BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF SOUTH DAKOTA

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HP 22-002

IN THE MATTER OF THE APPLICATION OF NAVIGATOR HEARTLAND GREENWAY, LLC FOR A PERMIT UNDER THE SOUTH DAKOTA ENERGY CONVERSION AND TRANSMISSION FACILITIES ACT TO CONSTRUCT THE HEARTLAND GREENWAY PIPELINE IN SOUTH DAKOTA,

REBUTTAL TESTIMONY OF STEPHEN LEE

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

Answer: My name is Stephen Lee. My business address is 2626 Cole Avenue, Dallas, Texas. I am Senior Vice President of Engineering for Navigator Heartland Greenway LLC.

2. Have you previously submitted testimony in this proceeding?

Answer: Yes. I submitted testimony with the Application on September 26, 2022, and Supplemental Testimony on May 25, 2023.

3. To whose testimony are you responding in rebuttal?

Answer: I am responding to the testimony of Richard Kuprewicz, Bill Caram, Dr. John Abraham, William Byrd, Sara Throndson, Matthew Frazell, and Jon Thurber.

4. Do you have any general comment on Mr. Kuprewicz's experience with respect to carbon dioxide transportation pipelines?

Answer: Yes. Based on his experience summarized in his resume, Mr. Kuprewicz apparently has been involved in a number of pipeline-related cases, matters, and investigations, but very few if any relating specifically to carbon dioxide transportation pipelines. His most

directly relevant experience with respect to carbon dioxide handling and transportation may have been as a Hydrocracker Complex Supervisor at Arco Products refineries from 1973 to 1977.

5. In the paper he wrote for the Pipeline Safety Trust, which is attached to his testimony as Attachment 2, Mr. Kuprewicz says that because of the construction of CO2 pipelines, PHMSA "would be faced with the greatest and fastest pipeline expansion in the history of the U.S. pipeline industry, and many of these pipelines could threaten the safety of countless individuals and communities." Do you agree?

Answer: No. First, the development of shale oil recovery and "fracking" techniques in the last decade resulted in the expansion and development of crude oil, natural gas, and natural gas liquids production areas in the U.S., with corresponding development of many new pipelines to serve the production areas. Second, the article provides no data or other specifics to support the conclusion that many carbon dioxide pipelines could threaten the safety of countless individuals and communities. This broad generalization is not only unsupported, but at odds with available public data from PHMSA establishing that pipelines remain a safe way to transport hazardous materials. Vidal Rosa (who has submitted prefiled testimony for Navigator) and I have explained in our testimonies how the Navigator Heartland Greenway Pipeline will be engineered, designed, fabricated, constructed, inspected, tested, operated, and maintained in a safe manner while meeting or exceeding federal pipeline safety requirements. Mr. Kuprewicz's testimony does not address any specific facts about the design, construction, or operation of the Navigator Heartland Greenway Pipeline or the many ways that Navigator will exceed PHMSA's regulatory requirements with respect to this project.

6. Mr. Kuprewicz says in the paper that PHMSA currently has no regulations applicable to pipelines transporting CO2 as a gas, liquid, or in a supercritical state at

concentrations of CO2 less than 90%, which creates a regulatory gap. Do you agree that this is a concern with respect to the proposed Navigator Heartland Greenway pipeline?

Answer: No. The carbon dioxide in the pipeline will be compressed to a supercritical state, but will not be maintained in a supercritical state for the entire transport to the sequestration cite. Because the CO2 will be transported, at least part of the time, in a supercritical state, the pipeline falls within PHMSA's jurisdiction. PHMSA has publicly confirmed this, as stated in paragraph 15 of Mark Hereth's prefiled testimony. I attended PHMSA public meetings held on December 13, 14, and 15, 2022, and on May 31-June 1, 2023 at which PHMSA representatives discussed PHMSA' regulatory authority over pipelines transporting carbon dioxide in liquid, supercritical, and dual phase flow. PHMSA has also confirmed regulatory jurisdiction in their clarification to the Illinois Commerce Commission staff member Mark Maple on May 1, 2023 from Tewabe Asebe (attached as Exhibit A).

