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# Stakeholder Outreach and Exploration of Dust Mitigation and Suppression Strategies for Exposed Playa at the Salton Sea

**Science and Technology Program**
**Research and Development Office**
**Final Report No. ST-2022-21013-01**

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As the Salton Sea recedes, exposed playa is anticipated to become emissive and contribute to negative public health impacts in the region. Stakeholder outreach is a critical component before field testing new dust suppression strategies on exposed playa due to the complexity of issues at the Salton Sea, the various landowners and jurisdictions, and the many stakeholders required to implement projects and solutions. This project gathered feedback from Salton Sea stakeholders on dust suppression strategies to field test. It also compared dust suppression strategies across various objective categories.

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# Acknowledgements

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Cover photo: Image of exposed Salton Sea playa

# Stakeholder Outreach and Exploration of Dust Mitigation and Suppression Strategies for Exposed Playa at the Salton Sea

## Final Report No. ST-2022-21013-01

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Final Report ST-2022-21013-01

**Stakeholder Outreach and Exploration of Dust Mitigation and Suppression Strategies for Exposed Playa at the Salton Sea**

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# Acronyms and Abbreviations

| | |
|---|---|
| ASU | Arizona State University |
| DOI | Department of the Interior |
| DSAP | Dust Suppression Action Plan |
| EICP | Enzyme-Induced Carbonate Precipitation |
| IID | Imperial Irrigation District |
| MICP | Microbially-Induced Carbonate Precipitation |
| NASEM | National Academies of Sciences, Engineering, and Medicine |
| O&M | Operation and Maintenance |
| Reclamation | Bureau of Reclamation |
| QSA | Quantification Settlement Agreement |
| S&T | Science & Technology |
| SS AQM | Salton Sea Air Quality Mitigation |
| USACE | U.S. Army Corps of Engineers |
| YAO | Yuma Area Office |

# Contents

# Executive Summary

The Salton Sea is a 350-square mile terminal (closed basin) desert saline lake in southern California. Historically, this low-lying basin periodically flooded and dried as the Colorado River naturally changed course. The main recharge water for the Salton Sea today comes from agricultural runoff from the Coachella and Imperial subareas. The Salton Sea is a critical component of the 2003 Quantification Settlement Agreement (QSA) water transfer between the Imperial Irrigation District (IID) and the San Diego County Water Authority. As part of the QSA, the State of California assumed responsibility for restoration of the Sea ecosystem. A combination of naturally occurring evaporation and reduced inflows due to the QSA mitigation flows ending in 2017 has resulted in declining water surface elevations.

As the Salton Sea recedes, more lakebed is becoming exposed and may become emissive over time, contributing to fugitive dust emissions and human health concerns. Reclamation is working closely with the California Natural Resources Agency, California Department of Water Resources and IID to prioritize areas and methods to reduce dust emissions. A range of implementable dust control projects available to best suit the needs of different sites at the Salton Sea will be helpful in developing strategies to manage emissions.

This project sought to gather feedback from stakeholders on dust suppression techniques at the Salton Sea to address political, social, and biological concerns for field testing new dust suppression techniques. The effort includes the evaluation of enzyme-induced carbonate precipitation (EICP) and microbially-induced carbonate precipitation (MICP), which are bio-cementation techniques that will be field tested in Science & Technology (S&T) Project 21016. This project sought stakeholder feedback on EICP and MICP to determine if plans for S&T 21016 should be modified to address any political, environmental, or social concerns. Stakeholder feedback and response actions are described in Section 3.1 of this report. In summary, stakeholders were supportive of field testing EICP and MICP and did not have concerns that would alter the field testing plans.

Desktop research was completed for this project to compare dust control measures across various categories such as capital cost, operation and maintenance (O&M), durability risk, implementation effort, habitat impact, community impact, and water use. The dust control measures were compared using an assessment matrix provided in Appendix A of this report.

# 1 Introduction

## 1.1 Project Background

Historically, natural flooding of the Colorado River has caused large seas to cyclically form and dry in the Salton Sea basin. The current Salton Sea is a 350-square mile terminal (closed basin) desert saline lake located in southern Riverside and northern Imperial counties in southern California. It was created in 1905 when the Colorado River flooded, destroyed a major canal under construction, and diverted river water into the Salton sink for more than two years. The primary source of recharge water for the Salton Sea today is agricultural runoff from the Coachella and Imperial subareas.

The Salton Sea is a critical component of the 2003 Quantification Settlement Agreement (QSA) water transfer between the Imperial Irrigation District (IID) and the San Diego County Water Authority. As part of the QSA, the State of California assumed responsibility for restoration of the Sea ecosystem. In 2017, mitigation flows to the Salton Sea, as required under the QSA, ended and water levels began to decline at an increasing rate, exposing more lands that may become emissive over time and contribute to human health concerns in the region.

Reclamation owns approximately 90,000 acres of land under and adjacent to the Salton Sea, and the Department of the Interior (DOI) owns approximately 126,000 acres. Since windblown dust reduces air quality and poses significant health risks to residents in Imperial and Riverside Counties, the DOI's Clean Air Act (42 U.S.C. § 7401) responsibilities at the Salton Sea may be significant should conditions worsen. Under the Clean Air Act, Reclamation may be required to provide a comprehensive inventory of actual emissions from all sources and implement a plan for reducing emissions using available control measures within specific and enforceable timeframes. Models estimate that by 2025 approximately 13,200 acres of DOI lands (Reclamation: 5,614 acres, U.S. Fish and Wildlife Service: 5,409 acres and Bureau of Land Management: 2,180 acres) will be exposed from the receding Salton Sea. Using estimates derived from air quality mitigation costs at Owens Lake and assuming all acres require treatment, mitigation for DOI lands could cost $337 million in the next ten years.

## 1.2 Previous Work

A literature review aimed at identifying existing research, and where additional research is needed, was completed as Science and Technology (S&T) Project 20043. The final report for S&T 20043 focused on two topics at the Salton Sea:

1. Reducing impacts of fugitive dust on Reclamation's lands at the Salton Sea, and
2. Understanding the impacts of a receding Salton Sea on Colorado River supplies.

For the fugitive dust topic, the literature review summarized potential dust control measures and discussed enzyme-induced carbonate precipitation (EICP) and microbially-induced carbonate precipitation (MICP) as potential techniques to field test on exposed Salton Sea playa.

