



Hardening Beach Sand to Prevent Beach Erosion

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Background/Research:

- When I was on vacation in Hawaii, we saw that it has severe beach erosion. They said that about 70% of Hawaii's beaches are eroding. This is bad for the tourists, and people who live there. I thought that was sad. When I got home I saw that beach erosion is a big problem all over the world because of rising sea levels, stronger storms, and human activities. Erosion is bad because 40% of the world's population lives close to beaches, and those people could lose land if we don't do anything.
- I found out that there is not a lot of things that we can do to stop erosion without harming the environment.
- I wanted to see what we are doing to stop this so my dad helped me look online for articles on preventing erosion. I found this study from Northwestern University that was done in 2024 called "Electrodeposition of calcareous cement from seawater in marine silica sands". I liked that a University in the Midwest was doing something to fix the problem of erosion.
- I liked how they said this was good for the environment so I wanted to try.
- The article I used to help me for this project is from Northwestern University called "Fighting coastal erosion with electricity" (news.northwestern.edu, Aug 2024).

Question:

Can we use low voltage to make beach sand harder to prevent erosion?

Hypothesis:

If low voltage (about 3 volts) is added to beach sand that is soaked in seawater using graphite rods to conduct electricity, then the sand will become noticeably harder (measured by a drop test, and shows resistance to being scooped) compared with beach sand in fresh water, or sand with no voltage, because this process will use the minerals in the beach sand and seawater to bind the sand together (like glue).

Materials Used:

- Three Non-Conductive Containers
- 4 4 inch Graphite Stir Rods
- Two Battery Holder with Alligator Clips
- 4 AA Batteries
- 1 bag of Beach Sand (Hermit Crab Sand)
- 1 box of Salt Water (Aquarium Salt Mix) (1/2 cup for 1 gallon)
- 3 cups of Fresh Water
- Strips of Tape
- 1 metal ruler with inches and centimeters
- 1 Metal Chop Stick for Drop Test
- 1 Small Spoon for Scoop Test

Procedures:

- **Step 1:** I filled three containers with equal amounts of beach sand.
- **Step 2:** I labeled the first container as the control with Salt Water and Beach Sand Only.
- **Step 3:** I labeled the second container as my test with Salt Water and Beach Sand with low voltage.
- **Step 4:** I labeled the third container as my comparison test with Fresh Water and Beach Sand with low voltage.
- **Step 5:** I then Mixed the Salt Water from the Salt Water Aquarium mix. I added 1/2 cup for 1 gallon of water.
- **Step 6:** I poured equal amounts of the salt water mix in the Control Container (about 3 Cups), and Test Salt Water Container.
- **Step 7:** I then poured the same amount of Fresh Water (3 Cups) in the comparison test container.
- **Step 8:** I then placed 2 graphite stir rods in the Salt Water Test container at opposite ends making sure they were firmly in the beach sand.
- **Step 9:** I placed 2 graphite stir rods in the Fresh Water Test container at opposite ends making sure they were firmly in the beach sand..
- **Step 10:** I put two AA batteries into the battery holder and taped it onto the test and comparison containers.
- **Step 11:** I then placed the positive (red) and negative (black) Alligator Clips on the graphite stir rods in each test container making sure they were spaced across the container leaving room for my tests.
- **Step 12:** I turned on the each of the battery holders for the Test and comparison containers.

Daily Test Procedures:

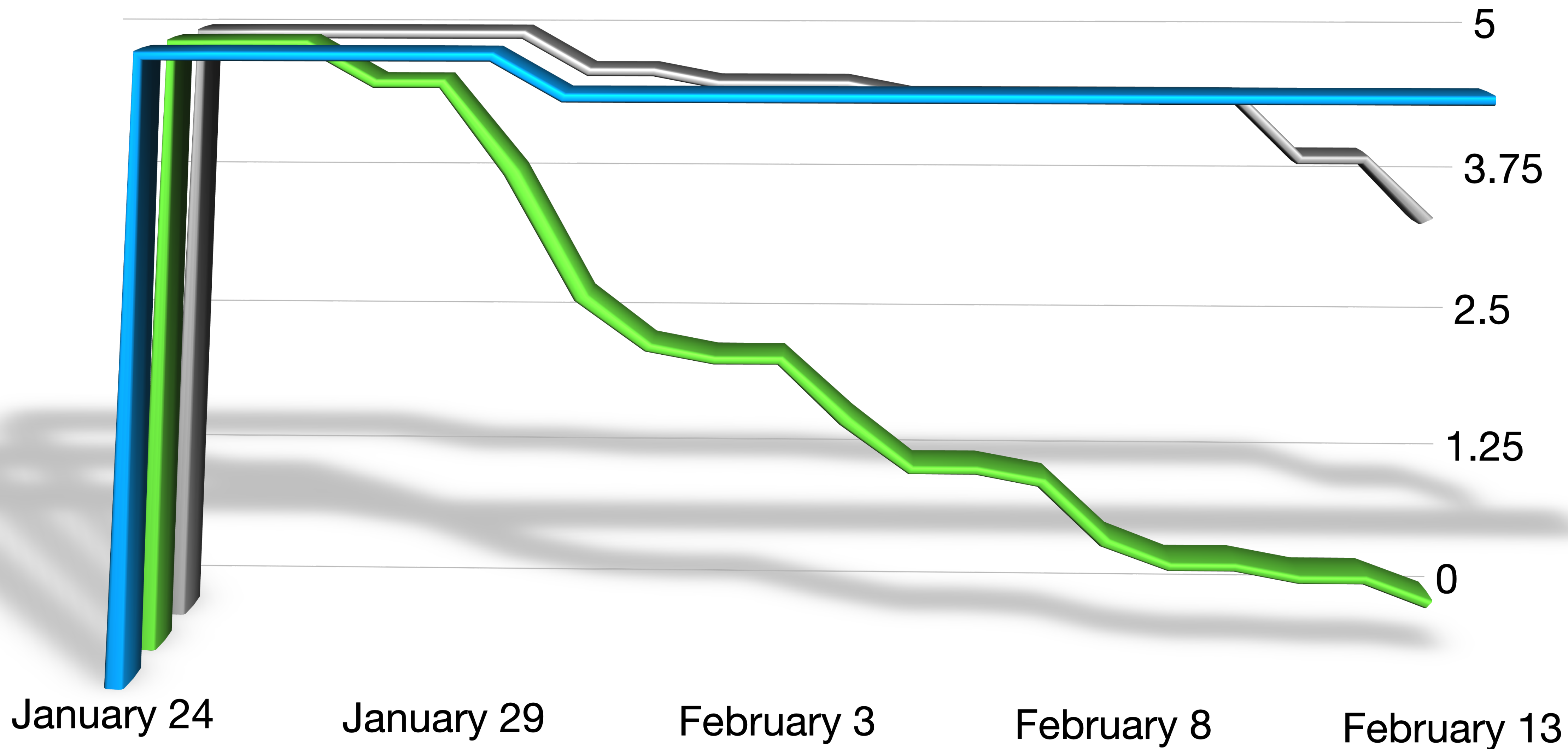
- **Step 1:** I would look at each container and write down any changes.
- **Step 2:** I would do the Drop Test to see how far the metal can go into the sand for each container.
 - I then measured how deep a metal chop stick went into the sand using centimeters from my ruler. I then wrote down the results for each container.
- **Step 3:** I did a Scoop Test for each container using a small spoon. I then wrote down the results for each container.

Key for Testing

- **Visual Inspection:** I would look at each container and write down notes on what I saw.
- **Poke and Scoop Test:** I would use the small spoon to scoop the sand, and write down the result based on a score based on 1 to 10:
 - 1 through 4 = Is loose wet sand, which is easy to scoop
 - 5 through 8 = Is firm but deniable sand which is easy to scoop, but is not loose.
 - 9 through 10 = Is very hard and rock like.
- **Drop Test** (how far the metal chop stick will go into the sand when dropped from the height of the container lid:
 - I would measure the depth in centimeters for each drop.
 - To keep the test the same, I put the tip of the metal chop stick even with the container lid, and then I dropped in the center between the graphite rods.
 - Once I dropped the metal chop stick, I measured how deep it went into the sand in Centimeters using my metal ruler.

