**BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF SOUTH DAKOTA**

IN THE MATTER OF THE APPLICATION OF NAVIGATOR HEARTLAND GREENWAY, LLC FOR A PERMIT UNDER THE SOUTH DAKOTA ENERGY CONSERVATION AND TRANSMISSION FACILITIES ACT TO CONSTRUCT THE HEARTLAND GREENWAY PIPELINE IN SOUTH DAKOTA	**HP22-002** **RICHARD KUPREWICZ SURREBUTTAL TESTIMONY IN SUPPORT OF LANDOWNER INTERVENORS**

INTRODUCTION

1. Please state your name, position, and business address.

Answer: My name is Richard B. Kuprewicz. I am the President of Accufacts Inc. ("Accufacts") which is headquartered at 8151 164th Ave. NE, Redmond, Washington 98052.

2. Have you previously submitted testimony in this proceeding?

Answer: Yes.

3. To whose testimony are you responding in surrebuttal?

Answer: I am responding to the rebuttal testimony of the following individuals:

- Mark Hereth, dated June 23, 2023, including his Rebuttal Testimony and its Exhibit A, "Management of Ground Movement Hazards for Pipelines - Final Report," CRES Project No. CRES-2012-M03-02, February 29, 2017; and Exhibit B, "Guidelines for Management of Landslide Hazards for Pipelines, prepared for INGAA Foundation and a Group of Sponsors, prepared by Geosyntec Consultants, Inc., Golder Associates, Inc. and Center for Reliable Energy Systems (CRES), Version 1 August 17, 2020.

- Stephen Lee, dated June 26, 2023, including his Rebuttal Testimony and its Exhibit A, PHMSA email to Mark Maple (ICC Safety division ICC) indicating, "If a pipeline transports CO_2 as a fluid consisting of more than 90 percent carbon dioxide molecules compressed to a supercritical state, the pipeline is regulated pursuant to part 195, even if a segment of the pipeline **temporarily** [emphasis added] experiences operating conditions in which the fluid in not maintained in a supercritical state;" and Exhibit B, DNV Design Verification Report, dated June 6, 2023.

SUMMARY OF TESTIMONY

4. Please summarize your testimony.

Answer: Based on my background and experience, I will briefly focus my Surrebuttal Testimony concerning the carbon dioxide pipeline proposed by Navigator Heartland Greenway, LLC ("NHG"), into three key areas related to siting of carbon dioxide pipelines:

1. The need for the South Dakota Public Utilities Commission ("SDPUC") to require NHG to provide approximate temperature profiles (temperature versus milepost) for its proposed pipelines so as to identify areas of the pipeline that will transport carbon dioxide in a liquid phase and not in a supercritical phase, as outlined further below;
2. The need for the SDPUC to require NHG to conduct and disclose computer modeling and a methodology to predict the dispersion of carbon dioxide from a rupture of the proposed pipeline, that is capable of taking into account all of the

following factors: the actual initial phase of the carbon dioxide along the pipeline; pipeline diameter, operating pressure, purity of the CO_2 stream, pipe segment length, distance between mainline valves, valve closure times, product release rate, representative climatological data, and characteristic topography, so as to assist the Commission in its assessment of the unavoidable risks that would be created by the proposed pipeline.

3. The fact that numerous industry practices, such as those included in Exhibit A and B to the testimony of Mark Hereth, referenced above, are not incorporated into federal pipeline safety regulations for many good safety reasons, as they are gravely inadequate and even incomplete in many important areas as discussed further below.

5. Why should the Commission require that approximate temperature profiles be provided for the proposed pipelines in South Dakota?

Answer: In making informed siting decisions related to the risks of siting a carbon dioxide pipeline, the approximate temperature profile should be provided by the Applicant so that the most likely phase of carbon dioxide along the pipeline can be ascertained. Where the temperature of the carbon dioxide is below approximately 88 degrees Fahrenheit (the critical temperature of carbon dioxide), the carbon dioxide will be in a liquid phase at pipeline pressures, and not in a supercritical phase. Given the weather extremes exhibited in South Dakota, the depth of the frost line in South Dakota, and the fact that the pipeline will not be insulated or heated, it is certain that most of the proposed pipeline will operate at temperatures well below the critical temperature, in which locations the pipeline will not be transporting supercritical carbon dioxide. Based on public responses supplied by