Reclamation's Yuma Area Office (YAO) previously completed laboratory testing of EICP and MICP with Arizona State University (ASU) through S&T Project 1840. Results of that study recommended that surface stabilization tests be conducted with EICP on soils from highly emissive areas, such as the Salton Sea playa (Gutierrez, Kavazanjian, Lakshminarayanan, Wooley, & Hamdan, 2019).

Various Salton Sea stakeholders have completed research on dust suppression techniques. The State of California's dust suppression research is described in their Dust Suppression Action Plan (DSAP) (California Natural Resources Agency, 2020). Research performed by IID on the topic is detailed in the Salton Sea Air Quality Mitigation (SS AQM) Program website and annual reports (IID, 2022).

The National Academies of Sciences, Engineering, and Medicine (NASEM) also completed a dust control study for Owen's Lake, a smaller lakebed in California. Though Owens Lake is smaller than the Salton Sea and has a cooler, less arid climate, it faces similar dust control issues. The mineral composition of both Owens Lake and the Salton Sea soils is dominated by sodium carbonate and sodium sulfate, causing more easily erodible salt crusts (NASEM, 2020). The research on dust control at Owens Lake could be used to complement research on dust control at the Salton Sea.

## 1.3 Objectives

The objectives of this study are to:

1. Obtain stakeholder feedback on dust suppression techniques at the Salton Sea, including EICP and MICP;
2. Gather stakeholder feedback needed to address political, social, and biological concerns for field testing new dust suppression techniques, such as EICP and MICP, at the Salton Sea; and
3. Summarize stakeholder concerns and feedback in a report that can be used to inform and shape future dust mitigation projects at the Salton Sea.

To meet these objectives, Reclamation presented results of the literature review from S&T 20043 and plans for field testing EICP and MICP on Salton Sea playa at Salton Sea stakeholder meetings. The stakeholder feedback is summarized in Section 3.1. Desktop research was also completed to compare dust control measures across various objective categories. Using stakeholder feedback and desktop research, a dust control assessment table was developed and is provided in Appendix A. Results from this project will be used to inform S&T Project 21016, which will complete field testing of EICP and MICP on the Salton Sea playa.

# 2 Methodology

Reclamation presented results from the S&T 20043 literature review and plans for S&T 21016 field testing of EICP and MICP at stakeholder meetings in 2021 and 2022. These included:

- Salton Sea Management Program Coordination meeting, February 2021,

- Salton Sea Board Authority meeting, February 2021,
- State Water Resources Control Board meeting in April 2021, and
- Salton Sea Federal Partners meeting in May 2022.

Stakeholders who attend the Salton Sea Management Program Coordination Meetings were also emailed a copy of the updated 2022 presentation in July 2022. During the presentations, Reclamation asked stakeholders if there were any concerns with field testing at the Salton Sea, if there were concerns with specific dust control measures, if there were any dust control measures that should be prioritized for additional research, and if there are any other research needs for the Salton Sea that should be prioritized. The stakeholder feedback and response actions are described in Section 3.1. The stakeholder power point presentations are provided in Appendix B.

Desktop research on dust suppression techniques was completed to add to information collected from the S&T 20043 literature review, and to address stakeholder comments. The stakeholder feedback and desktop research were used to develop a dust control assessment table, included in this report as Appendix A.

# 3 Results

## 3.1 Stakeholder Feedback

The Salton Sea is a complex environment with many stakeholders and agencies working together on solutions to implement dust control and create habitat. There are many agreements between the agencies and existing programs implementing various projects. There are also complex land ownerships and jurisdictions at the Salton Sea. Due to these social, environmental, and political complexities, stakeholder input is critical before Reclamations tests new dust control measures on the Salton Sea playa.

For this project, Reclamation reached out to Salton Sea stakeholder groups to discuss plans for field testing EICP and MICP, and to ask if there are any other considerations for dust control research. Table 1 describes the stakeholder feedback received and how it will be addressed. Appendix B includes the stakeholder presentations.

**Table 1. Stakeholder feedback and proposed response actions**

| Stakeholder Feedback | Response action |
|---|---|
| Coordinate with the Imperial County Air Pollution Control District on dust control measure and field-testing projects. | The Imperial County Air Pollution Control District will be notified as the EICP and MICP field testing progresses and a site is selected. |

| Stakeholder Feedback | Response action |
|---|---|
| Prepare preliminary cost estimates to implement EICP and MICP at the Salton Sea. Are costs prohibitive or is it feasible to consider spending more time and effort to research these techniques? | A life cycle sustainability assessment for EICP compared to water application for dust control was completed in 2019. See section 3.3 for a discussion of preliminary costs. At this point, costs do not seem prohibitive for using EICP for dust control at the Salton Sea. |
| When working on the full life-cycle analysis for EICP (a future task for S&T 21016), get stakeholder feedback on cost and benefit points that will be evaluated. | The life cycle analysis will be discussed with Salton Sea stakeholders as part of S&T 21016. |
| Stakeholders wanted to know about water availability and requirements for EICP and MICP, and if Salton Sea water could be used during EICP and/or MICP application. | Different source waters at the Salton Sea can be analyzed in the lab, as part of S&T 21016, to determine suitability for use with EICP and MICP. |
| Consider environmental justice and disadvantaged community impacts. | Environmental justice and community impact will be considered when evaluating dust control projects and when completing the life cycle assessment on EICP and MICP through S&T 21016. |
| Need a plan to get projects implemented. Stakeholders are interested in implementable projects, not just research. Need to know which projects can happen, the potential costs, and if they are feasible. | The research and field testing of EICP and MICP through S&T 21016 will expand the range of management activities and implementable dust control projects available to best suit needs for different sites at the Salton Sea. |

| Stakeholder Feedback | Response action |
|---|---|
| Surface surfactants may not be allowed at Owens Lake because of habitat impact. Habitat impact should be considered at the Salton Sea. | The NASEM study on dust control at Owens Lake did not evaluate surface surfactants in detail. It briefly discussed soil binders as dust control but stated that there are concerns about their durability. In 2013, there was a small-scale field test with soil binders at Owens Lake, but it was interrupted by a flood event. A larger study was proposed to test a variety of chemical stabilizers but as of 2020 it was still awaiting approval from the California Department of Fish and Wildlife (NASEM, 2020).<br><br>EICP and MICP are not surface surfactants. Their environment and habitat impact will be evaluated in the life cycle assessment to be completed after field testing under S&T 21016. |
| Federal partners were interested in durability of the crust formed by EICP/MICP, what the operation and maintenance (O&M) entails, and the type of microbial species possible to use with MICP. | Durability of EICP/MICP will be evaluated through S&T 21016. Various microbial species can be used to induce cementation. MICP uses *sporosarcina pasteurii*, which is naturally found in most soil strata. |
| Suggestion to reach out to the U.S. Army Corps of Engineers (USACE) Research and Development Center, where research has been done on dust control at military bases. | The USACE Dust Control Field Handbook was reviewed and used to gather information on chemical dust suppressants. |
| Stakeholders were interested in research on toxicity of the Salton Sea sediments and human health impacts from dust emissions as a chemical irritant in addition to a physical irritant. | Reclamation is working on a grant with the University of California, Riverside to start that research this year. |