As Mr. Kuprewicz states on page 1 of his paper, the United States currently has over 5,000 miles of carbon dioxide transmission pipelines, which is the most carbon dioxide transmission pipeline mileage of any country. PHMSA and its predecessor agency the Office of Pipeline Safety in the USDOT have had safety regulation authority over carbon dioxide transportation by pipeline for more than 30 years.

PHMSA's regulations provide specific safe harbor requirements for the design, installation, and operation and other aspects of a pipeline transporting carbon dioxide. This is especially important for the operator of an interstate, multi-state pipeline such as Navigator, which would want to be subject to and comply with a single set of federal regulations rather than multiple sets of potentially inconsistent and conflicting state regulations.

As a practical matter, and in the real world, PHMSA is already actively engaged with Navigator and other industry organizations (like the American Petroleum Institute, Pipeline Research Council International, and Pipeline Safety Trust) with respect to the safety requirements for the proposed pipeline, including design and engineering plans and specifications, fabrication and installation requirements, geological hazard evaluations, maximum pressure specifications, public education and awareness programs, emergency response, High Consequence Areas on the pipeline route, and other topics. Navigator has been meeting with PHMSA at least quarterly since January 2022 to inform PHMSA of its project development progress and discuss compliance with PHMSA's regulations, including those pertaining to safety. PHMSA will be further involved in detailed reviews of the project's design specifications, plans, procedures, and other material that may be requested; as Navigator's pipeline design and construction cost exceeds $2.5billion, Navigator will enter into a Master Agreement with PHMSA for payment of a design review fee under 49 C.F.R. Part 190 Subpart E, Cost Recovery for Design Reviews.

Moreover, as stated in the Application, Navigator has committed to meeting or exceeding PHMSA's pipeline safety requirements.

7. On page 5 of his paper discussing transporting CO2 in a supercritical state, Mr. Kuprewicz states that "a clever pipeline operator could employ loopholes to avoid pipeline safety oversight by PHMSA." Is this Navigator's intention?

Answer: No. I am not aware of any case in which a carbon dioxide transportation pipeline operator attempted to avoid PHMSA regulation, or in which PHMSA disclaimed safety jurisdiction or authority over an interstate carbon dioxide transportation pipeline transporting carbon dioxide in a fluid or dense phase. As indicated, Navigator knows that PHMSA has

regulatory oversight of the Navigator Heartland Greenway Pipeline, is working with PHMSA, and will in many cases exceed PHMSA's requirements.

8. Mr. Kuprewicz states on page 6 of his paper that a carbon dioxide pipeline operating in a supercritical state can be more prone to pipe running ductile fractures than hazardous liquids or natural gas pipelines. Attachment 2 to Bill Caram's testimony raises the same issue. Do you agree?

Answer: No. Mr. Kuprewicz cites no data on how frequently or how many times carbon dioxide pipelines have experienced ductile fractures in 30 years under federal safety regulation, nor any specific instances of such occurrences. Navigator's pipe specification is being developed with the assistance of third-party subject matter experts (specifically, DNV GL USA) to mitigate ductile fracture propagation. As verified by DNV in its third Design Verification Report dated June 2, 2023, and attached as Exhibit B, addressing materials and pipeline design, the engineering specifications for the pipeline include 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 redundant utilization of crack arrestors located through the pipeline systems will serve to further mitigate ductile fracture propagation in natural gas, hazardous liquids, and CO2 pipeline systems. These design specifications address the concern in Attachment 2 to Bill Caram's testimony about fracture toughness and steel pipe quality.

9. On page 10 of his paper, Mr. Kuprewicz states that a CO2 pipeline's impact area, if there is a release, may be measured in miles and not feet. What is your response?

