EVOLUTION OF AN INNOVATIVE DREDGING TECHNOLOGY FOR HARVESTING COARSE-GRAINED SEDIMENT

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ABSTRACT

Dredging is the process of excavating sediments and other materials from underwater locations, including the transportation and placement of the material, for an intended purpose (e.g., constructing or maintaining navigation channels, beach nourishment, obtaining materials from borrow sites, etc.). A conventional dredge usually consists of a floating platform equipped with machinery that operates on mechanical and/or hydraulic principle(s) and advances into the bottom material to achieve subsequent excavation, transportation, and placement of that sediment. An innovative sediment management method has been developed that, instead of using equipment that advances into the sediment, achieves production by relying on natural physical processes to transport sediment to the equipment. Given the current and expected future economic and environmental constraints imposed on dredging projects, this fundamental reversal in operational methodology can provide significant advantages. The Bedload Collector is a new technology that operates on the principle that bedload sediment can be harvested by gravity and excavated at the natural rate of transport. The Bedload Collector system basically consists of a stainless-steel hopper set into the submerged ground that collects coarse-grained sediment as it is transported by hydrodynamic forces. A urethane manifold system then pumps slurry via pipeline to a placement area or re-handling station. While this technology has been successfully used in riverine flow applications with unidirectional water current as the primary sediment transport driver, an ongoing investigation is being conducted on Galveston Island to evaluate its performance as a beach sediment bypass and/or backpass management option where directionally variable waves and longshore currents drive sediment transport processes. Participants in this investigation include the Galveston Park Board of

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Trustees, U.S. Army Corps of Engineers Galveston District and Engineer Research and Development Center, Streamside LLC, Freese and Nichols Inc., and Texas A&M University. Objectives of this initial Galveston Island project are to demonstrate this system’s capability to harvest sand being transported by waves and longshore currents, select an appropriate harvesting location, and design a Bedload Collector system that dewaters sand for beneficial use by the Galveston Park Board of Trustees to maintain the quality of Galveston Island’s beaches. Scale sampling of bedload transport rates and wave and current data were collected during summer and winter conditions in support of this effort. This paper describes how the bedload collector system works, provides an update on its use in riverine applications, and presents results from the ongoing investigation on Galveston Island as this technology evolves from riverine to marine applications.

Keywords: Dredging, sediment bypassing, sediment backpassing, beach nourishment, and sediment harvesting.

INTRODUCTION

Dredging is the process of excavating sediments and other materials from underwater locations, including the transportation and placement of the material, for an intended purpose (e.g., constructing or maintaining navigation channels, beach nourishment, obtaining materials from borrow sites, etc.). A conventional dredge usually consists of a floating platform equipped with machinery that operates on mechanical and/or hydraulic principle(s) and advances into the bottom material to achieve subsequent excavation, transportation, and placement of that sediment. An innovative sediment management method, the Bedload Collector, has been developed that, instead of using equipment that advances into the sediment, achieves production by relying on natural physical processes to transport bedload sediment to the equipment. Bedload is that fraction of the total sediment transport that moves by rolling, sliding, or bouncing on the bed. The Bedload Collector is a new technology that operates on the principle that this bedload sediment can be harvested by gravity and excavated at the natural rate of transport. It consists of a stainless-steel hopper set into the submerged ground that collects coarse-grained sediment as it is moved by hydrodynamic forces. A urethane manifold system then transports pumped slurry via pipeline to a placement area or re-handling station. This paper describes how the bedload collector system works in riverine applications, and presents results from the ongoing investigation on Galveston Island as this technology evolves from riverine to marine applications. Given the current and expected future economic and environmental constraints imposed on dredging projects, this fundamental reversal in operational methodology that lets water do more of the work can provide significant advantages.

FOUNTAIN CREEK, PUEBLO, COLORADO

The first large capacity Bedload Collector, patented, designed and manufactured by Streamside LLC, was installed in Fountain Creek, Pueblo, Colorado upstream of the confluence with the Arkansas River (location shown in Figure 1). This Sediment Collector was installed to demonstrate technology needed to alleviate the need for dredging by lowering the downstream grade to reduce flooding and ultimately reduce sediment deposition as far downstream as John Martin Reservoir, a U.S. Army Corps of Engineers (USACE) managed lake.

Figure 1. Fountain Creek Bedload Collector location map.

System Operation

The system operates on the principle that sediment in bedload can be harvested by gravity and removed at the natural rate of transport, instead of episodically. A 30 ft (9 m) wide, high capacity Sediment Collector was installed in Fountain Creek Pueblo, CO upstream of the confluence with the Arkansas River in July 2011 to demonstrate the viability of this new technology. The sediment collector system installed in Fountain Creek consisted of 6 main parts (Thomas et al. 2017):

1. Bedload Collector: grate dimensions 30 ft (9 m) long by 2 ft (0.6 m) wide
2. Pump: 50 hp (37 kW), submersible variable frequency drive (VFD) pump
3. Controller: electronic controls with internet access and remote interface
4. 6 in (150 mm) discharge and 8 in (200 mm) water return DR 11 (160 psi) (1.1 MPa) high density polyethylene (HDPE) pipelines
5. Sand washer (a.k.a. a screw or spiral classifier): 100 tons/hr (90 metric tons/hr)
6. Radial stacker: capable of storing approximately 1,000 yd^3 (765 m^3)

The primary component of the Bedload Collector is a stainless steel hopper (Figure 2) placed on the bottom along a sediment transport pathway. A manifold system (see Figure 3) inside the hopper focuses flow across a small region within the hopper, providing high velocities needed to entrain sediment. A dredge pump, housed in the hull with the hopper, pumped water and sediment through the manifold to the placement area. The pump can also be mounted remotely on land, the preferred configuration for maintenance.

