Project Description

Project Macoma, LLC, a wholly owned subsidiary of Ebb Carbon, is proposing a temporary pilot-scale marine carbon dioxide removal (mCDR) project (pilot project or Project Macoma) sited at Terminal 7 of the Port of Port Angeles (Port) in Port Angeles, Washington (see Attachment 1, Drawing C-001). Ebb Carbon has developed an mCDR technology to safely and permanently remove carbon dioxide (CO_2) from the atmosphere while reducing seawater acidity locally. Ebb Carbon's mCDR technology removes acid from seawater, generating alkaline-enhanced seawater in the process. The alkaline-enhanced seawater is returned to the ocean, which enables the ocean to draw down and store additional CO_2 from the atmosphere.

The proposed pilot project, owned and operated by Project Macoma, LLC, would intake seawater via a barge moored at the Terminal 7 dock, pipe the seawater over the existing Terminal 7 pier structure to a modular treatment facility on land, and process and deacidify the seawater before returning it to Port Angeles Harbor via the barge-based outfall system (see Attachment 1, Drawings C-101 and C-800). The purposes of the proposed pilot project are to operate Ebb Carbon's mCDR technology under real-world conditions, support scientific research through scientific and academic collaborations, and gather additional data to inform future deployments. This field trial is conservatively designed to remove 500 net tons of CO_2 from the atmosphere per year and reduce ocean acidification locally. Project Macoma, LLC, plans to undertake this pilot project with Pacific Northwest National Laboratory, the University of Washington, and other agency and scientific partners. Project Macoma, LLC, and the Lower Elwha Klallam Tribe are discussing the potential for partnership on this pilot project. The proposed pilot project would run for approximately 1.5 years, beginning in summer 2024.

This section provides additional information about the pilot project's elements along with a description of construction and operational activities.

1 Project Elements

As a pilot project, the proposed project elements would be installed as temporary features. The main elements consist of the following:

- A moored barge at the Terminal 7 pier with pumps and pipes that are used to intake, transport, and discharge seawater to the Port Angeles Harbor, part of the Salish Sea.
- Onshore modular water treatment equipment that is used to filter and soften the water and create a concentrated brine.
- Onshore electrochemical processing equipment that is used to deacidify the seawater.
- Onshore equipment used to neutralize the acidic byproduct.

For safety, control, and research purposes, the project design also includes sensing and monitoring equipment that will be located at the site and throughout the harbor.

The proposed project footprint would roughly occupy 275 feet by 93 feet onshore, with the barge occupying roughly 30 feet by 80 feet adjacent to the Terminal 7 dock. The onshore area is located on Port-owned property and is currently being used as a log yard. Access and parking would be provided by existing infrastructure at the Port. The in-water portion of the site is located on state-owned aquatic lands that are leased by the Port under a Port Management Agreement.

1.1 Onshore Elements

A majority of the process equipment would be located onshore and would utilize shipping containers (up to 9.5 feet high with 2 additional feet for electrical lines) as machine housing. The treatment equipment would be procured from a combination of third-party manufacturers and assembled by Ebb Carbon. The treatment equipment and process are described in greater detail in Section 2.3 and Attachment 1, Drawing C-201.

In total, there would be 10 shipping containers, six mobile tanks, two utility sheds, and one office trailer, which would be used for the following functions:

- The shipping containers would contain seawater processing equipment. Plastic pipelines would connect the treatment facilities to and from the barge intake and outfall structures.
- Alkaline minerals and the equipment used for acid neutralization would be stored on site in lined containers with weather coverings.
- The mobile tanks would be used to store pumped seawater and the acid and base extracted from the brine. The mobile tanks would contain approximately 8,000 to 21,000 gallons and be 10 feet high with 2 additional feet for electrical lines. Any hazardous chemicals would be stored with appropriate secondary containment following best management practices (BMPs). All tanks would have containment suitable for minor leaks.
- Two of the utility sheds would house electrical equipment, providing required electrical protective measures consistent with City of Port Angeles (City) requirements. The third would be for storage and maintenance operations.

The office trailer would be for staff operations. The pilot project would rely on the Port’s existing stormwater system at Terminal 7 for stormwater runoff. The area was previously graded to slope away from the shore to a collection point where water is captured and treated by the Port’s stormwater system.

1.2 In-Water Elements

The in-water elements of the proposed pilot project include the barge, which would be equipped with intake and outfall infrastructure, water pumps, and water quality monitoring equipment.

