

<b>AMERICAN WATER MANAGEMENT</b>	:	<b>Common Pleas No. 16 CV 006218</b>
<b>SERVICES, LLC</b>	:	
	:	
<b>Appellant,</b>	:	<b>Appeal of Oil and Gas</b>
	:	<b>Commission Case Nos. 889 &amp; 890</b>
	:	
<b>v.</b>	:	<b>Judge Kimberly Cocroft</b>
	:	
<b>DIVISION OF OIL &amp; GAS</b>	:	
<b>RESOURCES MANAGEMENT</b>	:	<b>RESPONSE TO COURT’S</b>
	:	<b>ORDER OF DECEMBER 23, 2016</b>
<b>Appellee,</b>	:	<b>DIRECTING SUBMISSION OF</b>
	:	<b>PROPOSED ENTRY</b>
	:	

On January 19, 2017, the Division filed a Notice of Appeal with the Tenth District Court of Appeals in this matter, and further, filed a Motion for Emergency Stay with this Court. While the Motion for Stay has not yet been addressed by the trial court and the appellate court's jurisdiction has been invoked, the Division hereby submits the following proposed language for an entry as directed by the Court's December 23<sup>rd</sup> Order. The Division re-asserts its position that the Oil and Gas Commission's Order upholding the Chief's Orders suspending the AWMS #2 Well's injection operations was lawful and reasonable, and without waiving any arguments in support of that position, hereby provides the attached Proposed Entry Order pursuant to the Court's December 23<sup>rd</sup> Order.

Respectfully Submitted,

MICHAEL DEWINE  
Ohio Attorney General

/s/Brett A. Kravitz

Brett A. Kravitz (0069101)

Brian Becker (0089738)

Assistant Attorneys General

Environmental Enforcement Section-ODNR Unit

2045 Morse Rd., Bldg. A-3

Columbus, Ohio 43229

Phone: (614) 265-6850

Facsimile: (614) 268-8871

Brett.Kravitz@OhioAttorneyGeneral.gov

Brian.Becker@OhioAttorneyGeneral.gov

Counsel for Appellee, Division of Oil & Gas Resources Management

**IN THE COURT OF COMMON PLEAS  
FRANKLIN COUNTY, OHIO**

<b>AMERICAN WATER MANAGEMENT</b>	:	<b>Common Pleas No. 16 CV 006218</b>
<b>SERVICES, LLC</b>	:	
	:	<b>Appeal of Oil and Gas</b>
<b>Appellant,</b>	:	<b>Commission Case Nos. 889 &amp; 890</b>
	:	
<b>v.</b>	:	<b>Judge Kimberly Cocroft</b>
	:	
<b>DIVISION OF OIL &amp; GAS</b>	:	
<b>RESOURCES MANAGEMENT</b>	:	<b>ORDER AND ENTRY</b>
	:	
	:	
<b>Appellee,</b>	:	
	:	

---

The Court finds that the proposed plan submitted by the Division of Oil and Resources Management (“Division”) shall be adopted by the Court and that AWMS may resume operations at the AWMS #2 Well consistent with the attached plan and all applicable R.C. Chapter 1509 requirements and rules. The Division’s plan is fully adopted and incorporated herein.

IT IS SO ORDERED.

/s/  
**Judge Kimberly Cocroft**

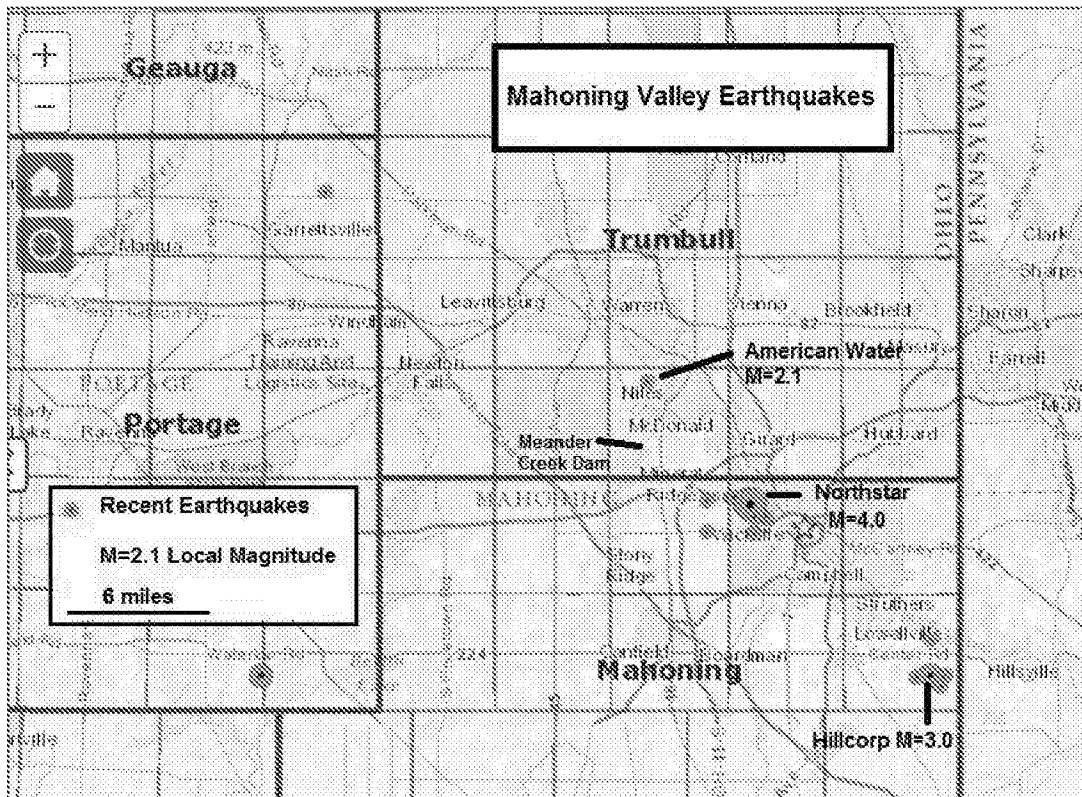
**Division of Oil and Gas Resources Management's Plan  
 Adopted by The Franklin County Court of Common Pleas**

