RECONCILING PROPERTY RIGHTS WITH CARBON CAPTURE AND STORAGE

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INTRODUCTION

The United Nations' Intergovernmental Panel on Climate Change (IPCC) suggests that the best strategy to combat climate change is a multipronged approach that includes large scale carbon capture and storage (CCS)—a process that involves "capturing" carbon dioxide (CO_2) from the atmosphere or industrial emissions and then injecting the CO_2 deep underground for permanent storage.[1] Likewise, each of the last four U.S.

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1. Intergovernmental Panel on Climate Change, IPCC Special Report on Carbon Dioxide Capture and Storage 3 (Bert Metz et al. eds., 2005), https://archive.ipcc.ch/pdf/special-reports/srccs/srccs_wholereport.pdf [https://perma.cc/FW7N-NM5P].

presidential administrations (Biden, Trump, Obama, and Bush) have supported the use of CCS to address climate change.[2]

Huge investments in numerous projects will be needed to deploy CCS on the scale contemplated by the IPCC and the United States government.[3] However, investors dislike uncertainty, including legal uncertainty, and the injection of CO_2 into the subsurface on a large scale raises basic property law questions that are not well-resolved.[4] For example, if the owner of Blackacre injects CO_2 into a formation deep beneath Blackacre, the CO_2 will migrate laterally within that formation.[5] Eventually, a portion of the CO_2 will enter the subsurface of neighboring tracts, such as Whiteacre.[6] If the owner of Whiteacre has not consented to this migration, is the intrusion of CO_2 into the subsurface of her land a subsurface trespass?

This article addresses three property law issues raised by CCS. First, under the common law, does a landowner's ownership of land include an interest in excluding the migration of CO_2 into the pore spaces of rock formations located deep beneath the surface? If so, would this interest entitle a landowner to injunctive relief to prohibit CCS operations that would cause a subsurface intrusion of CO_2? And finally, if the migration of CO_2 constitutes a trespass, what should be the measure of monetary damages for such an intrusion?

This article argues that a landowner has a valid property interest in excluding the migration of CO_2 into the subsurface of her land, but that a landowner should not be entitled to injunctive relief to enjoin the operation of a CCS project that would cause such migration. The landowner should, however, be entitled to monetary compensation in an amount equal to the fair market value of the pore spaces into which the CO_2 migrates.

Section I provides an overview of CCS. Section II reviews the concepts of ownership and trespass, then discusses case law that has imposed trespass liability for certain types of intrusions into the airspace above or subsurface below the land. Section III discusses case law that has held that

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2. *See Biden-Harris Administration Announces Over $2.3 Billion Investment To Cut U.S. Carbon Pollution*, U.S. DEP'T OF ENERGY (May 5, 2022), https://www.energy.gov/articles/biden-harris-administration-announces-over-23-billion-investment-cut-us-carbon-pollution [https://perma.cc/EFB3-XQLR]; Akshat Rathi, *Trump signed a landmark bill that could create the next big technologies to fight climate change*, QUARTZ (Feb. 9, 2018), https://qz.com/1203803/donald-trump-signed-a-landmark-bill-to-support-carbon-capture-and-nuclear-power [https://perma.cc/P4ME-X3B3]; *Federal Task Force Sends Recommendations to President on Fostering Clean Coal Technology*, WHITE HOUSE (Aug. 12, 2010), https://obamawhitehouse.archives.gov/administration/eop/ceq/Press_Releases/August_12_2010 [https://perma.cc/V8RF-W7LE]; Press Release, Council on Env't Quality, https://georgewbush-whitehouse.archives.gov/ceq/clean-energy.html [https://perma.cc/MQA9-GK4T].

3. *See* Scarlett Evans, *The cost of carbon capture: is it worth incorporating into the energy mix?*, POWER-TECH. (Jun. 23, 2020), https://www.power-technology.com/analysis/carbon-capture-cost/ [https://perma.cc/U497-XXPU].

4. *See* Intergovernmental Panel on Climate Change, *supra* note 1, at 49.

5. *Id.* at 206.

6. *See id.* at 97.

no trespass liability existed for other types of airspace or subsurface intrusions. Finally, Section IV discusses why public policy supports the conclusions reached by this article and why a subsurface migration of CO_2 is distinguishable from the types of airspace or subsurface intrusions that do not support trespass claims.

I. OVERVIEW OF CCS

Because public discussion of CCS is relatively new,[7] some readers may have various questions. What is CCS? What does it mean to "capture" carbon? How is CO_2 "stored"? Why should society encourage people to "capture" and "store" CO_2? This section addresses each question in turn.

A. What is CCS?

Carbon capture and storage (CCS)[8] is the *capture* of CO_2—either directly from the atmosphere or from industrial emissions—followed by the injection of the CO_2 deep into the subsurface of the earth for permanent *storage*.[9] This process is sometimes called "carbon capture and sequestration," particularly in older discussions.[10] CCS is a subset of a broader concept called "carbon capture, utilization, and storage" (CCUS), in which CO_2 is captured and then either *utilized* (used) or stored.[11]

B. What does it mean to "capture carbon?"

In the context of CCS, to "capture carbon" is to separate CO_2 molecules from other types of molecules in a gaseous mixture.[12] This is done to facilitate the injection of CO_2 into the subsurface for permanent storage.[13] The separation of CO_2 from other components in a gaseous mixture serves at least two purposes.[14] First, the separation allows a CCS operator to minimize the amount of gas that must be injected into the surface in order to store a

7. *See id.* at 54.

8. The "carbon" of the phrase "carbon capture and storage" refers to carbon dioxide. *See id.* at 3. As recently as several years ago, the process was typically called "carbon capture and sequestration," but now it is more common to refer to it as "carbon capture and storage." *See id.* at 54 n.2.

9. *See id.* at 31.

10. *See id.* at 54 n.2.

11. *See About CCUS*, Int'l Energy Agency (Apr. 2021), https://www.iea.org/reports/about-ccus [https://perma.cc/CKM6-NVWE]. The "use" of carbon dioxide in CCUS would be a use that either prevents the carbon dioxide from being emitted to the atmosphere or which replaces some other carbon dioxide that otherwise would be emitted to the atmosphere. *See id.*

12. *See* Intergovernmental Panel on Climate Change, *supra* note 1, at 19.

13. *See id.* at 197.

14. *See id.* at 25.

given amount of CO_2.[15] Suppose, for example, that CO_2 constituted 20% of a gaseous mixture. If that CCS operator injected the entire mixture into the subsurface, the operator would need to inject five molecules of gas for every molecule of CO_2 that would be stored in the subsurface.[16] This would increase the costs of the operation and, because the storage formation will have a finite volume,[17] would cause the storage formation into which the gas is injected to fill up sooner than if a stream of nearly pure CO_2 was injected.[18] Second, in some cases, CO_2 might be mixed with other substances that an operator should seek to avoid injecting into the subsurface for permanent storage—either because the substances are valuable or because the substances are potentially harmful.[19]

There are various sources of the gaseous mixtures from which a CCS operator might seek to capture CO_2.[20] One source could be the post-combustion outlet (or stack) of an industrial facility that burns coal, natural gas, or some other substance to create heat.[21] This could be a power plant using heat to vaporize water into steam that will turn a turbine that generates electricity, or it could be some other industrial process that operates at a high temperature.[22] Alternatively, the gaseous mixture might be emissions from some other industrial process that, apart from any combustion that might take place, involves chemical reactions that produce CO_2.[23] Examples include the

15. *See id.*

16. *See id.* Thus, to inject a given amount of carbon dioxide, the CCS facility's equipment and piping would need to be larger. *See id.* Further, subsurface storage reservoirs have a finite volume. *See id.* Injecting a purified stream of carbon dioxide will allow the CCS operator to store more carbon dioxide than it would be able to do otherwise. *See id.*

17. The fact that the volume of storage reservoirs is finite is reflected in regulations. *See*, *e.g.*, *Carbon Capture and Sequestration Protocol Under the Low Carbon Fuel Standard*, Cal Air Res. Bd., at 40 (Aug. 13, 2018), https://ww2.arb.ca.gov/sites/default/files/2020-03/CCS_Protocol_Under_LCFS_8-13-18_ada.pdf [https://perma.cc/HKV5-W52A] (requiring that a storage reservoir be "of sufficient volume . . . to receive the total anticipated volume of the CO2 stream"); La. Admin. Code tit. 43, pt. XVII, § 3615(A)(1) (2022) (requiring that storage reservoir be of sufficient size "to receive the total anticipated volume of the carbon dioxide stream").

18. *See* Intergovernmental Panel on Climate Change, supra note 1, at 25.

19. *See id.* at 136. The injection of carbon dioxide into the subsurface for permanent storage is regulated under the Safe Drinking Water Act ("SDWA"), 42 U.S.C. § 300f, a set of federal statutes whose goal is to protect drinking water. *See* 42 U.S.C. § 300f. Under federal regulations promulgated pursuant to the SDWA, wells used to inject carbon dioxide for permanent underground storage are "Class VI" wells. 40 C.F.R. § 144.6(f)(2011). For a brief overview of the SDWA and its underground injection control (UIC) program that is designed to protect underground sources of drinking water (USDWs), *see* Keith B. Hall, *Regulations of Hydraulic Fracturing under the Safe Drinking Water Act*, 19 BUFF. ENV'T. L.J. 1 (2011).

20. *See Intergovernmental Panel on Climate Change*, *supra* note 1, at 108.

21. *See id.* at 77.

22. *See id.* at 19.

23. *See id.*

making of ethanol,[24] steel,[25] cement,[26] and fertilizers.[27] Or, it might be emissions from a facility that removes CO_2 from some substance, such as natural gas,[28] in which the CO_2 is sometimes found as a contaminant.[29]

Finally, CO_2 could be captured and removed from the atmosphere.[30] This is called "direct air capture" (DAC).[31] At present, the concentration of CO_2 in the atmosphere is about 412 ppm.[32] Thus, only about 0.04% of the air consists of CO_2.[33] For this reason, a large amount of air must be handled and processed to separate out a significant amount of CO_2.[34] This can make DAC expensive, but an advantage of DAC is that it can be done almost anywhere.[35] A DAC facility need not be placed next to a source of CO_2 emissions.[36] The only locational requirement is one that can be satisfied at uncounted

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24. *Decarbonization: Status, Challenges, and Policy Options for Carbon Capture, Utilization, and Storage*, *Gen. Acct. Off.*, at 10, 14 (Sept. 2022), https://www.gao.gov/assets/730/723198.pdf [https://perma.cc/99BB-L2WR].

25. Class VI - Wells used for Geologic Sequestration of Carbon Dioxide, Env't Prot. Agency (Dec. 9, 2022), https://www.epa.gov/uic/class-vi-wells-used-geologic-sequestration-carbon-dioxide#back_info [https://perma.cc/78KJ-RT5G] (referring to steelmaking as a potential source of carbon dioxide).

26. *See, e.g.*, Decarbonization: Status, Challenges, and Policy Options for Carbon Capture, Utilization, and Storage, *supra* note 24, at 4 ("approximately two-thirds of CO2 emissions from cement production are *process emissions*, which are released by limestone as it is heated rather than by fuel as it burns"); *see also* Intergovernmental Panel on Climate Change, *supra* note 1, at 3.

27. *See* EPA, Documentation for Greenhouse Gas Emissions and Energy Factors Used in the Waste Reduction Model (WARM), EPA, at 1-20 (Nov. 2020), https://www.epa.gov/sites/default/files/2020-12/documents/warm_organic_materials_v15_10-29-2020.pdf [https://perma.cc/8EBU-5ZFF] (noting that the manufacture of fertilizer releases carbon dioxide); *see also* Intergovernmental Panel on Climate Change, *supra* note 1, at 22. In some cases, an industrial process might yield a gaseous waste stream that is almost all carbon dioxide from the start. *See id.* at 28. In such cases, it might be practical to place the entire waste stream into storage, without undergoing the expense of "capturing" and separating the CO2. *See id.* at 220.

28. Decarbonization: Status, Challenges, and Policy Options for Carbon Capture, Utilization, and Storage, *supra* note 24, at 18.

29. *See id.* at 25. Natural gas that comes out of the ground is a mixture of valuable components (primarily methane) and other components that are not valuable (at least they are not valuable as an ingredient in natural gas), such as nitrogen, water vapor, hydrogen sulfide, or carbon dioxide. *See* Andrew Turgeon & Elizabeth Morse, *Natural Gas*, NAT'L GEOGRAPHIC (May 20, 2022), https://education.nationalgeographic.org/resource/natural-gas [https://perma.cc/4F7K-V9KL]. The natural gas stream can be made more valuable by removing those less valuable substances from the mixture. *See id.*

30. ANGELA C. JONES & ASHLEY J. LAWSON, CONG. RSCH. SERV., R44902, CARBON CAPTURE AND SEQUESTRATION (CCS) IN THE UNITED STATES 13 (2022).

31. *See id.*

32. Alan Buis, *The Atmosphere: Getting a Handle on Carbon Dioxide*, NASA (Oct. 9, 2019), https://climate.nasa.gov/news/2915/the-atmosphere-getting-a-handle-on-carbon-dioxide/ [https://perma.cc/62M5-JQZR].

