Copyright © 2025 Environmental Law Institute®, Washington, DC. Reprinted with permission from ELR®, http://www.eli.org

THE ROLE OF MARINE CO_2 REMOVAL IN COMBATING CLIMATE CHANGE

SUMMARY

Combating climate change requires not only rapid reduction of greenhouse gas emissions, but also removal of significant amounts of carbon dioxide (CO_2) from the atmosphere. CO_2 removal (CDR) comes in many different forms, but climate scientists and policymakers are focusing on the potentially important role of large-scale use of emerging ocean-based techniques, often referred to as marine CDR (mCDR). In the United States, mCDR in domestic waters is governed by a patchwork of laws and regulations. There are also major uncertainties concerning regulation of mCDR in the open ocean, where international treaty regimes have struggled to develop coherent rules. On September 30, 2024, the Environmental Law Institute hosted a panel of experts that explored the issues, challenges, and opportunities for large-scale mCDR deployment. Below, we present a transcript of that discussion, which has been edited for style, clarity, and space considerations.

Sarah Vican is Manager of Educational Programs at the Environmental Law Institute.
Meghan Gavin (moderator) is a Partner with Cascadia Law Group.
Wil Burns is Founding Co-Director of the Institute for Responsible Carbon Removal at American University and Associate Director of the Environmental Policy and Culture Program at Northwestern University.
Douglas Edwards is General Counsel and Head of Operations at Vesta and Adjunct Faculty at Colorado Law.
Romany Webb is a Research Scholar at Columbia Law School, Deputy Director of the Sabin Center for Climate Change Law, and Adjunct Associate Professor of Climate at the Columbia Climate School.

Sarah Vican: We'll be taking a look at the governance and regulation of marine carbon dioxide removal (mCDR) and the challenges and opportunities associated with its large-scale deployment. I want to thank our speakers for lending us their expertise on such an important and emerging topic, and to give a special thanks to our moderator, Meghan Gavin.

Meghan is a partner at Cascadia Law Group, where she practices environmental and federal Indian law. Meghan was previously named one of the Environmental Law Institute's Emerging Leaders, was an advisor to Yale University's Carbon Containment Lab before it successfully spun out in 2024, and is a recommended partner with XPRIZE Carbon Removal and a volunteer with Partnerships for Tribal Carbon Solutions.

Meghan Gavin: I'd like to take a few minutes to have our panelists introduce themselves.

Wil Burns: I'm co-director of the Institute for Responsible Carbon Removal at American University, and also the Associate Director of the Environmental Policy & Culture Program at Northwestern University. I serendipitously got into what used to be broadly denominated the field of climate geoengineering. In 2010, I was a visiting scholar at Williams College. On the way to Williams, I realized that I had one more week in my international environmental law course I was going to teach that I hadn't filled. I was getting off the plane and a gentleman next to me left his *USA TODAY* on the seat and, while we were disembarking, I saw a piece talking about climate geoengineering.

At the time, what people were discussing was another kind of intervention called solar radiation management, or solar radiation modification. It was putting things like sulfur into the sky to reflect more incoming sunlight back to space. I thought that would be a good legal topic for my course. It encompasses questions of science, technology, ethics, law, and politics. So, by week 16, I was ready to teach that in class. Then, I just got fascinated by the topic.

The Central Intelligence Agency shortly thereafter announced that they were going to fund the National Academy of Sciences to conduct a study on solar radiation management. They started to realize that this would be important. Ultimately, as carbon removal came to the forefront, I became very interested in issues of governance and ethics associated with the "other" kind of climate geoengineering. I have a background in ocean issues, originally working on international whaling law, so it was a natural progression to work on mCDR law and policy issues.

Douglas Edwards: I'm the general counsel at Vesta. I'll start on who we are to preface how I got to Vesta and ocean CDR. For those of you who don't know, Vesta is develop-

Copyright © 2025 Environmental Law Institute®, Washington, DC. Reprinted with permission from ELR®, http://www.eli.org

ing an mCDR approach to help ease carbon capture. This involves adding milled olivine sand to coastal protection projects for the dual purpose of protecting coastlines and removing carbon dioxide (CO_2) from the atmosphere.

Olivine is an abundant natural alkaline mineral that, when dissolved in seawater, can increase alkalinity in the ocean and accelerate the speed at which the ocean naturally removes and permanently stores CO_2 from the atmosphere. If you place olivine in its sand form as part of the coastal protection project, it can also become a valuable sediment, dissolving over a decadal timeline and potentially producing a meaningful co-benefit to any recipient beach or community that is at risk of erosion from sea-level rise or otherwise.

This dual-benefit approach is promising, and may be one of the lowest-cost and most scalable carbon removal solutions in the broader CDR portfolio. While the idea has been around for a long time, high-quality field trial data are almost nonexistent. Vesta was founded specifically to conduct responsible field trials and to advance scientific and public understanding of this potential approach.

My journey to Vesta and ocean-based carbon removal is a little unusual. I was a lawyer at WilmerHale and Hogan Lovells and over the years represented a number of pro bono clients—nonprofits who were in need of legal services. Early on, Vesta was one of my pro bono clients. So, I did something very rare, I think, in going in-house to my pro bono client. My entire career has shifted to thinking about how Vesta should best pursue its mission within the existing legal frameworks for mCDR.

Romany Webb: I'm the Deputy Director of the Sabin Center for Climate Change Law at Columbia Law School and an Adjunct Professor at the Columbia Climate School. I, not too dissimilar from Doug, started my career in private practice.

I worked at a large firm in Australia called Gilbert and Tobin doing primarily energy regulation and water regulation work. That really sparked for me an interest in the climate space. I was working with water utilities in the driest inhabited continent on earth and seeing them grapple with this changing normal, the changing baselines that they were having to manage and how that affected everything that they did, and then the flow-on effects for all of us water consumers.

After doing that for a few years, I decided to transition my career into a more academic space. I spent some time at the University of California, Berkeley, and the University of Texas at Austin. It was really at the latter that I discovered the world of carbon removal. As one might expect for a junior academic in Texas, I did a lot of work on oil and gas. In particular thinking about, in a world where we need to do something about climate change but the oil and gas industry remains very dominant, how do we make oil and gas production as clean and as climate-friendly as it can be for that period of time? That led me to the world of geologic carbon sequestration, which I did a lot of work on, and then that led me to the world of carbon removal at Columbia.

Meghan Gavin: I'd like to touch on five topics with our panelists. The first is mCDR generally, to set the stage for our audience, followed by global governance, strategies for scaling, and recommendations for meaningful community engagement. And if we have time, monitoring/measurement, reporting, and verification—commonly known as MRV—and environmental impacts.

For mCDR 101, I'd like to start with Wil. mCDR approaches generally fall into two categories: biotic approaches, which rely on biology and photosynthesis, and abiotic approaches, which do not. Wil, you run a podcast called *Plan Sea* and another called *Scrubbing the Skies*, in which you discuss all types of ocean interventions for combating climate change with guests pursuing those technologies. Could you please provide an overview of the various approaches of these two categories of mCDR, including their current state of development?

Wil Burns: With the caveat that this will be quick and dirty and won't encompass every approach that people are looking at, I want to highlight some that seem to be the most advanced in terms of research and attention and in terms of funding at this point.

I'll start on the abiotic side. Doug mentioned one of these already, which is ocean alkalinity enhancement. The idea here is to introduce alkaline materials into the world's oceans. This could be things like limestone, olivine, wollastonite, or basalt. By doing so, we ultimately convert CO_2 in the ocean to carbonates and bicarbonates, which can be used by shell-forming species. Then, when those species die and drop to the bottom of the ocean, there can be substantial sequestration of CO_2 for a millennium or more.

Now, that doesn't reduce the amount of CO_2 in the atmosphere in itself. It just reduces the CO_2 in the ocean. But by reducing the amount of CO_2 in the ocean, it changes the pressure differential between the CO_2 in the atmosphere and in the oceans. That allows more CO_2 from the atmosphere to enter into the ocean, which results in a net drawdown of atmospheric CO_2.

There's also an approach called direct ocean capture. A lot of it involves electrochemical approaches that seek to directly take CO_2 out of the water and to effectuate the same kind of drawdown from the atmosphere.

