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REMOVING CARBON DIOXIDE THROUGH OCEAN ALKALINITY ENHANCEMENT: LEGAL CHALLENGES AND OPPORTUNITIES

**By Romany M. Webb, Korey Silverman-Roati, and Michael B. Gerrard
August 2021**

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EXECUTIVE SUMMARY

Many scientists now agree that achieving the 2015 Paris Agreement's goal of limiting global warming to "well below" 2°C, and ideally to 1.5°C, above pre-industrial levels will require both major reductions in greenhouse gas emissions and the removal of massive amounts of carbon dioxide from the atmosphere. Various terrestrial and ocean-based carbon dioxide removal techniques have been proposed, but further research is needed to evaluate their relative benefits and drawbacks. Initial studies suggest that terrestrial carbon dioxide removal techniques, such as bioenergy with carbon capture and storage, may require large amounts of land, which could lead to conflicts with other users. This may be less of an issue where carbon dioxide removal is performed in the oceans, given their large surface area and the fact that human users of the oceans are typically broadly dispersed.

One widely discussed ocean carbon dioxide removal technique is ocean alkalinity enhancement, which involves adding alkalinity to ocean waters, either by discharging alkaline materials (e.g., ground olivine or dunite rock) or through an electrochemical process. The addition increases ocean pH levels, thereby enabling greater uptake of carbon dioxide, while also reducing the adverse impacts of ocean acidification.

This paper examines the international and U.S. legal frameworks that apply to ocean alkalinity enhancement. Subsequent work will examine the relevant laws of selected other coastal countries.

While there are currently no international or U.S. laws dealing specifically with ocean alkalinity enhancement, various general environmental and other laws could apply to the practice. At the international level, the most directly applicable instruments are the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter ("London Convention"), and the Protocol to that Convention ("London Protocol"). Both instruments regulate the dumping of materials into ocean waters and could apply to ocean alkalinity enhancement projects involving the discharge of alkaline rocks. Assuming that is the case, projects occurring under the jurisdiction of a party to the London Convention or London Protocol would have to be permitted by that party, in accordance with the terms of those instruments. The London Convention gives parties broad authority to permit projects, provided they do not use certain, prohibited substances listed in the Convention. The London Protocol is more restrictive, however. Parties to the London Protocol likely could not permit ocean alkalinity enhancement projects.

As well as the London Convention and Protocol, several other international and regional instruments could also apply to ocean alkalinity enhancement, depending on exactly how and where it occurs. Examples include the Convention on Biological Diversity, the United Nations Convention on the Law of the Sea, the International Convention for the Prevention of Pollution from Ships, the Basel Convention, and European Union Marine Strategy Framework Directive. Various principles of customary international law, including the so-called "no harm" rule, could also apply.

Potentially applicable U.S. laws include the Outer Continental Shelf Lands Act, the Marine Protection, Research, and Sanctuaries Act, the National Environmental Policy Act, the Endangered Species Act, the Coastal Zone Management Act, and the Clean Water Act.

The application of these laws will depend on, among other factors, the offshore location of any ocean alkalinity enhancement project, the materials and technology used in the project, and whether the project makes use of the sea floor. None of the laws expressly prohibit ocean alkalinity enhancement, but several impose permitting and other requirements, which could make project development more difficult or costly. Projects may also be subject federal and state requirements to consult with Native American tribes and other stakeholders. A full list of requirements is included in Appendix A to this paper.

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1. INTRODUCTION

Keeping global average temperatures “well below” 2°C, and ideally to 1.5°C, above pre-industrial levels—i.e., the goal set in the 2015 Paris Agreement¹—will require a rapid and dramatic reduction in greenhouse gas emissions. Modeling by the Intergovernmental Panel on Climate Change (“IPCC”) and others shows that emissions must be reduced to “net zero” by mid-century or shortly thereafter.² According to the IPCC, achieving such steep reductions in such a short period of time will require “systems transitions [that] are unprecedented in terms of scale,” with “far-reaching” changes needed across all economic sectors.³ There is growing concern that the necessary changes will not be achieved in time, leading to excess greenhouse gas emissions, which will later need to be removed from the atmosphere.⁴ Even if steep emission reductions do occur, greenhouse gas removal will likely be needed to offset residual emissions from difficult-to-eliminate sources (e.g., aviation and heavy industry).⁵ Indeed, all of the emissions pathways identified by the IPCC as consistent with limiting warming to 1.5°C above pre-industrial levels assume some level of greenhouse gas removal,⁶ as do most of the IPCC’s 2°C-consistent emissions pathways.⁷

Past research on greenhouse gas removal has focused primarily on options for drawing carbon dioxide out of the atmosphere and storing or utilizing it in some way. Much of the focus has been on terrestrial-based approaches, such as afforestation and reforestation, direct air capture, and bioenergy with carbon capture and storage (“BECCS”).⁸ While each has been shown to be technically feasible, their use presents various risks and challenges. For example, many terrestrial-based approaches require large amounts of land and other resources, which could lead to conflicts with other uses and thus limit their deployment.⁹ This has led to growing interest in the possibility of using the oceans for carbon dioxide removal.

The oceans already remove approximately ten gigatons of carbon dioxide from the atmosphere annually through natural processes.¹⁰ Initial research suggests that uptake of carbon dioxide by the oceans could be increased in a number of ways, including by adding

1 Paris Agreement, Dec. 12, 2015, Art. 2(1)(a).

2 Myles Allen et al., *Summary for Policymakers in GLOBAL WARMING OF 1.5°C: AN IPCC SPECIAL REPORT* (V. MASSON-DELMOTTE ET AL. EDS., 2018); OTTOMAR EDENHOFFER ET AL., *CLIMATE 2014: MITIGATION OF CLIMATE CHANGE, CONTRIBUTION OF WORKING GROUP III TO THE FIFTH ASSESSMENT REPORT BY THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE* (2014), <http://perma.cc/T8J5-MBTA>. See also, e.g., UN ENV’T PROGRAM, *EMISSIONS GAP REPORT 2020* (2020), <https://perma.cc/6G97-9X68>;

3 Allen et al., *supra* note 2, at 15.

4 UN Env’t Program, *supra* note 2, at 33-34.

5 *Id.*

6 Allen et al., *supra* note 2, at 17.

7 Edenhofer et al., *supra* note 2, at 14-15.

8 See generally, NATIONAL ACADEMIES OF SCIENCES, ENGINEERING AND MEDICINE, *NEGATIVE EMISSIONS TECHNOLOGIES AND RELIABLE SEQUESTRATION: A RESEARCH AGENDA* (2019), <https://www.nap.edu/catalog/25259/negative-emissions-technologies-and-reliable-sequestration-a-research-agenda>.

9 *Id.* at 9-13.

10 Wil Burns & Charles R. Corbett, *Antacids for the Sea? Artificial Ocean Alkalinization and Climate Change*, 3 ONE EARTH 154, 154 (2020).

alkalinity to the water (“ocean alkalinity enhancement”).¹¹ Given the large extent of the oceans, which cover approximately seventy-one percent of the Earth’s surface, significant amounts of carbon dioxide could be stored through this approach.¹² Moreover, because human users of the oceans are fairly broadly dispersed, the potential for conflicts is reduced. Ocean alkalinity enhancement may have other drawbacks, however. The potential for ocean alkalinity enhancement to adversely affect marine ecosystems is currently poorly understood. There is also currently no established process for measuring and verifying the amount of carbon dioxide removed through ocean alkalinity enhancement and the longevity of its storage. As such, it may be difficult to use ocean alkalinity enhancement projects to generate carbon credits or similar instruments for sale (e.g., under an emissions trading scheme), which is likely a necessary precondition for private investment.

Research into ocean carbon dioxide removal has recently been supported by government bodies in the U.S. and Europe. In the U.S. the Consolidated Appropriations Act of 2021 directs the Secretary of Energy to establish a “research, development, and demonstration program . . . to test, validate, or improve technologies and strategies to remove carbon dioxide from the atmosphere on a large scale.”¹³ Among the technologies covered by the program are enhanced weathering, which could include ocean alkalinity enhancement.¹⁴ The Act authorizes the appropriation of up to \$60 million in fiscal year 2021 for research on this and other non-direct air capture technologies.¹⁵

The European Union (“EU”) is similarly supporting research into ocean carbon dioxide removal. In 2020, the EU announced that it would provide over €7 million to fund an interdisciplinary research program, known as OceanNETs, to explore the feasibility and positive and negative impacts of various ocean carbon dioxide removal techniques, including ocean alkalinity enhancement.¹⁶ The EU has also provided over €5 million in funding for a separate project, known as NEGEM, to explore whether and how various technical, economic, and socio-political factors could limit the use of different carbon dioxide removal techniques (both terrestrial and ocean-based).¹⁷

This paper is intended to complement the ongoing technical, economic, and other research into ocean carbon dioxide removal. It provides the first comprehensive analysis of the laws applicable to ocean alkalinity enhancement at both the international level and domestically in the U.S. As we show, while there are currently no international or U.S. laws dealing specifically with ocean alkalinity enhancement, those projects could be regulated under various general environmental and other laws. There is some uncertainty regarding exactly how those laws,

11 See *infra* Part 2.

12 Burns & Corbett, *supra* note 10, at 154.

13 Consolidated Appropriations Act, 2021, H.R. 133, 116th Cong., §5001, 1076-77 (2020), <https://rules.house.gov/sites/democrats.rules.house.gov/files/BILLS-116HR133SA-RCP-116-68.pdf>.

14 *Id.* at 1077.

15 *Id.* at 1087 (The Act authorizes \$175 million for CDR research, \$115 million of which is allocated to direct air capture prize competitions).

16 European Commission, *Ocean-based Negative Emission Technologies: Project Description*, <https://cordis.europa.eu/project/id/869357> (last updated Apr. 20, 2020).

17 European Commission, *Quantifying and Deploying Responsible Negative Emissions in Climate Resilient Pathways*, <https://cordis.europa.eu/project/id/869192> (last updated Oct. 14, 2020).

which were developed to regulate other activities, will apply to ocean alkalinity enhancement. Much will depend on precisely where and how ocean alkalinity enhancement projects are conducted. Appendix A to this paper lists key permitting and other legal requirements applicable to ocean alkalinity enhancement projects by location and type of activity.

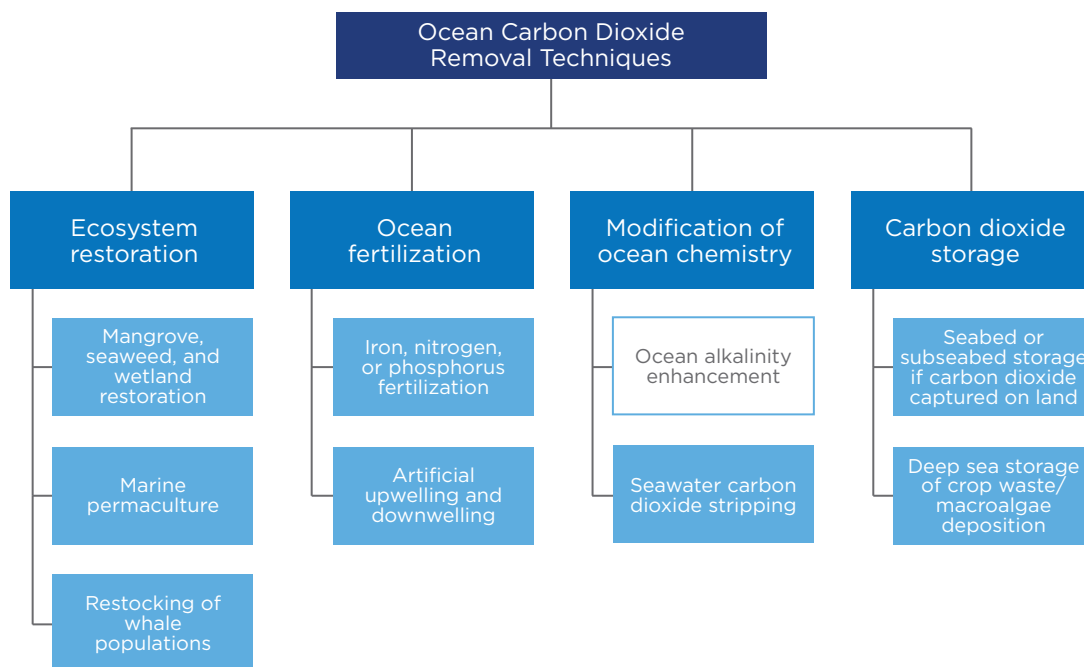
The remainder of this paper is structured as follows: Part 2 begins with a brief introduction to ocean alkalinity enhancement as a carbon dioxide removal technique. Part 3 then discusses key principles of international and U.S. law defining jurisdiction over the oceans. In part 4, we explore several international agreements that could apply to ocean alkalinity enhancement, while part 5 discusses applicable U.S. law. Part 6 concludes.

2. OVERVIEW OF OCEAN ALKALINITY ENHANCEMENT

Carbon dioxide removal refers to intentional efforts to take carbon dioxide out of the atmosphere and utilize it in some way or store it in geologic formations, terrestrial ecosystems, or the oceans.¹⁸ Ocean-based approaches to carbon dioxide removal can take a number of forms, but are often divided into four broad categories as shown in Figure 1 below. Here, we focus on ocean alkalinity enhancement, which is a form of ocean chemistry modification.

As the name suggests, ocean alkalinity enhancement involves adding alkalinity to ocean waters, which increases pH levels and thereby enables greater uptake of carbon dioxide by the oceans. As a result of natural processes, the oceans have absorbed approximately thirty percent of anthropogenic carbon dioxide emissions since the beginning of the Industrial Revolution.¹⁹ When carbon dioxide enters the oceans, it reacts with the water, forming carbonic acid.²⁰ The acid dissociates (i.e., breaks) into hydrogen ions and bicarbonate ions.²¹ Over time, calcifying

Figure 1: Types of Ocean Carbon Dioxide Removal²²



¹⁸ National Academies of Sciences, Engineering and Medicine, *supra* note 8, at 1.

¹⁹ Nicholas Gruber et al., *The Oceanic Sink for Anthropogenic CO₂ from 1994 to 2007*, 363 *SCIENCE* 1193, 1193 (2019).

²⁰ Gagern, *supra* note 19, at 9.

²¹ *Id.*

²² Based on figure in Antonius Gagern et al., *Ocean Alkalinity Enhancement: Current State of Knowledge and Potential Role of Philanthropy* 7 (2019), <https://perma.cc/A92F-AEY4>.

organisms convert the bicarbonate ions into calcium carbonate, which forms the basis of their shells and skeletons.²³ When the organisms die, they sink to the ocean floor and a portion of the calcium carbonate is buried, effectively resulting in long-term storage of carbon dioxide in mineral form.²⁴

Past uptake of carbon dioxide by the oceans has increased the acidity of the water by approximately thirty-percent above pre-industrial levels.²⁵ Ocean acidification impairs the ability of many corals, crustaceans, and other calcifying organisms to form their skeletons and shells.²⁶ It also limits the conversion of dissolved carbon dioxide into bicarbonate ions and carbonate sediments which, in turn, limits the oceans' ability to absorb more carbon dioxide.²⁷ Ocean alkalinity enhancement aims to mitigate these problems by adding alkalinity to ocean waters.