Navigator in Illinois, I expect that the vast majority of the pipeline mileage (on an order greater than 95%) will be permanently operated with carbon dioxide in a liquid phase and not in a supercritical phase, though the Commission should require NHG to confirm this. Pipeline operating temperature affects carbon dioxide density and related pipeline release dynamics. Carbon dioxide density substantially impacts the mass of carbon dioxide that can be released and the geographic scope of the area that could be affected by a pipeline rupture. Given the expected operating conditions of the pipeline I would expect the liquid phase to be on the order of 20 to 40 percent denser than carbon dioxide at its supercritical state at its injection temperature. The lower the operating temperature, the greater the mass of carbon dioxide in the pipeline and the greater the amount of carbon dioxide that would be released upon rupture. Therefore, the NHG pipelines proposed operating temperature range, its average operating temperatures by month, and its temperature profile are important safety information needed to determine the accuracy of NHG's worst case discharge calculations. Normally, such information is supplied in at least two basic boundary cases: 1) the temperature profile of the pipeline during the coldest time of the year, and 2) the temperature profile of the pipeline during the warmest time of the year. Absent such temperature information, the Commission will not be able to independently verify the reasonableness of NHG's plume dispersion modeling.

6. How do you respond to Mr. Hereth's statement that the carbon dioxide in NHG's pipeline will be transported in a supercritical state, such that the regulatory concerns identified in your paper do not apply to its project?

Answer: It is a virtual certainty that the vast majority of the carbon dioxide in NHG's pipeline will be in a liquid state, because the carbon dioxide will cool below 88 degrees

Fahrenheit (the approximate supercritical temperature) as it is transported through the much cooler earth in the uninsulated underground pipeline. It is likely that NHG has conducted engineering studies related to pipeline operating temperatures, which studies would settle this issue. To resolve this dispute, the Commission should simply require NHG to disclose these important studies or to develop and release such important information for this proceeding. In the unlikely event that NHG has not conducted temperature profile studies, then Mr. Hereth's testimony has no basis in fact.

7. How do you respond to the statements by Mr. Lee that the carbon dioxide in NHG's proposed pipeline will not be maintained in a supercritical state during transport, but that this fact is irrelevant because PHMSA has asserted that it has jurisdiction over the entire pipeline?

Answer: First, I note that Mr. Lee's statement is in conflict with Mr. Hereth's statement. Second, Exhibit A to Mr. Lee's testimony, the email from Tewabe Asebe, an unidentified PHMSA employee, to Mark Maple of the Illinois Commerce Commission, is not as clearcut as implied by Mr. Lee. The PHMSA employee states: "If a pipeline transports CO_2 as a fluid consisting of more than 90 percent carbon dioxide molecules compressed to a supercritical state, the pipeline is regulated pursuant to part 195, even if a segment of the pipeline temporarily experiences operating conditions in which the fluid is not maintained in a supercritical state. If, however, a pipeline has operational controls in place (e.g., pressure limiting devices) that prevent CO_2 from entering a supercritical state, the pipeline would not be regulated under Part 195." This statement fails to address a situation where a segment of a carbon dioxide pipeline operates below the critical temperature at all times, such that the operating conditions are not "temporary." Moreover, the email fails to recognize that low temperature is more likely to result in operation in a liquid state than low pressure, because NHG's pipeline operators would be able to increase operating pressure via use of pumps, whereas its operators have provided no evidence as to how carbon dioxide will be maintained above its critical temperature, a requirement to assure supercritical state.

NHG will have little control over carbon dioxide temperature, because its pipeline will be neither insulated nor externally heated and the temperature will be substantially impacted by heat loss to the ground, that in turn is subject to seasonal variations in ground temperature, the rate of throughput, and distance from pump stations, which pumping would provide the only heat added to the carbon dioxide. PHMSA's assertion of jurisdiction is not as clear as suggested by Mr. Lee.

The question of PHMSA's jurisdiction over NHG's proposed pipeline and other proposed carbon dioxide pipelines when they are transporting carbon dioxide in a liquid phase is a legal matter that has not yet been determined by the courts. In the event of a leak or rupture of a carbon dioxide pipeline operating in a liquid state, to avoid liability, a pipeline operator could argue that the pipeline at the time of rupture was not within federal pipeline safety jurisdiction. I recommended that PHMSA amend its regulations to eliminate this ambiguity. Until PHMSA does so via a rulemaking, PHMSA's jurisdiction over transportation of liquid carbon dioxide is ambiguous.