On the biotic side, there are a number of approaches we're looking at. One is called ocean iron fertilization. This is kind of the "OG" of all of the mCDR approaches. This approach, which was researched extensively more than a decade ago, involves fertilizing the ocean, in most cases with iron, to try to increase phytoplankton production. The theory is that in somewhere between 25% and 30% of the world's oceans, there are ample macronutrients, such as phosphorus and nitrogen, to optimize phytoplankton growth, but there's a critical shortage of one micronutrient. That micronutrient is iron.

The proposals for ocean iron fertilization contemplate seeding areas with iron to increase phytoplankton production. The phytoplankton, in turn, will take up more CO_2 and then, when these organisms die, ultimately the CO_2 can end up sequestered at the bottom of the ocean. Again,

Copyright © 2025 Environmental Law Institute®, Washington, DC. Reprinted with permission from ELR®, http://www.eli.org

by removing CO_2 from the oceans, it can facilitate drawing down more CO_2 from the atmosphere.

A second biotic approach that has received quite a bit of attention in recent years is seaweed farming. The idea is to cultivate large quantities of seaweed or kelp in the oceans. A lot of the proposals entail cultivating seaweed on buoys. As the seaweed grows, it takes up substantial amounts of CO_2. Then, at a certain level of growth, the buoys could drop to the bottom of the ocean. Again, we could see substantial sequestration of CO_2 on long time frames when it's buried in sediments.

Another biotic approach is termed biomass sinking, whereby we take biomass, such as crop residues or forest residues, from land and ultimately sink it to the bottom of the ocean. If you leave biomass on land, within a couple of years, most of that CO_2 is released. If you sink it into the ocean below a certain layer, in theory it will ensure, via the pressure differential, that the CO_2 does not reenter the atmosphere for a long time. Again, you will see more of a drawdown of CO_2 from the atmosphere.

A final biotic approach that I'll highlight is artificial ocean upwelling. Since we've already talked about how ocean iron fertilization can effectuate CO_2 removal, this one's fairly easy to understand. The idea would be to pump nutrients from the rich bottom of the ocean into the upper layers of the ocean to increase phytoplankton growth. As is the case with ocean iron fertilization, this could stimulate phytoplankton growth, resulting in removal of CO_2 from surface waters, and then ultimately, drawdown of CO_2 from the atmosphere.

Meghan Gavin: Doug, picking up from where Wil started, Vesta is the first company to receive permits for a stand-alone mCDR pilot project. In the United States, we have two major permitting schemes for mCDR, those falling under the Clean Water Act (CWA)[1] and those falling under the Marine Protection, Research, and Sanctuaries Act (MPRSA).[2] Could you please provide us an overview of that dual framework, particularly where Vesta's deployments fall within it?

Douglas Edwards: I'm sure Romany will be talking about the London Protocol, so I won't touch on that. But the MPRSA is obviously the domestic implementation of the London Convention. There's a lot to think about here, a lot of jurisdictional framework.

The place to start is that we are very proud of the field trial that has been permitted. As some of you may know, it's been conducted offshore by the U.S. Army Corps of Engineers (the Corps) research facility in Duck, North Carolina. If you're not familiar with the field research facility in Duck, it is a world-class coastal engineering research facility where lots of data have been produced for decades.

It's widely considered one of the best coastlines in the world to study; it might be the best-studied coastline in the world. Because we're operating in that space, we feel very grateful to be able to produce data for our project and to make that available to the world as well. All of the data from the Duck project will be made available to the public.

We're a long way off from a scaled mCDR solution, but Duck is a very important step in the right direction in our view. From a legal perspective, Duck is permitted by the Corps under §10 of the Rivers and Harbors Act (RHA)[3] and under §404 of the CWA.[4]

Section 10 of the RHA covers certain activities related to navigation. Section 404 of the CWA covers the discharge of fill materials. If you're thinking about increasing the height of the ocean bottom, as we did when we placed the olivine, you need a §404 permit to do that.

The project at Duck is also permitted by North Carolina under the state's Coastal Area Management Act. It covers coastal development, so it's permitted there as well. If you're familiar with activities like coastal restoration work or beach nourishment, this framework will be generally familiar to you because it's implemented in other states in similar fashions.

Despite the fact that some number of permits every year are issued under that framework, and Vesta has permits in that framework, that's just a tiny piece of the broader statutory scheme for regulating the waters of the United States out into the exclusive economic zone (EEZ) and into the high seas.

It's helpful to think through what the broader regulatory scheme looks like. I'll tell you how I think about it. It's kind of a three-step process, if you're considering how to permit an mCDR project.

The first step is, if you have a technology that involves the discharge of a pollutant from an outfall structure, you're probably going to be in the National Pollutant Discharge Elimination System (NPDES) to begin with. That's the easy one. As Wil mentioned, some of these technologies involve pumping of ocean water or that type of thing from a point source. So, you can carve that one off. That's the easier one to understand.

Once you get through that step, if what you're doing doesn't require an NPDES permit, then you're either going to be in the MPRSA or you're going to be in a statutory framework that involves state law and the CWA, likely §404, and likely §10 of the RHA as well, if you're integrating into a navigation channel.

To think through that, the place to start is at the baseline of the territorial sea. The baseline is a well-defined concept in this arena. For purposes of this discussion, you should think of it as what you would expect the shoreline to be. It's the low watermark along the ocean. It skipped over inlets and that type of thing.

So, if you're standing at the baseline of the territorial sea and you look inland, you're looking at the internal waters of the United States, and the MPRSA doesn't apply there. What you'll be regulated under in that space is

1. 33 U.S.C. §§1251-1387.
2. 33 U.S.C. §§1401 et seq.; 16 U.S.C. §§1431 et seq.
3. 33 U.S.C. §403.
4. *Id.* §1344.

Copyright © 2025 Environmental Law Institute®, Washington, DC. Reprinted with permission from ELR®, http://www.eli.org

likely CWA §404, maybe RHA §10, and some number of state or local regulations.

For example, Vesta's first field trial was actually conducted with the town of Southampton. We placed a small amount of olivine sand in the surf zone of a beach on the Peconic Bay. That's not on the ocean side of Long Island, so that project was permitted through an amendment to an existing set of §404 permits and state-level permits as an inland placement of fill material.

If you're standing on the baseline and you turn around and look out to the ocean, the first three nautical miles of what you're looking at is the territorial sea. Beyond that is ocean waters. This is spelled out on the U.S. Environmental Protection Agency's (EPA's) website.[5] If you're proposing an mCDR project beyond three nautical miles, then the statute that generally applies is the MPRSA. In order to do any type of mCDR work in that area of the ocean, you should expect that an MPRSA permit will need to be issued.

Now, if you're operating like we are in the first three nautical miles of the ocean, which is the territorial sea, there's overlapping jurisdiction between the MPRSA and §404 of the CWA. So, the question becomes, do you need one of those permits or both? How do you know? The place to go is the "dumping" definition under the MPRSA.[6] If you've looked at this before, you'll see that it starts with "the disposition of material." Those two terms—disposition and material—are broadly defined in the statute. And EPA interprets them as broadly as they probably could be interpreted. That's of course appropriate to do in these circumstances.

Then, the question becomes, is there an exception to those? With that definition, these certain technologies fall outside of it. Historically, not every single thing that you might do from a placement perspective is regulated as dumping in the territory. For example, historically, the placement of sand has been regulated only under §404. So, all of the Civil Works Program, and a lot of municipal activity that involves the placement of sand for coastal protection and for beach nourishment, is not regarded as dumping under the MPRSA.

The important thing here is that the exact scope and the reasons for this exclusion are not set out in the statute. I think it would be helpful if EPA and the Corps better defined these lines for a number of reasons. But I think the exception for this type of work at least best covers mCDR projects, because what we are doing is designed to specifically mimic or supplement an existing practice that has not generally been regarded as dumping.

To talk specifically about the Duck project, it is a small-scale field trial of what is called a nearshore berm. These are devices that have been used by coastal engineers to provide coastal protection benefits through the addition of sand to coastal systems. The idea is that the berms move over time and bring sediment benefits to the local beach system.

