCH, DIRECTOR, ENVIRONMENTAL PROTECTION DIVISION, GEORGIA DEPARTMENT OF NATURAL RESOURCES,	:	
Respondent,	:	
GREENBOW, LLC,	:	
Respondent-Intervenor.	:	

FINAL DECISION

For Petitioners:

Christopher R. Reeves, Esq.
Swift, Currie, McGee & Hiers, LLP

For Respondent:

Aaron B. Mason, Esq.
Georgia Department of Law

For Respondent-Intervenor:

Robert C. Norman, Jr., Esq.
Jones, Cork & Miller, LLP

[1] The spelling of Petitioner Wood's first name has been corrected in accordance with her testimony at the evidentiary hearing.

I. INTRODUCTION AND PROCEDURAL BACKGROUND

On December 21, 2007, Dr. Carol Couch, Director of the Environmental Protection Division of the Georgia Department of Natural Resources ("Respondent"), issued Solid Waste Handling Permit No. 099-019D(MSWL) to Greenbow, LLC ("Intervenor"). The permit authorizes the Intervenor to construct and operate the Turkey Run Municipal Solid Waste Landfill in Meriwether County, Georgia.

On January 18, 2008, Evelyn Zarate, Deanna Work, Steven Work, Ronald Doche, Darrek W. Hay, Dawn Campbell, Sanfred L. Wood, and Herb Bartlett ("Petitioners")[2] filed their Petition for Hearing challenging the issuance of the permit.[3] The matter was assigned to be heard by the undersigned administrative law judge of the Office of State Administrative Hearings, a court of administrative law.[4]

The Petitioners subsequently filed an Amended Petition for Hearing ("Amended Petition") setting forth eight grounds[5] upon which the Petitioners contend the permit should be invalidated or modified. On April 2, 2008, this Court granted summary determination in favor of Intervenor and Respondent as to four of those claims: Counts I, II, IV, and IX of the Amended Petition. See Segraves v. Couch, OSAH-BNR-SW-0819020-60-Miller (OSAH April 2, 2008)

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[2] Darrell Segraves and Traci Segraves were originally named as Petitioners but were voluntarily dismissed prior to the commencement of the evidentiary hearing. (T. 7.)

[3] The Petition was received by the Respondent on January 18, 2008, and filed with the Office of State Administrative Hearings on January 31, 2008.

[4] A related Petition challenging the same permit was also filed before this Court. See Petition for Hearing, Hines v. Couch, Docket No. OSAH-BNR-SW-0819021-60-Miller. However, that Petition was resolved in its entirety by motion of the Intervenor and Respondent. Hines v. Couch, OSAH-BNR-SW-0819021-60-Miller (OSAH April 2, 2008) (order granting Intervenor's motion to dismiss or for summary determination).

[5] The original Petition contained a ninth ground, pled as Count V, which was withdrawn. (Amended Petition for Hearing at 16.)

(order granting in part and denying in part Intervenor's motion to dismiss or for summary determination). Therefore, only Counts III, VI, VII, and VIII remain for determination.

In the remaining four counts, the Petitioners set forth several related allegations with respect to potential contamination of water resources. More specifically, Count III alleges that the Intervenor failed to demonstrate that the landfill will not cause or contribute to violations of state water quality standards and that the groundwater monitoring plan approved by the Respondent is insufficient. In Counts VI, VII, and VIII, the Petitioners contend that the Intervenor failed to demonstrate that the landfill will not adversely impact private and public wells in the vicinity, as well as the Blue Creek water supply watershed and a groundwater recharge area underlying the site.

The evidentiary hearing in this matter was held over a period of four days, on April 14, 15, 16, and 22, 2008. For the reasons set forth below, the Respondent's decision to issue the permit is hereby **AFFIRMED**.

II. FINDINGS OF FACT

A. The Petitioners

Each of the Petitioners lives in the vicinity of the proposed landfill site and relies on public or private wells in the area for drinking water. Petitioner Evelyn Zarate lives within two miles northwest of the proposed landfill site and relies on water from her private well as her primary source of drinking water. (Written Direct Testimony of Evelyn Zarate ("PST-7") at 1-2; T. 59.) She also operates a tortilla-manufacturing business in a separate building located on her property. Water from a second private well is utilized in the production of tortillas for her business. (PST-7 at 2-3; T. 60-61.)

Petitioner Deanna Work and her husband, Petitioner Steven Work, live in Hogansville and rely on the Hogansville Reservoir for drinking water. (Written Direct Testimony of Deanna Work ("PST-6") at 1-2; T. 57; Written Direct Testimony of Steven W. Work ("PST-8") at 1-2.) Both Petitioners are employees of Petitioner Zarate's tortilla-manufacturing business and rely on water from the business' well for continued employment and drinking water during working hours. (PST-6 at 2; PST-8 at 2.)

Petitioner Ronald Doche lives in the Town of Lone Oak, approximately 1.5 miles from the proposed landfill site.[6] His primary source of drinking water is the Lone Oak water system, which provides water drawn from public wells in Lone Oak. (Written Direct Testimony of Ronald Doche ("PST-3") at 1-2; T. 44.)

Petitioner Darrek Hay is a resident of Hogansville and relies primarily on the water from the Hogansville Reservoir for drinking water at his home. In addition, Petitioner Hay's father owns a home, which Petitioner Hay expects to inherit, located approximately one-half mile from the proposed landfill site in a northwesterly direction. Petitioner Hay is a daily consumer of water from a private well on his father's property. (Written Direct Testimony of Darrek Hay ("PST-4") at 1-4; T. 51-53.)

Petitioner Alisa Dawn Campbell lives approximately two miles northwest of the proposed landfill site and relies on water from a private well as her primary source of drinking water. (Written Direct Testimony of Alisa Dawn Campbell ("PST-2") at 1-2; T. 42.)

Petitioner Sanfred Wood lives approximately 2.5 miles southeast of the proposed site and relies primarily on water from the Lone Oak public wells for drinking water. (Written Direct Testimony of Sanfred Lee Wood ("PST-5") at 1-2; T. 54.)

[6] Petitioner Doche, who is the Mayor of Lone Oak, has asserted standing in his individual capacity only and not as a representative of Lone Oak or its citizens. (T. 7.)

Petitioner Herb Bartlett lives approximately nine miles south of the site and relies on water drawn from a private well on his property as his primary drinking water source. He also consumes water from the public well located in the town of Lone Oak once per month. (Written Direct Testimony of Herb Bartlett ("PST-1") at 1-3; T. 36-39.)

B. The Permitting Process

On June 1, 2006, the Intervenor submitted an "Application for Solid Waste Handling Permit and Request for Site Suitability" to the Georgia Environmental Protection Division ("EPD"), requesting authorization to construct and operate the proposed Turkey Run Municipal Solid Waste Landfill in Meriwether County, Georgia. (Written Direct Testimony of Jeff Cown ("RST-1") at 3; Exhibit J-7.)

The permitting process for municipal solid waste landfills in Georgia is governed by the Rules of the Department of Natural Resources ("DNR") regarding solid waste management, GA. COMP. R. & REGS. § 391-3-4-.01, et seq. (cited hereinafter as "DNR Rules"). The first step toward acquiring a permit for a municipal solid waste landfill is to conduct a geological and hydrogeological evaluation of the proposed site in accordance with DNR Rule 391-3-4-05. A guidance document incorporated in the Rule, referred to as "Circular 14,"[7] sets forth the specific data that must be submitted to EPD for a determination of site suitability. DNR Rule 391-3-4-.05(1)(k)8.(4). (Exhibit J-4.)

The Site Hydrogeologic Assessment Report ("Hydrogeologic Assessment") for the proposed Turkey Run landfill was prepared and sealed by a Georgia registered geologist, Mark S. Preddy, and a Georgia-registered geotechnical engineer, Daniel Bunnell. (Written Direct Testimony of Mark S. Preddy ("GBST-3") at 2-3; T. 959-962; Exhibit J-8.) The Hydrogeologic

[7] William H. McLemore and Paul D. Perriello, Criteria for Performing Site Acceptability Studies for Solid Waste Landfills in Georgia, GEORGIA GEOLOGIC SURVEY (1991) (amended 1997).

Assessment included an evaluation of the landfill site restrictions, an investigation of surface and subsurface geology and hydrogeology, an analysis of groundwater movement, an evaluation of local public and private drinking water supplies, and recommendations for the landfill's design and monitoring systems. (GBST-3 at 4-15; T. 962-965; Exhibit J-8.)

The Hydrogeologic Assessment was reviewed by two EPD staff geologists, Bret McClellan and Steve McManus. Both Mr. McClellan and Mr. McManus determined, based on the information provided in the Hydrogeologic Assessment and a site visit by Mr. McClellan, that the proposed site met the investigative requirements established by EPD and the suitability requirements for construction and operation of a municipal solid waste landfill. (Written Direct Testimony of Bret McClellan ("RST-3") at 3-7; Written Direct Testimony of Steve McManus ("RST-4") at 3-7; Exhibits J-9, J-10.) Accordingly, on March 6, 2007, EPD issued a Site Suitability Notice for the proposed Turkey Run landfill. (Exhibit J-11.) The Site Suitability Notice set forth thirteen site limitations recommended by Mr. McClellan and Mr. McManus, including a prohibition on waste disposal south of Blue Creek and a minimum 150-foot buffer between Blue Creek and the waste disposal area. (RST-3 at 5-6; RST-4 at 3-4; Exhibits J-9, J-10, J-11.)

Following the issuance of the Site Suitability Notice, the second step in the permitting process was to obtain EPD's approval of the Design and Operation Plan for the proposed facility. The initial Design and Operation Plan for the Turkey Run landfill was submitted to EPD in April 2007 by William F. Hodges, its lead project engineer, and it was reviewed by several EPD staff members, including Derrick Williams, a mechanical engineer and EPD's unit coordinator for the commercial and industrial permitting unit; Ken Simonton, an EPD geologist; and Jeff Cown, EPD's solid waste program manager. (RST-1 at 3-4; Written Direct Testimony of Derrick

Williams ("RST-2") at 1-3; Written Direct Testimony of Ken Simonton ("RST-5") at 1-4; Written Direct Testimony of William F. Hodges ("GBST-1") at 3-4, 13-14; Exhibit GB-41.) Following this review, which included both formal and informal discussions between EPD staff, Mr. Hodges, and others involved in the project, Mr. Hodges submitted a revised Design and Operation Plan on November 6, 2007. (GBST-1 at 13-14; RST-1 at 4; RST-2 at 3-4; RST-5 at 4; T. 608-609; Exhibits J-12, J-13, J-14, GB-42, GB-43.) Subsequently, Mr. Hodges incorporated several additional recommendations made by EPD staff and submitted the final Design and Operation Plan to EPD on December 18, 2007. (GBST-1 at 15; Exhibits J-15, GB-48A.) The final Design and Operation Plan consists of forty-five engineering sheets that set forth the specifications for design, construction, operation, and closure of the landfill. (Exhibit J-15.)

On December 21, 2007, Carol Couch, the Director of EPD, issued a solid waste handling permit for the Turkey Run landfill in accordance with her staff's recommendations. (RST-1 at 4; T. 339-340; Exhibit J-16.) The permit incorporates the specifications of the Design and Operation Plan and contains an additional thirty-three conditions for construction and operation of the landfill. (Exhibit J-16.) Under the permit, the landfill will consist of 417.54 acres, which includes the 192.59 acres that has been permitted for waste disposal, as well as the required buffer zones and areas for other activities related to operation of the landfill. (Exhibit J-15 at sheets 2, 45.) The Petitioners have challenged both the landfill's siting and its design. Specifically, the Petitioners contend that the Permit should be revoked or modified because EPD committed errors in its consideration of the permit application that resulted in the improper placement of the landfill in a significant groundwater recharge area and failed to eliminate significant threats to the environment and local water supplies.

C. Geology and Hydrogeology of the Site

The Hydrogeologic Assessment prepared in connection with the proposed Turkey Run landfill included an evaluation of the siting and location restrictions contained in DNR Rule 391-3-4-.05, as well as a hydrological site investigation that analyzed the following factors: (1) distance to nearest point of public or private drinking water supply; (2) depth to the uppermost aquifer; (3) uppermost aquifer gradient; (4) topographic setting; (5) landfill setting; (6) hydraulic conductivity; (7) sorption and attenuation capacity; and (8) distance to surface water. (Exhibit J-8.) See DNR Rule 391-3-4-.05(1)(k). The Hydrogeologic Assessment submitted by the Intervenor followed the requirements of DNR Rule 391-3-4-.05.

1. Summary of Findings[8]

The proposed landfill site is located in the inner Piedmont region of Georgia. The Hydrogeologic Assessment prepared by Mr. Preddy included the results of 28 soil borings performed on the site, including 21 undisturbed samples, which were sufficient to characterize the hydrogeology of the site.[9] (GBST-3 at 6-8; Exhibit J-8 at § 3.4.1 and tables 1-3.) The site does not have complex geologic features and is characterized by an upper residuum with soils that consist of sandy, clayey silts and silty, clayey sands. A deeper residual soil component consists of micaceous slightly clayey, sandy silts and silty sands. Below the deep residuum is a zone of partially weathered bedrock. Well-foliated medium-grained gneiss and schist bedrock underlies the partially weathered bedrock. (Written Direct Testimony of James L. Kennedy

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[8] Inasmuch as only a relatively small portion of the Hydrogeologic Assessment's findings and conclusions are in dispute, a summary of the report will be provided, followed by a more detailed factual analysis of the particular issues in this case.

[9] Circular 14 prescribes one boring per twenty acres and generally requires at least as many undisturbed samples as there are borings. In this case, although only 21 undisturbed samples were obtained, the 28 total borings and 200+ disturbed soil samples adequately characterized the physical properties of the subsurface soils. (RST-3 at 6-7; T. 412.)

("RST-6") at 3-4; GBST-3 at 10; Written Direct Testimony of David L. Hargett ("GBST-4") at 8-10; T. 477-480, 984-991; Exhibit J-8 at § 3.4. and table 3.) Soil thickness above the bedrock ranges from 10 to 55 feet. (Written Direct Testimony of Mark A. Quarles ("PST-10") at 10; RST-6 at 4; GBST-4 at 9-10; Exhibit J-8 at figure 8.) The clays and silts that are mixed with the sandy materials tend to slow the movement of groundwater. (GBST-3 at 18; GBST-4 at 9-10; Written Direct Testimony of L.T. Gregg ("GBST-5") at 4; T. 992-993.)

The groundwater aquifer is also typical of a Piedmont site. The uppermost aquifer consists of the residual soil, partially weathered rock, and the upper portion of the fractured bedrock. In lower elevations along the floodplain, alluvial soils also comprise some portion of the water table aquifer. These units, which are hydraulically connected, comprise a single unconfined aquifer. (GBST-3 at 10; Exhibit J-8 at § 3.5.) The seasonal high water elevation at the site was determined using monthly water level measurements collected from piezometers at the site over a period of thirteen months. (GBST-3 at 8; Exhibit J-8 at § 3.5.2 and figure 11.) The characteristics of the subsurface geology at the site, like those generally seen throughout the Piedmont, cause groundwater to seep, dispersing in a teardrop shape rather than flowing through a channel. (T. 477-480, 1012-1013, 1097-1099.)

The flow of groundwater at the site generally mirrors that of the surface water. In preparing the Hydrogeologic Assessment, Mr. Preddy determined that the direction of groundwater and surface water flow at the site is to the west, southwest, and south. (GBST-3 at 10; T. 974-975; Exhibits J-8 at §§ 3.5, 4.2 and figure 10, GB-3.) In addition, Blue Creek and its tributaries, which surround the site on the northwest, west, southwest, and south, are hydraulic divides for groundwater flow, such that groundwater discharges into Blue Creek and its tributaries at those locations. (GBST-3 at 10; Exhibit J-8 at §§ 3.5, 4.2 and figure 10.) A

localized component of groundwater movement to the east exists at the northeastern corner of the site. (PST-10 at 11; RST-6 at 8.)

The conclusions set forth in the Hydrogeologic Assessment regarding soil composition and groundwater and surface water flow were confirmed by Georgia's State Geologist, Dr. James Kennedy, as well as by two other experts, L.T. Gregg, a Georgia-registered geologist, and Dr. David Hargett, a soil scientist and groundwater expert. (RST-6 at 8-9; GBST-4 at 31; GBST-5 at 3-6; T. 1122-1126; Exhibits GB-3, GB-78.)

2. Significant Groundwater Recharge Area

The proposed landfill site is not located in a "significant groundwater recharge area." The term "significant groundwater recharge area" is defined in DNR Rules as follows:

> any area designated on Hydrologic Atlas 18 . . . unless an applicant for a solid waste handling permit or other interested party can demonstrate to the satisfaction of the Director that an area designated on Hydrologic Atlas 18 is or is not, in fact, a significant groundwater recharge area."

DNR Rule 391-3-4-.01(63). With respect to the proposed landfill site, it is undisputed that the area is not listed on Hydrologic Atlas 18. (RST-6 at 4; GBST-3 at 16; GBST-5 at 5; T. 518-519; Exhibit J-6.) However, the Petitioners contend that the site nonetheless bears the characteristics of a significant groundwater recharge area and should be recognized as such.

The testimony of the Petitioners' expert, Mark A. Quarles, in this regard was simply not persuasive. According to Mr. Quarles, the site should be considered a significant groundwater recharge area because groundwater under the site discharges into Blue Creek and its tributaries, and these surface waters in turn supply the Blue Creek reservoir in Hogansville, where the water is eventually used as a drinking water source by local residents. However, groundwater that feeds surface water, as exists on this site, is not appropriately considered in determining whether a significant groundwater recharge area exists. (T. 518-522.) Furthermore, Hydrologic Atlas 18

elaborates that significant recharge areas in northern Georgia "are characterized by thick soils or saprolite coupled with low (less than 8 percent) slope . . . ." (Exhibit J-6.)[10] Here, the site contains soil thicknesses of only 10 to 55 feet, and ground surface slopes over most of the facility are greater than eight percent. Because of this relatively thick soil above bedrock and the significant slopes, the site does not meet the criteria for designation as a significant groundwater recharge area. (RST-6 at 4; T. 480-481.) Accordingly, the Court finds that the proposed landfill site is not located in a significant groundwater recharge area.

3. Public and Private Wells

The Hydrogeologic Assessment identified the locations of all public and private water supplies in the vicinity of the Turkey Run site. With respect to public water supplies, two water supply wells for the community of Lone Oak are located approximately 4900 feet east of the proposed landfill. (GBST-3 at 5-6; T. 972.) The site is well outside the outer management zones for both of these wells, which EPD has established at 1221 and 2012 feet under the wellhead protection plan. (GBST-3 at 5-6; T. 976-977; Exhibits GB-35, GB-36.) In addition, both wells are located hydraulically upgradient from the proposed landfill and across hydraulic divides. (GBST-3 at 5; GBST-4 at 31-32; T. 978, 1125-1126; Exhibits J-8, GB-78.)

Mr. Preddy's assessment of the site also included an evaluation of the distance from the landfill site to the nearest surface water intake for a public drinking water source. The City of Hogansville Blue Creek reservoir is the nearest such surface water intake, and it is located approximately 2.5 miles from the proposed landfill. (GBST-3 at 5; T. 972.)

Mr. Preddy determined, with respect to private water supplies in the vicinity, that twenty-six private wells are located within a one-half mile radius of the proposed landfill site. (Exhibit

[10] Kenneth R. Davis, et. al., Most Significant Ground-Water Recharge Areas of Georgia, HYDROLOGIC ATLAS 18, GEORGIA GEOLOGIC SURVEY (1989) (reprinted 1992).

J-8 at figure 7.) Residents rely on these private wells as a primary source of drinking water, and homes in the area are not served by a public water source. (PST-10 at 11-12.) All of the private wells are also located beyond the minimum buffer distance of 500 feet from the waste disposal boundary. (GBST-4 at 14.) It was the consensus of the four credible experts who testified on behalf of the Respondent and Intervenor that all of the private wells identified in the Hydrogeologic Assessment are located either upgradient of the waste disposal cells or across a hydraulic divide, or both. (RST-6 at 8; GBST-3 at 6, 19; GBST-4 at 31; T. 408-410; Exhibits J-8 at § 3 and figure 7, GB-78.) These experts therefore opined that the proposed landfill will not affect the quality of water in the surrounding public and private wells. (RST-6 at 8; GBST-3 at 6; GBST-4 at 31-32; GBST-5 at 6.) Mr. Quarles' testimony to the contrary was not persuasive.[11]

Mr. Quarles suggested that drawdown from residents' use of their wells could cause a reversal of groundwater flow. (PST-10 at 11-12; T. 170-171.) However, this possibility was considered and rejected by Mr. Preddy when he prepared the Hydrogeologic Assessment. (T. 973-974.) The typical domestic well pumps 150 gallons of water per person per day, or 750 gallons per day for a family of 5. In order for residents' use of private wells to have any measurable effect, pumping rates would have to reach 40,000 gallons per day.[12] (T. 482-485.) Given the nature of Piedmont geology, the relatively low pumping rates of domestic wells, and the distance of the private wells from the landfill site, there is no basis for a conclusion that

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[11] Mr. Quarles erroneously concluded that one of the private wells was immediately adjacent to and downgradient of Cell No. 10B. (PST-10 at 11.) Although this well is the closest of any of the wells to the waste disposal area (and is therefore the subject of greater concern), the evidence showed that groundwater at the site does not travel toward the well. (T. 980-981, 1122-1125; Exhibits J-15 at sheet 27, GB-78.) Further, no credible evidence supported Mr. Quarles' conclusion that groundwater continues to move south through the fractured bedrock underlying Blue Creek. (T. 175-176, 1120-1128; Exhibit GB-78.)

[12] Although Petitioner Zarate uses a private well in the operation of her business, there is no evidence that its pumping rate approaches the level required to impact the direction of groundwater flow. (T. 506-508.) As a point of reference, even the Lone Oak public wells pump less than 100,000 gallons per day. (T. 525.)

drawdown from domestic wells will cause a cone of depression or otherwise change the direction of groundwater flow. (RST-6 at 8-9; T. 482-485, 973-974.)

Mr. Quarles was also concerned that drought could impact the direction of groundwater flow. (T. 171.) However, outside of agricultural irrigation areas, the drought that Georgia is currently experiencing has had little effect on groundwater. Because groundwater recharge systems are long-term systems covering tens to hundreds of years, a short-term event like a drought will not have an overall effect on groundwater. (T. 503-506.) The Petitioners presented no evidence to support a conclusion that drought will impact the direction or flow of groundwater at the site.

4. Groundwater Velocity

Groundwater-flow velocities of the uppermost aquifer were calculated and discussed in the Hydrogeologic Assessment, as required by Circular 14, in order to provide EPD with an understanding of how quickly leachate could migrate from the site in the event of a contamination event. Calculations of groundwater velocity are based on "Darcy's Law," an equation that utilizes values from the site for hydraulic conductivity (based on laboratory and field tests), effective porosity (based on laboratory tests), and hydraulic gradient (based on the potentiometric map of the uppermost aquifer). (T. 485-489.) Circular 14 suggests that a permit applicant should calculate both the typical and worst-case scenario values for groundwater velocity by utilizing two different values for hydraulic conductivity: one value that represents an average of measurements across the site, and another value that represents the highest measurement of hydraulic conductivity. (Exhibit J-4 at 28-29.)

At the hearing, four different experts testified regarding their calculations of the average and worst-case scenarios for groundwater velocity. The calculations of three of the experts (Mr.

Preddy, Dr. Kennedy, and Dr. Hargett) were approximately equivalent geologically, although they used slightly different data or methods of calculation to reach their conclusions. Mr. Quarles' calculations, in contrast, differed significantly from those of the other experts. The Court finds Mr. Quarles' testimony to be less convincing than that of the other experts, and in particular Dr. Kennedy, whose methodology the Court found most persuasive.

Mr. Preddy performed the calculations of groundwater velocity found in the Hydrogeologic Assessment. For the deep residual soil, he used the geometric mean[13] for hydraulic conductivity across the site of 1.23 feet per day, along with the geometric means for hydraulic gradient (0.026) and effective porosity (0.267). Using these values, he determined that the geometric mean groundwater velocity for the site in the deep residual soil is 0.120 feet per day.[14] (T. 993-997; Exhibit J-8 at § 4.3, table 6.) Mr. Preddy calculated the groundwater velocity using a geometric mean value for hydraulic conductivity, rather than an average and highest value, because variability in orders of magnitude existed across the site. As a result, the geometric mean provided a more representative value for groundwater velocity on the site as a whole. (GBST-5 at 6; T. 997-999, 1065-1067, 1071-1072, 1074.)[15]

Dr. Kennedy, the State Geologist, calculated the worst case estimate of groundwater velocity by using the highest hydraulic conductivity value, the hydraulic gradient in the area of that highest hydraulic conductivity, and the smallest effective porosity for that same water-bearing area. Using this method, he calculated a worst-case estimate for groundwater flow in the

[13] The geometric mean is not an arithmetic average. (T. 1065-1067.)

[14] Mr. Preddy further determined that the geometric mean value for groundwater velocity is 0.336 feet per day in the partially weathered bedrock and 0.361 feet per day in the bedrock. (Exhibit J-8 at § 4.3, table 6.)

[15] Mr. Preddy also made specific calculations of groundwater velocity at GWC-42, which is the monitoring well on the southern boundary of the landfill site closest to Blue Creek, and determined that the groundwater velocity was 0.192 feet per day at that location. (TGBST-3 at 13; T. 1008-1012.)

deep residuum of approximately 0.2 feet per day. (RST-6 at 5-6; T. 490-491.) As an additional measure of conservativism and in order to add an extra margin of safety, Dr. Kennedy arbitrarily doubled the hydraulic gradient, which resulted in a groundwater flow rate in the deep residuum of approximately 0.4 feet per day.[16] (RST-6 at 6; T. 491-493.)

Dr. Hargett, the soil and groundwater scientist, used a method similar to those of Mr. Preddy and Dr. Kennedy, but his calculations included what he felt were more representative values for effective porosity. Dr. Hargett eliminated the highest and lowest values for effective porosity and determined the arithmetic mean. He then determined that in a realistic worst-case scenario, the groundwater velocity in the deep residuum on the site would be 0.183 feet per day. (GBST-4 at 27-28; T. 1090-1095.)

Mr. Quarles, in contrast to the other experts, used the highest values for all three variables (hydraulic conductivity, hydraulic gradient, and effective porosity) when he determined the worst-case scenario for groundwater velocity at the site, which he calculated at 0.90 feet per day in the deep residuum, 1.6 feet per day in the partially weathered rock, and 3.4 feet per day in the bedrock. (PST-10 at 12-13.) However, Mr. Quarles' presentation of the worst-case scenario was an unrealistic interpretation of the hydrogeology of the site. The mathematical laws of hydrogeology dictate that hydraulic conductivities and gradients are balanced to maintain the flux of groundwater movement, such that hydraulic conductivity increases as hydraulic gradient decreases, and vice versa. (RST-6 at 5; T. 486-489.) Mr. Quarles' utilization of the highest values for both variables cannot occur in nature, and his calculations are therefore less reliable than the calculations of the other experts.

[16] Dr. Kennedy further calculated that the worst-case scenario for groundwater velocity in the partially weathered rock is 0.8 feet per day and in the bedrock 1.6 feet per day. (RST-6 at 6.)

D. Design of the Landfill

The approved Design and Operation Plan, which is incorporated by reference in the solid waste handling permit, authorizes the construction of the landfill utilizing one of two bottom liner systems. The first option is the regulatory liner system prescribed in the Georgia Solid Waste Management Rules. The regulatory liner system is based on the design approved pursuant to 40 C.F.R. Part 258, otherwise known as the "Subtitle D regulations," which set forth the criteria established by the United States Environmental Protection Administration ("EPA") for municipal solid waste landfills. The second option is an alternate liner system that represents an improvement over the regulatory liner system and has been used for the design and construction of a number of municipal solid waste landfills in Georgia and the Southeast. According to Mr. Hodges, the project engineer, there is a high probability that the landfill will be constructed with the Alternative Liner System due to its superior design and greater availability of the required materials. Under either option, a minimum five-foot vertical buffer will be maintained between the bottom of the composite liner and the seasonal high water elevation. (GBST-1 at 16; Written Direct Testimony of Gregory N. Richardson ("GBST-2") at 9; T. 613-623; Exhibits J-15, J-16, GB-50, GB-51.)

The regulatory bottom liner system consists of a minimum 24-inch thick compacted clay liner component with a field-tested permeability no greater than $1x10^{-7}$ centimeters per second. A 60-millimeter thick flexible membrane liner ("FML") manufactured from high density polyethylene ("HDPE") sits on top of the clay liner. The clay liner and the FML together constitute the "composite liner" system referred to in DNR Rule 391-3-4-.07. (GBST-1 at 19-20; T. 613-614; Exhibits J-15 at sheet 41, GB-51.)

The alternate base liner system consists of a minimum 24-inch thick compacted clay liner of $1x10^{-5}$ soil material, rather than $1x10^{-7}$ as required for the regulatory liner. A reinforced geosynthetic clay liner ("GCL") is then placed on top of the clay liner. The GCL represents an improvement in landfill design, as it has a permeability of less than $5.3x10^{-9}$ centimeters per second, which is 1.5 orders of magnitude less permeable than the clay component of the regulatory liner system with its permeability of $1x10^{-7}$ centimeters per second. In addition, the GCL creates a smooth surface over the clay liner, which allows direct contact between the GCL and the FML, which sits on top of it. The GCL, because of its decreased permeability, also minimizes any potential leakage through the FML. (GBST-1 at 19-20; T. 617-621; Exhibits J-15 at sheet 41, GB-50.)

For both the regulatory liner and the alternate liner, a minimum 24-inch thick leachate collection and liner protection layer is placed on top of the FML. This layer contains the leachate drainage system, which is designed to remove the leachate, or liquid waste generated within the landfill from liquids and rainwater, as quickly as possible. The leachate collection system is composed first of a geonet drainage media (similar to a net placed between two pieces of fabric), which is placed over the liner floor. A 24-inch layer of highly permeable sand or gravel is then placed over the fabric. Placed within this highly permeable soil on the landfill floor and perimeter berms are leachate collection gravel columns, consisting of a perforated 8-inch diameter HDPE pipe within a permeable gravel filter, which is placed within an even more permeable crushed stone drain. Together, the highly permeable floor, the more highly permeable gravel drainage column, and the perforated pipes ensure speedy removal of leachate from the base liner system. The leachate collection system also provides a protective layer over the FML

component of the liner system. (GBST-1 at 20-21; T. 623-629; 677-680; Exhibits J-15 at sheets 7 and 41, GB-56, GB-57, GB-60, GB-61, GB-62, GB-63, GB-65, GB-66.)

The waste disposal cell floors are sloped so that the leachate flows by gravity through the leachate collection system to leachate collection "sumps" placed around the perimeter of each of the landfill waste disposal cells. The leachate collects in the sumps and is pumped out to leachate holding tanks by means of dual-contained HDPE pipes. The leachate collection sumps are designed with an underlying liner system consisting of two feet of compacted clay liner covered by two layers of GCL components overlaid by an FML. Each sump is four feet deep and measures eight by eight feet at its base and twenty-five feet by twenty-five feet at the top. The sumps are filled with gravel to create a large reservoir that can accept leachate. Numerous controls are in place to ensure that the pump operates properly, including a duplicate riser pipe allowing for a second pump to be used if needed during a heavy rainfall or due to failure of the original pump.[17] (GBST 1, at 17-18; T. 630-633, 677-680; Exhibit J-15.)

The proposed landfill will accept municipal solid waste, including waste from residential, commercial, and industrial sites that is deemed non-hazardous, either because it does not contain hazardous components or because the volume of such waste is below the hazard threshold. The facility will be authorized to collect limited amounts of yard waste and construction debris, but it will not be authorized to accept liquid waste, lead acid batteries, biomedical waste, radioactive waste, sewage sludge, hazardous waste, or wastes from out of state. (GBST-1 at 38; T. 836-838; Exhibit J-15 at sheet 32.)

[17] This leachate collection system has been designed and constructed by Mr. Hodges and by Dr. Richardson in other municipal solid waste landfills. Although two of these landfills have experienced significant storm events brought on by hurricanes, the systems continued to function properly. (T. 634-635.)

The waste received in the landfill is deposited and spread out in a relatively small area of the cell called the working face. The waste is compacted by heavy, steel wheeled compactors. Deposited waste is covered on a daily basis with six inches of soil and on a monthly basis with 12 inches of soil. The landfill is constructed in individual cells; waste is disposed and leachate collected within each cell, and each cell is covered with a final cover system when the cell reaches its waste disposal capacity. In addition, the cells are designed with additional controls, including temporary stormwater rain flaps and berms, to minimize the volume of leachate within each cell. (GBST-1 at 50-51; T. 615-616.)

The final cover system for each waste disposal cell in the landfill consists of, from bottom to top: a final layer of soil cover 12 inches thick; a minimum 18-inch thick compacted clay liner with a permeability no greater than $1x10^{-5}$ centimeters per second; a 40-millimeter thick FML; a layer of geonet drainage media; a minimum 18-inch thick erosion layer of soil material; and a 6-inch thick layer of vegetative growth soil upon which grass is grown. The landfill cover system is required to be maintained throughout the operational life of the landfill and the post-closure care period, which under DNR Rules is a minimum of thirty years. Regular inspections of the final cover system over closed waste disposal cells in the landfill continue through the post-closure care period and will reveal any settlement of the final cover system. In addition, any problems with the liner component would be revealed by distressed vegetation and by odors caused by landfill gases escaping from the area of the breach. (GBST 25-27; T. 648-654, 861-863; Exhibits GB-50, GB-51, GB-58, GB-61.)

E. <u>Potential for Contamination</u>

The Petitioners presented evidence at the hearing that landfills may cause contamination of groundwater and/or surface water. Under Georgia landfill design rules, a landfill is not

required to prevent all contamination. Rather, the design of the landfill must prevent unacceptable concentrations of certain harmful constituents at the relevant point of compliance (in this case, the boundary of the site). (PST-10 at 6.) The Petitioners' expert witnesses, Mr. Quarles and Dr. G. Fred Lee, identified a number of issues regarding potential contaminant releases at the Turkey Run landfill. Specifically, the Petitioners contend that contaminants may be released to groundwater through leaks in the landfill liner; that the groundwater monitoring wells are not properly placed to ensure detection of contamination; that the groundwater monitoring schedule adopted in the permit is insufficient to provide adequate notice of contamination; and that contaminants may be discharged to surface water through leachate spills or outbreaks.

1. Potential Releases to Groundwater

One possible pathway for contamination from the landfill is a release to groundwater caused by a leak in the landfill liner. Regardless of the quality control measures used in constructing the landfill, small holes are assumed to exist in the landfill's liner – even prior to the commencement of activity in the landfill. (PST-10 at 6-7; T. 166, 190-91.) However, the potential for leaks at the proposed Turkey Run landfill will be minimized by stringent quality control measures and the design of the liner and leachate collection system.

The Petitioner offered evidence that landfills can, and sometimes do, leak contaminants. According to EPD's database, there were 55 active municipal solid waste landfills in Georgia through 2006, and 12 of those landfills had a release of one or more constituents to the underlying groundwater. (PST-10 at 6, T. 190-191; Exhibit P-B.) Of the twelve landfills, nine were constructed with a composite liner and leachate collection system. However, each of those nine Subtitle D landfills was located immediately adjacent to an unlined landfill. Although EPD

has not specifically identified the sources of the leaks, the leaks are more likely to have come from the unlined landfills.[18] (T. 334-335, 343-345, 371-374, 377-378.)

