

# BEFORE THE OIL & GAS COMMISSION

AWMS WATER SOLUTIONS, LLC,

Appellant,

-VS-

DIVISION OF OIL & GAS RESOURCES

MANAGEMENT,

Appellee.

Appeal No. 997

Review of Chief's Orders 2021-97

(AWMS #2 Well)

## **FINDINGS, CONCLUSIONS AND ORDER OF THE COMMISSION**

Appearances:

Brian A. Coulter, Matthew Vansuch, Counsel for Appellant AWMS Water Solutions, LLC; Brett Kravitz, John McManus, Matthew Meyer, Assistant Attorneys General, Counsel for Appellee Division of Oil & Gas Resources Management.

Date Issued:

6/30/2022

## **BACKGROUND**

This matter comes before the Oil & Gas Commission upon appeal by AWMS Water Solutions, LLC ["AWMS"] from Chief's Order 2021-97. Chief's Order 2021-97 ["Restart Order"] was issued on May 21, 2021 and terminated previously-issued Orders 2014-372 and 2014-374 ["Suspension Orders"]. Orders 2014-372 and 2014-374 were affirmed by the Commission and upheld on appeal by the Tenth Appellate District Court of Appeals. Rather than restate all facts contained in that Decision, the Commission incorporates the facts in the Tenth District Decision by reference.

Chief's Order 2021-97, which became effective on June 20, 2021, authorized AWMS to resume injection operations at the AWMS #2 Well and provided specific conditions upon which AWMS can resume operations of the #2 Well. AWMS asks the Commission to modify the conditions (2)(12) and (2)(14) in the Order claiming these conditions to be unlawful and unreasonable.

In advance of the merit hearing, the parties jointly submitted stipulated facts and joint exhibits. The Oil & Gas Commission has reviewed the parties' stipulated facts and stipulated joint exhibits and find them to be well-taken and, absent objection, accepts them into the record. On February 8-9, 2022, this **appeal** came on for an evidentiary hearing before the Oil & Gas Commission. At hearing, the parties presented evidence and examined witnesses.

## **ISSUES**

The primary question posed to the Commission is: **Whether the Division Chief acted lawfully and reasonably when he issued the Restart Order which included operating conditions in paragraph (2)(12) and (2)(14) of the Restart Order which (1) orders the immediate suspension of AWMS' operations if a M 2.1 seismic event occurs within three miles of AWMS' facility, and (2) forbids AWMS from restarting operations after an automatic suspension unless and until it first obtains the Division's concurrence that AWMS can resume operations.**

In order to decide these issues, the Commission must consider: **(1) whether it is reasonable to impose the seismic threshold of M 2.1, (2) whether the requirement to stop injection after exceeding Restart Order thresholds is unlawful or unreasonable, and (3) whether it is lawful and reasonable for the Order to require the Division's concurrence before restarting operations.**

## **FINDINGS OF FACT**

1. Appellant AWMS Water Solutions, LLC (fka American Water Management Services, LLC) ["AWMS"] is an Ohio limited liability company that lawfully disposes of certain waste from oil and gas production sites and drilling sites. AWMS Holdings, LLC is an Ohio limited liability company that operates as a holding company for the membership interest in AWMS Rt. 169, LLC.

AWMS Rt. 169, LLC is an Ohio limited liability company that is a wholly-owned subsidiary of AWMS Holdings, LLC and was formed to operate two saltwater injection wells located in Weathersfield Township, Trumbull County, Ohio. AWMS manages AWMS Rt. 169, LLC.

2. Stephen Kilper is an Executive Vice President of AWMS Holdings, LLC; Vice President of AWMS; and President of AWMS Rt. 169, LLC. Bryan Saska is AWMS' CFO. Avalon Holdings Corporation ["Avalon"] is the parent company of Appellant. Avalon is not a party to this action.

3. The Division of Oil and Gas Resources Management [the "Division"] is a division of the Ohio Department of Natural Resources ["ODNR"], created under O.R.C. §1509.02. That statute vests the Division with "sole and exclusive authority to regulate the permitting, location, and spacing of oil and gas wells and production operations within the state." This authority vested with the Division includes the power to regulate saltwater injection wells. Pursuant to O.R.C. §1509.02, the Chief of the Division is responsible for the administration of the Division. Richard Simmers was the Chief of the Division from November 27, 2011 to February 28, 2020. Eric Vendel became Chief of the Division in March of 2020 and continues to serve as the Division's Chief.

4. Gearmar Properties, Inc. ["Gearmar"] owns a 120-acre parcel of real property in Weathersfield Township, Trumbull County, Ohio, that is zoned industrial. The property was previously used for industrial purposes. On December 19, 2011, AWMS executed a lease with Gearmar [the "lease"] for 5.2-acres of the 120-acre property [the "Site"] for constructing and operating saltwater injection wells, also known as class II disposal wells, for the disposal of oil and gas production waste. There is no termination date for the lease.

5. Class II Underground Injection Control (UIC) wells may be constructed for the specific purpose of providing underground disposal of fluid wastes. These disposal wells are known as "injection wells." Oilfield brine fluids are pumped into the well bore, generally under pressure, into porous rock formations far below the Earth's surface and below ground water. In constructing an injection well, an operator must identify a target zone, containing lithologic units with the proper porosity and permeability to accept injected fluids. Most of the injection well's bore, and specifically all shallow

portions of the bore, is encased in multiple layers of protective steel and cement, ensuring the containment of fluids being injected for disposal. Certain deep portions of the well's bore may be open (*i.e.*, uncased) or perforated. The open or perforated sections of the well bore line up with porous geologic zones targeted to receive the injected fluids. Once introduced into the targeted zones, the injectate disperses, moving under pressure away from the well bore through pore spaces and into the permeable rock reservoir.

6. The #2 Well Site is located in an urban area of Weathersfield Township, Trumbull County, Ohio, near the city of Niles. Schools, residences, the Mineral Ridge Dam, a fire department, a hospital, and other infrastructure are within three miles of the Site. The Niles Intermediate School is located approximately 2,000 feet away from the Site. The Site is approximately a quarter mile from the nearest residence. Glunt Industries, Inc. is across St. Rt. 169 from the AWMS Site. The Mahoning Valley Sanitary District estimates that the Mineral Ridge Dam, which is approximately three miles from the Site, is currently in need of more than \$41 million dollars of repairs to make it safe.

7. The #2 Well Site is located in the Mahoning Valley, which is a glaciated plateau comprised of flat-lying sedimentary rock underlain by the Precambrian basement. The Mahoning Valley is covered by various thicknesses of glacial drift and outwash consisting of unconsolidated sands, gravels, and clay.

8. The Northstar #1 Well, a saltwater injection well identified as API# 34-099-2-3127-00-00, is located in Mahoning County about seven miles from the Site. The Northstar #1 Well was originally permitted by and drilled by D & L Energy, Inc. The Northstar #1 Well was drilled into the Precambrian basement. On September 9, 2010, D & L Energy, Inc. transferred the Northstar #1 Well to North Star Disposal Services LLC.

9. Reports of seismic events in Youngstown, Ohio were recorded by the United States Geological Survey ["USGS"], some of which occurred at the following magnitudes on the following dates:

- a. March 17, 2011 (M 2.6),
- b. September 2, 2011 (M 2.2),

- c. September 26, 2011 (M 2.6),
- d. September 30, 2011 (M 2.7), and
- e. December 24, 2011 (M 2.7).

10. These “felt” and reported seismic events were also reported by several news outlets including the Youngstown Vindicator, Canton Repository, New York Times, Associated Press, Zanesville Times-Recorder, Pittsburgh Post-Gazette, Dover Times Reporter, and the Akron Beacon Journal. The December 24, 2011 2.7 magnitude earthquake was recorded within one mile of the Northstar #1 Well. On December 30, 2011, the owner of the Northstar #1 Well voluntarily ceased injection operations at the Northstar #1 Well at the request of the Division because of suspected induced seismicity resulting from injection operations at the Northstar #1 Well. On December 31, 2011, a 4.0 magnitude seismic event was recorded within one mile of the Northstar #1 Well. Almost 5,000 people reported to USGS that they felt the December 31, 2011 4.0 magnitude earthquake [M 4.0 event].

11. The USGS is the federal agency responsible for maintaining and reporting earthquake activity nationwide and maintains the National Seismic Hazard Model. Citizens, emergency responders, and engineers rely on the USGS for accurate and timely information on where an earthquake occurred, how much the ground shook in different locations, the expected economic and human impacts, and what the likelihood is of future significant ground shaking. The USGS determined the M 4.0 event to be of a Modified Mercalli Intensity of IV or V.

12. On July 10, 2012, Governor John Kasich issued Executive Order 2012-09K, making two underground injection control rules effective immediately as emergency rules. The July 10, 2012 emergency rules added new testing, monitoring, and drilling requirements and conditions for injection wells. Further, the Division hired a seismologist in July of 2012, who developed a seismic monitoring network by installing new seismic monitoring stations and setting up an earthquake monitoring system in response to the induced seismicity issues. Subsequently, the Division hired additional staff to address induced seismicity in the state.

13. The induced seismicity in the vicinity of Northstar #1 Well occurred in the Precambrian basement rock, which the Northstar #1 Well was using as one of its injection formations.

As a result of the M 4.0 event, the Division imposed a moratorium on the issuance of injection well permits in order to investigate the event and study the issue of induced seismicity. The Division resumed issuing injection permits in November, 2012.

14. On December 23, 2011, AWMS applied to the Division for permits to construct and operate two saltwater injection wells, to be designated as the AWMS #1 Well and the AWMS #2 Well, along with supporting facilities and equipment. The two proposed wells would be the first injection wells constructed and operated by AWMS. The wells were proposed to be located in Weathersfield Township, Trumbull County, Ohio. At the time AWMS submitted its applications for drilling permits, AWMS had invested approximately \$100,000 into the development of the Site. The Division's procedure for obtaining authorization to operate a Class II injection well is a two-step process. First, an owner must apply for a permit to drill and construct a Class II injection well. Second, an owner must apply to inject into the well. AWMS is currently registered with the Division as the regulatory owner of the AWMS #1 and AWMS #2 Wells.

15. On July 18, 2013, the Division issued a permit to AWMS authorizing AWMS to drill the AWMS #2 Well, identified as API# 34-155-2-4075-00-00. On August 14, 2013, AWMS met with the Division in Columbus to discuss the drilling of the wells and construction at the Site. The AWMS #2 Well was completed from the Knox formation to the top of the Mt. Simon Sandstone, penetrating the Mt. Simon less than 100 feet. The AWMS #2 Well was drilled to a true vertical depth of approximately 8,502 feet below ground surface. The AWMS #1 Well was completed in the Newberg (aka Lockport) Dolomite formation. The AWMS #1 Well was drilled to a true vertical depth of 4,403 feet below ground surface.

16. In September 2013, AWMS issued a Confidential Offering Memorandum to potential qualified investors to raise the capital necessary to construct the AWMS #1 and #2 Wells and the associated structures [the "Facility"] and begin operations. The Confidential Offering Memorandum informed investors that "[o]nce operational, AWMS #1 has an estimated injection rate of 1,500 to 2,500 barrels per day and AWMS #2 has an estimated injection rate of 3,000 to 5,000 barrels per day or a combined total estimated average injection rate of 6,000 barrels per day." It also informed investors that "[i]f the Weathersfield Wells do not accept the anticipated quantities of saltwater

brine, the result of operation of the Company may be adversely affected.”