Ocean alkalinity enhancement can be performed in several ways, including by discharging ground alkaline rock into ocean waters, where it reacts with dissolved carbon dioxide to produce carbonate and bicarbonate ions, which eventually become carbonate sediments on the ocean floor (i.e., via the process described above). One widely available alkaline rock is limestone, but initial research suggests that discharging it into ocean waters may be of limited use because the upper oceans are already supersaturated with calcium carbonate (i.e., the primary component of limestone), limiting its dissolution.²⁸ To address this issue, limestone could be converted to lime, which is principally calcium oxide and thus dissolves more rapidly.²⁹ Silicate-rich rocks and minerals, such as dunite and olivine, could also be used.³⁰ In all cases, the rock or mineral would be mined and processed on land and then transported to the coast, where it would be loaded onto ships for discharge into ocean waters.

As an alternative to adding alkaline rocks to ocean waters, ocean alkalinity enhancement could be performed through an electrochemical process in which an electric current is applied to the water, causing it to separate into basic and acidic streams.³¹ The basic stream could be returned to the ocean, where it would increase the alkalinity of the water, leading to additional uptake of carbon dioxide. The acidic stream, which comprises hydrochloric acid, could be collected and transported to land for use in industrial processes. For this process to yield a net reduction in atmospheric carbon dioxide levels, the electricity used would have to be generated from zero-carbon sources. The most commonly discussed option involves using offshore wind turbines that are co-located with the electrochemical system.³²

23 *Id.*

24 *Id.* at 8.

25 Nat'l Oceanic & Atmospheric Admin., *Ocean acidification*, <https://perma.cc/DDE2-A4ZH> (last visited Jan. 21, 2020).

26 See generally Nathaniel R. Mollica et al., *Ocean Acidification Affects Coral Growth by Reducing Skeletal Density*, 115 PNAS 1755 (2018).

27 Gagern, *supra* note 19, at 9.

28 *Id.* at 11-13.

29 *Id.* at 11.

30 Jens Hartman et al., *Enhanced Chemical Weathering as a Geoengineering Strategy to Reduce Atmospheric Carbon Dioxide, Supply Nutrients, and Mitigate Ocean Acidification*, 51 REV. GEOPHYSICS 113 (2013).

31 This process can be performed via electrolysis or electrodialysis. See generally, Greg H. Rau et al., *The Global Potential for Converting Renewable Electricity to Negative-CO₂-Emissions Hydrogen*, 8 NATURE CLIMATE CHANGE 621 (2018).

32 *Id.*

Whatever approach is used, ocean alkalinity enhancement has the potential to remove and store large amounts of carbon dioxide, likely for tens of thousands of years. A 2013 study found that ocean alkalinity enhancement using silicate-based rocks could result in the storage of four gigatons of carbon dioxide annually (i.e., equivalent to twelve percent of annual global energy-related emissions).³³ Ocean alkalinity enhancement would also have the co-benefit of mitigating the negative effects of ocean acidification on marine ecosystems.³⁴ It also presents risks and challenges, however.

Ocean alkalinity enhancement is thought to be one of the more expensive carbon dioxide removal techniques. Initial research puts the cost of ocean alkalinity enhancement at \$55 to \$107 per ton of carbon dioxide sequestered,³⁵ which is well above recent estimates for afforestation (\$24 per ton)³⁶ and some forms of BECCS (\$15 to 400 per ton)³⁷ and direct air capture (\$27 to \$136 per ton).³⁸ Ocean alkalinity enhancement may also have other drawbacks. Some rock and mineral materials (e.g., dunite and olivine) proposed for use in ocean alkalinity enhancement contain heavy metals, which could contaminate ocean waters and harm marine ecosystems.³⁹ They could also act as fertilizers, stimulating the growth of certain marine plants and other organisms, which could have negative flow-off effects.⁴⁰

33 Peter Köhler et al., *Geoengineering Impact of Ocean Dissolutions of Olivine on Atmospheric CO₂, Surface Ocean pH and Marine Biology*, 8 ENVIRON. RES. LETTERS 014009 (2013). Global energy-related carbon dioxide emissions were approximately 33 gigatons in 2019. See Int'l Energy Agency, *Global CO₂ Emissions in 2019*, <http://perma.cc/NTL5-TJWZ> (last updated Feb. 11, 2020).

34 Burns & Corbett, *supra* note 10, at 155.

35 Gagern et al., *supra* note 19, at 13.

36 Jessica Strefler et al., *Potential and Costs of Carbon Dioxide Removal by Enhanced Weathering of Rocks*, 13 ENVTL. RES. LETTERS 030410, 18 (2018). Strefler et al. reported costs for direct air capture of \$430 to \$570 per ton, but other, more recent studies put the figure significantly lower. See e.g., Brandon R. Sutherland, *Pricing CO₂ Direct Air Capture*, 3 JOULE 1571, 1572 (2019).

37 Christopher Consoli, Global CCS Institute, Bioenergy and Carbon Capture and Storage 9 (2019), <https://perma.cc/GK6J-4BXE>.

38 Brandon R. Sutherland, *Pricing CO₂ Direct Air Capture*, 3 JOULE 1571, 1572 (2019).

39 Gagern et al., *supra* note 19, at 16.

40 *Id.* at 48.

3. JURISDICTION OVER THE OCEANS

Regulatory jurisdiction over the oceans is governed by international law. The relevant principles of international law and their application in the U.S. are discussed in this part.

3.1 International Legal Framework

The United Nations Convention on the Law of the Sea (“UNCLOS”) defines the extent of countries’ jurisdiction over the oceans. UNCLOS has been ratified or otherwise adopted by 167 countries and the European Union.⁴¹ The U.S. has not ratified UNCLOS, but recognizes many of its provisions, including those discussed in this Part, as forming part of customary international law.⁴²

Under UNCLOS, non-landlocked countries (“Coastal Countries”) have jurisdiction over areas within 200 n.m. of the low water line along their coasts (the “baseline”) and further in some circumstances.⁴³ The 200 n.m. zone is generally divided into three key parts (see Figure 2), each of which has a different legal status as follows:

- The **territorial sea**, which comprises the waters and submerged land extending twelve n.m. from the baseline, and forms part of the sovereign territory of the Coastal Countries.⁴⁴
- The **exclusive economic zone** (“EEZ”), which comprises the waters situated beyond the territorial sea, up to 200 n.m. from the baseline.⁴⁵ Within the EEZ, the Coastal Countries have sovereign rights to explore, exploit, conserve, and manage natural resources and undertake other activities for the economic exploitation of the zone, among other things.⁴⁶
- The **continental shelf**, which comprises the submerged land extending beyond the territorial sea to the farthest of 200 n.m. from the baseline or the outer edge of the continental margin,⁴⁷ up to sixty n.m. from the foot of the continental slope or the point where sediment thickness is one percent of the distance thereto.⁴⁸ Each Coastal Country has sovereign rights over its continental shelf for the purpose of exploring and exploiting natural resources.⁴⁹

41 United Nations, *Law of the Sea*, <https://perma.cc/AZ7L-APX4> (last updated Jan. 19, 2021).

42 *Id.* See also U.S. Dept. of State, *Law of the Sea Convention*, <https://perma.cc/A8A5-QA98> (last updated Mar. 7, 2019).

43 United Nations Convention on the Law of the Sea, Dec. 10, 1982, 1833 U.N.T.S. 397 [hereinafter UNCLOS].

44 *Id.* Art. 2-3.

45 *Id.* Art. 55 & 57.

46 *Id.* Art. 56.

47 The “continental margin” refers to the submerged prolongation of the land mass of the Coastal State. See *id.* Art. 76(1).

48 *Id.* Art. 76(5). The continental shelf cannot extend more than 100 n.m. from the 2,500 meter isobath or 350 n.m. from the baseline. See *id.*

49 *Id.* Art. 77.

Except as noted above, Coastal Countries generally do not have jurisdiction over areas more than 200 n.m. from shore, which form part of the high seas.⁵⁰ UNCLOS provides for “freedom of the high seas,” which is defined to include, “for both coastal and land-locked states: (a) freedom of navigation; freedom of overflight; freedom to lay submarine cables and pipelines . . . ; freedom to construct artificial islands and other installations . . . ; freedom of fishing . . . ; [and] (f) freedom of scientific research.”⁵¹

3.2 U.S. Jurisdictional Areas

Consistent with international law the U.S. has claimed jurisdiction over all waters up to 200 n.m. from its coast (“U.S. waters”).⁵² Jurisdiction is shared among the coastal states, which have primary authority over areas within three n.m. of shore (and further in some cases) (“state waters”) and the federal government, which has authority over areas lying beyond state waters within U.S. territory (“federal waters”).

3.2.1 State Waters

Under the Submerged Lands Act of 1953 (“SLA”), the boundaries of each coastal state extend three n.m. from its coastline, except in the Gulf of Mexico, where the boundaries of Texas and Florida extend nine n.m. from the coastline.⁵³ For the purposes of the SLA, a state’s “coastline” is defined as “the line of ordinary low water along that portion of the coast which is in direct contact with the open sea and the line marking the seaward limit of inland waters.”⁵⁴

Offshore waters within state boundaries fall under the primary jurisdiction of the relevant coastal state, though the federal government also has some regulatory authority within state waters. Each coastal state has title to, and ownership of, all lands beneath its state waters and the natural resources (including minerals, marine animals, and plant life) within those lands and waters.⁵⁵ The federal government has relinquished all of its rights to, and interests in, land and resources within state waters (though it retains some regulatory authority).⁵⁶

3.2.2 Federal Waters

Waters lying beyond state boundaries up to 200 n.m. from shore fall under the exclusive authority of the federal government. The federal government also has exclusive authority over offshore land, comprising the seabed and subsoil of the outer continental shelf (“OCS”). The federal Outer Continental Shelf Lands Act (“OCSLA”) defines the OCS as those “submerged

50 *Id.* Art. 86-87.

51 *Id.* Art. 87.

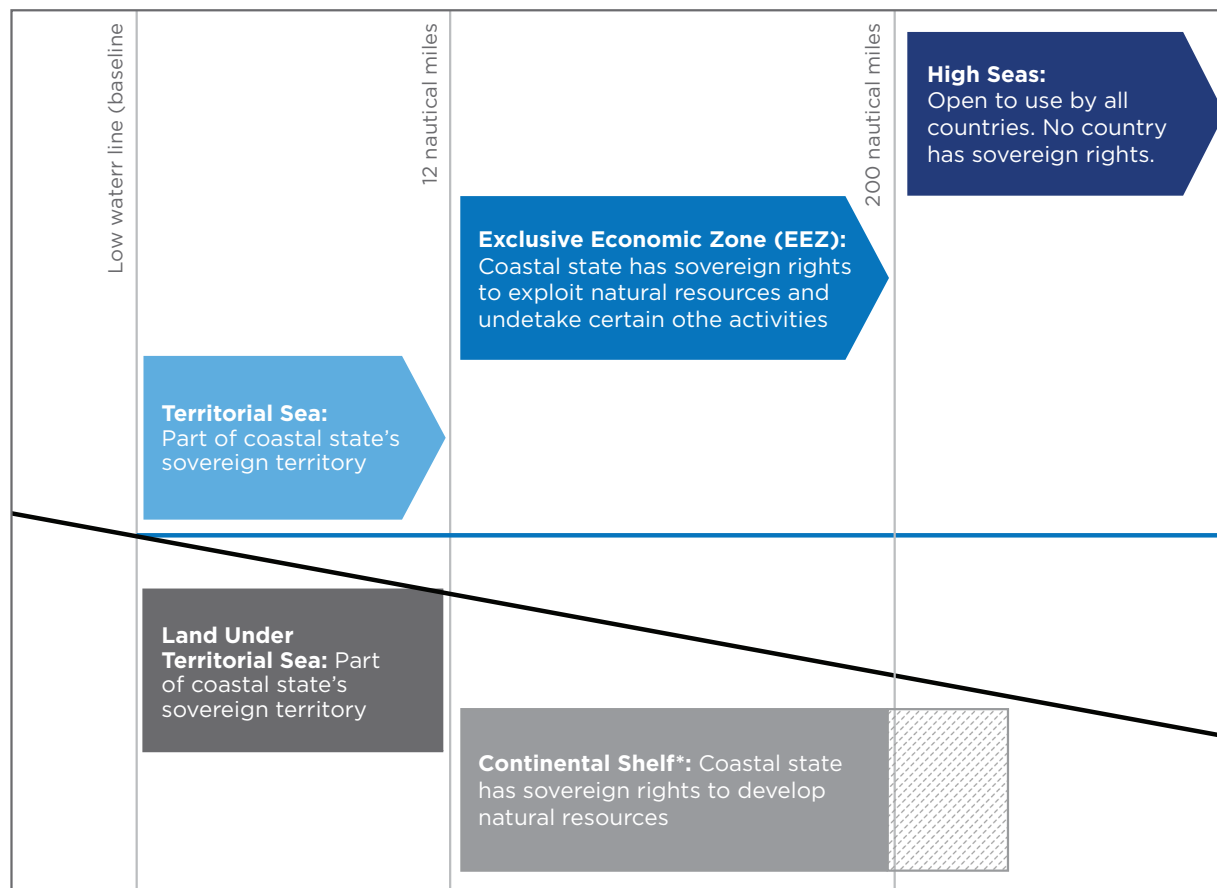
52 Proclamation No. 5030, 48 Fed. Reg. 10605 (Mar. 14, 1983).

53 43 U.S.C. § 1312 (providing that “[t]he seaward boundary of each original coastal State is approved and confirmed as a line three geographic miles distant from its coast line”). *See also id.* § 1301(b) (defining the term “boundaries” and providing that “in no event shall the term boundaries . . . be interpreted as extending from the coast line more than three geographical miles in the Atlantic Ocean or the Pacific Ocean, or more than three marine leagues into the Gulf of Mexico”). A “marine league” is equivalent to three n.m. Thus, in the Gulf of Mexico, the boundaries of Texas and Florida extend nine n.m. from the coastline. *See generally* U.S. v. Louisiana, 100 S.Ct. 1618 (1980), 420 U.S. 529 (1975), 394 U.S. 11 (1969), 389 U.S. 155 (1967), 363 U.S. 1 (1960), 339 U.S. 699 (1950).

54 43 U.S.C. § 1301(c).

55 *Id.* § 1311(a)(1).

56 *Id.* § 1311(b).

Figure 2: Offshore Zones Identified in UNCLOS⁵⁷

* The continental shelf typically extends 200 n.m. from shore. However, in some circumstances, it may extend beyond this point to the farthest of 100 n.m. from the 2,500 meter isobath or 350 n.m. from the baseline.

lands lying seaward and outside of the area [subject to state jurisdiction] . . . and of which the subsoil and seabed appertain to the U.S.”⁵⁸ As discussed in subpart 3.2.1 above, state jurisdiction typically ends three n.m. from shore (except off Texas and the west coast of Florida, where it ends nine n.m. from shore), at which point the OCS begins. The OCS extends to the seaward limit of U.S. jurisdiction, defined under international law as the farthest of:

- 200 n.m. from the baseline (i.e., normally the low-water line along the coast); or
- if the continental margin exceeds 200 n.m., a line:

57 ROMANY M. WEBB & MICHAEL B. GERRARD, OVERCOMING IMPEDIMENTS TO OFFSHORE CARBON DIOXIDE STORAGE: LEGAL ISSUES IN THE U.S. AND CANADA 8 (2019), <https://perma.cc/92MV-4Y5Q>.