## 3.2 Dust Suppression Methods

As the Salton Sea recedes, newly exposed playa can become emissive and contribute to poor air quality with negative health impacts in the region. A variety of dust control measures may be available to control fugitive emissions. Appendix A provides a dust control measure assessment to

compare dust control measures across various categories such as capital cost, O&M, durability risk, implementation effort, habitat impact, community impact, and water use.

Dust control measures may provide additional benefits, such as habitat and community benefits. Appropriate dust control measures and requirements are unique to each site and different regions of the Salton Sea. For example, surface roughening has been implemented in areas around the Salton Sea and continues to be recommended due to its effectiveness, waterless application, and quick implementation. However, it is unsuitable for predominantly coarse-grained sandy soils since the ridges will rapidly degrade (Formation Environmental, LLC, 2021). Vegetation establishment is a recommended dust control measure. It can be used on sites with coarse-grained sandy soils or combined with surface roughening; however, it can be challenging in areas with limited water availability (Formation Environmental, LLC; Air Sciences, Inc.; PlanTierra LLC, 2016). Other dust control measures are also available. Shallow flooding is effective and commonly used at Owens Lake but is unsuitable in areas with limited water resources. Gravel cover is low in water use but has a high capital cost and does not have added habitat benefits. Brine stabilization may be an option but requires additional research and may not be appropriate up gradient of saline-sensitive areas such as managed vegetation sites (NASEM, 2020).

Surface stabilizers show potential as they are widely available, typically inexpensive and can be quickly implemented. Under the SS AQM program, IID is testing surface stabilizers for use at the Salton Sea (Formation Environmental, LLC, 2022). There are many different types of surface stabilizers that may be useful in isolated areas or to control emissions while more permanent dust control measures are being planned. Stakeholder feedback indicated that some stabilizers, such as surface surfactants, may not be appropriate due to potential habitat impacts. This would need to be researched further if surface surfactants were evaluated for dust control at the Salton Sea.

EICP is an emerging dust control technology studied by ASU and Reclamation. It accelerates the natural bio-cementation process through the application of free urease enzyme, which causes a geochemical reaction (hydrolysis of urea) and forms an erosion-resistant crust. MICP is similar to EICP, but it relies on microbial urease for the geochemical reaction that forms the crust. EICP and MICP will be field tested on Salton Sea playa as part of Reclamation S&T Project 21016, which is currently ongoing.

## 3.3 Preliminary Cost Estimates for EICP

A life cycle sustainability assessment was completed in 2019 for EICP as fugitive dust control for infrastructure construction (Raymond, et al., 2019). The study compared the environmental, economic, and social impacts of EICP with the impacts of water application for dust control. The analysis assumed a 1-acre treatment area for two weeks in Maricopa County, Arizona. The study concluded that EICP was potentially a more sustainable dust control option than water application due to lower water and fuel requirements that reduce environmental impacts and costs.

The estimated cost for EICP in the life cycle sustainability assessment was about $5,000/acre. This figure is a preliminary estimate based on chemical costs, vehicle and equipment rentals, fuel costs, and crude extraction of the urease enzyme. The highest cost for EICP is extraction of the urease enzyme, and further development could reduce these costs (Raymond, et al., 2019).

Additional research is needed to determine how to apply the EICP cost estimates to other project locations. The durability of the crust formed by EICP is still being evaluated to establish reapplication frequency and O&M costs. At this point, costs do not seem prohibitive for using EICP as a dust control measure at the Salton Sea.

Costs are not the only consideration when choosing a dust control measure. While EICP may be cost-effective and water efficient, it may not provide habitat benefits like vegetative swales or managed vegetation. See Appendix A for preliminary details on EICP compared with other dust control measures.

A full life cycle analysis based on field testing at the Salton Sea will be completed by ASU and Reclamation as part of S&T 21016. This will build on the 2019 assessment to provide a better cost estimate and consider other impacts and benefits.

## 3.4 Future Research

Reclamation will be completing further research related to dust control at the Salton Sea. S&T 21016 will complete field testing for EICP and MICP, see Section 3.4.1 for more detail. Reclamation is also funding research at the University of California, Riverside on human health impacts from exposed playa dust.

### 3.4.1 S&T 21016

EICP is an emerging dust control technology that accelerates the natural bio-cementation process by applying free urease enzyme. MICP is similar to EICP, but it relies on microbial urease.

Reclamation previously tested EICP in laboratory settings under S&T 1840. S&T 21016 will build on those results and includes field testing EICP and MICP on an IID site at the Salton Sea. The project will test durability of the carbonate crust, and if ammonia by-products that form during the EICP and MICP processes would impact the environment. The project will demonstrate the efficacy and potential environmental impact of EICP and MICP for fugitive dust control, including the potential impact of residue from agricultural runoff in the Salton Sea playa on the effectiveness of these techniques.

Data collected during laboratory and field testing of EICP and MICP will be used to evaluate the sustainability and economic advantages of these innovative technologies compared to other dust control measures at the Salton Sea. A full life cycle sustainability analysis for EICP and MICP will be prepared for use by Reclamation and project stakeholders. If proven effective, EICP and MICP may reduce the cost of fugitive dust control and benefit inhabitants of the areas downwind of the Salton Sea playa (e.g., Imperial Valley) by improving air quality and reducing the associated health risks.

Results from this research can benefit regions outside the Salton Sea where dust control may be needed, such as the Great Salt Lake. It's estimated that currently, 9% of the Great Salt Lake may contribute to dust emissions, though a maximum of 22% could become dust sources (University of Utah, 2019). The EICP and MICP research could also benefits regions where dust control is needed for access roads, canal embankments, and new construction.