33. JONES & LAWSON, *supra* note 30.

34. *See id.*

35. *See id.*

36. *See id*.

locations—the need for the existence of a subsurface formation into which carbon dioxide can be injected and reliably stored.[37]

C. How does someone "capture" carbon dioxide?

There are various ways that CO_2 can be captured and separated from the other components of a gaseous mixture.[38] In one type of process, a gaseous mixture is passed over a solid substance onto which the CO_2 adsorbs, adhering to the surface as a film.[39] The other components of the gaseous mixture do not adsorb onto the surface, or at least if they do, not to any significant extent.[40] This allows the CO_2 molecules to be captured and separated from the compounds in the gaseous mixture.[41] Before the surface becomes saturated with CO_2, the flow of the gaseous mixture over the solid will be stopped.[42] The operator of the process can then perform an operation, such as heating the solid onto which the CO_2 has adsorbed, that causes a relatively pure stream of CO_2 to desorb from the surface.[43] This CO_2 can then be routed to an injection disposal well.[44]

To allow the "capture" process to operate continuously, the operator can have two separate solid adsorption units.[45] While the first unit is going through the heating and desorption process, the operator routes the gaseous mixture through the second unit.[46] When the desorption process is finished on the first unit, meaning that the surface is relatively free of CO_2 and is ready to start adsorbing CO_2 again, the gaseous mixture can be switched back to flowing through the first adsorption unit and the second unit can be put through the desorption process.[47]

A second way to capture and separate CO_2 from a gaseous mixture is similar to the first, but instead of passing the gaseous mixture over a solid onto which CO_2 adsorbs, the gaseous mixture is brought into contact with a liquid into which CO_2 is absorbed, separating it from the rest of the gaseous mixture.[48] The liquid can then be heated to cause a release of the absorbed CO_2.[49]

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37. *Direct air capture: our technology to capture CO2*, Climeworks, https://climeworks.com/direct-air-capture [https://perma.cc/X8H4-6H4W](noting that "DAC plants can be located anywhere as they do not need to be attached to an emissions source.").
38. *See* Intergovernmental Panel on Climate Change, *supra* note 1, at 25.
39. *See id.* at 109.
40. *See id.*
41. *See id.*
42. *See id.*
43. *See id.*
44. *See id.* at 31.
45. *See id.* at 109.
46. *See id.*
47. *See id.*
48. *See id.*
49. *See id.* The liquid might be continuously circulated. *See id.* That is, the liquid does not go through a batch process in which it first absorbs carbon dioxide, then is taken out of

The third main way that CO_2 can be captured and separated from a gaseous mixture is to bring the mixture in contact with a membrane through which the CO_2 will pass, but through which relatively little of the remaining portion of the mixture will pass.[50] Thus, the CO_2 ends up on one side of the membrane, while the remainder of the gaseous mixture remains on the other.[51]

D. How is CO_2 "stored"?

The main way of storing CO_2 is to inject it into the subsurface.[52] This is done by drilling a well deep underground to a subsurface rock formation that will serve as the "storage formation."[53] This storage formation must be porous, meaning that it has pore spaces that can hold and thus store CO_2, and the formation must be permeable, meaning that a fluid can flow through the formation.[54] Typically, interconnections between pore spaces allow fluid to flow through a formation by moving from one pore space to the next, making the formation permeable.[55] The CO_2 typically will not flow back to the surface because of the existence of one or more layers of impermeable caprock above the storage formation.[56]

The storage formation can be a depleted oil or natural gas reservoir—meaning a formation that once contained oil or gas, but from which the oil or gas has been recovered already, leaving behind a formation with relatively empty pore spaces that once contained oil and gas.[57] Alternatively, the storage formation can be a saline formation—meaning a subsurface rock formation that is porous, permeable, and contains salty water.[58] Many subsurface formations contain such salty water—the remnants of ancient seas—that is not suitable for drinking water (at least not without extensive, expensive treatment).[59]

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service for a desorption step. *See id.* Instead, the liquid is circulated in a loop. *See id.* In one portion of the loop, the gaseous mixture is brought in contact with the circulating liquid. *See id.* In another part of the continuous loop, while the liquid is no longer in contact with the gaseous mixture, the liquid is put through the process (perhaps heating) that liberates the carbon dioxide. *See id.*

50. *See id.* at 109–10.

51. Intergovernmental Panel on Climate Change, *supra* note 1, at 109–10.

52. *See CCS Explained: Storage*, GLOB. CCS INST., https://www.globalccsinstitute.com/ccs-101-storage/ [https://perma.cc/C675-QFWM] (last visited Nov. 21, 2022) [hereinafter *CCS Explained*].

53. *See id.*

54. *See id.*; *see also About CCUS*, Int'l Energy Agency (Apr. 2021), https://www.iea.org/reports/about-ccus [https://perma.cc/CKM6-NVWE] [hereinafter *About CCUS*].

55. *See About CCUS*, *supra* note 54.

56. *See id.*; *see also Carbon Storage FAQs*, NAT'L ENERGY TECH. LAB'Y, https://netl.doe.gov/carbon-management/carbon-storage/faqs/carbon-storage-faqs [https://perma.cc/Q528-TKP5] (last visited Nov. 21, 2022) [hereinafter *Carbon Storage FAQs*].

57. *Carbon Storage FAQs*, *supra* note 56.

58. *Id.*

59. Intergovernmental Panel on Climate Change, *supra* note 1, at 217.

E. Why would society encourage people to "capture" and "store" CO_2?

Scientists explain that the climate is changing as a result of a rise in average global temperatures, which is caused in large part by an increase in the concentration of CO_2 and other greenhouse gases in the atmosphere.[60] Greenhouse gases are gases that help trap heat in the atmosphere.[61] Scientists also explain that humans contribute to climate change by engaging in activities that emit greenhouse gases.[62] The most common greenhouse gas is CO_2,[63] and the main anthropogenic source of CO_2 emissions is the combustion of fossil fuels[64] for energy,[65] though there are other industrial

60. *See, e.g.*, *Climate Change Science: Basics of Climate Change*, ENV'T. PROT. AGENCY, https://www.epa.gov/climatechange-science/basics-climate-change [https://perma.cc/25UH-W2YH] (last updated Aug. 19, 2022).

61. *Overview of Greenhouse Gas Emissions*, ENV'T PROT. AGENCY, https://www.epa.gov/ghgemissions/overview-greenhouse-gases [https://perma.cc/4CQU-KP5S] (last updated May 16, 2022) [hereinafter *Overview of Greenhouse Gas Emissions*].

62. *See id.* (explaining that human activities such as transportation and industrial production are responsible for the increase in carbon dioxide emissions); *see also* Alison Kole, *Carbon Capture and Storage: How Bad Policy Is By-Passing Environmental Safeguards*, 20 J. ENV'T. & SUSTAINABILITY L. 115, 120 (2015).

63. *See Overview of Greenhouse Gas Emissions*, *supra* note 61. Others include methane (CH_4), nitrous oxide (N_2O), and fluorinated gasses such as hydrofluorocarbons. *Id.*

64. The non-renewable resources we refer to as fossil fuels are so named because of their origin in the fossilized remains of prehistoric plants and animals that lived millions of years ago. *See Energy Sources: Fossil*, U.S. DEP'T OF ENERGY, https://www.energy.gov/science-innovation/energy-sources/fossil [https://perma.cc/QM73-5LMB] (last visited Nov. 21, 2022); *see also* Melissa Denchak, *Fossil Fuels: The Dirty Facts*, NAT. RES. DEF. COUNS. (June 1, 2022), https://www.nrdc.org/stories/fossil-fuels-dirty-facts#sec-whatis [https://perma.cc/55DB-W8TW]. Examples of fossil fuels include coal, oil, and natural gas. *See id.*

65. *See* Kole, *supra* note 62; *see also Energy and the Environment Explained: Where Greenhouse Gases Come From*, U.S. ENERGY INFO. ADMIN., https://www.eia.gov/energyexplained/energy-and-the-environment/where-greenhouse-gases-come-from.php [https://perma.cc/QE5W-XU9L] (last updated June 24, 2022).

processes whose chemistry results in the production and emission of CO_2 (such as the manufacture of steel,[66] cement,[67] and fertilizers).[68]

These changes in climate can disrupt both human societies and natural environments in various ways.[69] It is too late to avoid these disruptions altogether, but a number of countries have adopted a goal of preventing the average global temperature from rising more than 2 °C compared to pre-industrial times,[70] and one international meeting concluded that society should pursue an even more ambitious 1.5 °C goal.[71] The IPCC concluded that, in order to accomplish these goals, the world will need to use a multi-strategy approach that includes transitioning away from fossil fuels toward low or zero-emission sources of energy,[72] promoting energy

66. *Iron and Steel Technology Roadmap*, Int'l Energy Agency at 26 (Oct. 2020), https://iea.blob.core.windows.net/assets/eb0c8ec1-3665-4959-97d0-187ceca189a8/Iron_and_Steel_Technology_Roadmap.pdf [https://perma.cc/MQ8U-M5EF] (describing how, in addition providing heat, coal provides carbon that is converted to carbon monoxide, which then reacts with iron ore to make carbon dioxide and relatively pure iron); Mark Peplow, *Can industry decarbonize steelmaking?*, Chem. & Eng'g News (June 13, 2021), https://cen.acs.org/environment/green-chemistry/steel-hydrogen-low-co2-startups/99/i22 [https://perma.cc/6KXB-KRGH].

67. The Center for International Climate Research estimates that worldwide carbon dioxide emissions from making cement reached almost 2.9 billion tons in 2021—more than 7% of all carbon dioxide emissions. Seth Borenstein, *Cement Carbon Dioxide Emissions Quietly Double in 20 Years*, ASSOC. PRESS NEWS (June 22, 2022), https://apnews.com/article/climate-science-china-pollution-3d97642acbb07fca7540edca38448266 [https://perma.cc/CP7A-XK9C]; *see also* Lisa J. Hanle, CO2 Emissions Profile of the U.S. Cement Industry 1 (2004).

68. *Overview of Greenhouse Gas Emissions*, *supra* note 61; *see also CCS Explained*, *supra* note 52.

69. *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, IPCC FIFTH ASSESSMENT REPORT: SUMMARY FOR POLICY MAKERS 2, 13–16 (2014) [hereinafter FIFTH IPCC REPORT].

70. *See* Paris Agreement to the United Nations Framework Convention on Climate Change, Dec. 12, 2015, T.I.A.S. No. 16-1104, art. 2(1)(a) [hereinafter Paris Agreement] (establishing the two-degree goal of the Agreement, under which the parties aim to "hold . . . the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels"). There are 194 parties to the Agreement—193 states plus the European Union. *See Climate Action: The Paris Agreement*, UNITED NATIONS, https://www.un.org/en/climatechange/paris-agreement [https://perma.cc/YEW5-UAQ2] (last visited Nov. 23, 2022). However, scientific projections indicate that the world is not yet on target to meet the two-degree goal. *See, e.g.*, UNITED NATIONS ENV'T PROGRAMME, THE EMISSIONS GAP REPORT 2016, XI (2016) (estimating that the world is instead poised for global warming of up to 3.4°C). For a further look at the Paris Agreement and its drafting implications, *see* Maria L. Banda, *The Bottom-Up Alternative: The Mitigation Potential of Private Climate Governance after the Paris Agreement*, 42 HARV. ENV'T. L. REV. 325 (2018).

71. Paris Agreement, *supra* note 70, at art. 2(1)(a).

72. *See generally* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2022 MITIGATION OF CLIMATE CHANGE, WORKING GROUP III CONTRIBUTION TO THE IPCC SIXTH ASSESSMENT REPORT: SUMMARY FOR POLICY MAKERS (Priyadarshi R. Shukla et. al. eds., 2022) [hereinafter Sixth IPCC Report]. These primarily include such "renewable"

conservation or energy efficiency,[73] and using CCS to limit CO_2 emissions from fossil fuels and manufacturing processes such as cement making.[74]

Like the IPCC, various other authorities also concluded that CCS is an important tool for fighting climate change.[75] The last several U.S. presidential administrations reached that conclusion,[76] and the Department of Energy funded research on CCS under multiple administrations.[77] The United States Congress has reached the same conclusion and amended the tax code to implement tax credits for CCS projects.[78] Moreover, several states have enacted legislation to foster CCS.[79] Thus, there is widespread agreement that promoting CCS is an important public policy.[80]

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sources as solar, wind, traditional hydropower, tidal and wave power, and geothermal, as well as biofuels. *See id.* It can also include nuclear power. *See id.*

73. *Energy Efficiency*, OFF. OF ENERGY EFFICIENCY & RENEWABLE ENERGY, https://www.energy.gov/eere/energy-efficiency [https://perma.cc/2S8S-FZ3Q] (last visited Nov. 23, 2022).

74. Sixth IPCC Report, *supra* note 72, at 32 (referring to CCS as a "critical mitigation option" for the cement and chemical industries). The report also states that "[u]ntil new chemistries are mastered, deep reduction of cement process emissions will rely on already commercialized cementitious material substitution and the availability of CCS." *See id.* at 33. Other authorities have come to the same conclusion. *See* David Hodgson & Paul Hugues, *Cement Tracking Report*, INT'L ENERGY AGENCY (Sept. 2022), https://www.iea.org/reports/cement [https://perma.cc/7RBW-BPKN] (stating that [t]technological innovation is needed to reduce cement process emissions," and that CCS has a "critical role in decarbonizing cement, as it would enable the capture of process emissions."). It can also involve seeking to find alternative processes for the cement, fertilizer, and steel industries, whose processes involve the emission of carbon dioxide. *CCS Explained*, *supra* note 52.

75. *See, e.g.*, Hodgson & Hugues, *supra* note 74; *see also Carbon Dioxide Capture and Sequestration*, ENV'T PROT. AGENCY, https://19january2017snapshot.epa.gov/climatechange/carbon-dioxide-capture-and-sequestration-overview_.html **[**https://perma.cc/KR7M-UPMX] (last visited Nov. 23, 2022).