17. Pursuant to Construction Condition #14 in the July 18, 2013, permit to drill the AWMS #2 Well, AWMS notified the Division on February 27, 2014, that the company was prepared to commence injection operations at the AWMS #2 Well. AWMS, at its expense, installed four seismic monitoring stations for monitoring seismic activity around the Site and surrounding community in accordance with and at the request of the Division.

18. On March 24, 2014, the Division authorized AWMS to commence injection operations at the AWMS #2 Well in Chief's Order No. 2014-69. Pursuant to Construction Condition #11 in the July 18, 2013, permit to drill the AWMS #1 Well, AWMS notified the Division on February 27, 2014, that the company was prepared to commence injection operations at the AWMS #1 Well. On March 24, 2014, the Division authorized AWMS to commence injection operations at the AWMS #1 Well in Chief's Order No. 2014-68. The AWMS #1 Well is approximately 600 feet away from State Route 169.

19. AWMS spent approximately \$5.6 million constructing its Facility, which included the costs of the AWMS #1 and #2 Wells' infrastructure, drilling, tanks, pumps, installation, and start-up. Full commercial operations of the AMWS #1 and #2 Wells began in May and June 2014. AWMS employed five individuals to operate and administer the Facility.

20. From May through August 2014, the AWMS #1 Well represented 5% of total injections between the two wells, while the AWMS #2 Well represented 95% of total injections into the two wells.

21. On July 28, 2014, an earthquake event measuring M 1.7 occurred in Trumbull County in the vicinity of AWMS #1 and AWMS #2 Wells. The July 2014 M 1.7 event was detected by ODNR's OhioNET seismic monitoring system ["OhioNET"] and ranked as "A" quality. Seismic events that are detected by OhioNET and reported by the Earthworm System are given a quality rating, from "A" for the highest to "D" for the lowest. ODNR did not receive any "felt reports" for the July, 2014 event.

22. On August 31, 2014, an earthquake measuring M 2.1 occurred in Trumbull County in the vicinity of AWMS #1 and AWMS #2 Wells. The August 2014 M 2.1 event was detected by the OhioNET System and ranked as "A" quality.
23. On September 3, 2014, the Division issued Chief's Order No. 2014-372, which was modified by Order No. 2014-374 on September 5, 2014, ordering the suspension of injection operations for both wells [collectively, "Suspension Order"]. Upon receiving the Suspension Order on September 3, 2014, AWMS ceased injections into the AWMS Wells. On September 5, 2014, AWMS submitted to the Division a Letter Report in Response to September 3, 2014 Chief's Order No. 2014-371 Saltwater Injection Well AWMS #1. On September 18, 2014, the Division terminated the suspension of the AWMS #1 Well. On September 18, 2014, AWMS provided a letter to the Division seeking to reinitiate operations at AWMS #2 Well.
24. On October 2, 2014, AWMS appealed the Suspension Order to Ohio's Oil and Gas Commission ["Commission"]. On October 31, 2014, the Division met with AWMS in person. On February 24, 2015, the Division and AWMS met to discuss resolution of the appeal of the Suspension Order. The Division provided AWMS with a list of 14 criteria consisting of additional tools for AWMS to consider. On March 4, 2015, AWMS sent a five-page letter to ODNR employee Robert Worstall with the subject "Supplemental Information – Saltwater Injection Well #2, API No. 3415524075 Weathersfield Township, Trumbull County, Ohio." The Division did not respond to AWMS's March 4, 2015 letter before the March 11, 2015 hearing before the Commission.
25. The Commission heard AWMS's appeal of the Suspension Order on March 11, 2015. At the Oil and Gas Commission hearing on March 11, 2015, Division Chief Simmers issued a report and testified that "AWMS has not submitted a plan with sufficient detail or information to minimize risk presented by induced seismicity." He testified that the Plan had "no risk assessment" or "quantitative evaluation," and that, "if it's based in science, the science has not been shared...." Chief Simmers further testified at the Commission hearing that, "our preference is to wait and have the statewide plan, with its many variations, rather than go piecemeal facility by facility." He

stated: "My preference is to have a plan that I can apply statewide to any situation like this. I'm not saying I won't review a thorough plan on an individual basis." Additionally, he testified that if AWMS "presented a very comprehensive plan; then it's possible we would consider that plan."

26. At the Commission hearing, AWMS's expert, Daniel Arthur, testified that the concept behind AWMS' Plan was "a reasonable approach" but he could not say that the Chief's Order suspending operations was unreasonable. Although, he testified that it was unnecessary. At the same hearing, AWMS's expert, Michael Hasting, also testified that he believed that AWMS "can operate it [the AWMS #2 Well] at reasonable rate." However, he declined to offer an opinion on the "reasonableness or unreasonableness" of the Chief's Order, although he did say that the suspension was unnecessary.

27. After the hearing, AWMS did not submit or otherwise provide the Division with a new plan to resume operations at the AWMS #2 Well.

28. On August 12, 2015, the Commission unanimously affirmed the Chief's Suspension Order, concluding that the Suspension Order was lawful and reasonable. On September 8, 2015, AWMS filed a notice of appeal of the Commission's decision with the Franklin County Court of Common Pleas. Initially, the Common Pleas Court dismissed the appeal because AWMS did not file the notice of appeal with the Commission as required by O.R.C. §1509.37 and AWMS appealed to the Tenth District Court of Appeals. The Court of Appeals reversed the Court's decision, finding the Commission had not properly given notice of the Commission's decision to AWMS [the court found that notice of the decision to counsel is insufficient notice to the party]. AWMS was thus provided a second opportunity to appeal the Commission's decision to the Franklin County Court of Common Pleas after proper service of the August 12, 2015 Order from the Commission.

29. On June 30, 2016, AWMS appealed the Commission's August 12, 2015 Order to the Franklin County Common Pleas Court. The Franklin County Common Pleas Court found the Commission's Order lawful but reversed it on reasonableness grounds. The Division appealed the Franklin County Common Pleas Court decision to the Court of Appeals, and the 10th District Court of Appeals reversed the Common Pleas Court's decision. As a result, the 10th District Court

of Appeals upheld the lawfulness and reasonableness of the Suspension Order.<sup>1</sup>

30. Current Division Chief Eric Vendel issued Chief's Order No. 2021-97 on May 21, 2021, terminating the Suspension Order ("Restart Order"), but by its own terms, the Restart Order was not final and effective until June 20, 2021. The Restart Order authorized AWMS to resume injection operations at the AWMS #2 Well by modifying operational conditions of Chief's Order 2014-69. On June 16, 2021, AWMS Vice-President Steve Kilper sent a letter to the Chief responding to the Restart Order. Through a letter dated July 19, 2021, Chief Vendel responded to Steve Kilper's letter. On July 19, 2021, AWMS appealed the Restart Order to the Commission in *AWMS Water Solutions, LLC v. Division of Oil and Gas Resources Management*, Oil and Gas Commission Appeal No. 997.

31. On December 3, 2021, AWMS submitted to the Division a proposed monitoring plan in response to Chief's Order 2021-97. Through a letter dated December 20, 2021, the Division accepted AWMS's monitoring plan and noted that the Division must approve the locations for the two surface motion instruments to be deployed.

32. To date, AWMS has not sought a stay of the Restart Order and has not resumed injection operations at the AWMS #2 Well. The AWMS #2 Well has not operated since September 2, 2014.

33. Following the termination of the suspension orders on the AWMS #1 Well, AWMS injected waste into the AWMS #1 Well from September 2014 until September 2015. AWMS ceased operations at the AWMS #1 Well in September 2015. The monthly revenues generated from the AWMS #1 Well did not cover the monthly expenses incurred to keep the Facility operating. AWMS was unable to inject the volumes at the AWMS #1 Well that AWMS expected in its confidential offering memorandum.

34. ODNR believed that the seismic events detected near the Site in July and August 2014 occurred

---

<sup>1</sup> *Am. Water Mgmt. Servs., LLC v. Div. of Oil & Gas Res. Mgmt.*, 10th Dist. No. 17AP-145, 2018-Ohio-3028, 118 N.E.3d 385, jurisdictional motion overruled, 154 Ohio St. 3d 1431, 2018-Ohio-4670, 111 N.E.3d 1192 (Table), reconsideration denied, 154 Ohio St. 3d 1467, 2018-Ohio-5209, 114 N.E.3d 216. On April 5, 2019, AWMS filed a *Motion to Vacate Decision* with the Commission. On August 16, 2019, the Commission issued an Order granting the Division's *Motion to Dismiss AWMS' Motion to Vacate Decision* finding that the Commission lacked jurisdiction to revisit, review or reconsider the final decision rendered by the Commission on August 12, 2015.

at 11,050 and 10,985 feet below ground surface, respectively. The two seismic events of July and August 2014 near the Site were related to AWMS's injection activities.

35. Comparing seismic events requires mathematical calculations because the seismic magnitude scale is a base-10 logarithmic scale. For every M 1.0 increase in the scale, the event is a ten-fold increase of magnitude and a thirty-two-fold increase in energy released. Compared to an M 2.0, an M 3.0 is 10 times higher and releases 32 times more energy, an M 4.0 is 100 times larger than a M 2.0 and releases 1,000 times more energy, and an M 5.0 is 1,000 times larger than a M 2.0 and releases almost 32,000 times more energy.

36. OhioNet currently has seismic monitoring stations located in approximately 13 of Ohio's 88 counties. While they were active, AWMS seismic monitoring stations contributed to the Division's OhioNET seismic monitoring network.

37. From at least April 2014 through the present, ODNr and its consultant ISTI have run an "Earthworm System," which sends email notifications to the Division of seismic events M 1.5 or higher detected by the OhioNET seismic monitoring stations. Generally, the Division personnel review the Earthworm System notifications and determine whether the event is the result of noise, blasts, or earthquakes, for example.

38. Induced seismicity refers to ground movement (*i.e.*, seismic events, earthquakes, or tremors) caused by human activity. Induced seismicity from injection wells was first recognized in the 1960s after the federal government conducted a study at the Rocky Mountain Arsenal near Denver, Colorado that determined injection wells could induce seismicity. Issues relating to induced seismicity at class II disposal wells began to appear in the southern/mid-continent of the United States in 2009. Ground shaking at the surface can be amplified from seismic activity occurring in an area where bedrock is overlain by unconsolidated soil. Before December 2011, AWMS was aware that saltwater injection wells may have triggered induced seismicity in Ohio and elsewhere.

39. On September 28, 2015, the Induced Seismicity Work Group of the Ground Water Protection Council and the Interstate Oil and Gas Compact Commission produced the Potential Injection-

Induced Seismicity Associated with Oil & Gas Development: A Primer on Technical and Regulatory Considerations Informing Risk Management and Mitigation [Primer].

40. The Primer included an example of a Traffic Light System prepared by the American Exploration and Production Council ["AXPC"]. Former Division Chief Richard Simmers was the co-chair of the Induced Seismicity Work Group. He served as one of Ohio's representatives and was on the editorial committee. Former Division Deputy Chief Robert Worstall also participated in the drafting of the Primer.

41. The second edition of the Primer was released in 2017. A third edition, although under a different name, Ground Water Protection Council and Interstate Gas Compact Commission, 2021, Potential Induced Seismicity Guide: A Resource of Technical and Regulatory Considerations Associated with Fluid Injection, was issued in March 2021. The third edition of the Primer notes that: "Management and mitigation of the risks associated with induced seismicity are best considered at the state level, with specific considerations at local or regional levels. A one-size fits-all approach is infeasible, due to significant variability in local geology and surface conditions, including such factors as population, building conditions, infrastructure, critical facilities, and seismic monitoring capabilities."

