March 28th, 2025

The Honorable Dr. Stephen Cliff
Executive Officer
California Air Resources Board
1001 I Street
Sacramento, CA 95814

Re: Comments from Capture6 on the Carbon Capture, Removal, Utilization, and Storage Workshop held February 27th, 2025

Dear Dr. Cliff,

Thank you for the workshop you held on February 27th, 2025 on the CCRUS Program and the opportunity to submit comments on the implementation of SB 905. California is a global leader in climate, and its plan to reduce and remove GHG emissions is ambitious and necessary given the impacts of climate change we experience here. An excellent example of this ambition is the 2022 Scoping Plan's goals of 20 and 100 million tonnes of CO_2 removal and capture by 2030 and 2045 respectively. In light of these high goals, we are encouraged by CARB's foresight to recognize the role of both CCUS and CDR as key decarbonization strategies needed to meet California's carbon neutrality goals. We strongly support CARB's efforts in SB 905 implementation, and we look forward to the future workshops on technology assessments and preliminary regulatory structure.

This comment is in response to several topics that were discussed during the CCRUS workshop, summed by the following recommendations, and discussed in more detail below:

1. Marine carbon dioxide removal (mCDR) will be necessary for California to meet its 2030 and 2045 removal and reduction targets, so we encourage the adoption and inclusion of mCDR protocols that will encourage this sector's project development in California.
2. Communities need CDR and CCS technologies that don't add to California's water and air pollution crises. We ask that consideration be given to incentivize CDR and CCS technologies that solve multiple climate and environmental impacts rather than not contributing to them or worsening them.
3. CDR and CCS seem firmly linked to the subsurface storage of CO_2 in Class VI wells and the transport of CO_2 via pipelines - but they don't need to be. We advocate for the inclusion of protocols that leverage alternative storage mechanisms that are geologically, environmentally, and socially sound.
4. We strongly support the interagency efforts that are already underway in California as well as the additional budgetary requests to ensure CARB has sufficient staff and resources to implement SB 905.

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Capture6: Direct air capture, water production, and ocean alkalinity enhancement
Capture6 is a Berkeley-based CDR company with a flexible technology that supports both carbon removal and reduction goals through integrations with water, CCUS, and other industries. We are a proud recipient of funding from the California Energy Commission's Commercializing Industrial Decarbonization program. This funding supports Capture6's Project Monarch, the first California-funded direct air capture (DAC) facility, and to our knowledge, the first DAC facility fully integrated with a water treatment plant globally. **Project Monarch** is located in Palmdale, CA in partnership with the Palmdale Water District's Pure Water Antelope Valley (PWAV) water recycling facility. Here, our technology removes atmospheric CO_2 while creating 50% more freshwater than PWAV could alone. Our integration with PWAV circumvents the need for brine evaporation ponds, as waste salt is the key input we use to create our CO_2 capture solvent. The final form of removed CO_2 is an alkaline fluid that can be stored in a UIC Class I or Class V well.

Project Monarch represents one possible permutation of our technology, but we are deploying several projects globally that include other aspects of our technology relevant to California. **Project Wallaby** in Western Australia is an integration with an offshore CO_2 storage project. Capture6 receives the produced brines from CO_2 injection and transforms the waste salt into water for green ammonia production and its CO_2 removal solvent. Removed CO_2 is transformed into an alkaline fluid that can be used for ocean alkalinity enhancement (OAE). **Project Octopus** in South Korea is an integration with a seawater desalination project. Capture6 creates additional freshwater and CO_2 removal solvent from desalination brine. Removed CO_2 in the form of alkaline fluid is used to absorb industrial point sources of CO_2 and the resulting alkaline fluid can be used for OAE.

I. California's mCDR opportunity

California's ambitious plan to achieve net-zero requires affordable, scalable CDR technologies. The oceans play an outsized role in modulating the carbon cycle by buffering variations in atmospheric CO_2 on geological timescales as the largest Earth-surface reservoir of CO_2. mCDR technologies seek to leverage this capacity and its ability to rapidly absorb CO_2, and California's coastal waters are highly advantageous for multiple mCDR removal and storage pathways. In a report presented in their March 3rd, 2025 hearing, California's Ocean Protection Council highlights OAE, electrochemical removal of CO_2 from marine waters, ocean iron fertilization and kelp sinking as the mCDR technologies likely to be the most effective in California's waters.

***mCDR technologies are already among the lowest-cost carbon credits, and the price continues to decrease*:** Ocean iron fertilization is potentially one of the lowest price per tCO_2 removed CDR technologies, and between 2023 and 2024, the average cost of mCDR credits across five different technologies decreased by 70% - the largest decrease among any CDR technology seen during that time period.