The barge would be an approximately 30- by 80-foot platform (2,400 square feet) that houses the intake and outfall structures and pumps. The barge would also house some utilities and monitoring equipment. The intake would consist of a pipe that is attached to the barge, equipped with fish screening and mesh that complies with state and federal requirements. The outfall would be an approximately 4-inch-diameter and 50-foot-long pipe that is affixed to and runs the length of the barge, with half-inch perforation holes spaced approximately 2 feet apart and pointing toward the surface across the pipes to diffuse the discharged alkaline-enhanced seawater back into the harbor. The pipe would be submerged approximately 2 meters below the water surface (approximately 28 to 35 feet from the substrate at low to high tide levels, respectively).

Scientific monitoring would occur in the receiving waters throughout operations. Water quality sensors would be attached to existing piers to collect regular measurements. Ebb Carbon would use these measurements to adaptively manage operations, if needed, and to monitor environmental health and benefits.

2 Construction

Project construction is anticipated to begin in 2024. Construction activities would involve site preparation, construction, and assembly of onshore structures (i.e., electrical equipment enclosures); deployment of the barge; and assembly of intake/outfall and monitoring equipment. No existing structures would be demolished. All activities would be conducted in a manner appropriate to minimize the potential for erosion or spills consistent with applicable regulations and required permits and approvals. All ground-disturbing activities are expected to be conducted outside sensitive cultural resource areas.

Site preparation is anticipated to require minimal ground disturbance, mainly in the form of targeted areas of excavation required for the electrical equipment (i.e., not for larger structures). Elements of design that would involve potential onshore ground disturbance include the following:

- One to two copper ground rods (10 feet long and 3/4 inch in diameter) would be placed adjacent to each container/trailer corner, and two to four ground rods would be placed at each electrical building/shed. The ground rods would be driven vertically into the ground for site/system grounding. All ground cable and ground connections to equipment would be run above grade.
- An equipment pad would be constructed for the site electrical shed.
- Improvements to the existing utility main electrical room may include excavation of a conduit trench between the existing electrical room and the existing City utility transformer vault (on the northwest side of the utility vault). This conduit trench excavation may be avoided or minimized if an above-grade conduit is permitted by the City when the new transformer is installed.

- Excavation would be avoided for anchorage of trailers/containers/tanks for the electrical shed foundation and the utility vault building electrical area by laying down gravel and anchoring the trailers/containers/tanks to concrete blocks, if necessary.

Above-grade gravel fill would be used for access paths and the areas where the containers are located. This excludes the existing electrical area, which would not receive fill. Based on the approximate area of 21,018 square feet, the pilot project would use 12 inches of aggregate base under trailers and for access area. These include approximately 950 cubic yards of hauled loose aggregate gravel and approximately 800 cubic yards of compacted aggregate gravel, for a total of approximately 1,750 cubic yards.

Ebb Carbon would also prepare and implement a Contaminated Materials Management Plan (CMMP) to address potential issues if contaminated sediments are encountered. Although the level of ground disturbance would be minimal, the CMMP would help to ensure potential concerns are adequately addressed. The CMMP would include testing and appropriate disposal of excavated materials. Ebb Carbon also expects to develop a Monitoring and Inadvertent Discovery Plan for cultural resources.

The intake and outfall piping, screens, flexible connections, and other components would be prefabricated and connected to pump skids, which would be mounted on the barge. The barge would be moored on the north side of the existing dock. The pre-assembled pipelines and intake and outfall structures would then be mounted to the barge using small hoists. Scientific monitoring equipment would also be installed on the barge and to existing piers.

2.1 Bunker Building and Electrical Equipment

The existing bunker building would receive various architectural, mechanical, and electrical updates and improvements. The building updates include adding insulation to the interior walls and ceiling. The existing door would be replaced with a larger door meeting equipment access and egress requirements. The space would be conditioned with a new mechanical HVAC system to maintain proper humidity and temperature for the new electrical equipment.

The existing electrical service and associated equipment would be removed and upgraded as part of the proposed pilot project. A larger electrical utility transformer would be installed in place of the existing service due to the increased electrical demands of the pilot project. This new transformer would supply power to new electrical distribution equipment installed within the bunker building, including lighting and convenience receptacles. Existing electrical gear that is to remain in service would be connected to the new equipment being procured and installed.

All modifications and improvements would be done per local, state, and federal codes and guidelines.

