

STATE OF NEW MEXICO
ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT
OIL CONSERVATION COMMISSION

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**APPLICATION OF LIGHTNING DOCK
GEOTHERMAL HI-01, LLC FOR APPROVAL
TO INJECT INTO A GEOTHERMAL AQUIFER
THROUGH THREE PROPOSED GEOTHERMAL
INJECTION WELLS AT THE SITE OF THE
PROPOSED LIGHTNING DOCK GEOTHERMAL
POWER PROJECT, HIDALGO COUNTY, NEW
MEXICO**

CASE NO. 15357

**APPLICATION OF LIGHTNING DOCK
GEOTHERMAL HI-01, LLC TO PLACE WELL
NO. 63A-7 ON INJECTION-GEOTHERMAL
RESOURCES AREA, HIDALGO COUNTY, NEW
MEXICO**

CASE NO. 15365

**LIGHTNING DOCK'S PROPOSED
FINDINGS OF FACT AND CONCLUSIONS OF LAW**

Lightning Dock Geothermal HI-01, LLC ("Lightning Dock"), by and through its attorneys, Patrick J. Rogers, LLC and Michelle Henrie, LLC, hereby submits Proposed Findings of Fact and Conclusions of Law in connection with the hearing before the Oil Conservation Commission ("Commission") commencing on September 10, 2015.

Proposed Findings

1. Lightning Dock owns and operates a utility-scale binary (two closed loops) geothermal power plant. The power plant generates base-load renewable electricity which is sold to Public Service Company of New Mexico ("PNM").

2. Lightning Dock seeks to drill new injection wells. Through Lightning Dock's injection wells, geothermal fluids that have already passed through the power plant's heat exchanger are re-injected back into the geothermal system.

Findings Relating to Procedural Matters

3. *Lightning Dock* submitted to the Oil Conservation Division (“Division”) four applications to drill injection wells. The first two applications, for wells for 15-8 and 76-7, were filed on June 1, 2015. The third application, for well 13-7, was filed on June 15, 2015. The fourth application, for well 63A-7, was filed on July 1, 2015.

4. Proposed Well 13-7 is located in Unit E, 1537 FNL and 504 FWL, Section 7, Township 25 South, Range 19 West, Hidalgo County, New Mexico.

5. Proposed Well 15-8 is located in Unit L, 2141 FSL and 345 FWL, Section 8, Township 25 South, Range 19 West, Hidalgo County, New Mexico.

6. Proposed Well 76-7 is located in Unit I, 1896 FSL and 1128 FEL, Section 7, Township 25 South, Range 19 West, Hidalgo County, New Mexico.

7. Proposed Well 63A-7 is located in Unit G, 1934 FNL and 1403 FEL, Section 7, Township 25 South, Range 19 West, Hidalgo County, New Mexico.

8. The form of these injection well applications is Form G-112. Pursuant to the injection well application rules at 19.14.93.8 NMAC, *Lightning Dock* submitted, in duplicate, each G-112 application packet containing: (a) a plat showing the location of the proposed injection/disposal well and the location of all other wells within a radius of one mile from said well, and indicating the perforated or open-hole interval in each said well, together with the ownership of all geothermal leases within said one-mile radius; (b) the log of the proposed injection well, if available; and (c) a diagrammatic sketch of the proposed injection well showing casing strings, including diameters and setting depths, quantities used and tops of cement, perforated or open-hole interval, tubing strings, including diameters and setting depths, and the type and location of packers, if any.

9. Pursuant to the injection well application rules at 19.14.93.8 NMAC, Lightning Dock sent copies of each G-112 application (without the above attachments) to all other geothermal lease owners within a one-half mile radius of the proposed injection well.

10. AmeriCulture, Inc. (“AmeriCulture”) objected to all four G-112 applications. It objected to the applications for wells 15-8, 76-7 and 13-7, on June 20, 2015. It objected to the application for well 63A-7, on July 15, 2015. The reason AmeriCulture stated to support its objection is: “Owing partially to the potential for endangerment of the regional geothermal resource, underground water supplies, and businesses that rely upon the regional geothermal resource, we believe that [the] applications should be denied.”

