

ADVANCED MONITORING OF DREDGED MATERIAL PLACEMENT SITES AT THE MOUTH OF THE COLUMBIA RIVERJ.K. Norton¹, H.R. Moritz², M.E. Ott³, J.M. McMillan⁴ and G.C. Roegner⁵**ABSTRACT**

The US Army Corps of Engineers, Portland District, has looked to expand its nearshore placement of dredged material at the Mouth of the Columbia River. Traditional disposal methods have taken material offshore, where the sediment is lost to the nearshore environment, and removed from the littoral zone. Due poor disposal practices in the 1970's and 1980's, the Portland District has faced many challenges in authorizing nearshore dredged material disposal sites over the last twenty years. To ease stakeholder concern and support the selection of nearshore dredged material placement sites, the Portland District has engaged in extensive/intensive stakeholder outreach and developed a number of advanced monitoring techniques. The stakeholder outreach process uses collaborative governance in order to address wicked problems. Because seeing is believing, the Portland District and stakeholders used video-based monitoring at placement sites to validate laboratory studies simulating disposal impacts on the benthos. These innovative methods provide stakeholders with video footage of benthic response to the sediment plume during disposal operations at the dredged material placement sites.

Keywords: Dredging, beneficial uses, stakeholder engagement, collaborative governance, disposal monitoring.

INTRODUCTION

The Mouth of the Columbia River (MCR) is located between the states of Oregon and Washington, on the coast of the Pacific Northwest. A 6 mile long navigation channel, the MCR Federal Navigation Channel (FNC), is maintained by the US Army Corps of Engineers (USACE), Portland District. The FNC is divided into a 609m wide north channel maintained to -18m, and a 195m wide south channel maintained to -16m. The MCR channel downstream terminus is the Pacific Ocean, and the upstream nexus is the Columbia and Lower Willamette FNC.

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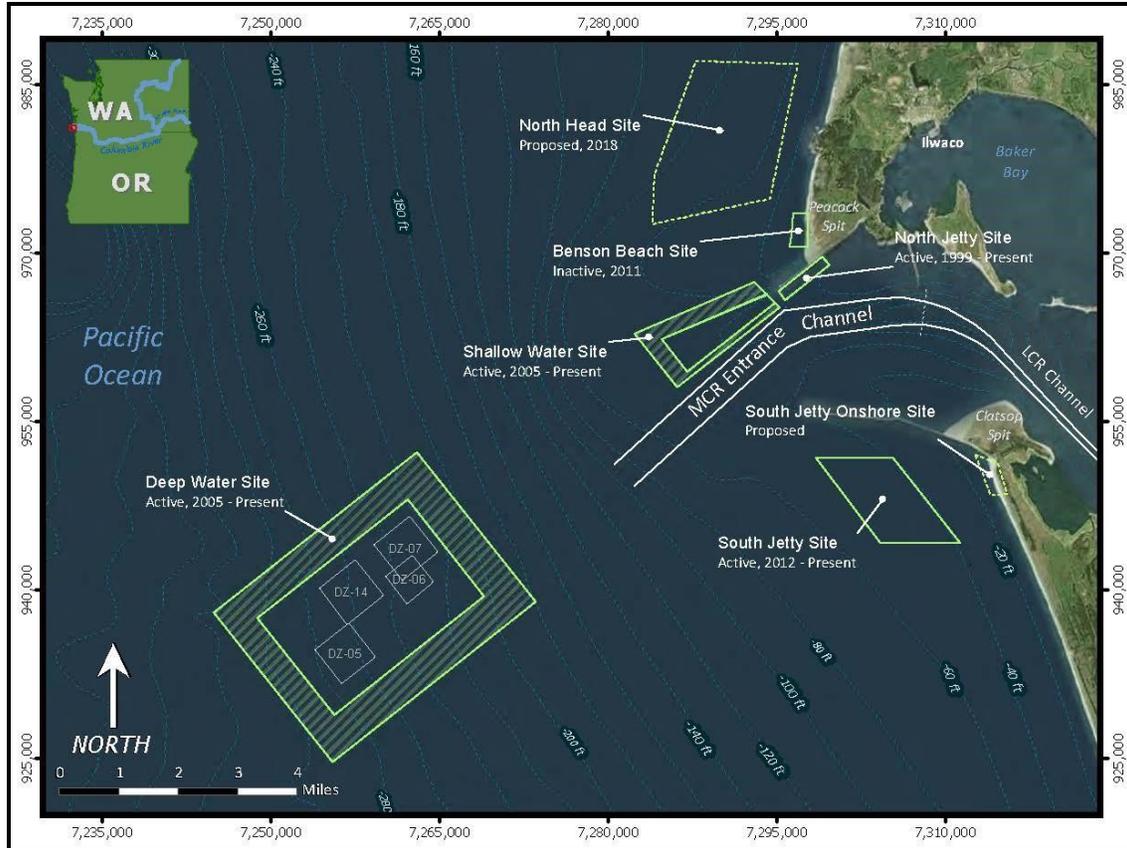