The potential for leaks increases when defects in manufacturing or installation create holes in the FML. It is generally accepted in the engineering community that approximately six small holes will exist for every acre of liner installed. For the Turkey Run landfill, this estimate would equate to 1182 holes overall when the landfill has reached capacity. (PST-10 at 6-7; GBST-2 at 7-8; T. 166, 190-191.) If a contaminant leaks through one of these holes, its progress will be slowed by the clay layer. However, the potential exists that over time, the contaminant will seep through the clay liner into the ground and aquifer below. (T. 167, 173-74, 261.)

Potential defects in the FML are minimized in the manufacturing process through quality control, quality assurance procedures, and inspections. The quality control program includes rigid specifications and destructive samples of every roll of liner material. (T. 636-638, 696-699.) In addition, the approved Design and Operation Plan contains a construction quality assurance plan that minimizes any potential defects in the installation of the liner system. The quality assurance plan includes fusion welding, testing, and inspections in an attempt to eliminate defects in the installation of both the FML and clay liner. The quality assurance procedures are performed by an independent construction quality assurance firm separate from the design engineering firm or other firms involved in the design of the project. These procedures minimize wrinkles, dessication cracks, and other defects in the liner system, thereby decreasing the potential for leaks into the subsurface. EPD also inspects the liner upon its installation. (GBST-1 at 27-36; T. 636-647, 674, 857-860.)

[18] Evidence was also presented that one of the fifty-seven lined landfills in Georgia has leaked. However, no evidence was presented regarding the cause of the leak. (T. 335-336, 345-346.)

The rate of leakage through potential defects is also minimized by reducing the depth of leachate acting on the liner system. Under the Design and Operation plan, the leachate depth, or "head," is significantly less than the 30 centimeters allowed by DNR Rules and is designed to maintain less than one inch of liquid on top of the membrane in typical operations. In traditional leachate collection systems, clogging of the collection pipes can lead to an increase in the head of liquid, thereby creating a greater risk of leakage through any defects in the flexible membrane liner. However, the design of the leachate collection system for the Turkey Run landfill minimizes the potential for clogging of the leachate collection pipes with solid materials in the leachate. (GBST-1 at 20-21; T. 624-629, 677-680; Exhibits J-15, GB-43, GB-77.) In addition, the limitations on the types of waste accepted by the landfill and other leachate control measures will serve to reduce the amount of harmful leachate generated. (GBST-1 at 39.)

The testimony of Dr. Lee that the landfill will indisputably fail at some undetermined time in the future was not persuasive. His theory was effectively refuted by the testimony of Mr. Hodges and Dr. Richardson, both of whom are design engineers with many years of experience in the design, construction, maintenance and monitoring of municipal solid waste landfills in Georgia and other states in the Southeast. The estimated life of the FML component of the liner designed for this landfill is 700-800 years. In addition, landfill cover systems can be maintained, and problems or failures of those cover systems can be prevented and corrected when discovered. This is true both during the operational life of the landfill and during the minimum 30-year postclosure care period, which may be extended for as long as EPD determines that the landfill may pose a risk to the environment. Finally, the landfill will largely stabilize over a period of 15-30 years after closure of waste disposal cells due to decomposition of the waste. (PST-9 at 5-6; GBST-2 at 10; T. 647-654, 700-704, 860-864; Exhibits GB-74, GB-81.)

Dr. Lee's testimony that low-molecular weight solvents will move through even an intact FML by a process of diffusion or permeation is likewise unconvincing. The studies that Dr. Lee relied on to support this premise utilized significant concentrations of solvents far above the concentrations of the constituents of municipal solid waste landfill leachate. (PST-9 at 6; T. 709-711.)

Accordingly, the Court finds that while the possibility of leaks from a landfill cannot be eliminated, appropriate steps have been taken to minimize the potential for leaks at the Turkey Run site.

2. Placement of Monitoring Wells

In the event of a leak, the first opportunity for detection is when the contaminant reaches a monitoring well. (PST-10 at 7; T. 167.) If the monitoring wells are not properly placed, the potential exists for a contaminant plume to go undetected. (T. 1046-1050.) For the proposed Turkey Run landfill, the location and spacing of the groundwater monitoring wells were determined based on site specific hydrogeologic and hydraulic conditions under and around the landfill site, the location of facility structures and property boundaries, and the characteristics of the saturated subsurface related to groundwater flow velocities, directions, and distances. (GBST-1 at 39-41; GBST-3 at 11-15; T. 770-806, 1004-1006; Exhibit GB-52.)

Well placement was determined based on the locations of the waste disposal cells, the leachate collection sumps (which is where any leakage is most likely to occur, given that this is where the leachate is collected), the five sediment ponds around the site, geologic features such as lineaments, bedrock fractures, areas of groundwater convergence, a private well located northeast of the landfill site, and the leachate collection storage tanks. Five additional wells on the east side of the landfill were added to the groundwater monitoring plan at EPD's request. In

addition, two well pairs, consisting of a shallow and a deep well, were included to respond to the presence of bedrock fractures along on-site topographic lineaments. (GBST-1 at 39-41; GBST-3 at 20-25; T. 781-806, 999-1006; Exhibits J-11, GB-52.)

Additional groundwater monitoring wells were added to comply with EPD's general policy requiring minimum 500-foot horizontal spacing of groundwater monitoring wells downgradient of landfill sites. The horizontal spacing between the wells was measured by measuring the "hydraulic distance" from waste disposal cells based on the direction of groundwater flow. The hydraulic distance can be significantly different from the surface distance. For example, the surface distance between the wells north of cells 5 and 6B is 400 feet, but the hydraulic distance is significantly less, at 200 feet. (GBST-1 at 39-41; GBST-3 at 20-25; T. 781-806, 944-949, 999-1002; Exhibits J-11, GB-52.)

The monitoring wells are placed between the waste disposal boundary and the landfill property boundary, within the 200-foot buffer zone, utilizing wherever possible a distance between 100 and 250 feet from the waste disposal cells. The purpose of this is to allow a potential contamination plume to spread between the origination point and the corresponding monitoring well, while also ensuring that adequate time exists to address the contamination upon detection. Where design considerations required monitoring wells to be placed near the sediment ponds, the distances from the waste were reduced to less than 100 feet. This was done to address potential mounding at the sediment ponds, to ensure that pond function would not impact the wells' effectiveness, and to enable detection of a contaminant plume in the upper aquifer before it reached the ponds. (GBST-1 at 40-41; T. 786-795, 949-953, 1003-1006.)

Both Dr. Lee and Mr. Quarles expressed concerns about the effectiveness of the groundwater monitoring system. Dr. Lee suggested that the landfill be designed and constructed

with a double composite liner system, which is the liner system required for hazardous waste landfills, based on his conclusion that a narrow plume of contamination could escape detection by the monitoring wells. (PST-9 at 8-9.) However, his conclusion was based on research performed in unique conditions of very clean and permeable sand at a location in Canada. Further, his opinion is at odds with the opinions of the other experts and is inconsistent with the geologic and hydrogeologic conditions at the site, as well as with Georgia Piedmont geology in general. A theoretical contaminant from the landfill would disperse in a teardrop shape rather than a narrow plume, and the placement of the wells ensures a high likelihood of detection even if the plume were as narrow as thirty to fifty feet, which is unlikely. (T. 477-479, 719-722, 797-800, 845-848, 1097-1099.) In addition, a double composite liner design is unnecessary and inappropriate for a municipal solid waste landfill, including the proposed Turkey Run municipal solid waste landfill. No provision exists, either in the Subtitle D regulations or in the Georgia Solid Waste Management Act or Solid Waste Management Rules, that would authorize the Director to require a double composite liner system. Such a design is not required by the vast majority of states, and those states that have enacted such requirements did so prior to EPA's implementation of the Subtitle D regulations for municipal solid waste landfills. (T. 686-689, 719, 896.)

Mr. Quarles suggested that a double row of monitoring wells be installed at the site. (PST-10 at 14.) However, given that the groundwater monitoring system detailed in the Design and Operation Plan is adequate to detect potential contamination from the landfill, a second row of monitoring wells is both unprecedented and unnecessary. (T. 161, 251-252, 722, 848.)

3. Sampling Schedule

Semi-annual sampling for detection monitoring is required under DNR Rule 391-3-4-.14, which also includes specific time frames for the occurrence of certain events following the detection of a contaminant. The Director has the authority to require modifications to monitoring well systems as semi-annual monitoring events occur and the landfill operator submits the results of those events to EPD. Under the Rules and the approved Design and Operation Plan, these results must include updated potentiometric maps with current groundwater elevations and directions and velocities of flow. Based on the updated potentiometric maps, EPD may require modifications to the groundwater monitoring system, including sampling frequency and well placement. In addition, during the construction of the monitoring wells, current information regarding groundwater elevations, velocity, and direction of flow must be provided to EPD. On the basis of these submissions, the operator may recommend or EPD may require modifications to the monitoring well system. (T. 364-366, 516-518, 776-778, 1013-1017, 1186).

Based on Mr. Quarles' calculations of groundwater velocity, the Petitioner contends that in the six months between monitoring events, contaminated groundwater could travel 160 feet in the soil aquifer, 288 feet in the partially weathered rock, and 612 feet in the bedrock. (PST-10 at 13.) Under this scenario, contaminated groundwater would likely reach Blue Creek prior to detection. However, because contaminants within the groundwater move more slowly than the water itself, and, in any event, Mr. Quarles' calculations of groundwater velocity are less reliable that those of the other experts, the Petitioners have significantly underestimated the time required for contaminant migration.

Dr. Kennedy offered a credible estimate of groundwater velocity and the rate of pollutant movement in a worst-case scenario. Taking into account retardation factors for typical landfill contaminants, which are between one-half and one-fifth the groundwater flow rate, Dr. Kennedy estimated that the rate of pollutant movement in the deep residuum would be between 0.1 and 0.04 feet per day, or 0.2 to 0.08 feet per day if the hydraulic gradient were arbitrarily doubled. At that rate, it would take 3,000 to 7,500 days (or 1,500 to 3,750 days if the hydraulic gradient were arbitrarily doubled) for a hypothetical contaminant to migrate from the landfill to a receiving stream, and it would take 1,350 to 3,375 days (675 to 1,688 days if the hydraulic gradient were arbitrarily doubled) to migrate 135 feet from a monitoring well to a receiving stream. (RST-6 at 6-7; T. 490-493.)[19]

Accordingly, the Court finds that the monitoring wells are placed a sufficient distance from Blue Creek and the proposed monitoring is sufficiently frequent to provide adequate notice of a contaminant release from the landfill. The monitoring well system and sampling frequency are expected to detect any possible contaminants before water supplies and recharge can be compromised.

4. Potential Releases to Surface Water

It is possible for landfill contaminants to be released to surface water through leachate spills or outbreaks. (PST-10 at 15-16; T. 161-62, 556.) In the event of an outbreak or spill, contamination could be picked up by rainwater and moved through stormwater conveyance ditches and pipes to the sediment ponds. (PST-10 at 15-16; T. 161-62.) There, the contamination could either be released immediately or held in the pond until sufficient water is collected to create a release. (T. 556-58.) To address these issues, landfill designs seek to employ "run-

[19] Dr. Kennedy's testimony was supported by that of Dr. Hargett. (T. 1093-1095, 1103-1115.)

on/run-off" controls in order to prevent stormwater from contacting the waste and becoming leachate. Run-on controls divert as much water as possible away from the landfill cell, while run-off controls consist of conveyance, treatment, and release systems for stormwater. (GBST-1 at 22; T. 866-882.)

The design of the stormwater management system for the proposed landfill was guided by the Georgia Stormwater Management Manual. (GBST-1 at 22; Exhibit J-15.) At the top of the landfill, stormwater is guided as sheet flow and captured in side slope berms, where it then flows in a 1% grade channel to down drain pipes. These drain pipes direct the stormwater into a perimeter ditch on the outside of the landfill waste cells, where it is conveyed to drop inlets. There, the stormwater is piped across the landfill access road into sediment ponds. (GBST-1 at 23-24; T. 866-871; Exhibits J-15, GB-83.)

The perimeter ditches are generally graded at slopes of approximately 1% to slow the stormwater flow and allow sediment to fall out and cleaned from the perimeter ditch. Ditches with a steeper grade are lined with stone rip-rap to dissipate energy and convey the stormwater without soil erosion. The stormwater enters sediment ponds from the perimeter ditches via drop inlets and cross-culverts. (GBST-1 at 23-24; T. 866-871; Exhibits J-15, GB-83.)

The sediment ponds are designed to allow settling of any remaining sediment prior to discharge by providing a minimal volume of 67 cubic yards per disturbed acre plus hydraulic storage in the sediment pond below the overflow. Moreover, additional storage is provided to allow a 100-year storm event to be routed through the sediment pond. (GBST-1 at 23-24; T. 866-871; Exhibit GB-83.) The final cover system for the landfill was designed to facilitate quick drainage from the landfill cover, in order to minimize the possibility that rainwater would enter the landfill cells and become leachate. (GBST-1 at 25; Exhibit J-15.)

The landfill must also obtain a National Pollutant Discharge Elimination System ("NPDES") permit in addition to the solid waste handling permit. This is obtained under the Georgia Stormwater Industrial Activity Permit. The NPDES permit requires that stormwater discharges may not contain non-stormwater including any type of processed wastewater, and specifically prohibits discharges containing leachate from landfill waste. Under the NPDES permit, and under the provisions of the approved Design & Operation Plan, stormwater discharges are monitored for constituents other than sediment, including a number of indicator parameters and metals. The NPDES permit also requires that stormwater controls be managed under a Stormwater Pollution Prevention Plan for controlling both discharge of sediment from stormwater and preventing non-stormwater discharges. (T. 876-880; Exhibit GB-85.)

A leachate outbreak that occurs during the operational phase of a disposal cell appears as a saturated spot on the soil cover material. When a leachate outbreak is discovered, the affected soil must be dug out and disposed of in the landfill, and additional clay soil material is packed into the area of the removed soil and sealed. Leachate outbreaks generally do not occur following the closure of a disposal cell because the leachate is contained within the cells by an impermeable cover system. (T. 873-875; Exhibit J-15.)

Small leachate spills may occur when leachate is transferred from the leachate holding tanks to trucks for transport to a Public Owned Treatment Works. Under the Design and Operation Plan, this transfer will take place on a contained leachate pad and any spillage, including any rainwater that comes in contact with the spillage, will be collected within this containment system and pumped back into the leachate storage tanks. This system is designed to prevent leachate spillage from being carried by stormwater beyond the leachate tank containment

system. The leachate storage tanks themselves are dual steel and glass tanks constructed within a lined pad. (T. 808-810, 876; Exhibit J-15.)

Finally, the approved Design and Operation Plan requires a buffer of 100 feet on both sides of the stream as measured from the stream banks, with no impervious surface within a 150-foot setback area on both sides of the stream as measured from the stream. No septic tank or septic tank drainfield may be placed within this 150-foot setback. (GBST-1 at 50; Exhibit J-15.) Herbicides and pesticides cannot be used in the undisturbed buffer to control vegetation, and only water may be sprayed on the landfill for dust control purposes. (T. 874-876, 880-881.)

These controls minimize the likelihood that waste constituents will be carried to or discharged from the sediment ponds. The Court finds, based on the stormwater management and erosion and sedimentation control provisions of the Design and Operation Plan, that the proposed landfill is designed to minimize the possibility of contamination of surface water due to leachate outbreaks or spills.

III. CONCLUSIONS OF LAW

This matter is the *de novo* review of the Respondent's issuance of Solid Waste Handling Permit No. 099-019D(MSWL) to the Intervenor. In this proceeding, the Petitioners bear the burden of proof. GA. COMP. R. & REGS. § 616-1-2-.07(1) (cited hereinafter as "OSAH Rule 7(1)). The standard of proof is a preponderance of the evidence. OSAH Rule 21(4).

A. Standing[20]

In order to pursue an administrative appeal of a permitting decision by the Respondent, a party must be "aggrieved or adversely affected by any order or action of the director." O.C.G.A.

[20] By agreement of the parties, a separate hearing on standing was not held prior to the commencement of the evidentiary hearing, as provided in O.C.G.A. § 12-2-2(c)(3)(A). Instead, the standing issues were litigated in conjunction with the substantive issues in the case, and the Court deferred ruling on standing until the conclusion of the evidentiary hearing. (T. 13-15.)

§ 12-2-2(c)(2)(A). The statute further provides that "persons are 'aggrieved or adversely affected' . . . where the challenged action has caused or will cause them injury in fact and where the injury is to an interest within the zone of interests to be protected or regulated by the statutes that the director is empowered to administer or enforce." O.C.G.A. § 12-2-2(c)(3)(A).

1. Injury in Fact

Establishing an injury in fact for a petitioner in an environmental matter is a relatively easy task. "[E]nvironmental plaintiffs adequately allege injury in fact when they aver that they use the affected area and are persons 'for whom the aesthetic and recreational values of the area will be lessened' by the challenged activity." Friends of the Earth, Inc. v. Laidlaw Environmental Svcs., Inc., 528 U.S. 167, 183 (2000). For the purpose of a standing analysis, the Court must assume that the adverse environmental affects alleged by a petitioner will actually occur. In Re: Coffee County Solid Waste Handling Permit, DNR-EPD-SW-AH 4-86, 1986 Ga. Env. LEXIS 17, at *3 (1986); see also Upper Chattahoochee Riverkeeper Fund, Inc. v. Reheis, OSAH-DNR-WW-01-11087-74-MMM, 2003 Ga. Env. LEXIS 63, at *1 n.1 (OSAH 2003) ("whether the substantive allegations are merely 'ungrounded fears' . . . would be the subject matter of the second hearing [on the substantive allegations]").

As set forth in the Findings of Fact, above, the Petitioners are residents of the area surrounding the proposed site of the landfill. They are consumers of water from private and public wells and water from the Blue Creek Reservoir, and they assert that they will be adversely affected by a contaminant release from the landfill. Accordingly, the Petitioners have adequately alleged an injury in fact.

2. Zone of Interests[21]

In order for a Petitioner to establish individual standing, he or she must also show that "the injury is to an interest within the zone of interests to be protected or regulated by the statutes that the director is empowered to administer and enforce." O.C.G.A. § 12-2-2(c)(3)(A). The Georgia Comprehensive Solid Waste Management Act was enacted with the intent to:

> . . . protect and enhance the quality of its environment, to institute and maintain a comprehensive state-wide program for solid waste management and to prevent and abate litter, so as to assure that solid waste does not adversely affect the health, safety, and well-being of the public and that solid waste facilities, whether publicly or privately owned, do not degrade the quality of the environment by reason of their location, design, method of operation, or other means and which, to the extent feasible and practical, makes maximum utilization of the resources contained in solid waste.

O.C.G.A. § 12-8-21. Access to clean, uncontaminated water is clearly within the zone of interests set forth in the Georgia Comprehensive Solid Waste Management Act.

Accordingly, this Court finds that each Petitioner has standing to challenge the Director's decision to issue the permit.

B. Petition Requirements

On March 27, 2008, the Petitioners filed an Amended Petition for Hearing ("Amended Petition"). On March 28, 2008, the Intervenor filed an Answer to the Amended Petition which asserted, for the first time, that the Amended Petition fails to comply with DNR Rules 391-1-2-.05(1)(g) and (h), which set forth certain procedures to be employed in contested cases.

DNR Rule 391-1-2-.05(1) provides, in pertinent part:

> (1) A petition for hearing on the grant or denial of a permit or license shall contain:
> . . . .

[21] The Intervenor does not appear to argue that the allegations of the Amended Petition fail to meet the zone of interests test.

> (g) In cases contesting the issuance of a license or permit, those suggested permit conditions or limitations which the petitioner believes required to implement the provisions of the law under which the permit or license was issued; and
>
> (h) In cases contesting conditions, limitations or requirements placed on the issuance of a license or permit, specific reference to the conditions, limitations or requirements contested, as well as suggested revised or alternative permit conditions, limitations or requirements which the petitioner believes required to implement the provisions of the law under which the permit or license was issued.

DNR Rule 391-1-2-.05(1)(g), (h). Pursuant to DNR Rule 391-1-2-.04(4), failure to comply with the requirements pertaining to the content of submissions "may result in the noncomplying portions of the submission being excluded from consideration." DNR Rule 391-1-2-.04(4). See Coosa River Basin Initiative v. EPD, BNR-ES-0713085-57-Malihi, 2007 Ga. Env. LEXIS 6, at *13-18 (OSAH 2007) (dismissing two legal issues for failure to comply with DNR Rule 391-1-2-.05(1)(g) & (h)).

In this case, the Amended Petition suggests certain additional and revised permit conditions that the Petitioners believe are required by law. (Amended Petition, ¶¶ 45, 59, 62-64, 67-69.) In addition, the expert testimony presented by the Petitioners and their written brief following the hearing cured any remaining procedural defects in the Amended Petition. Accordingly, the Court finds that the Petitioners have satisfied the petition requirements set forth in DNR Rule 391-1-2-.05.[22]

C. Substantive Issues

The issuance of solid waste handling permits in Georgia is governed by the Georgia Comprehensive Solid Waste Management Act, O.C.G.A. § 12-8-20, et seq. (hereinafter "Act"), and DNR Rules promulgated pursuant to that statute. DNR Rules, Chapter 391-3-4. Under

O.C.G.A. § 12-8-24, the Director of EPD "shall issue the permit, specifying on the permit the conditions under which such [solid waste handling] activities shall be conducted," unless she determines that the proposed disposal facility violates the Act or DNR Rules. O.C.G.A. § 12-8-24(d). To prevail in their appeal, then, the Petitioners are required to show, by a preponderance of the evidence, that the Director's exercise of her authority was unlawful or unreasonable. The Petitioners have not met their burden.

1. Hydrological Assessment of the Proposed Site

The Petitioners have alleged that the Intervenor failed to conduct an adequate hydrological assessment of the proposed site. (Amended Petition, ¶¶ 61-64.) The specific factors and criteria that must be evaluated in a hydrological site investigation of a proposed landfill are set forth in DNR Rule 391-3-4-.05(1)(k), which provides:

> 1. Distance to nearest point of public or private drinking water supply: all public water supply wells or surface water intakes within two miles and private (domestic) water supply wells within one-half mile of a landfill must be identified;
>
> 2. Depth to the uppermost aquifer: for landfills, the thickness and nature of the unsaturated zone and its ability for natural contamination control must be evaluated;
>
> 3. Uppermost aquifer gradient: for landfills, the direction and rate of flow of groundwater shall be determined in order to properly evaluate the potential for contamination at a specific site. Measurements of water levels in site exploratory borings and the preparation of water table maps are required. Borings to water are required to estimate the configuration and gradient of the uppermost aquifer;
>
> 4. Topographic setting: features which shall be provided include, but are not limited to, all upstream and downstream drainage areas affecting or affected by the proposed site, floodplains, gullies, karst conditions, wetlands, unstable soils and percent slope;

[22] Further, the Court is inclined to agree with the Petitioners that the Intervenor waived its right to raise this issue by failing to address it in the Motion to Dismiss or for Summary Determination, as required by the Scheduling Order.

5. Geologic setting: for landfills, the depth to bedrock, the type of bedrock and the amount of fracturing and jointing in the bedrock shall be determined. In limestone or dolostone regions, karst terrain shall not be used for waste disposal. This consideration does not preclude the siting of landfills in limestone terrains, but rather is intended to prevent landfills from being sited in or adjacent to sinkholes, provided, however, that the demonstration required by section (h) has been made[;]

6. Hydraulic conductivity: evaluation of landfill sites shall take into consideration the hydraulic conductivity of the surface material in which the wastes are to be buried, as well as the hydraulic conductivity of the subsurface materials underlying the fill;

7. Sorption and attenuation capacity: for landfills, the sorptive characteristics of an earth material and its ability to absorb contaminants shall be determined; and

8. Distance to surface water: municipal solid waste landfills shall not be situated within two miles upgradient of any surface water intake for a public drinking water source unless engineering modifications such as liners and leachate collection systems and groundwater monitoring systems are provided.

DNR Rule 391-3-4-.05(1)(k)1.-8.

As set forth in the Findings of Fact, above, the Hydrogeologic Assessment evaluated each factor as required by DNR Rule 391-3-4-.05, as well as those required by Circular 14. Accordingly, the Court finds that the Petitioners have failed to establish, by a preponderance of the evidence, that the issuance of the permit or operation of the landfill pursuant to the permit violates DNR Rule 391-3-4-.05(1)(k).

2. Significant Groundwater Recharge Area

The Petitioners contend that the permit is invalid because the proposed landfill is improperly placed in a significant groundwater recharge area. (Amended Petition, ¶¶ 61-64.) DNR Rule 391-3-5-.05 provides, with respect to significant groundwater recharge areas:

> Significant Groundwater Recharge Areas. A new municipal solid waste landfill or lateral expansion of an existing municipal solid waste landfill shall not have any part of such site located within two miles of any area that has been designated by

> the Director as a significant groundwater recharge area unless such municipal solid waste landfill will have a liner and leachate collection system. In the case of a regional landfill which accepts solid waste generated outside the counties or special districts constituting the region or a municipal solid waste landfill which accepts solid waste generated outside the county in which the landfill is located, no part of such site shall be within any area that has been designated as a significant groundwater recharge area.

DNR Rule 391-3-5-.05(1)(j).

As set forth in the Findings of Fact, above, the landfill site is not located in a significant groundwater recharge area, and its siting is therefore not restricted by DNR Rule 391-3-5-.05(1)(j). Accordingly, the Court finds that the Petitioners have failed to establish, by a preponderance of the evidence, that the issuance of the permit or operation of the landfill pursuant to the permit violates DNR Rule 391-3-5-.05(1)(j).

3. Surface Water Intakes for Public Drinking Water

The Petitioners contend that the permit is invalid because the Intervenor failed to demonstrate that the landfill will have no adverse impact on community water supplies, including surface water intakes. (Amended Petition, ¶¶ 61-64.) Pursuant to DNR Rule 391-3-4-.05(1)(k), construction of municipal solid waste landfills is prohibited "within two miles upgradient of any surface water intake for a public drinking water source unless engineering modifications such as liners and leachate collection systems and groundwater monitoring systems are provided." DNR Rule 391-3-4-.05(1)(k)8.

As set forth in the Findings of Fact, above, the site is not located within two miles of any surface water intake for a public drinking water source. Nevertheless, the landfill is designed and permitted with a liner and leachate collection system as well as groundwater and surface monitoring systems. Accordingly, the Court finds that the Petitioners have failed to establish, by

a preponderance of the evidence, that the issuance of the permit or operation of the landfill pursuant to the permit violates DNR Rule 391-3-4-.05(1)(k)8.

4. Wellhead Protection

The Petitioners have alleged that the permit is invalid because the Intervenor failed to demonstrate that the proposed landfill poses no danger to wells and springs surrounding the landfill site. (Amended Petition, ¶¶ 55-59.)

Wellhead protection requirements are set forth in DNR Rule 391-3-5-.40, which is intended "to help protect wells and springs used as sources of water supply for community public water systems owned by and/or serving municipalities, counties, and authorities from nearby pollution sources." DNR Rule 391-3-5-.40(1). The Rule further provides, in relevant part:

> Every Wellhead Protection Area shall consist of two zones, as follows:
>
> (a) The Control Zone: Within this zone, the owner shall control all activities so that there are minimal sources of potential pollution in the immediate vicinity of the well bore.
>
> (b) The Management Zone: Within this zone, certain potential pollution sources are prohibited or certain activities must be performed in accordance with the rules listed below. The size and shape of the management zone will vary according to aquifer type, aquifer hydraulic conductivity, pumpage rate, hydrologic province, and proximity to recharge.

DNR Rule 391-3-5-.40(4)(a), (b). The Rule elaborates that "[w]ithin the inner and outer management zones of existing wells and springs . . . [t]he Division shall not issue any new permits for municipal solid waste landfills, industrial waste landfills or construction/demolition waste landfills." DNR Rule 391-3-5-.40(8)(a).

As set forth in the Findings of Fact, above, the boundary of the landfill site is well beyond and the management zone for the two Lone Oak wells at issue in this case, and neither the Lone Oak Wells nor the private wells in the area will draw groundwater from the landfill site.

Accordingly, the Court finds that the Petitioners have failed to establish, by a preponderance of the evidence, that the issuance of the permit or operation of the landfill pursuant to the permit violates DNR Rule 391-3-5-.40.

5. Groundwater Monitoring System

The Petitioners argue that the permit is invalid because the placement of the groundwater monitoring wells will not ensure that potential contamination is detected and the sampling schedule will not provide adequate notice to the public. (Amended Petition, ¶¶ 42-45, 47.) Pursuant to DNR Rule 391-3-4-.07, a landfill's design "must provide for a groundwater monitoring plan in accordance with the requirements for GroundWater Monitoring and Corrective Action as provided in [DNR] Rule 391-3-4-.14." DNR Rule 391-3-4-.07(1)(l).

DNR Rule 391-3-4-.14 provides, in pertinent part:

> (11) The number, spacing, and depths of monitoring systems shall be:
>
> > (a) Determined based upon site-specific technical information that must include thorough characterization of:
> >
> > 1. Aquifer thickness, groundwater flow rate, groundwater flow direction including seasonal and temporal fluctuations in groundwater flow; and
> >
> > 2. Saturated and unsaturated geologic units and fill materials overlying the uppermost aquifer, materials comprising the uppermost aquifer, and materials comprising the confining unit defining the lower boundary of the uppermost aquifer; including, but not limited to: thicknesses, stratigraphy, lithology, hydraulic conductivities, porosities and effective porosities.

DNR Rule 391-3-4-.14(8), (11).

Under DNR Rule 391-3-4-.14(22), semi-annual sampling of monitoring wells is required. The landfill operator must notify EPD within fourteen days if the detection monitoring indicates any "statistically significant increase" for any of the constituents for which monitoring is

conducted, which are listed in Appendix I. DNR Rule 391-3-4-.14(23)(a). Within the next 90 days, if the operator cannot prove that the detection was the result of sampling error or was a detection of a naturally occurring metal, the landfill operator must within that 90-day period initiate assessment monitoring. DNR Rule 391-3-4-.14(23)(b), (c). This requires additional sampling and analysis for both the Appendix I constituents and the constituents listed in Appendix II. DNR Rule 391-3-4-.14(25).

If assessment monitoring continues to indicate the presence of constituents of concern in the groundwater, then the landfill operator must initiate an assessment of corrective measures, followed by recommendation of a remedy to EPD for correcting and remediating the problem. DNR Rule 391-3-4-.14(30). The Director has the authority to change and accelerate the time frames provided in the Rule in order to address potential contamination. DNR Rule 391-3-4-.14(7).

As set forth in the Findings of Fact, above, the groundwater monitoring system for the proposed Turkey Run landfill was properly designed in accordance with the requirements of this Rule, and the sampling schedule is adequate to ensure notice to the public of a contamination event. Accordingly, the Court finds that the Petitioners have failed to establish, by a preponderance of the evidence, that the issuance of the permit or operation of the landfill pursuant to the permit violates DNR Rule 391-3-4-.14.

6. Run-on/Run-off Control and Surface Water Requirements

The Petitioners have alleged that the permit is invalid because the Intervenor failed to demonstrate that the proposed facility will not cause or contribute to violations of any applicable Georgia water quality standard. (Amended Petition, ¶¶ 39-41, 46.)

DNR Rule 391-3-4-.07(3) provides, in relevant part:

(i) Run-on/Run-off Control.

1. Owners or operators of all MSWLF units must design, construct, and maintain:

   a. A run-on control system to prevent flow onto the active portion of the landfill during the peak discharge from a 25-year storm;

   b. A run-off control system from the active portion of the landfill to collect and control at least the water volume resulting from a 24-hour, 25-year storm.

2. Run-off from the active portion of the landfill unit must be handled in accordance with section (j) of this Rule.

(j) Surface water requirements[.] MSWLF units shall not:

1. Cause a discharge of pollutants into waters of the state or the United States, including wetlands, that violates any requirements of the Clean Water Act, including, but not limited to, the National Pollutant Discharge Elimination system (NPDES) requirements pursuant to section 402[;]

2. Cause the discharge of a nonpoint source of pollution to waters of the state or the United States, including wetlands, that violates any requirement of an area-wide or State-wide water quality management plan that has been approved under section 208 or 319 of the Clean Water Act, as amended.

DNR Rule 391-3-4-.07(3)(i), (j).

As set forth in the Findings of Fact, above, the proposed landfill is designed to manage a 100-year storm event and to prevent the discharge of pollutants. Accordingly, the Court finds that the Petitioners have failed to establish, by a preponderance of the evidence, that the issuance of the permit or operation of the landfill pursuant to the permit violates DNR Rule 391-3-4-.07(3)(i) or (j).

7. Water Supply Watershed

Finally, the Petitioners have alleged that the permit is invalid because the Intervenor failed to demonstrate that the landfill poses no human or environmental health threats to the Blue Creek water supply watershed. (Amended Petition, ¶¶ 67-69.)

DNR Rule 391-3-16-.01 provides, in relevant part, as follows:

Stream Corridor Criteria for Small Water Supply Watersheds.

1. The perennial stream corridors of a small water supply watershed within a seven (7) mile radius upstream of a governmentally owned public drinking water supply intake or water supply reservoir are protected by the following criteria:

   (i) A buffer shall be maintained of a distance of 100 feet on both sides of the stream as measured from the stream banks.
   (ii) No impervious surface shall be constructed within a 150 foot setback area on both sides of the stream as measured from the stream banks.

DNR Rule 391-3-16-.01(7)(b)1.(i), (ii).

As set forth in the Findings of Fact, above, the evidence presented at the hearing showed that the design of the proposed landfill is protective of human health and the environment, including the Blue Creek watershed. Accordingly, the Court finds that the Petitioners have failed to establish, by a preponderance of the evidence, that the issuance of the permit or operation of the landfill pursuant to the permit violates DNR Rule 391-3-16-.01.

Volume _____ Page _____

IV. ORDER

The issuance of Solid Waste Handling Permit No. 099-019D(MSWL) was lawful, reasonable, and within the scope of the Director's authority. Therefore, in accordance with the above Findings of Fact and Conclusions of Law, the Director's issuance of the permit is hereby **AFFIRMED.**

SO ORDERED, this 14th day of May, 2008.

KRISTIN L. MILLER
Administrative Law Judge

I HEREBY CERTIFY THAT THIS IS A TRUE AND CORRECT COPY OF THE ORIGINAL FILED IN MY OFFICE.

STATE OF GEORGIA

Volume _____ Page _____

IN THE UNITED STATES DISTRICT COURT
MIDDLE DISTRICT OF TENNESSEE
NASHVILLE DIVISION

TENNESSEE CLEAN WATER NETWORK and TENNESSEE SCENIC RIVERS ASSOCIATION,

Plaintiffs,

v.

TENNESSEE VALLEY AUTHORITY,

Defendant.