**Background:**

*Regional geology of the Mahoning Valley*

The Mahoning Valley is a glaciated plateau comprised of flat-lying sedimentary rocks underlain by Precambrian crystalline basement rocks. The valley is covered by 20-50 feet of unconsolidated sands, gravels, and clay that were deposited as outwash by water from melting glaciers. These sediments are very prone to particle motion due to earthquakes, known as site amplification, as opposed to a site with hard, consolidated bedrock outcrops. Thus, surface effects from earthquakes may be magnified in this area.

The Precambrian crystalline basement rocks are cut by several known faults, and likely others that have yet to be identified. The known faults trend east-northeast, approximately parallel to the regional axis of maximum stress field in the area. Thus, they are already under stress and may move and cause earthquakes if subjected to injected fluids or pressures. It is also important to know their length that has an effect on the magnitudes they may create.



### *Local Concerns*

Within three miles of the AWMS #2 injection well local infrastructure includes numerous residences, businesses, at least nine schools, two hospitals, and one fire department. Meander Dam forms the reservoir that supplies water to over 200,000 people in this area. It is located less than 3 miles south of the AWMS # 2 injection well. Officials of the water system have reported cracks in both the dam and in brick buildings in the area, and are questioning whether this may have been caused by recent earthquakes.

### *Area Seismology*

From March 2011 to December 2011 the Youngstown area experienced 12 earthquake events that ranged in magnitude from 2.1 to 4.0. The Northstar #1 injection well was caused to be shut down by the Division of Oil and Gas Resources Management ("Division") when studies demonstrated that the aforementioned earthquake events were associated with operation of that well.

On March 14th, 2014 completion work at a Hilcorp location was associated with a 3.0 magnitude earthquake event for which those operations were shut down by the Chief of the Division. No additional earthquakes associated with well activity have been recorded after the hydraulic fracturing operations were shut down.

On August 31st, 2014 a 2.1 magnitude event was recorded about 400 meters northwest of the AMWS # 2 in the Precambrian crystalline basement rock along an east-northeast trending fault. From waveform cross-correlation it was found that there had also been 108 low magnitude fore-shocks were identified prior to the 2.1 magnitude earthquake. The Division issued an administrative order causing the well to be shut down.

Subsequent studies by Dr. Michael Brudzinski, Professor of Seismology at Miami University, suggest that the Northstar #1 injection well was injecting close to an east-northeast trending fault similar to the one found at the AMWS # 2 location. The AMWS # 2 well is less than 7 miles northwest of the Northstar # 1. Recent work by Dr. Brudzinski indicates that these events were also associated with an east-northeast trending fault. Dr. Brudzinski's study supports the Division's conclusion that "the AWMS # 2 is very likely related to the earthquakes based on strong spatial and temporal correlations between injection and seismicity".

### **Description of elements in operation plan:**

The elements detailed below are diagnostic tools that are used independently or in conjunction with each other to monitor and evaluate the potential for induced seismic events and actual induced seismic events. Each element or diagnostic tool provides different types of information that assists the Division in evaluating risks, attempting to prevent or minimize induced seismic events, and to protect public health and safety.

### *Environmental Site Assessment*

The Division of Oil and Gas Resources Management ("Division") proposes, and the Court adopts, that American Water Management Services ("AWMS") perform an environmental site assessment prior to resuming injection operations. The purpose of this environmental site

assessment is to determine the potential effect of a seismic event on the local community. The assessment must consider the cumulative effect of small and large (at least magnitude 4.0) seismic events on buildings, bridges, dams, and other structures that could be impacted by ground shaking resulting from a seismic event. Ground shaking associated with seismic events has the potential to impact the structural integrity of all types of construction. The assessment will help the Division evaluate the risk associated of structural damage to buildings and other structures.