## **2022 COMMISSION HEARING**

42. During the hearing, a 2018 videotape deposition of Professor Brian Currie from Miami University was shown by AWMS. Professor Currie testified as an expert qualified in the field of geology. Professor Currie testified that using cross-correlation and real-time monitoring gives the operator the ability to institute operational changes in response to swarming low-level seismic events near an injection well to mitigate against increases in magnitudes. This approach is the underpinning of the Traffic Light Systems which have been employed across the world, but he said that no responsible scientist in the field would testify you can prevent an earthquake from happening. Professor Currie's research team from Miami University undertook a limited underground study of the AWMS #2 Well and identified earthquakes up to 1.5 miles away caused

by the AWMS #2 Well. Professor Currie testified that the AWMS #2 Well and the Northstar Well have very similar bedrock and surficial geology, the earthquakes occurred at similar depths, and both wells would be capable of producing very similar maximum magnitude events.

43. At the hearing, Ivan Wong testified on behalf of the Division as an expert witness qualified in the fields of seismology and earthquake risks and hazards. Mr. Wong serves as Senior Principal Seismologist with Lettis Consultants International, Inc. Mr. Wong testified that if an injection well is inducing earthquakes, there is a risk of escalation and that damages from induced earthquakes, with events as small as M 3.4, can cause damage to vulnerable unreinforced masonry structures. Mr. Wong testified induced earthquakes have damage potential within five kilometers of a hypocenter for a M 4.0 earthquake. Mr. Wong testified the Mineral Ridge Dam presents a special risk. The dam is classified as a Class-I, high hazard dam because a dam failure would result in probable loss of life and structural collapse of buildings and residences.

44. Mr. Wong testified that detailed engineering studies by Gannett Fleming, a dam engineering firm, indicate that the dam's existing upstream slope does not meet current safety criteria for the maximum credible earthquake loadings and that because this is an earthen dam built on unconsolidated sediments, an earthquake could cause liquefaction of the dam itself. Mr. Wong testified that even in the absence of a dam failure, an M 4.5 earthquake could result in significant damage to the dam.

45. Mr. Wong testified that even if the magnitude of the earthquakes were lower than the range that causes structural damage, frequent "felt" earthquakes would not be acceptable in Ohio, which is why, in his expert opinion, M 2.1 is reasonable. Due to the underlying soil and geologic conditions in the Mahoning River Valley, earthquakes begin to be felt at lower magnitudes (M1.6 to M 2.1). Earthquakes as low as M 2.4 were reported as being felt by hundreds of people in the Mahoning River Valley.

46. Mr. Wong testified that the strength of an earthquake depends on how long and wide the fault(s) are that have been ruptured and Northeast Ohio has faults as long as 80 kilometers and several faults that are tens of kilometers. Mr. Wong testified that no one knows with certainty the full size

of the fault(s) beneath AWMS #2 Well, which means no one can know the maximum strength of an earthquake that can be caused by AWMS's injections. Mr. Wong testified that AWMS' claim that there is a single fault under its well that is only 500 meters long is unsupported by the evidence.

47. Mr. Wong testified that a Miami University research team, which included Professor Currie, found the epicenters of AWMS's earthquakes extended well beyond this 500-meter range and off the AWMS parcel and given the length of the faults in Northeast Ohio and the lack of information about the fault beneath AWMS, the regulator must, as Mr. Wong said, "proceed with caution." Mr. Wong testified that a M 5.5 earthquake should be considered as a possibility because that is in range of the largest earthquake that has been experienced in Ohio

48. Mr. Wong testified that James Verdon and Julian Bommer's October 15, 2020 scientific study identified examples from around the world of substantial jumps of magnitude occurring both pre- and post-shutdown. The Verdon/Bommer study showed that while traffic light systems and near real time monitoring can be good tools, in roughly 1 out of 4 of the 35 studied cases, Traffic Light Systems failed to prevent escalating magnitude earthquakes and trailing events. The authors of the study noted that when Traffic Light Systems failed, the magnitude jumps were generally about 1 unit of magnitude; but it also noted that jumps as high as 2.7 units of magnitude have occurred. As a result, the Verdon and Bommer study also recommended setting a 2 to 2.5 magnitude buffer between the level regulators seek to prevent and the injection cutoff level.

49. Mr. Wong testified that an earthquake could cause ground shaking, liquefaction, and landslides, resulting in loss of life, injuries, building damage, infrastructure damage, economic loss, psychological impacts, and nuisance. Mr. Wong testified that the community surrounding AWMS is an urban area comprised of homes, schools, and businesses, many of which are old and vulnerable structures not designed like modern buildings to withstand earthquakes. In the event of an earthquake of sufficient size, he testified that these buildings could have damage ranging from cracked walls to collapsing buildings and could result in injuries or deaths.

50. Mr. Wong testified that induced earthquakes have been known to jump in magnitude from one earthquake to the next. This is what happened with Northstar #1, and that these higher

magnitude earthquakes can occur even after shut down of an injection well. Should a M 4.0 earthquake result from AWMS's injection operations—as it did with Northstar #1—the estimated impacts would, according to Mr. Wong, be significant to the following areas near AWMS: Niles (Intensity 7, very strong); Warren (Intensity 5, moderate); and Youngstown (Intensity 4, light). Mr. Wong testified that should a M 4.5 earthquake result from AWMS's injection operations, there could be significant damage to Mineral Ridge Dam, even if the dam would not completely fail.

51. Mr. Wong testified that while the threat of escalating more powerful earthquakes from induced seismicity may be mitigated with a traffic light system, real time monitoring and the adjustment of operational parameters, that these measures have failed. He testified that the homes and businesses surrounding AWMS #2 Well have not been constructed to withstand earthquakes. Many of them are brick buildings that do not have structural supports and/or have unreinforced masonry wall facades and chimneys. Mr. Wong testified that the M 2.1 level is set conservatively because of three location-specific factors:

- (1) Soil and geologic conditions in the Mahoning River Valley in Northeast Ohio make it prone to greater surface shaking than other parts of Ohio.
- (2) The Mahoning River Valley is an urban area with many people, much infrastructure, and an aging dam that is critical to the lives of almost a quarter of a million people, and
- (3) An earthquake with a magnitude as low as M 4.5 could result in significant damage to the Mineral Ridge Dam, undoubtedly escalating the current \$41 million price tag for repairs.

52. Mr. Wong testified that in evaluating how to respond to induced seismicity, the operator needs to acquire information, review data, and discuss and collaborate with the Division, and that flexibility is needed as every situation is different. As a result, he testified that the Division cannot know at this point how much time it will need to complete a review and knew of no other regulations establishing a length of suspension for evaluating the information related to an induced seismicity investigation.

53. At the hearing, Paul Friberg testified on behalf of AWMS as an expert witness qualified in the fields of induced seismicity and observational seismology. Mr. Friberg is Co-Founder and Chief Executive Officer of ISTI. Mr. Friberg agreed that the Verdon and Bommer study noted magnitude increases in 25 percent of the studied wells, and he conceded that the study recommended a 2.0

magnitude safety buffer.

54. Mr. Friberg testified that the use of AWMS's Traffic Light System cannot guarantee that there will not be "felt" or damaging earthquakes, but admitted he is not an expert in setting up Traffic Light Systems. Mr. Friberg testified that a M 2.1 threshold would be a reasonable threshold if the Division's goal was to prevent felt earthquakes. Mr. Friberg admitted that he did not know the basis for the various thresholds in AWMS' proposed Traffic Light System. Mr. Friberg testified that once the AWMS #2 Well was shut down in 2014, there was no further earthquake activity.

55. At the hearing, Michael Hasting testified on behalf of AWMS as an expert qualified in the field of seismic data acquisitions. Mr. Hasting is President and Chief Executive Officer with HMSC Inc. Mr. Hasting testified the seismic data shows that almost as soon as the AWMS #2 Well started operating, the well started triggering a series of small earthquakes.

56. Mr. Hasting testified that injections at the AWMS #2 Well could safely resume, AWMS' own proposed Traffic Light System<sup>2</sup> monitoring was adequate protection, and that the M. 2.1 threshold was too low in his opinion. Mr. Hasting testified that Traffic Light Systems mitigate risks of earthquakes escalation, but they cannot prevent earthquakes from escalating. Mr. Hasting did not know how the number thresholds were arrived at for AWMS's Traffic Light System.

57. Mr. Hasting testified there was a Traffic Light System put in place by Switzerland when a certain well began producing earthquakes in the M 2.0 to 3.0 range and after that well was shut-in, a M 3.4 earthquake occurred causing an unknown, but not unsubstantial, amount of damage. Mr. Hasting testified he has no reason to disagree with Professor Currie's assessment that the fault below the AWMS #2 Well would be capable of producing a very similar magnitude event as the Northstar Well, which produced a M 4.0 earthquake. Mr. Hasting testified there could be deep undiscovered faults that were unknown unless you either rupture them or look for them. Mr. Hasting confirmed his 2015 hearing testimony that the goal of Traffic Light Systems was to use them as an aide to keep induced seismicity at undetectable and safe levels. Mr. Hasting testified that he believed it is both the operator

---

<sup>2</sup> See Division's Exhibit 4

and the regulatory agency's responsibility to investigate earthquakes at an injection well.

58. At the hearing, Steve Kilper testified on behalf of AWMS as a fact witness. Mr. Kilper testified that his only experience operating injection wells was the couple of months he operated the AWMS wells in 2014. Further, he testified that he does not want to cause earthquakes that shake people. Mr. Kilper testified that he did not calculate the level of risk the Mineral Ridge Dam would be exposed to when they constructed the well. Mr. Kilper testified that AWMS has overall insurance coverage north of \$10 million and a \$15,000 bonding requirement, but regarding damages caused by an induced earthquake, he could not guarantee anything. Mr. Kilper testified that he prepared the document contained in Division's Exhibit 4. He testified that document represents AWMS' proposed Traffic Light System, which included a "red light" at a M 3.0 event. He testified that AWMS believes the M 2.1 threshold in the Restart Order is too low since a M 2.1 will not cause harm and the associated indefinite suspension is unreasonable. Mr. Kilper further testified that these conditions cause uncertainty, and a business cannot deal with this uncertainty considering AWMS' operations were previously suspended for seven years after a M 2.1 event.

59. At the hearing, Weathersfield Fire Chief Tom Lambert testified on behalf of the Division that the area near State Route 169, where AWMS drilled its wells, contains a large number of older homes and trailer parks. Chief Lambert reported that the Mineral Ridge Dam was built nearly 100 years ago using Depression-era standards and building techniques and was not designed using modern standards to withstand earthquakes. He confirmed the dam holds Meander Creek Reservoir which is the drinking water source for 220,000 people and upstream from homes, businesses, and industrial sites that would be catastrophically flooded in the event of its breach. Chief Lambert testified that the Weathersfield Township Volunteer Fire Department would not be able to adequately respond a disaster of that magnitude and described the consequences of a dam failure:

It's projected that the water would go back north. It would totally flood out the south side of Niles, downtown Niles and keep heading towards the City of Warren. Then the water would come back to the Mahoning River, which runs over the viaduct that I was speaking of earlier. That [sic] the Mahoning River runs into Mahoning County and into Pennsylvania. The projection was with a flood there that it would flood all the way into Beaver County Pennsylvania....

[T]here would be a lot of lives involved. We would have to, you know, really focus

on life first and then go back to, you know, how we recover from this. You know, what do we do for the people that now don't have any drinking water because the Sanitary District would be flooded out also. We would have to come up with ways of getting drinking water and utility water to the residents until a plan can be formed to have a secondary source of water, which I have not a clue where they would get that.