Case No. 3:15-cv-00424

- -

BEFORE THE HONORABLE WAVERLY D. CRENSHAW, JR., DISTRICT JUDGE

TRANSCRIPT

OF

PROCEEDINGS

January 30, 2017

Trial Volume 1

- -

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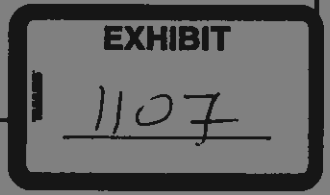

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I N D E X

Monday, January 30, 2017

INDEX OF WITNESSES

EXHIBITS

JOINT EXHIBITS		MARKED FOR I.D.	RECEIVED IN EVD.	WITH-DRAWN
1 - 276	As Described in Document 227-4	9	9	
277	Document 221, Stipulations re Qualifications of Expert Witnesses	7	7	
278	Document 226, Stipulations of Fact	7	7	
279	Map	8	8	

PLAINTIFFS' EXHIBITS		MARKED FOR I.D.	RECEIVED IN EVD.	WITH-DRAWN
1	Chart Compliing Surface Water Sampling Results - Revised for Accuracy	13	13	
2	Groundwater Monitoring Reports from 2011-2014	13	13	
3	Chart Compiling Groundwater Sampling Results - Revised for Accuracy	13	13	

EXHIBITS (CONTINUED)

PLAINTIFFS' EXHIBITS		MARKED FOR I.D.	RECEIVED IN EVD.	WITH-DRAWN
4	Administrative Order No 85-188 (In the Matter of VA Kingston Steam Plant)	13	13	
5	Letters to Private well owners Re: Ffecal coliform in their wells	13	13	
17	Chris Groves Direct Testimony Statement	114	114	

DEFENDANT'S EXHIBITS		MARKED FOR I.D.	RECEIVED IN EVD.	WITH-DRAWN
8	Plaintiffs' Permit Appeal Petition	13	13	
9	Tenn. Bd. Of Water Quality & Gas Final Order of Dismissal	13	13	
10	Chancery Court Final Order of Dismissal	13	13	
11	Notice of Appeal of Tenn. Court of Appeals	13	13	
12	Plaintiffs' Notice of Voluntary Dismissal of Certain Claims			
61	Unmanned Aerial System Video-Gallatin Fossil Plant	13	13	

The above-styled cause came on to be heard on January 30, 2017, before the Honorable Waverly D. Crenshaw, Jr., District Judge, when the following proceedings were had, to-wit:

THE COURT: All right. Be seated. Good morning.

ALL: Good morning.

THE COURT: We're here to start the trial in Tennessee Clean Water Network and Tennessee Scenic Rivers Association v. Tennessee Valley Authority, Number 15-424.

If counsel could introduce themselves and their corporate representatives for the record.

MS. ALEXANDER: Your Honor, Elizabeth Alexander with the Southern Environmental Law Center. And my colleagues Anne Davis, Jonathan Gendzier, Annie Passino, and Shelby Ward, who represents the Tennessee Clean Water Network.

THE COURT: All right.

MS. ALEXANDER: And today we have representatives in the courtroom from the Tennessee Scenic Rivers Association, Mr. Daniel Boone and Mr. Don Safer. And Renee Hoyos is with the Tennessee Clean Water Network.

THE COURT: Okay. Thank you.

MS. ALEXANDER: Thank you.

MR. AYLIFFE: Good morning, Your Honor, David Ayliffe on behalf of Defendant Tennessee Valley Authority.

Please allow me to first introduce TVA's party representative, Mr. John Kammeyer, who is TVA's vice-president of civil projects and CCR management; TVA's deputy general counsel, Edwin Small; James Chase, Lane McCarty, and our indispensable paralegal, Tracy Descamps.

THE COURT: Indeed, thank you.

To the party corporate representatives, I'm sure your counsel has told you, but just to be sure, the Court does need you all here every day on time for the full amount of the trial. I appreciate that emergencies occur, but let your counsel know and we'll make a judgment if we can proceed without you or not. Thanks.

Okay. We're here to start the trial, and the Court starts with thanking the counsel for your hard work to get to this point. Let's start with Docket Number 221 -- 221 -- which is your stipulation regarding the qualification of the witnesses.

I take it from there, then, that we can start the examination of the expert witnesses. And I guess so the record's clear, I would suppose that this document becomes part of the trial record.

Agreed?

MS. ALEXANDER: Agreed.

MR. AYLIFFE: Yes, Your Honor.

THE COURT: Okay. And this courtroom is big. So

it's sometimes hard for me to hear. There is on your desk that green light, a microphone. So I need you to talk into that as much as possible if you're not at the podium.

So Document 221 will be part of the trial record.

(Whereupon Joint Exhibit 277 was marked for identification and received in evidence.)

Document Number 226, stipulations of fact -- and, again, I thank you for the considerable work to do that; that's going to save us some time -- again, that will be part of the trial record, correct?

MS. ALEXANDER: Yes, Your Honor.

MR. AYLIFFE: Yes, Your Honor.

(Whereupon Joint Exhibit 278 was marked for identification and received in evidence.)

THE COURT: All right. And then that takes us to the map, which the Court reviewed. You've got -- and we placed it on the monitor Friday. And it shows up pretty good.

We also have a separate -- I have a separate monitor; you have monitors. So we can actually put a copy of the map -- it looks like it may be there now. Okay. Let's turn it on. My hope is that the witnesses can use that as appropriate when they're giving their testimony.

And I assume the map will also be a joint --

Let's see. Let's blow it up a little bit, you can

see it better. A little bit more. Oh, good. All right.

Can everyone see that? You should be able to see it on your monitors as well as on your desks. And you can adjust it as you want.

So is that going to also be a trial exhibit? Agreed? Trial exhibit? Joint exhibit?

MR. AYLIFFE: It's -- I think that's fine, Your Honor. Subject to what the Court put in its order about TVA's ability to challenge the different points.

THE COURT: Sure.

MR. AYLIFFE: That's fine.

THE COURT: For testimony purposes, they can show on the map what they're referring to.

MS. ALEXANDER: Yes, Your Honor.

THE COURT: And this will become part of the record on appeal.

MS. ALEXANDER: Yes, Your Honor.

THE COURT: Okay. So that will be part of the trial record.

(Whereupon Joint Exhibit 279 was marked for identification and received in evidence.)

THE COURT: So that takes me to the -- again, I'll compliment you all -- we've got plenty of paper here, exhibits. But looks like we're down to Document Number 223 and 224, which are the plaintiffs' objection to TVA's

exhibits and TVA's objections to the remaining plaintiffs' witness.

So I guess first -- I take it that all other exhibits are going to be joint exhibits?

MS. ALEXANDER: That's correct, Your Honor.

THE COURT: Okay.

MR. AYLIFFE: Yes, Your Honor.

THE COURT: All right. And what's the number of those? We'll go ahead and admit those into evidence right now. What's the -- the joint exhibit numbers?

MS. ALEXANDER: That's a good question.

MR. AYLIFFE: Total number?

MS. ALEXANDER: Let's see. We have exhibits -- Joint Exhibits Number 1 through 276, Your Honor.

THE COURT: Agreed by TVA?

MR. AYLIFFE: Yes, Your Honor. That's correct.

THE COURT: Okay. Exhibits 1 through 276 are admitted into evidence.

(Whereupon Joint Exhibits 1 - 276 were marked as exhibits.)

MS. ALEXANDER: Yes, Your Honor. And that's reflected in Document Number 225-1 in the record, where the joint exhibit list is filed.

THE COURT: Did you all do that this morning?

MS. ALEXANDER: I'm sorry, Your Honor?

MR. AYLIFFE: Friday.

THE COURT: Friday?

MR. AYLIFFE: Yes. 225-1 is a listing of the joint exhibits.

MS. ALEXANDER: That's correct, Your Honor.

And this morning we filed Joint Exhibit 85A, which was inadvertently omitted from the joint list. So that should be -- I don't know what docket number it is, but it was filed this morning.

THE COURT: Agreed by TVA?

MR. AYLIFFE: I haven't seen the document, Your Honor, so I'm a little hard pressed to say whether it's agreed or not.

THE COURT: Okay. Why don't you all look at that at the next break and then we'll come back to 85A.

MS. ALEXANDER: Okay.

THE COURT: So that takes me to, if I'm correct -- and correct me if I'm wrong -- to Document 223, which is the plaintiffs' objections to TVA's Exhibits 8, 9, 10, 11, 61, 195, and 199.

That's -- those are the ones that the plaintiffs continue to object to, correct?

MS. ALEXANDER: Yes, Your Honor. If -- if TVA intends to present those into evidence in this trial, we will object.

THE COURT: Okay. Would it be helpful for me to go ahead and rule on those so things can go smoothly, or do you want to wait until we get there?

MR. AYLIFFE: I think at least with regard to a couple of exhibits, it would be helpful just to take care of it right now, Your Honor.

THE COURT: Okay. I need some help on 199. Plaintiffs point out that there is no author. That does strike me as a problem.

MR. CHASE: That --

THE COURT: What is 199?

MR. CHASE: 199 is a fish tissue report. The author's signature is not on it. It was prepared by Mr. Tyler Baker, whose deposition testimony has been proffered and designated.

THE COURT: Okay.

MR. CHASE: But the document itself does not bear his signature.

THE COURT: But it's explained in his deposition designation --

MR. CHASE: No, it is not. This exhibit was created after his deposition. His deposition, I believe, was taken in May of 2016. The document is dated January of 2017 -- January 12, I believe. And it was created after his deposition testimony.

THE COURT: By him?
MR. CHASE: By him.
THE COURT: But it's not going to be explained in his deposition testimony?
MR. CHASE: No. But Mr. Baker can be available to explain it.
THE COURT: Okay.
MS. ALEXANDER: Your Honor, we object. The document --
THE COURT: Why don't you come to the podium. I can hear you even better.
MS. ALEXANDER: I'll be happy to.
We object. The document was not only created after Mr. Baker's deposition, but, in fact, it was disclosed to us on January 17th and the exhibit list was provided to us on December 23rd. The document is dated January 12th, 2017. So it didn't exist prior to the exhibit list, and we think it's untimely. It's in the nature of an expert report --
THE COURT: Uh-huh.
MS. ALEXANDER: -- and unfairly prejudicial to the conservation groups.
THE COURT: Anything further on that before I --
MR. CHASE: No, Your Honor. The only additional point I would raise is that there were no objections. It was disclosed in our exhibit list filed on December 23rd. The

Court was identified -- Document Exhibit 199. There were no objections filed to it at that time, and it's our position that all objections are waived except for relevance under Rule 403 and 402.

THE COURT: Okay. I'm going to reserve ruling on that one. And then, if we have Mr. Baker here, then we'll take that back up.

But, with the remainder of TVA's exhibits, Number 8, 9, 10, and 11 will be admitted. 61 will be admitted. 195 is excluded. And then I reserve ruling on 199.

(Whereupon Defense Exhibits 8 - 12 and 61 were marked for identification and received in evidence.)

THE COURT: On the plaintiffs' exhibits, Number 14 through 16, 184, and 191, the objection to those will be sustained and excluded.

So I think that takes care of all the exhibits on the objection list, except for 199, I'll reserve.

(Whereupon Plaintiff Exhibits 1 - 5 were marked for identification and received in evidence.)

MR. CHASE: I believe also, Your Honor, our filing reflects 14 through 16, but we have since received the supplemental or the amended exhibits, and we're withdrawing our objections to Exhibits 14 through 16.

THE COURT: All right. Then 14 through 16 would

be admitted.

MR. CHASE: Yes, sir.

THE COURT: Okay. Before the plaintiffs presents its first witness, let's go back to our map.

And I guess can you identify on the map where the ten seeps are that are covered by the State enforcement action?

MS. ALEXANDER: Your Honor, the seeps that are covered by the State enforcement action, it's my understanding that those are Seeps 1, 2, 6, 5, 4 --

THE COURT: Hold on. 5. 6. Oh, 5. I found it.

MS. ALEXANDER: Yeah. And I can point to them on the ELMO if that helps.

THE COURT: Okay.

MS. ALEXANDER: So, again, 1, 2, 6, 5, 4, 3, 7, 10, 12, and 11.

THE COURT: Okay. So those are the ten seeps identified in the State enforcement action. Thanks.

And I assume TVA agrees?

MR. AYLIFFE: Well, Your Honor, actually, we think there are probably more than that identified in the State enforcement action, but those ten we believe are included within those identified in the State enforcement.

THE COURT: Those were the ten identified in the State enforcement action complaint. I think it was paragraph

37.

MR. AYLIFFE: That's correct.

THE COURT: Okay.

MR. AYLIFFE: We think those are the ones that are included within that.

THE COURT: That was all that the Court asked for.

Okay. Anything else preliminarily before we get started from the plaintiff?

MS. ALEXANDER: No, sir.

THE COURT: Okay. From TVA?

MR. AYLIFFE: Your Honor, before we -- we call the first witness or plaintiff calls the first witness, TVA has a short video we would like to play for the Court. It's two minutes long. It's TVA's Exhibit 61 that was just admitted.

THE COURT: Okay. Have you all seen it?

MS. ALEXANDER: We have, Your Honor.

THE COURT: Okay. And you're showing this in the nature of an opening statement?

MR. AYLIFFE: That's right.

THE COURT: Okay. All right.

I guess I'll ask plaintiff, do you all want to make your opening statement first?

MS. ALEXANDER: That's what we were expecting, Your Honor.

THE COURT: Okay. Well, why don't you go first

and then TVA.

MS. ALEXANDER: Your Honor, conservation groups' case in this action is very simple and straightforward. TVA, as Dr. Chris Groves will testify this morning, built its coal ash impoundments on fractured, porous limestone, riddled with sinkholes, and they didn't put a liner under it. And the result is that that containment facility acts as a colander and not a container.

Dr. Groves will testify this morning that, for the first eight years that the Ash Pond Complex was in use, it didn't hold any waste at all. All of the waste that TVA put in there day after day went in through the sinkholes and under the river, and it was a total of 27 billion gallons of waste, according to TVA records and TVA testimony.

Dr. Groves, who's an expert in sinkholes and karst geology, will testify that TVA attempted to plug up some of those sinkholes to fix the problem. And they did plug a portion of them. But it did not fix the problem because they left many of them unplugged. And even the ones that they did plug were not effective to fix the problem, because water has to go somewhere, and if you plug one sinkhole, another one's going to form next to it.

The proof will show that TVA's own experts admit that karst cannot be eliminated.

Dr. Groves is going to talk about the extensive

efforts that TVA went to to study the groundwater problem after it had the loss of 27 billion gallons of waste. And he's going to testify that the conclusions that he's reached after reviewing all those historic documents that were not prepared for litigation and all the data, that he comes to the same conclusion that those TVA engineers came to before this case was filed.

And that is that there is a direct hydrologic connection between the groundwater and the Cumberland River, and that ash goes into the ash ponds, through the groundwater, and ends up in the river.

We're also going to hear from geologist Mark Quarles today. He's going to testify that the contamination is readily apparent in red water seeps on the shores of Old Hickory Lake. And it's also apparent from the nature of the sediment in the bottom of Old Hickory Lake.

Not only is he going to testify that you can see the contamination, but he's gone out and conducted sediment sampling of the levels of boron in the sediment, which everyone, both parties agree, is a good indicator of coal ash contamination. And in every location where Mr. Quarles tested the sediment, boron was elevated, indicating contamination.

He's also going to testify that in 11 of the 15 samples that were collected of the sediment, arsenic was also

elevated.

Mr. Quarles is going to talk about a 2012 report from one of TVA's own consultants, called Arcadis, and Arcadis informed TVA that the ash would continue to contaminate the river and that it posed a risk to ecology. But TVA didn't do anything about it then.

So, again, Your Honor, our case is simple: The coal ash is stored not in a sealed container but in a colander, and that colander sits in the middle of Old Hickory Lake, and the science shows that the lake is therefore contaminated.

Today we're also going to hear from Mr. Vojin Janjic. Mr. Janjic is a TDEC employee. He's in charge of the water pollution permits that TDEC issues to those who want an exception to the Clean Water Act so that they can discharge pollution into the waters off the states of the United States. He's going to testify that TDEC granted TVA a limited exception to the Clean Water Act, that they could discharge coal ash waste from one point, called Outfall 001, and from no other place at their facility.

That's all I have, Your Honor, unless you have questions.

THE COURT: Thank you.

MR. AYLIFFE: Good morning, Your Honor.

THE COURT: Good morning.

MR. AYLIFFE: May it please the Court, as I mentioned at the outset, the first thing TVA would like to do is to show this short video that will provide a helpful orientation to the Court and is actually superior to any photograph we can put up here in the courtroom. And it will also provide the Court with the actual footage of the Ash Pond Complex in operation, which is one of the issues here.

So, Tracy, if you can start.

(Video played.)

MR. AYLIFFE: This is coming downstream, Your Honor, down the Cumberland River around Odom's Bend. And here we're coming around -- this is the nonregistered site here, Your Honor. And that's the Ash Pond Complex. This is Pond E.

Could you hit pause right there, please.

This right here, Your Honor, is the location -- right here on the map -- where a lot of the little dots and pins you can see are concentrated -- it's this location right here.

Go ahead.

This is the wastewater conveyance into Pond A. Those are the syphons taking the water over from Pond A to the stilling pond. You can't see it, but this is Outfall 001 right here.

Thank you, Tracy.

THE COURT: And that's Exhibit --

MR. AYLIFFE: 61, Your Honor.

THE COURT: And is that a joint exhibit?

MR. AYLIFFE: It was not. It was one to which there was an objection.

Your Honor, at the pretrial conference the Court requested that the parties provide a brief opening statement that would preview for the Court the evidence we would present at trial this week. Because the plaintiffs will be presenting their case first, I have a little bit less to say than I might if our witnesses were going to be called.

So if the Court would allow me to just briefly provide framework that I think sets up the case and to talk specifically about the facts that will be shown, I think, today.

TVA expects the evidence presented at trial this week and today to show that TVA is entitled to a verdict in its favor on the issue of liability at both the Ash Pond Complex and the nonregistered site. As the Court held in its memorandum opinion, TDEC contemplated seeps from the embankment dikes into groundwater when it reissued the Gallatin NPDES permit in 2012. And because this is a CWA citizen suit, the plaintiffs act as private attorneys general. That means they stand in the shoes of TDEC.

And I agree with counsel for the plaintiffs, this

case is simple. The central issue here is whether plaintiffs can meet their burden of proving that there are flows from the ash pond complex and -- or the nonregistered site that would, number one, violate the Clean Water Act, and, two, exceed the volume of flow that TDEC reasonably contemplated when it reissued the NPDES permit in 2012.

All of the plaintiffs' claims are dependent upon this dispositive showing. That includes plaintiffs' claims of individual permit violations, because, under the basic contract principles that govern NPDES permit interpretation, the evidence will show that these provisions do not apply to the flows which TDEC reasonably contemplated.

Your Honor, it's TVA's position that the evidence presented today will show that plaintiffs cannot meet their burden of proof.

And just very briefly, I want to talk about some of the issues that are not in dispute, because they're going to come up today and throughout the week, and I would like to contrast those issues with what I think the facts will show starting today and then throughout the week.

Number one, beneath the Ash Pond Complex there are limestone formations that are susceptible to karst formation. That's not in dispute and it's not dispositive here. And the reason is, plaintiffs' evidence that we will see presented today does not show that any of these karst features extend

up and inside the ash ponds causing a conduit flow condition.

In very simple terms, Your Honor, there's no evidence of a karst pipeline extending up into the pond and sucking water out. As we just saw in the video, the ponds are a functioning system that is functioning as designed. And because they can't show the location of a karst feature, they also can't show any evidence of the volume of the alleged flow.

Number two, in the 1970s the Ash Pond Complex did lose a large amount of wastewater through karst features such as sinkholes. That's not disputed here and it's not dispositive. And the reason for that is the Court will hear today that TVA took action in the 1970s to repair those karst conditions and that those repairs were effective in stopping the water loss.

Number three, there are small amounts of ash in the Cumberland River adjacent to both the nonregistered site and the Ash Pond Complex. That's not disputed and it's not dispositive here, because what the evidence will show today is that this is the result of TVA's operation of the Gallatin facility for the last 65 years. And some documents from the 1960s and '70s do show that some ash escaped from the nonregistered site. But the evidence will show these are wholly past events and, more importantly, such things are not happening today and certainly not during the term of the

current NPDES permit that's at issue here.

Number four, there is a history of seeps from the dikes of both the Ash Pond Complex and the nonregistered site. That's not disputed and it's not dispositive here, because at Gallatin, for the most part, embankment seeps had historically been areas where there are damp or wet spots on the face of the earthen dikes.

Some of the embankment seep areas at Gallatin have in the past had a trickle of water flowing, and because this type of seep represents a dike structural stability concern, these seeps have been repaired by installing what's called a reverse-graded filter, which we saw in the video at the seep locations that's -- where the concentration of dikes are. That's riprap that is laid down to buttress the dike and also dissipate and diffuse the water that was trickling.

And the evidence will also show that none of the historic seep areas at Gallatin are flowing into the Cumberland River now.

The other thing that I expect the evidence to show this week is that there had been exceedances of MCLs in the groundwater monitoring wells at the nonregistered site. That's not disputed, and I don't say this to sound cavalier, but it's not dispositive here.

TVA takes that issue very seriously, but it is not indicative of conduit flow conditions. In fact, the evidence

will show that there are no conduit flow conditions at the nonregistered site.

And the evidence will further show that the reason water moves at the nonregistered site is primarily, if not exclusively, because of surface water infiltration -- that is, rainfall infiltration -- which is an example of non-point-source pollution. And that if that infiltration is cut off, the groundwater issue should be remediated. And that's how TVA proposes to address it, and the proof will show that this week as well.

Another point, Your Honor, is the contention that the Ash Pond Complex should not have been put in that location. Well, that's an example of 20/20 hindsight, looking back at a decision made in the 1950s, and it's just not an issue here.

And I would say, finally, it's not disputed that groundwater at some level at the Gallatin site is connected to the river. We all learned that in fifth grade science class when we saw the hydrologic cycle chart put up. But the key issue, and it's what Judge Haynes about talked in the Aluminum Processors decision, is tracing a direct hydrologic connection and being able to show that the pollutants flow from the source to surface waters.

And so I think this week you'll hear a lot about many of these issues, but I think what the bigger story here

is, is what the Court will not hear. And I don't expect the proof to show these witnesses connecting up the evidence and actually proving there are flows from the Ash Pond Complex or the nonregistered site that, number one, violate the Clean Water Act and, number two, exceed the volume of flow that TDEC reasonably contemplated when it reissued the NPDES permit in 2012.

And so, Your Honor, on behalf of the TVA and my co-counsel, we appreciate the opportunity to tell Gallatin's story and to present TVA's case here this week.

Thank you.

THE COURT: All right. Thank you.

Can the plaintiff call its first witness.

MS. ALEXANDER: Your Honor, Conservation Groups are going to call Dr. Chris Groves to the stand as our first witness.

Your Honor, at the pretrial conference we discussed the possibility of our experts reading a portion of their testimony into evidence.

THE COURT: Sure.

MS. ALEXANDER: And so he is not going to read his entire testimony to the Court today. And Mr. Quarles will not either. We have shortened what they're going to read, and hopefully they won't overlap with each other.

CHRIS GROVES,

called as a witness by Plaintiffs, was duly sworn and testified as follows:

MS. ALEXANDER: Your Honor, before Dr. Groves begins, I don't intend to recite all of his credentials, but there are a number of things that have come up since we submitted his CV to the Court.

First of all, on January 9th, just a few weeks ago, Dr. Groves was awarded China's International Science and Technology Cooperation prize for his 20 years of work cooperating with Chinese scientists regarding karst and other groundwater issues in China. It's China's highest award for foreign scientists. He was one of the six scientists in the world given the prize. And this is a photograph of President Xi Jinping giving Dr. Groves this prize at Beijing's Great Hall of the People before 3,300 scientists and officials.

Part of the basis for the award was that Dr. Groves oversaw a project that gave over 14,000 Chinese children in State-run orphanages clean water for the first time.

Secondly, another issue that has come up since Dr. Groves's CV was submitted was that, last Thursday afternoon, there was an anonymous complaint issued to the Geology Licensing Board of the State of Tennessee, and it was issued from Knoxville, Tennessee, anonymously. And the basis

for the complaint was that Dr. Groves is testifying as an expert witness today.

Dr. Groves was in the process of applying for his license as a Tennessee geologist, which is a reciprocal program, and was not -- did not contemplate that he was practicing geology by providing expert testimony in this case. And, in fact, there is a specific exemption for being employed by a firm that's not engaged in geology under the statute.

So I wanted to make the Court aware of that.

THE COURT: Okay. Well, I think you all stipulated to his qualifications under 702, so he can proceed to testify as an expert.

MS. ALEXANDER: Thank you, Your Honor.

Do you have your testimony?

THE WITNESS: No. I need a copy.

MS. ALEXANDER: That would help.

THE WITNESS: I have one in the witness room.

Do you want me to grab it?

MS. ALEXANDER: That would be great.

THE WITNESS: Excuse me, Your Honor.

THE COURT: Sure.

THE WITNESS: Thank you.

In karst landscapes -- in karst landscapes, water that is infiltrated into the ground, called recharge, often

moves rapidly through a natural underground "plumbing system" of crevices, conduits, and caves.

Tributary networks combine with one another, leading to larger and larger flows, until the water eventually reemerges at the surface at a spring that flows into the local area's base level stream.

TVA correctly recognized this in its 2008 study within the Central Basin aquifer system, when it said (as read):

> Groundwater flows from the recharge areas through fractures and conduits and eventually discharges to springs and gaining streams. Large conduits or interconnected conduit systems may consolidate groundwater flow, similar to the way surface water flows from small tributaries to larger streams. These interconnected open conduits, called the groundwater conduit system, can transmit water rapidly and can act as important local and regional drains of the groundwater system.

Let's see. Is there a pointer?

MS. ALEXANDER: I'm afraid we don't have a pointer.

THE WITNESS: Okay. That's fine.

Figure 4 -- yeah, Figure 4 shown up there shows

examples of common surface and subsurface karst features, such as caves, sinkholes, and underground streams shown in the diagram there. I am familiar with this diagram through my work in this field and from my studies.

Figure 5 is a photograph that I took of exposed Carters Limestone within Tennessee's Central Basin during cold conditions, where the emerging groundwater forms small frozen waterfalls. This photograph is an excellent illustration of the colanderlike nature of the aquifer framework through which the groundwater flows and the ease with which water moves through solutionally enlarged fractures and conduits within the rock.

TVA also recognized in its 2008 report that, because the spaces for water flow are typically larger in karst aquifers than in areas where karst is not present, both dissolved and particulate substances in the water can be carried along as the water moves through the subsurface, often with little filtration.

As stated, groundwater in karst terrains is readily susceptible to contamination, as the water can travel long distances through conduits with no chance of the natural filtering processes of soil or bacterial action to diminish the contamination.

In unconfined conditions, karst aquifers have very high flow and contaminant transport rates under rapid

recharge conditions, such as storm events. Consequently, the groundwater sources in karst aquifers considered most vulnerable to contamination are those that are under the direct influence of surface water.

At the Gallatin Fossil Plant, as is typical for any area with karst topography, underground water primarily flows through openings that have been enlarged by the flow of water within the purer limestones.

The underlying aquifers are characterized by very highly dissolved bedrock, producing features such as underground rivers, caves, sinkholes, and sinking streams. If the area had not been covered by coal ash waste, one would expect to see rainfall landing on the ground and quickly sinking underground into the highly porous bedrock.

The Carters Limestone that underlies the Ash Pond Complex transmits water comparatively easily and rapidly through numerous fractures and other conduits that have been enlarged by dissolution of the limestone bedrock by groundwater flowing through it.

Figure 7 shows a map prepared by TVA which states (as read):

> This shows previously unmapped -- excuse me -- this shows previously unmapped limestone sinkholes and prominent rock features as they appear on preconstruction aerial photographs.

The note on the map indicates that TVA collected information regarding the existence and extent of the karst and sinkholes in 1951 before completing construction of the plant and ash disposal sites, but, nonetheless, decided to dispose of ash in unlined pits.

The handwritten orange line shown up there indicates TVA's interpretation of the extent of the Carters Limestone. The map also shows a very large number of sinkholes on the footprint of Odom's Bend, indicated by the black circles and ovals in the image -- more than 100 by some counts that I have seen in TVA documents.

Rainfall or snow melt landing in or near the area of high sinkhole density would have quickly disappeared into the subsurface.

The cross marks shown depict lineaments. These are naturally occurring linear features of the landscape, inferred as here from topographic maps or from aerial photographs that provide insight into the subsurface fracture patterns and magnitude.

The map in Figure 7 provides clear evidence that subsurface fractures on Odom's Bend Peninsula are extensive. These fractures would also allow water and any waste in the water to drain into the groundwater.

It is my professional opinion that fractures and related solutionally enlarged conduits under the coal ash

disposal areas transmit coal ash waste to the groundwater. I have never seen any TVA documentation that these fractures were repaired, and it seems as though it would be nearly impossible to do so, given how extensive they are.

TVA and its contractors have conducted borings into and in the vicinity of the Ash Pond Complex. Boring logs from these explorations show that at least 70 voids were encountered during these drillings. Many of these voids were listed as apparent voids, although the difference between "voids" and "apparent voids" was not explained.

The height of these range from a few inches to at least 8.7 feet, with at least ten apparent void zones ranging from 4 to 18.6 feet tall, and many were shown to be connected to the groundwater flow system.

The most prominent landscape feature on Odom's Bend Peninsula is the Valley of Sinking Creek. At Odom's Bend, sinking streams disappear underground at what are called swallets, defined as holes into which streams disappear into the subsurface. Once the water disappears underground and cannot be seen at the surface, it continues to flow underground.

The sinking creeks are a continuous drainage feature that extend to the Cumberland River and did not terminate within the agricultural fields before being covered with ash. To the contrary, the only feasible exit for the

water is the Cumberland River.

Sinking Creek is now under the Ash Pond Complex and thus these swallets are now also under the Ash Pond Complex.

At Gallatin there is no impermeable bottom lining or bedrock layer below the ash ponds that are currently keeping coal ash waste from migrating down into the karst aquifer. In fact, because of the sinkholes, lineaments, voids, potential caves, and sinking creeks, the bottom of the ash pond is more like a colander than a liner.

For all these reasons, the karst aquifers below the coal ash disposal areas of the Gallatin Fossil Plant are highly vulnerable to contamination. For decades TVA's employees have studied the karst aquifer at Gallatin and generated multiple reports of its findings, including one in September 1982, one in April 1987, one in 1989, one in March of 1992, one in June of 1999, one in September of 2002, and a more general report in September 2009 titled "Groundwater Monitoring Program Plan."

Many of the internally produced groundwater reports reached the same conclusion. For example, the 1982 Groundwater Report stated (as read):

> In the vicinity of Gallatin Steam Plant, most of the subsurface streams flow a short distance across the ground then disappear into sinkholes

and drain into underground channels in the limestone bedrock.

This is what I would expect in the karst topography of Odom's Bend Peninsula. Other reports make similar conclusions.

As I would also expect, the 1982 Groundwater Report includes (as read):

> Precipitation and surface water entered the underground system by infiltration either through sinkholes or vertical joints in the limestone that are subjected to weathering and solutional processes. Groundwater may also flow through horizontal sheetlike openings that occur along the bedding planes between rock stratum. The Gallatin Steam Plant is hydrologically bounded on three sides by the Cumberland River. The general direction of groundwater flow is expected to be from the ash pond -- expected to be -- excuse me -- from the ash pond to the river. Bedrock joints and the topography probably control the actual flow of groundwater. Water table elevations are probably within the ash disposal pond.

And the 1987 Groundwater Report acknowledges that (as read):

There is even the possibility that holes or solution cavities in the bedrock can exist below TVA waste disposal facilities, which could result in the flow of impounded water in a waste disposal facility directly to groundwater with little attenuation.

The 1987 Groundwater Report also correctly discusses the porosity of carbonate rock like the Carters Limestone. (As read):

Water of low pH dissolves carbonate rock and forms solution cavities through which large quantities of water can flow. Flow through these solution cavities more closely resembles flow through a pipe than flow through a porous medium such as characterized in conventional groundwater flow.

The 1987 Groundwater Report also acknowledges that the water table is believed to be within the waste pond.

By 1989, TVA was beginning to recognize that the groundwater flow could be contaminating domestic wells to the north of the Ash Pond Complex -- excuse me -- yes, to the north of the Ash Pond Complex, stating that (as read):

One should consider that domestic Wells P1 and P3 are at risk of contamination from the ash pond. According to TVA memos, all of the coal ash waste,

some 27 billion gallons of coal ash waste that TVA sluiced into the facility's Ash Pond Complex from 1970 to 1978, drained down through the system of underground conduits and into the Cumberland River.

According to TVA's 1989 report, "An Evaluation of the Impacts of the Gallatin Fly Ash Pond to Groundwater Resources," by Young and Carden, from June 12th, 1970, until December 1978, leakage through (as read):

> Sinkholes and extensive network of solution cavities underlying the pond occurred at such a rate that no pond overflow occurred through the NPDES permitted discharge structure.

TVA's director of power productions reported in a January 25, 1979, memo that the pond's water level generally remained about 2 feet higher than the adjacent Old Hickory Reservoir. It generally fluctuated with the reservoir's level.

The fact that the pond failed to hold water and the level of the ash pond fluctuated with the level of Old Hickory Lake is unequivocal proof of a direct hydrologic connection between the ash pond and Old Hickory Lake through one or more subsurface conduits.

A February 23rd, 1977, memo and other documents reflect the sluice water and stormwater were unable to raise the pond level, even though TVA continued to sluice

wastewater to the pond at a rate of 6,000 gallons per minute. Assuming this figure represents an average flow rate until repairs commenced, and that, as I previously stated -- previously stated, this represents a total of some 27 billion gallons of coal ash waste flowing directly into the karst aquifer and then into the Cumberland River between about April 1970 and December 1978.

For reference, as I illustrated in Figure 11, the amount of coal ash waste that TVA discharged into the Cumberland River over more than eight and a half years at Gallatin was roughly 9,000 times the amount of waste lost at the Gold King spill -- excuse me -- the Gold King Mine spill in 2015, about 128 times the estimated volume of the oil released by the Deepwater Horizon, and more than 25 times the volume of what TVA released in the Kingston, Tennessee, coal spill ash in December 22nd, 2008.

TVA studies that I have reviewed indicated that leakage was occurring through some number of sinkholes, variously reported from between 59, 101, and 111, but TVA could not identify the actual number of sinkholes that were leaking.

Although they cannot be seen due to the deposit of coal ash waste, most of the conduits below the Ash Pond Complex were never plugged or repaired. Accordingly, coal ash waste is certainly still within the groundwater and is

likely still flowing into the river.

Given the extensive karst nature, it is improbable that the subsurface drainage system at Odom's Bend Peninsula has been somehow plugged up in a way that now prevents water and coal ash waste from moving --

Oh, this is a pointer? Great. Thank you so much.

Excuse me. Given the extensive nature -- excuse me.

Given the extensive karst nature, it is improbable that the subsurface drain at Odom's Bend Peninsula has been somehow plugged up in a way that now prevents water and coal ash waste from moving from the ash disposal facilities through groundwater conduits to the Cumberland River.

Indeed, TVA documents reflect that sinkholes have been identified repeatedly at or near the Ash Pond Complex in 1979, 1990, 1991, 2005, 2010, and, most recently, a likely sinkhole was identified by TDEC in November of 2016.