11. On July 16, 2015, the Oil Conservation Commission issued Order No. R-14021. Even though AmeriCulture did not file an application for a hearing pursuant to 19.14.112.8(C) NMAC, this order “granted” AmeriCulture’s “application for hearing” and set three of the four applications for a Commission hearing on August 13, 2015. Order No. R-14021 also ordered AmeriCulture to file an application for a hearing that meets the requirements of 19.14.112.8(C) NMAC.

12. On July 22, 2015, AmeriCulture’s attorney wrote a letter to the Commission’s Secretary asking to reschedule the August 13th hearing. Lightning Dock was not informed of the request. The Commission issued a second order, Order R-14021-A, adding the fourth well, Well LDG 63A-7 to the hearing docket and postponing the hearing to September 10, 2015.

13. On August 7, 2015, Lightning Dock filed an Objection to the procedural demands that AmeriCulture was forcing on the Commission. Lightning Dock’s concern is that these

demands invite errors by the Commission and set bad precedent for the Commission in its interpretation of geothermal regulations.

14. Pursuant to Order No. R-14021, on August 12, 2015, AmeriCulture filed an application for a hearing that purportedly met the requirements of 19.14.112.8(C) NMAC. However, this application failed to state any grounds why the Commission should hold a hearing and should have been rejected as an improper application.

15. On August 31, 2015, as amended on September 2, 2015, Lightning Dock submitted a Proposed Order by which the Commission could address the procedural errors and irregularities caused by AmeriCulture in this proceeding. The Commission hereby finds the material provisions of that Proposed Order:

A. 19.14.93.8 NMAC does not require the Commission or the Division to hold a hearing when an objection to an injection well is received.

B. 19.14.112.8 NMAC does not require the Commission or the Division to hold a hearing when an application for a hearing is received.

16. Notice of the hearing set for September 10, 2015 was posted on OCD's website and published in the Hidalgo Herald.

17. On September 1, 2015, OCD filed its Pre-Hearing Statement, including draft Conditions of Approval. Lightning Dock has no objection to these Conditions of Approval.

18. On September 1, 2015, the Hidalgo Soil & Water Conservation District filed a Notice of Intervention. After Lightning Dock raised questions of the District's standing, Hidalgo Soil & Water Conservation District filed a pleading adequately addressing standing on September 10, 2015.

19. On September 3, 2015, pursuant to Order R-14021-B, Lightning Dock and AmeriCulture filed Pre-Hearing Statements. This is the first time that AmeriCulture identified any specific concerns that Lightning Dock could begin preparing to address.

20. On September 4, 2015, AmeriCulture filed an Expedited Motion to Vacate. The Commission denied this Motion at a Pre-Hearing Conference on September 8, 2015.

Findings Relating to Substantive Matters

21. At the hearing on September 10-11, 2015, Lightning Dock presented expert testimony that the “Lightning Dock geothermal system” consists of the hot, high-fluoride fluids contained in the deep semi-confined geothermal aquifer and all the overlying strata, including the fractured bedrock and the valley fill. Stated differently, the evidence shows that the Lightning Dock geothermal system extends vertically from the water table to deep within the bedrock. Lightning Dock presented expert testimony that the Lightning Dock geothermal system as a whole is interconnected by fracturing and flow through the valley fill. The geothermal water is not limited to any specific stratigraphic zone or zones. The shallow groundwater within the Lightning Dock area—the warm or hot water in the valley fill—is part of the Lightning Dock geothermal system.

22. Lightning Dock presented testimony that shallow wells in the Lightning Dock geothermal system are warm or hot, with relatively higher fluoride and relatively lower total dissolved solids (TDS), nitrate, chloride and sulfate concentrations than are found in many of the cold wells outside the geothermal system; and that shallow wells in the Lightning Dock geothermal system do not access water that is safe to drink: all water in the in the Lightning Dock geothermal system is too high in fluoride. There is no “underground drinking water

source” in the Lightning Dock geothermal system. The “underground drinking water source” is outside of the Lightning Dock geothermal system.