#### *Principle Stress Determination*

The Division proposes, and the Court adopts, that AWMS perform a dipole survey to determine the principle axis of stress orientation in the vicinity of the AWMS #2 injection well. Knowing the orientation of the principle axis of stress in combination with the fault geometry would allow the Division to anticipate if faults are more likely to slip. Fault planes that align with the principle stress orientation are more likely to slip because of the earth's natural forces acting on the fault.

#### *Geology Review*

The Division proposes, and the Court adopts, that AWMS conduct a complete geologic review of each potential injection zone coupled with modeling of the fluid injection into those zones. The review shall include a study of the rock mechanics related to potential or stored energy. Rock types capable of storing more energy have the potential to cause higher magnitude induced seismic events. This review and model will allow the Division to assess the risk of the likelihood of a seismic event associated with injection into each of these geologic zones.

#### *Three Dimensional Seismic Survey*

The Division proposes, and the Court adopts, AWMS complete or acquire a three-dimensional seismic survey of the local area. A seismic survey uses a noise source (percussion, dynamite, vibration, etc.) to transmit energy into the subsurface. A portion of this energy is reflected back off the rock layers and can be measured at the surface. The reflected energy is analyzed to produce diagrams of the subsurface geology. These diagrams are reviewed for indications of subsurface faults and structures. Seismic events occur along faults where the rocks slip past one another. Knowledge of the location, distribution, and length of faults assist the Division in protecting public health and safety by prohibiting injection in formations containing faults. The fault geometry may be used in conjunction with the principle axis of stress orientation to determine if a fault is more likely to slip and create seismic events. The survey should be an area of 4 square miles centered on the AWMS #2 injection well in order to completely image the Precambrian crystalline basement rock. A processed and interpreted version of the three-dimensional survey must be submitted to the Division for review.

#### *Plug-back & Proximity to Precambrian Crystalline Basement Rock*

One of the principal findings of the "Potential Injection-Induced Seismicity Associated with Oil and Gas Development" primer was to avoid drilling into or injecting into or near the Precambrian crystalline basement rock. In this case the total depth of the injection well is within approximately 150 feet or less of the Precambrian crystalline basement rock. In order to provide additional space between the bottom of the well and the Precambrian crystalline basement rock

the Division proposes, and the Court adopts, that AWMS plug back the #2 well from the present depth of 8,500 feet to at least 8,000 feet using Class A cement spotted with tubing. After allowing time for the cement to properly cure, plug placement must be tagged or otherwise verified by AWMS prior to proceeding with running and cementing a string of injection casing detailed in the following section.

#### *Well Construction Design Modification*

In order to increase certainty as to the geologic interval receiving the injected brine, the Division proposes, and the Court adopts, that a new production string (7" diameter steel pipe) be placed in the well from surface to the top of the new bottom plug at 8,000 feet and cemented to a depth of 6,700 feet (500 feet above the base of the existing 9-5/8" diameter casing already set at 7,201 feet). The porous and permeable intervals as identified on open hole logs and on the radioactive tracer survey can then be perforated and used for controlled injection. This construction design is utilized by approximately 90% of the class II wells in Ohio. This proposed design will provide a more controlled injection environment and provide more isolation of injected fluids from the Precambrian crystalline basement rock.

#### *Seismic Monitoring*

Proper deployment and continuous monitoring of an appropriate array of seismic monitoring instruments is essential to detecting, measuring, and locating seismic events. Seismic events can be reviewed by seismologists to provide accurate information to regulators in order to protect the public. Currently, four instruments are deployed in the vicinity of the AWMS #2 injection well. The Division proposes, and the Court adopts, AWMS reactivate these four instruments and resume data streaming to the Division. Additionally, the Division proposes that AWMS deploy a fifth instrument approximately one mile to the east to ensure this network can provide precise seismic event locating capability. Adding the additional seismic monitor will completely surround the AWMS #2 injection well with seismic monitors. Seismic monitoring instruments are vital to the Division providing a timely and appropriate response to any measured seismic events to protect public health and safety. In the Division's past experience, these small events are indicators of larger events and may be used to help prevent larger events. Detecting and responding to these small events is dependent upon a robust seismic monitoring network.