Answer: Mr. Kuprewicz does not explain what volume or concentration percentage of carbon dioxide or amount of time following a release would be required to produce an impact miles from the location of the release. He also states that carbon dioxide may not disperse quickly and gives several reasons why this may be the case, but he fails to identify other factors that could result in rapid dispersal, such as wind speed and atmospheric instability. Further, in asserting that federal pipeline regulations do not require that pipeline operators adequately address this risk, he ignores 49 C.F.R. § 195.452 as well as the use of plume modeling as a tool to assess the risk he refers to.

While plume modeling is not required by federal regulation, it is part of Navigator's design and routing analyses and assessments to achieve compliance with 49 C.F.R. § 195.210, which specifies that "Pipeline right-of-way must be selected to avoid, as far as practicable, areas containing private dwellings, industrial buildings, and places of assembly," and that "No pipeline may be located within 50 feet (15 meters) of any private dwelling, or any industrial building or place of public assembly in which persons work, congregate, or assemble, unless it is provided with at least 12 inches (305 millimeters) of cover in addition to that prescribed in § 195.248." The cover requirements specified in § 195.248, and the depths at which navigator will bury the pipeline, are stated in the Application and exceed these requirements. Navigator is using plume modeling to identify buffer zones where applicable that exceed the Part 195 requirements as well as maintain at least 60 inches (5 feet) of cover over the pipeline. While Mr. Kuprewicz states on page 8 of his paper that a release from a carbon dioxide pipeline may potentially increase the "affected" or "potential impact" area and recommends that PHMSA should identify in regulations the potential impact areas of carbon dioxide pipeline ruptures (page 12), he does not

recognize the use of plume modeling to identify the area that may be impacted by a postulated release.

"PIR" is defined in the PHMSA regulations pertaining to integrity management for gas transmission pipelines as "the radius of a circle within which the potential failure of a pipeline could have significant impact on people or property." 49 C.F.R. § 192.903. This regulation also provides the formula for calculating PIR, which NHG used the concept and basis of PIR in its analyses to evaluate the potential impact buffer. Although "PIR" appears specifically in the PHMSA integrity management regulations pertaining to gas transmission pipelines, I believe the PIR concept is also useful for a risk assessment of a carbon dioxide transportation pipeline.

10. Dr. John Abraham states in his testimony that PHAST modeling is not the gold standard, is unreliable, and should not be relied upon for risk assessments. Do you agree?

Answer: No. There are a number of different models that Navigator considered as part of its risk assessment, and it used ALOHA modeling and retained DNV to conduct PHAST modeling. As explained by John Godfrey of DNV, the use of PHAST modeling is reasonable and appropriate for the scale and design of the Navigator Heartland Greenway Pipeline. The PHAST model utilized for Heartland Greenway was post DNV's Spadaem planned release utilized to update the model software from real world research data collected and outlined in the *COSHER JIP: Large scale pipeline rupture tests to study CO2 release and dispersion.*

11. Mr. Kuprewicz addresses impurities in carbon dioxide on pages 10-12 of his paper, and specifically discusses water and hydrogen sulfide, or H_2S. Will these impurities be found in the carbon dioxide being shipped from ethanol plants in South Dakota?

Answer: As addressed in the Application, the carbon dioxide shipped on the Navigator Heartland Greenway Pipeline will come from high purity sources. The carbon dioxide stream

entering the system at the ethanol and fertilizer facilities who will be Navigator's customers will meet the CO2 quality specifications required in the shipper agreements and be of a very high purity level, above 98% carbon dioxide, which is one of the reasons the carbon dioxide produced by ethanol and fertilizer facilities is an excellent candidate for capture, transportation, and sequestration. As discussed in the application, we have measures in place to ensure specifications are met or the product will not be allowed to enter the system. Further, there is no source from which H_2S could be introduced into the pipeline. In his paper, Mr. Kuprewicz states that "[t]here are some very pure sources of CO2 emitters, such as ethanol plants and some hydrogen reformers, that emit very high concentrations of CO2 to the atmosphere that require very little, if any, impurity treatment to prepare for pipeline transportation for CCS." I agree with that.