76. PETER FOLGER, CONG. RSCH. SERV., R44902, CARBON DIOXIDE STORAGE AND SEQUESTRATION (CCS) IN THE UNITED STATES 8 (2017); *see also* Leah Douglas, *Factbox: Biden administration sees carbon capture as key tool in climate fight*, REUTERS (Feb. 7, 2022), https://www.reuters.com/business/environment/biden-administration-sees-carbon-capture-key-tool-climate-fight-2022-02-07/ [http://perma.cc/JK8A-8MBC].

77. U.S. DEP'T OF ENERGY, CARBON CAPTURE, TRANSPORT, AND STORAGE: SUPPLY CHAIN DEEP DIVE ASSESSMENT, 10 (2022) (stating that the Department has invested $7.3 billion in CCS-related research and development activities).

78. 26 U.S.C. § 45Q; *see also Carbon Capture Provisions in the Inflation Reduction Act of 2022*, CLEAN AIR TASK FORCE (Aug, 19, 2022), https://cdn.catf.us/wp-content/uploads/2022/08/19102026/carbon-capture-provisions-ira.pdf [https://perma.cc/F5HR-NV68].

79. *See, e.g.*, ALA. CODE § 9-17-151 (1975) ("The underground storage of gas which promotes the conservation thereof . . . is in the public interest and welfare of this statute and is for a public purpose."); LA. STAT. ANN. § 30:1102(A)(1) (2009) ("The geologic storage of carbon dioxide will benefit the citizens of the state and the state's environment by reducing greenhouse gas emissions."); MISS. CODE ANN. § 53-11-3(1)(a) (West 1972) ("It is declared to be in the public interest that… (a) [t]he geological sequestration of carbon dioxide will benefit the citizens of the state and the state's environment . . .").

80. However, there are critics of CCS. *See, e.g.*, *CCUS in Clean Energy Transitions: A New Era for CCUS*, INT'L ENERGY AGENCY (2020), https://www.iea.org/commentaries/car

II. REASONS WHY LANDOWNERS MIGHT BE ABLE TO BLOCK CCS OR DEMAND COMPENSATION

The right of landowners to exclude others—a right vindicated by the law of trespass—taken together with the *ad coelum* doctrine, the notion that a landowner owns not merely the surface, but also all the airspace above it and all the subsurface directly below it, all the way to the center of the earth, could support an argument that a CCS operator commits a trespass if it causes CO_2 to migrate into the subsurface of tracts of nonconsenting landowners.[81]

A. Ownership and the right to exclude others

Ownership is a "collection of rights to use and enjoy property."[82] Commentators and courts often analogize ownership to a bundle of sticks,

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bon-capture-in-2021-off-and-running-or-another-false-start [https://perma.cc/9SCQ-M3GT] [hereinafter A New Era for CCUS]; Charles Harvey & Kurt House, *Every Dollar Spent on This Climate Technology Is a Waste*, N.Y. TIMES (Aug. 16, 2022), https://www.nytimes.com/2022/08/16/opinion/climate-inflation-reduction-act.html [https://perma.cc/V2M7-9NP4]; Pranshu Verma, *There's a carbon-capture gold rush. Some warn better solutions exist*., WASH. POST (June 23, 2022), https://www.washingtonpost.com/technology/2022/06/23/carbon-capture-climate-change/ [https://perma.cc/AW9V-AUXM] [hereinafter A New Era for CCUS].

The critics further ignore the fact that experts believe the world will find it challenging to meet the 2°C goal (much less the 1.5°C goal) even if we work hard at *both* transitioning toward renewables and implementing CCS. *See generally* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, MITIGATION PATHWAYS COMPATIBLE WITH 1.5°C IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT: SUMMARY FOR POLICYMAKERS (2018) (emphasizing the need to implement a wide portfolio of mitigation policies); *see also A New Era for CCUS*, *supra* note 80 (referring to CCS as one of "four key pillars of global energy transitions," alongside, in part, renewables).

Finally, some critics suggest that CCS might prove more expensive than transitioning toward renewables, but this again ignores the fact that experts believe we need to do both—that is, to meet climate change goals we need to transition to renewables and utilize CCS. *See id.* It also again ignores the fact that there are some industries—such as cement making—for which we do not have a viable substitute. *See* Samantha McCulloch, *Carbon Capture in 2021: Off and Running or Another False Start?*, INT'L ENERGY AGENCY (Nov. 24, 2021), https://www.iea.org/commentaries/carbon-capture-in-2021-off-and-running-or-another-false-start [https://perma.cc/62JE-6HB7]. CCS can be useful for capturing the carbon dioxide from those industries. *See id.* Further, this criticism of CCS ignores the fact that the IPCC suggests that direct air capture and subsequent storage of carbon dioxide may be necessary even after we have transitioned toward renewables. *See A New Era for CCUS*, *supra* note 80.

81. *See generally* MARK A. FIGUEIREDO, PROPERTY INTERESTS AND LIABILITY OF GEOLOGIC CARBON DIOXIDE STORAGE: A SPECIAL REPORT TO THE MIT CARBON SEQUESTRATION INITIATIVE (2005), https://sequestration.mit.edu/pdf/deFigueiredo_Property_Interests.pdf [https://perma.cc/TWT6-L7R6].

82. *Ownership*, BLACK'S LAW DICTIONARY (11th ed. 2019); Concord Steam Corp. v. Concord, 519 A.2d 266, 269 (N.H. 1986) (quoting Trs. of Phillips Exeter Acad. v. Exeter, 33 A.2d 665, 673 (1943)); *see also* LA. CIV. CODE ANN. art. 477 (1999) (defining ownership as "the right that confers on a person direct, immediate, and exclusive authority over a thing.

explaining that ownership includes several benefits akin to how a bundle can include several sticks.[83] One of the benefits associated with ownership is the right to exclude others.[84] Thus, the owner of land typically has the right to exclude others from the land.[85] The law of trespass protects this right to exclude others by giving a landowner a cause of action in tort if some other person violates the landowner's right of exclusive possession by intruding

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The owner of a thing may use, enjoy, and dispose of it within the limits and under the conditions established by law.").

83. *See* STEVE SHEPPARD, THE WOLTERS KLUWER BOUVIER LAW DICTIONARY, 2228–29 (Desk ed. 2012) (explaining that the concept of ownership as a bundle of sticks is a "pervasive metaphor for the ideas of ownership and property itself. Ownership is depicted as the sum of all . . . the interests owned relative to some thing, which may be pulled like a straw from a bundle, dividing elements of the thing, as well as privileges in each or all . . ."); *but see generally* J.E. Penner, *The "Bundle of Rights" Picture of Property*, 43 UCLA L. REV. 711 (1996); Craig Anthony Arnold, *The Reconstruction of Property: Property as a Web of Interests*, 26 HARV. ENV'T L. REV. 281 (2002) (both critiquing the bundle of sticks concept and proposing their own replacements for it).

84. *See* 2 WILLIAM BLACKSTONE, COMMENTARIES *2 (defining ownership as "that sole and despotic dominion which one man claims and exercises over the external things of the world, in total exclusion of the right of any other individual in the universe."); *see also* Cedar Point Nursery v. Hassid, 141 S. Ct. 2063, 2072 (2021) (stating that "…the right to exclude is 'universally held to be a fundamental element of the property right,' and is 'one of the most essential sticks in the bundle of rights that are commonly characterized as property.'" (quoting Kaiser Aetna v. United States, 444 U.S. 164, 176, 179–80 (1979)); Lightning Oil Co. v. Anadarko E&P Onshore, 520 S.W.3d 39, 46 (Tex. 2017) (explaining that the "owner of realty generally 'has the right to exclude all others from use of the property.'"); Sammons v. Am. Auto. Ass'n, 912 P.2d 1103, 1105 (Wyo. 1996) (stating that "[o]wnership of property implies the right of possession and control and includes the right to exclude others; that is, a true owner of land exercises full dominion and control over it and possesses the right to expel trespassers."); Guimont v. Clarke, 854 P.2d 1, 6 (Wash. 1993) (referring to the right to exclude others as one of the "fundamental attributes of property ownership"): State v. Hall, 47 P.3d 55, 57 (Or. Ct. App. 2002) (stating the general rule that "one of the incidents of property ownership is the right to invite other persons to use property or, conversely, to exclude them from doing so.").

85. An action for trespass protects the right of possession, rather than ownership. W. PAGE KEETON ET AL., PROSSER AND KEETON ON THE LAW OF TORTS § 13, at 77 (5th ed. 1984) (stating that the "action for trespass is designed to protect the interest in exclusive possession of the land in its intact physical condition."); Florig v. Estate of O'Hara, 912 A.2d 318, 327 n.13 (Pa. Super. Ct. 2006) (citing Roncace v. Welsh, 14 A.2d 616, 617 (Pa. Super. Ct. 1940)). However, the owner of land generally has the right to possess the land and a right to exclude others. *See* Babb v. Lee Cnty. Landfill SC, LLC, 747 S.E.2d 468, 473 (S.C. 2013) (explaining that a trespass is "any interference with 'one's right to the exclusive, peaceable possession of his property'") (quoting Ravan v. Greenville Cnty., 434 S.E.2d 296, 306 (S.C. Ct. App. 1993)); Johnson v. Paynesville Farmers Union Coop. Oil Co., 817 N.W.2d 693, 701 (Minn. 2012). When land is leased, the lessee might be the proper party (rather than the owner) to bring a trespass action. *See* Bascom v. Dempsey, N.E. 744, 744–45 (Mass. 1887) (lessor who was not in possession could not maintain a valid trespass action). Further, if someone other than the landowner has wrongfully established possession, the landowner may not have a trespass claim, though the landowner may have the right to bring an ejectment action that would force the possessor to leave. KEETON, LAW OF TORTS § 13, at 77. If the owner does not possess the land, but no one else has established possession, the landowner likely has constructive possession and therefore could bring an action in trespass against an intruder. *See id.*

onto the land or causing an object to do so.[86] The Restatement (Second) Torts § 158 states a general rule that a person is liable to another for trespass if he intentionally "enters land in the possession of the other, or causes a thing . . . to do so," without regard to "whether he thereby causes harm."[87]

When there has been a trespass, a landowner typically can obtain a money judgment to compensate for any actual damages that the trespasser has caused.[88] If the trespasser did not cause damage, the landowner may be able to obtain an award of nominal damages to vindicate his or her right of exclusive possession.[89] If the trespass does not harm the land, but the trespass is continuing, the landowner may be entitled to a damages award measured by the fair rental value for the trespasser's use of the property (or the diminution in value of the property if the trespass is permanent).[90] Further, if a trespass is continuing or repeated, the landowner may be entitled to injunctive relief to require the cessation of an ongoing trespass or to enjoin a repetition of the trespass.[91] However, the award of injunctive relief is

86. *See* RESTATEMENT (SECOND) OF TORTS § 158 (AM. L. INST. 1965) (stating that a person is liable for trespass, "irrespective of whether he thereby causes harm to any legally protected interest of the other, if he intentionally . . . enters land in the possession of the other, or causes a thing or a third person to do so . . . ."). The comments to the Restatement indicate that it is the possessor of the land who can bring a trespass action. *Id.* at cmt. c. Being in possession of land requires occupancy of it. RESTATEMENT (SECOND) OF TORTS § 157 (AM. L. INST. 1965). This means that there is a manifest claim "of exclusive control over the land." *Id.* at cmt. a. As an example, the comments to the Restatement further note that a person's construction of an enclosure around land generally qualifies as occupancy of the entire area enclosed. *Id.*

87. *See* RESTATEMENT (SECOND) OF TORTS § 158 (AM. L. INST. 1965); *see also* Team Enters., LLC v. W. Inv. Real Est. Tr., 647 F.3d 901, 912 (9th Cir. 2011) (under California law, a trespass is "'an invasion of the interest in the exclusive possession of land,'"); Minch Fam. LLLP v. Buffalo-Red River Watershed Dist., 628 F.3d 960, 968 (8th Cir. 2010) (Minnesota law); KEETON ET AL., *supra* note 85.

88. *See, e.g.*, Smith v. Carbide & Chems. Corp., 226 S.W.3d 52, 56–57 (Ky. 2007) (holding that an intentional trespass qualifies as a harm sufficient for a plaintiff to obtain actual damages); Whitten v. Cox, 799 So. 2d 1, 18 (Miss. 2000) (acknowledging that a trespass alone qualifies as a harm sufficient to obtain at least nominal damages but that "'in order to recover more than nominal damages, actual damages must be shown.'") (quoting Chevron Oil Co. v. Snellgrove, 175 So. 2d 471, 474 (Miss. 1965)).

89. *See* Whitten, 799 So. 2d at 18; *see also* Coastal Oil & Gas Corp. v. Garza Energy Tr., 268 S.W.3d 1, 12 n.36 (Tex. 2008) (noting that a "trespass against a possessory interest . . . may result in an award of nominal damages") (citing McDaniel Bros. v. Wilson, 70 S.W.2d 618, 621 (Tex. Civ. App. 1934)).

90. *See, e.g.*, Devenish v. Phillips, 743 So. 2d 492, 494 (Ala. Civ. App. 1999); Krejci v. Capriotti, 305 N.E.2d 667, 669–70 (Ill. App. Ct. 1973); *In re* Minnwest Bank Litig. Concerning Real Prop., 873 N.W.2d 139, 147 (Minn. Ct. App. 2015).