#### *Surface Motion Monitors*

The Division proposes, and the Court adopts, AWMS deploy at least three surface motion monitors to measure ground shaking in the area. Surface motion monitors measure ground motion or shaking where they are deployed. This information will allow the Division to evaluate the potential for damage from measured ground shaking resulting from a seismic event. Seismic monitors (mentioned previously) measure P (primary) and S (surface or secondary) wave arrivals and amplitudes that allow for determination of location and magnitude of measured seismic events. Location and magnitude information coupled with the measurement of surface ground motion or shaking allows the Division to assess the amount of risk to persons and property from seismic events. This technology has been used by the mining industry to monitor and restrict ground motion caused by blasting. AWMS shall deploy surface motion monitors near the AWMS #2 injection wellsite, near the Meander Reservoir Dam, and near the AWM #3 seismic

monitoring location. If the surface motion monitors show a maximum peak particle velocity or frequency-dependent particle velocity limits in exceedance of safe standards established for structures AWMS shall cease operations regardless of the magnitude of induced seismic events.

#### *Real-time Wave form Cross Correlation*

The Division proposes, and the Court adopts, that AWMS or its consultant implement a real-time monitoring program that works to match the wave form of previously measured seismic events to the live data being recorded by the seismic monitors. This “real-time wave form cross correlation” is intended to “fingerprint” the wave forms of a previous earthquake (seismic event) and match it with live wave forms data being recorded. The purpose of this is to identify very small seismic events. These very small seismic events are sometimes too difficult to be identified in real-time without cross correlation because they are overshadowed by ambient background noise being recorded by the seismic monitor. It is useful to identify these very small seismic events because they are often precursors to future seismic events that can be larger. Implementing real-time wave form cross correlation would allow the Division to detect small seismic events and intervene before larger potentially damaging events may occur in an effort to protect public health and safety.

#### *Daily Data Submission*

The Division proposes, and the Court adopts, that AWMS submit injection volume and pressure data on a daily basis. This daily data will be reviewed by the Division in an effort to identify any anomalies that may be indicators of problematic downhole conditions. Current regulations require continuous monitoring of this data and daily submission could be accomplished through electronic mail to the Division. This information will be a tool for the Division to intervene if necessary to protect the public and minimize the risks to the public.

#### *Quiet Period*

The Division proposes, and the Court adopts, that AWMS refrain from injection operations for a period of at least 60 days after installing and activating the required seismic and surface motion monitors. This quiet period will allow the Division to record and review data from the seismic monitors and ground motion monitors while the well is not in operation. These pre-operational recordings can be reviewed to determine what level of background seismicity and ground motion is normal for the area. This will be valuable information once the well becomes operational as the Division will be able to have some perspective on what level of measurements are typical for the area.

#### *Determine Minimum Operating Pressure*

The Division proposes, and the Court adopts, that AWMS perform an injectivity test to determine the minimum operating pressure that the AWMS #2 injection well will accept fluids. This minimum pressure would be recommended by the Division as the starting maximum allowable injection pressure. This determination may be accomplished by filling the borehole with fluid and slowly applying incremental pressure until the formation(s) begin to accept the fluid. The pressure at which the formations begin to accept the fluid would be considered the minimum operating pressure. Applied injection pressure is considered to be a contributing factor associated with induced seismicity. Therefore, the Division believes an incremental increase in



operating pressures at the AWMS #2 injection well is necessary to properly protect public health and safety. The details of the operational plan prescribe conditions surrounding incrementally increasing this maximum allowable injection pressure after operational milestones are reached.

#### *Pressure Fall-off Testing*

A pressure fall-off test (PFT) can be used to gather information on reservoir flow characteristics. A PFT consists of an injection period and a shut-in period. A constant rate of injection will increase the pressure of the reservoir over the injection period. Once the shut in period begins, the pressure will decrease as the fluid pressure begins to equilibrate in the reservoir environment. The downhole pressure and injection rates must be recorded throughout the test in order to analyze the results. Graphing the results may assist the Division in identifying flow regimes or reservoir conditions. Some types of reservoir conditions can be problematic and may indicate pressure communication with a fault or fracture. The Division proposes, and the Court adopts, AWMS conduct a PFT prior to resuming injection operations and submit the results and interpretation of the results to the Division for review. In addition, the Division proposes AWMS perform a new PFT every 60 days after resuming injection operations. This will allow the Division to review and analyze the downhole flow conditions through the operational life of the well.

#### *Tracer Survey*

Reservoir parameters such as permeability and porosity may be obtained by a radioactive tracer log. The survey involves injecting radioactive liquid or beads into the well and pumping a calculated volume of brine into the well in order to displace the radioactive material into the entire open-hole portion of the well. After the calculated volume is pumped, a wireline tool is lowered into the well and used to measure and locate the radioactive material. The geologic zones indicating high radioactive responses are considered to be likely receptive injection zones. In this case the only tracer survey performed was completed prior to normal injection operations. It has been the Division's experience that the shallowest porous and permeable zones in the open-hole section will accept the radioactive material initially. Over time, additional zones not receiving fluids initially will begin to receive fluid once the shallower zones start to fill and require increased pressure to take fluid. The Division is proposing, and the Court adopts, that a follow-up radioactive tracer survey be completed prior to AWMS resuming injection in order to identify potential disposal zones. Once the well construction modification has been completed, DOGRM proposes that a follow-up radioactive tracer survey be completed once the injection zone(s) are perforated to provide assurance the injected brine is being placed in the intended zone. Once injection operations commence, the Division proposes, and the Court adopts, that AWMS complete tracer surveys every 60 days to ensure fluid is entering the intended zones as the well continues to operate.