12. Attachment 2 to the testimony of Bill Caram discussed the Denbury carbon dioxide pipeline rupture and carbon dioxide release occurring near Satartia, Mississippi in February 2020 and PHMSA's subsequent investigation report. Are you familiar with the incident and PHMSA's report?

Answer: Yes. I and my colleagues in the design, construction, and operations functions at Navigator, and our engineering and design consultants, are familiar with this report and the underlying incident.

13. What do you understand to have been the principal cause of this incident?

Answer: Per PHMSA's incident report 20-176125 dated May 26, 2022, a landslide or mudslide of soil that had become saturated due to substantial precipitation over an extended period of time, resulting in the collapse of ground supporting the pipeline, placed excessive stress on the pipeline and resulted in an unplanned release of carbon dioxide into the atmosphere. The

risk of this geohazard and 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. In addition, it appears that although the pipeline operator learned of the leak soon after it occurred, the pipeline operator did not promptly notify local emergency medical services ("EMS"), emergency response units and authority, other first responders, and local authorities in the area, of the carbon dioxide release; as a result, there was confusion and lack of information for first responders as to what had been discharged and its source.

14. What lessons has Navigator taken from the Denbury Pipeline incident in designing and constructing the Navigator Heartland Greenway Pipeline?

Answer: Navigator has proactively addressed the failures related to the Denbury incident in its design and operation of the Navigator Heartland Greenway Pipeline. Recognizing the physical cause of the Denbury Pipeline rupture, and as a matter of sound engineering practices, Navigator has retained Terracon Consultants, Inc., a leading provider of geotechnical engineering services, to complete a Geohazard Assessment Study for the pipeline route, as described in discovery responses and my supplemental testimony, that will identify areas of risk due to geologic conditions that we will account for. DNV, which is one of the engineering firms that was retained to perform forensic analysis of the weld failure on the Denbury pipeline, has been retained by Navigator to assist with pipeline design and to verify Navigator's compliance with its standard for Design and Operation of Carbon Dioxide Pipelines (DNV-RP-F104), also as described in my supplemental testimony. DNV has validated the metallurgical analysis for the line pipe and 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.

In addition, Navigator has focused on the need for systems and procedures to recognize a release and notify appropriate EMS, emergency management, other first responders, and other local government personnel as early as possible. In addition to development of a NAV-911 system and researching a unique odorant for the carbon dioxide being transported in the pipeline, which have been previously described in testimony, Navigator may install fiber optic sensing cables along the pipeline that can detect the acoustical signal of a leak and also detect temperature drops which may indicate a leak, and that will thereby enable the fiber optic sensing cables to identify the location of the leak so that the pipeline segment can be isolated. The fiber optic sensing cables will enable quicker and more precise identification of any leak, so that first responders, other local authorities, and the public can be notified more quickly. This is one technology that could be utilized in a comprehensive and redundant leak detection system with other proven leak detection technologies (computational pipeline monitoring, negative pressure wave, control room management, etc.) working together in order to identify an unplanned release.

15. In his testimony for PUC Staff, William Byrd, P.E., recommends that the Commission require Navigator to use inspectors during construction with API 1169 certification (p. 5 lines 41-42). Do you agree with this recommendation?

Answer: We are evaluating the requirement for inspectors to be API 1169 certified. API1169 is one of several methods for validating competency associated with the quality assurance of construction methods being adhered to in pipeline installation. There are new construction operator qualifications through ISNeworld and Veriforce, experience and standards

verification through company exams, etc. Navigator utilizes a combination of several parameters to ensure there are competent inspectors performing quality assurance of the installation.

16. Mr. Byrd also suggests that Navigator's pipeline design may include too many valves, and that other forms of risk management are more cost-effective than extra automated valves, so that valve spacing should comply with 49 CFR § 195.260(c) rather than (g) (p. 9 lines 9-25). Mr. Byrd nevertheless concludes that Navigator's proposed valve spacing "seems to be more than adequate" (p. 9 lines 22-23). Please comment on Navigator's valve placement with respect to 49 CFR Part 195 and Mr. Byrd's comments.