91. *See* Gilbert Wheeler, Inc. v. Enbridge Pipelines (E. Tex.), L.P., 449 S.W.3d 474, 478 n.1 (Tex. 2014) (citing R.R. Comm'n of Tex. v. Manziel, 361 S.W.2d 560, 567 n.2 (Tex. 1962)); City of Providence v. Doe, 21 A.3d 315, 319–20 (R.I. 2011) (explaining that the standard for injunctive relief "when the underlying harm derives from an incident of continuing trespass is well established and provides that '[a] continuing trespass wrongfully interferes with the legal rights of the owner, and in the usual case those rights cannot be

discretionary, and a court may decline to award injunctive relief if such relief would be adverse to the public interest.[92]

B. The *ad coelum* doctrine and the extent of a landowner's ownership

The "*ad coelum* doctrine" is a common law principle which provides that a person who owns land owns the airspace above it to an indefinite height and the subsurface below it, all the way to the center of the earth.[93] This doctrine's name comes from a Latin phrase, "*cujus est solum ejus est usque ad coelum et ad inferos*," that has been used by Blackstone and others to express the doctrine.[94] One particularly colorful translation of this phrase is, "for whoever owns the soil, it is theirs up to Heaven and down to Hell."[95] Both courts and commentators tout this common law doctrine.[96] Further, Louisiana—a civil law jurisdiction—generally follows the same rule.[97] Louisiana Civil Code article 490 states in part that "the ownership of a tract of land carries with it the ownership of everything that is directly above or below it."[98]

C. Combining trespass and the *ad coelum* doctrine

Numerous courts have relied on the *ad coelum* doctrine in holding that a defendant incurred trespass liability for an unauthorized intrusion of the airspace above or the subsurface below a plaintiff's land.[99] For example,

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adequately protected except by an injunction which will eliminate the trespass.'") (quoting Santilli v. Morelli, 230 A.2d 860, 863 (R.I. 1967)); Hobbs v. Mobile Cnty., 72 So. 3d 12, 18 (Ala. 2011) (citing Town of York v. McAlpin, 167 So. 539, 539–40 (Ala. 1936)); S.L. Garand Co. v. Everlasting Memorial Works, Inc., 264 A.2d 776, 778 (Vt. 1970); Allred v. Harris, 18 Cal. Rptr. 2d 530, 533 (Cal. Ct. App. 1993).

92. *See* Madison v. Ducktown Sulphur, Copper & Iron Co., 83 S.W. 658, 666–67 (Tenn. 1904) (awarding damages but denying injunctive relief, in part because of the public interest in allowing a continuance of the challenged activities).

93. Thrasher v. City of Atlanta, 173 S.E. 817, 825 (Ga. 1934).

94. 2 WILLIAM BLACKSTONE, COMMENTARIES.

95. *See* Prah v. Maretti, 321 N.W.2d 182, 188 (Wis. 1982) (citing United States v. Causby, 328 U.S. 256, 260–61 (1946)) (translating the maxim to mean that "the owner of land owns up to the sky and down to the center of the earth," but noting that "[t]he rights of the surface owner are, however, not unlimited.").

96. *See Prah*, 321 N.W.2d at 188; *see also, e.g.*, RESTATEMENT (SECOND) OF TORTS § 159 (AM. L. INST. 1995); KEETON ET AL., *supra* note 85, at 78–80 (outlining the four different approaches that courts have taken when evaluating the vertical extent of possession).

97. *See* Nunez v. Wainoco Oil & Gas Co., 488 So. 2d 955, 962 (La. 1986) (acknowledging the general rule and noting its statutory modifications).

98. LA. CIV. CODE ANN. art. 490 (1979).

99. *See* Hannabalson v. Sessions, 90 N.W. 93, 95 (Iowa 1902) (intrusion into airspace was a trespass); Hastings Oil Co. v. Texas Co., 234 S.W.2d 389, 398 (Tex. 1950) (intrusion into subsurface was a trespass); *see also* RESTATEMENT (SECOND) OF TORTS § 159 (AM. L. INST. 1965) (a trespass may occur "on, beneath, or above the surface of the earth.").

courts have held that a plaintiff has a cause of action for airspace intrusions by portions of a defendant's building, such as eaves,[100] cornices,[101] and roofs,[102] that extended over the property line and above a plaintiff's land. At least one court has held that wires passing over a plaintiff's property constituted a trespass,[103] and one court even held that a defendant committed a trespass when she extended her arm over the property line.[104]

Courts have also held that a company commits a subsurface trespass if it drills a slant well that bottoms below the plaintiff's land without authority to do so.[105] Courts have held that a person who enters a cave opening on his property, then walks through a portion of the cave that is beneath his neighbor's property commits a trespass.[106] Some courts have imposed trespass liability based on a subsurface migration of contaminants.[107] And one court concluded that the intrusion of hydraulic fracturing fluid into the subsurface of the plaintiffs' tract would constitute a trespass.[108] Similarly, the Restatement (Second) of Torts recognizes that a trespass can occur above or below the surface.[109]

D. Issues raised by the application of these principles to CCS

When a CCS operator injects CO_2 into a subsurface formation, a plume of CO_2 will migrate away from the injection point.[110] If the injection of CO_2 goes on for a long enough period of time, some will migrate into the subsurface of neighboring properties.[111] Unless the CCS operator has obtained rights to use the subsurface of the neighboring properties, a court could conclude that the migration of CO_2 across property lines constituted a

100. *See* Huber v. Stark, 102 N.W. 12, 12 (Wis. 1905) (intrusion of eaves over plaintiff's property is an actionable trespass); *see also* Butler v. Frontier Telephone Co., 79 N.E. 716, 717 (N.Y. 1906) (noting decisions that support imposing trespass liability for intrusion of eaves over property).

101. *See* Harrington v. McCarthy, 48 N.E. 278, 278 (Mass. 1897).

102. *See* Murphy v. Bolger, 15 A. 365, 368 (Vt. 1888).

103. *See Butler*, 79 N.E. at 718; *see also* Marcus Cable Assocs., L.P. v. Krohn, 90 S.W.3d 697, 703 (Tex. 2002) (unauthorized intrusion of wires over landowner's property was a trespass).

104. *See Hannabalson*, 90 N.W. at 95.

105. *See* Hastings Oil Co. v. Texas Co., 234 S.W.2d 389, 398 (Tex. 1950); Gliptis v. Fifteen Oil Co., 16 So. 2d 471, 474 (La. 1944); Alphonzo E. Bell Corp. v. Bell View Oil Syndicate, 76 P.2d 167, 177−78 (Cal. Dist. Ct. App. 1938).

106. *See, e.g.*, Edwards v. Sims, 24 S.W.2d 619, 620−21 (Ky. 1929); *see also* Edwards v. Lee's Adm'r, 96 S.W.2d 1028, 1029−30 (Ky. 1936) (affirming a finding of trespass).

107. *See* Beck v. N. Nat. Gas Co., 170 F.3d 1018, 1022 (10th Cir. 1999); Hoery v. United States, 64 P.3d 214, 216 (Colo. 2003).

108. *See* Stone v. Chesapeake Appalachia, LLC, 2013 WL 2097397 (N.D. W. Va.).

109. RESTATEMENT (SECOND) OF TORTS § 158 (AM. L. INST. 1965).

110. Quanlin Zhou et al., Modeling Basin- and Plume-Scale Processes of CO2 Storage for Full-Scale Deployment 10 (2009).

111. *See* Jeffrey W. Moore, *The Potential Law of On-shore Geologic Sequestration of CO2 Captured from Coal-Fired Power Plants*, 28 ENERGY L.J. 443, 454 (2007); *see also* Intergovernmental Panel on Climate Change, *supra* note 1, at 206.

subsurface trespass.[112] Further, because the intent of a CCS operator would be to leave the carbon dioxide in place permanently, a neighbor could argue that the intrusion of CO_2 into the subsurface of his or her land constituted a *continuing trespass*.[113] The neighbor could make a plausible argument for an injunction requiring the CCS operator to cease any further injections.[114] And, if there is a trespass, issues will arise as to the remedies available for such trespasses.[115]

The next section of this article examines why the migration of CO_2 from a CCS operation might support trespass claims, and the section after that examines why such migration might not support trespass claims.

III. WHY NEIGHBORING LANDOWNERS MIGHT NOT HAVE A TRESPASS CLAIM FOR SUBSURFACE MIGRATION OF CO_2, AND WHY THEY THUS MIGHT NOT BE ABLE TO ENJOIN CCS OPERATIONS OR OBTAIN COMPENSATION

Although several courts have held that a defendant incurred trespass liability intruding or causing an intrusion into the subsurface beneath or airspace above a plaintiff's land, numerous courts have held—perhaps in factually distinguishable situations—that a defendant was not liable in trespass for a subsurface or airspace intrusion he or she caused. The courts that have found no liability for such intrusions often have used one or the other (or both) of two explanations for finding no liability in trespass. First, they have explained that public policy favored a rule that there should be no trespass liability for the type of intrusion at issue. Second, they have stated that a landowner's interest in excluding becomes attenuated for locations far below the surface or high above it, that the landowner could not reasonably expect to use and where the defendant's activities would not disturb the plaintiff's use and enjoyment of his or her land. These lines of authority are discussed below—first, the cases holding that there was no liability for an

112. *See* Peter S. Glaser et al., *Global Warming Solutions: Regulatory Challenges and Common Law Liabilities Associated with the Geologic Sequestration of Carbon Dioxide*, 6 GEO. J.L. & PUB. POL'Y 429, 439−42 (2008); *see also* Moore, *supra* note 111, at 478 (discussing the potential for trespass actions arising out of subsurface migration).

113. *See U.S. Dep't of Energy*, *Carbon Storage FAQs*, NAT'L ENERGY TECH. LAB'Y, https://netl.doe.gov/carbon-management/carbon-storage/faqs/carbon-storage-faqs [https://perma.cc/5TRG-LMAF] (last visited Nov. 24, 2022) (indicating that geologic storage entails permanent storage in the subsurface); *see also* Allan Ingelson et. al, *Long-Term Liability for Carbon Capture and Storage in Depleted North American Oil and Gas Reservoirs: A Comparative Analysis*, 31 ENERGY L.J. 431, 438−41 (2010) (acknowledging the concept of continuing trespass to land in the context of gas injections in the subsurface).

114. *See* Young v. Ethyl Corp., 521 F.2d 771, 775 (8th Cir. 1975) (holding that plaintiff seeking an injunction prohibiting defendant from injection in surrounding properties properly stated a cause of action for trespass).

115. *See* Glaser et al., *supra* note 112, at 442 (noting the obstacles to recovery and proving damages in trespass actions predicated on subsurface carbon dioxide invasions).

airspace intrusion, and second, the cases holding that there was no liability for a subsurface intrusion.

A. The main example of an activity that causes airspace intrusions, but which does not trigger trespass liability is high altitude air travel.

Notwithstanding the *ad ceoleum* doctrine, a landowner generally has no cause of action in trespass against persons who engage in high-altitude air travel over his or her land.[116] In *Thrasher v. City of Atlanta*, the plaintiff sued, asserting that the defendant committed a trespass by flying an aircraft over the plaintiff's land.[117] In this case, the Georgia Supreme Court noted that the state's Civil Code contained a provision declaring that "the right of the owner of lands extends downward and upward indefinitely."[118] Further, the Georgia Civil Code expressly stated that "an unlawful interference with his rights, below or above the surface, alike gives him a right of action."[119] The Georgia Supreme Court acknowledged the importance of air travel,[120] implying that this might provide a public policy rationale for denying trespass liability, but the Court declined to base its decision on such a rationale. Instead, the Court relied on a property rights analysis to resolve the case against the plaintiff.[121]

The Court concluded that the relevant provisions of the Georgia Civil Code were based on the common law's *ad coelum* doctrine. Accordingly, those provisions of the Civil Code should be understood as incorporating any limitations that the common law would impose on the *ad* coelum doctrine.[122] The Court concluded that, as applied to high altitude air travel, the *ad coelum* doctrine is dicta.[123] The Court stated: "[t]he common-law cases from which the ad coelum doctrine emanated were limited to facts and conditions close to earth and did not require an adjudication on the title to the mansions in the sky."[124] Therefore, the doctrine was dicta with respect to higher altitudes.[125]

The Georgia Supreme Court then explained that "[p]ossession is the basis of all ownership."[126] Given this basis, title to land should not "extend above an altitude representing the reasonable possibility of man's occupation and domain."[127] Under this reasoning, a landowner can claim possession to

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116. *See, e.g.*, Atkinson v. Bernard, Inc., 355 P.2d 229, 233 (Or. 1960); Thrasher v. City of Atlanta, 173 S.E. 817, 818 (Ga. 1934).

117. *Thrasher*, 173 S.E. at 818.

118. *Id.* at 825 (citing GA. CIV. CODE § 3617 (1910)).

119. *Id.* (citing GA. CIV. CODE § 4477 (1910)).

120. *Id.* at 819.

121. *Id.* at 825–26.

122. *Id.* at 825 ("These provisions of the Code should therefore be construed in the light of the authoritative content of the maxim itself.").