#### *Noise Log*

Noise logging is a downhole diagnostic tool that can be used to identify flow through constricted spaces. Fluid flow through narrow spaces creates noise resulting from turbidity. This noise can be measured and recorded by a wireline instrument that is placed in the well to create a noise log. The Division can use a noise log to determine if fluid flow is occurring in places that may be problematic other than the intended inject zone. Fluid flow behind the cemented casing,

near the bottom plug, or other suspect locations can be recorded by the noise log and remedied before the issue worsens. The Division is proposing, and the Court adopts, AWMS run a noise log prior to injection operations and every 60 days once injection has begun to identify any new sources of noise during the operational life of the well. This ensures that fluid is entering intended injection zones and not in unintended locations that may eventually communicate with a fault. Thus, this ensures the Division may protect the public from unintended seismic activity.

### *Operational Parameters*

The detailed operational parameters have been designed to minimize the risk of earthquakes associated with injection into the AWMS #2 injection well. The Division currently regulates 217 active class II saltwater injection wells. Only two of these (<1%) saltwater injection wells have been linked to measured seismic events with any certainty. The Division takes the threat of induced seismicity very seriously and takes all necessary actions to prevent, or in this case, stop the continued occurrence of induced seismic events.

If at any time the deployed surface motion monitors as discussed above show a maximum peak particle velocity or frequency-dependent particle velocity limits in exceedance of safe standards established for structures the Court orders that AWMS shall cease operations regardless of the magnitude of induced seismic events.

Following the performance, analysis, and submission of all the prerequisite requirements and authorization from the Division, the Division proposes, and the Court adopts, an introductory operating period of 120 days. This initial injection would be at the minimally practicable applied pressure as determined by pre-operational condition (b) of the plan to resume operations at the AWMS #2 injection well. This minimal pressure and limited volume (maximum 500 barrels/day) would provide AWMS and the Division a period to observe the operation of the well under controlled parameters. The 120 day period is designed to allow for equilibration of the system at the prescribed pressure and volume on a time scale longer than that observed during the previous operation of the injection well and subsequent induced seismic events. The first seismic event linked to the AWMS #2 injection well occurred more than 100 days after the beginning of injection operations. Allowing the incremental operational periods to be less than 120 days may not give the geologic system enough time to reveal the risk associated with the operational parameters of that period.

Each operational period is accompanied by required responses if seismic events are measured and linked to the operation of the AWMS #2 injection well. The responses are associated with measured event magnitudes recorded by the seismic monitoring instruments to be deployed and activated as described in monitoring condition (a) of the plan to resume operations at the AWMS #2 injection well. During the first 120 days of limited operation, if a seismic event up to a magnitude 1.5 occurs, AWMS may continue to operate as prescribed in accordance with the parameters within the period the well is currently operating. If a seismic event of magnitude 1.5 but less 2.0 occurs, AWMS shall begin conversations with the Division regarding mitigating risk of continued seismicity. If a seismic event of magnitude 2.0 but less than 2.5 occurs, AWMS must immediately but temporarily suspend operations and submit a plan for modifying the well construction and/or propose reduced operating pressures and volumes. Additionally, the operational schedule shall return to the beginning of the first 120 day

operational period. If a seismic event of magnitude 2.5 or greater occurs, AWMS must suspend operations and submit an application to plug and abandon the AWMS #2 injection well.

The second 120 day period of operation allows AWMS to operate the injection well at increased pressure and volume (maximum 1000 barrels/day) if injection operations during the first 120 day period occurs without a seismic event of magnitude 2.0 or greater. During the second 120 day period of operation, if up to a magnitude 1.5 occurs, AWMS may continue to operate as prescribed. If a seismic event of greater than magnitude 1.5 but less than 2.0 occurs, AWMS must begin conversations with the Division regarding mitigating risk of continued seismicity. If a seismic event of at least magnitude 2.0 but less than 2.5 occurs, AWMS must immediately but temporarily suspend operations and submit a plan for modifying the well construction and revert to the operational parameters outlined in "First 120 days". If a seismic event of magnitude 2.5 or greater occurs, AWMS must suspend operations and submit an application to plug and abandon the AWMS #2 injection well.