(Lambert, TR, pp. 394-395)

60. At the hearing, Andrew Adgate testified on behalf of the Division as a fact witness. Mr. Adgate serves as an Administrator with the Division. Mr. Adgate testified that the induced seismicity events at the Northstar and AWMS# 2 Wells caused the Division to increase its knowledge on induced seismicity through a variety of sources which paved the way for the Division's Chief to issue the Restart Order. Mr. Adgate testified that the Division set the level for magnitude at 2.1 because, for that location, an earthquake stronger than M 2.1 may be felt by the community and raise anxiety over safety. Furthermore, the M 2.1 threshold provides a sufficient buffer to mitigate the risk of AWMS's operations causing large, damaging earthquakes that threaten public health and safety.

61. Mr. Adgate testified that should AWMS cause earthquakes that trigger the thresholds, then additional study is needed, and the exact scope of that analysis would depend on the circumstances of the event. Mr. Adgate testified that each situation must be considered based on the facts of that particular earthquake and neither AWMS nor the Division can know in advance what data will be available should an earthquake trigger one of the thresholds established in the order. Mr. Adgate testified that the Division found AWMS's proposed plan unreasonable since AWMS's restart plan has a M 3.0 red light that is a pause of twenty days with an automatic restart at a temporarily lower injection rate. AWMS' complaint that it will face the risk of an extended shutdown due to an earthquake from some other source is unsupported.

62. There was no evidence presented to the Commission of an earthquake occurring within the three- mile radius established by the Restart Order at or close to the M 2.1 threshold set by the order, except for those events caused by AWMS.

63. At the hearing, Chief of the Division of Oil and Gas, Eric Vendel testified on behalf of the

Division and indicated it was his job and the Division's duty to balance public safety and the regulation of the oil and gas industry. Mr. Vendel testified that he set the threshold at M 2.1 in the Restart Order in part to avoid, or at least reasonably limit, felt earthquakes and the anxiety associated with them. Mr. Vendel testified that several felt earthquake events associated with oil and gas operations had been reported to the USGS at M 2.2 and M 2.4 levels and were specifically considered by him in determining the threshold.<sup>3</sup> Mr. Vendel testified that the Restart Order sets a threshold reasonably low enough to protect health and safety, but also allows AWMS to operate with flexibility to implement any additional measures to stay or return under the threshold should it be exceeded.

64. Testimony was elicited at hearing which demonstrates the situation involving induced seismicity from oil and gas operations in Washington County is distinguishable from the AWMS #2 Well for three primary reasons. First, the rock structures are different.<sup>4</sup> Second, the urban setting of the AWMS #2 Well versus the rural setting in Washington County means any given magnitude earthquakes caused by the AWMS #2 Well pose a greater threat to more people because of the increased population density and nearby infrastructure which are vulnerable to the earthquakes in the urban setting. Third, the Ohio Supreme Court already considered AWMS's attempt to claim the two situations were equivalent and the Court disagreed.<sup>5</sup> There was no new evidence presented that would allow the Division to reconsider that determination.

---

<sup>3</sup> The ten earthquakes measuring M 2.1 or less generated only 67 felt reports, for an average of 6.7 felt reports per earthquake. The 12 earthquakes measuring M 2.2 to M 3.0 generated 1,584 felt reports, for an average of 132 report per earthquake.

<sup>4</sup> Washington County has rock structures at and near the surface that is far more resistant to shaking compared to the loose material in the Mahoning River Valley.

<sup>5</sup> *State ex rel. AWMS Water Solutions v. Mertz*, 162 Ohio St.3d 400, 2020-Ohio- 5482, 165 N.E.3d 1167, ¶ 76 ("AWMS fails to identify anything in the record that affirmatively negates the state's emphasis on the wells' proximity to population centers. And even if it had done so, there are still enough differences between well #2 and the [Washington County] well to persuade us that the state did not unfairly single out [AWMS] well #2.").

## **DISCUSSION**

Industry produces waste and the oil and gas industry is no exception. The drilling and operation of oil and gas wells both require and produce certain fluids. However, if these fluids cannot be recycled, they must be properly disposed of. The best-known method of disposing of oilfield-related fluids is by injecting these fluids into porous rock located far below the Earth's surface. Class II disposal wells handle oilfield wastes and are regulated by the Division Chief under Ohio Revised Code Chapter 1509.

In 2011, AWMS entered into the oilfield waste disposal business by applying to install two injection wells and were issued a permit to drill the AWMS #2 well in 2013. Commercial injections at the wells were authorized on March 24, 2014, and full commercial operations beginning no later than June 2014. Seismic events related to the AWMS #2 Well occurred in July and August 2014. By early September 2014, injection operations at the AWMS #2 Well had been suspended by order of the Division Chief.

Individual disposal wells differ. The effectiveness of a particular injection well is influenced by items such as: well construction, geology, and the characteristics of the injected fluids. We cannot directly visualize the "terrain" that exists thousands of feet below the Earth's surface. It is possible that geologic connections exist at these great depths that we cannot readily anticipate. There are simply many unknowns regarding the complexities of deep geology in eastern Ohio.<sup>6</sup>

The AWMS #2 Well is located seven miles from the Northstar #1 Well. Seismic events of magnitudes M 2.7 and M 4.0 were attributed to injections at the Northstar #1 Well, suggesting the existence of an energized fault in the area. Seven miles distance in geological terms is not so great. In its 2015 Order, the Commission previously found that it is entirely possible that the AWMS #2 Well had tapped into the same geologic fault system that plagued the Northstar #1 Well.

---

<sup>6</sup> For example, while most geologic units are identified, "deep" injection wells drilled in Ohio have encountered unnamed formations, drilling into geologic formations that have not been previously studied or "mapped."

Despite a record that includes robust documentary evidence and expert testimony, there remains many unknowns in this situation. Yet, the fact that data may be imperfect or uncertain does not relieve the Division Chief of his responsibility to allow utilization of natural resources while protecting public health and safety.

### **Division Chief Has The Authority To Suspend Injection Well Permits**

In Ohio, oil and gas operations are conducted under the authority of Chapter 1509 of the Ohio Revised Code. The Division of Oil & Gas Resources Management possesses permitting, regulatory, and enforcement authority over all aspects of oil and gas operations and the Chief possesses robust authority to protect the public.<sup>7</sup> Under O.R.C. §1509.03, the Chief is tasked with permitting wells. Safety concerning the drilling and operation of any such well is within the purview of the Chief and the Chief may issue orders to enforce this chapter, rules adopted thereunder, and terms or conditions of permits issued thereunder. O.R.C. §1509.06 specifically authorizes the Division Chief to grant drilling permits relating to oil and gas activities and requires that wells be operated in accordance with approved plans.<sup>8</sup>

O.R.C. §1509.22(A)(2) forbids any person from placing, or causing to be placed, any oilfield wastes in surface or ground water, or in or upon the land in a manner that could be reasonably be anticipated to cause damage or injury to public health or safety or the environment. Other sections of O.R.C. §1509.22, and the rules amplifying O.R.C. §1509.22 (O.A.C. §1501:9-03-1 through §1501:9-3-10), provide additional requirements regarding the appropriate handling of oilfield waste. These are baseline rules, and the Chief may require compliance with standards more stringent than those in O.R.C. §1509.22.<sup>9</sup>

While these laws confirm the exclusive regulatory authority of the Division Chief

---

<sup>7</sup>*D&L Energy, Inc. v. Ohio Div. of Res. Mgmt.*, 2014 Ohio Misc. LEXIS 10510, (finding that the Chief had inherent authority to revoke a saltwater injection permit when there is sufficient cause such as protecting public health and safety even when one of the provisions expressly authorizing revocations in O.R.C. §1509.04 (C) for material and substantial violations did not apply); *see also* Ohio Adm. Code §1501:9-3-06 (H)(2)(b) and (H)(2)(d)(iii) (injection well permitting provisions which mandate that the proposed injection will “protect public health or safety.”)

<sup>8</sup> O.R.C. §1509.06(E)

<sup>9</sup> *See State ex rel. Fisher v. Nacelle Land & Mgmt. Corp.*, 90 Ohio App. 3d 93, 628 N.E.2d 67, 1993 Ohio App. LEXIS 4060 (11<sup>th</sup> Dist. 1993).

and reinforce his important duty to protect a broad range of public interest, including public health and safety, none of these sections of law specifically addressed the issue of injection-induced seismicity at the time the Restart Order was issued. However, the law very clearly protects a broad range of public interests. The General Assembly does not require the Chief of the Division to sit back and wait for calamity to occur before acting. By using the words “causes, or could reasonably be anticipated to cause,” the General Assembly was giving the Chief the authority to avert and prevent problems before they occurred. Consequently, the law yields regulatory flexibility to address issues which might present themselves to the public in the future. The term “reasonable anticipation” grants the Chief discretion to consider numerous factors in protecting public interests.

Case law and logic indicate that the term “reasonably anticipated” suggests that it is to be applied in a manner that accounts for the circumstances faced at that time in that particular situation.<sup>10</sup> This is the standard to apply instead of creating a broad principle applicable to all oil and gas-operation-induced-seismicity in Ohio. The Ohio Supreme Court defined “reasonable anticipation” as:

[T]hat expectation created in the mind of the ordinarily prudent and competent person as the consequence of his reaction to any given set of circumstances. If such expectation carries recognition that the given set of circumstances is suggestive of danger, then failure to take appropriate safety measures constitutes negligence.<sup>11</sup>

The Tenth Appellate District Court of Appeals reached a similar conclusion in considering the AWMS #2 Well, concluding that predicting what is likely is extremely difficult at best and could be dangerous at worst, while noting questions about the state’s liability if legitimate damages were to occur.<sup>12</sup> The statutory language grants regulatory latitude for the Chief in exercising his authority under O.R.C. §1509.22 to assess the range of possible events, the likelihood of those events occurring, and the severity of the outcome should a particular event

---

<sup>10</sup> In addition to appearing in R.C. 1509.22, the term “reasonably anticipated” appears in 20 sections of the Ohio Revised Code in situations ranging from insurance regulation (R.C. 3960.01), securities regulation (R.C. 1707.043), nursing home regulation (R.C. 3721.026), calculation of child support (R.C. 3119.23) and more, but is not defined anywhere in the code. The term “reasonably anticipated,” or the variant “reasonable anticipation,” is ubiquitous in the case law of Ohio (and other states) in areas relating to negligence, products liability, public records, court jurisdiction and more. Appellee’s Pre-Hearing Brief at 10.

<sup>11</sup> *Hetrick v. Marion—Reserve Power Co.*, 141 Ohio St. 347, 359, 48 N.E.2d 103 (1943).

<sup>12</sup> *Am. Water Mgt. Servs., LLC v. Div. of Oil & Gas Resources Mgt.*, 2018- Ohio-3028, 118 N.E.3d 385, ¶ 44-47 (10th Dist.).

occur and then address those possible events and their attendant risks based on the circumstances.

In the *D&L Energy* case, the Commission found that, based upon the facts presented, the Division Chief possessed inferred and inherent regulatory powers to take the extreme action of permanently removing this operator from the oilfield disposal business when that operator was found to be in "material and substantial violation" under O.R.C. §1509.01(EE). The Court of Common Pleas for Franklin County affirmed the Commission's decision.<sup>13</sup>

The actions of AWMS regarding the AWMS #2 Well do not qualify as material and substantial violations, were not egregious acts, and did not violate the terms and conditions of its permit. However, the Court of Appeals upheld the Division's initial suspension of the AWMS #2 Well. In its 2015 Order, the Commission also determined that the seismic events occurred in an area that had not previously experienced notable seismicity.