Mr. Lee does not discuss the underlying point here that pipeline operating temperature at the time of a rupture can substantially impact the amount of carbon dioxide released, and this in turn impacts the danger zone of the proposed pipelines. NHG should release temperature studies so that the Commission, intervenors, and first responders are able to assess the accuracy of NHG's dispersion modeling, as well as PHMSA's asserted claims of jurisdiction.

8. What is your response to the statements of Mr. Hereth and Mr. Lee statements related to running ductile fractures and his reliance on his Exhibit B, the DNV Design Verification Report?

Answer: First, I note that the entirety of the federal regulation on prevention of running ductile fractures is contained in 49 C.F.R. §111, which states in full: "carbon dioxide pipeline system must be designed to mitigate the effects of fracture propagation." Thus, this federal regulation contains no detailed safety standards for prevention of running ductile fractures. Instead, the judgment about how to prevent running ductile fractures is left entirely to pipeline operator judgment. Mr. Hereth asserts that this utterly vague federal safety standard has the benefit of allowing "new methods to be used as they are developed and published," which statement assumes that the pipeline industry will in fact develop and implement new methods to prevent such fractures. In my experience, such vague standards are more likely to result in passivity and a failure to adopt improved technology due to cost considerations or operator inertia. Moreover, since PHMSA regulations establish safety standards related to pipeline operating pressure, 49 C.F.R. § 195.406, there is no reason why PHMSA could not establish pressure-based safety standards for methods to prevent running ductile fractures, for example to determine the need for greater steel strength or the design and use of crack arrestors, based on the pressures that can be predicted to result from the explosive decompression of carbon dioxide pipelines. Also, where crack arrestors are used, PHMSA could specify their maximum spacing along a pipeline.

Second, the DNV Design Verification Report does not specifically describe any actions to be taken by NHG or specific requirements for the design of NHG's pipeline with regard to prevention of running ductile fractures. Instead, the DNV report claims to be a comprehensive review of NHG's "design philosophy" and it generally confirms that NHG's design references the appropriate industry standards. Mr. Lee claims that the DNV document includes "steps to mitigate ductile fracture propagation, including sections or areas of pipeline of more conservative design factors including locations of bores, horizontal directional drills, valves and crack arrestors as warranted to further design and implement redundant fracture control mitigation systems." The DNV document does not describe or discuss any of these engineering issues. It does not expressly confirm that NHG has in fact identified "sections or areas of pipeline of more conservative design factors" needed to prevent running ductile fractures; does not describe if and where NHG will install crack arrestors to prevent running ductile fractures; and does not otherwise state how NHG will mitigate this risk. It merely lists a large number of industry standards and states in general terms that the NHG design paperwork complies with them.

Moreover, running ductile fractures may also be caused by variations in the proportion of contaminants including noncompressible gases, but as discussed in the report attached to my direct testimony, PHMSA currently has no safety standards related to carbon dioxide stream quality and contaminant controls.

9. What is your response to Mr. Hereth's and Mr. Lees discussion of carbon dioxide pipeline release dynamics and modeling?

Answer: Carbon dioxide exhibits several unusual properties that distinguish its movement on release from the movement of products released by conventional hydrocarbon transmission pipelines (e.g., petroleum or natural gas transmission pipelines). A review of phase diagrams for carbon dioxide shows that upon rupture a carbon dioxide pipeline will decompress from the operating pressure at the time of the rupture to atmospheric pressure, and the carbon dioxide will increase in volume forming a gas by a factor of approximately 400 to 500 times the pipeline initial volume upon warming to ambient temperature. Such decompression is explosive and is the result of the carbon dioxide converting from a dense (liquid or supercritical) phase to a low-density gas phase. The force of this explosion may be impacted by the phase of the carbon dioxide (i.e., liquid or supercritical), its temperature and pressure, and the presence of contaminants.

Moreover, the rate of carbon dioxide release from a pipeline rupture can vary considerably over time, even above the initial rate of release, due to the possible formation of dry ice within the pipeline upstream and downstream of the pipeline failure site. As a result, the dynamics of carbon dioxide pipeline ruptures are remarkedly different than conventional hydrocarbon transmission pipeline ruptures that decline with time. These dynamics make carbon dioxide pipeline ruptures much more dangerous and their dynamics and impacts more difficult to predict than conventional hydrocarbon transmission pipelines ruptures.

Since release volumes and dynamics depend in part on the phase of the carbon dioxide at the time of rupture, the Commission should require that NHG identify the areas of the pipeline that will be in supercritical and which segments will be in liquid phase for the boundary cases identified above, supported by appropriate temperature profiles.