# 4 Conclusion

As the Salton Sea recedes and more lakebed is exposed, it's anticipated to become emissive and contribute to lower air quality and negative public health impacts in the region. A range of implementable dust control projects available to best suit the needs for different sites at the Salton Sea will be helpful in developing strategies to manage emissions. This project aimed to gather feedback from stakeholders on dust suppression techniques at the Salton Sea, to include EICP and MICP. These are bio-cementation techniques that offer potential for sustainable, cost-effective mitigation of fugitive dust. EICP and MICP will be further evaluated by Reclamation in S&T 21016. Stakeholder feedback received through this project is summarized in Section 3.1, and the stakeholder presentations are included in Appendix B. In summary, stakeholders were supportive of field testing EICP and MICP and did not have concerns that would alter the field testing plans.

In addition to costs, other objective categories such as habitat and community impact should be used to evaluate the best dust control measure for specific sites. Stakeholder feedback and desktop research was used to develop a preliminary assessment of dust control measures across objective categories. This assessment is provided in Appendix A. The dust control measures were rated as low, medium, or high risk for each category. The ratings are based on desktop research. Field testing was not completed for this project, and actual performance of the dust control measures likely varies by site.

# 5 References


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# Appendix A – Dust Control Measure Assessment

This appendix compares dust control measures across various categories such as capital cost, operation and maintenance (O&M), durability risk, implementation effort, habitat impact, community impact, and water use.

Each dust control measure is rated as low, medium, or high risk. Definitions for these ratings are provided in Table A-1. In general, a dust control measure with a "low" rating is better suited than a dust control measure with a "high" rating in a specific category. For example, under the Capital Cost category, surface roughening is rated as "low" since it has a lower capital cost, whereas managed vegetation is rated "high", since it has a higher capital cost. The table is also color coded, with the "low" ratings shaded green, the "medium" ratings shaded yellow, and the "high" ratings shaded red.

The dust control measures were evaluated based on standard conditions. The ratings could change if they were modified. For example, the moat and row dust control measure rating could be changed to "low" in the durability risk and habitat impact categories if vegetation were added to the rows, however this may increase the capital cost and implementation effort ratings to "high".

The ratings for each dust control measure are based on desktop research. Field testing was not completed for this project. Actual performance for the dust control measures likely varies by site.

References used in rating the dust control measures include:

- Salton Sea Air Quality Mitigation Program, prepared by Formation Environmental, LLC; Air Sciences Inc; and PlanTierra LLC for the Imperial Irrigation District in July 2016 (https://saltonseaprogram.com/aqm/docs/Salton_Sea_Air_Quality_Mitigation_Program.pdf)
- Effectiveness and Impacts of Dust Control Measurements for Owens Lake, prepared by the National Academy of Sciences, Engineering, and Medicine in 2020 (https://doi.org/10.17226/25658)
- Life Cycle Sustainability Assessment of Enzyme-Induces Carbonate Precipitation (EICP) for Fugitive Dust Control, 3rd International Conference on Bio-Based Building Materials, 2019 (https://journal.augc.asso.fr/index.php/ajce/article/download/1069/623)
- U.S. Army Corps of Engineers Dust Control Field Handbook, prepared in October 2006 (http://hdl.handle.net/11681/3293)

*Table A-1. Rating definitions for Dust Control Assessment (Table 2).*

| DEFINITION | CAPITAL COST | OPERATION & MAINTENANCE | DURABILITY RISK | IMPLEMENTATION EFFORT | HABITAT IMPACT | COMMUNITY IMPACT | WATER USE |
|---|---|---|---|---|---|---|---|
| **LOW** | <$10,000/acre | Not frequent/low cost | Durable | Quick design and implementation. Quickly achieves full performance. | Creates additional habitat and provides environmental benefits | Provides additional benefit to the community other than dust control (Ex: public access points, interpretive centers, educational opportunities, aesthetics) | No or very low water use required for implementation and maintenance. |
| **MEDIUM** | $10,000 - $20,000/ acre | Frequently needed **or** high cost | Durable but needs to be frequently monitored or maintained | Quick design and implementation but requires a longer period (>= 1 year) for full performance. **Or** May requires a larger design/implementation effort but achieves full performance quickly. | Does not create habitat but does not negatively impact habitat either. | Does not create additional community benefits outside dust control, but does not negatively impact the community either. | Requires water for implementation or maintenance, but not a significant or constant supply. |
| **HIGH** | >$20,000/acre | Frequently needed **and** high cost | Durability unknown or variable | Requires a larger design/implementation effort **and** a longer period for full performance. | Has a negative impact on habitats or the environment. | Has a negative impact on the community. | Water is the primary form of dust control (i.e. water application or shallow flooding) |

*Table A-2. Dust Control Measure Assessment*

| DUST CONTROL MEASURE (DCM) | CAPITAL COST | OPERATION & MAINTENANCE | DURABILITY RISK | IMPLEMENTATION EFFORT | HABITAT IMPACT | COMMUNITY IMPACT | WATER USE | NOTES |
|---|---|---|---|---|---|---|---|---|
| **SURFACE ROUGHENING** | Low | Low | Low | Low | Medium | Medium | Low | Suitable for moist, fine-textured soils, but less suitable for sandier soils. |
| **MOAT AND ROW** | Medium | Low | Medium | Medium | Medium | Medium | Low | Similar suitability as surface roughening, but can be enhanced (i.e. gravel, sand fences, vegetation added to rows). |
| **VEGETATIVE SWALES** | Medium | Medium | Medium | High | Low | Low | Medium | Requires time to establish, maintain, and monitor. |
| **MANAGED VEGETATION** | High | Medium | Medium | High | Low | Low | Medium | Requires time to establish, maintain, and monitor. |
| **SHALLOW FLOODING** | High | Low | Low | Medium | Low | Low | High | Dependent on a reliable water supply. |
| **GRAVEL COVER (2” THICK)** | High | Low | Low | Medium | Medium | Medium | Low | Maintenance may be needed if adjacent to a site with uncontrolled emissions where dust deposits on the gravel . |
| **BRINE STABILIZATION** | High | Low | High | Medium | Medium | Medium | Medium | Depends on salt minerology and weather conditions. Development of long-term/stable crusts had been challenging at Owen’s Lake. |
| **SURFACE STABILIZERS** | Low | Low | High | Low | Medium | Medium | Low | Benefits and impacts of surface stabilizers may be product specific. |
| **EICP** | Low | Low | To be assessed in S&T 21016 | Low | Medium | Medium | Low | To be field tested under S&T 21016. |
| **MICP** | Low | Low | To be assessed in S&T 21016 | Low | Medium | Medium | Low | To be field tested under S&T 21016. |