The extent of the karst is described in Figure 12, as attached hereto as Exhibit B. This is an April 21st, 1978, memorandum by Christopher Ungate at TVA. This memo basically describes a karst inventory of the site of the Ash Pond Complex. Its purpose was to identify and mark suspected sinkholes and points of leakage from the northeast arm of the pond. It describes individually 34 visible sinkholes, noting that more are under water.

One of the sinkholes, identified as Number 205, is described as "a large sink, straight sides, 30 feet wide by 50 feet long." Another one, Number 307, is 20 feet in diameter, and 205 is described as "150 feet long and 10 to 15 feet wide." The memo notes that 332 is a large hole filled with driftwood, and that the pattern of driftwood placement is indicative of vortex activity. There are notes of springs and sinkholes holding water, and two, Numbers 200 and 222, are reported to have coal ash in them, indicating a connection to the wet area of that storage.

The approximately 30-acre crosshatch area on the map, right in here, now ash ponds A and stilling ponds B and C, is described as an area of numerous sinkholes, characterized by open cracks in ground, large depressions and large rocks.

The memo states that numerous points of suspected leakage were identified in this area and would probably require treatment of the entire area to prevent leakage.

While TVA apparently tried to repair some sinkholes, there is no evidence that the entire area was treated.

Interestingly, the 1962 map, Figure 12, identifies the area of the current Ash Pond Complex as Old Hickory Lake.

Following TVA's coal ash disaster at Kingston, TVA's outside engineering firm, Stantec, conducted a TVA

disposal facility assessment at Gallatin.

Stantec's report states in the section titled "Notable Observations and Concerns" that (as read):

> Karst bedrock and sinkhole activity is present plant-wide and is a concern.

Stantec goes on to recommend that (as read):

> With respect to ash ponds A and E and the stilling ponds that long-term strategies relative to plant-wide karst subsurface conditions should be developed, including consideration to installing a lining system beneath the ponds -- beneath all ponds -- and converting to dry disposal operation where appropriate.

Because the former surface of the Valley of Sinking Creek is now the base of the Ash Pond Complex we can assume that coal ash wastewater now moves directly into the subsurface under the Ash Pond Complex to the Cumberland River, just as water moved through the bottom of Sinking Creek to the Cumberland River before it held the Ash Pond Complex.

Given the hydrogeologic conditions of Odom's Bend, the evidence of leakage into the Cumberland River, and the fact that groundwater on Odom's Bend Peninsula is expected to flow into the Cumberland River, any suggestion that coal ash wastewater is not currently going to the Cumberland River or

is going anywhere other than the Cumberland River is implausible.

Aquifers like the one underlying the area in the vicinity of the Ash Pond Complex have a lower saturated zone, where all available spaces in the rock are completely filled with water. There is also an upper unsaturated zone where spaces are filled with air along with water that may be moving down towards the water table.

The surface that separates the saturated zone from the unsaturated zone -- or, put another way, the top of the saturated zone -- is called the water table.

As I have said previously, water tends to flow from higher areas of the water table to lower areas of the water table. Maps of the water table are thus useful to show directions of groundwater flow.

A depiction of groundwater of Odom's Bend is shown within Figure 13. The labeled concentric lines, here, are water table contours or lines of equal evaluation of the water table. These are analogous to similar lines showing surface landscapes on a topographic map.

Just like a ball would roll downhill in any direction from the top of a hill, in this case water will flow in an outward radial pattern from the top of the groundwater mound, right here. One can see from the groundwater flow arrows that there is a radial flow outward

from the highest central part of the peninsula. This includes a flow from the Ash Pond Complex northward or northwestwards towards Odom's Bend Road, and that is this area flowing from here to there.

In TVA's 1989 Gallatin Groundwater Study, TVA engineers showed the same pattern, with groundwater flows converging from north and south on a line passing through the cluster of near-lake elevations shown on Figure 16, on which the arrows show directions of groundwater flows.

Can we move to the next one? Yeah. Yeah. It should be the Young and Carden one. Okay. Okay. That's fine. Okay.

One arrow at the top of the diagram is associated with an axis grid and is not related to groundwater flow.

That map is not up there. Okay.

Converging groundwater coming from both the north and south must be flowing into a trough in the water table parallel to and north of the axis of the Ash Pond Complex. If water flows down into this water table trough -- right here -- if water flows down into this water table trough from the Ash Pond Complex, since it cannot flow out the other side, it can only flow down the axis of the trough.

In this case, the only downward slope remaining in the water table is the slight drop to the lake to the southwest. That's from here down to here.

Such groundwater troughs are a common feature in karst aquifers, showing the location of conduits carrying significant underground rivers which form water table troughs like those of surface rivers.

Taken together, the water table elevations and inferred groundwater flow directions, including the water table trough shown by convergent groundwater, the linear arrangement of wells with water table elevations very close to that of the river, the correlation between changes in river and groundwater elevation in Wells GAP024 and GAP025, even though they are not adjacent to the river, the proximity to leaking sinkholes of the 1970s in the northwest arm of the ponds, and the presence of a very large void in Well 2 up in here are independently consistent with the presence of a significant karst conduit and associated underground river here.

The presence of a significant karst conduit and associated underground river at this location and the water table evaluations involved are consistent with the existence of a flow outlet into the Cumberland River on the western side of Odom's Bend that is now flooded by Old Hickory Lake.

Hydrologic conditions at Gallatin Fossil Plant are significantly influenced by the Sinking Creek karst drainage system, which has been formed from underground dissolution of the Carters Limestone.

The peninsula, along with a 2,300 acre drainage system to the north that leads to the upper sinkhole complex, exhibits a variety of classic karst features, such as sinkholes, sinking streams, and a blind valley, and explored and likely unexplored cave passages are nearby within the Carters Limestone.

The connectivity between the active Ash Pond Complex and the Cumberland River was clearly established when an estimated 27 billion gallons of wastewater moved through the karst aquifer to the Cumberland River between 1970 and 1978. During that time, by measuring water through altered conductivity, temperature, and pH, divers also found direct evidence that coal ash waste was leaking into the river.

Although leakage from the ash ponds has at least been partially -- partly ameliorated by plugging some of the sinkholes, there is no evidence that all of this leakage has been stopped. Because there were unrepaired sinkholes identified by TVA under the Ash Pond Complex, there remains a direct hydrologic condition between the Ash Pond Complex and the Cumberland River.

Consistent with the observations above, dewatering and capping the ash disposal areas without a liner will not prevent contamination of groundwater or the Cumberland River by coal ash waste, because:

Water draining through the karst system and into

the Cumberland River has not been eliminated and would not be eliminated by the installation of a cap.

The water table will be higher than the bottom of the ash pond in the axis of Sinking Creek so that saturated ash will remain in contact with all -- excuse me -- so that saturated ash will remain in contact with groundwater.

Water from areas not covered by such a cap would continue to flow laterally into the Ash Pond Complex.

Water moving into the ash pond would interact with the ash that now fills the Sinking Creek karst drainage system, and the presumably contaminated water will continue to require an exit from the system. This can only be the Cumberland River.

Thank you, Your Honor.

MS. ALEXANDER: Your Honor, consistent with the local rule, may I conduct a bit of limited direct?

THE COURT: Sure.

MS. ALEXANDER: Okay.

CONTINUED DIRECT EXAMINATION

BY MS. ALEXANDER:

Q. Dr. Groves, thank you very much.

One question I have, is -- is the fact that there is currently water sitting in the ash ponds and in the Ash Pond Complex proof that it's not leaking?

A. No. No, it's not. And in fact, I maybe could

illustrate if there's an opportunity.

MS. ALEXANDER: Your Honor, would you permit him to illustrate that?

THE COURT: Sure.

MS. ALEXANDER: Thank you.

THE COURT: Go ahead.

THE WITNESS: Great. Thank you.

MS. ALEXANDER: I believe we're going to use the back of this map.

THE WITNESS: Can you see this okay?

THE COURT: I can.

THE WITNESS: Do it this way. I guess one of the principal ideas here that's at a central place of the proceedings is that, clearly, between 1978 -- excuse me -- 1970 and 1978, all of the water being sluiced from the plant was disappearing into the Ash Pond Complex. The water level stayed at the same level even though the water was -- the waste and water were going in, the level of the ash pond -- the level of the pond stayed the same level for eight and a half years.

In 1977 and 1978, TVA repaired some, but not all of the sinkholes.

THE COURT: Doctor, if you would turn to me, I'm really the person you need to --

THE WITNESS: I'm sorry. Excuse me. Thank you,

Your Honor.

So the idea is, until 1978, they were pumping large amounts of ash and water in, and the ponds stayed at the same level.

In -- completing in 1978, December, they repaired some of the leaks, and the water level rose until it went over the outfall. And they have concluded that the -- the pond was repaired.

What I would like to illustrate is that does not show that the pond was repaired. The way I would like to do this is in a map -- I'm not a very good artist, but hopefully I can make the concept clear.

And, Your Honor, I'll point out this is -- this idea is something called a hydrologic balance. It's among the most fundamental concepts of all of hydrology. And this comes out in about the second week of my first semester hydrology course.

The idea is we have a bathtub. I'm showing it static to begin with. And this could represent any body of water, including the Ash Pond Complex. There's a spigot from which water could come. There's a drain, which is plugged in this picture. And the water level is at -- is some level in the -- in the bathtub.

All right. If we turn the water on and pull the plug out and we have something like this -- I apologize again

about my artistry. Here are the feet. Okay.

So here we have a situation -- and this is the principal concept. So say we have a situation where now we've pulled the plug, water is coming in, and let's say the water level stays at -- the same. Okay? Let's say for 8.6 years.

There -- really, it's one of three possibilities: If the water is staying the same, that means what's coming in must be exactly equal to what's going out. I also illustrate this in my class with a very analogous concept, if the deposits you make into your checking account are equal to the checks, the balance stays the same. The same idea.

The other possibility or a second possibility is, if water is coming in more quickly than it's going out, then the water will rise. Okay? If your deposits come in more quickly than you write checks, your balance goes up.

If the water is draining out more quickly than it's coming in, the water will drop. Those are the three possibilities. Okay? All right.

So let's say, then, with that concept that we observe the following. Okay. So now let's say we have, really, a very, very similar situation. But let's say this is a bathtub that, for whatever reason, has three exits. We can imagine the same concept will apply, that there is some amount of drainage coming in; there is some amount of

drainage coming out, here through three instead of one, but the same idea. And we can imagine that there's a rate of this input and this output where they're equal. And if that was the case, the water level would stay the same.

This was the condition at the Ash Pond Complex from 1970 to 1978. In 1977 and 1978, TVA came -- and their contractors, I suppose -- okay. So here was the condition. This was the water level at the time of the repairs that were completed.

The -- as far as the documents indicate, the 6,000 gallons per minute was continuing to come in. They plugged some, but, according to the report, not all of the sinkholes. The water level rose to the point where it rose here to the lip of the bathtub, but in that case to the outfall from the Ash Pond Complex.

They concluded that the pond was successfully sealed. Okay? A -- one of the most fundamental concepts of this entire trial, in my opinion, is this doesn't show that it was sealed. This just shows that, as long as what's coming in is greater than what's coming out, the water will rise. Okay? That doesn't mean that they were all sealed.

So if this is coming in faster -- well, excuse me. Let me step back a little bit.

As long as what's coming in here is faster than what's going out here, the water will rise. It rose to the

outfall. So now what's coming in here is equal to this plus whatever may be down here. We don't have that number. The point is that it's not required that all of the sinkholes have been plugged for this water to rise over the outfall.

And so that's really the answer of this -- that -- the fact that water is going over the outfall does not show that the leakage has been stopped, is what I'm trying to illustrate here.

MS. ALEXANDER: Thank you. I'll let you go back to your seat.

THE WITNESS: Thank you, Your Honor.

BY MS. ALEXANDER:

Q. So, Dr. Groves, as you sit here today, you can't say that there isn't -- you can't say for certain what amount of water is going out the bottom; is that correct?

A. No, it's possible to do. It could be done using something called a hydrologic budget, and there's been a lot of discussion about that, and so far one has not been produced.

MS. ALEXANDER: Okay. That's all I have for you. Thank you.

THE WITNESS: Thank you.

MR. AYLIFFE: Your Honor, if I could request just a brief break. We just got the joint exhibits today.

THE COURT: Sure. It's about -- it's right at

10:30. Why don't we take a quick morning break.

(Brief recess.)

THE COURT: All right. Be seated.

You can proceed with the cross.

MR. AYLIFFE: Thank you, Your Honor.

THE WITNESS: Your Honor, if I can make just one small comment. Before coming here, I left my glasses in Bowling Green. So I can't read the fine print. I'm familiar enough with where I know where everything is, but if I could just make that comment. Thank you.

CROSS-EXAMINATION

BY MR. AYLIFFE:

Q. Good morning, Dr. Groves. It's nice to meet you.

A. Thank you.

Q. Do you go by "professor" or "doctor"?

A. Doctor is fine.

Q. So you're a professor of hydrogeology at Western Kentucky University; is that correct?

A. Yes, sir.

Q. And according to the glossary attached to your testimony, hydrogeology is the branch of science concerned with the behavior, distribution, and movement of water beneath the soil and rocks beneath the Earth's surface; is that correct?

A. That's correct.

Q. And you prepared two reports in this case, yes?
A. As far as -- well, several, but some were state and some were federal. I guess two that are relevant here.
Q. Two in the federal case?
A. Yes.
Q. And both of those reports were submitted by you to the Southern Environmental Law Center, yes?
A. Yes, sir.
Q. And you submitted that first report on November 22nd, 2015, yes?
A. Yes. Uh-huh.
Q. And the second report on March 11th, 2016?
A. Yeah. About then. Yeah. Uh-huh.
Q. And I think as you just mentioned you also prepared a report in March 2016 in which you reviewed the environmental investigation plan for the State enforcement action?
A. That's right.
Q. And just a couple questions about your -- your CV.
You're a licensed professional geologist, I think as you said?
A. That's correct.
Q. You're not a licensed professional engineer, correct?
A. No, I'm not.
Q. And you're not a licensed toxicologist of any kind?
A. No, sir.

Q. I wanted to ask you, one of the statements from your direct testimony statement that you read on direct was paragraph 44 of your direct testimony statement, and you said (as read):

> At the Gallatin Fossil Plant, as is typical for any area with karst topography, underground water primarily flows through openings that have been enlarged by the flow of water within purer limestones.
>
> Yes?

A. That's correct.

Q. I just had to ask you -- I'm going to break one of my rules here. How many times have you been to the Gallatin Fossil Plant?

A. I have not been on the TVA property.

Q. Okay. So you've never been to the Gallatin Fossil Plant site?

A. No, sir.

Q. Okay. Well, let's talk about karst.

According to your report that you prepared for this case, you are a hydrogeologist with more than 30 years of professional experience in the study of landscape aquifer systems?

A. That's correct.

Q. And with -- I think you said with an emphasis in but not

restricted to those in karst regions throughout the world?
A. That's right.
Q. And according to the glossary attached to your testimony, "karst" is a term which refers to landscapes and aquifers that have been created through a chemical solution of especially soluble rock?
A. That's correct.
Q. Most commonly limestone, yes?
A. Uh-huh.
Q. Is that a "yes"?
A. Yes.
Q. Thank you. And I think you said in that definition it results in characteristic features, such as caves?
A. That's correct.
Q. Underground rivers?
A. Yes.
Q. Large springs?
A. Yes.
Q. Closed-surface depressions called sinkholes?
A. Yes.
Q. And your glossary defines "limestone" as a type of rock that in Middle Tennessee forms extensive, nearly horizontal layers, yes?
A. That's right.
Q. Okay. And is especially soluble in natural waters?

A. Yes.
Q. And it says that "in many places forms caves, sinkholes, and other typical karst landscape features," correct?
A. Yes.
Q. And that would include conduits, yes?
A. Yes.
Q. Now, your glossary defines "alluvial deposit" separate from its "karst" definition, correct?
A. Yes. They are two different things.
Q. Two different things.

And the glossary defines "alluvial deposits" as "unconsolidated sediment that has been deposited by a surface stream or river," correct?
A. Yes.
Q. Well, I wanted to ask you a couple of questions about something that's -- referenced in your testimony but really not covered in your -- your reports in this case. That's the nonregistered site.
A. Okay.
Q. In your initial report, you include as your Figure 8 -- I have it here if you want to get it out -- a portion of a 1964 geologic map of the Laguardo quadrangle.

Do you remember that?
A. Could I get a copy of my report, please?
Q. Yes. Let me first show you that section in your report

that I'm talking about and make sure we're talking about the same thing.
A. Actually, was the binder with my reports? I think it came over with the -- with the -- sort of in the boxes.
Well, we can -- I think we can go on. If we could -- if I can answer questions, but if I get to something where I need to --
Q. Yeah. Let's do this first. Let's look at Figure 8 from your report and then we'll see if they match.
How about that?
A. Okay. Yeah. Okay.
Q. Do you recognize that as Figure 8 from your direct report?
A. I recognize the map, and I don't necessarily remember the figure numbers, but that's Figure 8 as far as I know, yeah.
Q. Okay. I think you said --
A. Yeah. Yeah. That looks familiar.
Q. And that's from the 1964 geologic map from the Laguardo quadrangle, correct?
A. That's correct.
Q. Let me find a copy of that map.
May I approach, Your Honor?
I think you said you didn't have your glasses on; is that correct, sir?

A. That's right. I can see that fine. It's just the smaller print on the screen.
Q. I'll read it to you, and if you disagree with me, we can talk about it.
A. Thank you.
Q. So on that 1964 geologic map that you represented in your report, there's a symbol that says "QAL," correct?
A. Yes, sir.
Q. And "Qal" stands for alluvium, correct?
A. Quaternary alluvium, that's correct.
Q. And in the 1964 geologic map, it states that (as read):
The alluvial deposit is variable but can be as thick as 70 feet in places?
A. I don't remember the number. But that's -- I believe that to be true if you say so. Yeah.
Q. Okay. And the 1964 geologic map that's referenced in your report shows that the nonregistered site sits on top of alluvial deposits, correct?
A. That's correct.
Q. And I think you described it in your report as, quote, old Cumberland River sediment?
A. Yes. Uh-huh. I did.
Q. And you prepared two hydrogeological reports for this lawsuit, yes?
A. That's right.

Q. And neither report documents the existence of karst conditions at the nonregistered site, correct?
A. That's correct.
Q. In fact, your reports do not discuss groundwater movement at the nonregistered site at all, do they?
A. My reports do not.
Q. Okay. That takes care of the nonregistered site.
I want to ask you about something that's referenced in both your reports and your direct testimony statement, and that's the Gallatin Steam Plant Cave.
Do you know what I'm talking about?
A. Yes.
Q. Okay. It's kind of a misnomer, I suppose, since it's on the other side of the river, correct?
A. I didn't name it, so I wouldn't say that at all. Cave explorers are welcome to call a cave anything they want.
Q. But you've never been there, so you don't know?
A. I've been to the entrance, but I've never gone into the cave.
Q. So if you've been to the entrance, you know it's across the river from the Gallatin site, correct?
A. Yes. If I can add, that's not a name I gave to it --
Q. Oh --
A. Pardon me.
Q. And you say that the cave's location was provided to you

in your report by the Tennessee Cave Survey?
A. Yes.
Q. Okay. And you show a picture above paragraph 58 of your direct testimony statement that you say is the Gallatin Steam Plant Cave?
A. That's correct.
Q. Which you've never been inside?
A. No.
Q. Okay. And then immediately following your discussion of the Gallatin Steam Plant Cave, which you haven't been to, you discuss in your direct testimony statement in paragraph 59 that (as read):

> Boring logs from explorations in the vicinity of the Ash Pond Complex show voids.
>
> Correct?

A. In 59?
Q. Yeah. It's paragraph --
A. Yeah -- well -- well, they are listed as "apparent voids."
Q. You're not suggesting, are you, that there are caves there, are you?
A. I think there's very good evidence that there's caves there.
Q. That's not what you told -- not what you told the parties in this lawsuit when you prepared your report, is it?

A. I'm not sure what you're referring to.
Q. Well, in your report you talk about the Gallatin Steam Plant Cave, yes?
A. Yes.
Q. And according to your report, it says no known caves have been explored or surveyed on Odom's Bend, correct?
A. That's correct. Because there are 341 acres of ash sitting on top of what are likely many caves or some caves.
Q. But they haven't been exploerd, according to you, correct?
A. No.
Q. And you've never been to the site, yes?
A. No.
Q. And you said no systematic survey of caves or other karst features was undertaken prior to the deposition of ash in Sinking Creek?
A. That's right.
Q. And isn't it true that that location where the Ash Pond Complex is was under water before the Ash Pond Complex was built? Correct?
A. Part of it was under water after the construction of Old Hickory Dam, yes.
Q. And your report doesn't discuss anything that may have happened in that area in the -- what would that be -- 14 or so years between the impoundment of the reservoir and the

construction of the Ash Pond Complex?
A. Yeah. In fact, it does, my original report does.
Q. I mean, at the Ash Pond Complex per se. I know you talk about other parts, about the impoundment of the reservoir, but you don't discuss at the Ash Pond Complex what may have happened in that vicinity after the impoundment of the reservoir?
A. Yeah, I do. Because I discuss the -- the -- water very highly probably -- the conduits leading from the Ash Pond Complex to the Cumberland River and what happened during that time.

So I'm not sure how to discriminate between the Ash Pond Complex, where the Ash Pond Complex stops and before the conduit starts. It's the same system, and I discuss that.

Q. Well, let's talk about the Ash Pond Complex for a second then.

In your report you state that hydrogeology refers to the science of how underground water is distributed and moves the soil as soil water and rocks as groundwater beneath the Earth's surface, yes?
A. That's right.
Q. Okay. And groundwater is defined in EPA's karst lexicon as the part of the subsurface water that is in the phreatic zone, correct?

A. That's correct.
Q. And that definition in the EPA karst lexicon also says that the term is sometimes loosely and incorrectly used to refer to any old water beneath the surface?
A. What? The term "groundwater"?
Q. Yes, the term "groundwater."
A. Yes, but "loosely" doesn't mean correctly. Typically, groundwater is considered to be in the phreatic zone, yes.
Q. Below the earth's surface?
A. No, below the water table. Typically, groundwater is considered to be that below the groundwater -- beneath the water table in what you just called the phreatic zone.
Hydrogeology refers to that and -- hydrogeology refers to that below the surface. Groundwater typically refers to that below the water table.
Q. I'm sorry. We're talking about below the land surface?
A. Can you ask me again what you're asking about? I mean, the -- your question.
Q. I think you said that -- distinguished between groundwater and the water table, and I was asking whether or not we're talking about below the land surface, the physical land surface?
A. Groundwater is typically defined technically as that below the water table.
Q. Which is below the physical land surface?

A. Not always, no. In fact, not at the Ash Pond Complex.
Q. So it can exist --
A. The Cumberland River represents the water table, yes.
Q. What's that?
A. Well, no. Well, are you asking -- I'm sorry about my confusion about your question.

Groundwater is underground, below the water table.

Q. That's what I was asking.
A. I got confused in your question. The water table is not necessarily below the groundwater level.
Q. I meant that it's below the physical surface of the earth.

It's not in the air, for example?

A. The water table or groundwater?
Q. Any of it.
A. That's two different answers. The water table may be above or below the ground surface. Groundwater is below the ground surface.
Q. The water table can exist above the land surface?
A. Old Hickory Lake represents the water table, yes.
Q. Right. Right. Above the land surface; I'm talking about above the ground.
A. Yes.
Q. And so you said in your report that the most prominent landscape feature on Odom's Bend Peninsula is the Valley of

Sinking Creek.
A. In my opinion, that's correct.
Q. And that's the current location of the Ash Pond Complex, yes?
A. Yes.
Q. And you've testified that historically the surface stream bed of Sinking Creek was mostly dry, yes?
A. Yes.
Q. And that would be consistent with what's reflected in your report, which is a 1930 Corps of Engineers survey map that shows it as an intermittent drainage feature?
A. Well, there's some confusion of the terms. Sinking Creek itself is a -- is a dry valley. The -- the term "intermittent drainage feature" came from Dr. Kutschke's reports, and I'm not exactly sure about some of the terminology that was used.

The Valley of Sinking Creek was formally a dry valley because of the nature at the top of the karst bedrock beneath it.

Q. I was just asking you about a question about maps symbology. So we don't have -- that's fine.

And you said that the Carters Limestone that underlies the Ash Pond Complex transmits groundwater comparatively easily and rapidly through numerous fractures and other conduits, correct?

A. Yes, typically, that's correct.
Q. And you testified that at Gallatin there's no impermeable bottom lining or bedrock layer below the ash ponds, correct?
A. No. Well, in fact, there's a small one in the Carters Limestone, but it's not relevant to the discussion. But underneath the -- the ash pond is no -- nothing that acts like a liner or impermeable layer.
Q. That's what I was asking.
A. Right.
Q. And then you state (as read):

> Because of sinkholes, lineaments, voids, and potential caves and sinking creeks, the bottom of the Ash Pond Complex is more like a colander than a liner.
>
> Yes, sir?

A. Yes, I said that.
Q. Okay. However, would you acknowledge, Dr. Groves, that there is boring data that shows a clay lining between the top of rock and the bottom of the Ash Pond Complex?
A. Not everywhere, no. There's some clay in there. But no, there's not a continuous -- there are places where the ash is sitting on bare rock.
Q. Right. So my question is, wouldn't you acknowledge there is clay in places between the bottom of the ash pond

and the top of the rock at the Ash Pond Complex?
A. There -- yeah, there is some clay in there, but that does not create an impermeable liner.
Q. That's my question. And in 2010, Stantec found that native soils underlie all ponds, and the thickness varied from 1 to 30 feet thick; isn't that correct?
A. I -- I'm familiar with the Stantec report, but I don't remember that particular comment --
Q. Okay.
A. -- or that observation.
Q. Let's look at it.
A. Bless you.
Q. Sorry about that, Dr. Groves. I just got these exhibits today.
A. I'm not going anywhere.
MR. AYLIFFE: And I believe for the record, Your Honor, we're looking at Joint Exhibit -- I think it's 66, which is the 2010 Stantec report.
Q. Can you see that, Dr. Groves?
A. Yeah. If I squint.
Q. And wouldn't you agree with me right there that Stantec said (as read):
> The thickness of the native soils above the bedrock across the pond complex range from as little as about 1 foot or less to as much as

20 feet?
A. I agree that's what it says, but that's inconsistent with the data in the report. Because there are places where the ash is in contact with bare rock, which means that the soil would be -- have zero thickness.
Q. And it says most thicknesses are from about 10 to 25 feet?
A. Yeah, I agree that that's what it says.
Q. Let's look at some of the borings then.
Let me show you a map. This is from one of the appendices to the Stantec report.
A. Okay.
Q. It's the Maptech drilling plan.
Have you seen that before?
A. Yeah. If it was in -- that's the 2010 Stantec report?
Q. Yes, sir.
A. Yeah, I would have seen that.
Q. And do you see there boring Number 13, which is in Pond E?
A. Could you highlight that in yellow, please?
Q. Sure.
A. Okay. And I'm sorry, which number did you say that is?
Q. B13, B, as in bravo?
A. Okay.
Q. Do you see them there?

A. Yeah.
Q. And there's the log for B13. Do you see that? I'll highlight it for you.
A. Yeah. Thank you.
If I may say something to the stenographer, if I start speaking too quickly in any of the answers, please feel free to let me know.
Q. If I'm reading that correctly, Dr. Groves, that looks like approximately 12 feet of clay between the bottom of ash and the top of rock all the way down to elevation 4,340; is that correct?
A. It's hard for me to read, but I believe that's correct, if you say so.
Q. Okay. Then I'm going to show you B9, and that's right here also in Pond E.
A. Uh-huh.
Q. And wouldn't you agree with me, sir, that that shows about 35 feet of clay beneath the bottom of the ash and down to the top of rock, all the way to the approximate elevation 429?
A. Again, it's hard for me to read the details, but I believe that's correct, if you say so.
Q. You don't mention any of those borings in your report, do you, sir?
A. As far as I recall, not the two that you're referring

to, the two federal ones.
Q. You also didn't cite in your reports or your testimony Stantec's discussion in 2010 of the karst activity at Gallatin; isn't that correct?
A. I -- yeah, again, if you say so, I believe that -- yeah. I don't remember the detail. I believe my -- my discussion with Stantec was largely to do with drilling.
Q. If I could point your attention, Dr. Groves, there to that middle paragraph and the "Karst Activity" section. And it says that (as read):

> The recent expansion of Pond E was constructed over sinkholes which were reportedly mitigated during construction.
>
> Isn't that correct?

A. Yes.
Q. And it said approximately ten areas were mitigated, correct?
A. That's what it says.
Q. And it says that mitigation activities were reported to include pumping the pond dry, correct?
A. That's what it says.
Q. And it noted no backflow of water, correct?
A. That's what it says.
Q. You didn't cite any of that in your reports in this case, did you, sir?

A. No.
Q. Or in your testimony here?
A. No, sir.
Q. Okay. And at the bottom, if I could direct your attention to where I have the orange dot. That paragraph reads (as read):

> A small sinkhole appeared within the low-lying area just north of the Pond B saddle dike.

Do you see that?
A. Yes.
Q. And you mentioned -- you mentioned this occurred in 2010.
Do you see that?
A. Yes.
Q. And that's one of the things you said here this morning, that there was a sinkhole in 2010, correct?
A. Yes, I listed that. Uh-huh.
Q. And Stantec said that didn't occur inside the Ash Pond Complex, correct?
A. That could -- yeah, I believe that's correct.
Q. Okay. And that last sentence in the Stantec report from 2010, it says that (as read):

> Other than what was mentioned above, Gallatin has not experienced any known additional karst-related problems within the ponds in recent

years.

Correct?

A. That's what it says, yes.

Q. And you didn't cite any of that in your reports in this case?

A. No, apparently not.

Q. Nor in your testimony here before this Court?

A. No, sir.

MR. AYLIFFE: Okay.

THE COURT: And before you move on, is the Stantec report Joint Exhibit 66?

MR. AYLIFFE: 66 or 67. 67, Your Honor.

Q. So it would be fair to say, Dr. Groves, that your colander analogy ignores the Stantec data, correct?

A. I would not characterize it that way. No, I didn't have those data in there. I wouldn't say they were ignored.

Q. So let's talk a little bit about the history of the Ash Pond Complex leakage.

A. Okay.

Q. In the 1970s, there was documented water loss at the Ash Pond Complex through karst features, correct?

A. That's correct.

Q. Now, I noticed in your testimony here this morning that you switched back and forth between water loss and waste loss.

Do you recall that?
A. Well, I believe I said that, yeah. I don't remember the exact words.
Q. And what the reports actually said is that there was water loss, correct?
A. Sluiced water, yes.
Q. Ash sluiced water, yes, sir.
A. Yes.
Q. It didn't say that coal ash waste was lost, did it?
A. If -- to the extent there's a difference between sluiced ash water and coal ash waste, if there's a difference, that difference is lost on me.
Q. You would agree it says "ash sluice water," correct?
A. Yes.
Q. Doesn't say ash was lost, does it?
A. No. That says "ash sluice water."
Q. Thank you. So then your statement in the graph chart that you showed earlier about it being one of the worst waste losses in US history is inaccurate, yes, sir?
A. Again, I -- if there's a difference between coal ash sluice water coming from the plant and coal ash waste, that difference is not clear to me.
Q. And that wastewater that went through sinkholes would have gone out the outfall had it not gone through the sinkholes, correct?

A. Can you repeat that?
Q. The ash sluice water that was lost via karst features would have gone out the outfall?
A. If it wasn't leaking through the bottom?
Q. Yes, sir.
A. Yeah. If it was not leaking, I presume it would have gone through the outfall, yes.
Q. Thank you.
And into the Cumberland River?
A. From the outfall into the Cumberland River, yes.
Q. Thank you.
Now, you testified that although -- you testified that, although leakage from the ash ponds has been at least partly ameliorated by plugging some of the sinkholes, there is no evidence that all leakage has stopped.
A. That's correct.
Q. And in your report discussing the Ash Pond Complex in the 1970s, you mentioned that the pond did not reach the elevation of the planned outfall, correct?
A. That's correct. Well, between 1970 and 1978.
Q. Yes, sir. And you said it fluctuated with that of Old Hickory Reservoir?
A. That's correct.
Q. And you said that was evidence of a direct connection through one or more surface conduits?

A. Yes, subsurface conduits.
Q. Subsurface conduits, thank you.
And in another part of your report discussing the Ash Pond Complex in the 1970s, you said that not only did the pond's level not reach the elevation of the spillway over that time --
A. Okay.
Q. -- but it also fluctuated with the level of the Cumberland River, showing a direct hydrologic connection?
A. Yeah. I believe I said that, yeah.
Q. That would be the pond level responding to the river level, correct?
A. Yes. I think that's correct.
Q. And you're aware, sir, aren't you, that there's hydrograph data that goes to this issue of pond levels and river levels --
A. You mean recent data?
Q. I mean data that's been available in this case, yes, sir.
A. Yes, there is. Yeah.
Q. And you presented some of that data at a Geological Society of America conference in Denver, Colorado, in September of 2016?
A. Yes. I gave a presentation about it -- I don't remember discussion about the hydrograph data, but I may well have,

yes.
Q. Okay. And that was with Mr. Quarles; is that correct?
A. That's correct. He was a coauthor.
Q. And I noticed that nowhere in your reports do you discuss the hydrograph data.
A. No.
Q. Okay. And nowhere in your testimony today do you discuss the hydrograph data?
A. No. But I'm happy to.
Q. And one of the other things I wanted to ask you about about your presentation to the Geological Society of America was that you show what happened in the '70s at the Ash Pond Complex as a historical event, correct?
A. As a what?
Q. Historical event?
A. I didn't use the word "historical." So I'm not sure what you mean.
Q. Well, you said that it occurred from approximately 1970 to 1978; isn't that right?
A. That's correct.
Q. Okay. Does that look like your slide show, sir?
A. Yeah, that is the first slide. Uh-huh.
Q. Okay. Would that be some of the monitoring well data that we talked about? Yes, sir?
A. Yes. Uh-huh.

Q. And you didn't include any of that in your reports in this case?
A. Yeah, I did subsequently. Yeah. Not in these two, but I did in the state ones. In fact, this report came --
THE COURT: You need to talk up when you're not at the microphone.
MR. AYLIFFE: Yes, sir.
THE COURT: I'm hearing you, but. . .
THE WITNESS: Well, no. In fact, the -- that water level data --
THE COURT: Wait a minute. I don't know if there's a question.
THE WITNESS: I'm sorry. Could you ask the previous question again? You asked whether I had included that data in my direct testimony. And, in fact, I did.
BY MR. AYLIFFE:
Q. And there you multiplied the water loss by 8.6 years, correct?
A. Yes. That's 6,000 gallons per minute times 8.6 years.
Q. That's, I believe, the 22nd slide of your presentation, correct?
A. I don't remember what number slide it was.
Q. And that's a partial quote from TVA's October 14th, 1977, ash pond inspection memo?
A. That's -- I believe that's correct.

Q. Okay. And --

Your Honor, I apologize. That's Defendant's Exhibit 50, but I do not have the joint exhibit number.

I believe it's Joint Exhibit 42.