The other major point that commands much respect from carbon dioxide pipeline releases is that, once warmed by the atmosphere, carbon dioxide releases are colorless, odorless, and heavier than air and may travel considerable distances depending on weather and topography. For example, the Denbury Gulf Coast Pipeline, LLC, carbon dioxide pipeline rupture near Satartia, Mississippi, forced rescue and medical evacuation of the residents of Satartia, some located over one mile from the rupture site. This pipeline had a nominal diameter of 24-inches and the distance between the nearest upstream and downstream valves was 9.55 miles. Pipeline and Hazardous Materials Safety Administration ("PHMSA") Failure Investigation Report - Denbury Gulf Coast Pipelines, LLC, May 26, 2022, page 4 (Exhibit A).[1] In its Consent Agreement with Denbury, PHMSA ordered that Denbury reassess whether a rupture of the pipeline "could affect" all high consequence areas within two miles of the pipeline. PHMSA Consent Agreement, March 23, 2023, page 5, para. 19 (Exhibit B). Although the proposed pipeline would at six and eight inches in diameter contain less carbon dioxide per foot than the Denbury pipeline, it is possible that the distance of pipeline vented could be up to two times longer, assuming that NHG proposes to locate valves in accordance with 49 C.F.R. § 195.260(c), which allows valve spacing up to 15 miles apart where a pipeline could affect a high consequence area, and up to 20 miles apart in other areas. Even ruptures of relatively smaller diameter carbon dioxide pipelines could kill or harm persons and animals a considerable distance from the rupture site. To understand the risks that would be created by the proposed pipeline, the Commission should determine this danger zone based on a clear and defensible and conservative methodology.

While dispersion modeling can predict the possible danger zone resulting from a rupture of any carbon dioxide pipeline, not all dispersion modeling takes account of topography

[1] Because of the file size that may interfere with transfer through some servers, my Exhibit A may be downloaded from PHMSA's website at: https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/2022-05/Failure%20Investigation%20Report%20-%20Denbury%20Gulf%20Coast%20Pipeline.pdf.

and gravity, the range of weather conditions, and vegetation types. Reliance on simplistic dispersion models can be useless and even negligent. For example, Denbury relied on the PHAST model to predict the “could affect” areas near its pipeline. The PHAST model is owned by DNV, a consultant for NHG. The PHMSA Consent Agreement states that “the earlier PHAST dispersion analysis was wrong and that the town of Satartia was a “could-affect” HCA and should have been included in Denbury’s Public Awareness and Damage Prevention Program.” Exhibit B at page 5, para. 18. That is, the PHAST model substantially underpredicted the potential dispersion of the carbon dioxide following a rupture of the Denbury pipeline, with the result that Denbury did not include the Town of Satartia or its local first responders in the company’s emergency response planning or public education programs. With regards to this rupture, Mr. Lee’s testimony states: “sufficient emergency response training and awareness per 49 CFR 195.403 may not have been adequately considered and addressed in the operator’s integrity management plan and procedures.” Mr. Lee fails to recognize that the reason for Denbury’s complete failure to provide “emergency response training and awareness” to local residents and first responders was due entirely to the failure of DNV’s PHAST model to predict that the residents of the Town of Satartia were at risk. Denbury’s PHAST model runs found that Satartia was outside of the predicted area of hazardous carbon dioxide levels. Due to its reliance on the PHAST model, Denbury excluded Satartia area residents and emergency responders from its public education and training programs, such that neither the residents nor the first responders anticipated and were prepared for a rupture of the pipeline. The Satartia rupture demonstrated that use of the PHAST model to predict the full extent of the danger zone following a pipeline rupture is likely to underestimate the danger zone, such that its use is unreasonable and would constitute negligence.

Simple models, such as the PHAST model, fail to accurately account for weather conditions, turbulence, and more importantly the effects of topography and gravity on heavier than air carbon dioxide gas. In particular, gravity never shuts off and can easily overcome the effect of wind speed and direction, particularly during times of very low wind speed, which was the case at the time of the Satartia rupture.

It is critically important that the Commission, the public, and first responders have access to the best available dispersion modeling that takes into account all of the factors discussed herein, including but not limited to carbon dioxide phase, topography, and weather.