# Appendix B - Stakeholder Outreach Presentations

This appendix contains the presentation presented during stakeholder meetings in 2021, and a second presentation presented to stakeholders in 2022

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# Science and Technology Program Research

## Salton Sea Stakeholder Outreach

## 2021 Presentation

# Science and Technology Program Research

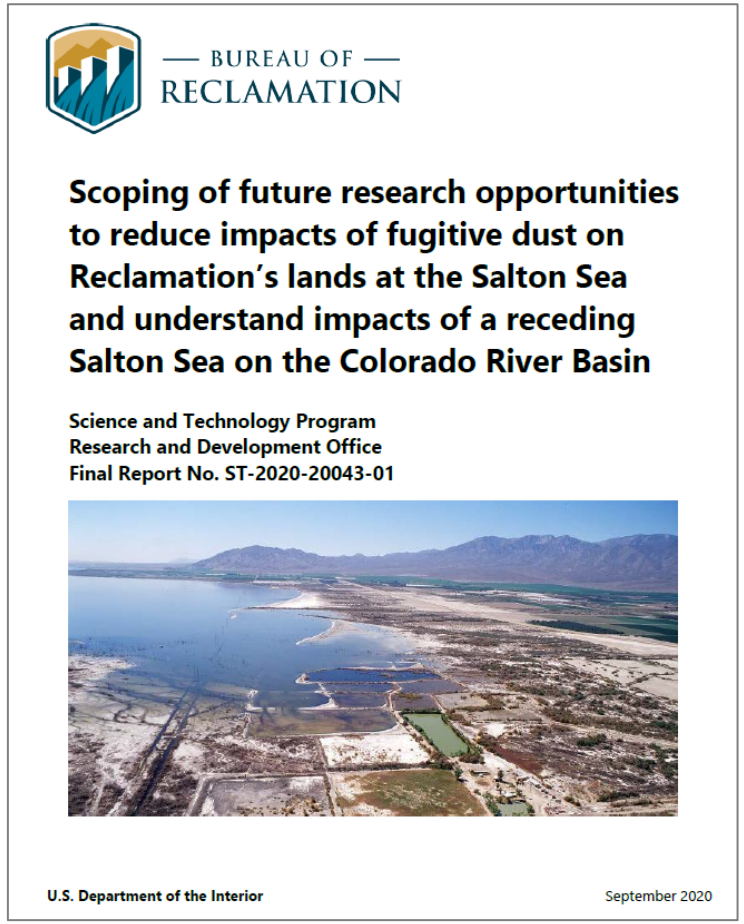
- Dust suppression at the Salton Sea
  - Step 1 - Literature Review
  - Step 2 - Stakeholder Outreach
  - Step 3 - Field testing for a specific measure
    - Enzyme Induced Carbonate Precipitation (EICP)
    - Microbially Induced Carbonate Precipitation (MICP)

# Literature Review – Scoping to reduce impacts of fugitive dust

- Literature review aimed at identifying existing research, and where additional research is needed, on two topics at the Salton Sea:

1. Reducing impacts of fugitive dust on Reclamation's lands at the Sea, and

2. Understanding the impacts of a receding Sea on Colorado River supplies.




Project website link:
https://www.usbr.gov/research/projects/detail.cfm?id=20043

# Literature Review Chapter 2 – Dust Suppression

- Dust Control Measures from Salton Sea Air Quality Mitigation Program
- Dust Control Measures evaluated for Owens Lake
  - National Academy of Science, Engineering, and Medicine Report, 2020
- Other Dust Control Measures
  - Chemical Dust Suppressants
  - Enzyme-Induced Carbonate Precipitation (EICP)
  - Microbially-Induced Carbonate Precipitation (MICP)

# Dust Control Measures at Owens Lake

- Best Available Control Measures (BACMs)
  - Shallow flooding
  - Dynamic management with shallow flooding
  - Brine with shallow flooding as backup
  - Tillage with shallow flooding as backup
  - Managed vegetation
  - Gravel cover

Dust control using the brine BACM
*Source: NASEM 2020, Effectiveness and Impacts of Dust Control Measures for Owens Lake; Photo courtesy of Stephanie Johnson, National Academies*

Managed vegetation BACM at Owens Lake
*Source: NASEM 2020, Effectiveness and Impacts of Dust Control Measures for Owens Lake; Photo courtesy of Valerie Eviner, OLSAP member*

# Dust Control Measures at Owens Lake

- Dust Control Measures evaluated that are not currently BACMs
  - Precision surface wetting
  - Artificial roughness (4 types)
  - Shrubs: modification of managed vegetation
  - Cobbles
  - Sand fences
  - Solar panels

- Dust Control Measures not evaluated
  - Chemical stabilizers/soil binders
  - Biocrusts

Engineered solid roughness elements test at Owens Lake
*Source: NASEM 2020, Effectiveness and Impacts of Dust Control Measures for Owens Lake; Photo in report from Holder, 2019d*

Cobbles and boulders at Owens Lake as part of the Land Art Project
*Source: NASEM 2020, Effectiveness and Impacts of Dust Control Measures for Owens Lake; Photo courtesy of Valerie Eviner, OLSAP member*

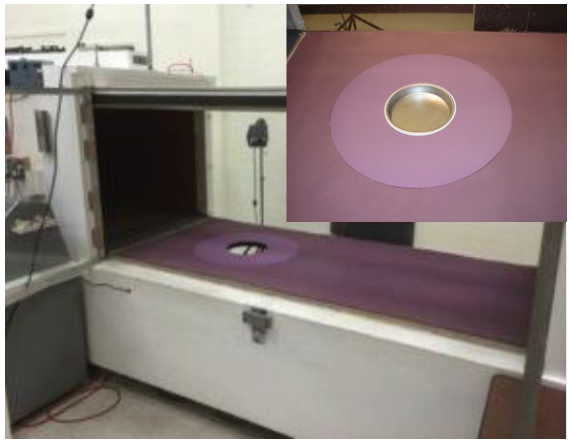
# Other Dust Control Measures discussed in the Literature Review

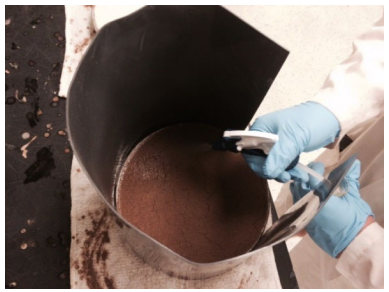
- Chemical Dust Suppressants (7 categories)
- Enzyme-Induced Carbonate Precipitation (EICP)
- Microbially-Inducted Carbonate Precipitation (MICP)