And the part that you've omitted from your presentation was this paragraph here, correct?

A. No. I gave that during the presentation. I said that when they were repaired, it went over the outfall. That -- what you're showing are the PowerPoint slides. That is not the text of my presentation.

Q. You didn't put this particular quote in your reports in this case, correct?

A. Not as a PowerPoint slide, no, the text is not up there.

Q. Didn't include the quote at all?

A. No. In a presentation, the PowerPoint slides is a backdrop to the verbal information I'm providing.

Q. Right. I'm asking about your reports in this case.

You didn't include this information in your reports in this case?

A. Of course I did. I said that they repaired -- they partially repaired the sinkholes in 1978. The water went over the outfall. That's exactly what that statement says.

Q. And they were sealed with stones and a mixture of coarse and fine ash and earth?

A. I said they had been partly repaired. I did not put the

detail of how they repaired them.
Q. Very good. The only thing I believe you talked about this morning, Dr. Groves, is a 1982 Groundwater Report.
A. Yes. Uh-huh. I'm familiar with that. I'm presuming the one by Steven Young.
Q. This is Joint Exhibit Number 44, "Potential Groundwater" --
A. No, that's not the one I was thinking of. Yeah. This one I mentioned in passing, yes.
Q. You mentioned that this morning, yes, sir?
A. Actually, let me -- can you tell me which number that I did?
Q. Paragraph 69.
A. I'm sorry?
Q. Paragraph 69.
A. Oh, okay.
Q. That's the one?
A. I believe so. Yeah. That's --
Q. Okay.
A. Yeah. Uh-huh.
Q. 1982, reported that no problems with leaks from the pond are known, correct?
A. That's what that says.
Q. You didn't mention that this morning either, did you?
A. No, sir.

Q. Okay. And you told TDEC in the reports you submitted in the state case that you don't know whether there's water leaking from the Ash Pond Complex?
A. No. Actually, during those reports I've been quite cautious to -- it's been very -- it's aptly sure to me that it's into the groundwater. During my reports, through the federal ones and the state ones, I've been very, very cautious to say that it's very probable that it's going in the Cumberland River.

Since the last report I've written, there is an exquisite dataset from the EIP that has made me absolutely certain --

THE COURT: I need you to slow down. I need you to slow down.

THE WITNESS: I'm sorry. Excuse me.

THE COURT: Go back to -- you said --

THE WITNESS: Yeah.

THE COURT: -- "It's very probable."

THE WITNESS: Yeah, so during my reports, including the federal and state ones, I have been very cautious to say that it's very highly probable that the water's going to the river, but I have not said 100 percent.

Since then, since the last report I wrote, very recently we've gotten data from the state EIP investigation, which is a wonderful dataset that has -- that has really

convinced me that this is the case. So I'm more sure now than I was at the time that I wrote those reports.
BY MR. AYLIFFE:
Q. Still yet, you've never been on site to actually see any of it, correct?
A. As far as the karst, there's nothing to see because it's covered with ash.
Q. But you've --
A. But no. I'm sorry. Excuse me. I have not on the site, on the property.
Q. You've not been involved in the EIP work that's been ongoing?
A. I have reviewed the plans but I have not been in the field or otherwise. Just seeing the data.
Q. That was my question. Thank you.
Now, in your rebuttal report in this case, you state that at the 2006 -- or in 2006, rather, you published two chapters in a book called "Methods in Karst Hydrogeology"?
A. That's correct.
Q. And I believe you published Chapter 4, correct?
A. Yeah. I think that's right, yeah. I'm not sure of the chapter numbers.
Q. I'm going to ask you a couple questions, Dr. Groves, about the intro to the textbook --

A. Sure.
Q. -- and then your chapter specifically.
A. That's fine.
Q. In the introduction to the textbook which you -- to which you contributed, it says, "The karst" --
A. Just to make sure, this intro was written by the editors and not me. Is that -- you're talking about the introduction?
Q. The introduction by the editors, yes, sir.
A. Right. Okay. Thank you.
Q. And in that textbook to which you contributed, it says that (as read):

> Karst aquifers require specific investigation techniques because they are different to other hydrogeological environments.
>
> Correct?

A. That's correct.
Q. And one of the things the textbook says is that it's difficult to draw potentiometric maps on the basis of water level measurements in wells or piezometers, correct?
A. That statement says it, but it -- in some places it is; in many places it's not.
Q. And it says that (as read):

> Karst aquifers are often characterized by a rapid and strong reaction to hydrological events?

A. That's correct.
Q. And down here it says (as read):
Continuous monitoring devices are particularly useful in karst systems?
A. That's correct.
Q. (As read):
For example, devices that monitor discharge, temperature, conductivity, et cetera?
A. Again, I -- I have trouble reading the text, but I'm very familiar with the material, and that is correct.
Q. You would agree with it?
A. I agree with that.
Q. That's your chapter, right?
A. Yes. It looks like it. One of the two.
Q. And you say there on page 46 that (as read):
The first challenge in any basin-scale karst hydrologic investigation is delineating the basin?
A. That's correct.
Q. And you say this is done by three primary methods, correct?
A. That's correct.
Q. Exploration and survey of caves?
A. That's correct.
Q. Potentiometric surface mapping?
A. That's correct.

Q. And one of the most important methods in karst hydrology, groundwater flow tracing with fluorescent dyes?
A. That's correct. But, again, it depends on the details of the particular setting. Those aren't the only three.
Q. Oh, and this is something I believe you said this morning.
You said there's a single fundamental basis for hydrologic analysis is the concept of water balance?
A. Yeah, in my opinion. Somebody might argue what the most fundamental idea is. In my opinion, the water balance is among them.
Q. And you say there that methods for evaluating karst hydrology continue to evolve?
A. Yeah, that's correct.
Q. And you said one of the most important technological advances has been the implementation of electronic datalogger probe setups?
A. That's correct.
Q. Which can be installed remotely throughout the karst drainage system?
A. Correct.
Q. In both the surface and the subsurface?
A. Yep.
Q. And these record flow, temperature, chemical, and other data?

A. That's right.
Q. Next I want to ask you, Dr. Groves, about an article that you wrote, I believe in 2008. It's entitled "Water Quality Impacts from Agriculture Land Use in Karst Drainage Basins of Southwest Kentucky and Southwest China."
A. Actually, one of my grad students was the first author; I was the second author.
Q. You list it in your references, correct?
A. Which references?
Q. In your -- attached to your direct testimony statement.
A. If I did, I don't recall. My -- my -- to my testimony? Yeah. I didn't recall that, if I did. Yeah, actually, I may have. I think that -- if I did, it was just referring to the -- to the vulnerability of karst aquifers to contamination.
Q. I wanted to ask you a couple questions about it, if I may.
A. Sure.
Q. You recognize that article, correct?
A. Yep.
Q. You say there that (as read):

> Modeling of groundwater flow and karst aquifers has not progressed very much over the last 20 years?

A. Yeah. And specifically I mean numerical modeling with

computers.
Q. And you say, though (as read):
Recently, water budgets, tracer studies, hydrograph analysis, and chemograph analysis have been used for characterizing karst aquifers?
A. That's correct.
Q. And for that study, I believe you said that that involved taking a karst hydrogeologic inventory, correct?
A. The study that you just had up there?
Q. Yes, sir.
A. Yeah, that would have been involved, yeah.
Q. And you said it involved hiking through the watershed, correct?
A. That typically is what happens and probably -- well, in that case, that did. Sure.
Q. And you also mentioned that two dye traces were conducted to determine connections?
A. I believe so. It's been a number of years, but I believe that's correct.
Q. And you said that dataloggers were established at certain points recording stage, temperature, pH, specific conductance?
A. I'm trying to remember the exact data, but I believe that's correct. Yes. If it's -- if that's what's in the paper, it's correct.

Q. And you've not performed a water budget for this case, have you?
A. For Gallatin?
Q. Correct.
A. No. I have not had access to the requisite data.
Q. And you didn't analyze any of the available hydrograph data?
A. Yeah, I did.
Q. You didn't conduct any field investigations?
A. No. I didn't have access to the facility.
Q. And you performed no dye trace work, correct?
A. No.
THE COURT: Again, just speak louder. You performed no what?
MR. AYLIFFE: Dye trace work.
THE COURT: And your answer?
THE WITNESS: My answer is no, that I have not conducted dye trace.
BY MR. AYLIFFE:
Q. Dr. Groves, one of the last portions of your testimony that you read from this morning were some of your opinions on the cap enclosure of the Ash Pond Complex?
A. That's correct.
Q. But according to the 25-page CV attached to your testimony, you've never designed a cap system, correct?

A. No, I haven't.
Q. Okay. And you've never installed a cap system?
A. No, I've never installed a cap system, no, sir.
Q. And you're not a licensed professional engineer, are you?
A. I am not.
Q. Yet you testified that installing a cap over the disposal areas will not stop contamination of the groundwater or surface water?
A. I said -- well, groundwater beneath the Ash Pond Complex or the surface water of the Cumberland River; that's what I was referring to, yes.
Q. And you opined in your rebuttal report that clean closure of the Ash Pond Complex is the most appropriate strategy?
A. Well, appropriate in if the -- in the sense of protecting the quality of the groundwater and the Cumberland River, yes.
Q. Did you write that sentence, that term, "clean closure," in your report?
A. Yeah, I wrote all of my reports.
Q. Okay. I wanted to make sure.
It didn't appear anywhere in your initial report, did it?
A. No. If you say so, no.

Q. And you know the term "clean closure" is a term used in the CCR, correct?
A. I was using that -- yeah, I believe -- I believe that's the case, yes.
Q. And you're aware that the CCR rule does not allow professional geologists, such as yourself, to certify whether a closure plan complies with the CRR rule, correct?
A. I don't believe I was providing such certification.
Q. Do you dispute that?
A. Well, it depends what you mean by "certification." I said that I didn't believe that the cap in place would prevent contamination, and I believe that still.
Q. My question to you, sir, is the CCR rule doesn't allow professional geologists to make that kind of certification?
A. Well, I believe that if you say it. That was just based on basic understanding of hydrology and how -- just the -- how caps would function. But I believe that, yeah, if you say that, yeah.
Q. You believe me?
A. I believe that CCR rule says that, if that's what you say. My statement was just based on a simple understanding of the site.

MR. AYLIFFE: Thank you for your time, Dr. Groves.

THE WITNESS: Thank you.

MR. AYLIFFE: No further questions.

THE COURT: Any redirect?

REDIRECT EXAMINATION

BY MS. ALEXANDER:

Q. Dr. Groves, I want to clear up what you said about the Gallatin Steam Plant Cave in your written direct testimony.

A. Yes, ma'am.

Q. I believe that you said that you did not name that cave; is that correct?

A. No.

Q. Do you know who did?

A. No.

Q. And would it probably have been the person who discovered it? Or what who named the typical --

A. Probably in this case.

MR. AYLIFFE: Objection. Leading.

THE WITNESS: This is a case -- a cave that's right on the Cumberland River. It's a very large entrance. It's very obvious. So I imagine this is a cave that was known as far back as, you know, the -- you know, long -- you know, in the past. Probably the person that -- and it may have gone by many names in the past and probably has.

Who named the Gallatin Steam Plant Cave -- and I -- I'm simply speculating here, to make clear.

THE COURT: Let's not speculate.

THE WITNESS: Okay. No, I don't know who named

the cave.
BY MS. ALEXANDER:
Q. That's fine. But it wasn't you.
And you testified that you -- you've been to the entrance but you didn't go inside.
Can you tell the Court why you didn't go inside?
A. There's a gate, yeah. Plus there's federal endangered bats in there. So it's restricted access.
Q. I'm sorry?
A. There are federally endangered bats, so there's a restricted access and a gate on the entrance. So I didn't attempt to go in there.
Q. You included a photograph of the inside of the cave in your expert testimony.
A. That's correct.
Q. And can you explain to the Court why you included that photograph?
A. Because I was trying to illustrate the nature of karst development within the Carters Limestone. And it's on the other side of the river. But it's the Carters Limestone. It's exactly the same condition -- well, not exactly. It's very, very similar hydrogeologic conditions to -- right on the other side of the Cumberland River. And that illustrated the fact that, in fact, underground rivers do exist.
Q. Is there an underground river in the photograph?

A. Yes. Uh-huh.
Q. And there was also testimony that you just gave about the fact that you've never seen an inventory of caves on Odom's Bend Peninsula; is that correct?
A. That's correct.
Q. And can you explain to the Court why there might not be an inventory of caves?
A. Yes. Because -- I guess what you could call the -- let's say modern or systematic -- or let's say the modern era of systematic collection of data with regard to caves is something that started in Tennessee after the -- after the lake -- after the lake was formed and presumably after the plant.

THE COURT: Do you know if an inventory of the caves exists at all.

THE WITNESS: There is an inventory of the caves of Tennessee.

THE COURT: But you've never seen it?

THE WITNESS: There is not one for the Gallatin Plant. I am aware of the inventory of the caves for the state of Tennessee, and it doesn't list any on Odom's Bend.

THE COURT: Okay.

THE WITNESS: Yeah. Thank you, Your Honor.

MS. ALEXANDER: Would you pull up 312.

Q. Dr. Groves, can you describe your understanding of what

Figure 12 is to the Court?
A. I will say again, I don't have my glasses.
To the extent that I'm familiar with the figure, this was a summary -- I believe -- in 1978 that had been written by Dr. -- or coauthor -- or authored by Dr. Ungate for TVA that was essentially a karst inventory of the karst -- particularly sinkholes and leakage points for the area shown on the map.
Q. So there has been a karst inventory conducted of this area, correct?
A. Yeah. They didn't call it that, but that's exactly what they were doing, yes.
Q. Have you reviewed the boring logs prepared by AECOM in 2015?
A. Yes, I have.
Q. And was there evidence in those boring logs that caves exist under the Ash Pond Complex?
A. Yes, indeed.
Q. Can you describe that evidence to me?
A. There are -- I would have to look at the borings to remember the exact figures, but there are -- there are at least one -- I don't recall the details -- maybe more voids -- that are big enough for a person to walk through.
Q. Do you recall the size of those voids?
A. I would have to look at the data. Right off the top of

my head, I believe there was one that was about 8 feet, but I would have to go back and look. I believe -- yeah, there was one that was 8 feet.

Q. Let me grab those logs so you can look at them.

A. I'm sorry?

Q. I'm going to find the exhibits so you can look at them.

A. Yeah. Thank you.

Q. Is this the data package that contained the logs?

A. I believe it is. Yeah.

Q. And I apologize. Can you read that?

A. I -- I can make it out. You know, if I can -- I can squint. Yeah. Great. Yeah.

In fact, it's not necessary to do that for everything, but if there are certain key things, that would be very helpful.

Q. I don't have a paper copy of it in front of me. So I'll have to flip through it electronically to get to the right page.

No. Keep going. Sorry. Sorry. Technology can be. . .

THE WITNESS: Your Honor, if I may ask a question, am I allowed to make notes on my testimony?

THE COURT: It's not necessary.

THE WITNESS: Well, just things for later. But, yeah, that's fine. Thank you.

MS. ALEXANDER: Okay. If you could turn to Document Number TVGF107204. And can you enlarge the text at the bottom of that boring log. Yes.

Q. Dr. Groves, it says there's an apparent void, very high yield, estimated 200 gpm, which I understand means gallons per minute?

A. That's correct.

Q. Can you explain to the Court what that means to you?

A. Yes. One of the common techniques when -- related to drilling wells is measuring the connection of a well to the groundwater system. And in some cases, you might drill a well and the actual well, you know, the hole itself, may go completely through impermeable rock and not encounter any water.

In other cases, you may drill down and the bore hole would encounter -- let's say in this case fractures that are connected to the groundwater system. And there are various measurements -- there's various methods by which the -- one can measure for various intervals of the well, the connection of -- the interconnectedness, let's say, of that section of the well to the groundwater system.

And one of these involves pumping water out to see how much you can pump, you know, without the well going dry. The other involves something called a packer test, which we have great data on now from the EIP, in which you seal off a

certain section of the well and inject water. And if it's a totally tight, impermeable hole, the well will not be able to accept any water. If it's connected to the fracture system, all kinds of water can squish in.

Here, they're measuring the -- the interconnectivity. I don't know the method that they're using, but the gallons per minute is presumably how much they're able to draw from the well without the well going dry. And 200 gallons per minute is a very large figure.

Q. Can you give us some context as to, for instance, how many houses you would expect could maintain themselves from a well of that quantity of the water?

A. Yeah. Just as a very rough rule -- I don't know off the top of my head of a classification of low, you know, medium or high yields. But just a -- just rule of thumb is that about 5 gallons per minute is enough to supply a family home.

So this would be something like, you know -- is that 40 -- 40 homes would be enough. So that's a very good producing well.

In this case, it's not used for water -- water supply. But it shows that not only is there a good -- good conductivity to the groundwater system, but there is abundant water flowing through that zone of the bedrock, yes.

MS. ALEXANDER: Could you pull up 107211, please. And can you enlarge the text at the bottom.

Q. Dr. Groves, that says there is an apparent void zone, 6 feet. Water returning to the surface at approximately 200 gallons per minute.

Again, can you explain to the Court what you understand this boring log to mean?

THE COURT: Is that any different than the one he just explained?

BY MS. ALEXANDER:

Q. Well, is this similar to the one you just explained to the Court and --

A. I believe this is a different one that you just showed.

Q. Yes it is.

A. Yeah.

THE COURT: Is your explanation any different than the one we just looked at?

THE WITNESS: Yeah, I would add something if I may, Your Honor. The -- the concept of the gallons per minute is exactly what I explained before. So it's clear this well is very well connected.

The other thing this points out is this is what they call an apparent void zone. It's not exactly what they mean. But you can see this is 6 feet, and it says fist-sized chunks of limestone returned to the surface.

My interpretation is that this is related to a well-developed karst feature both for the -- the conductivity

to -- you know to the groundwater system, the size of the void, and the fact that there's chunks of limestone means that there is loose rocks down there somehow. If it was solid rock, you don't find chunks of limestone coming back up.

And so I was not present at that drilling, but my interpretation would be that that's a cave or a cavelike feature that includes pieces of rock that are there. There really isn't another process than the dissolution that creates these karst features to produce this kind of data.

BY MS. ALEXANDER:

Q. Dr. Groves, you testified that the wastewater that escaped the Ash Pond Complex during the eight years when it was leaking would have gone out the outfall if it hadn't been leaking, correct?

A. To the extent there's been questions about the terminology, let me say "the fluid" -- I'll say "wastewater," unless that's incorrect.

But yes, I testified that if it had not been leaking through the bottom, that it would have gone over the outfall as designed.

Q. It would have gone out the outfall after treatment through the settling process though; is that correct?

A. Treatment through -- well, the treatment by settling, that's correct.

Q. The wastewater -- the Ash Pond Complex itself is a wastewater treatment facility, correct?
A. I'm not an engineer, and -- so to the -- to -- I'm not -- with -- with the caveat of whether there's a technical definition of "wastewater treatment facility," my understanding is that it is.
Q. And is it your understanding that the wastewater that goes out the outfall comes from the top of the body of water or from the bottom?
A. My understanding is from the top of the settling ponds, yeah.
Q. There was some testimony about data reflecting that there are monitoring wells at the Ash Pond Complex that fluctuate with the river?
A. Yes. And if I may clarify my testimony --
THE COURT: There's no question.
Ask the next question.
BY MS. ALEXANDER:
Q. Do you need to clarify your testimony about that?
A. Yes. I'm not sure the correct answer -- the gentleman that was asking me questions I think said that I had not referred to the fluctuating wells in my testimony.
In fact, I did not in the shortened version, but I did in the full version. I just wanted to make sure that was clear.

Q. Thank you. And what is your understanding of the cause of those wells fluctuating with the river?
A. Well, the three wells that I was referring to are Well -- GAP, I think it was, or GAF -- I think GAP -- 006, Well GAP024 and Well GAP025. These are in a straight line in what I earlier called the groundwater trough in my testimony.

The wells -- well 6 is very close to the river. And you would expect, because it's very close, for there to be a fluctuation, a -- a correspondence, let's say -- similar fluctuation, if it's very close to the river, because there's a connection over that short distance. You know, through whatever materials.

The Well 24 and the Well 25 are much farther away from the river. And the fact that they are fluctuating with the river -- that is, the water level in the well is fluctuating with the river -- and I'd point out this is according to datalogger data which I have reviewed -- they are a significant distance away from the river. Other wells in the vicinity do not have that same fluctuation.

So what this means is, the only plausible explanation I would have is that there's a very clear -- bless you -- hydrologic conductivity between the river and those two wells.

Q. And that figure is Figure 18 in your expert testimony, the full version?

A. I don't recall the figure number, but that's with the three wells lined up. Yeah. Those are the three wells, Number 6 -- the three wells are the ones circled.

Q. Could you use your pointer and show the judge?

A. Oh, yeah. Thank you. Okay.

The three wells are Number 6 here, Number 24 here, Number 25 here. The full name was GAP00- -- or -025, but I'll call them 6, 24, and 25, noting that they're lined up right along the axis of the trough that I have been discussing today.

Well Number 6, you would expect that, because it's right close to the river, it's not surprising that there would be a correspondence under many conditions. What's more difficult to explain -- although not in this case -- is that there is a number of wells here away from the river. The other wells other than Number 24 here and Number 25 there do not correspond to the river levels. 24 and 25 do.

And the fact that as the river goes up, the well -- the water -- the water table goes up in that well; as the river comes down, it drops, this means that somehow they are communicating.

And with the other evidence that I gave in my testimony of other completely independent evidence that there is a major conduit and -- I would say underground river -- right along that axis. I think this is -- this is very

strong proof -- or not proof -- excuse me -- this is strong evidence to suggest a very clear hydrologic connection along that line.

Q. Thank you. And there was some testimony about presentations that you did where you extolled the benefits of doing certain modern tests to determine if there's a hydrologic connection, correct?

A. That's correct, including dataloggers, which were used here.

Q. Do you feel like you need to have additional information to conclude that this shows a direct hydrologic connection to the river?

A. No. No, I don't feel -- well, I -- I feel the -- the -- these -- the strength of my conviction that there is -- is based on just this alone, but -- but remarkably strengthened by the concordance of all other data that is relevant.

THE COURT: But if you had performed some of those tests in your publication, then you would be able to testify here today, "based on my testing," that was what your conclusions were --

THE WITNESS: Okay. Well, if I understand right, Your Honor, I would say that my experience in other settings in this kind of testing make me feel qualified to interpret these data.

THE COURT: That's not my question. If you had

performed some of the testing, the dye, for example, here -- if you had done that here, you would be able to testify from your own knowledge that these things are connected -- from your own testing.

THE WITNESS: Well, yes.

THE COURT: That would presumably have confirmed one way or the other the conclusions you have reached.

THE WITNESS: Yes. Well, I would answer that two ways, if I may, Your Honor. The first is, if I was able to perform the tests -- you know, if I was able to design and perform the tests -- a variety of tests based on my experience, my sense is it would confirm that connection.

I guess what I'm saying is, my interpretation of their collection of the data based on my experience of having collected similar data in other places makes me confident of my conclusions here.

THE COURT: All right. Thank you.

BY MS. ALEXANDER:

Q. And, Dr. Groves, when was this data collected?

A. If I remember right, I believe this was the AECOM 2015. I may be misremembering, but I think that's correct.

Q. Do you see that says "Kutschke 2016" on Figure 18?

A. This was -- if I'm remembering correctly -- correctly -- excuse me -- this came, including the table at the bottom, from Dr. Kutschke's expert report. And he in turn was citing

the -- if I'm remembering correctly -- the AECOM 2015 data.
Q. And if you were to do field work to confirm his data in this case, you typically wouldn't be the person who goes out into the field and drills the wells and determines -- or goes out and drills the well.
You could rely on somebody else to go drill the well and send you the data and you could interpret it; is that correct?
MR. AYLIFFE: Objection. Leading.
THE COURT: Well, it's been leading all day. Sustained. All morning, rather.
THE WITNESS: That means --
THE COURT: I sustain the objection.
You need to state it more as a direct question.
MS. ALEXANDER: I will.
Q. If you were to be given this data, could you interpret it effectively?
A. Yes, of course. As long as I don't have any reason to think that the data are incorrect, it's not necessary for me to collect them myself. I could very easily interpret these, yeah.
Q. You testified on -- when you were speaking with Mr. Ayliffe about EIP data that's been collected that confirmed some of your testimony.
What were you referring to?

A. A number of things. I think the -- there are several. And -- I guess what I mean by confirming my -- my conclusions with regard to groundwater flow at Gallatin, what the new -- the EIP data do, is that I had developed a -- what we will call a conceptual model, my understanding of how groundwater is flowing, particularly with regard to the Ash Pond Complex.

This was quite challenging because -- for two reasons in particular -- well, three reasons.

One is that understanding the hydrology of the site is quite complicated by the fact that Old Hickory Lake is there and that the aquifer has been flooded by the lake.

The second thing is the fact that there is such an enormous quantity of ash sitting on top of the whole place also means that it would be very difficult to do the types of studies that I would have if I was in charge of designing an experiment there.

The third thing is that the reason that I have not been involved in field work primarily is I don't have access to do that. And so I have relied on -- on the data -- on data that have become -- that have been available.

Now, this is relevant to the EIP data, the new data, because, over the last year or more, as detailed in my reports both to the federal case and the state, I have -- in my mind, with some difficulty, gathered data -- well, let me say with -- with --

MR. AYLIFFE: Objection. Narrative.
THE COURT: I really think he's not answering your question --
THE WITNESS: Okay. I'm sorry.
THE COURT: Hold on. Let me finish this time.
THE WITNESS: I'm sorry, Your Honor.
THE COURT: I heard the testimony on both direct and cross. He's -- he's really restating what he said. I'm not sure that's useful. But --
MS. ALEXANDER: Yes, sir. I'll move on.
THE COURT: I don't think this is effective at this point.
MS. ALEXANDER: I'll move on.
THE COURT: Okay.
MS. ALEXANDER: I would like to hand the witness, if I could, the next numbered plaintiffs' exhibit. And I don't have another paper copy with me, but we can pull it up on the screen.
THE COURT: If you don't tell me the exhibit number, it's no way the record's going to reflect what we're about to look at.
MS. ALEXANDER: It would be Plaintiffs' Exhibit 6, Your Honor, for identification.
Your Honor, it's not in the plaintiffs' --
THE COURT: I was going to say, it stops at 5.

MS. ALEXANDER: It's not in the plaintiffs' book. We didn't anticipate it being --

THE COURT: Is this responsive to cross?

MS. ALEXANDER: Yes, it is.

THE COURT: How so?

MS. ALEXANDER: Because Mr. Ayliffe asked Dr. Groves if there was information -- the line of questioning was he's lacking certain information --

THE COURT: Uh-huh.

MS. ALEXANDER: -- to draw his conclusions, and Dr. Groves replied, "There has been recent evidence that has confirmed all of the work that I've done, and I've reviewed it recently, and in -- and it is consistent with the conclusion that I've drawn."

THE COURT: He said it was the 2016 work, which was the subject of Ms. -- Ms. Davis's motion. Okay.

MS. ALEXANDER: Yes. My understanding from the pretrial conference is that we could ask questions about it and the Court would weigh that evidence --

THE COURT: Yeah. I don't think redirect is the time to get into that.

MS. ALEXANDER: Yes, Your Honor.

THE COURT: He made the point.

MS. ALEXANDER: We'll wait.

THE COURT: I mean, he answered the question, as

he answered it: "Truthfully, I relied on the 2016 data." That answered his question, "What did you rely on?"

MS. ALEXANDER: Do you mind if I ask him some questions without introducing the exhibit about the data --

THE COURT: As it pertains to he relied on the 2016 data, why don't we go from there.

BY MS. ALEXANDER:

Q. Okay. Dr. Groves, do you recall that you saw data from the work that's been done pursuant to the EIP to determine the surface water elevation at Exhibit E -- I mean --

MR. AYLIFFE: Objection. Leading.

BY MS. ALEXANDER:

Q. -- I'm sorry at Ash Pond E?

THE COURT: Yeah. He is objecting to the leading. You've been doing it all morning. So I didn't say anything, but you need to ask him a -- what -- a question that starts with "W."

BY MS. ALEXANDER:

Q. What is the recent EIP data that you have reviewed?

A. The recent data is a karst-appropriate hydrologic investigation of the facility.

Q. What information did it include?

A. There was additional -- well, that that's relevant to my testimony is additional drilling and water level data. And, in fact, I -- there's been a variety of -- of new data, but I

believe that the drilling and the -- the water level data are most relevant to my discussion.

Q. What specifically is most relevant about the water level data?

A. There's several things that are striking to me. One is that, from the previous data, I -- well, the first thing is in general -- and I apologize for my rambling answer before -- the point that I was trying to make is that the -- my understanding of the hydrogeologic conditions at Gallatin pieced together from 50 years of piecemeal investigations is very, very nicely confirmed by this excellent new dataset associated with the EIP.

The particular data -- the most striking data to me, one is the very, very clear confirmation of the groundwater trough that I had discussed in my testimony, which I think is quite important.

The other is the fact -- well, three things. Excuse me.

The second is the fact that the wells that were drilled in a way to describe the water -- the water table elevations and thus directions of groundwater flow for the Carters Limestone in the area of the Ash Pond Complex were almost identical to those in the Lebanon Limestone. The wells are drilled in a way where they can either say here are the conditions in this layer of limestone, the water

conditions, or this layer, the Carters Limestone and the Lebanon.

Q. What does that mean? Can you translate that for the judge?

A. A map that I showed earlier showed a map of the surface of the water table. From that, you can determine direction of groundwater flow.

When you have different layers sandwiched, as here is in Gallatin, the conditions may be different in the different layers or they may be the same in the different layers.

The -- the summary of that is that the new data showed that the groundwater -- the conditions of groundwater in the Lebanon are the -- the water level maps are identical -- nearly identical; they're very similar -- between the Lebanon and the Carters in the vicinity of the Ash Pond Complex. This means that it is the same water. The -- the Carters Limestone and the Lebanon Limestone, to the extent there is water in there, are simply one -- one hydrologic system.

Q. And what is the second thing that you thought was important?

THE COURT: You mean the third. He's done two.

THE WITNESS: The first one was the trough. The second was the concordance between the Carters and the

Lebanon.

And the third, which is quite important, is the fact that the -- is the concordance with the groundwater position maps and the pond maps, in particular Pond E. And my conclusion is that these maps show that the water in Pond E is the groundwater.

BY MS. ALEXANDER:

Q. Why do they show that?

A. You mean -- well, you mean how do they show that?

Well, that -- that -- at Pond E, they show groundwater elevations, and there are data on surface elevations, and they are the same. There is -- there -- well. . .

Q. And just to be clear, what does it mean that the elevations are the same?

A. That's a very important point, because -- I think an important point of the case --

THE COURT: Just tell her why it's important. Just answer her question.

THE WITNESS: It's important because one of the questions of the case is whether groundwater is contaminated. And an apparently legal question with regard to whether it's groundwater contamination is what is groundwater and what is not groundwater.

This shows that Pond E is the same as groundwater.

It's not possible to discriminate between the water in the pond is one thing and groundwater is another thing. The new data make it clear this is the same water.

MS. ALEXANDER: That's all I've got, Your Honor.

THE COURT: Okay. You can step down.

THE WITNESS: Thank you, Your Honor.

MR. AYLIFFE: Your Honor, if I may, just a brief recross.

THE COURT: Okay.

MR. AYLIFFE: I'll be very brief.

RECROSS-EXAMINATION

BY MR. AYLIFFE:

Q. Dr. Groves, in your redirect you were asked about this boring log, GAP005, correct?

A. Yeah. I didn't pay attention to which numbers they were, but if you say so, I believe that.

Q. And these are from the AECOM 2015 boring logs, correct?

A. I believe so, yes, sir.

Q. And that's the location of GAP005, correct?

A. I don't recall, but if you say so, I believe that's correct.

Q. And this is the Ash Pond Complex over here, correct?

A. That's right.

Q. The other log you were asked about was GAP007.

A. That looks like -- that's correct.

MR. AYLIFFE: And, Your Honor, for the record, this is -- this is part of Joint Exhibit Number 97, the logs, but the map is part of Defendant's Number 76.

Q. And GAP7, Dr. Groves, is up here, up the bank and across the road from the Ash Pond Complex, correct?

A. That's correct.

Q. Now, you also testified on redirect that there was an excellent dataset that has been developed, correct?

A. I would say so. I would call it that, yes.

Q. And that was developed by AECOM, correct?

A. I believe so, yes.

Q. In particular, Dr. Walker Kutschke?

A. Yes. I -- well, I don't know who's done what, but I did see that he was -- had -- was the name on the report, so yes.

Q. The karst inventory data?

A. Yes.

MR. AYLIFFE: Nothing further of this witness.

THE COURT: All right. You can step down now.

THE WITNESS: Thank you. And Your Honor, I appreciate your patience.

THE COURT: Thank you for your time.

MR. AYLIFFE: Your Honor, if I may, the rule has been invoked, if the witness can be instructed to --

THE COURT: You shouldn't have any discussion about your testimony with anyone else who is going to be a

witness here.

THE WITNESS: That's fine. Thank you.

THE COURT: So the next -- plaintiffs' next witness is Mark Quarles?

MS. ALEXANDER: Yes, Your Honor.

THE COURT: Okay. And just so our record is clear, is it -- is it the parties' intention that Mr. Groves's testimony, Document Number 163 -- is the Court to consider this entire document? Or just the parts I heard?

MS. ALEXANDER: It's the entire document, Your Honor.

THE COURT: That's what I thought.

Do you agree?

MR. AYLIFFE: That was our understanding as well.

MS. ALEXANDER: I'm sorry. Yes.

THE COURT: So you all need to figure out how we're going to make that part of the record, but we've got some time to do that. Because right all now we have in the record what he said. You don't have the entire document here.

MS. ALEXANDER: Can I make a motion to move that into evidence?

THE COURT: Yeah. I think that's going to be a problem on both sides. So you all can figure out how to do that.

MS. ALEXANDER: Yes.

MR. AYLIFFE: Yes.

THE COURT: All right. Anything else we need to take up before the lunch break?

(Whereupon Plaintiffs' Exhibit 17 was marked for identification and received in evidence.)

MR. CHASE: Yes, Your Honor. Just an administerial item. When you ruled this morning on the admission of Defendant's Exhibits 8 through 11, there is a typographical error and it should have been Defendant's Exhibits 8 through 12. So Defendant's Exhibit 12 is included in that collection.

Those are the administrative appeal documents.

THE COURT: All right. Do the plaintiffs agree with that?

MS. ALEXANDER: I believe that's correct, Your Honor.

THE COURT: Okay. Then I'll -- 8 through 12 then are admitted.

MR. CHASE: Yes, Your Honor.

THE COURT: You're going to do Mr. Quarles -- Dr. Quarles after lunch?

MS. ALEXANDER: I think that would be our plan, Your Honor. That would be our preference, if it's okay with you.

THE COURT: I'm sorry?

MS. ALEXANDER: That would be our preference, if it's okay with you.

THE COURT: Oh, yeah. It's fine with me. It's your case. I will say, let's -- let's -- as you're prepping the witnesses on both sides, it's good to get the explanations, I do want that, but it's more helpful to answer the question.