23. Lightning Dock presented expert testimony that geothermal water enters the Lightning Dock geothermal system at depth through a geologic window via a leaky artesian aquifer. The geothermal water is less dense than surrounding water and naturally rises in an upflow. As the geothermal water rises, it mixes with the surrounding cooler groundwater. Thus, the evidence shows that the Lightning Dock geothermal system is a mix of geothermal water and surrounding cooler groundwater. Lightning Dock presented expert testimony that the mix ratios vary depending on where you are in the system; and that the hottest, least mixed portion of the system is at depth beneath the old Rosette greenhouse area of Section 7.

24. Lightning Dock presented expert testimony that the Lightning Dock geothermal system is naturally in mass balance; that geothermal water enters the system at depth and mixes as it rises; and that when the geothermal water, already partly mixed, reaches the bottom of the valley fill, it mixes with still more freshly recharged water and naturally moves downgradient in the Animas Valley. Lightning Dock presented expert testimony that this downgradient flow has formed a natural plume of 1-4 mg/l fluoride which extends for at least seven miles to the north; and that within the plume there also exists a concentrated sub-plume near the heart of the Lightning Dock geothermal system of >4 mg/l fluoride. Thus, the evidence shows that the Lightning Dock geothermal system discharges into the Animas Valley groundwater system and always has. Lightning Dock presented expert testimony that a naturally occurring high-fluoride plume in the Animas Valley extends both north *and south* of the Lightning Dock geothermal system; and that the source of this larger Animas Valley fluoride plume is the underlying source

of heat to the Lightning Dock geothermal system which also “leaks” along fault and fractures outside of the Lightning Dock geothermal system.

25. Lightning Dock presented testimony that its current operations involve producing from Well 45-7 approximately 2,000 gpm at 312°F, generating up to 4 MW of electricity in the power plant, and immediately reinjecting the spent geothermal fluid (ranging from approximately 180°- 210°F) back into the geothermal system at the same rate via Well 55-7, Well 53-7 and Well 63-7; that Lightning Dock has production capacity of 5,000 gpm or 10 MW net; and that Lightning Dock has a power purchase agreement with PNM to sell 10 MW base-load electricity. Lightning Dock presented testimony that two of its deep injection wells, Well 53-7 and Well 63-7, are currently marginal injectors; that Lightning Dock recently improved the injection pipelines to these wells to allow greater pressure to these wells; and that, based on past experience, it expects these wells to improve over time to become primary injection wells. Lightning Dock presented testimony that the proposed shallow injection wells will allow for better wellfield management; and that the goal of wellfield management is to maintain the highest temperature for the longest time possible, not to exhaust the heat.

26. At the Commission hearing in 2013, Dr. John Shomaker testified that after power plant startup, he expected there would be a change in how the mixing occurs within the Lightning Dock geothermal system, but that the system would eventually come into equilibrium again. At the hearing on September 10, 2015, Dr. Shomaker defined “equilibrium” as a system in which the pumping from the geothermal production well and the reinjection into the injection well (in terms of the relative pressures) comes into equilibrium with the drawdown in the production well. The rate at which water is pumped out is the same as in which it is injected, creating a closed loop within the geothermal system. Dr. Shomaker further testified that he

believes the Lightning Dock geothermal system reached equilibrium by the latter part of 2014 after power plant startup on December 20, 2013. Lightning Dock presented chemical, temperature, and depth-to-water (groundwater heads) evidence that the Lightning Dock geothermal system has reached equilibrium under current operations. Lightning Dock presented evidence that the temperature of its production well is stable under current operations.

27. Lightning Dock presented expert testimony that there is now a cone of depression at the production well, Well 45-7; and that pre-existing mounding at the water table has grown higher. Dr. Shomaker testified that the cone of depression at the production well and the mounding at the water table are part of an equilibrium. Lightning Dock presented expert testimony that the pressure differential between the proposed shallow injection wells and the deep production wells will ensure that reinjected water will replace water that is drawn into the production zone creating a closed loop effect; and that because all water within the Lightning Dock geothermal system is connected to a greater or lesser degree, there is no material difference between reinjecting at depths of 1,050' to 4,441', as Lightning Dock now does, and reinjecting at minimum depths of 150' to 500', as Lightning Dock proposes in its applications.