58 *Id.* § 1331.

- sixty n.m. from the foot of the continental shelf; or
- beyond the shelf foot where the sediment thickness is one percent of the distance thereto.⁵⁹

The OCS cannot, however, extend more than 350 n.m. from the baseline or 100 n.m. from the 2,500 meter isobath (i.e., a line connecting the depth of 2,500 meters).⁶⁰

59 UNCLOS, *supra* note 43, Art. 76(1) & (4).

60 *Id.* Art. 76(5).

4. INTERNATIONAL LEGAL FRAMEWORK FOR OCEAN ALKALINITY ENHANCEMENT

Activities performed at sea are governed by various international agreements to which individual countries have consented to be bound, as well as customary international law, which comprises universal legal standards that are binding on all countries. While there are no international agreements dealing specifically with the governance of ocean alkalinity enhancement, several instruments contain provisions that could apply to research or commercial-scale operations. These include UNCLOS, the Convention on Biological Diversity (“CBD”), the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (“London Convention”), and the Protocol to that Convention (“London Protocol”). Various rules of customary international law could also apply to ocean alkalinity enhancement projects. The relevant agreements and rules, and their application to ocean alkalinity enhancement, are discussed in this Part.

4.1 Relevant International Agreements

4.1.1 Convention on Biological Diversity

Adopted in 1992, the CBD aims to promote “the conservation of biological diversity, [and] the sustainable use of its components.”⁶¹ At the time of writing, the CBD had been ratified or otherwise accepted by 195 countries, as well as the European Union.⁶² The U.S. had signed, but not ratified, the CBD.⁶³

Article 7 of the CBD requires parties to, “as far as possible and as appropriate,” identify projects “which have or are likely to have significant adverse impacts on the conservation and sustainable use of biological diversity, and monitor their effects.”⁶⁴ Under Article 14 of the CBD, parties must require environmental impact assessments of the projects, “with a view to avoiding or minimizing [their] adverse effects.”⁶⁵ For projects that could have transboundary effects, parties must “[p]romote . . . notification, exchange of information and consultation” with potentially affected countries.⁶⁶ In the case of “imminent or grave” transboundary damage, parties must “notify immediately the potentially affected” countries, and “initiate

61 Convention on Biological Diversity, May 22, 1992 [hereinafter “CBD”].

62 Convention on Biological Diversity, *List of Parties*, <https://perma.cc/ZY3W-9PC3> (last visited Jan. 19, 2021).

63 *Id.* Article 18 of the Vienna Convention on the Law of Treaties provides that a country which has signed, but not ratified, a treaty is “obliged to refrain from acts which would defeat the object and purpose of a treaty . . . until it shall have made its intent clear not to become a party to the treaty.” This has been interpreted as requiring signatories to avoid acts that would make it more difficult or impossible for other parties to comply with the relevant agreement. Some researchers have argued that this requirement forms part of customary international law and thus applies to countries that are not party to the Vienna Convention (including the U.S.). However, even if this is the case, the obligation only applies until the country has signaled “its intent . . . not to become a party to the treaty.” The U.S. has arguably done this by failing to ratify the CBD for nearly thirty years (despite having signed it in 1993). See generally, Curtis A. Bradley, *Treaty Signature*, in THE OXFORD GUIDE TO TREATIES 208 (Duncan B. Hollis ed., 2012).

64 CBD, *supra* note 61, Art. 7(c).

65 *Id.* Art. 14(1)(a).

66 *Id.* Art. 14(1)(c).

action to prevent or minimize” any damage.⁶⁷ Parties should also have in place “national arrangements for emergency responses” to projects that represent a “grave and imminent danger to biological diversity.”⁶⁸

Provided the above requirements are met, the CBD would not prevent countries from undertaking or authorizing ocean alkalinity enhancement or other carbon dioxide removal projects, even if those projects adversely affect biodiversity.⁶⁹ However, the Conference of the Parties to the CBD has adopted a series of non-binding decisions, which recommend that countries avoid such projects. The first decision, adopted in 2008, applied specifically to ocean fertilization.⁷⁰ The decision:

request[ed] Parties and urge[d] other Governments, in accordance with the precautionary approach, to ensure that ocean fertilization activities do not take place until there is an adequate scientific basis on which to justify such activities . . . and a global, transparent and effective control and regulatory mechanism is in place for these activities.⁷¹

A second decision, applying more broadly to “geoengineering activities,” was adopted by the Conference of the Parties to the CBD in 2010.⁷² The decision “invite[d] Parties and other Governments” to consider specified guidelines “on ways to conserve, sustainably use and restore biodiversity and ecosystem services while contributing to climate change mitigation and adaptation.”⁷³ The guidelines recommended that countries:

[e]nsure . . . in the absence of science based, global, transparent and effective control and regulatory mechanisms for geo-engineering, and in accordance with the precautionary approach and Article 14 of the Convention, that no climate-related geo-engineering activities that may affect biodiversity take place, until there is in place an adequate scientific basis on which to justify such activities and appropriate consideration of the associated risks for the environment and

67 *Id.* Art. 14(1)(d).

68 *Id.* Art. 14(1)(e).

69 The CBD applies to all activities carried out under the jurisdiction or control of a party thereto, regardless of whether they occur within or beyond the area under the party’s national jurisdiction. *See id.* at Art. 4(b).

70 Report of the Conference of the Parties to the Convention on Biological Diversity on the Work of its Ninth Meeting, Decision IX/116 (2008). The decision does not define what constitutes “ocean fertilization.” Within the scientific community, the term “ocean fertilization” is generally used to refer to the addition of nutrients to ocean waters to stimulate the growth of photosynthesizing life, such as plankton, and thereby increase the natural biological pump which transports carbon dioxide from the surface ocean downward. The process is distinct from both ocean alkalinity enhancement and seaweed cultivation. *See generally*, ROYAL SOCIETY AND ROYAL ACADEMY OF ENGINEERING GREENHOUSE GAS REMOVAL 43 (2018), <https://royalsociety.org/-/media/policy/projects/greenhouse-gas-removal/royal-society-greenhouse-gas-removal-report-2018.pdf>.

71 *Id.* at Art. C(4). The decision included an exemption for “small scale research studies within coastal waters” and provided that “[s]uch studies should only be authorized if justified by the need to gather specific scientific data, and should be subject to a thorough prior assessment of the potential impacts of the research studies on the marine environment, and be strictly controlled, and not be used for generating and selling carbon offsets or any other commercial purposes.” *Id.*

72 Report of the Conference of the Parties to the Convention on Biological Diversity on the Work of its Tenth Meeting, Decision X/33, Art. 8 (2010) [hereinafter “2010 Decision”].

73 *Id.*

biodiversity and associated social, economic and cultural impacts, with the exception of small scale scientific research studies that could be conducted in a controlled setting . . . and only if they are justified by the need to gather specific scientific data and are subject to a thorough prior assessment of the potential impacts on the environment. (Internal citations omitted.)⁷⁴

That guidance was reaffirmed by the Conference of the Parties to the CBD in 2012⁷⁵ and again in 2016.⁷⁶

The 2010 decision defined geoengineering to mean “any technologies that deliberately reduce solar insolation or increase carbon sequestration on a large scale that may affect biodiversity.”⁷⁷ The Secretariat to the CBD subsequently determined, and the Conference of the Parties agreed, that geoengineering should be defined more broadly to include any “[d]eliberate intervention in the planetary environment of a nature and scale intended to counteract anthropogenic climate change and its impacts.”⁷⁸ That definition would encompass ocean alkalinity enhancement and other ocean carbon dioxide removal projects undertaken for the purpose of mitigating climate change. Nevertheless, the decision’s impact on ocean carbon dioxide removal projects is limited because it is non-binding, and merely “invites” countries to “consider” the guidelines provided.

4.1.2 United Nations Convention on the Law of the Sea

Often described as the “constitution of the oceans,” UNCLOS defines countries’ rights and responsibilities with respect to the management and use of offshore areas. At the time of writing, UNCLOS had been ratified or otherwise adopted by 167 countries and the European Union and signed, but not ratified or adopted, by an additional fourteen countries.⁷⁹ The U.S. has neither signed nor ratified UNCLOS. Notably, however, the U.S. has ratified the Agreement for Implementation of the Provisions of UNCLOS Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (“Straddling Fish Stocks Agreement”).⁸⁰ The U.S. recognizes many other UNCLOS provisions as forming part of customary international law.

Article 194 of UNCLOS imposes a general obligation on parties to take all necessary measures

⁷⁴ *Id.* Art. 8(w).

⁷⁵ Report of the Conference of the Parties to the Convention on Biological Diversity on the Work of its Eleventh Meeting, Decision XI/20, Art 6-9 (2012) [hereinafter “2012 Decision”].

⁷⁶ Report of the Conference of the Parties to the Convention on Biological Diversity on the Work of its Thirteen Meeting, Decision XIII/4, Art. 14 (2016).

⁷⁷ 2010 Decision, *supra* note 72, at footnote 3.

⁷⁸ SECRETARIAT TO THE CONVENTION ON BIOLOGICAL DIVERSITY, CDB TECHNICAL SERIES No. 66, GEOENGINEERING IN RELATION TO THE CONVENTION ON BIOLOGICAL DIVERSITY: TECHNICAL AND REGULATORY MATTERS 23 (2012), <https://perma.cc/LFU6-5RAU>; 2012 Decision, *supra* note 75, Art. 5.

⁷⁹ United Nations, *Chronological Ratifications of, and Accessions and Successions to the Convention and Related Agreements*, <https://perma.cc/JK47-SZG5> (last visited Jan. 9, 2020).

⁸⁰ Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, Sept. 8, 1995 [hereinafter “Straddling Fish Stocks Agreement”]. At the time of writing, there were 91 parties to the Straddling Fish Stocks Agreement. See United Nations, *supra* note 79.

to “prevent, reduce and control pollution of the marine environment.”⁸¹ That obligation was reiterated and elaborated on in the Straddling Fish Stocks Agreement, which requires parties to “minimize pollution” and “protect biodiversity in the marine environment,” among other things.⁸²

For the purposes of UNCLOS, pollution is defined broadly to mean:

the introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of the sea water and reduction of amenities.⁸³

Under this definition, ocean carbon dioxide removal techniques that involve adding materials to ocean waters, such as ocean alkalinity enhancement, could be considered forms of pollution if they harm the marine environment.⁸⁴ As the risk of harm is likely to vary between projects, a case-by-case assessment would need to be undertaken.⁸⁵ The assessment should consider not only the risks posed by the project but also its likely effectiveness in sequestering carbon dioxide and thus mitigating climate change.⁸⁶ This is relevant because carbon dioxide and certain impacts of climate change (e.g., ocean acidification) also arguably constitute pollution for the purposes of UNCLOS.⁸⁷

If an ocean alkalinity enhancement project were found to involve pollution of the marine environment, UNCLOS would require the party under whose jurisdiction it occurs to:

- take all necessary measures to minimize the adverse impacts of the project and ensure that it does not cause damage to other states or their environments;⁸⁸
- notify affected countries and competent international authorities of any imminent or actual damage from the project;⁸⁹ and
- study the risks and effects of the project and publish the results of that study.⁹⁰

According to UNCLOS, countries that fail to fulfil these requirements “shall be liable in accordance with international law.”⁹¹ The 2001 United Nations Resolution on the Responsibility of States for Internationally Wrongful Acts provides that, where a country breaches an

81 UNCLOS, *supra* note 43, Art. 194(1).

82 Straddling Fish Stocks Agreement, *supra* note 80, Art. 5.

83 UNCLOS, *supra* note 43, Art. 1(1)(4).

84 *See generally*, Jesse L. Reynolds, International Law, in CLIMATE ENGINEERING AND THE LAW 57, 76-77 (Michael B. Gerrard & Tracy Hester eds., 2018).

85 *Id.* at 77.

86 *Id.* at 77-78.

87 *Id.* at 76 (asserting that “GHGs and probably global warming qualify under UNCLOS as pollution of the marine environment”).

88 UNCLOS, *supra* note 43, Art. 194, 196, 202-209, & 211-212.

89 *Id.* Art. 198.

90 *Id.* Art. 204-206.

91 *Id.* Art 235(1).

international obligation and that breach causes harm to another, the former must cease the offending conduct and “offer appropriate assurances and guarantees of non-repetition.”⁹² The country must also make “full reparation” for any injuries caused by its conduct through restitution (i.e., action to re-establish the status quo ante), compensation (i.e., payments to cover any “financially assessable damage”), or satisfaction (i.e., “an acknowledgement of the breach, an expression of regret, a formal apology,” or similar statement).⁹³

4.1.3 London Convention and Protocol

The London Convention was adopted in 1972 with the aim of “promot[ing] the effective control of all sources of pollution of the marine environment,” particularly those resulting from the “dumping” of “waste or other matter” at sea.⁹⁴ In 1996, the parties to the London Convention adopted a new protocol, which is intended to update the Convention and will eventually replace it once ratified by all contracting parties.⁹⁵ The London Protocol sets more ambitious goals than the London Convention, aiming to “protect and preserve the marine environment from all sources of pollution,” and to “prevent, reduce and where practicable eliminate pollution caused by dumping” of “waste or other matter.”⁹⁶

At the time of writing, there were eighty-seven parties to the London Convention, and fifty-three parties to the London Protocol (see Figure 3 and Table 1).⁹⁷ For countries that are parties to both instruments, the London Protocol supersedes the London Convention. The U.S. has only ratified the London Convention and is, therefore, bound only by its terms.⁹⁸

Both the London Convention and London Protocol require parties to adopt domestic laws to regulate the dumping of waste and other matter within offshore areas under their jurisdiction (i.e., the territorial sea and EEZ) and, outside of those areas, by vessels or aircraft that are registered, or were loaded, within their territory.⁹⁹ Parties to the London Convention must prohibit the dumping of eight substances listed in Annex I to the Convention (“prohibited substances”),¹⁰⁰ but can permit the dumping of other (non-prohibited) substances.¹⁰¹

92 Resolution Adopted by the United Nations General Assembly, Responsibility of States for Internationally Wrongful Acts, A/RES/56/83 (Jan. 28, 2002) at Art. 30. See also *id.* Art. 2 (specifying when a country will be considered to have committed a “wrongful act”).

93 *Id.* Art. 31 & 34. See also *id.* Art. 35 (defining “restitution”), Art. 36 (defining “compensation”), & Art. 37 (defining “satisfaction”).

94 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, Dec. 29, 1972 [hereinafter “London Convention”], Art. I-II.

95 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matters, Nov. 7, 1996 [hereinafter “London Protocol”], Art. III.

96 *Id.*

97 International Maritime Organization, *Map of Parties to the London Convention/Protocol*, <https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/Parties%20to%20the%20LCLP%20February%202019.pdf> (last updated Feb. 22, 2019).

98 Env'tl. Prot. Agency, *Ocean Dumping: International Treaties*, <https://perma.cc/9K5U-756N> (last updated Feb. 28, 2019).