Figure 1. MCR Federal Navigation Channel and placement sites.

This area is characterized by high energy wave-current interactions, ocean waves regularly exceed 8m and currents in the Columbia River may exceed 7 knots during ebb tide. These dynamics along with a host of other factors make MCR one of the most volatile and dangerous coastal inlets in the world. The MCR is the Gateway to the Columbia-Snake River System, supporting the 2nd largest grain export system in the world. Additionally; 48 million tons of cargo worth over \$24 billion cross the bar annually. The navigational channel is supported by 3 jetties, 4 pile dike structures, and annual maintenance dredging of 3 to 4 million cubic meters of material. Dredged sediment at MCR is characterized as medium sand having fine to medium sand grain size range of 0.15 to 0.25 mm, depending on channel location. Fine grained material (<0.625 mm) constitutes less than 3% of sediment content at MCR.

After construction of the north and south jetties in the early 1900's, a large mass of sediment accreted on the coastal margins, north and south of MCR. As the area equilibrated in response the jetty construction, the accretion slowed and eventually reversed. The areas adjacent to MCR are now receding. This recession poses a threat to federal infrastructure, both in the reliability of the federal channel and to the channel training structures. The USACE Portland District has responded to this threat by developing a network of nearshore and intertidal dredged material placement sites. The introduction of material into these areas feeds the Columbia River littoral cell and more closely mimics natural processes. Nearshore and intertidal placement operationalizes USACE goals of Regional Sediment Management and Engineering with Nature, while also providing for a beneficial use of dredged material.

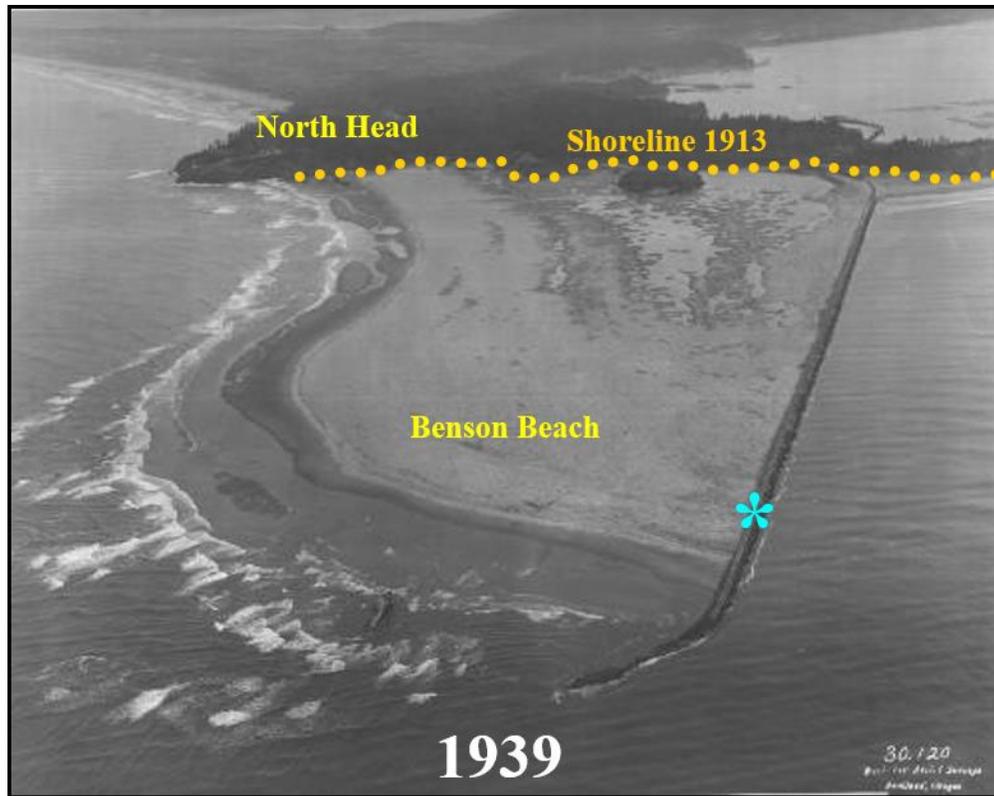


Figure 2. Post-jetty construction accretion of sand near the MCR North Jetty.