Current PHMSA federal minimum pipeline safety regulations do not adequately identify nor codify the actions that operators must take to address the unique properties and risks created by carbon dioxide pipelines designated for carbon sequestration services. This is a major deficiency in current federal pipeline safe safety regulations that needs to be addressed by PHMSA. Although PHMSA has announced a rulemaking to improve its carbon dioxide pipeline safety regulations, this effort will take at least another two years. While NHG seeks to build its pipeline so as to exploit the federal 45Q tax credit as soon as possible, such artificial federal incentive does not justify Commission approval of construction before PHMSA completes its rulemaking and among other improvements fully investigates carbon dioxide pipeline rupture dispersion modeling and acts to integrate robust modeling requirements into federal law.

Mr. Lee criticizes me because I did not provide volumes or concentrations of carbon dioxide following a rupture of NHG's proposed pipelines, essentially faulting me for not running my own dispersion models. Yet, Mr. Lee, who presumable has access to NHG's dispersion modeling fails to provide such data himself. He also states that I ignore 49 C.F.R. § 195.452, which relates to pipeline integrity management in high consequence areas, but he fails to discuss this regulation, the definitions related to it in 49 C.F.R. § 195.450, or Appendix C to the regulations, which provides guidance on implementation of integrity management programs. What Mr. Lee fails to recognize is that these regulations are intended to identify high consequence areas and specify design and operation safety standards for these areas, but they were originally written to address hydrocarbon pipeline spills, not carbon dioxide pipeline spills, which behave radically differently from each other. When PHMSA extended its high consequence area regulations to supercritical carbon dioxide pipelines it did not modify these regulations to account for the differences in these products. Therefore, these regulations are deficient in multiple ways, including by failing to recognized that carbon dioxide does not flow into water or overland like petroleum products. Moreover, as Mr. Lee recognizes, plume modeling is not defined nor required by this outdated regulation such that there are no standards for carbon dioxide plume modeling in the federal pipeline safety regulation. Thus, NHG's plume modeling is not subject to any specific federal plume modeling standards, whatsoever. Further, Mr. Lee does not describe or discuss the efficacy of NHG's plume modeling methodology, its assumptions, or its outputs. Therefore, he provides no assurance whatsoever about the quality or reasonableness of NHG's plume modeling effort.

With regard to NHG's compliance with 49 C.F.R. § 195.210(a), related to pipeline location, due to 49 U.S.C. § 60104(e), which statute was enacted after the regulation and which prohibits PHMSA from issuing safety standards related to pipeline location, Mr. Lee fails to recognize that 49 C.F.R. § 195.210(a) is unenforceable and in my experience PHMSA has therefore never attempted to enforce this rather meaningless regulation.

Mr. Lee also claims that NHG is using modeling "to identify buffer zones where applicable that exceed the Part 195 requirements." Mr. Lee fails to cite any reference for such carbon dioxide buffer zone requirements, because none exist. The word "buffer" is used exclusively in Part 195 in 49 C.F.R. § 195.12, which exclusively regulates "low-stress pipelines in rural areas," which category does not include supercritical or liquid carbon dioxide transmission pipelines. PHMSA regulations do not otherwise define any "zone" for carbon dioxide pipelines related to buffers, hazards to health, or high consequence areas. PHMSA regulations contain no plume modeling or "buffer zone" requirements for carbon dioxide pipelines. Thus, while it is certainly possible to use plume modeling to try to identify buffer zones, federal pipeline safety regulations contain no standards for such effort. Pipeline operators are free to use or not use any dispersion model in any way they wish and to choose a buffer zone (or not), with the result that federal law does not provide any assurance that NHG's dispersion modeling or buffer zone determination meets any quality or safety requirements other than those of the company's own invention.

Mr. Lee also references the "Potential Impact Radius" ("PIR") definition in the natural gas pipeline regulations in 49 C.F.R. § 192.903, which is defined by a formula to try and determine the hazard zone in the event of a pipeline rupture. This formula contains two variables: the pipeline diameter and its maximum allowable operating pressure, plus a natural gas-specific adjustment factor, which is based in theory on the heat of combustion. The formula is a simple way of estimating the area near a natural gas pipeline rupture in which a "potential failure of a [natural gas] pipeline could have significant impact on people or property." This formula was not designed for use in estimating the area in which people or property could be impacted by a carbon dioxide pipeline rupture. Since this formula is based on the theorical heat of combustion, and carbon dioxide does not combust, there is no engineering justification for its use in estimating the potential impact zone for natural gas pipelines. Unlike the blast and thermal radiation generating buoyancy from a natural gas pipeline rupture ignition, carbon dioxide does not combust and rarely if ever radiates from a rupture site in a circle. Thus, I disagree with Mr. Lee that the use of the PIR formula has any utility in estimating the hazard zone in the event of a carbon dioxide pipeline rupture.