3 Operation

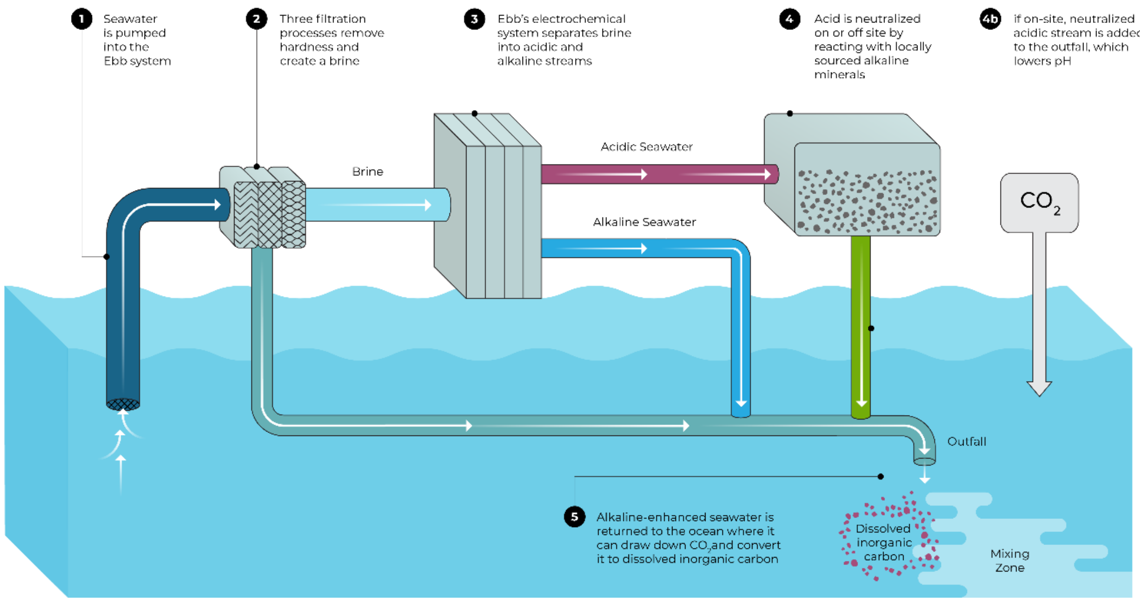
The pilot project's nameplate capacity is for 500 net tons of CO_2 removal per year from the atmosphere. The intake and outfall infrastructure would intake and return approximately 97,000 gallons per day (372,000 liters per day) of seawater from Port Angeles Harbor. Proposed pilot project operations are expected to last approximately 1.5 years post-construction (through 2025 and into 2026). If operations are extended, it would be in coordination with the Port, Lower Elwha Klallam Tribe, and review agencies. Monitoring is expected to occur after operations have concluded to gather post-operational data for review.

Operational activities include pilot-scale water treatment to deacidify seawater to support CO_2 removal from the atmosphere, possible sale and/or transport of acidic byproduct off site, transport on- and off site of alkaline minerals for acid neutralization, and monitoring and data collection activities. This section describes these aspects.

3.1 Water Treatment Process

A schematic of the treatment process is shown in Figure 1.

Figure 1
Schematic of Water Treatment Process



The main steps of the water treatment process include the following:

1. **Water Intake :** Water intake would occur at the barge.
2. **Water Pretreatment:** Once pumped onshore, the seawater would undergo pretreatment, which includes particulate filtration (to remove solids), nanofiltration (to remove hardness, calcium, and magnesium ions), and reverse osmosis to create a brine and permeate that will undergo electrochemical processing.
3. **Electrochemical Processing:** After pretreatment, the brine stream would be consumed electrochemically. Ebb Carbon's electrochemical technology uses low-carbon electricity to pass the brine through a series of ion-exchange membranes that separates the brine into two solutions: a base (sodium hydroxide [NaOH]) and an acid (hydrochloric acid [HCl]). The electrochemical process produces oxygen and hydrogen gases at ambient pressures that will be diluted below lower explosive limits and vented to the atmosphere following all applicable standards. The site generation rate of these are low, at 10 and 20 standard liters per minute undiluted, respectively.
4. **Acid Neutralization:** The acid produced from the brine may be neutralized at the site, so it does not return to the ocean. This would be done by reacting the acidic solution with alkaline materials such as ultramafic rocks, limestone, or unhardened concrete. If reacted on site, alkaline minerals would be transported to the site via truck and/or boat approximately once per week. The aqueous neutralized stream would then be filtered to remove solids and trace metals below acceptable limits before being recombined with the pretreated seawater and alkaline stream. Once combined, the streams would be pumped to the barge for outfall. Another option would be to remove and transport the acid off site rather than neutralizing on site.
5. **Discharge and Monitoring:** After processing on land, the combined streams (pretreated seawater, alkaline stream, and, if applicable, the neutralized stream) form an alkaline-enhanced seawater that would be pumped to the barge-based outfall. The outfalled alkaline-enhanced seawater would mix with ambient seawater to remove CO_2 gas from the air and store it as dissolved inorganic carbon, primarily bicarbonate ions—a safe and naturally abundant form of carbon storage in the ocean.
    a. The discharge is designed to be continuous for multiple hours per day throughout the pilot study with different discharge scenarios occurring to provide additional scientific information. Discharge may stop if monitors indicate that certain thresholds have been met.
    b. Although no new constituents would be added (e.g., no metals or organic compounds), the pH of the water could be altered from approximately 8 to 13.5 pH for short periods of time (a single tidal cycle). Preliminary mixing analyses indicate that surrounding pH would return to ambient within the nearfield mixing zone, approximately 21 feet from the discharge point at the barge. Water quality would return to ambient approximately 40 feet around the discharge, well within the allowable chronic mixing zone. During