Generally, those have only been regulated under §404. As a result, when we filed for permits, we expected that the Duck project would only need to receive the §404 permit under the CWA, for discharge into the territorial sea that constituted fill material. We also needed the RHA permit for navigation reasons, and the state permit because the Coastal Area Management Act applies to the North Carolina coastline.

The Corps generally agreed with that. We ended up having some discussions with EPA about whether or not the MPRSA should apply. Eventually, through those discussions, EPA concluded that an MPRSA permit was not required for Duck.

This legal issue is not fully resolved, and we expect that there will be future discussions about it. We also expect that where coastal carbon capture is designed to produce coastal protection benefits in addition to carbon removal benefits—for example, in the case of nearshore berm development for beach nourishment—those activities will be considered "not dumping," and will continue to be regulated under §404 of the CWA only.

Nonetheless, it's important to say here that the goal is not to live in a world in which EPA doesn't have oversight of the technology. Throughout this process, we've been advocating for something we call "404 Plus," and we think about EPA's resources engaging on these projects through the normal §404 framework. As you probably know, with all of the §404 permit applications, EPA has visibility into those and can engage. We look forward to potentially having something of a "big tent" approach to continue to evaluate the projects that we might propose in the future.

I know this has been a lot of information. To put it simply, the deployment of dredge sand or upland material for coastal protection purposes generally requires a CWA §404 permit and not an MPRSA permit. It seems clear to us that adding material that has the dual benefits of carbon removal and coastal protection shouldn't turn that type of activity into something that constitutes dumping and triggers an MPRSA permit. We'll see how that unfolds in the future, but that's our perspective.

The last thing I'll say here is that this may seem like a difficult process. It took us a long time to go through all of this. But what's important to us is that our approach nicely integrates into the existing framework for these existing coastal protection projects. We would really like to be integrating into the existing coastal protection framework in a way that makes that process easy for people to understand and to adopt.

Our industry knows §404 really well. It trusts that statute. It's used lots of times to think about complicated projects, projects way more complicated than what we ended up doing in Duck. It didn't make sense to us to try to upset that balance and enter into a set of projects where the addition of olivine sand might turn the entire project or at least our portion of it into something that is governed by a statute that is foreign to the industry.

5. U.S. EPA, *Marine Protection, Research and Sanctuaries Act (MPRSA) and Federal Facilities*, https://www.epa.gov/enforcement/marine-protection-research-and-sanctuaries-act-mprsa-and-federal-facilities (last updated Apr. 5, 2024).
6. U.S. EPA, *Marine Protection, Research, and Sanctuary Act Permits: Frequently Asked Questions*, https://www.epa.gov/ocean-dumping/marine-protection-research-and-sanctuary-act-permits-frequently-asked-questions (last updated Sept. 24, 2024).

Copyright © 2025 Environmental Law Institute®, Washington, DC. Reprinted with permission from ELR®, http://www.eli.org

So, as you can see, this is a complicated framework. Vesta's is a pretty narrow type of technology that fits into a pretty unique slot in that framework. I thought it made sense to join this discussion to explain it in some detail for anyone who's wondered how these activities are permitted under the CWA and why.

Meghan Gavin: Doug, thank you for that overview. I represent an mCDR startup that is regulated under the CWA, under the NPDES permitting regime, because their discharge will be a point source. But we've been thinking through a lot of the same issues that you've been thinking through, about how to consider the intent of the activity and the beneficial impacts of the activity.

When you're just adding seawater to seawater, is that really a pollutant? Should that be regulated as a pollutant? How do we think about these permitting paradigm shifts? Where do these new technologies fit into existing regimes or forthcoming regimes, as you talked about with the 404 Plus concept?

Romany, if you could wrap up this "mCDR 101" portion. Through your work with the Sabin Center, you wrote a publication examining the existing legal frameworks worldwide for mCDR.[7] Is there anything, any law or policy, pertinent to deployments within the United States that you believe is critical to know? Then, we'll move to global governance.

Romany Webb: Doug did a nice job of laying out two of the key regimes that can apply domestically to mCDR activities, the CWA and the MPRSA. There are a number of other laws that might also apply, depending on the precise mCDR activity that is being undertaken and exactly where it's occurring.

To your point, Meghan, none of these laws were designed with mCDR in mind. They are, for the most part, general environmental laws that were designed to control pollution or other potentially harmful activities. Now, we're trying to fit mCDR into them. That is not necessarily a problem in and of itself.

As Doug said, there may be real benefits to operating under these existing, well-established, well-understood frameworks. But there may also be some drawbacks. The existing regime is extremely complex, and there is often a real uncertainty as to how existing frameworks apply in the mCDR context.

What we learned through the book project is that this is not just a problem in the United States. It's a problem in many countries. For our book, we looked at seven countries throughout North America, Europe, and Asia. With just one notable exception, none of those countries have a purpose-built framework for mCDR activities. They each regulate mCDR under more general, environmental, and other laws.

Actually, the frameworks look in many cases very similar to what we see here in the United States. The one exception among the countries we looked at is Germany, which has enacted legislation dealing specifically with what's termed "marine geoengineering activities." That includes certain mCDR activities but also marine solar radiation management activities, the activities that we spoke about early on.

Through that legislation in Germany, they've created a very restrictive regime that prohibits many mCDR activities. Since our book was published, a second country, Australia, has also enacted legislation specific to mCDR. But that legislation has not yet entered into effect.

I do think it's worth thinking about the need for, and efficacy of, these more specific legal frameworks. Obviously, here in the United States, it's really hard to get anything through the U.S. Congress. We all are painfully aware of that. So, there is, and for the reasons Doug talked about, a lot of support for staying within existing frameworks and working with what we've got. But proceeding with the status quo might also present its own issues, and in particular might not be scalable as we look to do more mCDR projects on a much larger scale for longer durations of time.

These are issues we at the Sabin Center have been thinking a lot about. We did a project last year where we drafted a piece of model legislation, a bill, that could in theory be enacted by Congress to create a new legal framework specifically for mCDR research. Our goal there was to explore, if we were to start from scratch, what we would need to put in place to enable mCDR research but also to ensure that it occurs in a safe, responsible, and just way.

We published that draft legislation. It's available on our website.[8] We do not expect that the legislation will be enacted in the form we published it. But we do hope that it starts a conversation, that it starts people thinking about and talking about whether we need a new legal framework for mCDR. And if we do, what are the elements that need to be included there? We think it's good to have those conversations now because of the challenge of enacting legislation and the time that will be required.

Meghan Gavin: We heard Doug mention the London Convention and London Protocol.[9] Could you please give us an overview, addressing why we're thinking about it in the context of this conversation?

Romany Webb: We could spend days talking about the London Convention and Protocol in this context. Basically, they both regulate ocean dumping. The London Convention was first adopted in the 1970s. Then, in the

7. Ocean Carbon Dioxide Removal for Climate Mitigation: The Legal Framework (Romany M. Webb et al. eds., Edward Elgar Publishing 2023).

8. Romany M. Webb & Korey Silverman-Roati, *Developing Model Federal Legislation to Advance Safe and Responsible Ocean Carbon Dioxide Removal Research in the United States*, Sabin Ctr. for Climate Change L. (2023), https://scholarship.law.columbia.edu/sabin_climate_change/199/.

9. Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, Dec. 29, 1972, 1046 U.N.T.S. 120 [hereinafter London Convention]; 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, Nov. 7, 1996, 36 I.L.M. 1 [hereinafter London Protocol].

Copyright © 2025 Environmental Law Institute®, Washington, DC. Reprinted with permission from ELR®, http://www.eli.org

1990s, there was an effort to update and modernize the Convention. That led to the adoption of the Protocol.

The idea was that eventually the Protocol would replace the Convention, but so far not all of the Parties to the London Convention have ratified the Protocol. So, the two are operating in parallel. The United States is a Party only to the Convention. It hasn't ratified the London Protocol.

There are some important differences between the Convention and the Protocol, but very broadly they both say that a permit is required to dump waste or other matter into the ocean, and they restrict the circumstances in which permits can be issued. The London Protocol is more restrictive. It only allows the issuance of permits for the dumping of eight substances that are specifically listed in an annex to the Protocol.