I think we all admit Dr. Groves -- or Mr. Groves or whatever -- sort of rambled there. And it makes it extremely hard -- sometimes he never even answered the question. He's -- so we need to get our witnesses on both sides -- you know, answer the question, then explain. Yes, no, explain. It's a lot easier to follow. And then it sort of flows better too.

Is that okay? Does that make sense?

MS. ALEXANDER: It makes perfect sense. Sometimes, Your Honor, professors are really fond of explaining. So I apologize that he rambled on.

THE COURT: And I think that applies for both sides.

Okay. Well, let's break until 1:30. Is that enough time?

MS. ALEXANDER: That would be great.

MR. AYLIFFE: Yes, Your Honor.

THE COURT: Okay. Thanks.

(Whereupon a lunch break was observed.)

THE COURT: All right. Be seated.

Before we bring up Mr. Quarles, I just -- I've got Attachment A, which is Joint -- parties' Joint Exhibits 1 through 276. So that tells me about the first 11 books, right?

MS. ALEXANDER: Yes, Your Honor.

THE COURT: Okay. Right?

MR. AYLIFFE: Yes, Your Honor. I think that's correct.

THE COURT: What are these books, these defendant trial exhibits and plaintiffs'? Are these duplicates of what's already over here?

MS. ALEXANDER: I'm not 100 percent sure, Your Honor. But what we have is a book of joint exhibits -- or a group of books --

THE COURT: You have 11, to be exact.

MS. ALEXANDER: And then we have plaintiffs' and defendant's, as we were instructed.

THE COURT: Are these duplicates? Are these books -- are these exhibits already in 1 -- in Volumes 1 through 11?

MS. ALEXANDER: No.

THE COURT: No.

MS. ALEXANDER: I think those are the individual parties' books, and the other ones are the joint.

THE COURT: Okay.

MR. CHASE: Your Honor, I can speak for the defendants. The defendant's exhibits have the exhibits that you ruled upon this morning, as well as just the reports --

THE COURT: Of the experts.

MR. CHASE: -- of the experts. Not the filed in the case, but the reports that were filed in discovery, if necessary to reference -- for your reference during the examination.

THE COURT: And then I should look at the joint exhibits through the testimony; is that right?

MS. ALEXANDER: That's right.

THE COURT: Until you tell me otherwise.

MS. ALEXANDER: Yes, Your Honor.

THE COURT: Okay. Thank you. All right.

Mr. Quarles.

Ms. Alexander.

MS. ALEXANDER: Yes, sir.

THE COURT: Would you all have any objection that before we end the day, we might get Mr. Ayliffe --

MR. AYLIFFE: Mr. Ayliffe.

THE COURT: -- Ayliffe -- close -- would you mind if he replayed the video, but this time tell me what I'm

looking at?

MS. ALEXANDER: Not at all.

THE COURT: Okay.

MARK QUARLES,

called as a witness by Plaintiffs, was duly sworn and testified as follows:

THE COURT: Pull it towards you. Yeah. That's good.

MS. DAVIS: I might just step over here so I can see above the podium.

THE COURT: They told me y'all wanted the big podium.

MS. DAVIS: Your Honor, with Mr. Quarles, I know that you stated earlier that you had read all the expert witness testimony.

THE COURT: Well, let me correct. Yes, I haven't read his. I thought I was going to get at least a day's notice and that was going to be my homework, but that's okay.

MS. ALEXANDER: Well, Your Honor, what we would do, it is rather lengthy. And I had planned to just have him read select portions of it. And then if Your Honor has any questions after that about particular portions -- and then, of course, he'll be subject to cross-examination.

THE COURT: Okay.

MS. DAVIS: But we would like the entire testimony

admitted as part of the trial record. And the same is true of Mr. -- Dr. Groves, who just testified.

MR. AYLIFFE: Yes, Your Honor. I think that that would be helpful.

One of the things that we still need to do, because the joint exhibits were just solidified last Friday, we need to go through and put our correct numbers and our direct testimony statements.

THE COURT: Okay.

MR. AYLIFFE: And I think we would propose maybe some kind of oral stipulation to the ECF document numbers as to those direct testimony statements.

THE COURT: And that will be true for both sides. You can enter -- and we'll make sure we've read -- and you can cite in the posttrial findings from the complete version of the expert testimony.

All right. We've already agreed that you're qualified under 702 to give an expert opinion.

DIRECT EXAMINATION

BY MS. DAVIS:

Q. Okay. Good morning, Mr. Quarles, or good afternoon. I would like to ask you to skip over the portion of your direct written testimony -- skip over the portion that deals with your qualifications and some of the background information, the geographic information.

If you would go directly to paragraph 24 of your report.

A. Okay. Paragraph 24.

The current conditions for the Gallatin Plant with its land disposal units are illustrated below. This is a map prepared by SELC and includes:

Number 1, an accurate depiction of the Gallatin site current operations at the time the complaint was filed;

Number 2, overlay of sinkholes at the site contained in the report prepared by Steven C. Young in 1992 entitled "Impacts of Gallatin Fossil Plant on Groundwater Resources";

And 3, the location of TVA monitoring wells and independent sampling sites.

It's a true and accurate compilation of this information.

For the Court's convenience, I will refer instead to a demonstrative exhibit which overlays sinkhole data onto a stipulated map titled "Odom's Bend Peninsula and Gallatin Fossil Plant."

Q. And is that the map up there, Mr. Quarles?

A. It is.

Q. And could you point out the features on it, please?

A. So this map shows the Odom's Bend Peninsula with the Cumberland River on three sides, the east, the south, and the

west. The power plant, the coal pile, the original -- what's called the nonregistered site or the abandoned ash disposal area down here. And then what is referred to as the Ash Pond Complex, which is the large area up here.

And then, for reference, this is Odom's Bend Road along the north, and there are -- in the red dots there are some private wells that are located there.

So the area on the -- the western side of the Ash Pond Complex is Ash Pond E. In this area here is Pond A. Then we have a series of stilling ponds from B, C, and D. And this entire Ash Pond Complex began as a single surface impoundment.

Q. Thank you, Mr. Quarles. Can I ask you to skip to paragraph 33. And Dr. Groves has already testified to some background information, so I don't want to repeat it. But if you would skip to paragraph 35.

A. Paragraph 35?

Q. Paragraph 35. Sorry. Yes, sir.

A. Later topographic maps confirm that the Sinking Creek stream valley that eventually became the Ash Pond Complex was inundated around 1954 during the impoundment process that created Old Hickory Lake.

The impounded conditions are illustrated on Joint Exhibit 65, a United States Geologic Survey quadrangle map, 1955 photo revised below.

As the river was dammed, its elevation rose to an average pool of 444 to 447.5 feet msl, which means mean sea level. Areas below that level, both in the Ash Pond Complex and the NRS, can be identified as they're now covered with water.

So if you will blow up the area specific to the Odom's Bend -- the peninsula. Right through here.

So what this illustrates, if you look -- starting at the bottom -- all right? -- it says "Spillway Elevation 445," which is the -- kind of the middle-of-the-road normal pool between summer pool and winter pool that's typically exhibited on a USGS topographic map.

So what it illustrates is, with the impounded conditions, Sinking Creek stream valley has now become part of Old Hickory Lake. And so the waterline that you see at this spillway elevation of 445 is the perimeter of the blue, which is the area of the Ash Pond Complex. And this area down here was the original disposal area, the nonregistered site.

And you'll see a little notch right in there that is an old topographic -- what we would call a hollow, kind of a low-lying area, and you'll see that the water backs up into that -- that notch.

So we've got the -- an old stream, a drainage channel here, and then the perimeter of what became Old

Hickory Lake.
Q. Thank you. We can move on to the next paragraph, please.
A. 36?
Q. Yes, sir.
A. Joint Exhibit 70 below is an aerial photograph taken in 1958 and obtained from the Sumner County Soil Conservation Service Office. This photo was taken 12 years before disposal began in the Ash Pond Complex. The photo -- photograph illustrates how impounded water accumulated in circular low-lying sinkholes -- if you can see kind of the round circular areas here that are water filled -- in the former Sinking Creek stream valley and the locations where the original, main dike was constructed along the Cumberland River. Which is right here.

Also note that part of the area of the NRS, the nonregistered site, is filled with water, which is right in here. Because it was an original surface impoundment. At the time of this photograph, the large sinkhole complex to the northeast along Newton Lane, which is this area here, was dry.
Q. Thank you.
A. So -- so essentially what we see is a -- when they dammed Sinking Creek stream valley, this backed-up water -- this is in 1958 -- while they're disposing of the ash in the

nonregistered site, you see that the impounded water exists in the Sinking Creek stream valley. And so we have a dam here. And we do have one outlet right there where you see some discolored water coming into the Cumberland River.

And when you look at these -- these round circular areas that are water filled, those correspond to the locations of sinkholes that have been mapped by TVA.

Q. Would you move to the next paragraph, please.

A. The water-filled sinkholes apparent in Joint Exhibit 70 also correspond with those identified by TVA in the 1992 report by Steven Young, which is Joint Exhibit 47, and with an earlier map produced by TVA in discovery, which is Joint Exhibit 68.

It states that it was created as part of the planning process for constructing the Gallatin Plant, and it shows numerous sinkholes.

So what you see on the left is these circular -- hand-drawn circular oval areas, those are sinkholes that have been identified by TVA. And these lines that you see that are going northeast to southwest, and then, secondly, kind of perpendicular to those lines from the northwest to the southeast, those are lines that TVA described right here as lineaments. And you'll see in the legend they're distinguishing between sinkholes and lineaments.

And essentially what lineaments are are fractures

in the bedrock. And there's a primary fracture and a secondary fracture. And those are useful when -- when looking at sinkhole locations. And then the map on the right is the original 1950s -- a project area map. That's a topographic map produced by TVA during the planning stage of -- of the facility.

38? Paragraph 38?

Q. Yes, please.

A. For further illustration purposes, the 1950 impoundment topographic map was overlaid onto a June 5th, 1950, aerial photograph obtained from the Sumner County Soil Conservation Service Office. This overlay is shown below in a demonstrative exhibit entitled "1950 Project Area Topographic Map on 1950 Aerial Photograph."

Further, the location of the disposal area were digitized on the map and numerous features were highlighted. Streams and sinking streams are in blue -- which are -- if you start down here at the NRS, a stream that was under what became the NRS, then you see this stream here coming off of the TVA -- which is a hillside -- and discharges into a sinking point at that yellow oblong feature there, which is a mapped sinkhole by TVA, another stream that comes off the TVA hillside and sinks into another sinkhole at that point, and then this area here was shown as a drainage.

And then also, up in here with these blue lines,

it also shows topographic depressions and sinkholes that are in yellow. And it's hard to see. But underneath the purple in this area, underneath the purple and within the red line is -- there are several sinkholes there, there, and there, and then up here.

And so what this illustrates is the red line -- if you remember the previous exhibits, where we looked at the 445-foot water line from the USGS, and then the aerial photograph, if you take the topographic map and figure out where the 445-foot level would be, it corresponds to this red outline, which was the original impounded area in Sinking Creek when they impounded Old Hickory Lake.

Q. Thank you.

A. And I didn't finish.

Q. Okay.

A. So I -- I paraphrased, but let me finish that last sentence.

Note that the 440-foot topographic line corresponds with the actual wetted perimeter of the Ash Pond Complex illustrated on Joint Exhibit 70. These conditions are illustrated as follows.

Q. Thank you, Mr. Quarles.

And now we're going to skip over some other geographic information, some of which is redundant with -- a little bit with what Dr. Groves testified to, although, Your

Honor, we do want to call the Court's attention to that information. It's important.

But I'd like to ask Mr. Quarles to move to paragraphs 44 and 45.

A. Paragraph 44. Global Environmental developed conceptual geologic, hydrogeologic and waste management cross-sectional models for both the NRS and the Ash Pond Complex, which are Joint Exhibits 141 and 142. The foundations for these cross-sectional models were the 1930 and 1952 topographic maps and their predevelopment ground elevations, Joint Exhibit 69 and 68.

The purpose of these models -- and we have a model of the Ash Pond Complex on the left and a model on -- of the NRS on the right. The purpose of these models was to demonstrate how much the localized uppermost aquifer has risen since the Cumberland River was impounded and since TVA operations began.

So if you look at the left side of these diagrams, those blue dashes there and here and here, this is -- that is the Cumberland River. And we started preimpoundment with an elevation down here at about 410 feet mean sea level, and then, when they impounded Old Hickory at about 445, the water level of the river went from here up to here.

Same thing over here: Here up to here.

The second bullet, it illustrates how the

impounded water affects the groundwater beneath the disposal areas.

So one basic premise of groundwater flow is that water table aquifers flow into the nearest receiving stream, and they -- they would flow into the receiving stream at an elevation about the same or slightly higher than the receiving stream.

So what that means is the water table elevation would be at a minimum along the river at 445, or in this case there are two lines that are shown, 444 to 447.5, which is the winter and summer pool elevations. And you see that -- those two blue lines extend all the way across.

So I mentioned that we started with the original 1930s and '50s topographic map that showed the ground elevation in both areas to be about 440 feet above sea level. All right? So what that means is that everything below this top blue line that's hatched, there and here, would be below. Anything, any waste, any soil -- anything below those blue lines would be, in effect, inundated by the Cumberland River if you think back to the illustration that shows that wetted area.

And it also shows, just because we had mapped sinkholes on the 1952 diagram for the Ash Pond Complex, it shows some sinkholes that were present along the pathway of Sinking Creek.

So the third bullet, how much of the ash was likely placed below the uppermost aquifer, which I just described kind of below those two blue lines.

It also shows how the depth of groundwater monitoring wells are inadequate to effectively monitor the aquifer discharges into the Cumberland River.

So I'll direct you to the right-hand diagram here. These little rectangles that are kind of hatched, if you imagine a well, you drill a hole in the ground, and then perhaps you have a well screen. But it's a discrete interval where you are drawing water from that well. Okay?

And so if -- so it's -- it takes a lot of competence to understand, if you want to sample the uppermost aquifer, that you would want to bracket that uppermost water table elevation. And what you'll see is, like, we have two wells. They're actually screened below the base of the original Cumberland River channel, which is here. And then you'll also see that these wells that are drilled through the dikes, these two wells are drilled again below -- I think ultimately they were between 8 and 14 feet deeper than the water of the Cumberland River. And then there was one well that was an original well that was Well 19 that did bracket that uppermost aquifer.

The last bullet, where it also illustrates where solid coal combustion wastes have reached the Cumberland

River. And so if you look at this area here, what this is, this is an old original -- before they dammed up the river, this is a little alluvial ridge, and this was the floodplain. So when the water rose, this water has now inundated the old floodplain. And so the darkened area is where we're illustrating that we found coal combustion waste in the Cumberland River.

And what's not illustrated -- this is for the nonregistered site. What's not illustrated over here is a similar finding that we had for the Ash Pond Complex.

So paragraph 45. The cross-sectional ash-groundwater connectivity models prepared for each disposal area illustrates the near 40-foot rise in the uppermost aquifer -- again, on the left -- that discharges into the Cumberland River, in addition to the effects of the new 444-to-447.5-foot mean sea level pool elevation of the Cumberland River on wastes that were placed in the disposal areas. Again, anything below that.

And that would be the minimum elevation, the groundwater elevation.

The model also illustrates the saturated solid waste in the disposal areas. Okay? So, again, ash was placed onto the original ground surface. So, therefore, any ash that's below the double blue line would be ash that would be saturated by groundwater.

These models are illustrated below as Joint Exhibits 141 and 142.

Q. Mr. Quarles, if we can, now, I'd like to go and talk about the sampling that you did at the site. So if you would --

THE COURT: And before you leave 44 and 45, correct me if I'm wrong, are we talking about when the dam was -- way back when it was impounded? Is that --

THE WITNESS: Yeah, when they impounded Old Hickory Lake --

THE COURT: Okay. That's the time frame this reflects?

THE WITNESS: That's right.

THE COURT: Okay.

THE WITNESS: But it reflects the time period when they raised -- which I believe the full pool was the end of 1956. Okay?

But this -- these illustrations also show kind of current conditions of waste that have been placed in both disposal areas.

So this shows original ground topography, which is --

THE COURT: The last sentence, that's -- you haven't gotten there yet?

THE WITNESS: I'm sorry?

THE COURT: Disposal of the current condition.
THE WITNESS: This does -- those illustrations represent current conditions.
THE COURT: Not at the time of impoundment, then? Or is it both?
THE WITNESS: What it illustrates is the original ground surface, which is this line here --
THE COURT: Okay --
THE WITNESS: -- that is from the original ground topography prior to TVA building impoundments in both of the diagrams here.
Does that answer your question?
THE COURT: Yeah. Thank you.
THE WITNESS: Okay. So now we're going to paragraph --
BY MS. DAVIS:
Q. We're going to paragraph 46.
A. Together with Barry Sulkin and others, I inspected the shoreline of the Cumberland River along the Gallatin Plant Peninsula, looking for signs of coal and coal combustion waste at seeps, springs, and the riverbed of the Cumberland River. Those inspection efforts were based upon visual observation, aerial photography, historical topographic maps, and groundwater flow diagrams. Specific areas targeted for the inspections were shorelines that were hydraulically

downgradient of groundwater flow from the ash ponds.

And "hydraulically downgradient" means groundwater flows from a high elevation to low, similar as rolling a ball down the side of a hill.

Also along bedrock joint trendlines that can be preferred groundwater flow pathways. If you recall, one of the previous exhibits that showed the lineaments -- those -- which are also illustrated up here -- these lines -- focusing also on former valleys and hollows that are now fully or partially submerged by the now-impounded groundwater -- or excuse me -- now-impounded Cumberland River.

And, lastly, the areas of past impoundment dike failures. And we had -- there was plenty of history of some dike failures along this area here.

So boat-based inspection of this perimeter, keeping all of those groundwater and surface water flow opportunities.

THE COURT: And when did you and Barry Sulkin do this? What's the date?

THE WITNESS: We've sampled in 2014, 2015, and 2016. So, for example, if you look on the eastern side of the peninsula, do you see the blue area -- blue arrow here? From here to there was the original channel of the Cumberland River.

So when they -- with the impounded conditions, the

new width of the channel goes all the way over to here. So this sample here, that blue dot -- or red dot -- that was in an old hollow, if you will, topographic hollow that has now become the floodplain -- has now been inundated with the backflow of the Cumberland River, the higher elevation. Yeah.

47 or stopping at 46?

BY MS. DAVIS:

Q. Go to 47. Go to 47 if you would.

A. Okay. Okay.

Specifically, the following contaminants transport mechanisms were considered when reviewing documents and then performing the field inspections:

Perpetual discharges of groundwater into the river. Groundwater flows naturally 24/7, 365 days a year. Those are perpetual discharges that would occur into the river. Also, there would be an opportunity for water overflows from impoundment spillways.

So when you build a surface impoundment, it has a spillway and an overflow. And so those are typically low-lying areas that have been dammed up, and you have an overflow at that location.

So we had an overflow down here as well as up here in the Ash Pond Complex. The overflow down here was right about there. And the over- -- the last overflow -- the last

saddle dike to be built for the Ash Pond Complex was in this area where you see all the orange and red dots.

The third bullet: Conduit flow from cavernous limestone through sinking streams and sinkholes.

So, again, considering these bedrock lineaments, looking for bedrock exposures along the side of the river, and looking for, you know, flow from those. And then seeps from the uppermost aquifer onto the ground surface along the shoreline.

So we talked about those conceptual models that show the uppermost aquifer would be at a minimum right at the level of the impounded shoreline. So inspecting the shorelines for any seeps that looked suspicious for coal combustion waste.

Q. Thank you. And if you would just skip over 48 and go to paragraph 49, please.

A. The February 2015 aerial photography below is -- in Joint Exhibit 16 -- suggested that coal combustion wastes were in the Cumberland River adjacent to the NRS. If you will -- okay. Just to get -- let's back up. Let's take off that -- all right.

Just to give you the lay of the land, this is the western shore of the Cumberland River. This is a southern part of the peninsula. This area right here is the nonregistered site. Okay? The original disposal area.

And so it says -- let's go to the -- the blowup of this area here.

So when I saw this photograph, the thing that really stood out to me, knowing the history of that nonregistered site, was the reddish-brown shoreline here. And it's hard to tell in this -- in the light, but you can also see some dark black stuff. The water is very shallow.

But what really, really stood out was from here, you can see from there to at least right there, the -- the shoreline was very, very reddish-brown and orange.

What that -- what that highly suggests is that -- those are very common in areas where you have discharges and seeps from coal combustion waste, because it's the oxidation of iron that has been leeched out of the waste into the groundwater. And we -- and when it emerges to the surface, then it creates an oxidation effect and you see that reddened -- reddened color:

The shoreline was characteristically reddish-brown, possibly indicative of iron oxidation from coal combustion waste. Such reddish-orange sediments can be indicative of coal combustion waste contaminants, as noted by TVA in 1986 during their red water, quote-unquote, inspection program at the NRS.

"Red water" is what the coal industry -- coal plant industry typically refers to acidic orange seeps that

are quite common around the perimeter of disposal areas. And it's also quite common where -- where groundwater comes to the surface because of that oxidation effect. And the red water inspection program was widespread for the nonregistered site in the 1980s.

Q. Mr. Quarles, if you would continue reading paragraph 50 and 51 and describe the sampling locations, please.

A. Paragraph 50. Based on the sampling strategy and resources described above, we conducted a boat-based inspections -- or boat-based inspections in August and October 2014 and February and August 2015. Those inspections identified diffuse flow groundwater seeps and springs in suspect areas and also evidence that solid coal combustion waste had been deposited in the riverbed of the Cumberland River.

I will describe the sediment sampling locations and results; Barry Sulkin will discuss the water results.

And if I might add, kind of to clarify what I mean by evidence that solid coal combustion wastes have been deposited in the river --

If it's possible to go back to the previous illustration, it was the photograph that showed the reddish-brown sediment. Right here. And if you blow that up.

So what I mean by evidence of -- that solid coal combustion waste had been deposited in the riverbed is we

pulled the boat up and the water was, you know, about 3 feet deep in this lower end. And when I stepped out of the boat and started walking across that, I sank into -- at the time we had no idea what it was, but I had a pair of waders on, and I sank anywhere from, you know, ankle deep to almost waist deep in stuff that was black and really supersoft.

And that -- and, you know, then we used -- again, we didn't have any sampling equipment, but we used a paddle and probed down in there, and, you know, you could just by hand press -- press this paddle several feet into the whatever it was. And when we brought it back up it was just very, very, very black.

Paragraph 51:

THE COURT: Go back to 50. The second sentence, "Those inspections identified diffuse flow groundwater seeps and springs."

THE WITNESS: Yeah.

THE COURT: What does that mean?

THE WITNESS: Okay. So it would be best to go back to our main peninsula illustration, if we could do that.

Well, let's -- okay.

When I say "diffuse flow," when groundwater flows into a stream or river, the bank above the water line is wet. Okay? That's where that groundwater -- that perpetual flow flows naturally into the receiving stream. Part of the flow

in the river is groundwater that is recharging or flowing into the river. All right?

So like this area -- we'll go -- this area here. Like, when we were inspecting -- this is the boat ramp area. There's a public boat ramp there. There was a -- looked to be an area fill that was used to build the boat ramp, and then there was a little channel there that has some water in it that was -- that was visible.

And then here, at this, what -- this sample up here, the original -- one of those original hollows that's now back-flooded, you know, we couldn't get out of the boat and get up onto the shoreline, but the shoreline there was again very -- it was very wet in that topographic low point, and it was -- you know, you could see that the wetness would continue further up away from the river, up that natural low, which was the -- was -- was an old low-lying area.

So that's the sort of thing that we're looking at for diffuse flow. We're looking at those wet areas that would be coming out at the shoreline at or above the water elevation of the river.

Do you have any more questions on 50?

Paragraph 51. Care was taken not to -- to not collect any sample above the visible high water mark of the river.

In summary, the diffuse flow springs, shoreline

sediment, and riverbed sediment sampling locations, shown on the demonstrative exhibit entitled "Odom's Bend Peninsula and Gallatin Fossil Plant with Sinkhole Data Overlay," and descriptions are as follows.

And so the east side Number 1 -- I have to get my long vision goggles on. I think this one is incorrectly shown here.

Is that ES2? That --

BY MS. DAVIS:

Q. Yes.

A. That is ES2. So that should be labeled "ES1." The bottom line is that is the public boat ramp, East Side 1.

Illustrated here, we observed a diffuse flow spring located on the eastern peninsula at a public boat ramp along the shoreline of the Cumberland River. This site is hydraulically downgradient of the eastern portion of the Ash Pond A -- Ash Pond A is here -- and TVA has demonstrated that groundwater flows radially from here. And it's also kind of along these bedrock lineaments that -- that we see in both directions, along the secondary bedrock joint pattern, and is located in a preimpoundment valley.

The sample was collected from an opening in a submerged channel in fill material.

East Side 2 -- which is actually illustrated as ES1 -- we observed a diffuse flow spring also located on the

eastern peninsula at the shoreline of the Cumberland River. This site is downgradient of the northeastern portion of Ash Pond A along the secondary bedrock joint pattern -- again, secondary pattern here -- of Ash Pond A along -- the secondary bedrock joint pattern is in the vicinity of a former, parentheses, apparently closed or no longer sampled, well, GAF13 -- a well with demonstrated coal combustion waste constituents and up to 2,100 milligram per liter sulfate.

So there was an old well, GAF13, that was located -- this is Steam Plant Road -- and GAF13 was located somewhere right around in here.

Next sample location, Barton's Creek reference sample. And this is off this map. It's actually south and away from the Odom's Bend Peninsula. The sample site is located off TVA property, south of the Cumberland River along the shoreline of Barton's Creek, an upstream tributary of the Cumberland River. The shoreline sediment sample was collected at Barton's Creek boat ramp, a public boat ramp on the tributary to Old Hickory Lake, located off Coles Ferry Pike.

NRS4. The shoreline sediment sample was collected from the small southerly embayment adjacent to the NRS.

So if we can highlight the NRS here to here. Blow that up.

So NRS4 is here. It's collected outside the

submerged zone but below the high water mark of the river and within approximately 1 foot of the waterline of the Cumberland River.

So if you recall the aerial photograph that had the reddish-brown sediment along the shoreline, NRS4 was collected along that shoreline.

NRS3 was submerged sediment sample collected approximately 50 feet from the shoreline, in approximately 3 foot water depth, from the same southerly embayment adjacent to the NRS.

Again, we're in that same vicinity. It consisted of an undetermined mixture of a black sludge-like material and mud sediments that was at least 2 feet thick.

NRS2 is located again in the embayment next to the NRS but just further to the north, right here. The shoreline sample was collected from the southerly embayment adjacent to the NRS, but from the area nearest Well 27. You see that, JF27. It consisted of a coarse, reddish-brown to black clayey sand. It was collected outside of the submerged zone but below the high water mark and within 1 foot the waterline of the river, the Cumberland River.

NRS1, which is just to the north. Here another small embayment around the northwest side of the NRS. This submerged sample, approximately 3 foot water depth, was collected in the northerly embayment adjacent to the NRS and

located approximately 10 feet from the shoreline. Consisted of an undetermined mixture of black sludge-like material and mud sediments that was at least 2 feet thick.

And it's the little color discrepancy here, but this brown area was previously shown on the main diagram as yellow, which was a 1952 sinkhole map by TVA. And then you see these other lighter shaded areas, those are also areas that have been identified as sinkholes.

And then again, down here, this brown area was identified on a topographic map as a sinkhole, and it was also described as a wet weather pond pre -- preimpoundment.

And then sample APC1, which is located here, up in the Ash Pond Complex area. So western shoreline sample collected adjacent to riprap repair of the Ash Pond E. This was collected outside of the submerged zone but below the high water mark of the Cumberland River.

AP4, again from the same area. There's a little embayment there. This submerged sample, approximately 3 foot water depth, was collected approximately 75 feet from the shoreline adjacent to Ash Pond E. It consisted of black sludge-like material that was at least 2 feet thick.

And then we go back to the NRS. NRS5, in that northern embayment that's between the Pond E and the NRS, this submerged sample, approximately 3 foot water depth, was collected from the northerly embayment near NRS1. It's

located approximately 60 feet from the shoreline near the barge unloading conveyor belt.

So this little white line here. This goes from the river here. That is the barge unloader conveyor belt. The sample consisted of black sludge-like material.

NRS6. This submerged sediment sample was collected approximately 20 feet from the shoreline and approximately 1.5 foot water depth of the NRS. NRS6 is again right in here in a subembayment. There's a little island that separates this southerly embayment from what we call the middle and then the northern. Submerged sediment sample was collected approximately 20 feet from the shoreline, approximately 1.5 foot water depth of the NRS, and it consisted of a black sludge-like material that was at least 4 feet thick.

APC2, which we're back up here at the Ash Pond Complex, submerged sediment sample was collected approximately 40 feet from the shoreline of the Ash Pond Complex in approximately 3 to 4 feet of water. It consisted of a black sludge-like material that was approximately 2 feet thick.

And then NRS1A -- where is 1A? There is 1. NRS1. So, again, it was in that northern embayment. This sediment sample was collected approximately 50 feet from the eastern shoreline, approximately 3 to 4 feet of water, the northwest

corner of the NRS, south of the Ash Pond Complex barge conveyor, consisted of a black sludge-like material that was at last 2 feet thick.

THE COURT: Where is NRS1A?

THE WITNESS: It's by NRS1.

THE COURT: It's not shown up --

THE WITNESS: Same location, plus or minus a few feet.

THE COURT: But it's not on this map.

MS. DAVIS: That's correct, Your Honor.

THE WITNESS: And then NRS4A, which is again down here by NRS4 in the southern embayment. It was another sample that we collected. This submerged sediment sample was collected from the small embayment along the south end of the NRS, approximately 1.5 feet of water. It consisted of black sludge-like material and was mixed with tan silt. The black sludge was at least 2 feet thick.

So, to kind of wrap it up, we found the black sludge-like material in the Cumberland embayment here on the south side of the NRS, the middle embayment next to the NRS, the northerly embayment of the NRS and adjacent to Pond E, then also a little embayment, if you will, adjacent to Pond E.

BY MS. DAVIS:

Q. That's a good lead-in to paragraph 54, if you would,

Mr. Quarles.
A. The black material in the Cumberland River was sludge-like, had little strength, was saturated, was partially gritty-sandy.

I took a photograph showing an example of the material shown below in Joint Exhibit 144, which is that.

The sampling tube was easily pushed by hand through the material, and the full depth of the material was never reached.

Exceptions to the sludge-like description for waste collected from the river were numerous probe samples collected from the middlemost embayment adjacent to the NRS. That material was entirely black and gray sand and silt-like particles that were suspected to be fly ash and/or bottom ash based upon color and consistency. This material was later confirmed through microscopic analysis to be fly ash, bottom ash, and coal.

So you see -- you see this black material, and then this is the shoreline. So we're in relative close proximity to the shoreline.
Q. Thank you. Thank you. And now, Mr. Quarles, if you'll go to paragraph 58, and we'll talk about the results of your sampling.

Your Honor, the chart that we are pulling up that he's going to rely on I believe was -- well, it's a version

of Joint Exhibit 16. We updated joint -- we found a few errors in it, sent it to defendants over the weekend and --

THE COURT: So what is Joint Exhibit 145 is really Joint Exhibit 16? So what's at Joint --

MS. DAVIS: Your Honor, I'm getting ahead of myself.

THE COURT: Okay.

MS. DAVIS: This is not 14 or 16; this is just an exhibit to his testimony, and it's a summary of the sediment samples.

THE COURT: Joint Exhibit 145.

MS. DAVIS: Yes, sir. I'm sorry.

THE WITNESS: Okay. Paragraph 58. A summary of the analytic results from sediment and solid waste samples is included in Joint Exhibit 145 below. I have highlighted the constituents that are commonly found in coal ash, together with the elevated levels of those constituents in the various samples.

So if you -- this is a running table. The left-hand column on both tables are the constituents. The upper row on both are the sample location numbers or identifiers. It shows the dates that were collected, the description of kind of what the material looked like.

On the left-hand column of each in yellow I've highlighted -- I made a comment about -- I've highlighted the

constituents that are commonly found in coal ash.

THE COURT: Were you surprised?

THE WITNESS: Was I surprised --

THE COURT: To find it?

THE WITNESS: I was not surprised.

All right. So -- so when you look at -- so how did I determine what was commonly found in coal ash. Based on experience of looking at a lot of sites. The Electric Power Research Institute, they talk about what constituents are common in coal combustion waste. And, you know, EIP guidance documents and even TVA documents themselves talk about what is commonly found in coal combustion waste.

So it's a good starting point trying to figure out if we've had a release to the river. We start with what we know to be -- what we would call signature indicator parameters or constituents, right?

And so we did that. And so we have those that are in yellow, are those -- I think there's eleven or so that are, you know, those common constituents.

And then we have a reference sample, the Barton Creek reference, which, again, was located to the south. It was off site. It was a point of reference just to compare, you know, what our constituents -- our concentrations to another sample that's not on the TVA peninsula. All right?

So what I did was I compared the constituent

concentrations to the referenced sample of Barton Creek. And that was part of my analysis.

THE COURT: And what did you compare it -- the Barton Creek samples to?

THE WITNESS: I compared the Barton Creek reference sample -- each constituent -- like, if you'll blow up --

THE COURT: I understand that. Where did you get the reference sample?

THE WITNESS: It's -- Barton's Creek is a creek that flows into Old Hickory Lake.

THE COURT: And then what did you compare that to?

THE WITNESS: I compared it to the samples that were collected around the TVA peninsula.

THE COURT: Okay.

BY MS. DAVIS:

Q. To clarify, Mr. Quarles, you looked at the levels of various substances in the Barton Creek reference and compared those levels to levels you found in the samples you took?

A. That's right.

So if you -- if you could highlight the Barton's Creek just -- there you go. Okay.

And so, for example, the concentration of chromium in the Barton's Creek reference was 30 milligram per kilogram. Boron was nondetect. It was less than 1.3, which

is less than the report limit of the analysis. Aluminum, another example, is 17,000 milligram per kilogram.

So then, if you expand that --

THE COURT: So the Barton's Creek sample was your clean sample?

THE WITNESS: I wouldn't call it "clean." It's a good reference. It's a reference sample.

THE COURT: The -- the -- the findings in Barton's Creek did or did not --

THE WITNESS: I'm sorry.

THE COURT: Did they alarm you? Were they normal?

THE WITNESS: They didn't.

THE COURT: Okay. They were normal.

THE WITNESS: They didn't alarm me, just because, you know, I was comparing it to the sample constituent concentrations around the peninsula.

THE COURT: And you found the ones by the peninsula, in your opinion, abnormally high?

THE WITNESS: Yeah. And so if you -- for example, if you expand upon that --

Blow up there and go right.

So what I did was I -- I looked at those constituents, and I said, okay, which of these samples -- like this is NRS5, NRS6 -- and there were two NRS6s because two separate dates -- and I compared the constituent

concentrations from those samples to the reference sample, and when they exceeded that, then I highlighted those cells in yellow.

And so then we have some conclusions of what the results mean in paragraph 59.

BY MS. DAVIS:

Q. Please.

A. When the on-site samples are compared to the reference sample from Barton Creek boat ramp, notable observations can be made that differentiate the on-site samples to the reference sample. These exceptions were present even though Barton's Creek historically received municipal and industrial wastewater discharges from the city of Lebanon until approximately 15 years ago.