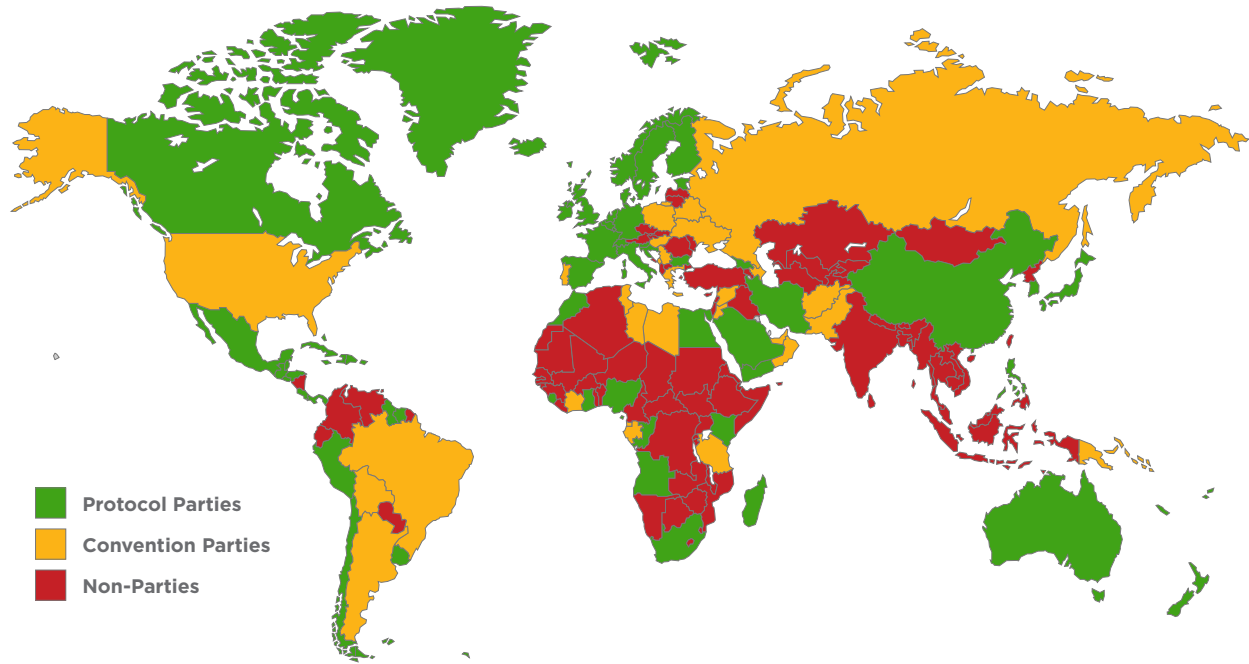
99 London Convention, *supra* note 94, Art. VII; London Protocol, *supra* note 95, Art. 10.

100 The prohibited substances are (1) organohalogen compounds, (2) mercury and mercury compounds, (3) cadmium and cadmium compounds, (4) persistent plastics and other persistent synthetic material, (5) crude oil and petroleum products and wastes, (6) radioactive wastes or matter, (7) materials produced for biological or chemical warfare, and (8) industrial waste.

101 London Convention, *supra* note 94, Art. IV.

The London Protocol is more restrictive, requiring parties to prohibit the dumping of all substances, except the eight listed in Annex I to the Protocol (“allowed substances”).¹⁰²

Figure 3: Parties to the London Convention and London Protocol¹⁰³



102 London Protocol, *supra* note 95, Art. 4. The allowed substances are (1) dredged material, (2) sewage sludge, (3) fish waste and material from industrial fish processing operations, (4) vessels, platforms, and other man-made structures at sea, (5) inert, inorganic geological material, (6) organic material of natural origin, (7) certain bulk items primarily comprising iron, steel, concrete, and similarly unarmful materials, and (8) carbon dioxide streams from carbon dioxide capture processes for sequestration. *Id* Annex 1.

103 International Maritime Organization, *supra* note 97.

Table 1: Contracting Parties to the London Protocol

Angola	France	Marshall Islands	South Africa
Antigua and Barbuda	Guatemala	Mexico	Spain
Australia	Georgia	Morocco	Suriname
Barbados	Germany	New Zealand	Sweden
Belgium	Ghana	Netherlands	Switzerland
Bulgaria	Guyana	Nigeria	Tonga
Canada	Iceland	Norway	Trinidad and Tobago
Chile	Ireland	Peru	United Kingdom
China	Islamic Republic of Iran	Philippines	Uruguay
Congo	Italy	Republic of Korea	Vanuatu
Denmark	Japan	Saint Kitts and Nevis	Yemen
Egypt	Kenya	Saudi Arabia	
Estonia	Luxembourg	Sierra Leone	
Finland	Madagascar	Slovenia	

Ocean alkalinity enhancement and other carbon dioxide removal techniques that involve adding materials to ocean waters may be found to constitute the “dumping” of “waste or other matter.” Both the London Convention and London Protocol define “waste or other matter” broadly to include “material of any kind, form or description.”¹⁰⁴ In both instruments, “dumping” is defined to mean the “deliberate disposal of waste or other matter at sea from vessels, aircraft, platforms, or other man-made structures.”¹⁰⁵ Notably, however, the definition expressly excludes the “placement of matter for a purpose other than mere disposal thereof, provided that such placement is not contrary to the aims of” the London Convention or Protocol (the “dumping exemption”).¹⁰⁶

In 2008, the parties to the London Convention and Protocol adopted a non-binding resolution, which declares “ocean fertilization activities” to fall within the scope of those instruments.¹⁰⁷ The 2008 resolution indicates that “ocean fertilization activities other than legitimate scientific research” (“non-research projects”) do not qualify for the dumping exemption because they are “contrary to the aims of the Convention and Protocol.”¹⁰⁸ Ocean alkalinity enhancement

104 London Convention, *supra* note 94, Art. III; London Protocol, *supra* note 95, Art. I.

105 London Convention, *supra* note 94, Art. III; London Protocol, *supra* note 95, Art. I.

106 London Convention, *supra* note 94, Art. III; London Protocol, *supra* note 95, Art. I.

107 Resolution LC-LP.1(2008) on the Regulation of Ocean Fertilization, Art. 3 (Oct. 31, 2008) [hereinafter “2008 Resolution”]. The resolution defined “ocean fertilization” to mean “any activity undertaken by humans with the principal intention of stimulating primary productivity in the oceans,” but expressly excluded “conventional aquaculture, or mariculture, or the creation of artificial reefs.” *Id.* Art. 2 and Footnote 3.

108 *Id.* Art. 8.

and other carbon dioxide removal techniques that involve adding materials to ocean waters are likely to be treated similarly to ocean fertilization.¹⁰⁹ Assuming that is the case, and the dumping exemption does not apply, non-research ocean carbon dioxide removal projects would be subject to the terms of the London Convention and London Protocol. Parties to the London Convention could, consistent with that instrument, permit any non-research carbon dioxide removal project that does not use prohibited substances.¹¹⁰ In contrast, parties to the London Protocol could not permit such projects, unless they involved the use of allowed substances.¹¹¹ The materials proposed for use in ocean alkalinity enhancement do not appear on the list of prohibited substances in the London Convention or the list of allowed substances in the London Protocol.¹¹² Consequently, non-research ocean alkalinity enhancement could be permitted under the London Convention, but not the London Protocol. Thus, non-research projects could not be performed in the territory of, or using ships or aircraft registered with, or loaded in, a party to the London Protocol.

Although non-research ocean fertilization projects have been found not to qualify for the dumping exemption, that exemption may apply to research projects in some cases. The 2008 resolution indicates that ocean fertilization projects that constitute “legitimate scientific research” should be regarded as a “placement of matter for a purpose other than mere disposal.”¹¹³ Such projects will, therefore, qualify for the dumping exemption if they are found not to be contrary to the aims of the London Convention and London Protocol. The parties have agreed that ocean fertilization research projects should be assessed on a case-by-case basis¹¹⁴ and, in 2010, adopted a framework to guide that assessment.¹¹⁵ The framework provides for the assessment of projects by the country under whose jurisdiction they occur.¹¹⁶ Countries must follow the guidelines set out in the framework, which provides for a two-stage assessment process, comprising:

1. an initial assessment which considers whether the project “has proper scientific attributes” and qualifies as “legitimate scientific research” into ocean fertilization; and
2. an environmental assessment which considers the potential short- and long-term effects of the project on the marine environment, characterizes the nature and extent

109 The 2008 Resolution indicated that, due to the limited understanding of their effectiveness and potential environmental impacts, ocean fertilization projects not involving “legitimate scientific research” could not be justified. There is similarly limited understanding of the effectiveness and potential impacts of other carbon dioxide removal techniques. *Id.* Preamble.

110 London Convention, *supra* note 94, Art. IV.

111 London Protocol, *supra* note 95, Art. 4.

112 London Convention, *supra* note 94, Annex 1; London Protocol, *supra* note 95, Annex 1.

113 2008 Resolution, *supra* note 107, Art. 3.

114 *Id.* Art. 4-5.

115 Resolution LC-LP.2(2010) on the Assessment Framework for Scientific Research Involving Ocean Fertilization (Oct. 14, 2010) [hereinafter “2010 Resolution”].

116 *Id.* Annex 6. For the purposes of the London Convention and Protocol, the dumping of materials into ocean waters is considered to occur under a country’s jurisdiction if (1) the material is carried on a vessel or aircraft registered in the country’s territory or flying its flag, (2) the material was loaded onto a vessel or aircraft within the country’s territory; or (3) the material is dumped within areas under the jurisdiction of the country under international law. See London Convention, *supra* note 94, Art. VII; London Protocol, *supra* note 95, Art. 10.

of project-related risks, and identifies measures to manage those risks.¹¹⁷

Based on the assessment, the responsible country must determine whether or not the project is contrary to the aims of the London Convention and Protocol. The assessment framework declares that countries “should” only conclude that a project is not contrary to the aims of the London Convention and Protocol if “conditions are in place to ensure that, as far as practicable, environmental disturbance would be minimized, and the scientific benefits maximized.”¹¹⁸ The framework is not legally binding, however.

In 2013, the Parties to the London Protocol agreed to an amendment, which would codify the above approach to assessing ocean fertilization projects.¹¹⁹ The amendment, which has not yet entered into force, would insert a new Article 6bis into the London Protocol stating:

Contracting Parties shall not allow the placement of matter into the sea from vessels, aircraft, platforms or other man-made structures at sea for marine geoenvironmental activities listed in annex 4, unless the listing provides that the activity or the subcategory of an activity may be authorized under a permit.¹²⁰

While the article refers generally to “marine geoenvironmental activities,” annex 4 only lists “ocean fertilization,” thus limiting the scope of the amendment.¹²¹ Under annex 4, countries cannot permit ocean fertilization projects, unless they are found to constitute “legitimate scientific research.”¹²² Before permitting any research project, the responsible country must conduct an assessment consistent with the process set out in the 2010 framework, and ensure that appropriate measures are put in place to manage and monitor any adverse effects.¹²³

In the future, annex 4 could be amended to include other carbon dioxide removal techniques, such as ocean alkalinity enhancement, and subject those techniques to the assessment process described above. However, that would have little legal effect, at least until the 2013 amendment to the London Protocol enters into force. Under the terms of the London Protocol, amendments do not enter into force until ratified by two-thirds of the parties to the Protocol, and then only for the parties that have ratified the amendment.¹²⁴ To date, just six of the fifty-three parties to the London Protocol have ratified the 2013 amendment, which is well below the two-thirds threshold required.¹²⁵ Even if the threshold is met, the amendment will only affect the London Protocol. Countries that are party to the London Convention, but not the London Protocol, will continue to be subject only to the 2008 and 2010 resolutions. Those resolutions are not binding.

In sum, assuming ocean alkalinity enhancement is treated similarly to ocean fertilization,

117 2010 Resolution, *supra* note 115, Annex 6.

118 *Id.*

119 Resolution LP .4(8), Amendment to the 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 to Regulate Marine Geoengineering (Oct. 18, 2013).

120 *Id.* Annex 1, Art. 1.

121 *Id.*

122 *Id.*

123 *Id.*

124 London Protocol, *supra* note 95, Art. 21.

125 The six countries are Estonia, Finland, Germany, the Netherlands, Norway, and the U.K.

projects involving “legitimate scientific research” are likely to qualify for the dumping exemption from the London Convention and London Protocol. Research projects would not, therefore, be subject to the permitting requirements in the London Convention or London Protocol and could take place after an environmental review by the country under whose jurisdiction they occur. In contrast, non-research projects are unlikely to qualify for the dumping exemption, and would thus require a permit under the London Convention or London Protocol. Parties to the London Convention could permit projects, provided they did not use any prohibited substance (which is unlikely). Projects could not, however, be permitted by parties to the London Protocol.

4.1.4 International Agreements Governing Shipping

Various other international agreements could, in some circumstances, apply to ocean alkalinity enhancement. There are, for example, several international agreements regulating the transportation of materials via ship, which is likely to occur in ocean alkalinity enhancement. As an illustration, in rock-based ocean alkalinity enhancement projects, ground rock may be shipped from land for discharge into ocean waters. Alternatively, where ocean alkalinity enhancement is performed electrochemically, the hydrochloric acid generated during the process would need to be shipped back to shore.

The International Convention for the Prevention of Pollution from Ships (“MARPOL”) aims to prevent marine pollution due to operational or accidental releases from ships carrying harmful substances.¹²⁶ MARPOL includes six technical annexes, each dealing with a different source of pollution. Annex II deals with pollution from ships transporting “noxious liquid substances” in bulk.¹²⁷ For the purposes of Annex II, hydrochloric acid is considered a noxious liquid waste,¹²⁸ and thus can only be carried on ships meeting certain design, construction, and operational standards specified in the Annex.¹²⁹ With some limited exceptions, Annex II prohibits ships from discharging hydrochloric acid and other noxious liquid substances into the sea,¹³⁰ but that is unlikely to impede electrochemical ocean alkalinity enhancement projects because the acid generated therein would be captured and returned to shore. Other ocean alkalinity enhancement projects that involve discharging ground rock into ocean waters would not be subject to the restrictions in Annex II of MARPOL because the rock materials do not constitute “noxious liquid substances” regulated under the Annex. Nor are the materials regulated under any other Annex of MARPOL.

Another potentially relevant international agreement is the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (“Basel Convention”), which regulates the import and export of certain waste materials that have been classified

126 International Convention for the Prevention of Pollution from Ships, Nov. 2, 2973.

127 *Id.* Annex II.

128 *Id.* Annex II, reg. 1 (defining “noxious liquid substance” to include “any substance identified in the Pollution Category column of chapter 17 or 18 of the International Bulk Chemical Code”). See also Int’l. Maritime Org., International Bulk Chemical Code, Chapter 17, <https://perma.cc/4KMR-HWQF> (listing “hydrochloric acid” as a pollutant).

129 *Id.* Annex II, reg. 11-12.