The third 120 day period of limited operation allows AWMS to operate the injection well at an increased pressure and volume (maximum 1500 barrels/day) if injection operations during the previous two 120 day operating periods occurs without a seismic event of magnitude 2.0 or greater. During the third 120 day period of operation, if up to a magnitude 1.5 occurs, AWMS may continue to operate as prescribed. If a seismic event of greater than magnitude 1.5 but less than 2.0 occurs, AWMS must begin conversations with the Division regarding mitigating risk of continued seismicity. If a seismic event of at least magnitude 2.0 but less than 2.5 occurs, AWMS must immediately but temporarily suspend operations and submit a plan for modifying the well construction and revert to the operational parameters outlined in "First 120 days". If a seismic event of magnitude 2.5 or greater occurs, AWMS must suspend operations and submit an application to plug and abandon the AWMS #2 injection well.

If after one year (365 days) of injection operations no seismic event of magnitude 2.0 or greater has occurred, AWMS may resume operations at the originally permitted maximum allowable injection pressure of 1680 psi without volume limitation. During this period of operation, if up to a magnitude 1.5 occurs, AWMS may continue to operate as prescribed. If a seismic event of greater than magnitude 1.5 but less than 2.0 occurs, AWMS must begin conversations with the Division regarding mitigating risk of continued seismicity. If a seismic event of at least magnitude 2.0 but less than 2.5 occurs, AWMS must suspend immediately but temporarily operations and submit a plan for modifying the well construction and revert to the operational parameters outlined in "First 120 days". If a seismic event of magnitude 2.5 or greater occurs, AWMS must suspend operations and submit an application to plug and abandon the AWMS #2 injection well.

The proposed incremental approach to resuming injection operations must be supplemented by the information gathering, well construction modification, monitoring, and pre-operational conditions discussed above in order to protect public health and safety in the area of the AWMS #2 injection well. Implementing these standards does not guarantee that the AWMS #2 injection well will not cause seismic events, but they will provide the Division the best opportunity to manage seismicity below levels that endanger public health and safety.

Based on the well founded concerns presented above, the Court further orders AWMS to comply with the following Operation Plan.

## **Operation Plan:**

### *1. Information Gathering:*

- a. Environmental site assessment – American Water Management Services (“AWMS”) shall perform an environmental site assessment prior to resuming injection operations to determine the potential effect of a seismic event on the local community. The assessment shall consider the cumulative effect of small and large (at least magnitude 4.0) induced seismic events on buildings, bridges, dams, and other structures, both public and private, with consideration given to age, construction type and use. This data shall be submitted to the Division of Oil and Gas Resources Management (“Division”) with detailed methodology and data analysis.
- b. Principle axis of stress determination – AWMS shall determine the principle axis of stress orientation in the immediate area of the AWMS #2 injection well. This data shall be submitted to the Division with detailed methodology and data analysis.
- c. Geology review – AWMS shall perform a study of the injection interval geology and submit it to the Division for review. AWMS shall conduct a complete geologic review of each potential injection zone coupled with modeling of the fluid injection into those zones. The review shall include a study of the rock mechanics related to potential or stored energy. This data shall be submitted to the Division with detailed methodology and data analysis.
- d. Seismic survey – AWMS shall complete or acquire a three-dimensional seismic survey to determine the presence and nature of any existing faults in the immediate area of the AWMS #2 injection well. This survey and the analysis of identified features shall be submitted to the Division for review. The review area shall extend at least one mile from the well site in each direction. The survey and a detailed analysis of geologic anomalies or features shall be submitted to the Division.
- e. Pressure front – prior to resuming injection operations, AWMS shall prepare and submit a model of the pressure front growth and development created by the fluid injection. The model shall include details of the anticipated pressure front and specifics regarding periodic reevaluation after injection operations have resumed.

### *2. Well Construction Modification:*

- a. Plug-back 500’ – AWMS shall plug-back the AWMS #2 injection well at least 500’ from the current total depth. The cement plug shall extend up into the cemented injection-casing to be pressure tested. AWMS shall submit proposed procedures for the plug-back operations to the Division for approval. AWMS shall plug back the AWMS #2 injection well from the present depth of 8,500 feet to at least 8,000 feet using Class A cement spotted with tubing. After allowing

time for the cement to properly cure, plug placement must be tagged or otherwise verified by AWMS. Records of plugging and testing shall be submitted to the Division.

- b. Install cemented injection-casing – AWMS shall install a new cemented injection string in the well from surface to the top of the new bottom plug at 8,000 feet. Prior to casing placement, AWMS must submit a plan to the Division that includes the proposed casing diameter, grade, weight and country of origin. The plan must address wellbore diameter (OAC 1501:9-1-08(H)) and centralizer standards (1501:9-1-08(K)). Casing must be cemented to a depth of 6,700 feet (500 feet above the base of the existing 9-5/8” diameter casing already set at 7,201 feet). The plan shall also include cement standards consistent with requirements of OAC 1501:9-1-08(J). Record of cementing and testing shall be submitted to the Division.