- Next Steps
  - Stakeholder Outreach
  - Field Testing EICP/MICP

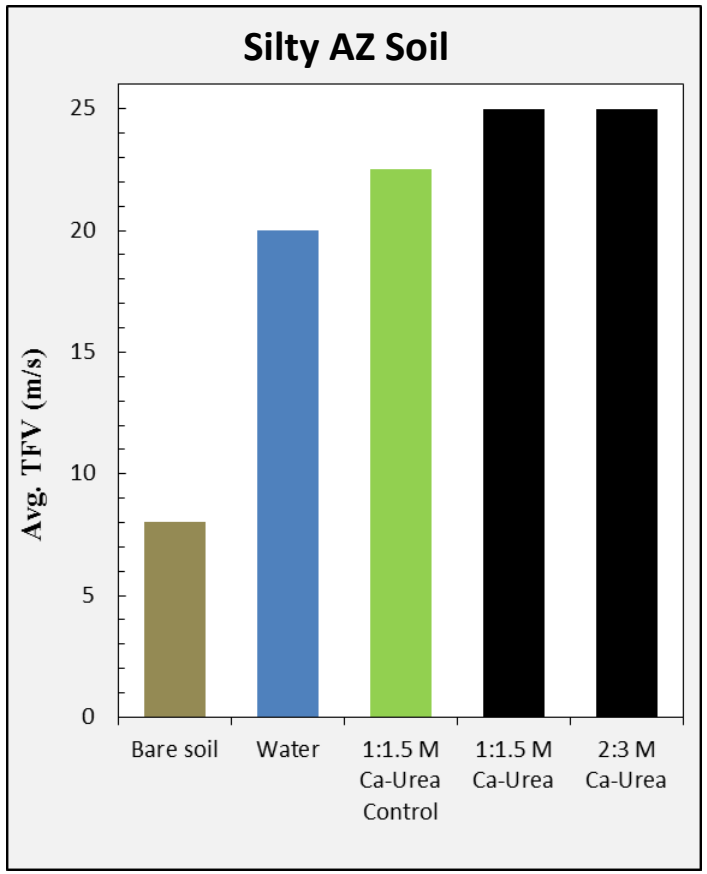
# Bio-cementation of Salton Sea Soils

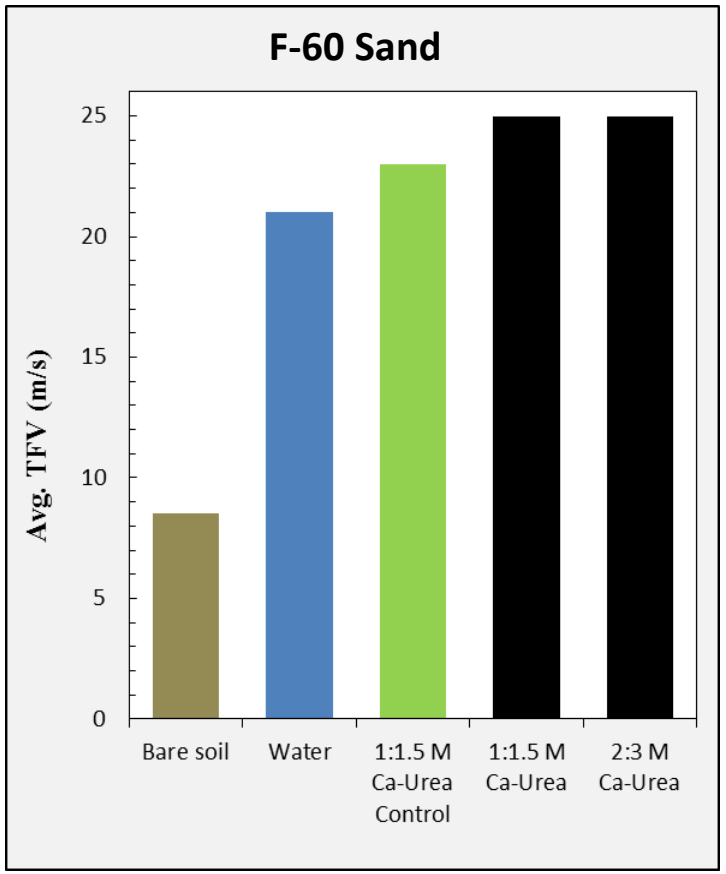
- Field test of bio-cementation on Salton Sea soils
  - EICP and MICP implemented as dust control mechanisms
- Induce $CaCO_3$ precipitation by hydrolysis of urea
  - Urease enzyme catalyzes hydrolysis, enables $CaCO_3$ precipitation
- ~10 years of research in bio-cementation at ASU