130 *Id.* Annex II, reg. 13.

as hazardous.¹³¹ The Basel Convention defines “waste” to mean “substances or objects which are disposed of or are intended to be disposed of”¹³² and includes, in Annex IV, a list of activities that constitute “disposal.”¹³³ The list in Annex IV includes, as a form of disposal, “[r]elease into seas/oceans.”¹³⁴ Rock-based ocean alkalinity enhancement involves the release of materials into ocean waters and thus could be considered a form of disposal under the Basel Convention. However, even if this were the case, the Basel Convention is unlikely to apply to the import / export of materials for ocean alkalinity enhancement for two reasons:

1. The Basel Convention does not apply to materials “the discharge of which is covered by another international agreement.”¹³⁵ As discussed in Part 4.3 above, the London Convention and London Protocol are likely to apply to the discharge of materials for ocean alkalinity enhancement, removing it from the scope of the Basel Convention.
2. The Basel Convention only applies to materials that constitute “hazardous waste,” defined as waste that has been designated as such in Annex I to the Convention or in domestic legislation enacted by the country of export, import, or transit.¹³⁶ The rock proposed for use in ocean alkalinity enhancement is not listed as hazardous in Annex I to the Convention or U.S. domestic legislation. A review would need to be conducted to determine if any other country has classified the rock as hazardous but, given its nature, that appears unlikely.

The Basel Convention also would not apply to the import/export of hydrochloric acid generated as a by-product of electrochemical ocean alkalinity enhancement. Regardless of whether it has been classified as hazardous by any country, the acid is not a “waste” for the purposes of the Basel Convention because it is destined for use in industrial processes and not disposal.

4.1.5 Potentially Relevant European Union Instruments

The EU has not adopted explicit regulations applicable to ocean alkalinity enhancement.¹³⁷ However, general environmental rules and standards may apply. The Treaty on the Functioning of the European Union (“TFEU”) establishes that EU environmental policy must be based on the precautionary principle.¹³⁸ Although the precautionary principle is not defined by the TFEU, the EU General Court (formerly called the Court of First Instance) has found that the principle applies in situations where there is scientific uncertainty about a preventive

131 Basel Convention on the Control of Transboundary Movements of Hazardous Waste and Their Disposal, Mar. 22, 1989.

132 *Id.* Art. 2(1).

133 *Id.* Art. 2(4) & Annex IV.

134 *Id.* Annex IV(A).

135 *Id.* Art. 1(4).

136 *Id.* Art. 1(1).

137 Ralph Bodle et al., Options and Proposals for the International Governance of Geoengineering, Ecologic Institute, Berlin 106 (2014); Stefan Schäfer et al., The European Transdisciplinary Assessment of Climate Engineering (EuTRACE): Removing Greenhouse Gases from the Atmosphere and Reflecting Sunlight away from Earth 92 (2014).

138 Consolidated version of the Treaty on the Functioning of the European Union, Article 191(2) (2012), <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:12012E/TXT&from=EN>.

measure.¹³⁹ In such situations, the Court reasons that political institutions should determine an appropriate level of protection for society from the preventive measure, and that scientific experts should undertake a risk assessment before the preventive measure is deployed.¹⁴⁰ Research into ocean alkalinity enhancement and trials of different approaches could be justified as a way of informing decisions on deployment under the precautionary principle. The TFEU clarifies that, in areas of research and technological development, the EU has competency to define and implement programs, but this shall not prevent Member States from exercising their own competency.¹⁴¹ In other words, the EU may establish its own programs to research ocean alkalinity enhancement, but this would not prevent Member States from conducting their own research. Proposed amendments in 2020 to the European Climate Law, although they do not lay out specifics, state that “[t]he natural sink of forests, soils, agricultural lands and wetlands should be maintained and further increased and carbon removal technologies, such as carbon capture and storage and carbon capture and utilisation, should be made cost-effective and deployed.”¹⁴²

Ocean alkalinity enhancement projects in EU waters would need to be in accord with the EU Marine Strategy Framework Directive, which applies to the territorial seas of Member States and extends out to the edge of each State’s jurisdictional rights,¹⁴³ meaning typically the EEZ up to 200 n.m. from shore.¹⁴⁴ The Directive aims to protect and preserve the marine environment, and prevent and reduce inputs with a view to phasing out marine pollution,¹⁴⁵ defined as:

[T]he direct or indirect introduction into the marine environment, as a result of human activity, of substances or energy, including human-induced marine underwater noise, which results or is likely to result in deleterious effects such as harm to living resources and marine ecosystems, including loss of biodiversity, hazards to human health, the hindering of marine activities, including fishing, tourism and recreation and other legitimate uses of the sea.¹⁴⁶

As described above, ocean alkalinity enhancement involves the addition of materials to ocean waters, which could have potentially harmful impacts on biodiversity. It may, therefore, be classified as a source of marine pollution under the Marine Strategy Framework Directive.

In order to ensure pollution is avoided, EU Member States were required to develop and implement a marine strategy by 2016, including an assessment of the environment status

139 Case T-13/99, Pfizer Animal Health v. Council, 2002 E.C.R. II-3318, 3375.

140 *Id.* at 3375-81.

141 Consolidated version of the Treaty on the Functioning of the European Union, Article 4(3) (2012), <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:12012E/TXT&from=EN>.

142 Proposal for a Parliament and Council Regulation 2020/0036 at 7 (2020) <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020PC0080&from=EN>.

143 Council Directive 2008/56/EC, Art. 3(1)(a) 2008 O.J. (L 164). <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02008L0056-20170607>.

144 Ronan Joseph Long, *The Marine Strategy Framework Directive: A New European Approach to the Regulation of the Marine Environment, Marine Natural Resources and Marine Ecological Services*, 29 J. ENERGY & NAT. RESOURCES L. 1, 22-23 (2011).

145 Council Directive, *supra* note 143, Art. 1(2).

146 *Id.* at Art. 3(8).

of marine waters, and a program of measures to achieve or maintain good environmental status.¹⁴⁷ If Member States do not meet their reporting obligations, the Commission may refer them to the European Court of Justice.¹⁴⁸ Member States must review their marine strategies every six years,¹⁴⁹ so if ocean alkalinity enhancement was ramped up, Member States may need to demonstrate in their review that the plans result in the avoidance of harm to the marine environment.

4.2 Relevant Principles of Customary International Law

Ocean alkalinity enhancement projects could implicate the so-called “no harm” rule of customary international law. Under the no harm rule, as articulated in the 1992 Declaration of the United Nations Conference on the Environment and Development, each country has a “responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other [countries] or of areas beyond the limits of national jurisdiction.”¹⁵⁰ The International Tribunal for the Law of the Sea described the rule as imposing an obligation of “due diligence” on countries to “exercise best possible efforts” or “do the utmost” to avoid or minimize transboundary environmental damage.¹⁵¹ What constitutes best efforts will depend on the circumstances.¹⁵² At a minimum, however, countries must closely oversee activities that could cause transboundary environmental damage (e.g., by adopting and strictly enforcing relevant domestic laws).¹⁵³ In this regard, the International Court of Justice (“ICJ”) has stated that the due diligence obligation “entails not only the adoption of appropriate rules and measures, but also a certain level of vigilance in their enforcement and the exercise of administrative control applicable to public and private operators, such as the monitoring of activities undertaken by such operators.”¹⁵⁴ Thus, to fulfil their obligation under the no harm rule, countries may need to adopt domestic laws and take other measures to mitigate the environmental impacts of ocean alkalinity enhancement and other ocean carbon dioxide removal projects.¹⁵⁵

147 *Id.* at Art. 5(2).

148 See, e.g., European Commission, *Marine environment: Commission decides to refer BULGARIA to the Court of Justice of the EU over late reporting under the Marine Strategy Framework Directive* (2020), https://ec.europa.eu/commission/presscorner/detail/en/IP_20_1234.

149 Council Directive, *supra* note 143, Art. 17(2).

150 Declaration of the United Nations Conference on Environment and Development, Principle 2, UN Doc A/CONF.151/26/Rev. 1, June 3-14, 1992. The no harm rule was first articulated by an arbitral tribunal in the so-called “Trail Smelter” dispute between the United States and Canada. See *Trail Smelter (United States v. Canada)*, Awards, 3 Reports of Intl. Arbitral Awards 1905 (1938 & 1941). The rule was subsequently recognized by the International Court of Justice. See *Legality of the Threat or Use of Nuclear Weapons*, Advisory Opinion, ICJ Rep 226 (July 1996); *Case Concerning Pulp Mills on the River Uruguay (Argentina v. Uruguay)*, Judgement, I.C.J. Rep. 2010, 14 (Apr. 2010) [hereinafter “Pulp Mills Case”].

151 *Responsibilities and Obligations of States Sponsoring Persons and Entities with respect to Activities in the Area*, Advisory Opinion, Int’l Tribunal for the Law of the Sea, Case No. 17, 110 (Feb. 2011).

152 *Id.* at 117 (noting that “due diligence is a variable concept. It may change over time as measures considered sufficiently diligent at a certain moment may become not diligent enough in light, for instance of new scientific or technical knowledge. It may also change in relation to the risks involved in the activity”).

153 *Id.* at 111 – 116. See also *Pulp Mills Case*, *supra* note 150, at 187 & 197.

154 *Pulp Mills Case*, *supra* note 150, at 197.

155 As discussed in Part 2, depending on where and how they are performed, ocean alkalinity enhancement projects could have a range of harmful effects on marine ecosystems (e.g., killing certain marine organisms and stimulating the growth of others).

The ICJ has also recognized that countries have a procedural obligation, under customary international law, to “undertake an environmental impact assessment where there is a risk that [a] proposed . . . activity may” cause “significant” transboundary environmental damage.¹⁵⁶ There is no agreed upon definition of what constitutes “significant” damage. However, the International Law Commission has interpreted the term as requiring damage that is more than merely “detectable,” but not necessarily “serious” or “substantial.”¹⁵⁷

Prior to undertaking or authorizing a project that has the potential to cause transboundary environmental damage, such as ocean alkalinity enhancement, countries must conduct a preliminary assessment to determine whether there is a risk of significant damage.¹⁵⁸ Projects that are found to present such risks must undergo a more comprehensive environmental impact assessment. Under international law, the assessment must be completed prior to the commencement of the project, but countries otherwise have broad discretion in conducting the assessment.¹⁵⁹ In this regard, the ICJ has observed that international law does not “specify the scope and content of an environmental impact assessment” and thus “it is for each [country] to determine in its domestic legislation or in the authorization for the project, the specific content of the environmental impact assessment required in each case.”¹⁶⁰ The U.S. and many other countries do, however, have domestic laws governing the conduct of environmental impact assessments. Many countries’ laws require consultation with potentially affected parties and the general public during the environmental impact assessment. Moreover, where the environmental impact assessment confirms that a project could cause significant transboundary environmental harm, the relevant country must notify and consult with other potentially affected countries and relevant international organizations.¹⁶¹

156 Pulp Mills Case, *supra* note 150, at 204.

157 INTERNATIONAL LAW COMMISSION, DRAFT ARTICLES ON PREVENTION OF TRANSBOUNDARY HARM FROM HAZARDOUS ACTIVITIES, WITH COMMENTARIES 152 (2001), <https://perma.cc/7BB3-B4MM>.

158 Certain Activities Carried out by Nicaragua in the Border Area (Costa Rica v. Nicaragua), Judgement, ICJ Rep. 2015, 665 at 706-707 (Dec. 2015) [hereinafter “Certain Activities Case”].

159 Pulp Mills Case, *supra* note 150, at 205.

160 *Id.*

161 Certain Activities Case, *supra* note 158, at 707.

5. U.S. LAWS GOVERNING OCEAN ALKALINITY ENHANCEMENT

As discussed in Part 3 above, the U.S. has jurisdiction over offshore areas extending 200 n.m. from its coast, and further in some circumstances.¹⁶² Under international law, the U.S. has full “sovereign rights” within that area, including rights to explore, exploit, conserve, and manage natural resources.¹⁶³ The U.S. is responsible for protecting and preserving the marine environment and must oversee marine scientific research and the development and use of artificial islands and other structures within its jurisdictional areas.¹⁶⁴ This part discusses key U.S. federal and state laws that could apply to ocean alkalinity enhancement projects undertaken in areas under U.S. jurisdiction.

5.1 Siting Facilities in U.S. Waters

Ocean alkalinity enhancement projects could, in some circumstances, require the installation of offshore structures, either floating or moored. For example, where wind energy is used to power electrochemical ocean alkalinity enhancement systems, offshore wind turbines would likely need to be anchored to the seabed.¹⁶⁵ In order to take advantage of higher wind speeds further from shore, the turbines would likely be situated in federal waters (extending three, or in Texas and west coast of Florida, nine to 200 n.m. from the coast).¹⁶⁶

5.1.1 Projects in U.S. Federal Waters

Persons wishing to make use of the OCS underlying U.S. federal waters (e.g., to install wind turbines) must obtain approval from the federal government.¹⁶⁷ The Department of the Interior’s Bureau of Ocean Energy Management (“BOEM”) is authorized to lease areas of the OCS under the OCSLA.¹⁶⁸ Under section 8(p)(1) of the OCSLA, BOEM may only grant leases for activities that:

- (A) support exploration, development, production, or storage of oil or natural gas . . . ;
- (B) support transportation of oil or natural gas, excluding shipping activities;
- (C) produce or support production, transportation, or transmission of energy from sources other than oil and gas; or

¹⁶² See *supra* Part 3.1.

¹⁶³ UNCLOS, *supra* note 43, Art. 56(1)(a).

¹⁶⁴ *Id.* at Art. 56(1)(b).

¹⁶⁵ Floating wind turbines, although not yet a widely used technology, are in early development. See Xin Shen et al., *Study of the unsteady aerodynamics of floating wind turbines*, 145 ENERGY 793, 793 (2018).

¹⁶⁶ While the wind turbines are likely to be located in federal waters, associated infrastructure (e.g., cabling) may need to be installed through state waters and/or onshore. Depending on the type of infrastructure and its location, installation may be subject to various permitting and other requirements at the federal, state, and/or local levels. See *supra* Part 5.1.2.

¹⁶⁷ ADAM VANN, CONG. RESEARCH SERV., R40175, WIND ENERGY: OFFSHORE PERMITTING 3 (2012), <https://perma.cc/36W3-3E66> (indicating that “[u]se of federal and federally controlled lands, including the OCS [i.e., the outer continental shelf], requires some form of permission”).

¹⁶⁸ 43 U.S.C. § 1301 et seq.

- (D) use, for energy-related purposes or for other authorized marine-related purposes, facilities currently or previously used for activities [relating to oil, gas, and other mineral development on the OCS].¹⁶⁹

BOEM could issue leases for the development of wind turbines to power electrochemical ocean alkalinity enhancement systems under paragraph (C) above. Leases must be issued through a competitive auction process, unless BOEM determines that there is no competitive interest in the area.¹⁷⁰ BOEM can propose areas for leasing on its own motion or accept requests from interested parties but, in both cases, must publish a notice in the Federal Register seeking expressions of interest in the area.¹⁷¹ If an expression(s) of interest is received, BOEM must auction leases;¹⁷² otherwise leases will be issued on a non-competitive basis.¹⁷³

When issuing leases, BOEM must comply with various procedural requirements, including conducting an environmental review, and consulting with other federal, state, and local government agencies as follows:

- The National Environmental Policy Act (“NEPA”) requires federal agencies, including BOEM, to conduct an environmental impact statement (“EIS”) for any major federal action “significantly affecting the quality of the human environment.”¹⁷⁴ The requirement applies whether the agency takes the action itself or authorizes or funds the action.¹⁷⁵ The EIS must assess the natural, economic, social, and cultural resource effects of the action, and the agency is required to release relevant documents to the public and consider their input.¹⁷⁶
- Under the Endangered Species Act (“ESA”), BOEM must consult with the Fish and Wildlife Service (“FWS”) before issuing any lease or taking any other action that may affect terrestrial or freshwater species, which have been listed as endangered¹⁷⁷ or threatened¹⁷⁸.¹⁷⁹ BOEM consults with FWS to ensure activities do not harm seabirds under the Migratory Bird Treaty Act.¹⁸⁰ Where an action may affect endangered or threatened marine species, or could harm “essential fish habitat” designated under the Magnuson-Stevens Fishery Conservation and Management Act, BOEM must consult with the National Marine Fisheries Service (“NMFS”).¹⁸¹ The National Marine Sanctuaries

169 43 U.S.C. § 1337(p)(1).