123. *Id.*

124. *Id.*

125. *See id.*

126. *Id.*

127. *Id.*

the height of any building, and to the space immediately above the "trees, buildings, and structures affixed to the soil."[128] Moreover, if a neighbor constructs a taller building with an overhang projecting over the landowner's property, that construction would demonstrate that the elevation where the intrusion occurs is subject to actual possession, and therefore the landowner could base a trespass action on the overhang.[129]

The Court reasoned that the act of flying an airplane over land at high altitude is not an act of possession of the land.[130] Therefore, air travel at high altitudes would not constitute an actionable trespass,[131] though air travel at low altitude across a person's property might constitute a trespass,[132] and the operation of aircraft at high altitudes might constitute a nuisance if it actually interferes with a landowner's use and enjoyment of the land.[133]

Other cases have reached similar results when landowners have sued based on aircraft flying over their property, concluding that the *ad coelum* doctrine is dicta to the extent that it suggests possession and title to land equally at high altitudes as they do nearer the surface.[134] For this reason, although landowners may be entitled to relief in trespass for low-altitude flights, and perhaps even for high altitude flights in the unlikely event that they cause actual harm or unreasonable inconvenience, the *ad coelum* doctrine does not entitle landowners to relief for high altitude flyovers that do not cause harm or unreasonable inconvenience.[135]

Another leading case is *United States v. Causby*, a 1946 decision of the United States Supreme Court.[136] In *Causby*, the plaintiff owned and lived on land near an airfield. He sued, arguing that low-level flights had effected a "taking" of his property that entitled him to compensation.[137] The Court determined that, under the facts shown, the plaintiff could assert a takings

128. *Id.* at 826.
129. *Id.* at 825.
130. *Id.* at 825−26.
131. *See id.* at 826.
132. *Id.* at 826.
133. *Id.* at 825 (a landowner "may complain of any [flights] tending to diminish the free enjoyment of the soil," even if the air travel is at an altitude above the height that is subject to possession); *id.* at 826 (landowner might have a claim based on nuisance if the air travel causes harm or inconvenience).
134. *See, e.g.*, Smith v. New England Aircraft Co., 170 N.E. 385, 393 (Mass. 1930) (noting altitude of "possible effective possession" as potential limit on trespass claims); Swetland v. Curtiss Airports Corp., 41 F.2d 929, 936 (N.D. Ohio 1930) (stating that cases suggesting title to land extended to indefinite heights did not involve disputes over the high altitudes generally used in air travel); Rochester Gas & Elec. Corp. v. Dunlop, 266 N.Y.S. 469, 471 (N.Y. Cnty. Ct. 1933) ("[I]t may be confidently stated that, if [the *ad coelum*] maxim ever meant that the owner of land owned the space above the land to an indefinite height, it is no longer the law," with the court's use of "if" suggesting that the *ad coelum* doctrine might never actually have been the law).
135. *See Smith*, 170 N.E. at 391−93 (finding no trespass at high altitudes, but that flights at low altitudes did constitute a trespass).
136. United States v. Causby, 328 U.S. 256, 256 (1946).
137. *Id.* at 256−58.

claim because the low level overflights seriously impaired the plaintiff's use and enjoyment of his property,[138] which extends upward from the surface to include "at least as much of the space above the ground as he can occupy or use in connection with the land."[139] In contrast, the Court suggested that a landowner probably would not have a cause of action if aircraft fly over his property at high altitudes.[140] The Court suggested that the *ad coelum* doctrine is dicta to the extent it would appear to apply at high altitudes. The court stated that the "doctrine has no place in the modern world," and the "public interest" requires that high altitudes be a "public highway."[141]

Both the First and Second Restatements of Torts have recognized that the high-altitude flights of aircraft over property generally are not a basis for trespass liability.[142] For example, although Section 159 of the Restatement (First) Torts states that a trespass "may be committed . . . above the surface of the earth," Section 194 contains an exception for air travel, provided that the air travel is done in a reasonable manner, in conformity with the law, and in a manner that does not substantially interfere with the landowner's use and enjoyment of the land.[143] The Restatement (Second) Torts also recognizes that airspace and subsurface intrusions can be the basis for trespass liability, but that high-altitude travel generally will not.[144]

138. *Id.* at 265−67.

139. *Id.* at 264.

140. *See id.* at 261.

141. *See id.*; *See also id.* at 266 ("The airspace, apart from the immediate reaches above the land, is part of the public domain."). The Ohio Supreme Court supported its holding that a zoning law that limited the heights of buildings near an airport did not support a takings claim by reasoning that the ad coelum doctrine does not apply literally. *See* Vill. of Willoughby Hills v. Corrigan, 278 N.E.2d 658, 664 (Ohio 1972) ("It is now well settled that the doctrine of the common law, that the ownership of land extends to the periphery of the universe, has no place in the modern world."). Such reasoning goes beyond the reasoning that a landowner's ownership does not extend beyond the height he can reasonably possess.

142. *See* RESTATEMENT (FIRST) OF TORTS § 194 (AM. L. INST. 1934); RESTATEMENT (SECOND) OF TORTS § 159 (AM. L. INST. 1965).

143. *Compare* RESTATEMENT (FIRST) OF TORTS § 194 (AM. L. INST. 1934), *with* RESTATEMENT (SECOND) OF TORTS § 159 (AM. L. INST. 1965) (listing an exception to the general rule detailing the scenarios in which flight does not constitute a trespass).

144. RESTATEMENT (SECOND) OF TORTS § 159 (AM. L. INST. 1965). §159(1) states that subsurface intrusions can constitute a trespass while §159(2) states flight intrusions only constitute a trespass if it "enters into the immediate reaches of the air space next to the land" and "interferes substantially with the other's use and enjoyment of his land."

B. The most notable example of an activity that causes subsurface intrusions, but which seldom triggers trespass liability, is injection disposal.

Underground injection has been a common method to dispose of liquid wastes as since about the 1930s.[145] During that time period, it became common to dispose of brine generated during oil and gas activity in this way. By the 1950s, underground injection had also become a common method to dispose of other types of fluid wastes.[146] In injection disposal, an operator pumps liquid waste into and down an injection well, from which the waste exits into a subsurface formation.[147] This is essentially the opposite of what occurs during the production of oil and gas.[148] The subsurface formations used for injection disposal are porous and permeable.[149] Because the formations are porous and permeable, the liquid waste pumped into the formations will migrate through the formation, with the liquid that is exiting the well pushing other liquid already in the formation further away from the well.[150] After enough waste liquid has been injected into the formation, this process will result in waste fluid migrating across the subsurface projection of property lines.[151]

In some cases, landowners have sued the operators of injection disposal wells, alleging that injection disposal operations caused a subsurface trespass of waste fluids.[152] In most of these cases, courts have held that a plaintiff does not have a remedy in trespass merely because fluids migrated into the subsurface of his or her property.[153] Instead, a plaintiff will not have a viable action for subsurface trespass in such cases unless the plaintiff can show actual damages or an interference with some reasonably anticipated use of his or her property.[154]

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145. *See General Information About Injection Wells,* ENV'T PROT. AGENCY, https://www.epa.gov/uic/general-information-about-injection-wells [https://perma.cc/2S3F-MXEU] (last updated Aug. 2, 2022).

146. *Id.*

147. *Id.*

148. *Compare Class II Oil and Gas Related Injection Wells, Env't Prot. Agency*, https://www.epa.gov/uic/class-ii-oil-and-gas-related-injection-wells [https://perma.cc/2ZVS-RVYX] (last updated Aug. 2, 2022) (discussing production process from oil wells via hydraulic fracking) *with* Env't Prot. Agency, EPA 816-R-01-007, CLASS I UNDERGROUND INJECTION CONTROL PROGRAM: STUDY OF THE RISKS ASSOCIATED WITH CLASS I UNDERGROUND INJECTION WELLS (2001) [hereinafter EPA CLASS I WELL STUDY] (detailing the injection disposal process).

149. EPA CLASS I WELL STUDY, *supra* note 148.

150. *Id.*

151. *Id.* at 13.

152. *See, e.g.*, West Edmond Salt Water Disposal Ass'n v. Rosecrans, 226 P.2d 965 (Okla. 1950) (in which a class action was filed for subsurface salt water intrusions); Baker v. Chevron USA, Inc., 2009 WL 3698419 (S.D. Ohio 2009) (in which a class action was filed against Chevron for subsurface petroleum intrusions).

153. *Baker*, 2009 WL 3698419 at *7.

154. *Rosencrans*, 226 P.2d at 968.

A leading case is *Chance v. BP Chemicals, Inc.*, in which plaintiffs sued, asserting that the defendant had committed subsurface trespass claims because the defendant's injection disposal operation allegedly caused waste fluids to migrate into the subsurface of the plaintiffs' properties.[155] The jury found that the plaintiffs had failed to prove actual damages or an unreasonable interference with a foreseeable use of their properties, and based on this, the trial court entered judgment for the defendant.[156] The plaintiffs appealed, but the appellate court affirmed. The Ohio Supreme Court then agreed to review the case.[157]

The plaintiffs argued that proof of a subsurface intrusion should be sufficient for them to prevail in their trespass action because proof of actual damages generally is not required when a plaintiff sues for trespass.[158] But the Ohio Supreme Court rejected that argument, stating that the *ad coelum* doctrine "has no place in the modern world," and citing both a prior Ohio Supreme Court case and a United Supreme Court case, *Causby*.[159] The Court also quoted from a case in which the Ninth Circuit declared that a person's ownership of the airspace extends above his land only as far as the space he can use and occupy.[160] The Ohio Supreme Court agreed with this statement and concluded that similar reasoning applies for the subsurface.[161] Therefore, for a plaintiff to recover in trespass based on a fluid's subsurface intrusion deep beneath the subsurface, plaintiffs must prove "physical damage or actual interference with the reasonable and foreseeable use of the properties."[162] The plaintiffs in *Chance* had not proven damages or interference with a foreseeable use of the property. Therefore, the Ohio Supreme Court affirmed the judgment against them.[163]

Similar injection disposal cases have been filed in other jurisdictions, and in most of the cases the result has been the same—the courts have found no trespass liability.[164] Some courts have reached similar results in different factual circumstances.[165] For example, in *Baatz v. Columbia Gas Transmission*, the United States Court of Appeals for the Sixth Circuit relied on *Chance v. BP Chemicals* in making an *Erie*-guess that, under Ohio law, a natural gas company would not have liability for the subsurface migration of

155. Chance v. BP Chems., Inc., 670 N.E.2d 985, 986 (Ohio 1996).

156. *Id.* at 989.

157. *Id.* at 990.

158. *Id.* at 993.

159. *Id.* at 991 (citing Vill. of Willoughby Hills v. Corrigan 278 N.E.2d 658, 664 (1972)).

160. *Id.* at 991–92.

161. *Id.* at 992 (also observing that "ownership rights in today's world are not so clear-cut as they were before the advent of airplanes and injection wells").

162. *Id.* at 993.

163. *Id.* at 994.

164. *See generally* Berkley v. R.R. Comm'n of Tex., 282 S.W.3d 240 (Tex. App. 2009) (holding that an injection permit for salt water disposal would not interfere with the use of adjoining property owner's land).

165. *Id.* at 243.

natural gas from an underground storage facility.[166] In *Boehringer v. Montalto*, a New York court denied the trespass claims of a plaintiff who complained that a sewer line installed 150 feet below the surface would run beneath his land.[167] The court stated that "the title of an owner of the soil will not be extended to a depth below ground beyond which the owner may not reasonably make use thereof," and that the sewer was located below the deepest depth that the defendant "can conceivably make use of the property."[168]

In addition to these court decisions, there have been other suggestions that there should not be trespass liability for the subsurface migration of fluids, at least absent actual harm.[169] For example, in *Coastal Oil & Gas Corp. v. Garza Energy Trust*, a Texas Supreme Court justice asserted in a concurring opinion that public policy supported a rule of non-liability for the subsurface intrusion of hydraulic fracturing fluid when drainage of hydrocarbons is the only alleged harm.[170] The majority opinion itself stated that the law of trespass need not be the same two miles below ground as at the surface,[171] though the opinion ultimately denied the plaintiffs' trespass claim on other grounds.[172] Further, a prominent oil and gas scholar has argued that, for public policy reasons, there should not be any trespass liability for the subsurface migration of fluids injected for hydraulic fracturing or injection disposal.[173]

IV. WHAT RULE SHOULD COURTS REACH?

As noted in prior sections of this Article, courts have held that defendants were liable in trespass for some types of airspace and subsurface intrusions, but they have held that there is no liability for other types of

166. Baatz v. Columbia Gas Transmission, LLC, 929 F.3d 767, 773 (6th Cir. 2019).

167. Boehringer v. Monalto, 254 N.Y.S. 276, 277 (N.Y. Sup. Ct. 1931).

168. *Id.* at 278.

169. *See, e.g.*, Coastal Oil & Gas Corp. v. Garza Energy Trust, 268 S.W.3d 1, 12–13 (Tex. 2008).

170. *Id.* at 35 (Willett, J., concurring).

171. *Id.* at 11.

172. *Id.* at 12–13 (holding the claim of trespass precluded by the rule of capture).

173. Owen L. Anderson, *Subsurface "Trespass": A Man's Subsurface is Not His Castle*, 49 WASHBURN L. REV. 247 (2010) ("Whenever [a] [] subsurface intrusion accomplishes an important societal need, . . . and so long as the subsurface owner suffers no actual and substantial damages, subsurface trespass should not be actionable."). The author of this Article agrees with Professor Anderson's premise that CCS is important and socially useful, and that landowners should not be able to obtain injunctive relief to bar a subsurface intrusion of CO2. The author also agrees that, if it was necessary to preclude landowners' right to compensation in order to make CCS practical, it would be good public policy to bar such a claim. It likely was a reasonable premise at the time Professor Anderson wrote his article that CCS would not be viable if operators had to pay for the use of pore spaces, but the emerging trends—perhaps pushed along with new, generous tax credits for CCS—now suggest that a rule recognizing landowners' right to compensation would not make CCS impractical.

airspace or subsurface intrusion.[174] This section of the Article analyzes what result courts should reach if a CCS project causes a subsurface intrusion of CO_2 that does not cause any harm. This Article does so by considering two things. First, what result is favored by public policy, and second, are there sound bases to distinguish the cases that would support a different result than is favored by public policy.[175]

A. What result is favored by public policy?

With respect to public policy, this section of the article makes two assumptions. First, CCS is one tool for limiting the amount of climate change,[176] and public policy favors taking steps to limit climate change.[177] Second, public policy favors the protection of property rights,[178] and one way of protecting private property, when there is a question regarding the scope of a property interest, is to lean toward broader protection.