Those observations include, as examples, boron was not detected in the reference sample -- here, less than the detection limit, 1.3 -- was not detected in the reference sample, but was reported in every sample collected from the TVA's shoreline area. Boron is a very classic coal combustion waste indicator that specifically TVA and the Electric Power Research Institute in my experience shows is a very good indicator for coal combustion waste.

Q. Mr. Quarles, can I ask you to clarify on the boron.

Did you have a clarification on the boron?

A. Oh, yeah. Yeah. Boron was not detected in the

reference sample but was reported in every sample collected from the TVA's shoreline area. There was one sample which it was less than the detection limit, I think less than 2.6, but a later sample from the same area showed boron in that sample.

So that first bullet where it says "in every sample," it was not detected in one sample from -- from the shoreline, but a later sample from the same area showed boron in that sample.

Second bullet, sulfate concentrations from TVA shoreline samples were up to 180 times higher than the reference sample.

All right. So if we could expand -- let's go back to the main Barton Creek reference.

The sulfate is discussed, I think, right -- oh, no. It's right -- I can't see that far. Okay. So I think we have to go back, just to confirm that this is Barton's Creek. Yeah. Barton's Creek here.

So I think that said that Barton's Creek was 34 milligram per kilogram. All right. So then, when you go across and look at all of these samples, some of the highest concentrations were 180 times that -- that reference sample. There were several thousand parts per million.

Like here, sulfate at NRS5 was 3,700. You know, 431. Numerous examples where we're in the thousands and

hundreds of parts per million for sulfate.

Sulfur concentrations from the TVA shoreline samples were up to 15 times higher than the reference sample.

Again, sulfur here at the Barton's reference is 1,100. As a comparison, NRS5 was 15,400. And here, NRS4 was 16,200, 14,000. Bottom line was there was, you know, a lot of sulfur compared to the reference.

And arsenic concentrations from the TVA shoreline samples were higher in virtually all -- 11 of the 15 on-site samples -- than the reference sample. Arsenic started at 8.6. You'll see 12 1/2, 21.9, 40 -- looks like 40.2, 23, 18.

And iron concentrations from the TVA shoreline were up to ten times higher than the reference sample. And iron, we were at -- looks like 26,000. And NRS5, as an example, looks like 129,000. Here's another one here, 157,000.

The last bullet. Detections of other constituents -- aluminum, barium, calcium, chromium, cobalt, lithium, manganese, selenium, sodium, strontium, and chloride -- were commonly reported among samples that had the highest concentrations of other constituents.

And paragraph 60, contamination of the sediment demonstrates that coal ash waste has been released from the Gallatin facility at areas adjacent to both the Ash Pond Complex and the NRS.

THE COURT: Which would not have been a surprise?
THE WITNESS: I don't expect to see solid coal combustion waste in the river.
THE COURT: But it's a depository for coal ash. I mean, it's a depository for coal ash over the years. Wouldn't you have expected to see something?
THE WITNESS: No. The solid coal combustion wastes are supposed to be contained in the surface impoundment, which is on -- which is not in the river.
THE COURT: Except for Outfall 101, wherever it is.
THE WITNESS: The Outflow 001, which is on the northern side.
THE COURT: Right.
THE WITNESS: Right? Right.
And so -- but even when you have an outfall structure, the reason the surface impoundment is there is to settle out those solids so that they drop out in the bottom of the ash impoundment and not flow over the top of the overflow into the river.
THE COURT: So you would have expected the numbers here to be the same as at Barton's Creek?
THE WITNESS: If there was no release to the river, they should be very similar.
THE COURT: And did -- Barton's Creek, you said,

had had industrial wastewater discharges, municipal industrial wastewater discharges.

THE WITNESS: Right.

THE COURT: I mean, help me. Is that coal ash?

THE WITNESS: Right. So what that means is like, if you're in the city of Lebanon, every time you flush the toilet or you're an industry or whatever, whether it's a pretreatment program, you've got industrial waste that ultimately gets to the sewage treatment plant and ends up in the effluent.

THE COURT: But Barton's Creek was never a coal ash source?

THE WITNESS: No.

THE COURT: Okay.

THE WITNESS: Correct.

BY MS. DAVIS:

Q. I think what you're trying to say, Mr. Quarles, is how clean was Barton's Creek?

A. I didn't compare Barton's Creek to a -- you know, any sort of closure standard per se. I just used it as a point of reference to compare to our samples along the shoreline.

And one of the reasons we did that is that some of the original, you know, 1980 -- I don't remember what date it was -- but one of the TVA employees surmised and concluded that virtually the entire peninsula was contaminated with

coal combustion waste groundwater.

THE COURT: And the distance between Outfall 001 and just take -- which one -- NRS1 -- what's that distance?

THE WITNESS: If you go back to the main -- if you can --

THE COURT: Looks like about a mile to me. Is that more than a mile?

THE WITNESS: This is the scale.

THE COURT: Yeah.

THE WITNESS: There to there is 1 mile.

THE COURT: Yeah.

THE WITNESS: And so you if you take that away from here to Outfall 001, is probably a mile, maybe a little over a mile.

THE COURT: Yeah. So what was coming out of Outfall 001, you still wouldn't expect these kind of numbers at NR1 or wherever?

THE WITNESS: The surface impoundments are supposed to be -- call them a treatment pond to settle out solids and to treat the wastewater prior to discharge into the Cumberland River. And --

THE COURT: You wouldn't have expected --

THE WITNESS: You wouldn't expect solid coal combustion waste to be leaving Outfall 001 to the Cumberland River.

BY MS. DAVIS:
Q. Thank you, Mr. Quarles.

We're going to skip over some of the historical investigations because Dr. Groves has testified to some of that. But I would like for you to read two of those paragraphs of your testimony. That would be paragraph 71 and paragraph 73, please.

A. Paragraph 71. TVA investigations have concluded that coal combustion waste in both the NRS and the Ash Pond Complex are saturated. These saturated conditions, determined from borings in 2010 in the actual disposal areas -- disposal site areas by TVA's consultant Stantec, are as follows:

The NRS saturated wastes currently exist even though the waste disposal reportedly ended in 1970, and the disposal cells had been periodically drained to repair and replace several sections of dikes.

In the Ash Pond Complex, saturated ash was confirmed during geotechnical investigations performed during completion of a May 2010 report to evaluate the geotechnical conditions and slope stability associated with the dikes.

Paragraph 73. Just last year, TVA's consultant AECOM confirmed in a report to TVA, contained in a PowerPoint presentation produced by TVA during discovery, that with respect to Pond E in the Ash Pond Complex, quote-unquote, a

portion of the ash is below, parentheses, up to 10 feet below, parentheses, the elevation of the Cumberland River, end quote.

And that's a highlight of the slide of that PowerPoint presentation. And it's under the category of "Engineering Challenges."

Q. Thank you.

A. A copy of the PowerPoint is Joint Exhibit 113.

Q. Thank you.

Now, Mr. Quarles, we're going to talk about a more recent study. If you would move to paragraph 80, please.

A. Arcadis, which is a consulting firm that's worked on behalf of TVA, completed groundwater modeling to assess the ecological and human risks based on the concentrations of constituents of concern that would theoretically reach the Cumberland River from the groundwater transport mechanism. Their report is appended to Joint Exhibit 59.

Their model predicted the concentrations at the bottom of the ash within the NRS; at the bottom of the soil, alluvium, or residuum, beneath the NRS; and within the Carters Limestone bedrock beneath the soil. And so, to emphasize, that the model predicted the concentrations.

The results of that predictive contaminant transport model demonstrated that constituents concentrations vary by depth and, in some cases, worsen as the depth

increases. The highest predicted concentrations of nickel, for example, increased with depth and traveled beneath the base of the Cumberland River.

If I might, let's -- let me explain the diagram above -- the two diagrams above.

So if we can blow up the highlighted area of the two.

So the top diagram, if you can imagine looking down on the peninsula, the way we've done with our big overall, what you'll see is this area here is the nonregistered site, which essentially is a perimeter of red. And what they're doing is they're -- and then this line here, the black line, is where they're drawing and creating a cross-section.

So this predictive model based on their input values, they're trying to determine if nickel is migrating away from the disposal area -- and remember that the disposal area is located on the bank of the river. All right? So this area here would be the Cumberland River. Okay?

So then, if you now look at the diagram below that, which is the cross-section along this black line. Let's focus on that. All right? So this area here where it's labeled the "NRS Landfill," just to the left of that is the river, the new impounded elevation of the river, and then this is the original channel of the Cumberland River.

And so this is the NRS, and so this is the ash. And then they're predicting the groundwater concentrations by depth here, vertical, and then laterally. And what you see is that the nickel concentrations go deep. And in fact, they're deeper -- across that line, deeper than the bottom of the original channel of the Cumberland River. And that these elevations, these concentrations, the red being the highest concentrations, are flowing -- in this case, it's westerly, southwesterly, towards and beneath and within the Cumberland River.

It also shows, if you go --

Let's just leave it the way it is right now.

It also shows that constituents vary by location. Some metal concentrations were worse to the north. Okay? So this is the north and this is south. North of Well Number 20 -- I'm sorry. Some metal concentrations were worse to the north of Well 20. Right about here. Some were worse to the south of Well 19R. 19R is to the south side. And some were worse between the monitoring Wells 20 and 19R.

And what that says is that we have -- depending on the metal -- they modeled the concentrations of several metals. Nickel is just one. So what we're showing here in red for another metal may have been extremely red up here on the north -- the northern side and perhaps the southern side.

The bottom line is, the metal concentrations

varied in location of highest to lowest, depending on where you were at the nonregistered site.

Third bullet. It also suggests -- or it says that the bypassed monitoring wells installed along the Cumberland River because well may be screened too deep or too shallow to intercept the highest concentration of a plume or to flow between wells.

So let's address and explain the "bypassed the monitoring wells." So, for example, you have a monitoring system that has wells here and here, but currently, at least prior to the EIP, didn't have any monitoring wells here, yet some of the constituents had the highest concentrations here.

So when I say constituents would bypass a monitoring well, they would essentially go unmonitored from a lateral extent. And then, if you imagine this -- this vertical cross-section, that you want to make sure that you have wells screened appropriately on a vertical extent so that you're measuring those concentrations that are migrating from the NRS into the Cumberland River, especially relative to the upper part of the Cumberland River, the water table, and then the lower portions that are flowing into it under the main channel.

And so, essentially, if you see this green area here, this is what Arcadis called the groundwater transition zone, meaning that's where groundwater is influent to the

river -- it's flowing into the river -- both laterally and also horizontally, and then vertically up from the bottom.

Last bullet: Reach the main channel of the Cumberland River and its shallow embayment adjacent to the NRS.

Q. Thank you.

A. That's paragraph 80.

Q. Now, Mr. Quarles, you've got some more about the Arcadis studies at paragraph -- if you'll skip to paragraph 99, please.

A. 99?

Q. Yes, sir.

A. As noted above, because of the exceedances of MCLs for some pollutants in the wells at the NRS, TDEC required TVA to initiate groundwater assessment activities consistent with TDEC rules. The NRS assessment activities included the installation of 11 new groundwater monitoring wells in 2011, two years after the assessment monitoring program was implemented. TVA collected groundwater from those wells and within the ash that was still present in the disposal areas in order to complete three key elements of the 2014 plan to close the NRS. TVA hired Arcadis to conduct this study for it.

The purpose of the three-element assessment was to determine -- quote-unquote, determine whether coal combustion

byproducts have or will impact groundwater at the Gallatin Plant site or pose any threat to public or private water supplies near the site.

The key elements included a groundwater quality assessment, ecological risk assessment, and human risk assessment.

100 as well?

Q. Yes, please.

A. Arcadis concluded that the contaminated groundwater discharges into the Cumberland River along the 143.6-acre groundwater transition zone -- so the groundwater transition zone calculated in -- developed by Arcadis is all of this area here -- groundwater transition zone -- of approximately a 4,600 feet length of the NRS shoreline.

So the length of the shoreline would be here along the -- thermal discharge channel, along this main stem of the Cumberland, and then here along the embayment.

So it's just shy of a mile.

Q. Okay. Keep going.

A. Paragraph 100?

Q. Yes, please.

A. 101?

Q. Yes, sir. Yes. Go on to 101.

A. On behalf of TVA, Acadis prepared a preliminary ecological screening evaluation of groundwater discharges,

reporting in December 2012, and concluded that the ecological risk may in fact be present and recommended that actual samples be collected to determine ecological risks.

Arcadis concluded that the concentrations of beryllium, cadmium, nickel, and zinc may in fact pose a risk to aquatic biota within the Cumberland River; however, the risk was downplayed with, quote-unquote, conservative assumptions of the model.

Arcadis suggested that actual sediment porewater samples should be collected from the actual discharge zone into the Cumberland River as, quote-unquote, the most effective way of determining risks and ecological exposures as a direct measure of exposure.

And so, if you will highlight -- or blow up yellow those two sentences or the first sentence. This is from that Arcadis 2012 report. "May pose a risk to the aquatic biota in the groundwater discharge zone within the Cumberland River, which they calculated to be about 143 acres.

And then, next, most effective way to refine the estimate -- again, it was a predictive model, mathematical predictive model. The most effective way to refine the estimate of current risk is to measure the concentrations of COPCs -- what that is, constituents of potential concern -- in sediment porewater in the discharge zone of the Cumberland River.

So let me explain what sediment porewater is in the -- of the Cumberland River, is that we know that they've calculated a groundwater transition zone, where groundwater flows up and into the bottom of the river. And there's sediment on the bottom of the river. So if -- sediment porewater is where you would go and stick a probe into the sediment, and the water that's in the pores of the sediment is what you sample, because that is where your aquatic biota live.

So they said the best way to figure that out is to go collect samples from the groundwater transition zone.

Q. Please continue.

A. 102?

Q. Right, yes, sir.

A. Arcadis later revised that report and prepared a ecological screening evaluation of groundwater discharges for the NRS on behalf of the TVA in 2014 as a key element in their NRS groundwater assessment.

The purpose of the 2014 ecological screening was, quote-unquote, evaluate the potential for adverse effects of aquatic ecological receptors from exposure to constituents associated with groundwater in the transition zone, end quote, i.e. the zone where groundwater mixes with surface water near the NRS at the Cumberland River.

The 2014 ecological screening evaluation was

specifically designed to focus on the benthic invertebrate community within the groundwater transition zone at the NRS because those receptors are, quote-unquote -- this is from Arcadis -- are in direct contact with the porewater in the transition zone.

Proceed to 103?

Q. Yes, sir.

A. That revised final report, the 2014 ecological assessment of the NRS, was substantially flawed. Major flaws of that assessment include: Instead of collecting actual samples from the groundwater discharge zones as recommended in the 2012 report, Arcadis chose to use other ecological and human data tests to estimate risks by extrapolating those results and creating mathematical models to predict maximum concentrations for exposure:

Arcadis used off-site locations to collect data for their NRS risk assessment as illustrated below in Joint Exhibit 59, TVGF005013, rather than collecting actual relevant specific data for the NRS.

So this is an illustration from the report that summarizes what they call the biomonitoring zone downstream of the Gallatin Plant.

And if you will -- let's get a point of reference here. So this is the nonregistered site. And keep in mind, they did the groundwater assessment -- risk assessment for

the nonregistered site, here.

And then, remember that TVA estimated the groundwater transition zone is essentially down in here near around this green area. "Transition zone" meaning groundwater leaves the NRS, enters horizontally into the river, and then flows upward from the bottom.

And that's where the sediment porewater, you know, that they talked about in 2012 of collecting would be.

So this is -- this is what they use as the basis for collecting samples and evaluating the risk to the river from the NRS.

So in red it says "Electrofishing Station." Do you see the red dots? Point of reference. Your Honor, you were asking about Outfall 001. That's here. "Gill Netting Station," the yellow diamonds, again down here. This is the Highway 109 bridge. That is the drinking water intake for Gallatin.

"Benthic Macroinvertebrate Transect" is down here.

And then the "Wildlife Observation Transect," you'll notice on the left shoreline of the Cumberland River, they generally follow the bank. And on the right side they're following the bank of the Ash Pond E. But they don't go into our little -- any of the notches, you know, that are where, you know, both sides have found, you know, seeps. They -- they did go into a part of the embayment northwest of

the NRS, but then they didn't do any shoreline assessment of the NRS for their wildlife observation transect, which seems a bit odd, because the intent -- the purpose of the assessment was to assess the risks associated with the NRS.

Keeping on to the next bullet. Arcadis used average not maximum NRS groundwater concentrations for a two-year period, 2010 and 2012, in their model and assumed that monitoring wells provided widespread, accurate results.

Arcadis mathematically predicted groundwater concentrations that discharge into the river at the NRS, instead of collecting actual samples.

Arcadis also mathematically predicted concentrations of metals that might be present in the sediment porewater in the groundwater transition zone instead of collecting actual samples.

Ar- -- and, lastly, Arcadis used results of the whole effluent toxicity wet test and a benthic macroinvertebrate survey report for the main facility, Ash Pond Complex, discharge, not for the NRS, instead of collecting actual samples.

Q. Thank you, Mr. Quarles.

Your Honor, with your permission, I would just like for Mr. Quarles to move to -- and if you have any questions, but if not, to move to his conclusions at paragraph 116 and read to the -- to paragraph 127 of your

conclusions.
A. 115?
Q. 116.
A. 116. When TVA dammed the former Sinking Creek stream valley that became the Ash Pond Complex in 1953 and 1954, the free-flowing stream valley was destroyed. That stream valley, with its characteristic sinking streams, over 100 documented sinkholes, and shallow and cavernous bedrock, was a poor location for disposing coal combustion waste because of the connectivity of groundwater to the Cumberland River.

The placement of coal ash here, combined with the crude construction methods used by TVA to build the Ash Pond Complex, has resulted in contaminants being released to the groundwater and surface water.

The former Sinking Creek stream valley, beneath wastes in the Ash Pond Complex, has become a submerged karst valley with its sinkholes, streambeds, sinking streams, and floodplain inundated with groundwater that is hydraulically connected to the rise and fall of the Cumberland River.

In addition, the location of the NRS was a poor location for disposing coal ash, as it was -- it has several documented sinkholes, has a low-lying area, and the groundwater beneath it is hydraulically connected to the Cumberland River.

Impounding the Cumberland River in 1957 raised the

uppermost water table aquifer at least 35 feet along the shoreline and beneath the peninsula, resulting in a rise in the groundwater level under the Ash Pond Complex and the NRS to at least 444 to 447.5 feet above mean sea level. Ash at both the Ash Pond Complex and the NRS is buried in some places at a level of 440 feet msl, meaning that ash is buried within the groundwater -- is in constant contact with it.

The hydraulic connection to the Cumberland River never ended, and coal combustion wastes still enter the river. Future sinkhole collapses are possible because of the conduit flow connectivity to the Cumberland River.

Coal combustion waste constituents will continue to enter into the Cumberland River through: Porous media groundwater flow through alluvial and residual soil along the river shoreline; second, direct conduit flow of solution-enlarged bedrock along bedding planes and joints; third, surface seeps of shallow groundwater.

The fact that saturated ash still exists in the NRS 45 years after the waste placement ended demonstrates that groundwater continues to recharge the wastes from topographically and hydraulically upgradient areas that flow into the waste. Continued groundwater contamination demonstrates the long-term persistent effects of the disposal activities.

Further, the continued existence of widespread

very acidic pH, for example, 2 to 4, that has existed at the NRS since at least the mid-1980s, demonstrates that the existing monitoring well system is incapable of detecting those widespread acidic conditions.

The increased elevation of the uppermost aquifer, the hydraulic connectivity of the underlying bedrock to the Cumberland River, sinkholes, and sinking streams on TVA property, sinkholes and sinking streams adjacent to the TVA property to the north, and the original ground topography at the Gallatin Plant, result in solid wastes in both the NRS and Ash Pond Complex that are saturated under natural groundwater and river flow conditions, regardless of the presence of sluice water or industrial wastewater discharges in the disposal areas.

Impacted groundwater has reached residential wells along Odom's Bend Road. The Ash Pond Complex can also influence standing water collected within the large sinkhole complex northeast of the Ash Pond Complex on Newton Lane. The monitoring well network and sampling programs for both the NRS and the Ash Pond Complex are incapable of comprehensively monitoring the uppermost water aquifer that discharges into the Cumberland River because wells are located too far apart and are too deep.

The uppermost aquifer occurs in alluvial and residuum soil and within the upper Carters Limestone bedrock.

This uppermost aquifer is laterally continuous across the peninsula. Any deeper groundwater -- or groundwater deeper than what occurs in the Carters formation would not be indicative of the uppermost aquifer or provide an indication of an early release.

Nevertheless, sampling from monitoring wells in both the Ash Pond Complex and the NRS demonstrates that pollutants from coal ash have been discharging -- have been discharged into the groundwater. Solid coal combustion wastes and confirmed fly ash and bottom ash were found several feet thick in the Cumberland River along the shoreline of the Ash Pond Complex and the NRS, using a very low-tech approach based on a simple visual inspection and manually probing by Global Environmental. The extent of the wastes along the shoreline has not been determined.

Laboratory analytical testing for potential constituents of concern confirmed contaminants that were indicative of coal combustion waste: For example, arsenic, boron, sulfate, silicon, and sulfur. A subsequent microscopic evaluation confirmed that fly ash, bottom ash, and coal were present in at least one sample location from the Cumberland River next to the NRS.

The ecological screening evaluation and the human risk assessment prepared by Arcadis regarding the NRS and their conclusions of no harm are filled with assumptions that

invalidate many of its findings. One conclusion that is valid, however, is that the construction of a composite cap over the NRS would offer, quote-unquote (as read):

> Minimal benefit in terms of preventing groundwater contamination from reaching the Cumberland River.
>
> As such, even with a constructed composite cap over current waste disposal areas in the future, contaminated groundwater would continue to reach the Cumberland River. Construction of a cap over the wastes will not result in cleanup of already contaminated groundwater beneath the wastes, groundwater that will continue to flow into the Cumberland River. Saturated wastes can be expected to remain in both disposal areas, and one can expect highly variable and declining groundwater quality for the foreseeable future.
>
> The variable groundwater quality by both depth and lateral extent will continue to present threats to ecological and human receptors.

Q. Thank you.

Your Honor, with your permission, could I just have a little latitude and a few follow-up questions?

THE COURT: Sure.

MS. DAVIS: Thank you.

Q. Mr. Quarles, could you just clarify for the Court what is the time period represented by the models that you talked

about here earlier today?
A. The time period of the model is really dating back to the original ground topography of the 1930s and '50s, which was the original ground surface that is illustrated on those cross-sectional models. And we used those original ground topographic levels to create the bottom, if you will, of both the NRS and the Ash Pond Complex.

And we used -- I used cross-sections for some of the dikes that were made from Stantec report in 2010, and the groundwater elevations that are shown on there came from a May 2012 groundwater flow diagram. So it's really from the 1930s, '50s, to relatively recent conditions. Especially with the coal combustion waste that are shown in the shallow embayments, that being be a relative new finding, you know, 2014 to 2016.
Q. I'm afraid my question wasn't clear. What time period did you intend for those to represent? Are those current conditions? past conditions? what?
A. They're current conditions as it stands right now with wastes that have been placed in the disposal areas.
Q. And on the map, if you could -- and we can use that map, too, but one thing that I didn't ask you to point out is what direction does the river flow? I think there's an arrow showing that, if you can point that out.
A. So the river flows here. It's flowing this direction.

So the 109 bridge, drinking water intake, the Boxwell Boy Scout, all of those would be down river. And then ultimately down river is the Old Hickory Dam and then the city of Nashville.

Q. Okay. And to be clear, what was TVA's response to the 2012 Arcadis report that you referenced that recommended collecting actual samples in the river?

A. They didn't collect actual samples in the river. They again used predictive models and mathematical calculations. Had they, for example, had this wildlife transect extended along the shoreline of the NRS, perhaps they would have seen what we saw, which was the reddish-brown sediment and the black sludge.

Q. Just three or four more questions.

From your review of historic documents, TVA documents, I mean, how long has TVA known that the ash pond -- active Ash Pond Complex has been located in karst -- a karst area with sinkholes and leaks or fractures?

A. Well, the original topographic planning area map shows sinkholes in the disposal area. And that was in the 1952 time period.

1982 TVA memo -- I don't remember if it was a memo or report -- says that the -- the waste in the Ash Pond Complex is, quote-unquote, probably within the water table. So that assumption has been, you know, made since 1982.

And then any sort of knowledge of -- what was the --

Q. I'd like to ask you how long TVA has known that the waste from the Ash Pond Complex has impacted or polluted the groundwater.

A. So review of the data for the Ash Pond Complex dating at least to 1990, there was sulfate in perimeter wells, downgradient wells around the Ash Pond Complex along the western shoreline, and then in this area that showed groundwater contamination.

And then there's that GF13 that was over here that had over 2,000 parts per million. Those were all old sample results.

As far as contamination -- did you ask about the NRS as well?

Q. No. But please tell me about the NRS as well, Mr. Quarles.

A. So the NRS is well documented because TDEC, the state agency, put them in assessment monitoring and required, because of groundwater contamination -- the red water seep program that is -- is shown in their inspection reports and such dates back to the 1980s: And so that suggests that you had groundwater contamination in the 1980s for the NRS.

Q. And, finally, Mr. Quarles, how long has TVA known that its coal ash waste was impacting private drinking water

wells?
A. TVA did some internal investigations in the late '80s, and there was a summary report in 1987, where they -- they have sampled the private wells up along Odom's Bend Road and used boron as a signature constituent, coal combustion waste constituent, and concluded that the -- boron was associated with their Ash Pond Complex disposal.
Q. I said that was my last question, but I do have one more.
What additional information would you need, if any, to state the opinions you just made to a reasonable degree of scientific certainty?
A. I don't need any information. I mean, the history -- the TVA documents themselves from the '70s and '80s, and '90s, you know, you talk about ongoing widespread contamination. It's been persistent.
MS. DAVIS: Thank you.
THE COURT: All right. Why don't we take a break and come back in about 15, 20 minutes.
(Brief recess.)
THE COURT: All right. Be seated.
Proceed.
MR. AYLIFFE: Thank you, Your Honor.

CROSS-EXAMINATION

BY MR. AYLIFFE:
Q. Good afternoon, Mr. Quarles.

A. Good afternoon.
Q. Mr. Quarles, your CV states that you're a public interest environmental consultant, yes?
A. That's -- that is what I do and what I've done for the last several years, yeah.
Q. That's what it states in your CV, right?
A. Correct.
Q. And you prepared two reports for this lawsuit, yes?
A. Yes.
Q. And both reports were prepared for the Southern Environmental Law Center, correct?
A. Correct.
Q. So you were working for the Southern Environmental Law Center in this case, correct?
A. That's correct.
Q. And both of those reports state that they were prepared by Global Environmental, LLC, yes?
A. Correct.
Q. And both reports list a Nashville, Tennessee, P.O. box as the address, correct?
A. Yes.
Q. And Global Environmental is a consulting business that you operate out of your home, correct?
A. That's correct.
Q. And it was formerly Globally Green, LLC?

A. It was.
Q. And you're the sole employee of Global Environmental, yes?
A. Correct.
Q. And on your CV you list an office telephone number, correct?
A. I don't remember specifically.
Q. And you list your email address as markquarles@comcast.net, correct?
A. Yeah.
Q. Now, according to your CV, you're a licensed professional geologist?
A. Correct.
Q. And according to your CV, you're not a licensed professional engineer?
A. Correct.
Q. And according to your CV, you're not a toxicologist?
A. Correct.
Q. You also have a LinkedIn page, correct?
A. I do.
Q. And your LinkedIn page states that you are Global Environmental's principal consultant?
A. Correct.
Q. And you market yourself on LinkedIn as a person that has a public interest focus on proper waste management and

environmental and social justice, yes?
A. Correct.
Q. And your LinkedIn page advertises that you provide consulting services as an environmental scientist?
A. Okay.
Q. That's what it says?
A. Okay. I haven't read my LinkedIn page in --
Q. And it says you also provide services an as expert witness, correct?
A. Correct.
Q. And it says that you provide services to local and national environmental public interest groups and NGOs, correct?
A. Correct.
Q. And it mentions Sierra Club?
A. Yes.
Q. Environmental Integrity Project?
A. Correct.
Q. Earth Justice?
A. Yes.
Q. Southern Environmental Law Center?
A. Yep.
Q. And a couple others.

Now, you prepared your first report in this case in November of 2015, yes?

A. Correct.
Q. And the second, I believe, was in March of 2016?
A. Correct.
Q. And you also prepared a report in the state environmental enforcement action?
A. I reviewed -- yeah, environmental investigation plan.
Q. That's right. Yes. Reviewed, yeah, the EIP comments.

And what I would like to do first is talk a little bit about some of the things that you pointed out on the joint map that's right here. And it may be easier if we put it on the screen so you can see it.

And you testified that TVA constructed the Ash Pond Complex between 1953 and 1954, correct?
A. Yeah.
Q. And you pointed it out a minute ago, but I think -- you said this is where TVA constructed the barge loader and the dock, correct?
A. I did.
Q. And that's sometimes referred to right here down -- as Dike C?
A. Yeah.
Q. And that -- right there is a coal barge unloader, is it not?
A. I'm sorry? Your pointer is moving.
Q. Sorry. Right there.

A. It is on the left bank, is the coal unloader.
Q. Okay.
A. Yeah.
Q. And also in your testimony in this case and in your reports you talk about the Sinking Creek that was depicted on the 1930 Corps of Engineers survey map, correct?
A. Correct.
Q. And that Sinking Creek outleted at the Cumberland River on that map, correct?
A. It is.
Q. And the location of the Sinking Creek outlet to the Cumberland River back -- as depicted on the 1930 map was right here at Dike C; isn't that correct?
A. It was.
Q. Okay. And also just want to mention, Dike C right here is just on the northern side of what I think you talk about in your testimony as a northerly embayment?
A. Yes.
Q. Where you did some sampling?
A. Correct.
Q. Okay. Now, do you see on this map up here -- it's a little hard to see -- where APC1, 2, 3, and 4 are located?
A. I do.
Q. And according to the scale -- I'm not going to get the ruler out, but it's about a quarter of a mile between APC1,

2, 3, and 4 and down here at Dike C, correct?
A. I haven't scaled that.
Q. Okay. We can look at it. This shows about three and a half inches is a quarter mile. And it looks closer to four on here.
So maybe a little over a quarter mile, would you agree with that?
A. Okay.
Q. And you told me earlier that Dike C was where Sinking Creek outleted to the Cumberland back in the 1930s.
A. Yes.
Q. So you would agree that APC1, 2, 3, and 4 are not where Sinking Creek outleted into the river in the 1930s?
A. The main flow of the channel -- Sinking Creek came down to where the Dike C was, but there were a couple of low-lying areas along the western bank.
Q. You testified in this case that Sinking Creek outleted down here, didn't you, sir?
A. I did, yeah.
Q. Okay. And so you would also agree with me that the axis of the historic Sinking Creek as depicted on the Corps' 1930 map did not come down here; it came down here, didn't it?
A. It did.
Q. And you know Barry Sulkin, right?
A. I do.

Q. And you reviewed his direct testimony, correct?
A. I did.
Q. And one of the things Mr. Sulkin says in his direct testimony is that he took samples at APC1, 2, and 3, and I think you participated in those same sampling events, yes?
A. Some of them I did.
Q. Okay. And one of the things Mr. Sulkin says about APC1 and 2 is that they were taken at the historic drainage outlet of Sinking Creek.

So he would be wrong, wouldn't he?
A. From an original stream channel standpoint, he would.
Q. And did you have an opportunity to review Mr. Groves's report in this case?
A. I did.
Q. And I want to just show you a photograph that's in -- I said "Mr." -- Dr. Groves's report.

Dr. Groves says in his report that that black line represents the axis of the historic Sinking Creek as depicted on the Corps's 1930 map.

And according to you, he's got it in the wrong place, doesn't he?
A. There's a lot of black lines on that diagram.
Q. This one right here. The one that says "Axis of Sinking Creek"?
A. Yeah, the lower part at the river is -- is not in the

right spot.
Q. Okay. And this is -- this is Dike C down here where the barge unloader was, correct?
A. Correct.
Q. This is where Sinking Creek outleted historically?
A. Correct.
Q. Okay.
A. Based on the 1930 topo map.
Q. Which you discuss extensively in your testimony and reports in this case?
A. I do discuss the topo map.
Q. And so on the topic of the sampling that was conducted by you and by Mr. Sulkin, I wanted to ask you a couple of questions there in the vicinity of the Ash Pond Complex.
And you talked about some of them earlier on your direct testimony, correct?
A. I did.
Q. You talked about NRS samples, yes?
A. I did.
Q. And you talked about Ash Pond Complex samples, correct?
A. I did.
Q. Okay. And you state in your report in this case that the materials obtained from your samples were later confirmed through microscopic analysis to be fly ash, bottom ash, and coal, correct?

A. Correct.
Q. Your report does not state how long the materials obtained from your samples had been in the river, though, does it?
A. It does not.
Q. Okay. And your report does not state how long the materials obtained from your Ash Pond Complex samples had been in the river, does it?
A. Does not.
Q. And you further state in your report that, quote, your investigation did not determine how the waste reached the Cumberland River, correct?
A. Correct.
Q. For both your Ash Pond Complex and NRS samples, correct?
A. Correct.
Q. And one of the things that you talked about in your direct testimony -- and the Court, I believe, asked you a question -- was your use of the term "diffuse flow."
Do you recall that?
A. I do.
Q. And I think what you said was -- I think what you said was that ES1 and ES2, which you've identified here on this document, were examples of diffuse flow springs?
A. Yeah. The ES1 for sure, because it was kind of a -- flowing through soil, and then the GS -- the ES2 that was

actually the ES1, was a -- diffuse flow through gravel and sandy mixture.
Q. And "diffuse flow" means groundwater that does not occur in a restricted conduit, correct?
A. It's flowing through a porous media, like a soil particle.
Q. Not a restricted conduit, correct?
A. Not a bedrock conduit.
Q. And "diffuse groundwater" is defined as (as read):

Generally slow moving, may be laminar and have a uniform discharge, and slow response to storms. Agree with that?

A. I'm not familiar with that definition, but that's sounds like an accurate description.
Q. Mr. Quarles, I'm now showing you what is attached to the complaint in this action as Exhibit 6, but I believe it's Document 1-8 in the record.

You would agree with me that Seep D is in the same location as your East Side 1 or ES1, correct?

A. Correct.
Q. And you would agree with me, sir, that Seep C as depicted on this complaint is the same location as East Side 2, correct?
A. Yes, sir.
Q. And you would agree with me that Seeps A and B right

here are in the general vicinity of what you describe in your testimony as APC1, 2, and I think it was 4, but it's right here on this --

A. Can you blow that up?

Q. I don't know. Can you see that now?

A. Yeah, I can see seep, the word S-e-e-p on the top, but then I see an S-e, but it looks like the labeling is the same color as the -- the interior of the ash pond.

So maybe you would like to point me to the two you're talking about.

Q. Sure. Well, you were a participant in the sampling events, correct?

A. Yes.

Q. And you called them in your report Seeps A and B, correct?

A. I did.

Q. Okay. And so those seeps are in the same vicinity of what you now call APC1, 2 --

A. Yeah. Yes, sir.

Q. Okay. Now, you've been retained as an expert or disclosed as an expert in the State enforcement action, correct?

A. I have.

Q. That's a copy of the intervenor's complaint in the State enforcement action. And attached to that, I believe, as

Exhibit 1 is this map.