170 *Id.* § 1337(p)(3). See also 30 C.F.R. Part 585, Subpart B. For a more detailed discussion of federal requirements on BOEM leasing, see ROMANY M. WEBB & MICHAEL B. GERRARD, POLICY READINESS FOR OFFSHORE CARBON DIOXIDE STORAGE IN THE NORTHEAST 17-21 (2017), <https://perma.cc/V3NF-7VE5>.

171 30 C.F.R. §§ 585.210 & 585.230.

172 *Id.* §§ 585.220 & 585.231.

173 *Id.* §§ 585.212 & 585.231.

174 42 U.S.C. § 4321 et seq., 4332(2)(C).

175 40 C.F.R. § 1508.18(a).

176 42 U.S.C. 4332(2)(C).

177 A species is considered “endangered” if it “is in danger of extinction throughout all or a significant portion of its range.” See 16 U.S.C. § 1532(6).

178 A species is considered “threatened” if it “is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.” See *id.* § 1532(20).

179 *Id.* § 1536(a)(2). See also 30 C.F.R. § 585.203.

180 16 U.S.C. § 703(a).

181 *Id.* § 1855(b)(2).

Act makes it unlawful to “destroy, cause the loss of, or injure any sanctuary resource managed under law or regulations for that sanctuary” in any area designated a marine sanctuary by the Secretary of Commerce.¹⁸²

- BOEM is also required to ensure authorized activities do not harm historic properties and religious sites of importance to American Indians. The National Historic Preservation Act requires federal agencies to take into account the effect of any license authorization on historic properties.¹⁸³ On the OCS, these include shipwrecks, sunken aircraft, and prehistoric archeological sites.¹⁸⁴ If a place of religious significance to American Indians may be affected, BOEM may need to consult with Indian religious practitioners pursuant to the American Indian Religious Freedom Act.¹⁸⁵
- BOEM must consult with other federal agencies with an interest in, and state and local governments affected by, the lease.¹⁸⁶ Where the BOEM lease will affect¹⁸⁷ land or water use or natural resources in state waters, and the relevant state has adopted a management plan under the Coastal Zone Management Act (“CZMA”), BOEM must ensure consistency with the state plan.¹⁸⁸ BOEM must submit a consistency determination to the relevant state,¹⁸⁹ and, if the state objects to the determination, BOEM must work with it to address the objection.¹⁹⁰

After completing the various reviews and consultations, BOEM must evaluate the effect of leasing on the human, marine, and coastal environments and develop measures to mitigate any adverse effects.¹⁹¹

With a BOEM-issued lease in hand, the lessee has the right to install and operate facilities on a designated portion of the OCS,¹⁹² subject to the lessee obtaining any necessary approvals from other agencies.¹⁹³ If the lessee wishes to install a structure that will be permanently or temporarily attached to the seabed, he/she/it must obtain a permit from the Army Corps

182 *Id.* § 1436(1).

183 54 U.S.C. §§306101-31

184 BOEM, *National Historic Preservation Act*, <https://perma.cc/N6KH-2CWN> (last visited Jan. 21, 2020).

185 BOEM, *Characterizing Tribal Cultural Landscapes Volume I: Project Framework* (2017), <https://perma.cc/J9ZP-EUAF>; 42 U.S.C. §1996.

186 43 U.S.C. § 1337(p)(7) (requiring the BOEM to “provide for coordination and consultation with the Governor of any State or the executive of any local government that may be affected by a lease”); 30 C.F.R. § 585.203 (providing that, when awarding leases, the BOEM will consult with “relevant federal agencies” and “any affected State, the executive of any affected local government, and any affected Indian Tribe).

187 An activity “will affect” land or water use or natural resources if it has “any reasonably foreseeable effect on any coastal use or resource . . . Effects are not just environmental effects, but include effects on coastal uses. Effects include both direct effects which result from the activity and occur at the same time and place as the activity, and indirect (cumulative and secondary) effects which result from the activity and are later in time or farther removed in distance, but are still reasonably foreseeable.” 15 C.F.R. § 930.11(g).

188 16 U.S.C. § 1456(c).

189 *Id.* § 1456(c)(1)(C); 15 C.F.R. § 930.39.

190 If resolution cannot be reached, BOEM may only proceed with leasing after serving the state with a notice, which clearly describes how leasing is consistent with the state management plan, to the maximum extent practicable. *See id.* § 930.43.

191 30 C.F.R. § 585.211(b)(2).

192 *Id.* § 585.200(a).

193 *Id.* For a more detailed discussion, see Webb & Gerrard, *supra* note 170, at 24-26.

of Engineers (“ACE”).¹⁹⁴ Thus, for example, an ACE permit would be required to anchor or otherwise attach offshore wind platforms or other facilities to the seabed. In issuing permits, ACE evaluates the probable impacts of construction of the facility on the public interest, balancing its beneficial and detrimental effects.¹⁹⁵ As part of this balancing test, ACE will consider the need for the construction, and its likely effect on other uses of the area.¹⁹⁶ In addition, if the construction is in an area with recognized historic, cultural, scenic, conservation, recreational, or similar values, ACE must consider its likely effects on those values.¹⁹⁷ ACE must also complete any necessary environmental and/or other reviews, for example, under NEPA¹⁹⁸ and work with the relevant coastal state(s) to ensure the project is consistent with any management plan(s) adopted under the CZMA.¹⁹⁹

Wind turbines and offshore structures, both anchored and floating, also require authorization from the U.S. Coast Guard (“USCG”) under the aids to navigation program.²⁰⁰ Before issuing such authorization, USCG must confirm that the structure is appropriately marked and complete any necessary environmental and other reviews under NEPA, CZMA, and other statutes.²⁰¹

If the structure extends above the surface of the water, additional requirements may be imposed by Federal Aviation Administration (“FAA”) regulations. Under the regulations persons proposing to construct structures above 200 feet must generally notify the FAA in advance.²⁰² If the FAA determines that the structure may result in obstruction or interference with the navigable airspace, the agency will then conduct a study to assess the extent of the hazard.²⁰³ Following the study, the FAA may make one of three findings: (1) a finding of “no hazard,” in which case the structure can be installed without marking or lighting; (2) a finding of “no hazard, subject to conditions,” in which case the structure can only be installed if specified marking, lighting, or other requirements are met; or (3) a finding of “hazard,” in which case the structure cannot be installed.²⁰⁴ Wind turbines are typically required to meet white paint and synchronized red light requirements.²⁰⁵

194 33 C.F.R. § 322.3(a)-(b).

195 *Id.* § 320.4(a)(1).

196 *Id.* § 320.4(a)(2).

197 *Id.* § 320.4(e).

198 *Id.* §§ 320.4(h), 325.2(a)(4). ACE’s NEPA review will need to be coordinated with any reviews undertaken by other federal, state, and/or local agencies.

199 16 U.S.C. § 1456(c). Under the CZMA, all federally-approved actions that affect coastal uses or resources must be consistent with state management plans, to the maximum extent practicable. See *Id.* § 1456(c)(3). This includes actions undertaken by non-federal agencies that require federal approval. Such actions are deemed to affect coastal uses or resources if they occur within state waters and the relevant state has listed the action in its management plan. See 15 C.F.R. § 930.53. Actions requiring ACE permits have been listed in the management plans adopted by Connecticut, Delaware, Massachusetts, New Jersey, New York, Rhode Island, and Virginia.

200 33 C.F.R. § 64.21 (requiring the owner or operator of an offshore structure to “apply for Coast guard authorization” prior to installation). See also *id.* §§ 64.03 (indicating that the regulations apply to structure located in “waters subject to the jurisdiction of the U.S.”) & 64.04 (defining “structure”).

201 *Id.* §§ 64.21, 64.23, & 66.01-5. See also U.S. Coast Guard, Aids to Navigation Manual Administration (2005), https://media.defense.gov/2017/Mar/29/2001724016/-1/-1/0/CIM_16500_7A.PDF.

202 14 C.F.R. § 77.9.

203 49 U.S.C. § 44718(b). See also 14 C.F.R. § 77.27-77.31.

204 14 C.F.R. § 77.31. See also Fed. Aviation Admin., FAA Determinations, <https://perma.cc/G7QT-U99T> (last visited Aug. 5, 2021).

205 Fed. Aviation Admin., *Wind Turbine FAQs*, <https://perma.cc/K3XD-2TVF> (last updated Jan. 21, 2021).

Additional permits and other regulatory requirements could also apply, depending on the nature and location of the offshore structures to be installed. For example, where the construction or operation of an offshore structure may harm species listed as endangered or threatened under the ESA, an incidental take permit would be required from the FWS.²⁰⁶ Similarly, projects involving anchoring or discharging of material in a marine sanctuary would require a permit from NOAA.²⁰⁷

Finally, construction of structures may also raise supply chain considerations. To the extent that any construction is deemed to be engaging in trade, the vessels carrying construction materials may need to obtain a certificate of documentation with endorsement for that trade from the U.S. Coast Guard.²⁰⁸ Trade includes the transportation of merchandise between points within 20 n.m. of shore,²⁰⁹ which could include transportation of construction materials. The Jones Act further requires that shipping between U.S. ports must be conducted by U.S.-flag ships,²¹⁰ and within U.S. waters extending 200 n.m. offshore, platforms attached to the seabed must be serviced by U.S.-flag ships, if the ship departs from a U.S. port.²¹¹ Building out the infrastructure of these projects would thus require investment both in the projects themselves and likely in U.S.-flag ships capable of carrying supplies to build and service them.

5.1.2 Projects in State Waters

As noted above, electrochemical ocean alkalinity enhancement systems and associated wind turbines are likely to be constructed in federal waters, rather than state waters. However, even if that is the case, associated infrastructure (e.g., cabling) may need to be installed in state waters. Depending on the type of infrastructure and its location, installation may be subject to various permitting and other requirements imposed by federal, state, and/or local law. For example, under the federal Rivers and Harbors Act (“RHA”), certain activities within state waters, including the placement of structures and modification of navigable waters, must be permitted by the Army Corps of Engineers.²¹²

A full review of all potentially applicable state and local laws is beyond the scope of this paper. We note, however, that coastal states generally require a lease or similar authorization to be obtained prior to the construction of any facility that will be attached to or otherwise utilize the seafloor underlying state waters.²¹³ For example, under California law, a lease must be obtained from the State Lands Commission to use the submerged land underlying state waters.²¹⁴ Similarly, in Texas, use of the submerged lands underlying state waters requires a lease or other authorization from the state General Land Office.²¹⁵ In some other states (e.g.,

206 16 U.S.C. § 1539(a)(1)(B).

207 See, e.g., 15 C.F.R. §§ 922.61-62.

208 42 U.S.C. § 12102.

209 46 C.F.R. § 67.3.

210 46 U.S.C. § 50101.

211 JOHN FRITTELLI, CONG. RESEARCH SERV., R45725, SHIPPING UNDER THE JONES ACT: LEGISLATIVE AND REGULATORY BACKGROUND 9 (2019), <https://fas.org/sgp/crs/misc/R45725.pdf>.

212 33 U.S.C. § 403.

213 See e.g., CONN. GEN. STAT. § 22a-361 (providing that a certificate is required to erect any structure in the tidal, coastal, or navigable waters of the state). See also Webb & Gerrard, *supra* note 170, at 52-55.

214 CAL. CIVIL CODE § 670; CAL. CODE REGS. tit. 2, § 2000 et al.

215 TEX. NAT. RES. CODE §§ 33.101 – 33.106.

Connecticut), offshore leasing is overseen by the state energy or environment agency.²¹⁶

Various other state approvals may also be required to install structures in state waters. The required approvals differ between states, though many require permits for construction in sensitive areas, such as wetlands. For example, in Maine, the construction of structures in or near coastal wetlands requires a permit from the state Department of Environmental Protection.²¹⁷ New York similarly requires structures in tidal wetlands to be permitted by the state Department of Environmental Conservation.²¹⁸

In some areas, state jurisdiction over coastal waters overlaps with local jurisdiction. New York courts, for example, have recognized municipal ownership of submerged lands in some instances.²¹⁹ This could create overlapping state and local permitting processes. Several coastal states and some local governments have established environmental review requirements, sometimes referred to as little NEPAs, that require an assessment of the environmental impacts of permitted activities.²²⁰

5.1.3 Projects Implicating Tribal Rights

Some ocean alkalinity enhancement projects, particularly those impacting fish or fish habitat, may implicate tribal rights. Native American tribes have secured rights to protect their property and way of life through several treaties with the U.S. government, which have, in turn, been recognized through congressional legislation and judicial decisions. Several treaties secure the rights of Native Americans to fish in historical fishing waters. For instance, the 1855 Treaty of Point Elliott states: “The right of taking fish at usual and accustomed grounds and stations is further secured to said Indians in common with all citizens of the Territory.”²²¹ The geographic scope of the fishing rights is not specified in the treaties, but the Washington Supreme Court recognized that they would extend to areas ceded to the United States by the tribes, and those areas “actually used” and occupied for an extended period of time.²²² As recognized by the 9th Circuit, tribal rights to take fish create an implied duty on the part of state and federal governments to avoid damage to fish habitat.²²³ Ocean alkalinity enhancement projects could, in some circumstances, impact the ability of tribes to take fish from historically-recognized ocean fishing areas (e.g., in areas where offshore wind turbines have been constructed).

216 See e.g., CONN. GEN. STAT. § 22a-361 (providing for the issuance of certificates, authorizing the use of submerged lands underlying state waters, by the Connecticut Department of Energy and Environment).

217 ME. REV. STAT. tit. 38, § 480-C (providing that a permit is required to undertake activities involving the “construction, repair or alteration of any permanent structure” in a “coastal wetland.” See also *id.* § 480-B (defining “coastal wetland”).

218 N.Y. COMP. CODES R. & REGS. tit. 6, § 661.8 (providing that a permit is required to conduct a regulated activity on any tidal wetland). See also *id.* §§ 661.4(ee) (defining “regulated activity”) & 661.4(hh) (defining “tidal wetlands”).

219 See, e.g., *Town of Oyster Bay v. Commander Oil Corp.*, 96 N.Y.2d 566, 572 (N.Y., 2001).

220 NEPA.gov, *States and Local Jurisdictions with NEPA-like Environmental Planning Requirements*, <https://perma.cc/Z674-SSZJ> (last visited Jan. 21, 2021). Examples include the California Environmental Policy Act, the New York State Environmental Quality Review Act, and similar acts in several other coastal states.

221 Treaty with the Dwamish, Suquamish, etc., (commonly known as Treat of Point Elliot), art. 5, Jan. 22, 1855, 12 Stat. 927.