Figure 3. 2002 condition of the area near the MCR North Jetty.

In order to be successful, the Portland District needs to supplement sediment to the north and south of the MCR entrance channel, while minimizing the impacts to environmental, recreational, and economic interests in the area. Two areas of great concern are impacts to benthic communities, and wave amplification as a result of dredged material mounding. Both of these issues are monitored with great scrutiny by local, state, and federal groups. The combination of potential impacts, and the proposed responses by USACE Portland District, created a problem in which no single solution could alleviate the problems. In order to move forward it was decided that a stakeholder working group would be assembled to take a collaborative governance approach to solving these wicked problems.

STAKEHOLDER ENGAGEMENT

Collaborative governance occurs when groups consisting of all interested parties convene to address and overcome an issue. The Lower Columbia Solutions Group (LCSG) was convened to bring federal, state, and local groups from both Oregon and Washington together to work through issues at the Mouth of the Columbia River in a collaborative way. The group consists of roughly 30 member organizations/agencies, and roughly 75 individuals. The group size fluctuates depending on turnover in organizations/agencies. Each member has a specific interest in the how/what/where/why dredging and dredged material placement occurs at the Mouth of the Columbia River. Some groups have a singular focus, such as the Columbia River Bar Pilots, who are strictly interested in having a reliable FNC. While others, like the Columbia River Crab Fisherman's Association, have an interest in dredging and disposal. They rely on safe navigation through the channel, but also have an interest in minimizing dredged material placement on their crab fishery.

The initiation of the group was a long process and even after the group was convened it took time for the collaborative processes to begin. For a number of years most members were guarded in order to protect their own interests, and were not amenable to anything that wasn't completely supportive of their goals. This paralyzed the group. Over time, the LCSG built trust through small incremental successes, and the walls began to come down. Collaborative processes began to emerge through brainstorming sessions about potential solutions to some of the challenges that we face in the area.

However, the group began making major breakthroughs by holding science-policy workshops. These workshops brought the technical experts, such as coastal engineers and biologists, together with the policy making and permitting agencies. This process was critical in identifying gaps in data, and research/monitoring needs that would minimize the impacts of dredged material placement. Through these workshops a number of advanced monitoring techniques were developed, and potential nearshore placement sites were identified.

Agreement to move forward with placement in the nearshore environment near the MCR South Jetty began in 2004. A pilot placement even was initiated in 2006, using Sediment Profile Imaging (SPI) in conjunction with thin-layer placement by the government hopper dredge ESSAYONS. These images were disappointing, while also promising. The SPI images did not provide the images showing deposition beyond the existing bedforms that many in the group expected to see (SAIC 2006). But many in the group were excited, in that this provided data showing that thin-layer placement by the dredge could spread dredged material extremely lightly through the disposal site. It showed that our target deposition height of 5cm was attainable. Thin-layer placement was accomplished by prescribing placement runs by the dredge ESSAYONS that targeting a minimum placement run of 2,500m. The ESSAYONS has 12 doors to control the rate of material leaving the hopper, they open in pairs. By sequencing the opening of the hopper doors, over a long placement distance, the dredge is able to place material that is almost

Through a series of data gathering exercises, and increased trust, operational placement began in 2012. Operational placement was agreed upon after the development of incredibly innovative monitoring techniques. These techniques will be discussed in detail later on. Placement in this site provides up to 500,000m³ of sand annually to the supplement eroded areas on the Oregon Coast. The LCSG continues to move forward to develop additional sites in the nearshore network. Following the success on the Oregon side of the MCR, the focus has shifted to the Washington side. Pilot placement at the North Head Nearshore Site is expected to occur in the fall of 2018.

CHRONOLOGY OF MAJOR LCSG EVENTS

2004 – Oregon Nearshore Beneficial Use Project initiated to collaboratively address the depletion of sand in the nearshore environment south of the MCR South Jetty.

2005 – First Science-Policy Workshop.

2006 – Pilot Placement event by the dredge ESSAYONS near the MCR South Jetty.