28. Lightning Dock presented expert testimony that its current operations and its proposed operations are all within the heart of the Lightning Dock geothermal system; that the heart of the Lightning Dock geothermal system will experience changes in mixing due to Lightning Dock's proposed changes, but the changes will be internal to the Lightning Dock geothermal system; and that the Lightning Dock geothermal system is expected to again come into an equilibrium after experiencing change from the proposed operations. Dr. Shomaker testified that with the proposed changes, water table mounding likely will look different, it will

probably be higher, but this simply reflects that greater heads will be pushing water down in the system to replace what's being pumped.

29. Lightning Dock presented expert testimony that its proposed operations will not change the amount of water exiting the Lightning Dock geothermal system; that all water produced for power plant operations will be reinjected into the Lightning Dock geothermal system; that the mass balance of the Lightning Dock geothermal system will not change; and that the natural groundwater flow direction will not change. Thus, there is no reason to believe that the Lightning Dock geothermal system will somehow expand as a result of Lightning Dock's proposed operations. To expand, the Lightning Dock geothermal system would need to experience more geothermal water entering the system or some change in the faults and fractures that control how water moves. Stated differently, a well that is now warm will, with a reasonable likelihood, always be within the Lightning Dock geothermal system; a well that is now cold will, with a reasonable likelihood, never be in the Lightning Dock geothermal system—unless Nature creates new fluid pathways or closes existing fluid pathways (e.g., through tectonic activity such as fault movement, or through sealing off fractures by mineral precipitation).

30. Lightning Dock presented expert testimony that every new well producing from or reinjecting into the Lightning Dock geothermal system (including wells for AmeriCulture's aquiculture operation or Dale Burgett's former Rosette operation) causes change to the system because the mixing of geothermal water and cooler water occurs differently thereafter.

Lightning Dock presented expert testimony that there will be changes in water chemistry within the Lightning Dock geothermal system with any new well because the geothermal water has relatively higher fluoride and relatively lower TDS, nitrate, chloride and sulfate concentrations than cooler Animas Valley water. Lightning Dock further provided testimony that its proposed

operations will not cause any Animas Valley drinking water well currently in compliance with State and Federal drinking water standards for fluoride to become non-compliant.

31. Lightning Dock presented testimony and evidence that naturally occurring fluoride, sulfate, and TDS in the deep geothermal system exceed the State of New Mexico water quality criteria stated in NMAC 20.6.2.3103; and that, since deep geothermal water naturally upwells into and mixes with cooler water, elevated concentrations of fluoride, sulfate, and TDS exist in the shallow groundwater within the Lightning Dock geothermal system, including samples collected by the Division from shallow wells in the Rosette green house area in 1986 and 1993 that contained up to 15.46 mg/l fluoride. Lightning Dock presented evidence that, through using an EPA-approved program called ProUCL, background threshold values (“BTV”) for these constituents were proposed to the Division based on pre-start up sampling events, which are described in Lightning Dock’s Groundwater Background and Compliance Report dated October 2014 and an April 20, 2015 addendum report. Lightning Dock presented evidence that the Division established an alternate concentration limit (“ACL” – the legal, maximum allowable concentration of these contaminants in groundwater in the Lightning Dock geothermal system) by letter dated May 14, 2015. The maximum allowable concentration for fluoride in the Lightning Dock geothermal system is 17 mg/l; the maximum allowable concentration for sulfate in the Lightning Dock geothermal system is 1200 mg/l; and the maximum allowable concentration for TDS in the Lightning Dock geothermal system is 2200 mg/l. The May 14, 2015 letter took into account Lightning Dock’s interest in “the relatively shallow injection of some percentage of spent geothermal waters from the power plant for an indeterminate period of time.”

32. Lightning Dock presented evidence that its proposal is in the interest of conservation and will prevent waste. Lightning Dock's current operations produce from and reinject into the same geothermal system, unlike other open system users of the Lightning Dock geothermal resource. Lightning Dock's proposed operations will reinject all water produced for the geothermal power plant into the same geothermal system from which it was produced.