The Convention takes the opposite approach and says permits can be issued for the dumping of any substances except for eight that have been blacklisted. They are set out in an annex to the Convention. There has long been a debate, dating back to those early ocean fertilization experiments that Wil mentioned, about whether various mCDR activities involve dumping within the terms of the Convention and the Protocol.

The definition of "dumping" in both of those instruments refers to the disposal of waste or other matter at sea,[10] which isn't really a great fit for mCDR because, while some of those activities—like ocean fertilization and ocean alkalinity enhancement—do involve putting something in the ocean, you're not really disposing of something. You're not putting the stuff in the ocean to get rid of it in the sense that disposal is traditionally used.

Even so, for various reasons that I won't get into now, the Parties have said that the London Convention and Protocol can apply here. Importantly, in 2013, the Parties to the London Protocol adopted an amendment that is intended to apply to so-called marine geoengineering activities.[11] That amendment has not yet entered into force, so strictly speaking, it's not legally binding. But it is having a huge influence on the way the international community and many domestic actors think about mCDR. It has influenced some of those domestic laws that I mentioned in Australia and Germany.

The amendment basically prohibits, with limited exceptions, the placement of matter into the ocean in connection with certain listed marine geoengineering activities that are identified in an annex. Currently, only ocean fertilization is listed, so that's the only activity that's covered under the 2013 amendment.

The amendment says that Parties to the London Protocol may permit ocean fertilization projects that involve "legitimate scientific research," but they cannot permit anything else, including any deployments. In 2010, the Parties adopted a framework that is intended to guide the assessment of whether something involves "legitimate scientific research" or not.

As I said, this only applies to ocean fertilization currently. But for the past few years, the Parties have been looking at whether to list additional activities under the 2013 amendment. They've formed a number of committees and other working groups to look at the issue. Those committees have been really active, in some cases meeting once a week or once a fortnight to discuss these topics.

Some of the groups involved have recently expressed the view that, for various legal reasons, the amendment actually can't be further amended at this time. Others have disagreed with that. My own view is that it's unlikely that we will see an amendment of the amendment, at least in the short term. What seems more likely is that we will see some other sort of pronouncement on these topics.

After the Parties to the London Convention and Protocol met in October 2023, they issued a statement on marine geoengineering in which they said that a variety of marine geoengineering activities—including ocean alkalinity enhancement, seaweed cultivation, and sinking—should be treated similarly to ocean fertilization.[12] That we should allow some research projects, but we should not allow deployment at this point in time.

One of the working groups on mCDR that's been established under the London Convention and Protocol recently drafted a resolution that says much the same thing.[13] The Parties are expected to consider that at the next meeting on October 28. It's definitely a very dynamic space in the international community, and there's a lot of international attention on these issues.

Meghan Gavin: Wil, for global governance, we also need to think about the United Nations Convention on the Law of the Sea (UNCLOS)[14] and including the Biodiversity Beyond National Jurisdiction (BBNJ) Agreement.[15] You've published a lot about international governance of mCDR. Is there anything that you'd like to share about UNCLOS or particularly the BBNJ Agreement and its implications for today's conversation?

Wil Burns: One of the things that Romany emphasized is that there's a lot of kinetic activity within the London

10. London Convention, *supra* note 9, art. iii(1)(a); London Protocol, *supra* note 9, art. 1(4.1).
11. Resolution LP.4(8) on the Amendment to the London Protocol to Regulate the Placement of Matter for Ocean Fertilization and Other Marine Geoengineering Activities (Oct. 18, 2023), https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/LCLPDocuments/LP.4(8).pdf.
12. International Maritime Organization, *45th Consultative Meeting of Contracting Parties to the London Convention and the 18th Meeting of Contracting Parties to the London Protocol (LC 45/LP 18), Marine Geoengineering—Statement*, https://www.imo.org/en/MediaCentre/MeetingSummaries/Pages/LC-45-LP-18.aspx (last visited Nov. 26, 2024).
13. Marine Geoengineering Including Ocean Fertilization: Progress Report From the Legal Intersessional Correspondence Group on Marine Geoengineering: Draft Resolution (Aug. 9, 2024), https://blogs.law.columbia.edu/climatechange/files/2024/10/LC-46-5-1-Progress-report-from-the-Legal-Intersessional-Correspondence-Group-on-MarineGeoengineering.-Co-Chairs-of-the-Correspo.pdf.
14. UNCLOS, Dec. 10, 1982, 1833 U.N.T.S. 397 [hereinafter UNCLOS].
15. Agreement Under the United Nations Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biological Diversity of Areas Beyond National Jurisdiction, UN Doc. A/CONF.232/2023/4 (June 19, 2023).

Copyright © 2025 Environmental Law Institute®, Washington, DC. Reprinted with permission from ELR®, http://www.eli.org

Convention and Protocol in terms of climate geoengineering issues. These two regimes have really taken point, along with the Convention on Biological Diversity (CBD)[16] to a lesser degree, on these issues.

UNCLOS, probably by the nature of its culture less so, but it clearly has a lot of provisions and some recent decisions that could be pertinent to mCDR, both in terms of research as well as potential large-scale deployment. For example, Part XIII of UNCLOS is devoted to marine scientific research. That would be pertinent to conducting marine CO_2 removal research operations, which is the stage where most approaches currently exist. UNCLOS broadly provides for privileging marine scientific research, but it places a lot of restrictions on such enterprises. As is true with UNCLOS in general, the closer you get to the coast, the more rights that coastal States have to regulate or even prohibit this kind of research under certain circumstances.

In territorial seas, States would essentially have to give permission if another State wished to conduct those operations. In the EEZs, the converse is true. Coastal States are generally to accord that right. But if there's potential adverse impacts or if it's a utilization of resources, whatever way that might be defined, a coastal State might still be able to veto such operations. In all cases, coastal States would have a right to participate in that research if they wished to, and to benefit from it.

There are also Part XII provisions focused on prevention and amelioration of marine pollution that are directly pertinent to mCDR. All of these approaches have potentially adverse impacts. Ocean iron fertilization could create toxic algae blooms. It could rob areas upstream of nutrients by drawing those nutrients down in the area in which phytoplankton would proliferate. This could adversely impact fisheries and reduce phytoplankton production in other regions, perhaps defeating the purpose of ocean iron fertilization. Seaweed cultivation ultimately could crowd out phytoplankton production by competing for nutrients, and could have impacts on benthic organisms when it drops to the bottom of the ocean. In all of these cases, I think that these potential impacts could be construed as "pollution" of the marine environment under UNCLOS.

"Pollution of the marine environment" is defined in UNCLOS as the introduction of energy or substances that results, or is likely to result, in adverse impacts on marine species, human health, and marine activities, including fishing and amenities.[17] I think it was generally acknowledged that CO_2 would qualify as an ocean pollutant under this capacious definition. Now, a recent advisory opinion by the International Tribunal for the Law of the Sea has affirmed this interpretation.[18]

One of the arguments that proponents of mCDR proffer is that mCDR is a way to actually address CO_2 as a marine pollutant, and thus should be considered as a way to fulfill the obligation of Parties under Part XII to protect the marine environment, but that's a tricky proposition. If you look at the International Tribunal for the Law of the Sea decision, the Tribunal very briefly addressed the potential role of "marine geoengineering," and its take is decidedly negative. The Tribunal indicated that such interventions might be contrary to Article 195 if it resulted in transformation of one form of pollution into another, and Article 196, because that requires States to take necessary measures to prevent, reduce, and control pollution, suggesting that it believed that marine geoengineering interventions could generate such pollution.

In my opinion, one of the problems with the pollution control provisions of UNCLOS is that they don't really contemplate comparative risk assessment. If there's an introduction of any kind of pollutants associated with a potential approach to combat climate change (e.g., marine carbon removal approaches), the regime seems hostile to deployment if there's any potential production of pollution, even, presumably, if it's possible that the net benefits of said approach from a climate perspective would be positive. One of the problems is that when UNCLOS was drafted, it probably wasn't contemplated that introducing substances into the marine environment might actually be salutary in ameliorating environmental stressors.