Co-benefits like ocean acidification remediation, ecosystem restoration, cleanup of other industrial outfall effluents and increased marine productivity are possible with mCDR: There

is reasonable skepticism about altering the ocean's rate of CO_2 uptake. But mCDR technologies like OAE and electrochemical CO_2 removal seek to *restore* pre-industrial conditions by reversing alterations we have already imposed upon the ocean - namely ocean acidification due to the atmospheric CO_2 burden, salination due to brine discharge, and deoxygenation due to agricultural and wastewater runoff. By adding alkalinity, removing CO_2, de-acidifying wastewater streams before their release, and consuming waste salt as an input to electrochemical processes, mCDR technologies can alleviate these harms.

mCDR can be deployed at scale on timelines that meet California's climate goals This week, over 400 of the world's leading mCDR technologists, academic researchers, and policy experts met in Vancouver, BC, Canada at the biennial Ocean Visions Summit. This community has made astounding progress in the last two years - not only in advancing mCDR pilot projects, but importantly in how to measure, monitor, report and verify that removals are occurring, and that they are doing so in socially and environmentally responsible ways. California-based companies like Submarine are advancing AI models to track mCDR deployments, new lost-cost sensor technologies are emerging, registries have published mCDR methodologies independently reviewed by leading scientists, and third party verifiers are in progress to validate and verify mCDR technologies for XPRIZE mCDR finalists like California-based Ebb Carbon and Captura. The mCDR ecosystem is no longer nascent - it is ready for real-world demonstration, and commercial facilities are coming online this year ready to meet the needs of carbon credit purchasers.

Multiple mCDR companies are headquartered in California due to its forward-thinking climate goals, talented workforce, world-leading ocean research institutes, and unique coastline. Work remains to be done on the way to large-scale implementation of mCDR projects, but this is California's opportunity to grasp. More commonly considered technologies like DAC will remain an important part of California's credit purchasing portfolio - but for reasons I'll discuss below, the rapid scalability of marine removal and storage will fill in an important gap in the next 5-10 years. **Inclusion of mCDR protocols will ensure California's success in meeting its climate goals.**

II. Decarbonization isn't enough, and it shouldn't exacerbate other climate issues

Many of the concerns raised during the workshop regarding CCUS and CDR technologies centered on their impacts to water and air quality and how California's frontline communities experience those impacts. These concerns are valid - we can do better than decarbonization that comes at the cost of water scarcity and cleanliness or increased mortality due to air pollution, particularly when there are CDR and CCUS technologies that don't just avoid these problems - they alleviate them.

California is first in water-positive DAC: CCUS, some forms of CDR, and CO_2 storage can be large consumers of water resources. Given California's increasing water demand and concurrent water scarcity, that's not a compromise to be taken lightly. We recommend that the technology reviews CARB executes examine not just the impact of technologies on global warming potential but their impact on California's water availability and quality.

The technology Capture6 is implementing at Project Monarch in Palmdale, CA is a first-of-a-kind water-positive direct air capture facility. Capture6 DAC not only generates clean water, it requires saltwater as an input - providing a mechanism for restoration of degraded aquifers and increasing the economic viability of developing groundwater resources that are accessible but require desalination. Furthermore - our technology is salt-agnostic. Our four demonstrations each use different salt sources - brine effluent from 1) water recycling (Project Monarch), 2) seawater desalination brine (Project Octopus), 3) produced brines from the offshore storage of CO_2 (Project Wallaby) and 4) industrial brine effluent (Project Tuatara). Water generated in these projects has multiple end uses that range from stocking municipal water reservoirs to supplying co-located industries with water generated on-site: water that doesn't detract from primary domestic and agricultural needs.

Finally, the technology that Capture6 is demonstrating at Project Monarch has multiple synergies with other carbon capture and storage mechanisms. First, the water that Capture6 DAC generates can be a footprint neutral source of water for co-located CDR and CCUS projects. Furthermore, injection of CO_2 into the subsurface can generate produced brines as flowback and can be used as an input to the Capture6 DAC process. Finally, the alkaline fluids that the Capture6 process creates can be used to absorb point sources of CO_2, circumventing the need to transport pure CO_2 (more on this below in section III).

CDR, CCS, and carbon storage projects shouldn't worsen air pollution: Air quality in California is already burdened by existing industry, transportation, arid landscapes, and wildfires. Presenters and attendees at the CCRUS workshop mentioned two key areas of concern with air pollution: further increases in particulate matter and other pollutant emissions due to the diesel transport of carbon from a DAC project in the San Joaquin Valley, and emissions associated with CCS projects.

As above, we urge CARB to consider the environmental tradeoffs associated with projects that remove or reduce emissions but have the potential to increase other environmental and human health harms like air pollution. Project Monarch's technology not only removes CO_2 and generates water, but it also circumvents the need for brine evaporation ponds. Until our inclusion in the project, evaporating brine and transporting it to a landfill was considered the most feasible waste management solution. Evaporation ponds can cause multiple harmful emissions as can transporting waste to landfills. By avoiding this, Project Monarch will prevent years of additional air pollutant emissions in the Antelope Valley.