Answer: The valve maps filed were baseline maps subject to change as we complete additional analyses. Throughout the application we discuss the various factors we use for risk mitigation and are not relying on any one factor; valves are one of those factors.

17. Mr. Byrd discusses the potential for a CO2 release from the pipeline to affect a High Consequence Area in South Dakota and states that to his knowledge, site-specific dispersion and overland flow modeling has not been done to determine which segments of the pipeline could affect an HCA (p. 8 lines 2-9). Please comment on this.

Answer: The updated HCA map provided in response to Staff's DR 2-10a depicts the current status of our HCA analysis, which is still in development as we are performing an EFRD analysis per Appendix C to Part 195. This is a continual process from input from stakeholders and ongoing integrity assessments of the pipeline. This is a component of the overall Integrity Management Plan. Mr. Byrd acknowledges the limitations and purpose of site-specific and overland flow modeling, otherwise known as computational fluid dynamic (CFD) modeling, as does Navigator witness Mr. Godfrey in his rebuttal testimony. Navigator does plan to use CFD modeling in the manner described on page 8 of Mr. Byrd's testimony, at discrete locations as

warranted from our hazard analysis. This will further inform Navigator of risk mitigation measures that may be warranted in proximity to population centers.

18. Mr. Byrd discusses PHMSA's authority to grant special permits that waive compliance with one or more of the safety requirements under Part 195, and states that to his knowledge Navigator has not requested a special permit from PHMSA (pp. 6-7, lines 42-46, 2-4). Is that accurate?

Answer: Yes. Navigator intends to exceed PHMSA's safety requirements and has no intention of seeking an exemption from any portion of 49 CFR Part 195.

19. Sara Throndson recommends that the PUC review the results of Navigator's geohazard analysis (Throndson Testimony at pp. 3-4). Please comment on the status of Navigator's geohazard study.

Answer: Navigator provided its geohazard assessment "Geological and Geohazard Desktop Study" report on April 14, 2023 and stated that a Phase II study including field verification and additional due diligence activities will be performed. The Phase II activities are planned for later this year and will not be available for review prior to the statutory deadline for a PUC decision on the docket. The Phase II assessment efforts to validate the results in the desktop assessment will include recommended mitigation measures that focus on reducing the probability of an incident occurring or reducing the vulnerability / impact to the pipeline in the event of a potential incident. Qualified geotechnical personnel will inspect areas identified in the desktop assessment including visual inspection, geotechnical investigations, aerial inspection, and soil testing / analysis. Mitigation measures during the construction phases of the project include site stabilization measures (e.g., trench breakers, terrace installation, slope reconstruction, drainage improvements, etc.), installation of appropriate erosion and sediment

control systems for surface water control to reduce the probability of an event occurring during construction, and post-construction activities. In addition, implementation of trench modification activities may be warranted during the construction phase (e.g., modifying the trench profile, backfill of fissures using large particles, use of free draining / engineer materials within the trench backfill material, trench breakers to restrict subsurface flow). After construction, a robust pipeline monitoring / maintenance plan will be developed and implemented, and it will include the required key activities to support safe operation of the pipeline (e.g., areas warranting increased frequency of aerial patrols, utilization of Light Detection and Raging Surveys (LiDAR) on a period basis and conducting field assessments to monitor potential problems areas).

20. In their testimony, Jon Thurber and Matthew Frazell indicate that Navigator has not provided sufficient information for them to evaluate the plume modeling that was done for the pipeline. Please respond.

Answer: Navigator is submitting a confidential document titled "Heartland Greenway System: CO2 Air Dispersion Guidance." A copy has been provided subject to the Protective Order entered in this proceeding. The document explains the modeling that was done and provides additional detail about the process and inputs used for the modeling

21. Does this conclude your rebuttal testimony?

Answer. Yes.

Dated this 26th day of June, 2023.

/s/Stephen Lee
Stephen Lee