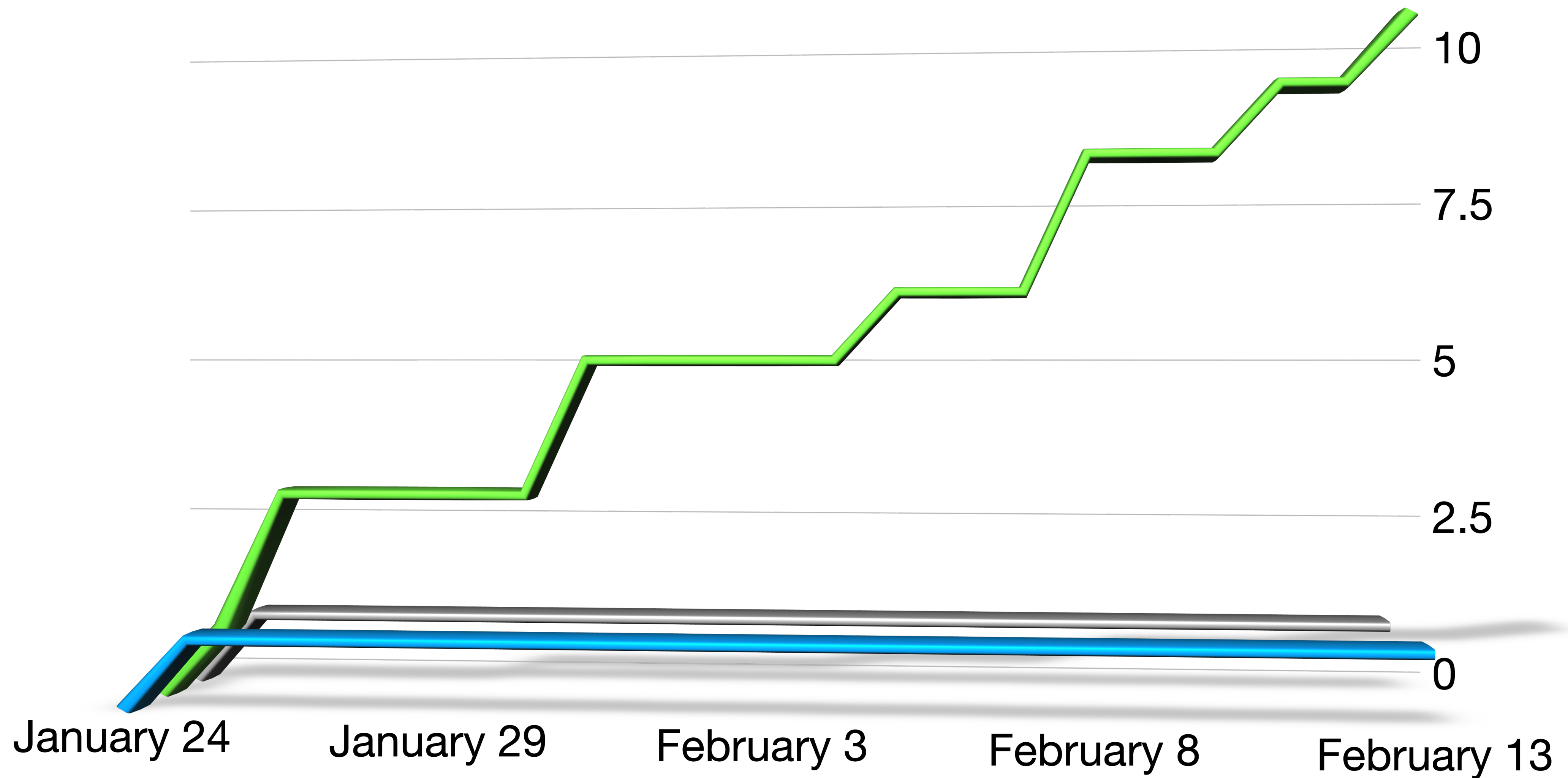
Drop test Results

Control Saltwater no-voltage Test Saltwater voltage Test Fresh Water voltage



Poke and Scoop Test Results

— Control Saltwater no-voltage — Test Saltwater voltage — Test Fresh Water voltage



Conclusions:

The results of my tests showed that when I did the drop test on the salt water with voltage it became harder each day. When I did the drop test on the fresh water it did not become harder each day, it mostly stayed the same. When i did the drop test on the control there was almost no change.

When I did the poke and scoop test on the salt water with voltage it showed the sand was hardening. When I did the poke and scoop test on the fresh water with voltage it did not get hard like the salt water with voltage. When i did the poke and scoop test on the control it never got hard.

The visual observation showed the salt water with voltage evaporated with in a couple days. I added water to make sure it was not normal evaporation. The control and the fresh water did not evaporate the same.

After adding salt water to the salt with voltage container, I saw that it evaporated quickly again. I saw that there was a noticeable result with the salt water with voltage.

Based on the results of the test I conclude that it is possible to harden beach sand with low voltage. I am not sure that this would work in real life because its a small test but the results were enough to prove my hypothesis. I am positive that this will not work on a fresh water lake and will never work without voltage on a beach.