222 *State v. Buchanan*, 138 Wash. 2d 186, 207 (1999).

223 See Richard Du Bey, Andrew S. Fuller & Emily Miner, *Tribal Treaty Rights and Natural Resource Protection: The Next Chapter United States v. Washington - The Culverts Case*, 7 AM. INDIAN L. REV. 54, 55 (2019).

Where ocean alkalinity enhancement projects require permits from U.S. federal agencies, and where those projects have substantial direct effects on Indian tribes, consultation is required with the tribes affected. Executive Order 13175 states: “Each agency shall have an accountable process to ensure meaningful and timely input by tribal officials in the development of regulatory policies that have tribal implications.”²²⁴ Policies that have tribal implications are “regulations, legislative comments or proposed legislation, and other policy statements or actions that have substantial direct effects on one or more Indian tribes”²²⁵ Permits granted by federal agencies for ocean alkalinity enhancement projects that may implicate treaty rights, such as those to take fish in historical fishing areas, may thus require consultation with tribes. NOAA has prepared guidelines for such consultations, which detail the procedures for initiating consultation, responding to requests for consultation, and determining consultation structure.²²⁶

5.2 Discharging Materials into U.S. Waters

Ocean alkalinity enhancement and other carbon dioxide removal projects that involve discharging materials into ocean waters may, depending on exactly where they occur, be regulated under the Marine Protection, Research, and Sanctuaries Act (“MPRSA”).²²⁷ Adopted to implement the U.S.’ obligations under the London Convention, the MPRSA regulates “the dumping of all types of materials into ocean waters” within twelve nautical miles of the U.S. coast and further in some circumstances.²²⁸ The MPRSA defines “dumping” broadly to include any “disposition of material.”²²⁹ The term “material” is also defined broadly to mean “matter of any kind of description.”²³⁰ Applying those definitions, the materials used for rock-based ocean alkalinity enhancement would constitute “material,” and their discharge into ocean waters would constitute “dumping” for the purposes of the MPRSA.

In general, and with some exceptions, the MPRSA prohibits the dumping of materials into ocean waters without a permit from the Environmental Protection Agency (“EPA”). Permits are required where:

- the materials to be dumped are transported from within the U.S. (regardless of where the dumping occurs);²³¹ or

224 Exec. Order No. 13175, 65 F.R. 67249 § 5(a) (2000).

225 *Id.* § 1(a).

226 NOAA, NOAA PROCEDURES FOR GOVERNMENT-TO-GOVERNMENT CONSULTATION WITH FEDERALLY RECOGNIZED INDIAN TRIBES AND ALASKA NATIVES (2013).

227 33 U.S.C. § 1401.

228 *Id.* § 1401(b).

229 *Id.* § 1402(f). There are several exceptions to the definition for: (1) “a disposition of any effluent from any outfall structure to the extent that such disposition is regulated under the provisions of the Federal Water Pollution Control Act . . . or under the provisions of the Atomic Energy Act of 1954;” (2) “a routine discharge of effluent incidental to the propulsion of, or operation of motor-driven equipment on, vessel;” (3) “the construction of any fixed structure or artificial island []or the intentional placement of any device in ocean waters or on or in the submerged lands beneath such waters, for a purpose other than disposal, when such construction or such placement is otherwise regulated by Federal or State law or occurs pursuant to an authorized Federal or State program.” None of those exceptions will apply to the discharge of materials for enhanced weathering.

230 *Id.* § 1402(c).

231 *Id.* § 1411(a)(1) (prohibiting any person transporting material from the U.S. for the purpose of dumping it into ocean waters). See also *id.* § 1402(b) (defining “ocean waters” to mean “those waters of the open seas lying seaward of the baseline from which the territorial sea is measured”).

- the materials are transported from outside the U.S. and:
 - transportation occurs on a vessel registered in the U.S. (regardless of where the dumping occurs); or
 - the dumping occurs within twelve nautical miles of the U.S. coast (regardless of how the materials are transported).²³²

EPA can only issue permits under the MPRSA if satisfied that the dumping of materials into ocean waters “will not unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities.”²³³ Dumping can only occur in EPA-designated dump sites, which are chosen to mitigate the adverse impacts of dumping on the environment, as well as the extent to which it interferes with other activities.²³⁴ At the time of writing, there were ninety-eight dump sites.²³⁵ Ninety-seven of those sites were approved only for the dumping of dredged material (i.e., removed from beneath navigable waters) and one only for the dumping of fish processing wastes.²³⁶ Thus, because ocean alkalinity enhancement projects would not use dredged material or fish processing wastes, none of the existing dump sites could be used for such projects (unless they were re-designated by EPA).

Persons wanting to engage in ocean alkalinity enhancement could apply to EPA for designation of a new dump site or approval to use an existing site.²³⁷ On receiving an application, EPA will evaluate the physical, chemical, and biological characteristics of the site, as well as the impacts of past dumping in areas with similar characteristics, to determine whether it is suitable for use.²³⁸ EPA must also conduct an environmental review under NEPA²³⁹ and consult with various federal and state bodies as required under the ESA, Magnuson-Stevens Fisheries Conservation and Management Act, and the CZMA.²⁴⁰

Once EPA designates an area as a dump site, it may permit the dumping of materials therein. Permits are issued by the relevant EPA regional office, which must consider “the environmental effect of the proposed dumping operation, the need for ocean dumping, alternatives to ocean dumping, and the effect of [dumping] on esthetic, recreational and economic values and on other uses of the oceans.”²⁴¹

232 *Id.* § 1411(a)(2) & (b).

233 *Id.* § 1412(a).

234 *Id.* § 1412(c); 40 C.F.R. § 228.5.

235 Env'tl. Prot. Agency, *Ocean Disposal Map*, OCEAN DUMPING, <https://perma.cc/XG2L-UYLG> (last visited Jan. 21, 2021).

236 *Id.*

237 40 C.F.R. § 221.1(f).

238 *Id.* §§ 228.4 & 228.6.

239 42 U.S.C. § 4321 et seq. NEPA requires federal agencies to prepare an environmental impact statement (EIS) in relation to any major federal action that “significantly affect[s] the quality of the human environment.” *See id.* § 4332(2)(C). That requirement has been held not to apply to actions taken under the MPRSA, but EPA voluntarily conducts a NEPA review when designating sites pursuant to the Act. *See* Policy and Procedures for Voluntary Preparation of National Environmental Policy Act (NEPA) Documents, 63 Fed. Reg. 58045, 58046 (Oct. 29, 1998).

240 *See supra* Part 5.1.1.

241 40 C.F.R. § 227.1.

5.3 Related Activities

While ocean alkalinity enhancement is performed offshore, it may necessitate various onshore activities. Rock-based ocean alkalinity enhancement will, for example, require the mining and processing of suitable rocks on land. Ocean alkalinity enhancement performed using electrochemical processes will generate by-products (e.g., hydrochloric acid) that will be transported back to land and used in industrial processes.

5.3.1 Mining and Processing of Materials for Rock-Based Ocean Alkalinity Enhancement

Mining and processing activities are regulated under various federal, state, and local laws. Before any activities can occur, the miner must obtain rights to the relevant minerals. Where the minerals are privately owned, the miner may contract with the owner their purchase or lease. The procedure for obtaining rights to minerals under federal and state ownership is more complex.

The U.S. federal government owns approximately 700 million acres of subsurface mineral resources.²⁴² While some of those resources are found on so-called “split estate” lands, where the surface is under private or state government ownership, most underlie federally-owned land.²⁴³ Mining is prohibited on certain federal land, including in national parks and monuments, wilderness areas, and some wildlife refuges, as well as on land that has been set aside for military reservations.²⁴⁴ It is, however, generally permissible on other federal land.

The Department of the Interior’s Bureau of Land Management (“BLM”) oversees most mining on federal land under the General Mining Law of 1987,²⁴⁵ which confers broad rights on U.S. citizens and certain others (“eligible miners”) to explore for and extract “valuable mineral deposits.”²⁴⁶ Under the General Mining Law, eligible miners can acquire rights to federally-owned minerals through a process known as “location,” which is based on historic claim-staking practices.²⁴⁷ Briefly, location enables a miner to claim a parcel of land which has been found to contain valuable mineral deposits by marking the boundaries of the claimed area, posting a location notice on the area, and recording that notice with BLM and other relevant agencies.²⁴⁸ On location, the miner acquires an unpatented claim to the land and

242 Bureau of Land Mgmt., *What We Manage*, ABOUT, <https://perma.cc/85KT-ARDP> (last visited Jan. 8, 2021).

243 Approximately 60 million acres of federally-owned minerals are located on so-called “split estate” lands, where the surface is not owned by the federal government, but rather under state government or private ownership. See *generally* BUREAU OF LAND MGMT., *SPLIT ESTATE: RIGHTS, REPOSIBILITIES, AND OPPORTUNITIES* (2007), <https://perma.cc/D3PX-37FZ>.

244 Bureau of Land Mgmt., *Locating a Mining Claim*, MINING CLAIMS, <https://perma.cc/CQH6-7VBS> (last visited Jan. 8, 2021).

245 30 U.S.C. § 22 et seq. Some materials have been excluded from the scope of the General Mining Law. See *id.* § 611.

246 *Id.* § 22.

247 BUREAU OF LAND MGMT., *MINING CLAIMS AND SITES ON FEDERAL LANDS* (2011), <https://perma.cc/8P9U-U489>.

248 43 C.F.R. §§ 3832.1 - 3821.12.

minerals, which gives him/her exclusive rights to mine the site.²⁴⁹ However, before engaging in mining activities, the miner must generally submit an operating plan to BLM for approval.²⁵⁰ On receiving the plan, BLM must make it available for public review and comment.²⁵¹ BLM must also conduct an environmental review under NEPA and, where activities could harm endangered or threatened species, consult with FWS under the ESA.²⁵² BLM may approve the plan if it determines that the proposed mining activities will not result in “unnecessary or undue degradation of public lands.”²⁵³

The above system of location cannot be used to claim so-called “common varieties” of limestone and certain other materials found on federal land.²⁵⁴ That stone must, instead, be purchased from the federal government under the Materials Act of 1947.²⁵⁵ The Materials Act authorizes BLM to sell common varieties of stone and certain other materials on federal land outside national forests, provided that the sale would “not be detrimental to the public interest,” in the sense that “the aggregate damage to public lands and resources would exceed the public benefits that BLM expects” from the sale.²⁵⁶ Sales cannot occur on land that has been identified as inappropriate for mining in a resource management plan issued by BLM.²⁵⁷ In other areas, stone is generally sold through a competitive auction process, after which BLM may award the highest bidder a contract for sale.²⁵⁸ Prior to awarding the contract, BLM may direct the bidder to submit an operating plan²⁵⁹ and must complete any required environmental reviews and consultations, for example under NEPA and the ESA.

Most state-owned rock and minerals are also available for purchase or lease.²⁶⁰ Each state has its own administrative regime for mineral sales and leasing, but several employ a process similar to that used by BLM. Like BLM, state land management agencies often develop

249 Historically, individuals holding unpatented claims could apply to BLM to have them patented, at which point the individual would acquire full title to the land. However, since 1994, Congress has prohibited BLM from accepting new patent applications through annual appropriations. See e.g., Further Consolidated Appropriations Act of 2020, Pub. L. 116-94, 113 Stat. 2534, § 404.

250 Plans are required for mining operations on land administered by BLM that involve more than “casual use” of the land. See 43 C.F.R. § 3809.11(a).

251 *Id.* § 3809.411.

252 *Id.*

253 *Id.*

254 The Multiple Surface Use Act of 1955 excluded “common varieties of sand, stone, gravel, pumice, pumicite, [] cinders and . . . petrified wood” from the scope of the General Mining Law. See 30 U.S.C. § 611. For the purposes of the Multiple Surface Use Act, the term “stone” has been interpreted broadly to include limestone. See BUREAU OF LAND MGMT., H-3630-1 MINERAL MATERIALS FAIR MARKET VALUE (FMV) EVALUATIONS (P) 3 (2016), <https://perma.cc/EB8H-ST8C>. The exclusion in the Multiple Surface Use Act does not, however, apply to “limestone of chemical or metallurgical grade or that is suitable for making cement.” That limestone is subject to location under the Mining Law. See 43 C.F.R. § 3830.12.

255 30 U.S.C. § 601.

256 *Id.* See also 40 C.F.R. § 3601.11. Materials located on land situated in national forests may be sold by the Secretary of Agriculture (through the Forest Service) under the Materials Act. See 30 U.S.C. § 601.

257 43 C.F.R. § 3601.12(c).

258 The highest bidder will only be awarded a contract for sale if his/her/its bid is equal to or above the fair market value of the materials and he/she/it is able to meet any obligations imposed by BLM. See *id.* §§ 3602.41, 3602.43, & 3602.45. BLM can enter into non-competitive contracts for sale in some circumstances. See *id.* § 3602.31.

259 *Id.* §§ 3601.40-3691.44.

260 See generally, AARON M. FLYNN, CONG. RESEARCH SERV., RL32813, HARDROCK MINING: STATE REGULATION (2005), <https://www.everycrsreport.com/reports/RL32813.html>.

resource management plans, which identify areas in which mineral development is permitted. Within those areas, the state land manager (or another state body) may sell or lease minerals, typically via a competitive auction process.²⁶¹

Regardless of whether they occur on federal, state, or private land, mining and processing operations must comply with any requirements imposed by applicable environment and other laws. For example:

- Mining and processing operations that release rock particles into the air may, depending on the size of the released particles, be regulated as a source of particulate matter pollution under the Clean Air Act (“CAA”).²⁶² Pursuant to the CAA, EPA has established National Ambient Air Quality Standards for two classes of particulate matter—PM2.5 (i.e., inhalable particles of 2.5 microns or less in diameter) and PM10 (i.e., inhalable particles of 10 microns or less in diameter).²⁶³ A permit from EPA or an authorized state or local entity is required to construct or operate any facility that constitutes a “major stationary source” of PM2.5 or PM10.²⁶⁴ Some states also require permits for other facilities, such as those that emit PM2.5 or PM10 at levels below the major source threshold or emit larger particles (i.e., exceeding 10 microns in diameter).²⁶⁵ Many also impose additional requirements, e.g., mandating the use of control measures to limit dust from the handling, transport, and storage of mined materials.²⁶⁶
- Mining and processing operations that involve the discharge of rock or other materials into waterways may require a permit under the CWA.²⁶⁷ A permit is required under the CWA to discharge any “pollutant,”²⁶⁸ with that term defined broadly to include “rock, sand, cellar dirt, and industrial, municipal, and agricultural waste.”²⁶⁹ Discharges occur where a pollutant is added to waters of the U.S. from a “point source,” defined as a “discernible, confined and discrete conveyance.”²⁷⁰ Thus, for example, a discharge will be considered to occur and a permit required if waste materials from mining or processing operations are deposited into a waterbody via pipeline or truck. Where the waste comprises mining overburden, tailings, or similar rock-based material, the discharge must be permitted by the Army Corps of Engineers or an authorized state

261 See e.g., FLA. STAT. ANN. § 253.45 (authorizing the sale or lease, by competitive bidding, of minerals and certain other substances “in, on, or under any land the title to which is vested in the state” of Florida); HAW. REV. STAT. §§ 182-4 & 182-5 (authorizing the auction of minerals on state lands); N.C. GEN. STAT. §§ 14608 & 146-9 (authorizing the sale, lease, or other disposal of “any and all mineral deposits belonging to the State”).