The London Convention's approach is a bit more nuanced, in that it provides in Article III that "dumping" does not include "placement of matter for a purpose other than the mere disposal thereof, provided that such placement is not contrary to the aims of this Convention." Thus, it recognizes that there may be circumstances in which interventions of the kind contemplated under the rubric of mCDR might be acceptable under some circumstances. However, to date, it's made it pretty clear that it only will sanction scientific research in this context.

There's a new treaty, the BBNJ Agreement, which is the third implementing agreement growing out of UNCLOS. The treaty's focus is on strengthening protection of biodiversity "areas beyond national jurisdiction" under UNCLOS, which encompasses about 60% of the world's oceans by volume.

There are a number of provisions in the BBNJ Agreement that could be pertinent to mCDR regulation. One is the extensive environmental impact assessment (EIA) provisions, which are less vague, and more precautionary than those found in UNCLOS. The BBNJ Agreement provides a much more structured approach and creates lower thresholds, at least for the initial screening, of whether an EIA should be conducted. This includes a provision that weighs in favor of a screening process to determine if an EIA is required if the proposed intervention involves novel approaches.

The standard is, essentially, if an mCDR approach could pose substantial risks—maybe in research, but certainly in deployment—it would give rise to the need to conduct an EIA. The BBNJ Agreement provides for a structured approach of consulting those that might be affected. It pro-

16. Convention on Biological Diversity, June 5, 1992, 1760 U.N.T.S. 79.
17. UNCLOS, *supra* note 14, art. 1.1(4).
18. International Tribunal for the Law of the Sea, Request for an Advisory Opinion Submitted by the Commission of Small Island States on Climate Change and International Law—Advisory Opinion para. 179 (May 21, 2024), https://www.itlos.org/fileadmin/itlos/documents/cases/31/Advisory_Opinion/C31_Adv_Op_21.05.2024_orig.pdf.

Copyright © 2025 Environmental Law Institute®, Washington, DC. Reprinted with permission from ELR®, http://www.eli.org

vides for a right of the scientific body of the Agreement to weigh in on whether they think an EIA is sound. It requires responses by those developing the projects to any concerns that are expressed by the scientific body, or other Parties, which may provide more accountability and pressure on the proponents in those projects. The Agreement also provides for "strategic environmental assessments," which are usually applied to "plans or programs." This might be pertinent to any wide-scale deployments of an mCDR approach, or suite of approaches.

The other key provisions of the BBNJ Agreement that might be pertinent to mCDR research and deployment are provisions to facilitate the deployment of what's termed "area-based management tools," which can include marine protected areas. States might opt to exclude mCDR activities, for example, from a marine protected area if such activities are deemed to undercut the objectives of the area. Conversely, mCDR might be deemed to be an area-based management tool that would help address threats to biodiversity in some portions of the oceans, such as ocean acidification.

The last thing I'll emphasize is a lot of these mCDR companies are U.S.-based. That is an important point to make when it comes to UNCLOS. UNCLOS was not signed or ratified by the United States. We recognize selectively, as we often do in terms of treaties we don't ratify, some provisions as customary international law and then things we don't want to do as not legally binding. So, that may severely limit the impact of UNCLOS in terms of U.S.-based mCDR companies.

In terms of the BBNJ Agreement, the United States under the Joseph Biden Administration had a very active role in drafting the treaty, and we signed the treaty. But we've had a very active role in drafting a lot of treaties in the past that we never ultimately ratified. It seems highly unlikely that the incoming Donald Trump Administration will seek to advance the treaty in the U.S. Senate. The treaty will not come into force until 60 states have ratified it, probably sometime in 2025 or 2026, but there's a very good chance we won't be part of the Agreement for the foreseeable future, if ever.

Meghan Gavin: I'd like to move us to our third topic, which is scaling strategies. Moving mCDR research from the lab to pilot projects and field trials to commercial-scale deployment is complex. As we've talked about, it is costly and necessary. For some, it's also a somewhat scary proposition because—as you've all touched on—so much remains unknown about the impacts of mCDR outside of the lab. Many of these techniques have not been tested in the ocean at scale.

Wil, you talked under the BBNJ Agreement about the concept of applying marine protected areas, perhaps for improving ocean acidification or mCDR. Romany, you have written on this topic with a model federal legislation to advance mCDR research in zones appropriate for it.[19] You also authored a piece with Aspen Institute recommending a "Code of Conduct" for mCDR research.[20] Could you please highlight what your recommendations are for responsibly, yet quickly, scaling mCDR from research to deployment?

Romany Webb: I think this idea of "quickly but responsibly" is really key in this space. We all know and feel that the climate crisis is getting worse with every passing day. We all feel the urgency of addressing it. We also know that because of past delay, because we've taken so long to do anything about emissions, we're forced to look at a broader range of options, including CDR and mCDR.

As Wil said, the initial work that's been done in this space does look very promising and suggests that mCDR approaches could be a really important way of combating climate change. But they also present risks and there are still a lot of unknowns associated with them. So, it's important that, in our haste to address one environmental disaster, we don't create or worsen another one. We need to proceed with speed, but with caution.

The "Code of Conduct" that we did through the Aspen Institute was designed to help with that. It sets out a framework for making decisions about whether and when to move ahead with mCDR research projects and factors that should be taken into account in designing and executing those projects.

It has a particularly heavy focus on community engagement, which is obviously key in this space, but it's quite challenging to conceptualize what that means in this context. If we're doing a project out in the ocean, particularly a long way from shore, on the high seas for example, how do we even identify the affected community in that situation? Once we've done that, how do we think about engaging with them in a meaningful way? The Code of Conduct project sets out some high-level principles that we think can help project proponents navigate the engagement process.

One piece of feedback that we got very regularly on the Code of Conduct was that compliance with it is going to delay projects because it creates all sorts of requirements that have to be met on the front-end of projects. It creates a need for a lot of engagement and other steps that have to be done before you can do anything in the water. Isn't that going to delay things?

Actually, when we look at this in the context of other sectors and particularly in the context of climate infrastructure development, we see that, yes, these things can add time, cost, and complexity on the front-end of projects. But they can also have really significant payoffs on the backend and make it much easier to move forward with these projects in the long run, by bringing communities into the process of developing them, lessening community opposition, and improving their design. Because project proponents can learn from local knowledge that those communities have. This is particularly important in the mCDR space because, for example, Indigenous communities and others have so

19. Webb & Silverman-Roati, *supra* note 8.

20. Miranda Boettcher et al., Aspen Institute, A Code of Conduct for Marine Carbon Dioxide Removal Research (2023), https://www.aspeninstitute.org/wp-content/uploads/2023/11/110223_Code-of-Conduct_FINAL2.pdf.

Copyright © 2025 Environmental Law Institute®, Washington, DC. Reprinted with permission from ELR®, http://www.eli.org

much knowledge about the ocean that can help inform the design and development of these projects.

In the Code of Conduct and also in the model laws project, we really did have a focus on ensuring that there are diverse voices in the project development, design, and execution process because we think that is really key to achieve both the speed and the responsible and safe deployment.

Meghan Gavin: Doug, Vesta is one of the few mCDR companies to actually successfully make this move from the lab to the field. We need many more companies to follow suit. What laws, policies, or relationships were particularly beneficial to Vesta during its initial transition, and/or what enabling laws or policies would you like to see to help Vesta and other mCDR companies avoid the "valley of death"?

Douglas Edwards: It's a great question. I'll focus on the second half of it. I think that's where there's a lot of work that can be done. As an initial matter, we're very much still in this transition phase. It's not as though Vesta crossed this gap, and now we're ready to go out and deploy at massive commercial scale. I don't want anyone in the room to have that kind of takeaway.

If you're like us, what you believe is that in these mCDR technologies the research should proceed, and that should be done on a timeline that is safe, responsible, and allows for the effective kind of work that needs to be done on the research and development (R&D) side for these strategies to be impactful to the climate over the long run.

As Romany suggested a minute ago, it is important to think about responsibly moving quickly. The question is, what is the best way to do that? In my view, intense coordination between the private sector and the public sector is really important here.

All U.S. policies right now are setting up, I think, to eventually support the private sector in doing this work if it is determined in the future that we should be doing it at scale—which again, as you'll hear me say a couple of times in this talk, is not really the best decision. What we hope for is that Congress gets into the game, so to speak, and figures out where to allocate direction and funding to make sure that the work is being done well.