In the immediate matter, the Division Chief is not revoking or even suspending the AWMS #2 Well permit. Rather, the Chief's Restart Order is imposing conditions on resuming injection operations, similar to what the Chief does for every injection well operation in the State.

So, while the immediate matter is distinguishable from the *D&L Energy* case and asks a different question than the previous AWMS case, the principles to be applied are the same. The law, while silent on the specifics of this situation, must be viewed as providing the Chief with

---

<sup>13</sup> *D&L Energy, Inc. v. Ohio Div. of Resources Mgt.*, C.P. No. 13CVF07-7831, 2014 Ohio Misc. LEXIS 10510 (November 20, 2014). In affirming the Commission, the Court held:

The Court is equally mindful that "if a statute provides the authority for an administrative agency to perform a specified act, but does not provide the details by which the action should be performed, the agency is to perform the act in a reasonable manner based upon a reasonable construction of the statutory scheme." [Citations omitted.] Clearly, in order to effectuate and enforce the numerous compliance provisions included in Chapter 1509, the statutory scheme bestows a number of inherent powers that extend to the Chief. Moreover, it is incongruent with the entire legislative purpose and language contained in R.C. Chapter 1509 to suggest that the Chief is unable to revoke a permit once it has been duly issued, or that enforcement is strictly limited to mere compliance notices. [D&L Energy's] interpretation leads to an absurd result whereby the Chief is impotent to effectuate ongoing enforcement of a permit's well-delineated terms and conditions. This is contrary to the express sections identified above, wherein exclusive regulatory authority is instilled with the Division and the Chief. \* \* \* [I]t is inconceivable that the Chief is left devoid of power to revoke permits when sufficient cause is demonstrated. This interpretation thwarts the explicit right of the Chief to maintain oversight after a permit is issued by providing reasonable enforcement mechanisms.

(Common Pleas Court Decision, pp 12 – 13.)

some inherent regulatory authorities to support his statutorily-imposed responsibilities to provide reasonable regulatory oversight of operating wells and to protect public health, safety and the environment. Given the Division's clear statutorily-imposed responsibility to protect health, safety, and the environment, there must be a means to reconcile this important responsibility with the Division's obligation to permit, monitor, and fairly regulate the oil and gas injection industry.

The ability to engage in oil and gas production and disposal operations is a privilege, granted only when an operator obtains the appropriate permits to engage in such activities. It is not a right. Injection well permitting provisions also mandate that the proposed injection well protect public health and safety. In obtaining a permit to engage in oil and gas disposal activities, an operator submits to the regulatory authority of the Division and its Chief. The Chief's authority to grant or deny permits infers the ability to also suspend or revoke permits where continued operation under an issued permit could cause adverse impacts to health, safety, or the environment, which would be the case in a future induced seismicity related suspension. The authorities to permit operations and to suspend or revoke permitted operations infers and equal authority to restore operations in a safe manner.

### **Restart Order Conditions Are Lawful & Reasonable**

The primary risk in this situation is the escalation of earthquake magnitude from a fault or faults of unknown length. The Chief must, therefore, take appropriate safety measures to mitigate that risk. A second risk is that the residents of Northeast Ohio, a community unaccustomed to earthquakes, will endure anxiety by experiencing repeated "felt" earthquakes, even at relatively low magnitudes.

Due to the fact the surrounding community is made up of homes, schools, and businesses, many of which are in old buildings and vulnerable structures not designed to withstand earthquakes, the M 2.1 limit provides a reasonable margin of safety to mitigate the risk of "felt" earthquakes and the escalation of earthquakes to magnitudes and levels of ground shaking that may cause damage and threaten public health and safety. In the event of an earthquake of a certain magnitude, these buildings can experience damage ranging from cracks to complete collapse.

Caution is warranted for these risks in addition to the risks associated with a collapse of the Mineral Ridge Dam which would pose a threat of loss of life and property and could leave area residents without a drinking water source and sanitation for an indefinite period of time.

The Division acknowledges that while a M 2.1 earthquake may be “felt”, it is unlikely to cause significant damage to structures or infrastructure. A M 2.1 earthquake is not, itself, a major threat; rather it is a warning threshold that future, more risky earthquakes may ensue. Injection induced earthquakes can and often do escalate. The region has demonstrated that an M 2.1 to 3.0 range is far from the expected maximum. The nearby Northstar #1 Well is particularly instructive because the largest earthquake attributed to that well occurred after the well was shut down and was an M 4.0. The previous earthquake for that well that was M. 2.7. This level of escalation is not unique and was seen in both AWMS #2 Well and the Northstar #1 Well.

At the hearing, seismologist Ivan Wong discussed a recent scientific study that identifies examples from around the world of substantial jumps of magnitude occurring both pre- and post-shutdown. The study shows that while a Traffic Light System and near real time monitoring can be useful tools, they do not eliminate the risk of escalating earthquakes that may cause damage absent a sufficient buffer between the threshold magnitude and the magnitude at which surface impacts can occur.

Injection induced earthquakes, only slightly more powerful than the ones AWMS’ proposed Traffic Light System would repeatedly be permitted to create, have caused millions of dollars of property damage in other parts of the world that have older buildings with unreinforced masonry construction which can collapse, hurt, and kill. Because of this, the Division has made a policy choice to implement a conservative threshold in the Restart Order. This is reasonable. The Division appropriately balances the interest of AWMS by allowing some induced seismicity with the public in the Mahoning River Valley, an urban area with many people, much infrastructure, and an aging dam that is critical to the lives of almost a quarter of a million people.

The Commission finds that the M 2.1 standard establishes a reasonable margin of safety in order to prevent or minimize “felt” earthquakes and to provide an acceptable degree of

security that injection-induced earthquakes can be addressed before the level of escalation becomes unacceptable for the restart of this particular well.

A higher threshold could result in earthquakes becoming the norm while being exposed to increased risks to earthquake damage to both person and property. The urban setting of the AWMS #2 Well and its location in the State provide, in our view, a valid basis for the Chief to set a conservative standard because of the population density and infrastructure surrounding this particular well.

The Commission cannot accept AWMS's proposed Traffic Light System in lieu of the Restart Order. A realistic outcome of AWMS's proposed Traffic Light System would allow AWMS' operations to cause a M 3.0 earthquake repeatedly with all the related risks of escalation without any mechanism for the Division to timely intervene. The Commission does not find such a plan to be reasonable in view of the potential adverse impacts and increased risks that could be caused by operations at this well. The Commission makes no finding regarding the acceptability of a Traffic Light System or a threshold of M 2.1 for any other well.

The historically infrequent nature of natural earthquakes in Northeast Ohio has led, not surprisingly, to construction practices that do not plan for earthquakes. In view of the lack of earthquake standards in construction codes, the Division's decision to use a threshold of M 2.1 to suspend operations pending additional review is reasonable for this well to minimize physical damage. Earthquakes in Northeast Ohio from oil and gas injection activity have been felt as low as M 2.2.<sup>14</sup> In our opinion, there are no objective criteria for "anxiety producing" events to which nearly everything could soon be attributed to this nebulous and subjective measure. In our view, it is not practical to eliminate all "felt" events. For example, trucks passing on the road, blasting for construction, seismic surveys, natural events such as thunder, or even perceived events such as phantom vibration syndrome from a cell phone are all "felt events". The Division should give operators the opportunity to demonstrate whether a "felt event" is the result of seismic activity

---

<sup>14</sup> There are a number of reports of M 2.2 earthquakes reported to the USGS of being felt in the Youngstown area. The USGS states that a M 2.0 earthquake is the smallest earthquake that can normally be felt by humans. There was even one report of a felt event from the AWMS M 2.1 earthquake, according to the academic literature.

caused by the injection well or from some other activity. Care and prudence must be exercised by the industry; however, the avoidance of any kind of unintended disturbance is an untenable standard to maintain.

Further, we hold the three-mile radius established in the Restart Order is reasonable as an appropriate distance. It encompasses the earthquakes that have been associated with the AWMS #2 Well and only the AWMS #2 Well has caused M 2.1 earthquakes in that area in the last 7.5 years. Three miles also takes into account the error factor associated with the limited underground study that has already taken place around AWMS #2 Well and would include some of the critical infrastructure in the area, including the Mineral Ridge Dam.

We also find that the evidence suggests that the fault(s) in the area of the AWMS #2 Well and the known fault below the Well could be larger than the portion mapped. In our view, the Chief has appropriately and reasonably exercised his discretion in applying a radius that is double the radius of the earthquakes triggered by AWMS because of the localized history of earthquakes. This is further supported by the fact that since AWMS discontinued operations after the Suspension Order was issued, no earthquakes have been recorded within that three-mile radius of the Well. Likewise, this area also had not previously experienced notable seismicity before AWMS commenced operations and the parties agree that the July and August 2014 events were attributable to injection operations at the AWMS #2 Well. Consequently, even utilizing this expanded radius, there is little risk that AWMS will have to pause its operations for any reason other than its own actions.

Further, we hold that the requirement to shut down and perform a full evaluation of data is reasonable given the risks and the limited information available about the fault(s) triggered by AWMS. The Commission finds thresholds established in the Restart Order are reasonable to assure the safety and well-being of the community while providing a means to resume operations. If AWMS exceeds the 2.1 threshold, the Restart Order does not mandate a permanent shut down. Instead, the Order requires AWMS to pause its operations until it can conduct a full investigation, make any changes that may be necessary to ensure safe operation and get the Division's concurrence on restarting. This condition is a reasonable requirement to ensure the safety of the

surrounding community because the Division has regulatory authority over injection operations and may suspend operations, which the Division reasonably believes may result in adverse impacts to the health and safety of citizens, or may endanger air, water, or environmental resources.

Because the Division has carefully considered the balance between its duties, the Commission, in this instance, defers to the expertise of the Division. The Commission finds that pausing injection operations at the AWMS #2 Well pending AWMS' response to the Division's request for additional investigation is appropriate under the facts of this specific case. The exact scope of that analysis would be dictated by the circumstances of ongoing seismicity but could reasonably include more subsurface mapping.<sup>15</sup>

Because it is unknown what specific circumstances will occur or what data will be available should an earthquake trigger one of the thresholds established in the Order, the Division did not impose a time limit on AWMS for the completion of its analysis under the Restart Order. The Division's review of AWMS's analysis is also dependent on the situation and on the quality of the analysis conducted by AWMS; these factors are not entirely in the Division's control. It is the Division's duty to assure that AWMS will complete the analysis required by the Restart Order and to perform such a review in a reasonable and timely manner. It behooves the Division to work closely with the operator when possible and to utilize resources of the State where practicable to better its knowledge base through the examination of any investigated event.

The authority of the Commission on appeal is coextensive with that of the Chief and the Commission may substitute its judgment for that of the Division. In fact, O.R.C. §1509.36 makes clear that far from being subordinate to the Division, the Commission is the immediate appellate authority over the Division. Absent a specific timeframe, the Commission expects the Division to conduct any such review in a reasonable amount of time. While not applicable to this case, the Commission notes that deadlines do not appear to be at odds with the Division's newly enacted regulatory regime, which requires the Chief to take action on a written corrective action

---

<sup>15</sup> AWMS would likely need to look at the location of the earthquake, the magnitude, the level of ground shaking, the operational parameters leading to the earthquake, the previous history of earthquakes and the vulnerability of infrastructure near the epicenter, among other things.

plan submitted by an operator of a well which has been suspended for causing induced seismicity within ten business days of receipt of the plan.<sup>16</sup>

It bears emphasizing that the Restart Order does not mandate a permanent shut down. Instead, the Restart Order only requires AWMS to pause its operations until it can conduct a full investigation, make any changes that may be necessary to ensure safe operation, and get the Division's concurrence on resuming operations. These conditions are a reasonable requirement because of the many unknowns underground which could have adverse effects in an urbanized area with an aging infrastructure.