### 3. *Monitoring:*

- a. Seismic Monitoring – AWMS shall reactivate the four seismic monitoring stations that were previously sending live data to the Division’s seismic network. Additionally, AWMS shall install a fifth seismic monitoring station approximately one mile east of the AWMS #2 injection well. The exact location of this fifth monitor shall be agreed upon by AWMS and the Division. AWMS shall submit a seismic monitoring plan to the Division. The plan shall include third party real time monitoring of the seismic network beginning at 60 days prior to resumption of injection operations and continuously throughout the operational life of the AWMS #2 injection well. The final monitoring plan must be approved by the Division.
- b. Surface Motion Monitors – AWMS shall install at least three surface motion monitors to measure for ground motion around the AWMS #2 injection well. The exact locations of monitors shall be agreed upon by AWMS and the Division. AWMS shall deploy the surface motion monitors near the AWMS #2 injection wellsite, near the Meander Reservoir Dam, and near the AWM #3 seismic monitoring location. If the surface motion monitors show a maximum peak particle velocity or frequency-dependent particle velocity limits in exceedance of safe standards established for structures AWMS shall cease operations regardless of the magnitude of induced seismic events.
- c. Real-time waveform cross correlation – AWMS shall monitor seismic data in real-time using a waveform cross correlation program capable of matching previously recorded seismic event waveforms to live data in order to detect microseismic events. AWMS or its consultant shall implement a real-time monitoring program that works to match the wave form of previously measured seismic events to the live data being recorded by the seismic monitors. Methodology for wave form cross correlation monitoring shall be included in the seismic monitoring plan. Once initiated, the data and data analysis shall be submitted to the Division weekly, or more frequently by request. If seismic

clusters are identified, the data and analysis shall be forwarded to the Division immediately.

- d. Daily data submission – AWMS shall electronically submit injection volume and pressure data to the Division on a daily basis. Current regulations require continuous monitoring of this data.

4. *Pre-Operation Conditions:*

- a. Quiet period – Once the approved seismic and ground motion networks have been installed and are operational, AWMS shall refrain from injection operations for a period of at least 60 days. The Division may require adjustments to the monitoring network based on a review of quiet period data. Adjustments may include the addition of monitors and/or the relocations of monitors.
- b. Identify minimum operating pressure – AWMS shall test the newly perforated disposal zones by injecting fluid in a manner to determine the minimum surface injection pressure required to inject fluids. A Division inspector must be present to witness the test. AWMS must submit test data and interpretation to the Division before injection authorization is granted.
- c. Pressure fall off testing – Prior to resuming injection operations, AWMS shall measure the bottom hole pressure and perform a pressure fall off test. The results and interpretation of this test shall be submitted to the Division before injection authorization is granted. AWMS shall perform a new pressure fall off test every 60 days after resuming injection operations. The results and interpretation of these tests shall be submitted to the Division within 30 days after completion of the tests.
- d. Tracer survey – Prior to resuming injection operations, AWMS shall run a tracer or spinner survey to identify intervals that are accepting fluid flow. This survey shall be submitted to the Division for review. AWMS shall perform a new tracer survey every 60 days after resuming injection operations until the Division approves injection at the maximum allowable injection pressure and with no volume restrictions. The results of each survey shall be submitted to the Division within 30 days after completion of the tracer survey.
- e. Noise log – Prior to resuming injection operations, AWMS shall run a noise log to record any sources of noise in the borehole. The results and interpretation shall be submitted to the Division for review. AWMS shall perform a new noise log every 60 days after resuming injection operations. The results and interpretation of each survey shall be submitted to the Division within 30 days after completion of the noise log.

5. *Operational Parameters:*

- a. First 120 day period – If above conditions are met and authorization is granted by the Division, AWMS may begin injection operations at the established minimum operating pressure at a rate no greater than 500 barrels per day.