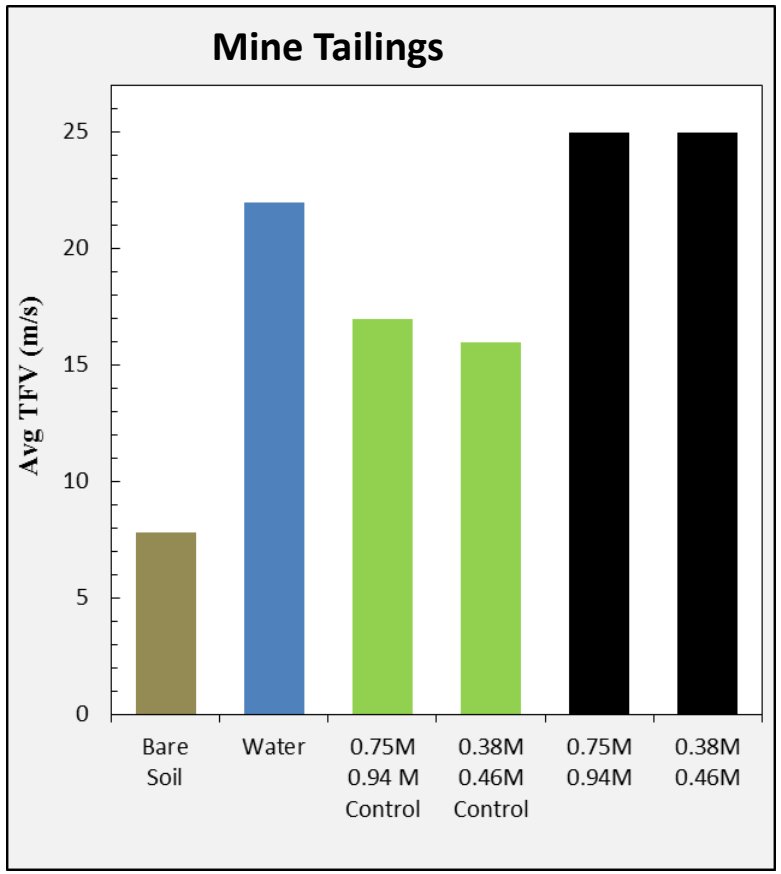




# NASA Wind Tunnel Testing



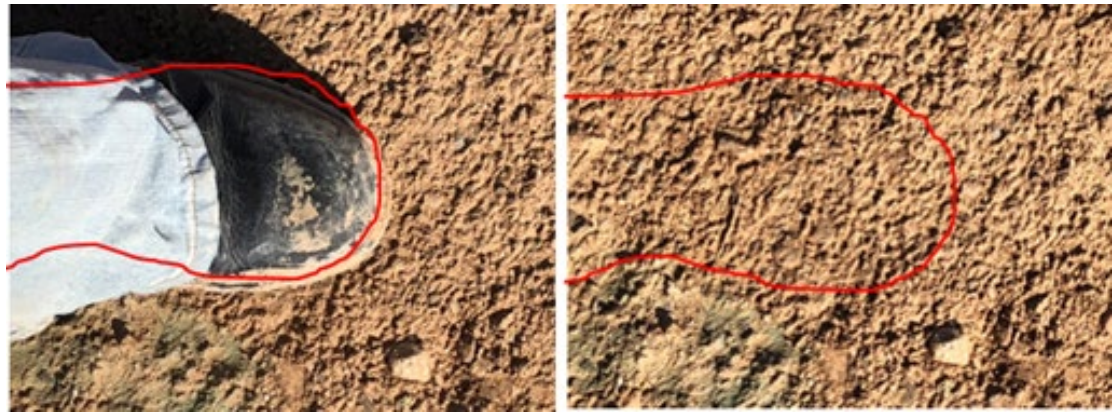



# Previous Field Trials

Untreated Plot

Treated Plot



RSI Apache Junction Landfill Field Trial

# Important Issues

- Treatment Method
- Level of Treatment
- Durability
- $NH_4CL$ by-product
- Impact of constituents in Playa soils
- Lifecycle cost and environmental impacts

Pictured above: EICP Treated AZ Silt

# Dust Control Measure Research Discussion

- Are there any concerns with field testing that should be considered?
- Are there concerns with Dust Control Measures specific to the Salton Sea?
- Are there Dust Control Measures would you like to see prioritized for additional research?
- Potential locations for future field testing?
- Other research needs at the Salton Sea?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# Science & Technology Program
## Salton Sea Dust Suppression Projects

### Stakeholder Outreach
### 2022 Presentation

# Science and Technology (S&T) Program

- Competitive internal research program
- Reclamation-wide
  - Lead researcher is Reclamation employee
- Can partner with external organizations

# Salton Sea S&T Research on Dust Suppression

- Step 1 - Literature Review – Completed Sept. 2020
  - https://www.usbr.gov/research/projects/detail.cfm?id=20043
- Step 2 - Stakeholder Outreach – In Progress through Sept. 2022
- Step 3 - Field testing for a specific measure – In Progress, Field site planning
  - Enzyme Induced Carbonate Precipitation (EICP)
  - Microbially Induced Carbonate Precipitation (MICP)

# Stakeholder Outreach

- Timeline: Feb 2021 - Sep 2022

- Objective: Seek input on new dust suppression techniques, field testing, and other research at the Salton Sea
  - Concerns with field testing?
  - Concerns with Dust Control Measures?
  - Dust Control Measures to prioritize for additional research?
  - Other research needs at the Salton Sea?

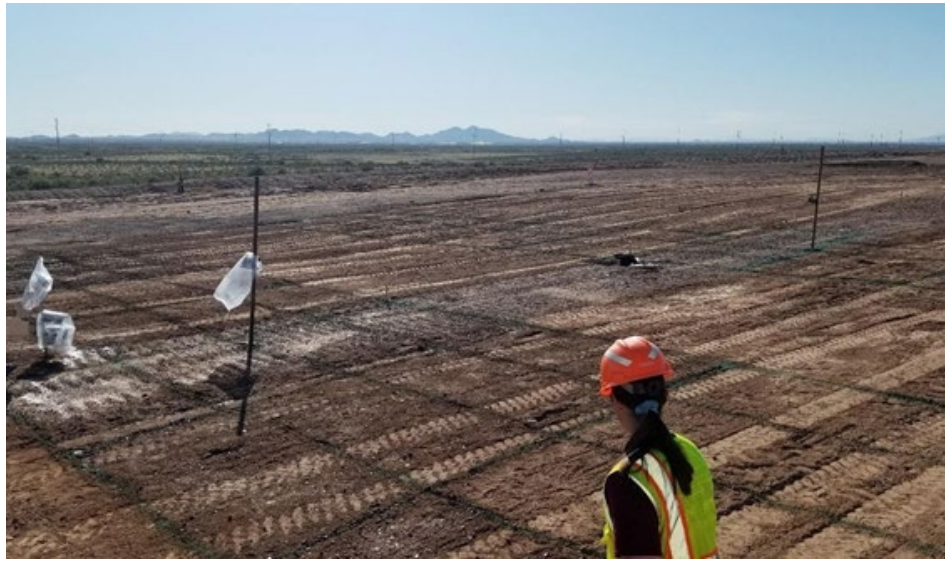
# Field Testing for a specific measure: EICP/MICP (Bio-cementation techniques)

- Status: Pilot site determination
- Objective: Reduce fugitive dust and complete life cycle assessment. Project will focus on treatment at the Salton Sea.
  - Compare EICP/MICP with current state-of-practice methods
  - Partnering with Arizona State University (ASU)
- Test plot: ~1/3 acre in partnership with Imperial Irrigation District (IID)