operations, the mixing zone will be maintained within permitted limits. The standard Washington State Department of Ecology required mixing zone distance is 207 feet from the point of discharge. Water quality monitoring and ecological monitoring would be conducted within both zones to ensure safe operations of the pilot study and to collect data to help inform further development and deployment of this technology. Water quality monitoring would occur to assess for potential acute and chronic mixing zone exceedances at proposed distances of 15 and 150 feet, respectively.

3.2 Acid Byproduct Removal and Handling

When combined with the pretreated seawater and alkaline stream, the acidic byproduct would lower the pH of the alkaline-enhanced seawater, resulting in a final product with a pH that is similar to the receiving waters. There is also a potential that the HCl could be separated from the influent stream and used off site for other processes (e.g., in cement manufacturing or laboratory research). While on site, acid byproduct would be handled, stored, and transported consistent with applicable local, state, and federal regulations. It is assumed that entities receiving the acid would also adhere to required standards and regulations. Truck traffic to transport acid byproducts would occur approximately once per month.

3.3 Water Quality Monitoring

Water quality monitoring would be accomplished by attaching sensors to existing piers to collect regular measurements of water temperature, salinity, dissolved oxygen, turbidity and suspended solids, chlorophyll, pH, and the partial pressure of CO_2. Less frequent seawater samples would be collected and analyzed for total alkalinity and dissolved inorganic carbon.

3.4 Best Management Practices

BMPs would be implemented during construction to avoid or minimize potential impacts to the environment. BMPs would include, but not be limited to, the following:

- Work would be performed according to the requirements and conditions of the project permits and approvals.
- Construction activities would be completed consistent with the Temporary Erosion and Sediment Control and stormwater site plans prepared for the project. Erosion control measures may include installing a stabilized construction access; construction road stabilization; installing mulching, nets, and blankets; applying surface roughing, gradient terraces, interceptor dikes, and swales; dust control; material delivery storage and containment; outlet protection; and installing waffles, filter berms, or silt fencing.
- A CMMP would be prepared and implemented during construction to address potential issues if contaminated soils are encountered.

- The contractor would be required to develop and implement a Spill Prevention, Control, and Countermeasure Plan to be used for the duration of the project to safeguard against unintentional release of fuel, lubricants, or hydraulic fluid from construction equipment.
- Construction equipment used on the project would be maintained in good working order to minimize airborne emissions.
- Dust control measures, such as application of water, would be employed during construction, as necessary.
- No uncured concrete would be in contact with surface waters.
- The contractor would be required to properly maintain construction equipment and vehicles to prevent them from leaking fuel or lubricants; if there is evidence of leakage, the further use of such equipment would be suspended until the deficiency has been satisfactorily corrected.
- Excess or waste materials would not be disposed of or abandoned in Port Angeles Harbor or allowed to enter waters of the state.
- Project Macoma, LLC, would adopt and implement the Port's Storm Water Pollution Prevention Plan (SWPPP) that specifies measures to avoid and minimize impacts to surface, ground, and stormwater water and drainage pattern impacts.
- Project Macoma, LLC, would develop, maintain, and implement a chemical management plan that includes specific procedures for procurement, delivery, transfer, storage, inventory, use, spill prevention and cleanup, emergency response, and disposal. All employees and contractors would receive chemical management training within 1 month of hiring and annually thereafter.
- New light fixtures for overwater structures would be directed away from the water to the extent practicable to minimize impacts on aquatic species.
- The intake screen would be designed to screen fish from entering the intake facilities in compliance with current fish screening guidelines from the Washington Department of Fish and Wildlife and the National Marine Fisheries Service.
- A Monitoring and Inadvertent Discovery Plan for cultural resources would be prepared and implemented during project construction.