The example I would use here is in 2026 or 2027, maybe in some place like Texas, we might be interested in doing a larger project than what we did in Duck, if the results from the Duck Project Council are in favor of moving down that path. To do this well at the next level, we would love to see a more formal public-private partnership that involves local, state, and federal government actors, academic institutions, nongovernmental organizations, potentially the National Laboratories, and so on.

We'd love to see all of those groups come together around a research partnership for a larger-scale entity, a project that involves coastal carbon capture. We'd also love to see some of the folks doing the advanced market commitment work to financially support those projects. These are very expensive projects. There are buyers willing to pay for carbon removal.

We think bringing all of those people together under the "big tent" makes a lot of sense to move forward. What that means is Congress allocating funding and direction. It's not just, here are the dollars, go and distribute to various research institutions, but rather, here are dollars to actually go do the work with the private sector.

We'd love to see more funding to places like the U.S. Army Engineer Research and Development Center facility, which is the R&D wing of the Corps. We'd love to see more dollars go to the National Oceanic and Atmospheric Administration's (NOAA's) Ocean Acidification Program, the National Laboratories, along with some direction around how to spend those dollars. That, in addition to all the things you probably hear people in our space talk about a lot, we need to facilitate pathways for investment to flow into this space that are very substantial.

The tax-crediting regimes that you hear about are important too. But from Vesta's perspective, the place where the most leverage exists is in bringing to bear the resources of federal, state, and local governments in actually doing these projects, and then getting all of that information out to the public to make evaluations on how to move forward.

Meghan Gavin: Wil, Doug mentioned how Congress can get in the game. You've done some writing on how states can get in the game of advancing large-scale deployments of mCDR.[21] Is there anything you'd like to add in terms of state or federal laws and policies that you would advocate for and think are necessary for responsible scaling?

Wil Burns: There are a lot of things that the federal government should be doing both to regulate and facilitate mCDR. On the facilitating side, we could take a more balanced approach in terms of federal funding for CO_2 removal. We're putting huge amounts of money into direct air capture, for example, approximately $3.5 billion, and allocating very little money to the panoply of other terrestrial and mCDR approaches.

That's not going to work in the long term. Direct air capture, even if we get past some of the big issues associated with energy use for example, is not from a sustainability or technological approach going to be able to get us 10-20 billion tons of annual removals down the road, which is what the Intergovernmental Panel on Climate Change has told us may be necessary to help meet the temperature objectives of the Paris Agreement. Thus, we're going to need a portfolio of approaches, and we're going to need substantial support by governments to help research and facilitate scaling of these options.

The government is spending tens of millions of dollars, as opposed to billions, for a lot of these approaches. Quite frankly, at a time when you've got companies like Occidental Petroleum purchasing direct air capture companies, we don't need the federal government to be spending the

21. Wil Burns & Toby Bryce, *States Can Be Laboratories for Climate Policy*, Hill (Mar. 17, 2022), https://thehill.com/opinion/energy-environment/598613-states-can-be-laboratories-for-climate-policy/.

Copyright © 2025 Environmental Law Institute®, Washington, DC. Reprinted with permission from ELR®, http://www.eli.org

lion's share of its CDR investments in this context. Let the private enterprises that now see market opportunities in direct air capture carry most of the load.

The orphans of this imbalanced federal policy are other CDR approaches that may have to play a critical role in climate policymaking in the future, including enhanced rock weathering, biochar, and the mCDR approaches we've been discussing. In my opinion, that's where the government should be spending a lot more money, not only here but in Europe and in other parts of the world. Historically, nascent energy technologies and climate technologies, including fracking, nuclear, wind, and solar, were initially bucked up by substantial government investments in basic R&D. Private enterprise has picked up the ball when these technologies were ready for wide-scale deployment; I expect CDR to follow a similar trajectory.

CDR start-up companies are currently engaged in some modicum of R&D, but definitely not as much as we need, and the federal government clearly has a role to play. So, that's one thing I would do, shift priorities a bit or grow the pie given how important carbon removal is going to be needed in the future.

Another important role for government in the context of mCDR is to structure public engagement and deliberation about the ultimate role of these approaches in addressing climate change. It's critical to facilitating mCDR, and it's an ethical imperative since all of these options will engender both risks and benefits in discrete communities and for society at large.

I think that in a lot of cases, private enterprise hasn't done a particularly good job in structuring public engagement, largely because they don't have the resources or the expertise to do so. The public sector has a lot of experience with high-risk/high-return technologies and the ability to engage communities in talking about the benefits and the trade offs that such approaches may entail. Governments are generally more trusted than the private sector in this context also. I think in the future the federal government should have more of a formal role in the structuring and execution of public engagement and deliberation protocols.

The literature suggests that optimal public engagement processes are characterized by engagement with stakeholders in early stages of potential project development. Moreover, every effort should be made to engage the community in co-development of proposed projects to ensure social license to operate.

The other major role for the federal government is in developing effective MRV protocols for mCDR approaches. When it comes to mCDR, it's often very difficult to measure the sequestration that's being effectuated. If you take ocean alkalinity enhancement as an example, if you're putting minerals in the ocean to ultimately enhance atmospheric uptake of CO_2, it may be that the air-sea flux exchange we talked about before, where ultimately CO_2 is removed from ocean surfaces and CO_2 subsequently enters from the atmosphere, may occur hundreds of miles away from where you intervened. It may also transpire in a time frame of a year or two after you've intervened. How do you ascertain with some confidence that your intervention created this much sequestration?

It's critical, especially in the voluntary carbon markets, to be able to quantify sequestration associated with your interventions. Even when possible, that can be a very expensive proposition. It's very hard for small start-up companies, which is the vast majority of what we have in the mCDR space, to be able to develop effective MRV protocols. And it's not clear that the public or investors will be confident that companies will conduct MRV with integrity. Thus, it really should be the federal government's responsibility to at least oversee results.

Again, back to Romany's point of facilitating, investors are probably going to be a lot more confident if there is a governmental role that's confirming that this is actually happening. There are some efforts on the part of the U.S. government, and the European Union, to develop effective MRV protocols, but a lot more needs to be done, especially in the field of mCDR.

Meghan Gavin: You led us nicely into our fourth topic, which is community engagement. Recognizing that not everyone will support a deployment, I have a question for all of you: What advice do you have for project developers hoping to undertake meaningful outreach and engagement or for the attorneys advising those companies on their community engagement?

Wil Burns: I am by no means an expert in this context. Our research director, Sara Nawaz, is actively engaged in field research to develop effective public engagement models for mCDR. But there a few things I've learned from her that I'll convey; one is something I've said before, which is the importance of early engagement.

Communities don't like to feel that a developer of a potential project views public engagement as simply a "check-the-box exercise" (i.e., it's actively seeking the requisite permits from the government and plans to proceed no matter what the public may think about the project if permitting is attained). We call that form of deliberation DEAD, which stands for "Decide, Educate, Announce, and Defend." Communities, understandably, don't like this kind of Kabuki Theater.

So, engagement should begin at the very early stages of a contemplated project, and what the public thinks should matter. Again, co-development of projects can go a long way to instill the community with a sense that project developers care about their concerns and view them as partners. Try to figure out ways to address concerns and try to figure out what kind of community co-benefits could be developed in those projects and how to do that in an effective way.

Also, be honest with communities. Acknowledge the fact that some of these approaches may pose some risks, but also talk about the community benefits that can flow from these projects. We also have to have a frank discussion with the public writ large that we can't engage in magical thinking and believe that we can decarbonize the world economy in five years, or that simply zeroing out our emis-

Copyright © 2025 Environmental Law Institute®, Washington, DC. Reprinted with permission from ELR®, http://www.eli.org

sions will be enough. The science tells us we need carbon removal also, so it's incumbent upon the carbon removal community to make the case.

Then, we have to really listen and try to figure out ways to minimize those risks that may be attendant to development of mCDR projects. One of the ways that we learn about that is talking to those people who are working on the frontlines of potentially affected sectors, such as fisheries or tourism, and to work with them to address potential impacts.