Mr. Lee also states that "DNV . . . has facilitated hazard identification and risk analysis, including studying the potential vapor cloud air dispersion for controlled and accidental releases of carbon dioxide from the pipeline," which suggests that NHG may have relied on DNV's PHAST model, in addition to the inappropriate use of the PIR formula, to establish the non-existent Part 195 "buffer zones" that it claims to have used in selecting a pipeline route.

Finally, Mr. Lee states that NHG is developing a NAV-911 system, researching possible odorants, and considering the installation of a fiber optic sensing system, but he does not otherwise describe these in-process and/or possible efforts. Absent greater assurance that NHG will successfully implement such efforts and the uncertainty that such research approaches will be ineffective in the field, the Commission should not rely on such statements.

10. What responses do you have to Mr. Lee's rebuttal testimony related to contaminants?

Answer: Mr. Lee states that the carbon dioxide will be produced by "high purity sources" and that the carbon dioxide will meet "quality specifications" contained in shipper agreements. He also states the NHG will have "measures in place to ensure specifications are met." He does not describe these measures, the equipment used to accomplish these measures, or how they will be enforced. He also fails to state that these "quality specifications" are not required by or regulated by federal pipeline safety standards, and instead are entirely private standards contained in private contracts that are subject to change without notice to PHMSA or any other regulator. Thus, Mr. Lee fails to provide any meaningful discussion of NHG's carbon dioxide quality specifications, the equipment used to control and monitor contaminants, or the contractual enforcement mechanisms available to enforce its private specifications. Mr. Lee also fails to recognize that water and hydrogen sulfide (H_2S) are not the only possible contaminants that could impact pipeline operations and safety. For example, pipeline operations may be impacted by the accidental inclusion of noncompressible gases, such as oxygen and nitrogen. Further, Mr. Lee does not discuss the potential for the NHG pipeline to be used to transport carbon dioxide product streams from additional types of industrial facilities, such as coal and natural gas power plants, chemical plants, cement plants, and other industrial facilities that produce less pure product streams.

11. What are your concerns about the industry references included by Mr. Hereth's Exhibit A and B?

Answer: Many pipeline safety industry practices are wisely not incorporated by reference into federal minimum pipeline safety regulations, either in whole or by part, for various good reasons, lack of proper public feedback in a regulatory pipeline safety process being one. Industry practice revisions are not necessarily improvements in safety. For example, Mr. Hereth's Exhibit A and B referenced above provide much discussion without addressing the specific threat associated with abnormal loading breakaway landside forces that usually result in pipeline rupture. The CRES report issued February 28, 2017 and the later Geosyntec Consultants, Inc. report of August 17, 2020 may be well meaning, but they missed an important concept: that no pipeline can be designed to handle the extreme abnormal loading forces associated with breakaway landslides, especially in steep terrain. Continued pipeline ruptures such as the February 2020 Satartia, MS rupture is a clear recent example of a pipeline's inability to deal with such abnormal loading forces, but also is instructive about the deficiencies in PHMSA's safety standards due in part to their vague requirements, excessive deferral to industry standards, and failure to require use of improved technology. The Satartia pipeline rupture was caused by liquification of soil in the pipeline's right-of-way in very steep terrain during heavy rainfall which is nothing new to that region. Possible breakaway landslide areas in a right-of-way are just not that hard to identify along a pipeline. Yet, according to the PHMSA Consent Agreement, Denbury implemented vague and outdated geohazard identification safety standards so as to fail to identify the geohazard that caused its rupture. Exhibit B pages 3-4, para. 14; page 5, para. 20. To correct Denbury's lax implementation, PHMSA ordered Denbury to "update" its geohazard program. Exhibit A at page 6, para. 30. Likely, this update requires Denbury to perform photogrammetry surveys via drone, which Denbury undertook in reaction to its rupture. PHMSA, Notice of Probably Violation, May 5, 2022, at page 12 (Exhibit C). Photogrammetry is a common, affordable, and long-available technology that uses standard photographs to generate three-dimensional images that can be used to track land threats such as possible breakaway landslides affecting a pipeline's ROW, and their possible movements over time. This technology identified 10 additional geohazard areas along the Denbury pipeline route. Even though this technology has been available for years, the pipeline industry continues to depend on simple visual inspection of pipeline routes by airplane pilots.

12. Does this conclude your testimony?

Answer: Yes.

/s/ Richard B. Kuprewicz

Richard B. Kuprewicz