33. Lightning Dock presented evidence that its proposal protects correlative rights. Under the principle of correlative rights, and New Mexico's geothermal statutes and regulations, all lease holders and mineral owners have a right to develop the resource in proportion to their corresponding acreage. Lightning Dock presented testimony that geothermal exploration activities have been conducted inside and outside its geothermal mineral leases of over 2500 and 640 acres; and that the existence of $>75^{\circ}\text{F}$ heat at 100' depth encompasses over 8.5 square miles. AmeriCulture has a state geothermal lease for 10 acres and AmeriCulture has no geothermal lease rights to any other State Trust Lands, specifically, the East half of Section 6 on which it has "permitted" a shallow injection well. AmeriCulture shares 15 acres of geothermal mineral lease with Lightning Dock pursuant to a Joint Facility Operating Agreement.

34. Lightning Dock presented testimony that AmeriCulture's operations involve blending cold water from its cold, non-geothermal well located 1-1 ½ miles away, with its hot geothermal water from its State Well #1 production well; that the blend ratio is approximately 90% cold to 10% hot; that the blended water is then run through AmeriCulture's fish tanks for use. Lightning Dock presented expert testimony that AmeriCulture has blend options available to it as among its cold water well, its hot "state" geothermal wells, and its warm "federal" well A-444; and that by using these blend options, AmeriCulture can effectively treat any (a) increase in fluoride by dilution and (b) any decrease in heat by blending more hot water. Lightning Dock

further presented evidence that a contract between it and AmeriCulture (the Joint Facility Operating Agreement) requires Lightning Dock to supply heat to AmeriCulture if it somehow caused loss of AmeriCulture's heat. To supply heat through the mechanism of a heat exchanger would not invoke State Engineer jurisdiction. Stated differently, the evidence does not support the claim that any reasonably foreseeable change in fluoride or temperature would cause a material change in AmeriCulture's operations.

35. Lightning Dock presented testimony that after AmeriCulture uses blended water in its fish tanks, the effluent is surface discharged to an artificial wetland; that this effluent discharge is a cooled mix of approximately 90% cold to 10% hot water; that this effluent discharge is adjacent to AmeriCulture's well A-444; and that well A-444 has historically been affected by other surface discharges such as storm flows. Lightning Dock presented expert testimony that AmeriCulture's effluent discharge has unnaturally changed the chemical composition of well A-444 to reflect more cold-water characteristics and less of a geothermal-water character, and has unnaturally quenched well A-444's heat from approximately 195°F to 111°F. Lightning Dock presented testimony and evidence refuting the hypothesis that a "boundary condition" exists between LDG's current production well (45-7) and its primary current injection well (55-7) and explains the unique characteristics of well A-444. To the extent that AmeriCulture has claimed changes in well A-444, it cannot ignore its own actions and the extent to which its own actions have contributed to such changes.

36. Lightning Dock presented testimony that it has been known since at least 1983 (Circular 177) it would be unsafe for anyone to drink water from the location of AmeriCulture's well A-444 (or any water from the Lightning Dock geothermal system). Lightning Dock

presented rebuttal evidence of State Engineer records showing that well A-444 has not been used since 2009.

37. Water right impairment is not a regulatory criterion or issue properly before the Commission. Even if it were, Lightning Dock presented testimony and case law establishing that neither AmeriCulture's alleged changes to "heat" nor "chemical composition" are elements of a water right. See Rosette v. United States, 2007-NMCA-136 and Ensenada v. Sleeper, 1988-NMCA-030. Stated differently, changes to heat or chemistry are not legal "impairment" to a water right. Further, pursuant to NMSA §71-5-2.1(B), the Commission and Division are the New Mexico regulators charged by the New Mexico Legislature with regulating Lightning Dock's proposed activities and a permit from the State Engineer is not required for Lightning Dock's proposed operations.

38. Reservoir capacity is not addressed in the geothermal regulations. Nevertheless, Lightning Dock presented testimony of numerous Lightning Dock geothermal reservoir capacity studies concluding that this geothermal reservoir is capable of producing 24 MW, 9-15 MW, >15 MW, and 19-35 MW. Lightning Dock's proposed operations will produce 10 MW net to meet its commitment to PNM. Lightning Dock further presented expert testimony of the errors in Mr. Jim Witcher's 2001 conclusion that the Lightning Dock geothermal reservoir is limited to 5 MW. Further, Lightning Dock presented evidence that the business model for geothermal power plants is to operate the well field for long-term sustainability and to minimize the reduction of heat in the system.