The Commission does not reach a conclusion on whether or not there is a nuisance as we do not believe it is determinative to this case and the issue is already before the Eleventh District Court of Appeals. However, if it were the Division's position that it has the authority to declare an oil and gas operation a nuisance, then it is necessary the Commission have authority to review the Division's Orders to abate or mitigate a nuisance.

## **CONCLUSIONS OF LAW**

1. O.R.C. §1509.36 provides that any person adversely affected by a Chief's order may appeal to the Oil & Gas Commission. O.R.C. §1509.36 addresses the standard of review applied in Commission appeals, and provides *inter alia*:

If upon completion of the hearing the commission finds that the order appealed from was lawful and reasonable, it shall make a written order affirming the order appealed from; if the commission finds that the order was unreasonable or unlawful, it shall make a written order vacating the order appealed from and making the order that it finds the chief should have made.

Hearings before the Commission are *de novo* in nature; meaning that the Commission

---

<sup>16</sup> O.A.C. §1509-3-07(O)(1) (effective January 31, 2022)

takes a "fresh look" at the evidence presented at hearing. The Commission is not restricted to a record developed before the Division Chief. Rather, the Commission may consider any evidence submitted that either supports or refutes the Chief's decision under appeal. In this appeal, Appellant AWMS shoulders the burden of proving, by a preponderance of the evidence, that the Restart Order was unlawful or unreasonable.

2. O.R.C. §1509.03(A) provides that no person shall act in violation of rules adopted by the Division Chief. O.R.C. §1509.04 allows the Chief to enforce the provisions of the law, and the terms and conditions of permits, through the issuance of orders.

3. O.R.C. §1509.22 requires injection operations associated with the disposal of oilfield waste to obtain a permit for an injection well and requires the Chief to adopt rules regarding injection operations associated with the disposal of oilfield waste.

4. O.R.C. §1509.22 (E) holds the owner, assignee, or transferee holding the permit liable for the obligations and liabilities imposed by Section 1509.22, any rules adopted, or orders for terms of conditions of a permit issued under it. The protection of ground water is part of the basis for the Chief's authority to issue permits and orders governing the injection of wastes by means of wells.

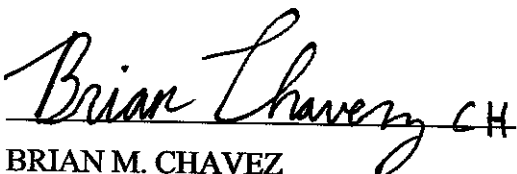
5. The Division Chief does not act in an unlawful or unreasonable manner in including a provision in his Order which would suspend the injection operations of an operator upon the occurrence of a seismic event where the Chief determines that continued injection operations could be reasonably anticipated to cause injury to public health or safety or damage to the environment.

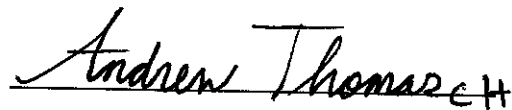
6. The Chief's issuance of the Restart Order [Order 2021-97], including its threshold seismicity level and conditions for Restart, was lawful and reasonable as the Chief possessed the authority to issue the Order in accordance with the law and the regulations were reasonable as the Division has provided sufficient factual foundation to support each condition of the Restart Order.


## **ORDER**


Based upon the foregoing Findings of Fact and Conclusions of Law, the Commission hereby **AFFIRMS** the Division's issuance of Chief's Order 2021-97.

Date Issued: 6/30/2022

 CH  
BRIAN M. CHAVEZ

 CH  
ANDREW R. THOMAS, *Acting Chairman*

 CH  
FRANK J. REED

 CH  
PHILLIP L. PARKER, *Secretary*

### **INSTRUCTIONS FOR APPEAL**

This decision may be appealed to the Court of Common Pleas for Franklin County, within thirty days of your receipt of this decision, in accordance with Ohio Revised Code §1509.37.

#### **DISTRIBUTION:**

AMWS Water Solutions, LLC, Via Certified Mail #9488 8090 0027 6042 2416 02

Brian A. Coulter, Matthew Vansuch Via Certified Mail #9488 8090 0027 6042 2416 19 & E-Mail [bcoulter@brouse.com, mvansuch@brouse.com]

Brett Kravitz, Matthew Meyer, John McManus Via Certified Inter-Office Mail #6922 & E-Mail

[brett.kravitz@ohioattorneygeneral.gov; john.mcmanus@ohioattorneygeneral.gov; matthew.meyer@ohioattorneygeneral.gov]

Chief Eric Vendel, Via Certified Mail #9488 8090 0027 6042 2416 26

# BEFORE THE OIL & GAS COMMISSION

AWMS WATER SOLUTIONS, LLC,

Appellant,

-vs-

DIVISION OF OIL & GAS RESOURCES  
MANAGEMENT,

Appellee,

:  
:  
:  
:  
:  
:  
:  
:  
:  
:

Appeal No. 997

Review of Chief's Order 2021-97  
(AWMS #2 Well)

## **INDEX OF EVIDENCE** **PRESENTED AT HEARING**

**Before:** Andrew R. Thomas

**In Attendance:** Frank J. Reed, Phillip L. Parker, Brian M. Chavez

**Appearances:** Brian A. Coulter, Matthew Vansuch, Counsel for Appellant AWMS Water Solutions, LLC; Brett Kravitz, Matthew Meyer, John McManus, Assistant Attorneys General, Counsel for Appellee Division of Oil & Gas Resources Management.

## **WITNESS INDEX**

### **Appellant's Witnesses:**

Paul Friberg  
Mike Hasting  
Stephen Kilper

Direct Examination; Cross Examination  
Direct Examination; Cross Examination  
Direct Examination; Cross Examination

**Appellee's Witnesses:**

Ivan Wong  
Thomas Lambert  
Andrew Adgate  
Eric Vendel

Direct Examination; Cross Examination  
Direct Examination; Cross Examination  
Direct Examination; Cross Examination  
Direct Examination; Cross Examination

**EXHIBIT INDEX**

**Stipulated Exhibits:**

Exhibit 3	Lease
Exhibit YY	September 5, 2014 letter report from AWMS
Exhibit HH	September 18, 2014 letter from AWMS
Exhibit II	Division seismic evaluation criteria
Exhibit PP	March 4, 2015 letter from AWMS
Exhibit	Joint Stipulation of Facts
Exhibit	Joint Stipulation Regarding Testimony of Frederick Shimp and Brian Currie, Ph. D.
Exhibit	January 18, 2018 Deposition of Frederick Shimp
Exhibit	Trial Deposition Transcript with Hyperlinked Exhibits and Video (June 1, 2018) and Trial Testimony (September 22, 2021) of Brian Currie, Ph. D., taken in Eleventh District Court of Appeals Case No. 2016-T-0085.

## **Depositions:**

Exhibit	Deposition of Stephen G. Kilper; filed February 7, 2022
Exhibit	Deposition of Michael Hasting; filed February 7, 2022
Exhibit	Deposition of Paul Friberg; filed February 7, 2022

## **Appellant's Hearing Exhibits:**

Exhibit L	USGS Modified Mercalli Intensity Scale
Exhibit 55	Paul Friberg CV (2017)
Exhibit 57	Paul Friberg expert witness report (2017)
Exhibit ZZZZZ	Paul Friberg expert witness report #2 (2021)
Exhibit 53	Michael Hasting expert witness report (2015)
Exhibit 54	Michael Hasting expert witness report (2017)
Exhibit AAAAAA	Michael Hasting expert witness report (2021)
Exhibit WWWW	site video 360
Exhibit UUUU	color slides from Glenda Besana-Ostman
Exhibit HH	September 17, 2014 AWMS letter plan
Exhibit II	seismic criteria
Exhibit YYYY	Suspension Orders (Chief's Orders 2014-371, 2014-372, 2014-373, and 2014-374)
Exhibit ZZZZ	February 25, 2015 email to Robert Worstall and Andrew Adgate
Exhibit 19/NN	February 26, 2015 email from Robert Worstall
Exhibit PP	March 4, 2015 AWMS supplemental response

Exhibit P

AWMS restart plan to Franklin County Common Pleas Court (2016)

### **Appellee Division's Exhibits:**

Appellee's Exhibit 1	Cost estimates for repairs
Appellee's Exhibit 2	Trumbull County Earthquakes Relocated by Skoumal et al (2015) - Figure 10 (Wong/Lettis Consultants Report January 2022)
Appellee's Exhibit 3	Geologic Block Diagram of the AWMS Wells #1 and #2 - Figure 4 (Wong/Lettis Consultants International, Inc. Expert Report January 2022)
Appellee's Exhibit 4	AWMS Seismic Mitigation (Traffic Light System)
Appellee's Exhibit 5	Youngstown Daily Business Journal Article – MSD seeks funding for 41M Meander Dam Makeover
Appellee's Exhibit 6	AWMS Expert Report #2 (Friberg, December 28, 2021)
Appellee's Exhibit 7	Design and implementation of a traffic light system for deep geothermal well stimulation in Finland (J Seismol (2020))
Appellee's Exhibit 8	Microseismicity induced by deep wastewater injection in southern Trumbull County, Ohio (by Skoumal, Brudzinski, and Currie)
Appellee's Exhibit 9	Chief's Order 2021-97 (May 21, 2021) (Restart Order)
Appellee's Exhibit 10	Notice of Appeal – Appeal of Restart Order
Appellee's Exhibit 11	Confidential AWMS Holdings LLC Confidential Offering memorandum (Sept 2013)
Appellee's Exhibit 12	Shumway Resources Report, AWMS Water

	Solutions, LLC v. Division of Oil & Gas Resources Management – Cost Estimate (October 20, 2017)
Appellee's Exhibit 13	Ivan Wong Bio and Resume
Appellee's Exhibit 14	Expert Witness Report on Induced Seismicity at the AWMS #2 (Ivan Wong/Lettis Consultants, January 11, 2022)
Appellee's Exhibit 15	Ivan Wong Slide Presentation
Appellee's Exhibit 16	IRIS Link – Buildings & Bedrock: Effects of amplification & liquefaction
Appellee's Exhibit 17	Buildings of Interest Within 9 km for AWMS #2 Well
Appellee's Exhibit 18	Revised MM Intensity Contours from a M 4.0 Earthquake at the AWMS #2 well – Figure 17 (Wong/Lettis Consultants Report, January 2022)
Appellee's Exhibit 19	Table 1 Modified Mercalli (Wong/Lettis Consultants Report, January 2022)
Appellee's Exhibit 20	Potential Induced Seismicity Guide (Primer)(2021 Update)
Appellee's Exhibit 21	Green, yellow, red, or out of the blue? An assessment of Traffic Light Schemes to mitigate the impact of hydraulic fracturing-induced seismicity. Verdon and Bommer, J Seismol (2021) 25:301, 322
Appellee's Exhibit 22	New York Times and other newspaper articles on Ohio Youngstown earthquake
Appellee's Exhibit 23	Drone Video of Mineral Ridge Dam
Appellee's Exhibit 24	Map of Seismicity near AWMS #2 Well and the Mineral Ridge Dam – Figure 16 (Wong/Lettis Consultants International, Inc. Expert Report, January 2022)
Appellee's Exhibit 25	Gannett Fleming, “Embankment Slope Stability and Seepage Analyses Report (2018)