Romany Webb: I agree with Wil that the engagement has to occur very early in the process, but it also should be ongoing. We often think about engagement as a one-off thing that we're doing as we're designing a project or once we're looking at putting something in the ground or in the water in this case. But actually, it needs to continue throughout the life of the project and evolve as the project evolves. That's really important to emphasize.

Also, Wil talked about the idea of co-developing projects, which gets at a really important point. A lot of developers tend to think of engagement as a one-way process. I'm going to the community and giving them information about this thing I'm going to do and how great it's going to be. Maybe I'll mention the risks as well.

But actually, the engagement really needs to be two-way so that the community can share their views, have input on the project, and ideally in a co-design scenario—as Wil talked about—inform and influence the development of that project.

The other thing that I will say is, as Wil mentioned in his answer to the previous question, all of that is hard. It takes a lot of time. It takes a lot of resources. Developers, in particular, need to dedicate resources to these things. Yes, it would be fantastic if the federal government played a larger role here. But absent that, developers really need to step up and fill this gap.

Across the climate space, often developers will talk a lot about how important community engagement is. They will have plans for doing that engagement, but they don't have the expertise on staff for doing it. The people in charge of community outreach are marketing executives that don't have the skill set to do meaningful engagement. We need to recognize that engagement is an element of these projects and recognize that doing it well requires specialized skills. We need to invest in that to make sure it happens.

Douglas Edwards: This is a great segue into the few things that I was hoping we would touch on at some point in this panel. One of the things that we say at Vesta is that progress moves at the speed of trust. So, Romany, I think you're spot-on.

This is a skill set in how to talk to communities and to make sure that the views of communities are integrated into projects. If you think about what Vesta is doing, there is a lot of science that has to be translated. It's very complicated. You also have to understand the co-benefits and the potential risks. Having an ability to talk about that with ease in the community is something that we have to invest resources in.

We've done that. We have an independent group monitoring the project in North Carolina. There had been Vesta employees on the ground in North Carolina, living there prior to the formation of the independent monitoring body that now employs those two individuals. We also hired Zach Cockrum as our vice president of policy and partnerships. He comes from the National Wildlife Federation and has spent his career thinking about how to do community engagement-type work.

When we think about moving at the speed of trust, as everybody said, part of that was starting early for both the projects in Southampton and then in Duck. We were engaging with those communities years in advance of actually placing the material and very well in advance of filing permit applications.

In terms of specific advice, I would focus on engaging deeply. This means bringing people in who are willing to sit down and talk about the risks and the science underpinning this work, and do it in a way where they're genuinely curious about the community's concerns and interests.

It also involves taking feedback from the community. One of the examples I would use is the coastal engineers who developed the project at Duck with us. They're from a group called Coastal Protection Engineering that is local to North Carolina. They developed the larger beach nourishment project that is done across four towns in North Carolina.

They know that coastline better than anybody from a beach nourishment perspective. We have worked closely with them for many years now in thinking about how to design the nearshore berm that we did in that environment. They also know the regulatory framework very well. All of the regulators have a relationship with them, so they understand how to sit down with both the community and the regulators who are acting on behalf of that community to say, well, this is what we're hoping to do. They helped us understand how to see the risks and how we might adjust these projects. And we did that.

In a number of cases, we were reacting to recommendations from the state. The state in this process effectively said, is there any way you can help us understand what is the minimum that you can do here? So, you'll see there's evidence about scaling down the project and moving it slightly further offshore, which helped complicate some of the questions under the MPRSA and §404, but we were trying to be very thoughtful about what they were saying, that they want to try to make sure the sand remains in the beach area and that not a lot of it goes up on the dry beach.

There are reasons for that. We could talk about it at length, but we heard that and tried to design that feedback into the project. So, if you take that in the next step, then I think that becomes the third piece of advice that I would give to anyone thinking about doing this type of work—to be transparent about how you proceed.

For example, we are very clearly trying to integrate this olivine sand concept into coastal protection work so that it will create coastal protection benefits. The field trial that

Copyright © 2025 Environmental Law Institute®, Washington, DC. Reprinted with permission from ELR®, http://www.eli.org

we did in North Carolina was very small. Relative to the size of the coastline and relative to the amount of sand that exists there now, it's not going to produce a material coastal protection benefit for the community. So, we're going to the community and making that clear. Like, these are the risks. We are hoping that this will counsel in favor of moving forward in a way that we can create coastal protection benefits, but that's not this project now.

The other thing is that this is an ongoing process. We have a three-year monitoring plan attached to the project in Duck. All of that information, all the data are going to get into peer-reviewed literature eventually, but there will be updates along the way.

Because Vesta is engaging in an independent monitoring process for that work, we don't often know all the answers to what the data says at the time that it's collected. For example, we recently had a presentation with our independent monitoring partner where we were learning at the same time as the rest of the room about the information coming out of the project. We're trying to be as transparent as possible by saying we're learning as the developer at the same time as the rest of the community what the results of the monitoring program are.

Doing things like that to indicate that we are being transparent and that we deserve the trust of the public and we're thinking about how to earn it is really important to Vesta as a company.

Meghan Gavin: Our questions are now rolling in. The first one is for you, Romany. Can you tell us about the benefits of the "research zones" concept that you proposed and why those are important in testing and/or scaling mCDR?

Romany Webb: We proposed, as part of our model legislation on mCDR research, the development of research zones. We know that we need robust oversight of mCDR activities, and we need them to be carefully evaluated in advance and monitored throughout. We established in our model legislation a permitting regime for facilitating that evaluation and monitoring.

But we recognize that often permitting takes a lot of time. It is often a very complex, costly, and time-consuming process. So, we were looking at different ways that we might streamline permitting without losing those benefits in terms of robust ex ante review and ongoing oversight throughout the life of the project.

One of the ways in which we thought about balancing those two objectives was by designating research zones, which would be areas of the ocean that are considered well-suited to conducting a particular type of mCDR research. Our thinking was that a federal agency could designate those zones in advance. As part of that designation process, it could do a lot of environmental assessments and other reviews to, for example, map baseline conditions and evaluate the impacts of a particular type of intervention in that space.

Then, when someone—like Doug from Vesta or someone else—comes along and wants to operate in that space, the federal agency can do an expedited review that's really tailored to the specifics of the project. It's not all that dissimilar from what we currently do in a lot of National Environmental Policy Act (NEPA)[22] reviews, where we do programmatic reviews to evaluate the impact of a particular type of activity in a particular location. Then, when a specific project is proposed that fits within those parameters, we do a simpler environmental review. That's then tiered to the programmatic review or incorporates analysis from the programmatic review.

That's really what the idea is based on, but we just adapted it to an ocean context. We do think it could be a good way of balancing this need to move things relatively quickly through the permitting process without losing any of the oversight or scrutiny.

Meghan Gavin: We have two questions that both involve iron fertilization. Wil, if you could take these first, but we might need the whole group's knowledge. The first question is: When we think about ocean iron fertilization, what if anything from the research side or policy side has changed since the original IronEx and SOFeX experience from the 1980s and 1990s?[23] The second question is: Does ocean iron fertilization pose any potential threat of increasing eutrophication?

Wil Burns: In terms of the first question, not a lot has changed because we haven't done a lot of additional field research. There was a large backlash that occurred because we had one rogue individual essentially who extended his middle finger to the world community and said, "I don't have to listen to coastal States, and there's no international law that stops me from conducting these operations."[24]

It began a backlash, spooked a lot of other researchers, and largely precipitated the response to ocean iron fertilization that we've seen from regimes like the London Convention and the CBD. There are efforts now to develop large-scale field research again, which is really what we need. The modeling and the mesocosm studies that we do in the context of ocean iron fertilization are only going to get us so far. We really need to characterize the very complicated potential impacts of ocean iron fertilization in terms of adverse impacts, but also whether it can actually effectuate large amounts of sequestration.