1. What results are suggested by the fact that public policy favors the use of CCS?

Because CCS is favored by public policy, public policy also favors an interpretation of trespass law that will not stand in the way of CCS projects.[179]

a. A neighboring landowner generally should not be entitled to injunctive relief.

As noted in a prior section, injunctive relief sometimes is available to enjoin a continuing or repeated trespass.[180] Given that the CO_2 injected during a CCS operation presumably will remain in place for a very long time—essentially, permanently—a migration of that CO_2 that is a trespass will be a continuing trespass. This leads to a question: should a neighboring landowner be able to obtain an injunction to halt a CCS operation that would cause carbon dioxide to migrate into the subsurface of his or her land?

The answer generally should be "no." As a general rule, the mere fact that a party can maintain a cause of action does not mean that the party

174. *See* discussion *supra* Section III.

175. *See* discussion *infra* Section IV.A, IV.B.

176. *See* discussion *supra* Section I.E.

177. It is widely accepted that society should take action to limit the effect of climate change. A defense of this proposition is beyond the scope of this article.

178. U.S. CONST. amend. V. This policy is reflected in the takings clause, which states "nor shall private property be taken for public use, without just compensation." Most state constitutions have similar provisions. *See, e.g.*, LA. CONST. ANN. art. I, § 4 (West, Westlaw through Jan. 2023 amendments).

179. *See* discussion *supra* Section I.E.

180. *See* discussion *supra* Section II.

has a right to injunctive relief.[181] The grant of injunctive relief is discretionary with the courts, and one of the factors that a court may consider in deciding whether to grant injunctive relief is the public interest.[182] If landowners could obtain injunctive relief in order to enjoin CCS operations, a single holdout landowner who refuses to consent could entirely stop a CCS project. Given the strong public interest in the use of carbon capture as a tool to address climate change, injunctive relief generally should not be available to enjoin the operation of a CCS facility that has obtained the proper permits from regulators.[183]

As noted, state legislators can enact legislation to ensure this result—that is, that CCS operators can use the subsurface pore spaces beneath neighboring land—and some state legislatures have, but in the absence of such legislation, courts should hold that injunctive relief is not available.[184] There may be one exception to this rule for situations in which the granting of injunctive relief might encourage the development of a CCS project. Suppose, for example, that a prospective CCS operator enters into voluntary transactions with landowners to pay for the use of pore space rights and to have the *exclusive* use of the pore spaces. A prospective CCS operator's ability to acquire exclusive use of the pore spaces will provide more certainty for investors in such a project and thus would help the development of the project. Suppose, though, that there is a holdout landowner who refuses to consent to granting pore space rights to the prospective CCS Operator No. 1. Later, after prospective Operator No. 1 has acquired by contract an exclusive right to use most of the pore spaces in the area, the holdout landowner grants

181. *See, e.g.*, Weatherspoon v. Dinsa, No. CV 14-12756, 2017 WL 9475924, at *1 (E.D. Mich. Mar. 1, 2017) ("[P]laintiffs . . . must affirmatively demonstrate their entitlement to injunctive relief.").

182. PGBA, LLC v. United States, 389 F.3d 1219, 1228–29 (Fed. Cir. 2004) ("In deciding whether a permanent injunction should issue, a court considers: . . . (4) whether it is in the public interest to grant injunctive relief.").

183. The footnoted sentence uses the word "generally" to note that there may be emergency situations in which injunctive relief is appropriate, but those should be exceedingly rare. *See, e.g.*, Williams v. S. & S. Rentals, Inc., 346 S.E.2d 665, 669 (N.C. Ct. App. 1986). A party with an interest should be able to appeal the administrative action granting permits to a CCS operator, but otherwise courts should not entertain collateral attacks that attempt to second guess the decision of an agency's action authorizing a CCS project or second-guessing the particular conditions that the agency includes in the CCS operator's permits. Further, any allegations that a CCS operator is violating regulations or conditions in its permits generally should be addressed by the regulator, and in the absence of action by the regulator, perhaps in a citizen-suit action if such an action is available under applicable law.

184. Some state legislatures have done so. *See* Section 1.E of this Article. Those legislatures also provide for the CCS operator to pay compensation to the neighbors. Assuming that a subsurface intrusion of carbon dioxide would be a trespass in the absence of such legislation, compensation might be required in order for the statutes not to constitute an unconstitutional taking. *See* NAT'L CONF. OF STATE LEGISLATURES, CARBON CAPTURE AND SEQUESTRATION 2 (2017), https://www.wyoleg.gov/Interimcommittee/2017/09-0629appendixg-1.pdf [https://perma.cc/YBC3-GDG9].

pore space rights to a different company, prospective Operator No. 2. Perhaps in such situations a court should be willing to grant an injunction, precluding prospective Operator No. 2 from causing CO_2 to trespass into the pore spaces of tracts where Operator No. 1 has secured exclusive rights.

b. Absent actual harm to the plaintiff, public policy weighs against the existence of trespass liability *if* liability would significantly deter CCS projects. Otherwise, public policy favors liability.

When trespass liability exists, a plaintiff can recover for any actual damages. CCS operations generally should not cause any actual damages to the land. If they do, fairness dictates that the landowner be compensated, rather than have the landowner incur the costs of CCS operations that are designed to benefit society as a whole, but presumably those will be uncommon and will not preclude the development of CCS projects. In the absence of damages, a successful trespass plaintiff generally is entitled to nominal damages. Such damages would not stand in the way of the development of CCS projects.

However, for a continuing trespass, many jurisdictions allow damages to be measured by the fair rental value for the period of the trespass (or the diminution in value for a permanent trespass).[185] Because the intrusion of CO_2 caused by a CCS project would be a continuing trespass, and likely a permanent trespass, the measure of damages for the migration of CO_2 might be the market value of a permanent storage easement or a long-term subsurface rental, assuming that trespass liability exists.[186] Depending on how much this costs, such a measure of damages, in theory, could stand in the way of the development of CCS projects. In such a case, public policy would favor a rule of no trespass liability.

However, what if the value of such an easement or long-term rental would not be so high as to block the development of CCS projects? Because the existence of monetary liability for a trespass would cost something, a rule that recognized such liability would at least marginally dampen the incentive for developing CCS projects. If a CCS project can reasonably absorb such costs, then the public policy favoring the development of CCS projects would not strongly weigh against a rule that recognized trespass liability.[187]

Because the use of CCS is relatively new, there is limited available evidence regarding whether CCS operators reasonably could afford to pay the market value of pore space rights.[188] However, the available evidence so

185. *See, e.g.*, Korstan v. Poor Richards, Inc., 188 N.W.2d 415, 417 (Minn. 1971).

186. *See id.*

187. The qualifier "strongly" is used in the sentence above because the existence of monetary liability for a trespass would be a cost and thus it would at least marginally dampen the incentive for developing CCS projects.

188. Further, in some cases, the value of the pore space rights itself might not be well established, though values have been placed on subsurface pore space rights in the past when eminent domain has been used by companies acquiring use of the subsurface for natural gas

far is that CCS projects can absorb such costs.[189] Numerous CCS projects are in the planning stages in various states, and so far, the general practice is that the CCS operators are paying for or are planning to pay for pore space rights.[190] For example, the State of Louisiana recently entered four separate agreements that granted pore space leases to operators for different areas for CCS.[191] Similarly, the State of Texas granted a lease for pore space rights to a prospective CCS operator.[192] These agreements are readily available because the lessor is a governmental entity, and the author of this article has both firsthand knowledge of negotiations for prospective CCS operators to pay private landowners for the right to use pore spaces for CCS and second-hand knowledge of numerous completed agreements in which prospective CCS operators have paid for the use of pore spaces beneath private lands.[193]

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storage. *See* Jerry R. Fish & Eric L. Martin, *Approaches to Pore Space Rights*, CAL. CARBON CAPTURE AND STORAGE REV. PANEL 2 (Aug. 10, 2010), https://www.stoel.com/getmedia/c9694db5-a899-4bd9-95df-a79fbdd42673/Pore_Space_Rights-1-pdf.pdf [https://perma.cc/SP63-B57J].

189. *See* Amanda Battersby, *World's largest CCS project gets financial shot in the arm*, UPStream (Mar. 9, 2022, 3:50 PM), https://www.upstreamonline.com/energy-transition/world-s-largest-ccs-project-gets-financial-shot-in-the-arm/2-1-1178784 [https://perma.cc/2D76-NHCE].

190. *See generally Lapis Energy Acquires Key Pore Space Rights in the Baton Rouge Corridor*, CRESTA FUND MGMT. (May 9, 2022), https://www.crestafunds.com/lapis-energy-acquires-key-pore-space-rights-in-the-baton-rouge-corridor/ [https://perma.cc/99AD-VNs2] [hereinafter *Lapis Energy*].

191. The State granted the leases through its Mineral and Energy Board, which handles the leasing of State lands for energy projects. *See id.* The agreements are called "operating agreements," but they have the characteristics of leases. *See id.* The State's agreement with Air Products Blue Energy LLC can be found at http://www.dnr.louisiana.gov/assets/OMR/media/forms_pubs/CS01A.pdf [https://perma.cc/L5S7-STKY]. The State's agreement with Capio Sequestration LLC can be found at http://www.dnr.louisiana.gov/assets/OMR/media/forms_pubs/CS02A.pdf [https://perma.cc/F5EE-T8M9]. The State's agreement with Venture Global CCS Plaquemines LLC can be found at http://www.dnr.louisiana.gov/assets/OMR/media/forms_pubs/CS003.pdf [https://perma.cc/95BB-FCP3]. The State's agreement with Venture Global CCS Cameron LLC can be found at http://www.dnr.louisiana.gov/assets/OMR/media/forms_pubs/CS004.pdf [https://perma.cc/F2RB-PW2G].

192. Press Release, Tex. Gen. Land Off., Indus. Leaders Usher in New Era of Carbon Sequestration Near Jefferson Cnty. (Sept. 3, 2021), https://www.glo.texas.gov/the-glo/news/press-releases/2021/september/cmr-george-p-bush-announces-new-coastal-partnership-for-carbon-sequestration1.pdf [https://perma.cc/T7KW-XD65]. The lease covers a portion of the Gulf of Mexico that is within Texas waters. Texas granted the lease through its General Land Office (GLO). Although the GLO has not posted a copy of the lease online, the lease can be obtained through an on-line public records request to the GLO. The author has a copy in his files.

193. *See Lapis Energy, supra* note 190. Some of these may be publicly available because of being recorded, so that the lessee or grantee gets the benefit of a state's public records doctrine, but in other cases the lessee or grantee apparently has recorded only a memorandum of lease in those states that allow someone to obtain the benefit of the public records doctrine by recording a document that summarizes the basic terms of a lease or other agreement.

Paying for the right to use pore spaces makes sense for prospective CCS operators. Because there are few (if any) states in which it is clear that there would be no trespass liability for the migration of CO_2, and because CCS projects are expensive, it makes no sense to develop such a project unless the operator has taken steps to ensure that it will not be derailed for failure to acquire pore space rights. Further, as part of a transaction in which they pay for pore space rights, prospective CCS operators can bargain for a landowner's *exclusive* grant of the right to use pore space rights.

The fact that the prospective operators of CCS projects in various states are paying to acquire pore space rights indicates that those operators believe their projects will be profitable even after paying for pore space rights. Perhaps they will be proven wrong in the long run, but their conclusions that their CCS projects can afford to pay for pore space rights is the best evidence available. This evidence suggests that CCS projects and the public policy favoring them can co-exist with a rule recognizing that landowner can recover monetary compensation in trespass for an unauthorized subsurface intrusion of CO_2 from a CCS project. Assuming compensation is to be required, the public policy favoring CCS does not provide a guide as to the appropriate measure of compensation, so long as the compensation does not endanger the viability of CCS.

2. What result is suggested by the public policy favoring protection of property rights?

Public policy favors the recognition and protection of property rights.[194] The very existence of property law suggests this. Society benefits by the recognition of property rights because such rules help keep the peace, such rules incentivize productive behavior that can lead to the acquisition of property, and because the fact that a particular person owns property means that someone has an incentive to maintain the property.[195] Indeed, if protection of property rights was not important, there would be little need for elaborate rules regarding what constitutes property, who owns it, how property rights are transferred, and so forth.[196] Further, the importance of protecting property is reflected in the Takings Clause of the United States Constitution and similar provisions in state constitutions.[197]

Of course, determining the scope of a person's property interest is a different question than deciding whether society should protect those property rights. And determining whether the migration of CO_2 from a CCS

194. *See* ROGER PILAN, CATO HANDBOOK FOR POLICY MAKERS 173 (8th ed. 2017).

195. *See id.*

196. *See* Rocio Hansen, *Property Law: How it Affects You and Why You Should Learn It*, VANDERLAW (Jan. 8, 2022, 1:00 AM), https://www.vanderlaw.com/property-law-how-it-affects-you/#:~:text=Property%20laws%20are%20in%20place,there%20would%20be%20no%20consequences [http://perma.cc/2MKZ-7FCO].

197. U.S. CONST. amend. V.

project would trigger trespass liability could be characterized as a question regarding the scope of a person's property interests. On the other hand, a policy that favors protecting property rights probably favors a broader, rather than a narrower scope, of a landowner's property interests. Further, although the full-throated version of the *ad coelum* doctrine—that is, that a landowner owns the space beneath his or her land all the way to the center of the earth—is best viewed as dicta, it should not be taken lightly. Given that a rule of no trespass liability for CO_2 migration would run against both the *ad coelum* doctrine's dicta and would involve a narrow interpretation of property rights, the public policy that favors protection of property rights weighs against a rule of no trespass liability unless there is a compelling reason to adopt such a rule.