# EICP/MICP as Dust Control

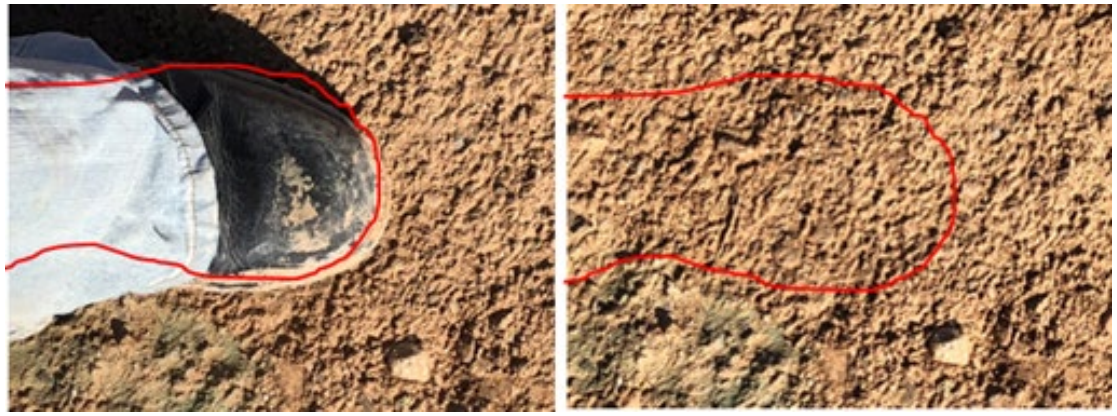
- Bio-cementation processes
- Urease enzyme catalyzes hydrolysis, enables $CaCO_3$ precipitation (crust formation)
- ~10 years of research in bio-cementation at ASU

RSI Apache Junction Landfill Field Trial



**Untreated Plot**

**Treated Plot**



# Important Issues for EICP/MICP

- Treatment Method
- Level of Treatment
- Durability
- $NH_4CL$ by-product
- Impact of constituents in Playa soils
- Lifecycle cost and environmental impacts

Pictured above: EICP Treated AZ Silt

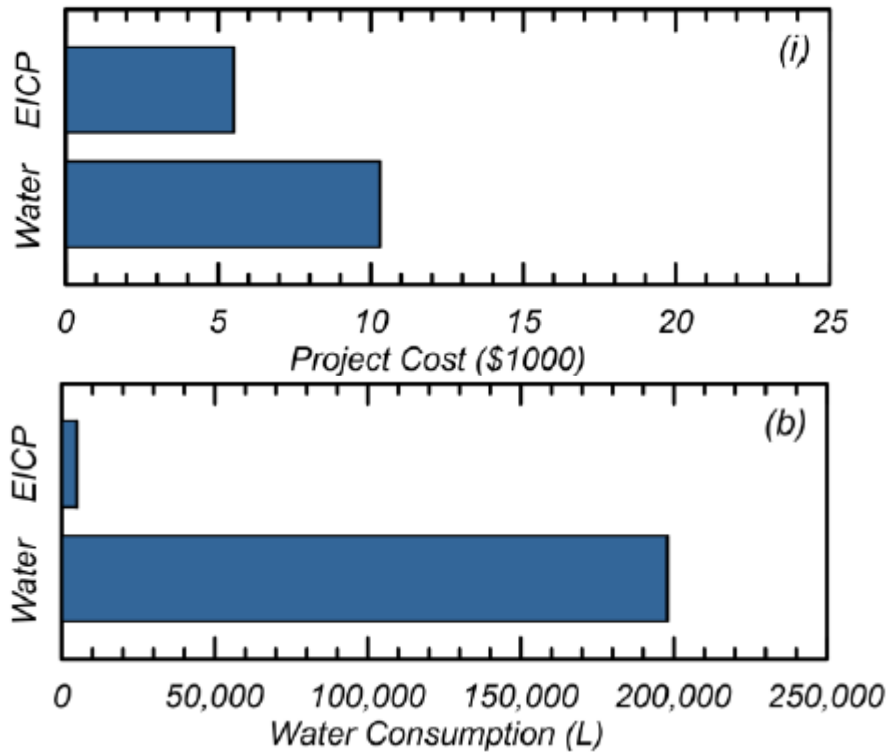
# Previous Outreach

- 2/8/21: Salton Sea Management Program – Coordination Meeting
- 2/25/21: Salton Sea Authority Board Meeting
- 4/7/21: State Water Resources Control Board Salton Sea Workshop
- 5/18/22: Salton Sea Federal Partners Meeting
- Feedback
  - Coordinate with Air Pollution Control Boards
  - Prepare preliminary cost estimates for EICP and MICP
  - Get stakeholder feedback for life-cycle analysis to be completed after field testing
  - Explore water availability/requirements for EICP and MICP
  - Consider environmental justice and disadvantaged communities
  - Need a plan to get projects implemented
  - Consider habitat impact with surface surfactants

# EICP Preliminary Cost Estimate

- Life cycle sustainability assessment, 2019
  - EICP ~$5,000/acre (preliminary, specific to 2 wk treatment)
  - Further development could make EICP more feasible
  - Other impact categories considered
- Compared to other dust control*:

| | |
|---|---|
| **Surface Roughening** | **$400/acre** |
| **EICP** | **$5,000/acre** |
| **Moat and row** | **$14,000/acre** |
| **Vegetative swale** | **$17,000/acre** |
| **Managed vegetation** | **$25,000/acre** |
| **Shallow flooding** | **$25,000/acre** |
| **Gravel cover (2-inch thick)** | **$36,000/acre** |




Pictured above: Results from a life cycle analysis in 2019 that compared EICP to water application for dust control for a 1-acre treatment area over a 2-week period.


Sources

"Life Cycle Sustainability Assessment of Enzyme-Induces Carbonate Precipitation (EICP) for Fugitive Dust Control", 3rd International Conference on Bio-Based Building Materials, 2019
https://journal.augc.asso.fr/index.php/ajce/article/download/1069/623


Cost estimate for other dust control measures are from the Salton Sea Air Quality Mitigation Program

***Costs are preliminary and do not consider O&M. The cost for EICP has likely decreased since 2019.**

# Discussion

- Creating a table/matrix to compare Dust Control Measures across multiple objectives besides just cost and water use
  - Previous studies for info gathering

- Objective categories (feedback?)
  - Capital and O&M Costs
  - Water consumption
  - Durability
  - Habitat Benefit
  - Public Access
  - Community Benefit
  - Aesthetics

- Ratings (feedback?)
  - Low/Medium/High
  - Text Descriptions
  - Other?

- Qualifiers?

# Discussion

- Concerns with field testing?
- Concerns with Dust Control Measures?
- Dust Control Measures to prioritize for additional research?
- Other research needs at the Salton Sea to prioritize?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