Appellee's Exhibit 26	Gannett Fleming Summary Table 3 Potential Failure Modes Analysis – Mineral Ridge Dam, Meander Water (June 2019)
Appellee's Exhibit 27	USGS Combined Felt Reports Northeast Ohio
Appellee's Exhibit 27A	Felt Event Table in Magnitude Order
Appellee's Exhibit 28	Suspension Orders for AWMS #1 and AWMS #2 (September 2014)
Appellee's Exhibit 29	Andrew Adgate CV/Resume
Appellee's Exhibit 30	September 5, 2014 AWMS Letter Report in Response to September 3, 2014 Chief's Order No. 2014-371 AWMS #1
Appellee's Exhibit 31	September 18, 2014 Division letter – Termination of Chief's Order Nos. 2014-371 and 2014-373 (AWMS #1)
Appellee's Exhibit 32	September 2014 AWMS Restart Plan
Appellee's Exhibit 33	14 Seismic Risks Criteria
Appellee's Exhibit 34	March 4, 2015 AWMS letter – supplemental information
Appellee's Exhibit 35	WITHDRAWN
Appellee's Exhibit 36	Photos taken by Weathersfield Township Fire Chief Tom Lambert of the AWMS Well site and area (9/28/21)
Appellee's Exhibit 37	Resume of Eric Vendel
Appellee's Exhibit 38	WITHDRAWN
Appellee's Exhibit 39	July 19, 2021 Chief Vendel Response Letter to Kilper
Appellee's Exhibit 40	December 3, 2021 Kilper letter to Division – seismic monitoring plan

Appellee's Exhibit 41	December 20, 2021 ODNR letter to Kilper – monitoring plan
Appellee's Exhibit 42	Permit Conditions for Horizontal Wells Drilled Near Faults or Areas of Seismic Activity
Appellee's Exhibit 43	Transcript of Thomas Lambert Testimony – 11 <sup>th</sup> District Court of Appeals case (8/24/21)
Appellee's Exhibit	Notice of Filing of Depositions of Stephen G. Kilper, Michael Hasting, and Paul Friberg; filed February 7, 2022
Appellee's Exhibit	Notice of Filing of Depositions of Stephen G. Kilper, Michael Hasting, and Paul Friberg; filed February 7, 2022
Appellee's Exhibit	Notice of Filing of Depositions of Stephen G. Kilper, Michael Hasting, and Paul Friberg; filed February 7, 2022

## **ODNR-Witness Deposition Exhibits**

- A. Ivan Wong's CV and Resume
- B. Ivan Wong's expert report and attached figures
- C. Primer (ODNR01024)
- C1. Primer – Second Edition (2017)
- D. Ivan Wong's 2015 OOGA White Paper on Induced Seismicity and Traffic Light Systems as Related to Hydraulic Fracturing in Ohio
- E. S.G. Holtkamp, M.R. Brudzinski, and B.S. Currie, "Regional detection and monitoring of injection-induced seismicity: Application to the 2010-2012 Youngstown, Ohio, seismic sequence"
- F. R.J. Skoumal, M.R. Brudzinski, B.S. Currie, and J. Levy, "Optimizing multi-station earthquake template matching through re-examination of the Youngstown, Ohio sequence"
- G. Permit Conditions for Horizontal Wells Drilled near Known Faults or Areas of Seismic Activity (ODNR 034485)
- H. Bedrock Map of Ohio
- I. Shaded Drift Thickness Map of Ohio

- J. I. Wong, J. Bott, M. Dober, P. Thomas, and E. Nemser, "Assessing the damage potential of injection-induced earthquakes in the U.S."
- K. Proposal from LCI for Washington County Work (ODNR033910)
- L. Proposal from LCI for Washington County Work (ODNR015699)
- M. Results from Phase I (ODNR031549)
- N. Email (ODNR016105) with results of Phase II
- O. Results from Phase II (ODNR017199)
- P. AWMS Proposed Restart Entry in Franklin County Common Pleas Court
- Q. Division's Proposed Restart Entry in Franklin County Common Pleas Court
- R. Richard Simmers' Expert Report
- R-B. Map (color) from Richard Simmers' Expert Report
- R-C. Graphic (color) from Richard Simmers' Expert Report
- S. Division's Responses to AWMS's Discovery Requests
- T. Division's Preliminary Report on NorthStar #1
- U. Heinrich No. 1 Permit (December 21, 2015) (ODNR030645)
- V. June 12, 2012 Email from Mac Swinford to Richard Simmers (ODNR013484)
- W. June 11, 2012 Email from Tom Tomastik to Robert Worstall (ODNR013525)
- X. June 12, 2012 Email from Dave Orr to Mac Swinford about Reporting Marietta Earthquake (ODNR013503); June 12, 2012 Email from Dave Orr to Chuck Salmons about Reporting Marietta Earthquake (ODNR013507); Geological Survey Report on May 29, 2012 Marietta Earthquake
- Y. Communications between Division and Long Run No. 1 Operator (ODNR006895, ODNR016258, ODNR014299, ODNR017635)
- Z. Abstract about Washington County by Glenda Besana-Ostman (ODNR027616)
- AA. Abstract about Washington County by Glenda Besana-Ostman (ODNR034262)
- BB. Abstract about Washington County by Glenda Besana-Ostman (ODNR033677)
- CC. Abstract about Washington County by Glenda Besana-Ostman (ODNR014274)
- DD. AGU Poster Session (2013) (ODNR017753)
- EE. PowerPoint presentation on Washington County seismicity (ODNR017176)
- FF. "Seismic Hazard and Risk Management in Ohio: ODNR-DOGRM's Efforts to Address Issues of Natural Earthquakes & Induced Seismicity" PowerPoint presentation (July 18, 2013) (ODNR034197) FF1 Ex. FF in a clearer black-and-white
- GG. "OhioNet: State of Ohio's Response to Induced Seismicity" Power Point presentation at AGI (April 14, 2017)
- GG1. Ex. GG in color
- HH. AWMS's September 17, 2014 Plan to Restart Operations ("the Plan")
- II. Division's 14 Seismic Evaluation Criteria (AWMS06632)
- JJ. Division's Draft Response to the Plan (January 8, 2015) (ODNR002553)
- KK. PowerPoint presentation of Division's Draft Response to the Plan (January 8, 2015) (ODNR017692)
- LL. January 29, 2015 Email from Steven L. Dade to Robert Worstall (AWMS041782) with attachments January 22, 2015 Division's Draft Response to the Plan (AWMS045481) and September 3, 2014 Suspension Order (AWMS045483)
- MM. Division's Draft Response to the Plan (January 29, 2015) (ODNR001786)

NN. February 26, 2015 Emails between Steve Kilper and Robert Worstall about 14 Seismic Evaluation Criteria (AWMS041756) (same as Ex. 19)  
 OO. March 4, 2015 Email from Steve Kilper to Robert Worstall submitting AWMS's Response to the 14 Seismic Evaluation Criteria (AWMS045471)  
 PP. AWMS's March 4, 2015 Response to the Division's 14 Seismic Evaluation Criteria (AWMS006627)  
 QQ. November 4, 2016 Letter from Counsel for the Division to AWMS Counsel (AWMS046462)  
 RR. November 18, 2017 Letter from AWMS Counsel to Counsel for the Division (AWMS046484)  
 SS. December 20, 2016 Letter from Counsel for the Division to AWMS Counsel (AWMS046527)  
 TT. Scott Kell's CV  
 UU. Scott Kell's Expert Report  
 VV. Cover Sheet for Scott Kell Binder  
 WW. 2014 Kell Emails AWMS 1.pdf (ODNR034263)  
 XX. 8 31 14 Event File (Kell).pdf (ODNR034267)  
 YY. 9 4 14 AWMS Ltr Reprot.pdf (ODNR034296)  
 ZZ. 9 5 14 AWMS Ltr Report AWMS#1 with O&G Analysis.pdf (ODNR034328)  
 AAA. AWMS Pressure and Run Times from Kell file.pdf (ODNR034360)  
 BBB. Contour Map.pdf (ODNR034395)  
 CCC. Draft 9 1014 documents AWMS 1.pdf (ODNR034396)  
 DDD. Geo Rev Class 2 Wells.pdf (ODNR034402)  
 EEE. Injection Well Data Sheet.pdf (ODNR034425)  
 FFF. Kell Notes 2014.pdf (ODNR034447)  
 GGG. SWIW Inventory Annual Volume.pdf (ODNR034458)  
 HHH. Wells Within Radius of AWMS.pdf (ODNR034476)  
 III. Robert Worstall's CV  
 JJJ. Robert Worstall's Expert Report  
 KKK. Robert Worstall's Handwritten Notes  
 LLL. Ken Malek/Roland Blauer's Expert Report  
 MMM. Roland Blauer's CV  
 NNN. Malek/Blauer Exhibit 3 – documents considered  
 OOO. Malek/Blauer Exhibit 4 – well log for AWMS #2  
 PPP. Malek/Blauer Exhibit 5 – well log for Long Run #1  
 QQQ. Malek/Blauer Exhibit 7 – analysis of 30(B)(5) testimony  
 RRR. Malek/Blauer Exhibit 8 – certification  
 SSS. Baker Hughes nuclear tracer test report (same as Ex. 20)  
 TTT. Brian Currie's expert report  
 UUU. Baker Hughes nuclear tracer test log report, 12/12/17 (same as Ex. 83)  
 VVV. AMWS #2 mud log  
 WWW. Malek/Blauer Exhibit 1 – Malek's CV  
 XXX. Malek/Blauer Exhibit 6 – Wade errors  
 YYY. Malek/Blauer Schedules  
 ZZZ. Bruce Langhum article  
 AAAA. Appendix A from William Wade's DCA income statement for AWMS

BBBB. Andrew Adgate's CV  
CCCC. Andrew Adgate's expert report  
DDDD. Ivan Wong's Supplemental Expert Report (7/28/21)  
EEEE. Gail M. Atkinson, "Ground-Motion Prediction Equation for Small-to-Moderate Events at Short Hypocentral Distances, with Application to Induced-Seismicity Hazards"  
FFFF. Gannett Fleming, "Geotechnical Interpretative Report for MVSD (2018)" [confidential]  
GGGG. Gannett Fleming, "Embankment Slope Stability and Seepage Analyses Report (2018) [confidential]  
HHHH. Bureau of Mines, "Report of Investigations 8507, Structure Response and Damage Produced by Ground Vibration from Surface Mine Blasting"  
III. Chief's Restart Order 2021-97  
JJJ. Ken Malek Supplemental Report (8/16/21)  
KKKK. Ken Malek Supplemental Report Schedule and Exhibits (PDF)  
LLLL. Ken Malek Supplemental Report Schedule and Exhibits (Excel)  
MMMM. 20210816 With Takings Alternatives (Suspension and Restart Scenario to 2034) (Excel)  
NNNN. 20210816 With Takings Alternatives (No Suspension Scenario) (Excel)  
OOOO. Ken Malek Letter to Counsel (8/24/21)