2007 – Science Policy Workshop, evaluating pilot placement results.

2008 – Sediment Tracer Study at the proposed South Jetty Nearshore Site.

2009 – Science-Policy Workshop, evaluating Sediment Tracer results.

2011 – Regional Sediment Management Plan for MCR complete, project charter signed by LCSG.

2012 – Operational Placement and Monitoring in the South Jetty Nearshore Site (Oregon).

2016 – Baseline data collection at proposed North Head Nearshore Site (Washington).

2018 – Anticipated Pilot Placement at North Head Nearshore Site.

NEARSHORE DISPOSAL SITE MONITORING

Central to the success of the LCSG has been the development of advanced monitoring techniques at the nearshore dredged material disposal sites. Through a series of iterative meetings USACE decided to fund NOAA to complete monitoring at the sites, and that video based monitoring would be the best way to capture what was occurring when dredged material was placed on the seafloor. Video was chosen due to lack of trust by the LCSG in model and lab results with some stakeholders.

The commercial availability of underwater cameras led NOAA to develop Deposition Monitoring Instruments (CamPods). They consist of a welded frame with two GoPro cameras mounted to observe the depth of single dredged material placement events. Bait is also attached to attract benthic organisms. The CamPods are placed on the seafloor for the government hopper dredge ESSAYONS to place dredged material over. Deployment is done just prior to the ESSAYONS arrival in the disposal site.



Figure 4. ESSAYONS placing over CamPods.

When the cameras are retrieved the resultant videos provide a wealth of quantitative and qualitative results. The videos quantitatively show the depth of individual dredged material placement events. Additionally, the response of benthic communities is observed as they react to the dredge plume. The use of video based monitoring provides for the ability to replay the events for new stakeholders, and provides conclusive data of what occurs when dredged material is placed on the seafloor.

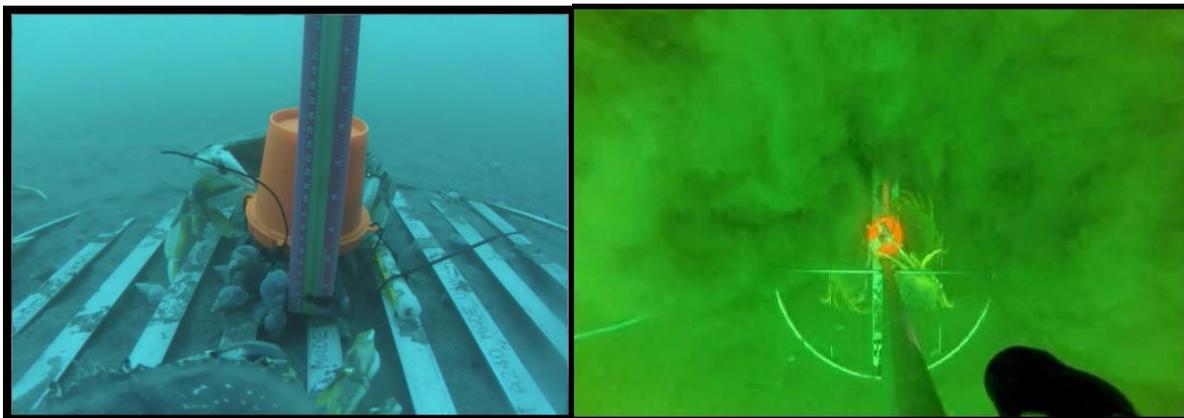


Figure 5. CamPod image (Courtesy of NOAA).

In addition to monitoring single placement events, presence and absence of species in the site is also of great interest. A benthic video sled was developed as a replacement for the trawls that have traditionally been used to

serve this purpose. The video sled is towed in a grid pattern through the site to capture images of the seafloor. The sled is been towed pre and post placement.



Figure 6. Benthic video sled.

The Portland District tasked the US Army Engineer Research and Development Center (ERDC) with developing a method of viewing the images collected by the benthic video sled. A Graduate Research Assistant from Oregon State University was used early in the process to view up to 40 hours of video data collected by the sled each year. ERDC reached out to a number of research organizations and through the Monterey Bay Aquarium Research Institute (MBARI) a benthic algorithm was found to be in development. The MBARI Video Annotation and Reference System (VARS) is in the process of being updated to fit the existing need to view benthic video sled data. Once fully operation the VARS will be able to process the video data while cataloging and counting the organisms the video captures.