And right there is Seep D, which is the same Seep D attached or referenced in the attachment to the complaint in this action, correct?

A. Correct.

Q. And it's the same one you refer to as APC -- excuse me -- East Side 1, correct?

A. Yes.

Q. And then here's Seep C.

That's the same Seep C that's referenced in the attachment to the complaint in this action, correct?

A. Yes, sir.

Q. And you now call it East Side 2, I believe, correct?

A. Yes, sir.

Q. And then here's Seeps A and B, and they're in the same location as they are in the attachment to the federal complaint, correct?

A. Correct.

Q. And they're in what you now refer to as -- I'll say the vicinity of APC1, 2, and 4; is that correct?

A. Correct.

Q. It's hard -- and 3 as well, I think. Yeah. 3 as well, correct? APC3?

A. That sounds about right.

Q. Those are coal barges parked right beside APC1, 2, and

4, correct?
A. They are.
Q. Okay. I wanted to ask you just a couple of questions about some of your NRS samples.
You said, I believe, earlier -- I think you were reading from the portion of your testimony where you talked about slides of the dikes from the NRS, correct?
A. Yes, sir.
Q. And your testimony specifically references a slide that occurred in June of 1967, right here?
A. Yes, sir.
Q. And that's just above the locations of your NRS 1 and 5, correct?
A. It is.
Q. And the dikes at the nonregistered site were made of both Earth and ash raises, correct?
A. Correct.
Q. NRS 5, you said, contained black sludge-like material, correct?
A. I did.
Q. And that's the same location that's right across from the coal unloader, isn't that correct?
A. It's -- yes, sir.
Q. NRS 2 and 5 are two samples you collected adjacent to the middle portion of the NRS, what used to be called, I

believe, Area B, correct?
A. Where is NRS 5?
Q. Or does that say 6? No. That's NRS 2 and 6. Excuse me, NRS 2 and 6.
A. Near Area B, correct.
Q. And based on your review of TVA's historical records, many of which are cited in your reports, you know that in 1974 TVA documented that ash carried by surface runoff is escaping from Area B, correct?
A. Correct.
Q. And TVA said that the escaped ash is forming a small delta in Old Hickory Lake, correct?
A. Correct.
Q. I would like to stay at the nonregistered site for a few minutes, if we could, please, sir.

You testified that waste disposal at the nonregistered site ended in 1970, correct?
A. Correct.
Q. And you testified that by 1973 the site had been drained of liquids, correct?
A. Correct.
Q. And the Stantec exhibit attached to your testimony states that in 1995 a formal closure plan for the nonregistered site was developed and submitted to TDEC, correct?

A. Yes, sir.
Q. And the attachment to your report, the Stantec 2009 report, said that TDEC approved the plan in 1997?
A. Correct.
Q. And further states that closure construction work for the nonregistered site was completed in 1998, correct?
A. I don't remember the specific date. That sounds about right.
Q. And the Stantec report attached to your testimony describes the nonregistered site as a closed disposal area, correct?
A. It does.
Q. Pardon me?
A. It does.
Q. Okay. And you would also agree with me, wouldn't you, sir, that after closure, the nonregistered site is no longer designed to hold an accumulation of liquid?
A. I'm sorry. Repeat the comment or question.
Q. After closure, you would agree with me that the nonregistered site is no longer designed to hold an accumulation of liquid?
A. That is correct.
Q. You testified that the NRS was a poor location for storing coal ash as it has several, quote, documented sinkholes?

A. Correct.
Q. And in your report you cite to a 2014 TVA Arcadis groundwater assessment monitoring project report, correct?
A. I do.
Q. And you cite to that for your discussion of the history of the NRS, correct?
A. I do.
MR. AYLIFFE: And, Your Honor, for the record, that monitoring report is Joint Exhibit Number 59.
THE COURT: Where is the Stantec report? I thought it was 267, but it's not there.
MR. AYLIFFE: The 2009 or the 2010, Your Honor?
THE COURT: I guess both.
MR. AYLIFFE: The 2009 is an attachment to Mr. Quarles's testimony in this case.
THE COURT: Uh-huh.
MR. AYLIFFE: And I'm not sure what the docket is.
And the 2010 I believe is Joint Exhibit 67.
The 2009, Your Honor, was a Phase I assessment and the 2010 was a full geotechnical exploration.
Q. So, according to Arcadis, the report you cited in your direct testimony statement, alluvial terraced deposits and residual soils mantle the bedrock beneath the NRS, correct?
Do you see it?
A. Maybe get your little pointer out and show me where

you're reading.
Q. Sure. Be happy to. Right there.
A. Okay.
Q. And further states that there's a combined thickness of alluvium and residuum mantling the bedrock ranging from 8 to 79 feet and averaging approximately 40 feet, correct?
A. Yes, sir.
Q. And although you said in your testimony that there was documented history of sinkholes, that's not what this says, is it?
A. It's not what Arcadis concluded.
Q. Yeah. Arcadis concluded that (as read):

> Although limestones beneath NRS are susceptible to karstification and sinkhole development, no sinkholes were observed in the preplant topography in the immediate vicinity of the NRS.

Correct?
A. That's what they say.
Q. There are no sinkholes that you've documented in your report at the NRS, correct?
A. Yeah. If you go to what is on page 8 of my -- paragraph 24, when I first started my direct --
Kristin, if you could pull that up.
Q. What paragraph did you say?
A. 24.

Q. My question was that you've documented, sir.
A. Yeah, in my report -- well, there is, covered with water now.
Q. Right. So the answer is, you haven't personally documented any sinkholes at the nonregistered site, correct?
A. Correct.
Q. Now, your testimony also distinguishes between porous media groundwater flow and direct conduit flow, correct?
A. It does.
Q. And you state that conduit flow occurs in bedrock, bedding planes, and joints, correct?
A. Correct.
Q. But the 2014 groundwater assessment that we just looked at says that here at the NRS, alluvial deposits and residual soils sit over top the bedrock beneath the nonregistered site, correct?
A. Yeah, based on where they put their holes to make that determination.
Q. And you haven't documented in your report that you poked any holes out there, have you, sir?
A. Correct.
Q. And you said -- excuse me.

The Arcadis report that you cite says that the depth of the alluvium and residuum is approximately 40 feet, correct?

A. I'm sorry. Say that again.
Q. The Arcadis report that you cite in your direct testimony states that the depth of the residuum and alluvium is approximately 40 feet, correct?
A. Okay.
Q. We can read it again if you want.
A. I -- I have no reason to doubt that. What paragraph are you referring to?
Q. This is your conceptual site model for the NRS that you talked about in your direct testimony.
A. It is.
Q. And you would agree with me, sir, that you show in that model ash sitting directly on top of bedrock, correct?
A. I don't.
Q. I'm sorry?
A. I don't.
Q. And that would be in contradiction of what's reflected in the Arcadis report, correct?
A. The Arcadis report said that there's a -- a layer of alluvial soil, and that's what's reflected on that diagram.
Q. It said 40 feet of alluvial soil?
A. Okay.
Q. Well, you didn't put any elevations on here?
A. I dind't --
Q. So it's impossible to tell, isn't it?

A. -- no.
Q. The Arcadis report that we've been talking about states that the nonregistered site at -- local groundwater recharge occurs by infiltration of precipitation, correct?
A. I don't remember that statement specifically.
Q. Right here. "Local groundwater recharge occurs by infiltration of precipitation."
A. Okay.
Q. Correct?
That means rainfall, correct?
A. Could be snow.
Q. Could be. And you don't dispute that conclusion in your report in this case, do you?
A. I don't.
Q. You also testified that, according to the 2014 groundwater assessment report, the Arcadis report, Joint Exhibit 67, the uppermost groundwater at the nonregistered site occurs in alluvial deposits and residuum soil?
A. It does.
Q. Well, your model shows groundwater occurring within the ash, doesn't it?
A. It does.
Q. So that would be inconsistent with what's reflected in the Arcadis report that you site in your direct testimony?
A. I don't think it's inconsistent. It's just that the

Arcadis report relied on wells around the perimeter and my report relied on wells and borings through the ash.
Q. Let's shift over to the Ash Pond Complex, if we could, sir.
A. Okay.
Q. In your direct testimony you cite to two Stantec reports, correct?
A. I remember the 2010 specifically.
Q. The 2009 Stantec disposal facility assessment report attached to your direct testimony was one.
A. Okay.
Q. And you also cite to the subsequent 2010 Stantec geotechnical exploration report, yes?
A. Okay.
Q. Is that a yes?
A. Yeah.
Q. And then you pick and choose from the reports and ignore portions that don't support your opinion, don't you?
A. No.
Q. Let's take a look. In the karst discussion portion of your testimony here, you state that (as read):

> According to Stantec for, quote, the entire Ash Pond Complex, karst activity and sinkhole activity is present plant-wide and is a concern.
>
> Isn't that what you say?

A. What paragraph are you reading?
Q. Hold on a second. I'll tell you. Paragraph 64.
A. 64?
Q. Yeah.
A. Yeah, I did quote that.
Q. Okay. And you said "for the entire Ash Pond Complex," is what your testimony says, correct?
A. Yes.
Q. And you cited the Stantec report as your authority for that, correct?
A. So let me clarify. So it said --
Q. Did you cite the Stantec report as your authority for that?
A. I did. Yeah. (As read):

> Notable Observation and Concern. For the entire Ash Pond Complex, the karst activity and sinkhole activity is present plant-wide.

So my testimony says, under the heading "Notable Observation and Concern" (as read):

> For the entire Ash Pond Complex, karst activity and sinkhole activity is present plant wide and is a concern.

MR. AYLIFFE: Move to strike the answer as nonresponsive.
THE COURT: I'll give it whatever weight it

deserves.
BY MR. AYLIFFE:
Q. This is attached to your report. And it talks about leakage in the 1970s from flash pond --
THE COURT: I can't hear you.
THE WITNESS: I couldn't hear you either.
BY MR. AYLIFFE:
Q. The portion that you cite talks about leakage in the 1970s from Pond E.
A. I did talk about leakage from the '70s in Pond -- what is now Pond E.
Q. Refer you to Joint Exhibit 67. It's the 2010 Stantec report of geotechnical exploration.
There's a whole section on karst activity at Gallatin, isn't there, sir?
A. There is.
Q. And at the end of the third paragraph in that section, 3.3.2, it says (as read):
Gallatin has not experienced any known additional karst-related problems within the ponds in recent years.
Doesn't it?
A. That's what Stantec said.
Q. You didn't cite any of that in the report you issued in this case, did you, sir?

A. I did not.
Q. Nor in your direct testimony here today, did you?
A. I did not.
Q. Instead, one of the things you said that's -- the Stantec 2010 report stated was that there are caverns in the bedrock underlying the Ash Pond Complex.
Isn't that your testimony?
A. It is.
Q. And you cited page 3 of the Stantec report for that?
A. Yep.
Q. We can look at it.
But that page doesn't say "caverns," does it?
A. So you can pull it up.
Q. Just really quickly, though, a cavern means an underground opening in soluble rock similar to a cave, correct?
A. It is. And -- it is an opening in bedrock.
Q. There's page 3. I don't see the word "cavern" anywhere on that page.
A. So what may have happened in that is the footnote may have been copied from a previous footnote. If you would like to give me the rest of the report, I'd --
Q. The report doesn't say "cavern" anywhere in it, does it, sir?
A. I don't know that it does or not.

Q. Okay.
A. I'm pretty sure --
Q. No. That's your answer.
A. And I can go get my -- my direct testimony from my briefcase, and I can -- I want to say, if you'll pull up page 6 and maybe page 9, see what those pages say, those come to mind.
Q. One thing that your testimony does state correctly, I think, about the 2010 Stantec report is that Stantec found that native soils underlie all ponds, and the thickness varied from approximately 1 to 30 feet thick.
A. Yeah, they did make that conclusion. But let's also remember that --
Q. Yes or no?
A. They did.
Q. Thank you. Specifically, Stantec found that these soils were native clays, correct?
A. I believe that's correct.
Q. And they further said that most thicknesses are from about 10 to 25 feet, correct?
A. That sounds about right.
Q. I'm going to show you what's Joint Exhibit 141. And that's a copy of your "Conceptual Ash-Groundwater-Surface Water Connectivity Model."
You testified earlier that the foundations to

these cross-sectional models were the 1930 and 1952 topographic maps, correct?
A. Correct.
Q. And so you're using 70-year-old surface elevation data to estimate 2017 subsurface condition, aren't you?
A. I did.
Q. Okay. And your model there doesn't even show a top of rock elevation, does it?
A. It does.
Q. Top of rock elevation?
A. Top of bedrock.
Q. Throughout the pond?
A. Yeah, if you want to put -- put it back up there, I'll get my pointer and I'll show you the top of rock.
So what's shown here in the hatched, kind of the brick-looking stairstep, this is a common symbol for limestone bedrock.
Q. Uh-huh.
A. And this line is the top of bedrock. And you'll see, like, right here I have a conceptual placement of a layer of soil, and then this is the contact of bedrock and alluvial soil.
Q. I knew you drew it on the picture. I'm asking if you put the elevation on there. And I don't see that you did.
A. That elevation is -- the bottom through there is about

440 feet, which is about -- to scale -- about 4 feet lower than the 444.
Q. And your conceptual model doesn't show the clay in the Stantec report, does it?
A. It does. It shows --
Q. It shows ash on top --
A. It shows alluvial soil here. And let's remember that the Stantec report was a dike stability report. So they drilled through the dike.
Q. And also a couple borings in the pond, correct?
A. I don't remember those. But the focus was the alluvial soils beneath the dikes, which is illustrated on the conceptual model.
Q. But what Stantec said in its report is that there's karst -- excuse me -- that there's clay across the pond.
You don't show any of that?
A. I did. There are -- I did illustrate soil in the conceptual diagram.
Q. You also -- let me put this back.
You showed -- you drew a little sinkhole in right here on your model, correct?
A. I did.
Q. Now, it's really hard to see.
You would agree with me, you drew the sinkhole in right up at the A end of the A Pond access, correct?

A. The sinkhole that that is referring to is actually -- let me see if I can -- right there. Which is on the 1952 TVA planning topographic map that shows a sinking stream, this blue line right here, sinking into the sinkhole right there.
Q. And that says Sinkhole 1950 topography, and it's not shown on this map, is it?
A. Well, because the black line covers it.
Q. You would agree with me, sir -- let's look at the big blowup map -- along your A-prime to A axis --
A. I can't see that. So if you would like to turn it --
Q. I'm sorry. I apologize.
A. -- that would be awesome.
Q. Let's do this. This is an older aerial image from 2014, I believe. So it's not current.

But you would agree with me that that aerial image doesn't show ponded water all the way across the pond on the axis that you drew on your model, does it?
A. Repeat the question:
Q. This photograph right here doesn't show ponded water all the way across, does it?
A. It shows a dry area right in here.
Q. Right. Exactly right. And your model shows ponded water all the way across from the A-prime to the A axis?
A. It does.
Q. Okay. And it also says "Groundwater elevation May 23rd,

2012"? It says that, doesn't it?
A. It does.
Q. Even if that's right, your model is based on nearly five-year-old data, isn't that correct?
A. May 2012.
Q. Five years, right?
A. Correct. For the groundwater elevation for that period.
Q. You talked some this morning on your direct examination about sinkholes and leaks at the Ash Pond Complex in the 1970s, correct?
A. Correct.
Q. And you cited to several TVA documents from the 1970s?
A. Correct.
Q. And you concluded in your testimony that the hydraulic connection that existed in the 1970s never ended --
A. Correct.
Q. -- correct?
But you ignored in your testimony and in your reports TVA's memoranda that concluded otherwise, correct?
A. Which memoranda are you talking about?
Q. TVA's August 8th, 1978, memorandum, for example, Joint Exhibit Number 79.
A. I don't remember what that memo says.
(Pause in proceedings.)
THE COURT: Okay. You can resume.

MR. AYLIFFE: Thank you.
Q. Joint Exhibit Number 89. (As read):
TVA concluded that after the repairs no correlation between the levels or rainfall could be found since early June 1978, apparently indicating that no hydraulic connection between the pond and the river presently exists.
Do you see that?
A. I do.
Q. You didn't cite any of that in your testimony, did you?
A. I don't believe I did.
Q. I want to show you what's been marked as -- what's in evidence as Joint Exhibit Number 88. And this is a memo from January 25th, 1979, discussing the history of leakage problems in the 1970s.
Do you see that?
A. I do.
Q. And that first sentence says (as read):
All the holes or lower areas where leakage might be suspected were filled with either rock and clay or coarse ash or a combination of these materials.
Do you see that?
A. I do.
Q. And the next sentence says (as read):

This effort was apparently successful, and we have now sealed the pond to the extent that water has risen to the designed elevation.

If you skip down with me, sir, it says (as read):

Also, recent heavy rains have affected the water level in the pond. Progressive rise of the water before rain started leads us to believe that the complete sealing of the pond has been achieved.

That's what it says, isn't it?

A. It is.

Q. You didn't discuss any of that in your testimony here today, did you?

A. I did not.

Q. Now, you've also offered some opinions at the end of your testimony about cap enclosure, correct?

A. I did.

Q. And according to the CV attached to your testimony, you've never designed a cap system, correct?

A. I personally haven't, but I've been a project manager of numerous projects that did.

Q. So the answer is no, correct? You personally haven't, correct?

A. Correct.

Q. And you're a licensed geologist, correct?

A. I am.
Q. And you're not a licensed professional engineer?
A. Correct.
Q. And you have opined in this case in your reports that closure in place under the CCR rule is not a proper closure method for the Ash Pond Complex?
A. Correct.
Q. And you commented extensively in your reports about whether closure in place will meet the requirements of the CCR rule, correct?
A. I do.
Q. So presumably you must have read them, right?
A. I did.
Q. And so you must know then, sir, that the CCR rule does not allow professional geologists, such as yourself, to certify whether a closure plant complies with the CCR rule, correct?
A. I don't know if the CCR rule requires a PE stamp or not.
Q. So you don't know?
A. I don't.
Q. Mr. Quarles, next I'd like to review some of the qualifications that you've listed in your direct testimony and in the CV attached to your testimony.
A. Okay.
Q. And in your CV there's a section entitled "Range of

Technical Experience, Coal Combustion Waste," correct?
A. Correct.
Q. And by my count, 11 of the 13 entries are on behalf of environmental groups, correct?
A. I haven't counted them.
Q. And one of the experiences you cite in your testimony is your work for Sierra Club commenting on the Gallatin Dry Ash Landfill, correct?
A. Correct.
Q. And you also testified here today that you're familiar with the Gallatin site because you submitted comments in 2014 on behalf of Sierra Club regarding the proposed Dry Ash Landfill at Gallatin?
A. Correct.
Q. And you submitted those comments on April 14th, 2014, yes?
A. I don't remember the exact date.
Q. And you submitted them to Mr. Patrick Flood, correct?
A. Sounds correct.
Q. And you signed and stamped it with your Tennessee professional geologist stamp, correct?
A. Correct.
Q. And you submitted 101 separate comments on behalf of Sierra Club, yes?
A. I don't remember the exact number.

Q. We'll look at some of them in a second.
And several of your comments specifically mentioned the ash ponds at Gallatin, yes?
A. Some of them do.
Q. And to summarize, the basic point of your comments was that the landfill permit does not meet minimum technical standards, correct?
A. Correct.
Q. Is not protective of the environment, correct?
A. I don't remember that word specifically.
Q. Is not protective of the environment?
A. Okay.
Q. And does not meet the protective measures necessary for problematic coal combustion wastes?
A. Okay.
Q. Correct?
A. Yeah.
Q. And you inform Mr. Flood that your comments were based on your nearly 25 years of experience permitting and designing landfills?
A. Correct.
Q. And then you told Mr. Flood that you and Sierra Club looked forward to receiving detailed responses from TDEC on each and every technical comment attached?
A. Yes, sir.

Q. And then you sent Mr. Flood an email about three days later, isn't that correct?
A. I don't remember.
Q. And in that email, you asked him about a new TDEC landfill permitting guidance document, correct?
A. I don't remember.
Q. Markquarles@comcast.net, you told me that's your email address, correct?
A. Yes.
Q. To Pat Flood, correct?
A. That is.
Q. And you submitted -- or you asked him questions about a new guidance document, correct?
A. I did.
Q. Okay. And Mr. Flood responded to your email and then you responded back; do you remember that?
A. I don't.
Q. Okay. There's his response, April 8th, 2014, 10:25. If we go up, there's your reply about 30 minutes later, April 18th, 2014.

Do you see that?

A. I do.
Q. And you told Mr. Flood that it would be useful and productive to allow the, quote, enviro community to review any draft documents, yes?

A. If you would like to point that out, show me with your highlighter, that would be great.
Q. I'll be glad to. Right there.
A. Yep.
Q. Then you went on to say that you encouraged TDEC to "contact the usual suspects," such as Sierra Club, yes?
A. Yes.
Q. Earth Justice, yes?
A. Yes.
Q. SELC?
A. Yes.
Q. TCWN?
A. Yes.
Q. And then at the end of that paragraph that's highlighted here for you, it said (as read):

> It would be nice to at least allow a more fair fight and consideration.
>
> Correct?

A. Correct.
Q. So it's about a fight to you?
A. It's really an opportunity to provide equal comments and get equal representation.
Q. And then Mr. Flood responded and you wrote back, and you accused the TVA staff of being idiots or liars, isn't that right?

A. I'm sorry. Where?
Q. Right here. Mark Quarles at 12: --
A. I'm sorry. Highlight that.
Q. (As read):

Pat, one last comment to your desire to have more similar TVA meetings in the future. A couple of observations.

A. Yeah.
Q. (As read):

TVA staff did not really answer any questions, choosing instead to say only URS knows the answer. Either they are idiots or they are lying.

That's what you said?

A. Yeah, the comment was "tell URS."
Q. That's what you said, isn't it, sir?
A. That's what I said.
Q. Yeah. Then Mr. Flood wrote back to you, and then you replied again.

And you accused TVA of withholding information, didn't you?

A. I -- if you'll blow that up so I can read that, please.
Q. You said --
A. Would you slide the -- the memo to the right.
Q. Certainly.
A. Thank you.

Q. You said (as read):

TVA knew the answers but chose to say nothing.

A. Yeah. And I don't remember -- maybe you can go back to the previous email that was talking about what the answers -- that I was referring to.

Q. And then at the end of that third paragraph in the email, you said about the meeting, "We lost," isn't that correct?

A. So you -- so you didn't answer my question about looking at the --

Q. I'm asking --

A. -- what I was asking on the answers.

Q. I'm asking the questions so -- you said, "We lost"?

A. Yeah. Let me read that full paragraph.

I did say that. Yeah.

Q. Yeah. And you then you told Mr. Flood even your (as read):

Next-door neighbor, every average person who can read the paper, knows that sending untreated leachate to a sinkhole-ridded pond and a liner below the water table is a dumb idea?

A. Correct.

Q. Mr. Flood said he didn't see it as winning or losing.

And then you replied again, and you said (as read):

I hope TDEC listens and reads carefully what I wrote.

Correct?

A. Correct.

Q. And you said on this subject, you know what you're talking about from lots of experience, correct?

A. Correct.

Q. And then you went on to criticize one of TDEC's geologist, Mr. Alan Spear [phonetic], correct?

A. Correct.

Q. And TDEC did respond to those comments, did they not?

A. I don't remember.

Q. You didn't read the comment responses?

A. I don't remember. That was how many years ago?

Q. Let's look at some of them.

A. So you're asking -- the response to the comment in the email or the response to the comments of the -- comments on the landfill.

Q. That's right. The technical comments that you submitted.

A. Oh, yeah, they did respond to the comments. Yeah.

Q. And those comments are public record, posted to TDEC's website, are they not?

A. They're public record. I don't know if they're on the data viewer or not.

Q. I wanted to ask you about a couple of them.

Your Comment 17 from your April 14th, 2014, letter, you said (as read):

> Research at another TVA coal-fired power plant included that localized fish population had been adversely affected by ongoing legacy releases to surface water due to selenium.

Isn't that correct?

A. If you would like to put it up there on the overhead, that would be fabulous.

Okay.

Q. And then TDEC responded to your comment, and it said (as read):

> Aquatic biological monitoring is required at all Tennessee fossil plants, and years of TVA research show a healthy community of fish in the vicinity of the Gallatin Fossil Plant.

Correct?

A. Correct.

Q. And --

MS. DAVIS: Objection, Your Honor. We're getting a little far afield here on some of the detailed comments on another project.

THE COURT: I think --

MS. DAVIS: I understand this is cross-examination

impeachment, but I also just want to make sure we don't stray too far.

THE COURT: Okay. Overruled.

Go ahead.

MR. AYLIFFE: And, Your Honor, I will limit it to ash pond comments.

Q. TDEC went on to say (as read):

The NPDES permit also requires the Gallatin ash pond discharge to show no toxicity by testing the outfall, ensuring the protection of the biologic communities in the Cumberland River.

Correct?

A. Correct.

Q. And you're not a toxicologist, correct?

A. I'm not.

Q. Your third comment said (as read):

According to TVA, leachate that is pumped to the Ash Pond A will receive treatment in the ash pond and will be properly managed in accordance with the facility's NPDES permit.

And you said, the pond provides no active treatment whatsoever.

A. Correct.

Q. And TDEC said (as read):

Ash Pond A is a large impoundment where

sedimentation, the dropout or settlement of suspended solids from the water column occurs. Correct?

A. Correct.

Q. And they further stated that this is commonly considered to be a form of treatment, correct?

A. Correct.

Q. Can you see that okay?

A. I can.

Q. Your Comment 11 talks about sinkholes at the Gallatin ash ponds, correct?

A. It does.

Q. TDEC responded to that comment; isn't that correct?

A. I don't remember the specific response to that comment. Perhaps you could put that up.

Q. Sure. TDEC said the reason for plugging any of the sinkholes was to slow down the discharge rate of treated water to surface and subsurface water, not to stop the intended slow discharge, yes?

A. That's what they said.

Q. June 30th, 2014, correct?

A. I don't remember the date.

There it is. Yep.

Q. Yeah. Your Comment 59 said (as read):

This existing contamination conclusion strongly

suggests that three aquifers -- soil residuum aquifer, Hermitage/Carters formation, and the Lebanon Limestone formation -- that flow beneath the proposed landfill are already contaminated with coal combustion constituents from the adjacent Ash Pond A.

Correct?

A. Correct.

Q. Is that correct?

A. Yep.

Q. TDEC said there are not three aquifers; only one, yes?

A. They do. "There are not three."

Q. So ultimately TDEC found your comments to be unpersuasive; isn't that correct?

A. They didn't agree with my comments.

Q. And TDEC permitted the landfill, correct?

A. They did.

Q. Despite the fact that you said it was a dumb idea?

A. They did.

Q. Okay. I want to talk to you about another item listed on your CV that's attached to your direct testimony.

In your CV you say that you provided testimony in an appeal of a municipal solid waste landfill permit in Georgia, correct?

A. Correct.

Q. And I believe the title of that case was Seagraves v. Crouch? That's what it says on your CV.
A. That's correct, yes.
Q. And you said in that case you were qualified by the Court as an expert in geology, hydrogeology, landfill design pertaining to landfill leakage and stormwater runoff, correct?
A. Correct.
Q. But in that case the Court found your opinion was not persuasive, correct?
A. Correct.
Q. Okay. And in that case the Court found that no credible evidence supported Mr. Quarles's conclusion that groundwater continues to move south through the fractured bedrock underlying Blue Creek, correct?
A. I don't remember that response specifically.
Q. "Mr. Quarles's testimony to the contrary was not persuasive."
A. Okay.
Q. Further (as read):

> No credible evidence supported Mr. Quarles's conclusion that the groundwater continues to move south through the fractured bedrock underlying Blue Creek.
>
> Correct?

A. That's what they concluded.
Q. Okay. And they also found that your presentation of the worst-case scenario was an unrealistic interpretation of the hydrogeology of the site, correct?
A. I don't remember that.
Q. (As read):

Mr. Quarles, in contrast to the other experts, used the highest values for all three variables. Do you see that?

A. I do.
Q. And move down to the middle of the paragraph. (As read):

Mr. Quarles's presentation of the worst-case scenario was an unrealistic interpretation of the hydrogeology of the site.
Do you see that?

A. I do.
Q. Further stated that (as read):

The mathematical laws of hydrogeology dictate that hydraulic conductivities and gradients are balanced to maintain the flux of groundwater movement.
Went on to say that (as read):

Mr. Quarles's utilization of the highest values for both variables cannot occur in nature.

Do you see that?
A. I do.
Q. And they said that your calculations are therefore less reliable than the calculations of other experts, correct?
A. Okay.
Q. I want to talk to you about another experience listed on your CV. And on your CV you mention a case called Republic of Ecuador v. Chevron Texaco that was in the Southern District of New York in 2007, correct?
A. Correct.
Q. And in that -- in your CV, you state that you provided written testimony regarding environmental investigation protocols in South America, correct?
A. Correct.
Q. And you submitted a declaration to the Court in that case, correct?
A. Correct.
Q. And in that case, you were working for a lawyer in New York named Steven Donziger, yes?
A. I don't -- I don't -- I don't recall working directly for Steven Donziger, but -- there was another firm, but I don't remember the name of the firm.
Q. E-Tech [phonetic]?
A. I'm sorry?
Q. E-Tech?

A. No. No, no, no. There was a law firm that I worked with up there.
Q. And after the work you did in the Ecuador case, Chevron Corporation filed a civil RICO action against Mr. Donziger; isn't that correct?
A. They did.
Q. And one of the allegations in the complaint was that Mr. Donziger pushed you to alter your declaration in a way that would be helpful to his case?
A. I don't remember that allegation.
Q. This is Civil Action 1:11-cv-691, Southern District of New York, Chevron v. Donziger.

Do you see that?

A. I do.
Q. And the allegation was in paragraph 285, that (as read):

> Mr. Donziger then told Quarles to delete language suggesting that any such contacts had taken place.
>
> It further alleged that (as read):
>
> Quarles accepted Donziger's request to delete the biasness passage, and ultimately signed the version containing the core of the false claim.

That's the allegation.

A. Okay.
Q. And then a miscellaneous action was filed here in the

Middle District of Tennessee by Chevron seeking to take your deposition; isn't that correct?
A. They did.
Q. And you were represented by the firm of Neal & Harwell in that case?
A. Correct.
Q. And there were over 100 entries in the docket for that case regarding your deposition, correct?
A. I don't know how many were regarding that.
Q. And that's Case Number 3:10-cv-686.

And ultimately, Magistrate Judge Brown ordered that your deposition be taken; isn't that correct?
A. Correct.
Q. And that you produce your emails, correct?
A. I don't remember what we produced or were asked to produce.
Q. One of those emails was attached to your deposition. I'd like to ask you some questions about it. It's Document Number 107-1 in the docket of this Court for Case Number 310-cv-686, the chain of emails between you and Mr. Donziger and a few others.

And you told him on February 7, 2007, that the -- the legal strategy drives the technical strategy, correct?
A. I guess you could show me that email.
Q. Okay. February 5th, 2000 [verbatim] email.

A. Can you blow that up, please.
Q. Sure. That's your email address, correct?
A. Yep.
Q. And on February 7th, you told Mr. Donziger you had been waiting for months for him to tell -- you said you had been waiting for months for him to tell you what to do, correct?
A. Yep.
Q. And you're talking about the work down in South America, right?
A. Yep.
Q. And you said right here (as read):

> As of the last time that we spoke, you did not exactly know the legal strategy that you wanted to take. That legal strategy drives the technical strategy.
>
> Correct?

A. Correct.
Q. And Mr. Donziger responded, and you said (as read):

> I like the way we had it before. You were supposed to put some $ in the bank, we kick ass to implement whatever scope that you tell us to do along the way.
>
> Correct?

A. Correct.
Q. So, again, it's about fighting with you, isn't it?

A. I'm sorry, what?
Q. It's about fighting to you, isn't it?
A. Fighting? No.
Q. Then you wrote another email and you asked about field investigations.

And those are your words --

A. Would you blow that up, please?
Q. Sure. I believe Mr. Donziger's response is in all caps, correct?
A. Would you scroll it down so that I can read? And now scroll up, please.
Q. And you had a question in Number 2, and he responded, and he told you (as read):

> The lawyers will control the scope, not the science people.

Correct?
A. Correct.
Q. And, ultimately, you went down to Ecuador for some period of days; isn't that correct?
A. I did.
Q. Which led to the declaration that was alleged in the complaint in the civil RICO action, correct?
A. That New York -- the New York complaint, my work was associated with observing a field team collect samples. And that's what my declaration was about.

Q. And you submitted that declaration to the Southern District of New York in that case, correct?
A. That sounds correct.
Q. And that declaration was the subject of your deposition here in the Middle District of Tennessee, correct?
A. I don't remember. Perhaps maybe they asked questions about what I observed of the sampling team, but I don't remember specifically the details of my sampling involvement. Or my witnessing and observing the sampling.
Q. You were asked the question (as read):

> Is it fair to say that your declaration got reduced from the original 14 down to the final six pages through this process of interaction between yourself and Attorney Number 2 and possibly Mr. Donziger?
>
> What did you say?

A. You're saying that I said, "It is."
Q. That's your answer, isn't it?
A. Is this the -- from the deposition? Okay.
Q. This is Mark Quarles.

> That's you?

A. Yeah.
Q. And it's Document Number 102-1 on the docket of this Court.

> Same document, 102-1. Returning to your

declaration, you got a question about your statement (as read):

A work plan was developed by Engineer Richard Cabrera?

Do you remember that question?

A. I don't, but I see it on the deposition.

Q. And you were also asked (as read):

What was the basis for your understanding that Mr. Cabrera had developed the work plan that we marked as Exhibit 6?

Do you see that?

A. I do.

Q. And you testified that you didn't have any independent knowledge, correct?

A. Correct.

MR. AYLIFFE: Thank you for your time, Mr. Quarles. No further questions.

THE COURT: Ms. Davis, I assume you have some questions?

MS. DAVIS: Yes, Your Honor, I do.

THE COURT: Why don't we break for the day.

Mr. Quarles, I am going to instruct you that even though Court's in recess, you're not to have any discussion with anyone about your testimony --

THE WITNESS: Okay.

THE COURT: -- between now and 9:00 tomorrow when we resume.

Do you understand?

THE WITNESS: I do.

THE COURT: Okay. We'll resume tomorrow at 9:00.

(Court adjourned.)

REPORTER'S CERTIFICATE

I, Lise S. Matthews, Official Court Reporter for the United States District Court for the Middle District of Tennessee, with offices at Nashville, do hereby certify:

That I reported on the Stenograph machine the proceedings held in open court on January 30, 2017, in the matter of TENNESSEE CLEAN WATER NETWORK and TENNESSEE SCENIC RIVERS ASSOCIATION v. TENNESSEE VALLEY AUTHORITY, Case No. 3:15-cv-00424, that said proceedings in connection with the hearing were reduced to typewritten form by me; and that the foregoing transcript (pages 1 through 230) is a true and accurate record of said proceedings.

This the 16th day of February, 2017.

/s/ Lise S. Matthews
LISE S. MATTHEWS, RMR, CRR, CRC
Official Court Reporter