- i. If a seismic event less than or equal to local magnitude 1.5  $M_L$  occurs, AWMS may continue operations as prescribed.
  - ii. If a seismic event greater than local magnitude 1.5  $M_L$  but less than 2.0  $M_L$  occurs, AWMS shall begin discussions with the Division regarding mitigating risk of continued seismicity.
  - iii. If a seismic event of at least local magnitude 2.0  $M_L$  but less than 2.5  $M_L$  occurs, AWMS shall suspend injection operations, submit an application to alter the disposal zone, and propose reduced operating parameters (reduced pressure, reduced volume, etc.). If a seismic event of at least local magnitude 2.0  $M_L$  but less than 2.5  $M_L$  occurs, the operational schedule returns to the beginning of the first 120 days.
  - iv. If a confirmed felt seismic event or seismic event of local 2.5  $M_L$  or greater occurs, AWMS shall suspend injection operations and submit an application to plug the AWMS #2 injection well.
- b. Next 120 day period – If no seismic event of local magnitude 2.0  $M_L$  or greater occurs within the previous 120 days of normal injection operations, AWMS may continue injection operations at an increased maximum allowable injection pressure determined by the Division and at a rate of no more than 1000 barrels per day.
  - i. If a seismic event less than or equal to local magnitude 1.5  $M_L$  occurs, AWMS may continue operations as prescribed.
  - ii. If a seismic event greater than local magnitude 1.5  $M_L$  but less than 2.0  $M_L$  occurs, AWMS shall begin discussions with the Division regarding mitigating risk of continued seismicity.
  - iii. If a seismic event of at least local magnitude 2.0  $M_L$  but less than 2.5  $M_L$  occurs, AWMS shall suspend injection operations and submit an application to alter the disposal zone and revert to the previous set of operational parameters titled “First 120 days”.
  - iv. If a seismic event of local magnitude 2.5  $M_L$  or greater occurs, AWMS shall suspend injection operations and submit an application to plug the AWMS #2 injection well.
- c. Final 120 day period – If no seismic event of local magnitude 2.0  $M_L$  or greater occurs within the previous 120 days of normal injection operations, AWMS may continue injection operations at an increased maximum allowable injection pressure determined by the Division and at a rate of no more than 1500 barrels per day.
  - i. If a seismic event less than or equal to local magnitude 1.5  $M_L$  occurs, AWMS may continue operations as prescribed.

- ii. If a seismic event greater than local magnitude  $1.5 M_L$  but less than  $2.0 M_L$  occurs, AWMS shall begin discussions with the Division regarding mitigating risk of continued seismicity.
  - iii. If a seismic event of at least local magnitude  $2.0 M_L$  but less than  $2.5 M_L$  occurs, AWMS shall suspend injection operations and submit an application to alter the disposal zone and revert to the previous set of operational parameters titled "Next 120 days".
  - iv. If a seismic event of local magnitude  $2.5 M_L$  or greater occurs, AWMS shall suspend injection operations and submit a permit to alter the disposal zone to a zone no deeper than the Clinton sandstone or submit an application to plug the AWMS #2 injection well.
- d. After 1 year – If no seismic event of local magnitude  $2.0 M_L$  or greater has occurred within the previous 365 days of normal injection operations, AWMS may resume operations at the originally permitted maximum injection pressure of 1680 psi without volume limitation.
  - i. If a seismic event less than or equal to local magnitude  $1.5 M_L$  occurs, AWMS may continue operations as prescribed.
  - ii. If a seismic event greater than local magnitude  $1.5 M_L$  but less than  $2.0 M_L$  occurs, AWMS shall begin discussions with the Division regarding mitigating risk of continued seismicity.
  - iii. If a seismic event of at least local magnitude  $2.0 M_L$  but less than  $2.5 M_L$  occurs, AWMS shall suspend injection operations and submit an application to alter the disposal zone and revert to the previous set of operational parameters titled "Final 120 days".
  - iv. If a seismic event of local magnitude  $2.5 M_L$  or greater occurs, AWMS shall suspend injection operations and submit an application to plug the AWMS #2 injection well.
- e. Surface motion monitors - If at any time the deployed surface motion monitors show a maximum peak particle velocity or frequency-dependent particle velocity limits in excess of safe standards established for structures AWMS shall cease operations regardless of the magnitude of induced seismic events.

IT IS SO ORDERED.

/s/  
**Judge Kimberly Cocroft**



Respectfully Submitted,

MICHAEL DEWINE  
Ohio Attorney General

/s/Brett A. Kravitz

Brett A. Kravitz (0069101)

Brian Becker (0089738)

Assistant Attorneys General

Environmental Enforcement Section-ODNR Unit

2045 Morse Rd., Bldg. A-3

Columbus, Ohio 43229

Phone: (614) 265-6850

Facsimile: (614) 268-8871

Brett.Kravitz@OhioAttorneyGeneral.gov

Brian.Becker@OhioAttorneyGeneral.gov

Counsel for Appellee, Division of Oil & Gas Resources  
Management

**CERTIFICATE OF SERVICE**

I certify that a true and accurate copy of the foregoing Division of Oil and Gas Resources Management's Response to Order of December 23, 2016 Directing Submission of Proposed Entry was served upon the following by operation of the Court's electronic filing system, as well as by electronic mail, pursuant to Civ.R. 5(B)(2)(f), on January 23, 2017:

COMSTOCK, SPRINGER & WILSON CO. LPA  
THOMAS J. WILSON  
1000 Federal Plaza East, Suite 926  
Youngstown, Ohio 44503-1811  
tjw@csandw.com

and

LARRY H. JAMES (0021773)  
CRABBE, BROWN, & JAMES, LLP  
500 S. Front Street, Suite 1200  
Columbus, Ohio 43215

ljames@cbjlawyers.com

*Counsel for AWMS Water Solutions,  
f/k/a American Water Management Services, LLC*

/s/Brett A. Kravitz  
Brett A. Kravitz

*Counsel for Appellee Division of Oil &  
Gas Resources Management*