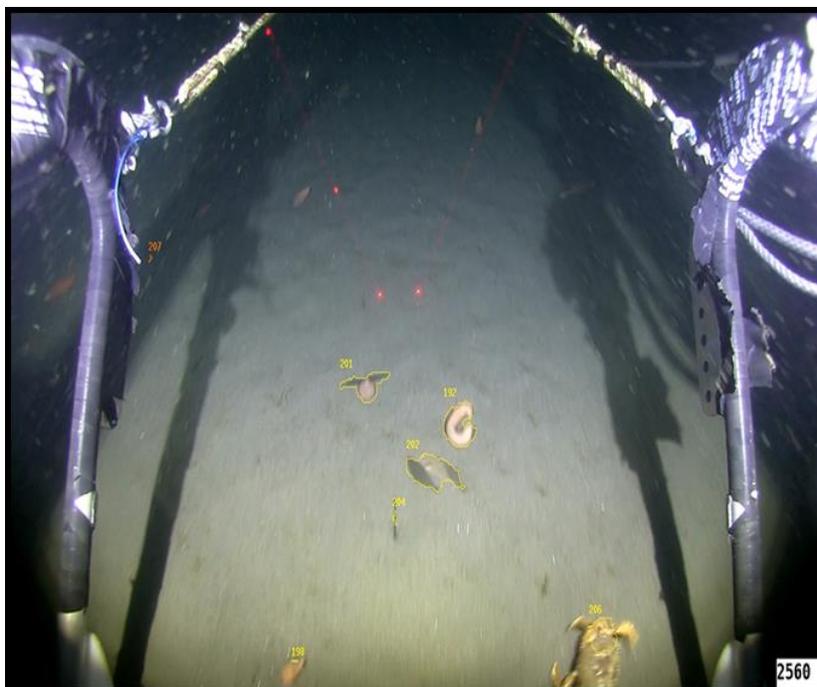


Figure 7. Benthic video sled images being processed through VARS.

The video collected through the advanced monitoring techniques provide an acute view of what happens during dredged material placement, and has been a critical tool in maintaining stakeholder support for dredged material placement. However, additional monitoring techniques have been needed to determine the effects of dredged material placement. Due to the critical importance of Dungeness crab (*Metacarcinus magister*) populations, both commercially and recreationally, additional emphasis was placed on the impacts to the species.

Through collaborative processes the LCSG decided that crab movement before and after dredged material placement was of concern. It was thought that crabs would be entrained in dredged material following placement and suffocate. Acoustic tagging was determined to be the best available method for addressing this concern. An array of hydrophones placed at the control and impact areas detects the movement of each tagged crab over the course of the dredging season. Tagged crabs are released at the same time as the CamPod deployments, at a pre-determined site that the dredge ESSAYONS will be placing material at. This occurs just prior to placement to ensure that the crabs are in the area. This has occurred for the previous 5 dredging seasons, and to date it has been determined that no crab mortalities have resulted from dredged material placement.



Figure 8. Acoustic tags on Dungeness crab.

Movements of individual crabs continue following placement throughout the site. Crabs have been observed moving between the control and impact areas over the course of the season. Some tagged crabs have been recovered by fishermen confirming their survival. One tagged crab traveled over 100 miles north and was recovered by a fisherman near La Push, WA.

CONCLUSION

Collaborative governance has the ability to address wicked problems by allowing for input from all parties to reach a path forward. Wicked problems inherently have no solution, but the ability to continue forward is the most important piece for nearshore disposal at MCR. The LCSG have built trust through time, and by allowing for the group to respond to problems that arise over the course of developing a network of nearshore disposal sites, it has led to the development of extremely innovative and advanced monitoring techniques. The Portland District allowed the process of collaboration to lead the way forward, and in doing so broke down years of distrust that previously existed.

Collaborating with local stakeholders has significantly increased the methods of nearshore disposal site monitoring that are available to USACE. Both the process of building a functional stakeholder working group, and the new methods of disposal site monitoring are applicable to other groups facing similar situations. Both are repeatable, and can be used as templates for the development of nearshore networks of disposal sites.

The use of video based monitoring is a critical tool in alleviating concerns related to dredged material placement. The video provides tangible evidence of what is occurring on the seafloor. When coupled with more traditional, and some non-traditional, monitoring methods a full picture of what is happening during placement is developed. There are both qualitative and quantitative data sets have been able to all questions arising at this time.

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