But there seems to be no compelling reason to avoid recognizing trespass liability for the migration of CO_2. Some reasons, in fact, support such a rule. First, applying trespass liability in this area is consistent with the *ad coelum* doctrine. Second, such a rule takes a broad view of the scope of landowner property rights and thus helps to protect property rights. Third, pore space rights are valuable and, in a given area, a subsurface formation will only be able to accommodate a finite amount of injected CO_2.[198] If a commodity is valuable and scarce, it makes sense to have someone own it, rather than have it open for the taking, first come, first served. By having an owner, someone will have an incentive to manage the pore spaces in an economically efficient way, perhaps helping avoid tragedy of the commons situations.[199] Further, if someone is to own the pore spaces, the most logical person to be the owner is probably the owner of the land above the pore spaces at issue.

Another factor that weighs in favor of recognizing the landowner's pore space rights is behavior. Custom is favored as a potential source of law. CCS projects are too new to describe the practices of prospective CCS projects as rising to the level of custom, but there is a nascent custom, norm, or prevailing practice of operators paying neighbors for the use of pore spaces.[200] Further, because the operators are paying for the use of pore spaces,

198. Intergovernmental Panel on Climate Change, *supra* note 1, at 220–21.

199. The "tragedy of the commons" refers to situations in which a finite resource or a renewable resource that can be damaged by overuse is not owned by anyone but is open to free use. *See generally* Garret Hardin, *The Tragedy of the Commons*, 162 SCIENCE 1243 (1968) (discussing limited finite resources). In such situations, each potential user of the resource may have relatively little incentive to moderate the rate of his or her use of the resource because he or she cannot control the actions of others and therefore he or she alone cannot prevent overuse. *See id.* Thus, he or she may have a significant incentive to engage in heavy use of the resource, to get his or her "share" of use before the resource is damaged by overuse. *See id.*

200. *See, e.g.*, Pam Boschee, *Pore Space Gains Value as CCS Picks Up Traction*, J. PETROLEUM TECH. (Sept. 1, 2022), https://jpt.spe.org/pore-space-gains-value-as-ccs-picks-up-traction [https://perma.cc/LL6L-LN4P].

they give landowners a stake in favoring CCS projects, rather than opposing these projects.

This leaves the question of the appropriate measure of compensation. The public policy that property rights be protected suggests that, if landowners cannot enjoin an intrusion of CO_2 from a CCS project, the appropriate measure of compensation is the fair market value of the pores spaces used. This is consistent with the compensation required in "takings" cases.[201]

Further, this measure of compensation is consistent with the general rule for the measure of damages for a continuing trespass.[202] As noted in Section II of this Article, existing authority supports a rule that the compensation owed for a continuing trespass is the rental value of the portion of the land used for the duration of the trespass, or, if the trespass is permanent, the diminished value of the land.[203] A CCS operation will cause a permanent emplacement of CO_2.[204] Thus, the trespass by CO_2 from CCS will be permanent. For this reason, existing authority suggests that the measure of compensation should be the diminished value of the property because of the CCS operation.[205] In most cases, the intrusion of CO_2 will not damage the property.[206] Thus, the only diminished value of the property will be the landowner's loss of the opportunity to sell (or lease) the subsurface rights to someone else.[207] Accordingly, the measure of compensation should be the fair market value for purchasing pore space rights.

3. Reasons why there is no compelling reason to reject trespass liability and the requirement that CCS operators pay for using pore spaces.

Given that public policy favors CCS, there would be a strong reason not to require CCS operators to pay for the use of pore space rights if such a

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201. *What Does Fair Market Value Mean in Determining Just Compensation?*, OWNERS' COUNS. OF AM., https://www.ownerscounsel.com/featured-article/what-does-fair-market-value-mean-in-determining-just-compensation [https://perma.cc/F3XR-L5WP]; U.S. CONST. amend. V.

202. *See, e.g.*, Korstan v. Poor Richards, Inc., 188 N.W.2d 415, 417 (Minn. 1971); RESTATEMENT (SECOND) OF TORTS § 158 cmt. m (AM. L. INST. 1965).

203. *See* discussion *supra* Section II; *see, e.g.*, *Korstan*, 188 N.W.2d at 417.

204. *See CCS Explained: The Basics*, GLOB. CCS INST., https://www.globalccsinstitute.com/resources/ccs-101-the-basics/ [https://perma.cc/CV5F-3WG8] (last visited Nov. 27, 2022).

205. *See, e.g.*, *Korstan*, 188 N.W.2d at 417; *see also* James M. Sabovich & Heather D. Hearne, *Diminished Property Value Claims in a Diminished Real Estate Market*, TOXICS L. REP. (2009), https://www.gibsondunn.com/wp-content/uploads/documents/publications/SabovichHearne-DiminishedPropertyValueClaims.pdf [https://perma.cc/7YGV-3TMN].

206. *See* Michael Faure, Liability and Compensation for Damage Resulting from CO2 Storage Sites, 40 WILLIAM & MARY ENV'T L. AND POL'Y REV. 387, 400–01 (2016) (discussing minimal damage of CO2 sequestration).

207. *See* Sabovich & Hearne, *supra* note 205.

requirement made CCS projects non-viable. Further, there might be some reason for courts to refrain from requiring compensation if there would be no way of reconciling such a requirement with analogous jurisprudence relating to airspace and subsurface intrusions. However, the available evidence is that requiring CCS operators to pay for the use of their neighbor's subsurface pore spaces would not destroy the viability of CCS.[208] Further, jurisprudence supports holding defendants liable for airspace or subsurface intrusions in *some* circumstances.[209] And, although jurisprudence denies trespass liability for subsurface or airspace intrusions in *other* circumstances, the subsurface intrusion of CO_2 can be distinguished from the intrusions involved in those other circumstances.[210]

a. Allowing monetary liability for trespass would not significantly inhibit CCS

Requiring the CCS operator to compensate neighbors for the migration of CO_2 should not significantly inhibit CCS projects.[211] The best evidence of this is the fact that prospective CCS operators currently *are* paying to acquire subsurface pore space rights.[212]

b. The cases finding no liability for airspace or subsurface intrusions can be distinguished.

Jurisprudence has rejected the imposition of trespass liability for certain types of airspace or subsurface intrusions.[213] However, both the line of cases rejecting trespass liability for certain airspace intrusions and the cases rejecting liability for certain subsurface intrusions are distinguishable.

i. <u>Distinguishing the airspace cases that reject trespass liability</u>

The main cases that reject trespass liability for airspace intrusions deal with high altitude air travel in which an aircraft passes through the airspace above a tract of land without damaging the land or interfering with

208. *See* Battersby, *supra* note 189.

209. *See* Marcus Cable Assocs., L.P. v. Krohn, 90 S.W.3d 697, 703 (Tex. 2002); Butler v. Frontier Tel. Co., 79 N.E. 716, 718 (N.Y. 1906).

210. *See* United States v. Causby, 328 U.S. 256, 256 (1946) (airspace); Boehringer v. Monalto, 254 N.Y.S. 276, 277 (N.Y. Sup. Ct. 1931) (subsurface).

211. *See Lapis Energy*, *supra* note 190. I use the qualifier "significantly" because obviously the fact that the CCS operator would have to pay compensation would be a cost that would have some inhibitory effect, even if it is minor.

212. *Id.*

213. *See* discussion *supra* Section II.

the landowner's use and enjoyment of the land.[214] Those cases are distinguishable from the migration of CO_2 injected by a CCS operation for several reasons.

1. Duration of intrusion

The fact that an intrusion is of short duration does not necessarily mean that the intrusion is not a trespass.[215] Nevertheless, the longer an intrusion lasts, the stronger the argument is that the intrusion is a significant violation of the landowner's right to exclude others and thus stronger is the argument that such an intrusion should be deemed an actionable trespass.

Airplanes fly at high speed. For this reason, an airplane rarely is above a particular tract of land for very long. A typical commercial flight maintains a 575 mile per hour cruising speed.[216] Imagine that aircraft crosses over a tract that is one-mile-long. Such a tract is large, but many tracts are larger. An aircraft traveling at 575 miles per hour would pass over that tract in about 6.2 seconds. Most tracts are smaller, and would be traversed in less time. If a tract was 350,000 acres—which would make it large even by Texas ranch standards[217]—a plane traveling that fast could traverse the airspace over the tract in a couple of minutes. Even if multiple flights pass over each day, the total time that the airspace is occupied will be relatively small. In contrast, the goal of CCS is to leave the injected carbon dioxide in the subsurface permanently.[218] This distinguishes the intrusion of CO_2 from a CCS operation from the intrusion by an airplane.

2. Practical uses of the space

Commercial aircraft typically fly at altitudes exceeding 30,000 feet.[219] The Burj Khalifa, the world's tallest building, is about 2716.5 feet tall,[220] less than ten percent as high. Thus, a landowner will never erect a building or other construction to the elevation at which commercial aircraft fly. In other words, no one will ever use that elevation *as landowner*. The

214. *See, e.g.*, Hinman v. Pac. Air Lines Transp. Corp., 84 F.2d 755, 758–59 (9th Cir. 1936).

215. RESTATEMENT (SECOND) OF TORTS § 158 cmt. h (AM. L. INST. 1965).

216. *How Fast Do Commercial Airplanes Fly?*, FLYING (June 24, 2022), https://www.flyingmag.com/guides/how-fast-do-commerical-planes-fly/ [https://perma.cc/CG95-XEYG].

217. *See Texas Ag Stats*, Tex. Dep't of Agric., https://www.texasagriculture.gov/About/Texas-Ag-Stats#:~:text=The%20average%20farm%20in%20Texas%20is%20411%20acres [https://perma.cc/U8SV-PHHZ].

218. *See generally* Angela C. Jones & Ashley Lawson, CONG. RSCH. SERV., R44902, CARBON CAPTURE AND SEQUESTRATION (CCS) IN THE UNITED STATES (2022).

219. *See How High Can Airplanes Really Fly?*, MONROE AEROSPACE (June 15, 2020), https://monroeaerospace.com/blog/how-high-can-airplanes-really-fly/ [https://perma.cc/7MES-LHJ5].

220. *Facts and Figures*, BURJ KHALIFA, https://www.burjkhalifa.ae/en/the-tower/facts-figures/ [https://perma.cc/F3Z3-CFSC] (last visited Oct. 30, 2022).

only practical use of that elevation is for air travel. But air travel generally will not be useful unless the aircraft can travel distances that will involve crossing above multiple tracts of land.[221] The inability of anyone to use high elevations *as landowner*, combined with the fact that air travel generally only will be useful if the aircraft is traveling a distance that will bring it over numerous tracts of land, supports treating that elevation as a free and open commercial highway for air travel.

In contrast, there are potential uses of the subsurface, at and below the depths where CCS occurs, that do not require using multiple tracts of land.[222] For example, oil and gas drilling does not necessarily require crossing through the subsurface of multiple tracts of land, and oil and gas drilling often is done at depths deeper than where CCS operators plan to inject CO_2.[223] Further, although the use of a particular subsurface formation of CCS does not completely preclude drilling through that formation to seek oil or gas from a deeper formation, the CCS might interfere with deeper drilling for oil and gas.[224]

For example, an oil and gas regulator might restrict drilling through the CCS storage zone. Alternatively, a regulator might require that any oil and gas wells drilled through a CCS storage formation use well construction techniques that are more expensive than those typically used. The regulator might do this to help ensure that there is no leakage of carbon dioxide from the storage formation. Further, because subsurface formations often contain water and because water becomes slightly acidic when CO_2 dissolves into it, a person drilling an oil or gas well through a CCS formation might need to use more expensive, corrosion-resistant materials to construct the well than the company otherwise would use.[225] The fact that use of a formation for CO_2 storage might interfere with or increase the cost of a landowner using the subsurface of his or her own land strengthens the argument for requiring compensation for CCS.

3. Whether one person's use precludes others from using the space

Another consideration is whether a space's capacity can accommodate multiple users. An airplane's flight over a particular tract of land does not preclude another airplane from flying over the same tract. The two airplanes cannot occupy the same space at the same time, but a particular plane will pass over the tract in a relatively short time and afterward. In fact,

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221. *Id.*

222. Alexandra B. Klass & Elizabeth J. Wilson, *Climate Change, Carbon Sequestration, and Property Rights*, 2010 U. ILL. L. REV. 363, 388–89 (2010).

223. *Id.* at 378; M.A. Celia et al., *Status of CO2 Storage in Deep Saline Aquifers With Emphasis on Modeling Approaches and Practical Simulations*, 51 WATER RES. RSCH. 6846, 6847 (2015).

224. *See* Klass & Wilson, *supra* note 222, at 412.

225. *See* M.A. Celia et al., *supra* note 223, at 6874.

numerous flights could traverse the same airspace in one day. Indeed, if two aircraft maintain sufficient *vertical* separation, they can fly above the same tract simultaneously. And even if a large number of aircraft fly over a tract today, more aircraft may fly over the tract tomorrow and each subsequent day.

It is different with the injection of CO_2 into a subsurface formation. Not all formations are suitable for CCS, and each formations that is suitable has a finite volume of pore space.[226] Further, because the CO_2 injected into a formation's pore spaces will stay in place forever, the pore space volume will become full when enough CO_2 has been injected. After that, the pressure of the subsurface formation will become too high to safely and economically inject more CO_2.[227] Indeed, it is anticipated that some CCS projects will, over time, inject enough carbon dioxide to fill a storage formation.[228] Thus, one operator's use of the space will preclude others from later using the space for the same purpose. This is a basis to distinguish CCS operations from high altitude air travel and favor imposition of trespass liability for CO_2 but not for high altitude air travel.