Global good with localized benefits: While the examples given here are specific to Capture6, the point I would most like to convey is that not all CDR/CCS is created equally. CDR and CCS projects that perform a global good in emissions removal and reductions can also provide direct local good to the communities that host them. California can focus and invest in CDR methods that align with its climate, water and health goals to benefit all Californians. **Therefore, we encourage CARB to seek out CDR and CCS technologies for review and implement protocols that provide multiple climate and environmental benefits to California.**

III. Storing carbon doesn't have to depend on pipelines and Class VI wells

While CO_2 pipelines and Class VI wells are the common images that come to mind when carbon sequestration is the topic at hand, they don't have to be. Class VI wells take on average 4 years to permit, and according to the IEA, "*the lead time for CO_2 storage development can be 3-10 years*." The progress that California has recently made in receiving four Class VI well permits in Kern County is encouraging, but it is not sufficient infrastructure to meet the carbon storage needs of California by 2030. Furthermore, wells are only part of the solution - CO_2 requires pipelines for transport from the removal or capture source to the injection site. The thousands of miles of CO_2 pipeline that need to be built are concerning to California residents and environmental advocacy groups due to leakage, safety and eminent domain issues. **Permanent carbon sequestration does not have to equate to moving liquid CO_2 in pipelines and injecting it in Class VI wells - there are faster, safer ways.**

Carbon-containing alkaline fluid is stable and can be stored in multiple ways: Different CDR technologies produce carbon outputs other than CO_2. For instance Capture6 creates atmospheric CO_2-containing alkaline fluids that can be used for 1) ocean alkalinity enhancement to generate more CDR and be stored in the ocean for thousands of years; stored via 2) injection into permeable reservoirs using UIC Class I, Class II, and Class V wells to be stored for millennia in the subsurface; 3) precipitated into minerals like trona and calcium carbonate and stored in evaporite deposits; and 4) utilized for a wide variety of durable products like building materials.

Using these alternative storage and use pathways for carbon-containing alkalinity unlocks rapid and scalable storage now that does not require pipeline infrastructure. Ocean alkalinity enhancement can use existing marine (and perhaps even riverine) outfalls. Class I, II and V wells are suited for the injection and storage of fluids that requires no alteration to the existing regulatory framework. Furthermore, carbon storage that does not require Class VI reservoir characteristics unlocks much more pore space that can be used for carbon sequestration - projects that output alkaline fluids can potentially store on site, requiring no transport. Furthermore, alkaline fluids can absorb additional CO_2, so that CDR and CCS projects that do output pure CO_2 can choose to co-locate with CDR projects that output alkaline fluid, allowing them to maximize site selection for resource optimization rather than Class VI well availability. These strategies work equally well for alkaline fluid injection and for ocean alkalinity enhancement and marine storage.

There is no doubt that California's geology will provide many Class VI well opportunities, but until those come to fruition, storage options that can deploy and scale at pace with California's 2030 CDR and CCS goals will be needed. **We advocate for CARB to include protocols for carbon storage that do not solely rely on Class VI well infrastructure and that incentivize projects with carbon storage mechanisms that are available now while the Class VI well ecosystem grows.**

IV. Interagency cooperation and resources for SB 905 implementation are needed for California's climate goals to succeed

We applaud the evident interagency cooperation that is already happening in California, and advocate for its continuation. This is a crucial piece of the puzzle to unlock carbon negative technologies in California, because while permitting subsurface storage of fluids is a well-understood process, other carbon removal and storage pathways are newer, and the regulatory pathways are less evident.

For instance, while the NPDES and MPRSA permitting systems provide guidelines at the federal level for mCDR activities, the interaction between the federal and California regulatory process is less clear at the moment. Making the process clear and streamlined for suppliers will ensure these projects can meet California's needs by 2030. As potential suppliers of OAE credits, we are not asking for ease in regulation, merely clarity. The first NDPES permit granted to a mCDR project in the United States is for California-based Ebb Carbon's Project Macoma in Washington State, with a timeline from submission of ~14 months. An October 2024 workshop on mCDR at the Southern California Coastal Water Research Project brought together representatives from many state agencies, ocean scientists, and mCDR industry-members for engagement on designing mCDR-appropriate environmental impact assessments and to discuss permitting. **We encourage CARB to join these discussions and to continue to work together with other agencies and California's excellent ocean organizations like the Ocean Protection Council and the Ocean Sciences Trust.**

We are also supportive of the budgetary asks for the CARB staff and resources needed for SB 905 implementation. **A comprehensive SB 905 CCRUS framework and its implementation deserves dedicated staff and resources.**

In conclusion, we thank CARB for its consideration of these comments and for its leadership in paving the path for California to meet its 2030 and 2045 climate goals. We look forward to future engagements on these issues and our opportunity to build CDR projects that benefit all Californians.

Sincerely,

DocuSigned by:
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