From: Terry Spragg
To: CWC Water Storage Investment Program
Subject: Fwd: Water Storage Plan
Date: Friday, January 29, 2016 2:50:01 PM
Attachments: Storm Water Long Beach water storage (4).pdf

Attached is a description of a new water storage technology that has been developed as a result of our work in waterbag transport technology. A video of a 100 mile, three day ocean test of our technology can be seen at: http.//www.youtube.com/watch?v=4TEJp6UZaDI. Additional information can be found on our website at: www.waterbag.com.

As we understand the application process, we must submit our plan along with a government agency in order to be considered for your program.

How do you suggest we go about this process and who do you suggest we contact, as all the water agencies we have contacted (Long Beach, Los Angeles, West Basin, MET, etc.) have told us they are only pursuing the storage plans that they have developed for their own agency.

Thank you for your advice. I can be reached at the above email address or by phone at: (562) 461-9195.

Best regards,

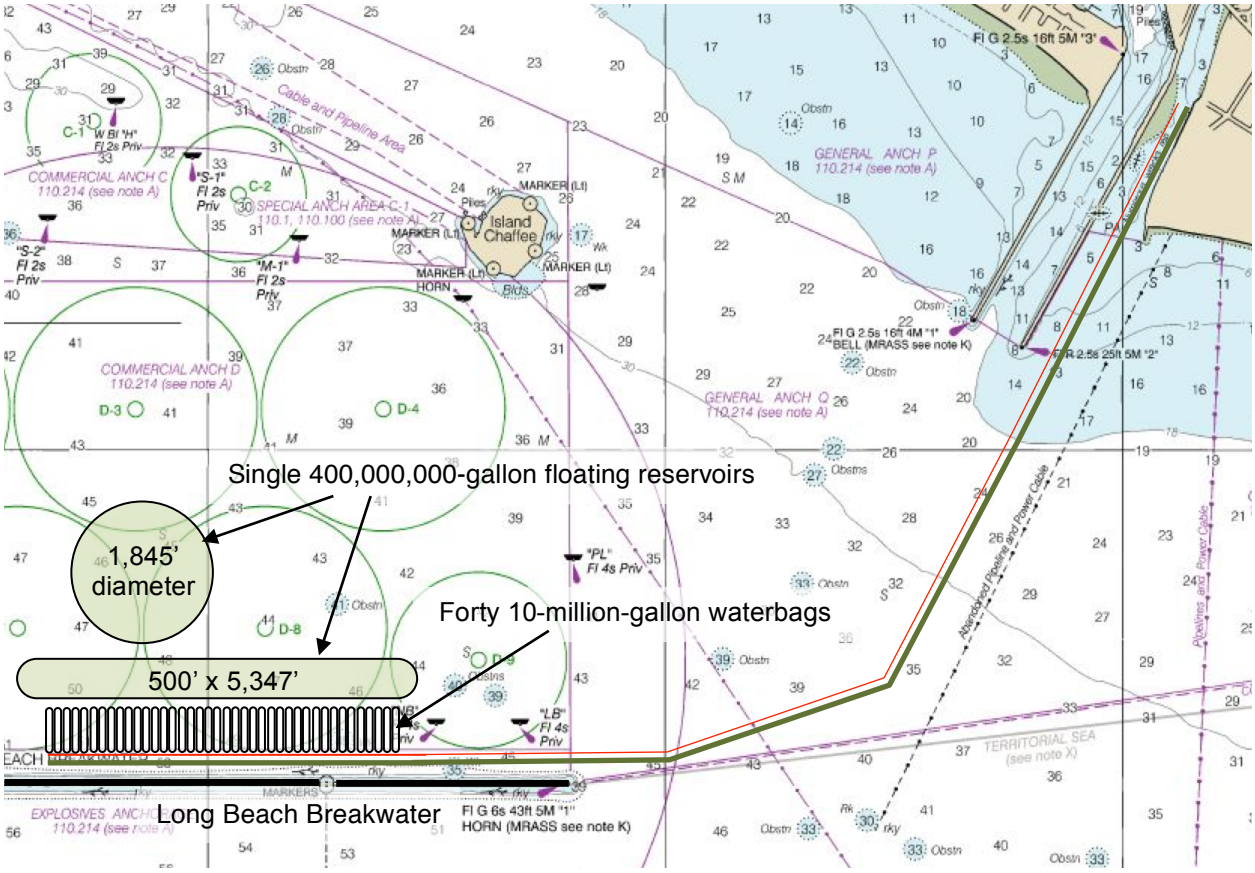
Terry Spragg

Modular Reservoirs for the Capture of San Gabriel River Runoff in Long Beach Harbor

Today, less that 10% of the runoff in LA County is captured for use in recharging groundwater, with the remainder making its way to the sea. Distributed storm-water capture is being encouraged, as climate change seems to drive rainfall to fewer but larger precipitation events but sites for new reservoirs are scarce and their construction is expensive. Underground cisterns and residential capture from roofs offer little relief.