262 42 U.S.C. § 7401 et seq.

263 National Ambient Air Quality Standards for Particulate Matter, 85 Fed. Reg. 82,684 (Dec. 18, 2020).

264 42 U.S.C. §§ 7475, 7502, 7503. The size threshold for “major” stationary sources varies depending on local air quality (among other things).

265 See e.g., FLA. ADMIN. CODE ANN. r. 62-210.300 (requiring permits for facilities that emits any air pollutant, regardless of amount); 9 VA. ADMIN. CODE § 5-80-1105(C) (requiring permits for facilities emitting more than 25 tons per year of particulate matter of any size).

266 See e.g., 9 VA. ADMIN. CODE § 5-40-90 (requiring “reasonable precautions” to be taken to prevent dust from storage piles becoming airborne).

267 33 U.S.C. § 1251 et seq.

268 *Id.* §§ 1311, 1342, & 1344.

269 *Id.* § 1362(6).

270 *Id.* §§ 1362(12), (14), & (16).

agency under section 404 of the CWA.²⁷¹ A section 402 (NPDES) permit from EPA or an authorized state agency is required for the discharge of other materials.²⁷²

- Mining wastes that are not discharged into waterways must be handled in accordance with the requirements of the Resource Conservation and Recovery Act (“RCRA”).²⁷³ Most mining wastes are regulated as non-hazardous wastes under subtitle D of RCRA.²⁷⁴ EPA regulations, adopted under subtitle D, impose limited restrictions on where and how non-hazardous wastes can be disposed of.²⁷⁵ States can and have adopted additional, more stringent requirements, with some mandating that non-hazardous waste only be disposed of at designated facilities or in designated ways.²⁷⁶

U.S. Coast Guard regulations require ships transporting hydrochloric acid in bulk to be certified and meet various design and other requirements.²⁷⁷ For example, the ships must transport hydrochloric acid in an independent cargo tank that does not form part of the hull, is separated from bunkers by double walls, and is lined with natural rubber, neoprene, or other approved materials.²⁷⁸ The ship must display a warning sign during load and unloading of the tanks and carry documentation indicating, among other things, the amount of hydrochloric acid on board and its location.²⁷⁹

The above requirements only apply to ships transporting hydrochloric acid in bulk. Ships engaged in non-bulk transportation are subject to different requirements, set out in regulations adopted pursuant to the Hazardous Materials Transportation Act (“HMTA”).²⁸⁰ For the purposes of the HMTA, hydrochloric acid has been designated as a hazardous material.²⁸¹ Regulations issued under the HMTA require ships transporting hazardous materials to be registered with PHMSA.²⁸² Registered ships must transport hydrochloric acid in approved receptacles that are clearly marked as containing corrosive materials and stored in approved

271 *Id.* § 1344 (authorizing the Army Corps of Engineers or an approved state to issue permits “for the discharge of dredged or fill material”). See also 33 C.F.R. § 323.2(e) (defining “fill material” to include “overburden from mining” and other rock that, when placed into waters of the U.S., has the effect of replacing any portion of the water with dry land or changing the bottom elevation).

272 30 U.S.C. § 1342 (authorizing EPA or an approved state to issue permits “for the discharge of any pollutant” other than dredged or fill material).

273 42 U.S.C. § 6901 et seq.

274 In 1980, Congress enacted the Bevill Amendment to RCRA, which conditionally exempt certain mining and other wastes from regulation as hazardous wastes, pending a review by EPA. See Solid Waste Disposal Act Amendments of 1980, Pub. L. 96-482, 94 Stat. 2334 (1980). EPA completed its review of mining wastes in 1985, concluding that most should be treated as non-hazardous. See ENVTL. PROT. AGENCY, REPORT TO CONGRESS: WASTES FROM THE EXTRACTION AND BENEFACTION OF METALLIC ORES, PHOSPHATE ROCK, ASBESTOS, OVERBURDEN FROM URANIUM MINING, AND OIL SHALE (1985), <http://perma.cc/869U-X5MW>.

275 40 C.F.R. Pt. 257.

276 See e.g., N.Y. COMP. CODE R. & REGS. tit. 6, § 360.9(b) (requiring all waste to be sent to approved facilities and not disposed of on land or in any other manner outside such facilities).

277 46 C.F.R. § 153.900. See also *id.* § 153.1 and Table 1 to Part 153.

278 *Id.* §§ 153.252, 153.554, & 153.557. See also *id.* Table 1 to Part 153.

279 *Id.* §§ 153.901, 153.907, 153.955 & 153.1045.

280 49 U.S.C. § 5101 et seq. Certain ships are exempt from the PHMSA regulations. See e.g., 49 C.F.R. § 176.5(b)(3) (exempting small ships of fifteen gross tons or less).

281 49 C.F.R. § 172.101

282 *Id.* § 171.2.

locations.²⁸³ While the receptacles are on board, the ship must carry documentation, including details of their contents and location.²⁸⁴

Once the hydrochloric acid reaches shore, it would need to be offloaded to a temporary storage facility. Storage facilities accepting hydrochloric acid may, depending on their size, be subject to reporting requirements under the Emergency Planning and Community Right-to-Know Act (“EPCRA”).²⁸⁵ The EPCRA applies to, among other things, facilities handling large amounts of any chemical that has been classified as posing a physical or health hazard.²⁸⁶ Health hazard chemicals include those that cause skin corrosion or irritation which is a characteristic of hydrochloric acid.²⁸⁷ Notably, however, only facilities handling 10,000 pounds (4,540 kilograms) or more of hydrochloric acid at any one time are subject to the EPCRA.²⁸⁸ Within three months of becoming subject to the EPCRA and annually thereafter, the facility must report to the relevant State Emergency Response Commission (or, if there is no Commission, the relevant state Governor).²⁸⁹

283 *Id.* §§ 172.101, 172.442, 173.202, & 197.800.

284 *Id.* §§ 176.24 & 176.30

285 42 U.S.C. § 11001 et seq.

286 29 C.F.R. § 1910.1200(c); 40 C.F.R. § 370.2, 370.10, & 370.66.

287 29 C.F.R. § 1910.1200(c) & Appendix A.

288 40 C.F.R. § 370.10.

289 *Id.* §§ 370.30 & 370.40-370.41.

6. CONCLUSION

There is growing interest in the possibility of using ocean-based approaches to remove and store carbon dioxide from the atmosphere. One option is ocean alkalinity enhancement, which can be performed either by discharging ground alkaline rock into ocean waters or through an electrochemical process, involving the application of an electric current to water.²⁹⁰ Both techniques ultimately increase ocean pH levels, which enables greater uptake of carbon dioxide.²⁹¹ It also has the co-benefit of combatting ocean acidification, which poses a serious threat to marine ecosystems.

There are no international or U.S. laws dealing specifically with ocean alkalinity enhancement. However, depending on precisely where and how ocean alkalinity enhancement is conducted, various general environmental and other laws could apply. At the international level, potentially applicable instruments include UNCLOS, the Convention on Biological Diversity, and the London Convention and Protocol. Domestically, the OCSLA, MPRSA, NEPA, ESA, and several other federal laws could apply to ocean alkalinity enhancement in some circumstances. None of the domestic laws prohibit ocean alkalinity enhancement, but several impose permitting and other requirements, which could impact project development. The key requirements are listed in Appendix A.

290 See *supra* Part 2.1.

291 *Id.*

APPENDIX A: PERMITTING REQUIREMENTS TABLE

The table below identifies the minimum permitting requirements for key water-based activities likely to be undertaken in connection with ocean alkalinity enhancement (OAE) projects in U.S. waters. All OAE projects in U.S. waters that involve the listed activities will require the listed permits. Depending on the specifics of each project, additional permits may also be required for the listed activities. For example, where the construction or operation of structures in connection with OAE projects requires the discharge of dredged material in state waters, a permit will be required from the U.S. Army Corps of Engineers under the Clean Water Act, and an associated consistency determination from the relevant state in whose waters the discharge will occur. As another example, construction or other activities that could harm marine or other species or their habitats may require permits under the Endangered Species Act, Marine Mammal Protection Act, Migratory Bird Treaty Act, and other species protection laws. Additional permits would also be required for any land-based activities (e.g., mining) associated with OAE projects.

Table A1: Minimum Permitting Requirements for Water-Based Activities Undertaken in Connection with OAE Projects

Activity	Location	Approval Required	Issuing Agency	Criteria for Issuance
Construction/operation of structures attached to the seabed (e.g., wind turbines)	U.S. state waters	State lease (or similar) authorizing occupation of state submerged land	Varies (often state land management agency)	Varies. Some states require an environmental review and consultation with local governments, Native American tribes, and other stakeholders prior to lease issuance.
	State construction approval	Varies (often state environmental agency)		
	U.S. state waters	Permit under Rivers and Harbors Act (RHA)	U.S. Army Corps of Engineers (USACE)	USACE must evaluate the probable effect of construction on the public interest. Environmental review and consultation with government, tribal, and other stakeholders* may be required.
	Authorization under the Aids to Navigation Program	U.S. Coast Guard (USCG)	USCG must confirm that the structure is appropriately marked and meets other regulatory requirements. Environmental review and consultation with government, tribal, and other stakeholders* may be required.	
	U.S. state waters	Documentation under the National Environmental Policy Act (NEPA)	USACE / USCG	USACE / USCG must conclude that an environmental review is not required under NEPA and issue documentation to that effect or conduct the required environmental review and publish the findings. An environmental review is required under NEPA where a federally-authorized activity significantly affects the human environment.
	Consistency determination under the Coastal Zone Management Act (CZMA)	Varies (often state environmental agency)	The state must be satisfied that the federal action is consistent "to the maximum extent practicable" with the enforceable policies of any state coastal management plan adopted under the CZMA. ⁶	
U.S. federal waters	Federal lease or other instrument authorizing occupation of federal submerged land	U.S. Department of the Interior, Bureau of Ocean Energy Management (BOEM)	Leases can only be issued for activities specified in the Outer Continental Shelf Lands Act (includes renewable energy development). BOEM must consider the effect of leasing on the human, marine, and coastal environments. Environmental review and consultation with government, tribal, and other stakeholders* may be required.	

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Activity	Location	Approval Required	Issuing Agency	Criteria for Issuance
Construction/operation of structures attached to the seabed (e.g., wind turbines)	U.S. federal waters	<p>Permit under the RHA</p> <p>Authorization under the Aids to Navigation Program</p> <p>Documentation under NEPA</p>	<p>USACE</p> <p>USCG</p> <p>BOEM / USACE / USCG</p>	<p>USACE must evaluate the probable effect of construction on the public interest. Environmental review and consultation with government, tribal, and other stakeholders* may be required.</p> <p>USCG must confirm that the structure is appropriately marked and meets other regulatory requirements. Environmental review* and consultation with government, tribal, and other stakeholders** may be required.</p> <p>BOEM / USACE / USCG must conclude that an environmental review is not required under NEPA and issue documentation to that effect or conduct the required environmental review and publish the findings. An environmental review is required under NEPA where a federally-authorized activity significantly affects the human environment.</p> <p>The state must be satisfied that the federal action is consistent “to the maximum extent practicable” with any state coastal management plan adopted under the CZMA.^</p>
Construction / operation of structures floating structures (not attached to the seabed)	U.S. state waters	<p>State construction approval</p> <p>Authorization under the Aids to Navigation Program</p> <p>Documentation under NEPA</p>	<p>Varies (usually state environmental agency)</p> <p>Varies (often state environmental agency)</p> <p>USCG</p> <p>USCG</p>	<p>Varies. Some states require an environmental review and consultation with governments, tribal, other stakeholders.</p> <p>USCG must confirm that the structure is appropriately marked and meets other regulatory requirements. Environmental review and consultation with government, tribal, and other stakeholders* may be required.</p> <p>USCG must conclude that an environmental review is not required under NEPA and issue documentation to that effect or conduct the required environmental review and publish the findings. An environmental review is required under NEPA where a federally-authorized activity significantly affects the human environment.</p> <p>The state must be satisfied that the federal action is consistent “to the maximum extent practicable” with the enforceable policies of any state coastal management plan adopted under the CZMA.^</p>

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Activity	Location	Approval Required	Issuing Agency	Criteria for Issuance
Construction / operation of structures floating structures (not attached to the seabed)	U.S. federal waters	Authorization under the Aids to Navigation Program Documentation under NEPA	USCG USCG	USCG must confirm that the structure is appropriately marked and meets other regulatory requirements. Environmental review and consultation with government, tribal, and other stakeholders* may be required. USCG must conclude that an environmental review is not required under NEPA and issue documentation to that effect or conduct the required environmental review and publish the findings. An environmental review is required under NEPA where a federally-authorized activity significantly affects the human environment.
Discharge of materials into ocean waters	U.S. state waters	Consistency determination under the CZMA Dump site designation under the MPRSA Ocean dumping permit under the MPRSA Documentation under NEPA	Varies (usually state environmental agency) U.S. Environmental Protection Agency (EPA) EPA EPA	The state must be satisfied that the federal action is consistent “to the maximum extent practicable” with any state coastal management plan adopted under the CZMA. [^] EPA must consider the physical, chemical, and biological characteristics of the proposed dump site and the impacts of past dumping in areas with similar characteristics. Environmental review and consultation with government, tribal, and other stakeholders* may be required. EPA must consider the need for, and effects of, dumping.
	U.S. federal waters	Consistency determination under the CZMA Dump site designation under the MPRSA [#]	Varies (often state environmental agency) EPA	The state must be satisfied that the federal action is consistent “to the maximum extent practicable” with the enforceable policies of any state coastal management plan adopted under the CZMA. [^] EPA must consider the physical, chemical, and biological characteristics of the proposed dump site and the impacts of past dumping in areas with similar characteristics. Environmental review and consultation with government, tribal, and other stakeholders* may be required.

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Activity	Location	Approval Required	Issuing Agency	Criteria for Issuance
Discharge of materials into ocean waters	U.S. federal waters	Ocean dumping permit under the MPRSA [#]	EPA	EPA must consider the need for, and effects of, dumping.
		Documentation under NEPA	EPA	EPA must conclude that an environmental review is not required under NEPA and issue documentation to that effect or conduct the required environmental review and publish the findings. An environmental review is required under NEPA where a federally-authorized activity significantly affects the human environment.
		Consistency determination under the CZMA [^]	Varies by state (usually state environmental agency)	The state must be satisfied that the federal action is consistent “to the maximum extent practicable” with the enforceable policies of any state coastal management plan adopted under the CZMA. [^]

* The issuing agency may be required to consult with other government agencies under the CZMA, Endangered Species Act, Magnuson-Stevens Fishery Conservation and Management Act, National Historic Preservation Act, and other federal laws. Consultation may also be required with Native American tribes and other stakeholders.

[^] The federal agency authorizing the activity must provide the relevant state with a “consistency determination,” explaining how its actions are consistent “to the maximum extent practicable” with any state coastal management plan adopted under the CZMA. The state must agree with the consistency determination. If it disagrees, the federal agency must work with the state to address its objections.

[#] Only required if materials are discharged within 12 nautical miles of the U.S. coast or, if discharge occurs further offshore, using a vessel that is registered or was loaded in the U.S.



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