39. Lightning Dock presented expert testimony that Mr. Witcher's 2001 report of AmeriCulture's State Well #1 test does not evidence a "direct" connection (i.e., a pipeline)

between AmeriCulture's 400' State Well #1 and Lightning Dock's current injection well, Well 55-7. Stated differently, although the Lightning Dock geothermal system is an interconnected system, this does not mean that specific wells are in "direct" connection with one another.

40. Lightning Dock has expended over \$50 Million to develop the Lightning Dock resource and as a result has expanded (and will continue to expand) its knowledge base. Lightning Dock's understanding of the geothermal system has advanced to include this new knowledge. Lightning Dock's witnesses all agree that the basic tenants of Circular 177, Geology and geothermal waters of Lightning Dock region, Animas Valley and Pyramid Mountains, Hidalgo County, New Mexico, authored by Wolfgang E. Elston, Edmond G. Deal and Mark J. Logsdon and published by the New Mexico Bureau of Mines and Mineral Resources in 1983, have been enhanced by Lightning Dock's expanded knowledge. Criticisms of Circular 177 have never been peer reviewed or accepted in the relevant scientific community.

41. Lightning Dock presented testimony that the proposed injection wells will be cased, cemented, and equipped in such a manner that there will be no danger to any natural resource (including geothermal resources, underground water supplies suitable for their current uses, and surface resources). Further evidence is provided in drilling handbooks attached to the applications in the Division's files.

42. Lightning Dock presented evidence that the Water Quality Act and the Water Quality Control Regulations do not govern Lightning Dock's injection wells; rather, consistent with NMSA § 74-6-12(G), and NMSA §71-5-8, the Commission's power to prevent or abate water pollution derives from the Geothermal Resources Conservation Act, NMSA §71-5-1 *et seq.*

43. Lightning Dock presented testimony that the Division and the Commission regulate Lightning Dock's wells and activities under the Geothermal Resources Conservation Act through Conditions of Approval on various permits and agreements between Lightning Dock and the Division, such as the Division-accepted Water Quality Monitoring Plan. The Conditions of Approval filed by the Division on September 1, 2015 require Lightning Dock to drill four new downgradient monitor wells. The Water Quality Monitoring Plan specifies the sampling protocol, sampled-for constituents (including fluoride), and frequencies.

The Commission Concludes that:

1. The Commission has jurisdiction of the parties to this case and the subject matter thereof pursuant to the Geothermal Resources Conservation Act, NMSA §71-5-1 et seq, and the geothermal regulations promulgated thereunder,

2. Due notice of the hearing on this application has been given.

3. Lightning Dock's proposal complies with 19.14.93.8 NMAC.

4. Lightning Dock' proposal is in the interest of conservation and will prevent waste.

5. Lightning Dock' proposal will protect correlative rights.

6. The proposed injection wells will be cased, cemented, and equipped in such a manner that there will be no danger to any natural resource, including geothermal resources, useable underground water supplies, and surface resources.

IT IS THEREFORE ORDERED THAT:

1. The applications of Lightning Dock to drill wells 15-8, 76-7 and 13-7, and 63A-7 and to place those wells on injection is hereby granted subject to the Conditions of Approval filed by the Division on September 1, 2015.

2. Hereafter, the Division Director shall exercise discretion about whether good cause exists to hear an objection to an injection well.

3. Hereafter, the Division Director shall exercise discretion about whether good cause exists to grant an application for a hearing.

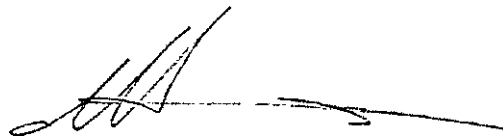
Respectfully Submitted,

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CERTIFICATE OF SERVICE

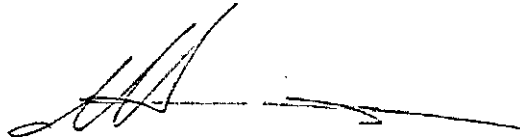
I hereby certify that a true and correct copy of the foregoing Proposed Findings of Fact and Conclusions of Law was e-mailed to the following on October 7, 2015:

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