But what if the runoff that so quickly overwhelms the present storage capacity could be captured just before it joined the sea and then, after the storm has passed, could be pumped back up to the spreading grounds.

We propose a pilot installation that has the capacity to capture 400 million gallons of water. Set up at to take water from the mouth of the San Gabriel River, a large diameter, submerged, fabric pipeline brings fresh water to a floating reservoir positioned inside the east end of the Long Beach Breakwater. Such a reservoir can take many forms from multiple floating waterbags to a single, open-top floating reservoir. In the former case, each waterbag is permanently connected to a water distribution manifold of the runoff pipeline and valves control their sequential filling. In the later case, the floating reservoir is circular in shape or rectangular with rounded ends.



In this view we see the San Gabriel jetties, and a storm-water pipeline (green) and smaller diameter return line (red), both submerged and leading to the breakwater. The three reservoir options are shown with the forty waterbags in place in the lee of the breakwater. Each waterbag is 60' in diameter and 600' long and holds 10 million gallons of water. Each is filled to 90% of capacity and has a draft of 20'.

The larger single-reservoir options are also shown for comparison. The long and the circular reservoirs have the same capacity as the forty waterbags but because they are open top and make more efficient use of fabric, they cost roughly half as much.

A pilot demonstration such as this would have little impact on other uses of the harbor and would reveal whether the approach is a workable solution for coping with runoff. However, there are many issues to be resolved such as how often would it be employed and whether there is sufficient time between runoff events to allow the water to be pumped up to the spreading grounds. Nevertheless, the technical challenges associated with the design of the fabric containers, the pipelines, and the pumping are manageable. Furthermore, the technology is scalable and enough reservoirs of this type could be placed inside the breakwater to easily duplicate the retention capacity of the Whittier Narrows Dam with little impact on navigation.

We envision a system that would be deployed either permanently or during the rainy season. Once deployed, there would be no movement of the containers, as they would be securely held in place by anchors. The enclosed waterbags would have air pockets to keep when afloat when empty. When full, the less-dense fresh water kept the bag afloat in the surrounding seawater. The large open-top containers have a buoyant rim that keeps the perimeter well above the water level. When empty, the entire container would float at the surface. While being filled, the container would increase its draft until filled to capacity with a 20' draft. Being open top, they would also collect rainwater.

We estimate the cost of the forty waterbags to be $12.5 million or 3.1¢ per gallon. The costs of the circular and rectangular open-top units are roughly half as much at $6.5 million and $6.8 million respectively. There would also be costs associated with mooring systems and of course the plumbing for both the high-rate filling process and the lower-rate piping to return the water to shore and then up the 18 mile long, 200' rise to the spreading grounds.

The filling process would be gravity driven while the return trip would require pumps, one at the storage container(s) to get the water ashore and at least one more on shore for the return trip. The return pipeline size and the required pumping power would depend on the duration available for spreading. Regardless of the details of this return plumbing, the energy involved in pushing 300 million gallons of water 200' uphill is 250 MWh ignoring piping losses and pump inefficiencies. Assuming overall 25% efficiency and at 10¢ per kWh, the energy costs would be $100,000 per cycle, or 0.025¢ per gal.

The costs become extremely competitive when the number of uses allows the capital costs to be amortized over the number of annual storm events and the likely years of service. Assuming ten storm events per year and a lifespan of 10 years, the capital costs for the open-top options become 0.016¢ per gallon. Combined with the energy costs of pumping, the total cost per gallon becomes 0.041¢ per gallon or $0.11 per cubic meter, a small fraction of the cost of new water alternatives.

The purpose of this analysis is to present a proposal for various fabric-reservoir alternatives designed to capture storm water, store it in Long Beach Harbor, and deliver it to the up-stream spreading grounds at an appropriate later date following major storm events. We hope that the concept, along with various alternatives, can see a through technical and economic review and the most appropriate options can be moved forward as a pilot project.