One of the keys is that, even if you get a lot of phytoplankton taking up CO_2, they have to fall below the photic, or light layer, after they die to really result in a lot of drawdown of CO_2 from the atmosphere. We're not certain that will happen. When you create huge amounts of phy-

22. 42 U.S.C. §§4321-4370h.
23. Emma Bazzani et al., *Southern Ocean Iron Limitation of Primary Production Between Past Knowledge and Future Projections*, 11 J. Marine Sci. Eng. 272 (2023); Stéphane Blain et al., *Effect of Natural Iron Fertilization on Carbon Sequestration in the Southern Ocean*, 446 Nature 1070 (2007).
24. Henry Fountain, *A Rogue Climate Experiment Outrages Scientists,* N.Y. Times (Oct. 18, 2012), https://www.nytimes.com/2012/10/19/science/earth/iron-dumping-experiment-in-pacific-alarms-marine-experts.html; Martin Lukacs, *World's Biggest Geoengineering Experiment "Violates" UN Rules*, Guardian (Oct. 15, 2012), https://www.theguardian.com/environment/2012/oct/15/pacific-iron-fertilisation-geoengineering.

Copyright © 2025 Environmental Law Institute®, Washington, DC. Reprinted with permission from ELR®, http://www.eli.org

toplankton, it's like creating a very large sushi bar for zooplankton. There may be a lot of consumption at the surface that results in immediate release of CO_2. So, we need that kind of field research.

There's a group at Woods Hole Oceanographic Institution led by a very good researcher that would like to thoroughly research ocean iron fertilization, but it's a very expensive enterprise. Obtaining that funding is a major challenge. There's been rumblings in other countries about doing this kind of research off the coast of Chile, for example, or South Korea. But again, it's been largely limited by both some of the legal concerns as well as the funding concerns. Very little has happened since then. There's been writings speculating what would happen, but that's pretty much it.

In terms of eutrophication, I don't want to minimize the potential impact of that, but I don't think that's the largest concern that we have from an environmental standpoint. Ocean iron fertilization would likely be deployed primarily in the open ocean, and some of the concerns about eutrophication are minimized in those environments. If we look at the historic evidence when we've seen large introductions of naturally based iron into those ecosystems, we did not see a lot of large-scale eutrophication.

I think a primary concern that we have with ocean iron fertilization is nutrient robbing, if you do it in the Southern Ocean. North of the Southern Ocean are some very rich fishing grounds. If large-scale proliferation of phytoplankton takes up a lot of the nutrients that ultimately would have ended up in those fisheries areas, it could wreak havoc with fisheries, and potentially lead to geostrategic tensions as well as have financial implications. Moreover, if these areas have fewer nutrients for phytoplankton growth, it could offset a lot of the benefits of the approach.

Then, we're also afraid that when you have phytoplankton die and create anoxic environments, you may get a lot of production of nitrous oxides and methane, which are more potent greenhouse gases than CO_2. That could obviate a lot of the benefits that you get from the process.

Meghan Gavin: Doug, why don't you take the next one: Do you think that there is currently sufficient monitoring and quantification to accurately estimate coastal carbon budgets to have a baseline to compare to? This made me think of Hourglass Climate, which you briefly touched on.

Douglas Edwards: I'll talk a little bit about Hourglass. I'm not a scientist. I can't give you an answer on exactly an estimate of the carbon budget and is there a baseline to compare to. That is the job of the science community that is working through Hourglass, to think about things like that.

The formation of Hourglass is a thing that Vesta supported in connection with the Duck project. A number of scientists that used to work at Vesta are now working with an independent nonprofit led by Dr. Grace Andrews. We have engaged that nonprofit to conduct the monitoring program at the Duck location required by the state as part of the overall development of this technology.

All of that work is being done on a completely independent basis. The goal is for Hourglass to go publish that work in the scientific literature unimpacted by whatever Vesta's use might be. Even the perception of that being a possibility is cut off through the creation of this relationship.

So, what I would encourage everyone to do is, if you have questions like this, you should reach out directly to Dr. Andrews at Hourglass and ask those questions. Approach her to understand what the monitoring program is at the project in Duck. Also, potentially engage her if you're representing or part of a group that is considering doing mCDR work. Part of Hourglass' role in the ecosystem here is to provide a voice that is independent and capable of answering these questions in a way that generates public trust in the mCDR community.

That is a longwinded answer to your question, but at the end of the day I think the goal here is to make sure that the right person with the right incentives is answering that. So, I'd suggest you reach out to Dr. Andrews.

Meghan Gavin: We have two questions left. First, do you believe that a federal permitting solution is needed to better regulate mCDR approaches? If so, what might that look like?

Second, beyond a code of conduct, what other mechanisms, tools, or policy instruments can be implemented to ensure meaningful engagement?

Romany Webb: I will say that there is federal permitting in this space. There is no question that there is an existing legal landscape that applies in this context. While we are talking about a new set of activities, that does not mean that existing law cannot apply to them. We are seeing the application of existing federal regimes to mCDR projects, as Doug talked about in the Vesta case but also in other cases as well. For example, we've seen the first permit applications for an mCDR project under the MPRSA, and EPA is evaluating them right now.

So, there is a federal permitting regime in place. It is clearly complex and challenging to navigate. If we are thinking about ultimately scaling these activities, we should think about whether this existing regime is fit for that purpose and can support the scale-up over time.

I would argue that there are issues within the existing regime that need to be addressed. They could be addressed through the creation of a new purpose-built framework along the lines of our model law or they could be addressed through changes and clarifications to the existing regimes. There are benefits and drawbacks to both of those approaches, but we are going to need to think about the best approach to take as we look to scale up these activities.

Since this is a legal audience, the only other wrinkle I will insert is that obviously there have been some really important court decisions of late around applying existing long-standing statutes to new classes of activities.[25] We

25. *See, e.g.*, Loper Bright Enters. v. Raimondo, 603 U.S. __, 144 S. Ct. 2244 (2024); West Virginia v. Environmental Prot. Agency, 597 U.S. 697, 124 S. Ct. 2587 (2022).

Copyright © 2025 Environmental Law Institute®, Washington, DC. Reprinted with permission from ELR®, http://www.eli.org

should think about what that means in this context and whether that suggests that one of those two approaches I laid out may be better than the other. That conversation is just starting to happen. I hear whispers of it happening in the mCDR world, but it is something that needs much greater attention.

Wil Burns: One thing I'll add is something that was adverted to earlier, that the statutes we have, especially the pollution-based statutes, aren't necessarily fit for purpose or contemplated for the kind of intervention that we're looking at. If you look at the MPRSA, for example, there's so much language in there that says we should seek to minimize the amount of materials we put in the ocean, or privilege land-based approaches for disposal. That certainly makes sense when you're dealing with radioactive materials and some toxic pollutants.

But in the case of things like ocean alkalinity enhancement, we actually want to put a fairly large amount of alkaline materials in the ocean to achieve the goal of sequestration. The MPRSA's language seems ill-suited to facilitate this. It needs language that acknowledges some interventions can be beneficial in the ocean and not always privilege absolutely minimizing those interventions. But that's complicated, and it's certainly not where we're at.

Douglas Edwards: I'll just say these frameworks can always be better. They can always develop and include progress as to how we think about developing these types of technologies. Whatever it is, Vesta will comply with it. That is our role, to work with government and make sure government has data available to it to understand what it should be regulating. Part of the reason we feel so strongly about putting information out to the public is so that the data can be used.

I've made this point to EPA and the Corps a number of times. We'd love to sit down and show them what we've learned, and that may help them think about whoever comes after us and is attempting to do something similar. We just want to be part of that ecosystem and if it means that Congress gets involved, that there is a rulemaking between the Corps and EPA, then great. We will engage there and try to be helpful in making sure that those rules and regulations come out in a way that is protective of the environment and helps develop the R&D and does all of that in the right balance.

Meghan Gavin: Regarding regulation of point source ocean alkalinity enhancement, which falls under the CWA, one strategy could be to comply with the laws as they are written now, recognizing that they are not the best fit, but they are what we have and, as Doug says, we need to comply. Then, maybe the industry pursues a general permit, so you are still within the current regime, but you are able to move faster; we will be able to get more of these projects off the ground once we know what their environmental impacts are, and we have more of a standardized process for regulatory compliance.

And then after that, years later maybe, is when you go for a permitting paradigm shift, establishing a regime besides NPDES. We need a multiphased strategy like this to make sure that we're scaling responsibly, always taking in and adjusting to feedback and information on project impacts to give our best efforts to acting in an environmentally sound and culturally sensitive way.