## **Exhibits from AWMS Witness Depositions**

- 01: Notice of Depositions of American Water Solutions, LLC, AWMS Holdings, LLC, and AWMS Rt. 169, LLC
- 02: drawing of organizational structure and relationship
- 03: injection well lease between Gearmar Properties, Inc. and American Water Management Services, LLC dated 12/19/11 (AMWS034551)
- 04: memorandum of lease between Gearmar Properties, Inc. and American Water Management Services, LLC dated 12/19/11 (AMWS034559)
- 05: unsigned assignment of lease from American Water Management Services, LLC to AWMS 169, LLC (AWMS 044450)
- 06: well site information (AWMS030208)
- 07: site suitability summary dated 9/1/11 (AWMS0012148)
- 08: 8/6/13 email from Tim Coxson to Steve Kilper about risk factors for potential investors (AMWS036318)
- 09: Exhibit C "risk factors" from North Lima Disposal Well #4, LLC offering (AMWS031295) [confidential]
- 10: prevention and risk management of induced seismic activity from salt-water injection wells dated 5/31/14 (AMWS006431)
- 11: risk assessment report – seismicity in vicinity of AWMS #2 salt water injection well from July 2016 (AWMS031272)
- 12: offering memorandum (AWMS006811) [confidential (withdrawn)]
- 13: 5/2/16 email from Steve Kilper to Mark Cawthorne about interest from Patriot Water (AWMS046288)
- 14: internal well calculations
- 15: injection pressures and run times/rate
- 16: 2/24/14 email from Don Kreager to Tom Tomastik and Steve Ochs about AWMS #1 Well Pfall test (AWMS039632)
- 17: report on AWMS #2 Well from BlueDot Energy Services LLC (AWMS044786)
- 18: pressure fall-off test data
- 19: 2/26/15 email from Robert Worstall to Steve Kilper about seismic evaluation criterion nos. 7 and 11 (AWMS041756) (same as Ex. NN)
- 20: nuclear tracer log on AWMS #2 Well from Baker Hughes (same as Ex. SSS)
- 20A: Ex. 20 in color
- 21: Baker Hughes report on porosity for AWMS #2 Well (AMWS010902)
- 22: questions about salt water injection facility from potential investor dated 10/29/13 (AWMS029415)
- 23: Relators' response to Respondents' to first set of requests for admission, interrogatories, and requests for production of documents
- 24: Relators' supplemental response to Respondents' to first set of requests for admission, interrogatories, and requests for production of documents
- 25: Relators second supplemental response to Respondents' to first set of requests for admission, interrogatories, and requests for production of documents
- 26: Proximity of Ohio Earthquakes Detected by OhioNet to Structures
- 27: 2/27/17 email from Paul Friberg to Steve Kilper about OhioNet events from 4/28/14 to

- 10/6/16 (AWMS 101200)
- 28: various tables of production and injection (AWMS046731-046736)
- 29: 10/10/14 email from Steve Kilper to Tim Coxson, Ken McMahon, Mark Cawthorne, and Jay Skolnick about first attempt at determining economic damages with Excel worksheet (AWMS049021)
- 30: customer list (AWMS000437)
- 31: 11/20/17 email from Mark Cawthorne with customer list
- 32: 11/17/16 email from Mark Cawthorne to Steve Kilper, Ken McMahon, and Bryan Saksa (AWMS048730) with AWMS 169 customer spreadsheet
- 33: list of brine prospects
- 34: 10/1/13 email from Doug Rutherford about deepwell target update (AWMS020562)
- 35: master service agreement between Brammer Engineering, Inc. and American Water Management Services, LLC dated 1/9/14 (AWMS011828) [confidential (withdrawn)]
- 36: 8/5/15 email from Mark Darrow to Mark Cawthorne and Brian Freeman about rail shipments to AWMS Facility (AWMS010513) [confidential (withdrawn)]
- 37: Notice of Depositions of Kilper, McMahon, Cawthorne, Saksa, and Coxson
- 38: organizational chart
- 39: 2013 annual report of Avalon Holdings (AWMS029326) [confidential]
- 40: American Water Management consolidated balance sheet through 12/31/14 (11/20/17, 8:52 am) [confidential]
- 41: American Water Management consolidated through 12/31/14, detailed income statement (2/26/15, 4:19 pm) [confidential]
- 42: AWMS Rt. 169, LLC projected income with no suspension (11/27/17, 4:43 pm)
- 43: AWMS Rt. 169, LLC projected income with no suspension (11/27/17, 5:16 pm)
- 44: 4/21/15 email from Steve Kilper (AMWS045541) with scenarios for hauling out to Miller #1 or shutting down (AWMS045542) and projected income with no suspension (AWMS045543) [confidential]
- 45: 1/5/16 email from Bryan Saksa to Steve Kilper (AMWS042204) with impairment analysis for 2015 (AWMS042205) and memo
- 46: 2015 impairment memo (AWMS042206)
- 47: 11/30/16 email from Bryan Saksa to Steve Kilper (AWMS011471) with impairment analysis and memo [confidential (withdrawn)]
- 48: 2016 impairment memo (AWMS011473) [confidential (withdrawn)]
- 49: investor listing [confidential]
- 50: letter to potential investors (AWMS037251)
- 51: 11/1/13 email from Ken McMahon to Tim Coxson, Mark Cawthorne, and Steve Kilper with attached responses to potential investor (AWMS038035) [confidential]
- 52: draft letter to potential investors (AWMS048662) [confidential (withdrawn)]
- 53: Hasting 2015 Report, 03-03-15
- 54: Hasting 2017 Report, 10-20-17
- 55: Curriculum Vitae
- 56: Cross-Correlation Traffic Light Systems for Induced Seismicity; an Example of an Operational Single Stateion Detector in Ohio
- 57: AWMS Expert Report, 10-17-17
- 58: Figure 2b
- 59: Email Chain, 02-11-15

- 60: Email Chain, 01-06-15
- 61: Email Chain, 04-14-15
- 62: Curriculum Vitae
- 63: Expert Witness Report
- 64: Figure 10a
- 65: Figure 12
- 66: Curriculum Vitae
- 67: Letter/Report, 01-20-17
- 68: Email Chain, 01-01-14
- 69: Curriculum Vitae
- 70: Email Chain, 11-28-14
- 71: Letter, 01-24-17
- 72: Expert Report
- 73: Financial Valuation
- 74: Expert Report: Penn Central
- 75: Expert Report: Lucas
- 76: Tomastik CV
- 77: Email chain ending 02/06/12
- 78: Email chain ending 09/20/12
- 79: Email chain ending 11/19/12
- 80: Email chain ending 07/18/13
- 81: Email chain ending 09/13/13
- 82: ALL Consulting Memorandum, 01/02/18
- 83: Baker Hughes American Water Management Services Report, 12/12/17 (same as Ex. UUU)
- 84: Steve Kilper's model methodology for restart
- 85: AWMS's responses to Respondents' Second Set of Requests for Admission and Requests for Production of Documents
- 86: 3/19/21 email from Mike Hasting
- 87: Gas Daily, "Arkansas bans injection wells on earthquake concerns" (7/28/11)
- 88a: Google Maps printout of Niles Intermediate School
- 89: Brian Roach's Validation Expert Report (3/8/21)
- 90: Brian Roach's Supplement Expert Report (7/5/21)
- 90B: AWMS Rt. 169, LLC Projected Income with No Suspension (PDF)
- 90C: AWMS Rt. 169, LLC Projected Income with Suspension and Restart through 2027 (PDF)
- 90D: AWMS Rt. 169, LLC Projected Income with Suspension through 2027 (PDF)
- 91: Expert witness report on induced seismicity and its relation to recorded Earthquakes in Trumbull and Washington Counties, Ohio

## **AWMS Trial Exhibits**

PPPP.	ODNR video "Class II Injection Wells in Ohio" <a href="https://youtu.be/VEth4Kg313w">https://youtu.be/VEth4Kg313w</a>
QQQQ.	Completion Record for AWMS #1 Well
RRRR.	Completion Record for AWMS #2 Well
SSSS.	Timeline (revised)
TTTT.	ODNR Graphic 4/6/11 "Erenpreiss, M.S., Wickstrom, L.H., Perry C.J., Riley, R.A., Martin, D.R., and others, 2011, Regional organic-thickness map of the Marcellus Shale with additional organic-rich shale beds in the Hamilton Group included for New York, Pennsylvania, and West Virginia: Ohio Department of Natural Resources, Division of Geological Survey, scale 1 inch equals 52 miles" available at <a href="https://ohiodnr.gov/static/documents/geology/2012_GSA_MappingOrganicThicknes">https://ohiodnr.gov/static/documents/geology/2012_GSA_MappingOrganicThicknes</a> sMarcellusShale_Erenpreiss.pdf
UUUU.	Color slides from Glenda Besana-Ostman
VVVV.	ODNR video "Seismic Monitors (June 16, 2014)" <a href="https://youtu.be/qIT_G3PteNA">https://youtu.be/qIT_G3PteNA</a>
WWWW.	Site Video 360°
XXXX.	Steve Kilper's Handwritten Notes and Summary from Calls on September 2 and 3, 2014
YYYY.	Suspension Orders (Chief's Orders 2014-371, 2014-372, 2014-373, and 2014-374)
ZZZZ.	February 25, 2015 Email from Steve Kilper to Robert Worstall about blasting seismographs
AAAAA.	Excel LongRun-BellsRun Master.xlsx
BBBBB.	AWMS Rt. 169, LLC detail income statements 2014-2021
CCCCC.	AWMS Rt. 169 Cash Model for Hauling
DDDDD.	Excel EW-catalog-2017-09-07.xlsx
EEEE.	Excel Alerts_Rush.xls
FFFF.	OhioNET Detected Seismic Events of M1.7 through May 23, 2017 (revised)
GGGGG.	Sample ODNR-DMRM response to blasting complaint (March 30, 2020 letter to David Ayscue III)
HHHHH.	Excel Blasting Complaint Database.xlsx
IIII.	Map of Blasting Complaints (revised)
JJJJ.	Brian Roach Brine Calculations Excels
KKKKK.	Brian Roach Economic Analysis Excels
LLLLL.	Brian Roach CV
MMMMM.	Appellee, Ohio Division of Oil and Gas Resources Management Final Witness Disclosure – Expert Witness Report of Richard J. Simmers
NNNNN.	Communications between Eric Vendel and Ohio Oil Gathering Corp. (June 2018 – February 2020)
OOOOO.	Steve Kilper's model of the effect of the May 21, 2021 DOGRM Order 2021-97 on AWMS through 2027
PPPPP.	Steve Kilper's model of the effect of the May 21, 2021 DOGRM Order 2021-97 on AWMS through 2034
QQQQQ.	Excel file provided by Steve Kilper detailing all AWMS brine deliveries referenced in footnote 1 of Brian Roach's 2017 report (Ex. 72)

- RRRRR. Excel file provided by Steve Kilper detailing all AWMS injection quantities referenced in footnote 8 of Brian Roach's 2017 report (Ex.72)
- SSSSS. Excel file detailing AWMS quarterly injection totals referenced in footnote 9 of Brian Roach's 2017 report (Ex. 72)
- TTTTT. Excel file detailing injection data for other wells referenced in footnote 16 of Brian Roach's 2017 report (Ex. 72)
- 89A. Dr. Roach's "no suspension scenario" model prepared in conjunction with his March 8, 2021 report validating Dr. Wade's analysis.
- 89B. Dr. Roach's "suspension scenario" model prepared in conjunction with his March 8, 2021 report validating Dr. Wade's analysis.
- 90A. Dr. Roach's "no suspension scenario" model prepared in conjunction with his July 5, 2021 report.
- 90B. Dr. Roach's "suspension and restart scenario to 2027" model prepared in conjunction with his July 5, 2021 report.
- 90C. Dr. Roach's "suspension and restart scenario to 2034" model prepared in conjunction with his July 5, 2021 report.

The exhibits introduced during Dr. Currie's videotaped trial testimony were filed with the Clerk of Court on June 18, 2018.