4. Effect on value of the land

If an intrusion decreases the value of land or hampers the use of it, that strengthens the argument that compensation should be paid for such an intrusion. Passage of an airplane at an extreme elevation does not harm the value of the tract or prevent the owner from using the tract in any way. Although the injection of CO_2 would not preclude most uses of the land, it could make it more expensive to drill deep wells on the same property or even, in some cases, might preclude drilling altogether.[229] Thus, the existence of a CCS project might detract from the value of a tract for future mineral development.[230] For example, some CCS operators will ask regulators to preclude drilling through the storage formation to deeper formations that might contain recoverable hydrocarbons.[231] And even if drilling through is not prohibited, it might be more expensive to drill because an oil and gas well that passes through a CO_2 storage formation will likely have to meet heightened well construction standards and use more expensive metal alloys.

226. *Id.* at 6849; Christine Ehlig-Economides & Michael J. Economides, *Sequestering Carbon Dioxide in a Closed Underground Volume*, 70 J. PETROLEUM SCI. AND ENG'G 123, 123 (2010).

227. *See id.* at 126.

228. *See id.* at 130.

229. *See* Klass & Wilson, *supra* note 222, at 416.

230. *Id.*

231. *See id.* at 416 n. 343.

5. Knowledge of which tracts suffer an intrusion

In the early days of air travel when courts were deciding whether to recognize a trespass claim for high-altitude air travel, it often probably would have been difficult to determine whether an aircraft actually passed over a particular tract (especially for smaller ones), as opposed to passing a little to one side or the other. Thus, in many situations there would have been difficult problems of proof in establishing an airplane's intrusion into the airspace above a particular tract. With respect to CO_2 migration, while there will be some uncertainties about the spread of the CO_2 plume,[232] federal Safe Drinking Water Act regulations will require that operators both model and actually monitor the estimated migration of the CO_2 plume.[233] This should provide a reasonably accurate basis for determining which tracts of land will suffer an intrusion of CO_2, and, consequently, which landowners are entitled to compensation where trespass claims are allowed.[234]

6. The number of tracts that suffer intrusions

If the passage of an airplane's flight over tracts of land constituted a trespass, the number of trespasses would be beyond count at today's level of air travel. Because a given flight may travel hundreds or thousands of miles, that single flight might cross thousands of tracts. Further, there are thousands of separate flights during a given day, and typically there will be a similar number of flights almost every other day. Even if a particular airline's daily or periodic flight along a particular route was simply considered a repeating trespass that a landowner could pursue in a single claim, there could still be perhaps millions of different trespass claims. Great practical difficulties would ensue if each of these required compensation. Now consider CCS. The IPCC and policymakers anticipate a large number of CCS projects, and the CO_2 plume from some of these will spread into the subsurface of numerous tracts.[235] But the number of tracts that see a subsurface intrusion likely will be smaller than the number of tracts that suffer an airspace intrusion from airplanes.[236] Thus, there would be less practical difficulty in compensating landowners for the subsurface intrusions.

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232. 40 C.F.R. § 146.81(2011) states: "Carbon dioxide plume means the extent underground, in three dimensions, of an injected carbon dioxide stream."

233. 40 C.F.R. § 146.90 (2011); U.S. ENV'T PROT. AGENCY, EPA 816-R-18-001, GEOLOGIC SEQUESTRATION OF CARBON DIOXIDE: UNDERGROUND INJECTION CONTROL (UIC) PROGRAM CLASS VI IMPLEMENTATION MANUAL FOR UIC PROGRAM DIRECTORS (2018).

234. *Id.*

235. R. Lee Gresham & Owen L. Anderson, *Legal and Commercial Models for Pore-Space Access and Use for Geologic CO2 Sequestration*, 72 PITT. L. REV. 701, 749–50 (2011).

236. *See* Klass & Wilson, *supra* note 222, at 388–89.

7. Customary practice

The rule is now well-established that landowners beneath high-altitude flight paths are not entitled to compensation or other relief.[237] In contrast, although case law dealing with injection disposal operations suggests that the common law *might* not impose liability on a CCS operator whose operations cause a CO_2 to intrude into the subsurface of neighbors' properties, there is not yet an established common law rule.[238] Further, the developing trend is for prospective CCS operators to pay for the use of pore spaces.[239] The fact that prospective CCS operators have made it a practice to pay for pore space rights is not, in itself, sufficient to justify a common law rule that they *must* pay, but law is often influenced by custom, and the fact that it is a common practice for CCS operators to pay for the use of pore spaces provides at least some support for a rule that they must pay.[240]

ii. Distinguishing cases that have declined to find liability for certain subsurface intrusions

Injection disposal cases are the main type of case in which courts have concluded that there was no liability for subsurface trespass.[241] Despite the similarity of CCS to those types of injection disposal, those cases should not be controlling.

First, it is noteworthy that most courts that have declined to impose liability for injection disposal are in jurisdictions where the state supreme court has not yet set down a conclusive rule.[242] Thus, it is possible the state's supreme court could later reach a different conclusion.

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237. *See* Gresham & Anderson, *supra* note 235, at 717.

238. *See id.* at 722.

239. Kenneth R. Richards et al., *Pouring Out Our Soils: Facing the Challenge of Poorly Defined Property Rights in Subsurface Pore Space for Carbon Capture and Storage*, 3 GEO. WASH. J. ENERGY & ENV'T L. 33, 34–35 (2012).

240. *Id.*

241. *See* Klass & Wilson, *supra* note 222, at 386.

242. An exception is Chance v. BP Chemicals, *Chance v. BP Chems., Inc.*, 670 N.E.2d 985, 985 (Ohio 1996), in which the Ohio Supreme Court held that there was no liability in trespass for a subsurface migration of fluids from an injection disposal well. A state's supreme court probably has the sole authority to determine whether, under a state's existing common law, a landowner's property rights would be violated by a subsurface intrusion of carbon dioxide that migrates from a CCS project. *See, e.g., id*. at 990.

In contrast, even if a landowner would not be entitled to compensation under the common law, a state legislature could require compensation to landowners for use of the subsurface for CCS, even if the common law would not. Consider, for example, the surface damages statutes that require an oil and gas lessee who obtains rights from the owner of a mineral estate to compensate the surface owner for use of the surface.

Assuming that the subsurface pore spaces are owned by someone, a state's supreme court probably has sole authority to decide whether the owner of the pore spaces is the landowner or the sovereign, and assuming it generally is the landowner, whether it is the surface owner

Further, there are other reasons for courts to reach a different result with respect to CCS. For example, CCS operations generally are designed to be money-making operations—even if just through tax breaks.[243] In contrast, many injection disposal wells are cost centers, not money makers.[244] They might be necessary as a tool for managing wastes that are a by-product of some important industrial activity, and thus they help make that activity possible, but they are not in themselves a profit-making venture.[245] One could perhaps defend the general rule of non-liability for most injection disposal wells based on the societal importance of managing wastes and the lack of a profit from these wells. On the other hand, the operator of a CCS well generally expects to make money from the CCS operation.[246] If the operator is going to use the pore spaces beneath land belonging to the operator's neighbors, it seems fair that the operator should pay for such use.

Also, the trend is for CCS operators who will dispose of CO_2 to pay neighbors.[247] But there does not appear to have been any similar trend during the early days of disposing of other substances by injection disposal to pay neighbors.[248] Although the trend of CCS operators to pay neighbors is not in itself sufficient to mandate that they must pay, the trend gives some support to a requirement.

Moreover, consider the actual subsurface *storage* of fluids, which bears some similarity to subsurface disposal. It is common for a storage operator to pay the neighbors whose subsurface will be used.[249] Indeed, both

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or the mineral owners when there is a severed mineral estate. The prevailing view is that, if subsurface pore spaces are owned, they are owned by the landowner, and that when there is a severed mineral estate the pore spaces are owned by the surface owner. *See, e.g.*, Lightning Oil Co. v. Anadarko E&P Onshore, LLC, 520 S.W.3d 39, 48 (Tex. 2017) (in case involving a split estate, stating that the pore space rights belong to the surface owner). Consistent with the prevailing view, this article assumes that, if the pore spaces are owned, they are not owned by the sovereign or the owner of a severed mineral estate. Rather, they are owned by the landowner (surface owner) or no one.

243. ANGELA C. JONES & MOLLY F. SHERLOCK, CONG. RSCH. SERV., IF11455, TAX CREDIT FOR CARBON SEQUESTRATION (SECTION 45Q) (2021).

244. William J. Schmelz et al., *Total Cost of Carbon Capture and Storage Implemented at a Regional Scale*, 10 INTERFACE FOCUS 1, 1 (2022).

245. Commercial disposal wells whose owners charge clients for disposing of wastes are an exception. *See generally id.* The owners of those wells generally make (or at least hope to make) a profit. *See id.*

246. *See id.* at 11.

247. *See* Richards et al., *supra* note 239, at 47–48.

248. *See id.* at 38–39.

249. *See id.* at 38–43.

federal law[250] and state laws[251] authorize the use of eminent domain for storage operators to acquire the right to use the subsurface of neighboring tracts for storing natural gas, and some of these statutes authorize the use of eminent domain to acquire subsurface rights for storing other fluids.[252] These laws suggest that legislators may have believed that subsurface migration of fluids would constitute a trespass if the storage operator did not pay for acquiring the right to use neighboring properties. Of course, it is a state's supreme court, rather than its legislature, that determines the scope of property rights,[253] but such legislation can be given some weight.

Further, as previously noted, courts have held that some types of airspace or subsurface intrusions support trespass liability, while other types do not.[254] Accordingly, it is possible to reconcile existing trespass jurisprudence with a rule that recognizes the migration of CO_2 from a storage facility as a trespass, particularly given that there are plausible bases to distinguish the jurisprudence holding that certain types of airspace or subsurface intrusion do not support trespass liability. Accordingly, and given that there are good reasons to require that landowners be compensated for subsurface intrusions of CO_2 from CCS operations, courts should limit the non-liability precedents for injection disposal of substances other than CO_2

250. Under the Natural Gas Act, federal law gives a company that acquires a "certificate of convenience and necessity" from the Federal Energy Regulatory Commission the right to use eminent domain to acquire rights for the subsurface storage of natural gas. 15 U.S.C. § 717f. In several places, companies store natural gas in the subsurface, near markets for the consumption of natural gas. *See* Richards et al., *supra* note 239, at 35. During times of the year when demand for natural gas is low (and thus excess pipeline capacity is available), a company can move natural gas from the fields where it is produced to subsurface storage locations near areas where large amounts of natural gas are consumed (such as large population centers) for easy delivery during other times of the year when demand is high (such as during the winter). *See id.* at 45.

251. More than half the states have their own statutes that authorize natural gas companies to acquire subsurface storage rights via eminent domain. *See, e.g.*, Ala. Code § 9-17-154; Ark. Code Ann. § 15-72-604; Cal. Pub. Util. Code §§ 221 & 613; Colo. Rev. Stat. Ann. § 34-64-103 & 106; Ga. Code Ann. § 46-4-57; Ill. Comp. Stat. 15/1, 15/2, and 15/6; Ind. Code Ann. § 32-24-5-2 & § 32-24-5-5; Iowa Code Ann. § 479.24; Kan. Stat. Ann. 55-1203; Ky. Rev. Stat. Ann. § 278.502; La. Rev. Stat. Ann. 19:2; Md. Code Ann., Env't § 14-202; Mich. Comp. Laws Ann. § 486.251 & 486.252 & 486.254; Miss. Code. Ann. § 53-3-159; Mo. Ann. Stat. § 393.430; Mont. Code Ann. § 82-10-303; Neb. Rev. Stat. Ann. § 57-603; N.M. Stat. Ann. § 70-6-7; N.Y. Env't Conserv. Law § 23-1303 (McKinney); Ohio Rev. Code Ann. § 1571.17 & § 1571.01; Okla. Stat. Ann. tit. 52 § 36.3; Or. Rev. Stat. Ann. § 520.350 (West); Tenn. Code Ann. § 65-28-101; Tex. Nat. Res. Code Ann. § 91.179; Utah Code Ann. § 78B-6-501 (West); Wash. Rev. Code Ann. § 80.40.030 (West); W. Va. Code Ann. § 54-1-2 (West). A few of these states authorize the use of eminent domain to acquire subsurface storage rights for other fluids.

252. *See, e.g.*, W. Va. Code Ann. § 54-1-2 (West 2023).

253. *Statutory Construction*, LEGAL INFO. INST., https://www.law.cornell.edu/wex/statutory_construction#:~:text=Statutory%20construction%20is%20the%20process,also%20known%20as%20statutory%20interpretation [https://perma.cc/9AM3-HAJB] (last visited Oct. 30, 2022).

254. *See* Gresham & Anderson, *supra* note 235, at 716–17.

to the contexts of those operations and require payment for subsurface intrusions in the context of CCS.

CONCLUSION

Public policy favors both the promotion of CCS and the protection of property rights. In the context of CCS projects that cause a migration of CO_2 that does no harm, these interests can be reconciled by denying any landowners' requests for injunctive relief to bar CCS operations that would cause migration of CO_2, while recognizing landowners' right to compensation if CO_2 migrates into the subsurface of their land without their consent, with such compensation pegged at the fair market value of subsurface pore space rights. Such a remedy is also consistent with the quantum of damages authorized by trespass jurisprudence for a continuing or permanent trespass, which seems fitting given that the intrusion of CO_2 from a CCS operation will be permanent.

Further, such a result can be reconciled with existing legal authority regarding whether intrusions into the airspace above or the subsurface below land supports trespass liability. Existing jurisprudence holds that some types of airspace or subsurface intrusion support trespass liability.[255] Existing jurisprudence holds that other types of intrusion into the airspace above or subsurface below a tract of land does not support trespass liability,[256] but those types of intrusion can be distinguished from the intrusion of CO_2 from CCS operations.

255. *See id.*
256. *See id.*