Figure 2. Bedload Collector installed at Fountain Creek.

While the Fountain Creek Bedload Collector was operated in a closed cycle mode, the system can either be operated in an open or closed cycle. In the open cycle, water is drawn into the Bedload Collector manifold from across the screen and because the area of the screen openings is much greater than the area of the manifold orifices, velocity across the screen is very small (<1 ft/s (0.3 m/s)), even though velocity at the manifold is large enough to transport sediment. In the closed cycle, slurry is discharged into a sand washer where sand is separated from water, and then the water is returned to the opposite side of the manifold as injection water. Because water is drawn from the sand washer's tub (or a holding tank) instead of across the screen; advantages of the closed cycle include minimal impingement velocity (reducing potential for clogging) on the hopper screen and reduced risk of entrainment of aquatic organisms. Slurry was pumped from the Bedload Collector and discharged into the sand washer's tub where the coarse-grained fraction was conveyed up the Archimedes' screw (Figure 4 left) and dropped onto the radial stacker (Figure 4 right). Sand stockpiled under the radial stacker until it was trucked away.

Figure 3. Bedload Collector components.

Figure 4. Sand washer (left) and radial stacker (right).

Electronic controls (Figure 5) enabled automatic or remote operation that reduced the cost of labor to operate the plant. The control system could be set to run at specified times or as a function of stream gage data. Dredge pumps, piping, and the sand washer and radial stacker were all off-the-shelf technology used in dredging and other industries with documented performance metrics.

System Performance

System performance parameters that were planned for measurement included stream bed elevation within ½ mile (800 m) of the collector, water level, sediment volume removed, electricity usage, maintenance required, and hours in operation. But unfortunately, due to primarily political reasons, the system was only operated intermittently and for only a short amount of time. Specific performance data that was collected happened at various flow rates over approximately 500 hours. Since the system was not operated continuously over many months and with the bedload transport continuing when the system was not in operation, short-term stream bed elevation and coarsening impacts were overwhelmed. Therefore, stream bed elevation was not resurveyed at the end of the project.

Figure 5. Electronic control panel with sand washer in background.

Record breaking rainfall in September 2011 resulted in extreme flooding and record creek flows of 13,800 ft^3/s (390 m^3/s). High water damaged the junction box, causing total down time of about 2.5 months while the City of Pueblo worked to get a repair contract executed. This flood demonstrated survivability of the system in an extreme event. Repair time was less than one day, once the repair contract was executed. Winterization (heat tracing and freeze protection) was not specified and the system was not operated for about 2 months during the winter months.

Production rate was the key performance parameter measured. Prior to installation of the 30 ft (9 m) long bedload collector, a 2 ft (0.6 m) long bedload collector (shown in Figure 6 left) was temporarily installed in Fountain Creek to estimate bedload transport extraction rates and assess optimal elevation for collector operation. The 2 ft (0.6 m) collector pumped sediment into a drop box (Figure 6 right) that, in turn, allowed a 3 ft^3 (0.08 m^3) container to be filled with the subsequent fill time noted to calculate a production rate. Sediment was collected over a three day duration with extraction rates at respective stream flows listed in Table 1. Assuming a linear extraction rate function for a longer collector, respective production rates were estimated for a 30 ft (9 m) long collector and listed in Table 1 as well.

Figure 7 plots maximum production rate vs. creek discharge for all data collected, with a second order polynomial trend line fit to the data. These production rate values were not independently verified by the USACE. Excluding the September 2011 flood, the range of discharge rates captured represents the typical range expected at this site during any year. The figure shows the dependence of bed load on discharge. The estimated production rates in Table 1 (based on the 2 ft (0.6 m) collector extraction rates) agree well with the production curve in Figure 7 at the lower flow rates of 100 and 120 ft^3/s (2.8 and 3.4 m^3/s), but less so for the 600 ft^3/s (17.0 m^3/s) flow rate condition. Peak measured production rate for the 30 ft (9 m) Collector is 100 yd^3/hour (77 m^3/hr). Hypothetically, at this rate of creek discharge, if a single 30 ft (9 m) collector could be operated continuously for a year with sufficient bedload available, it would harvest approximately 876,000 yd^3 (670,000 m^3).

Visual inspection of the hopper and other system components were made at least monthly over the course of the year. No significant wear or corrosion is shown on any parts although the urethane coating on the mild steel hull did sustain scouring and erosion. No repairs have been required other than those associated with initial system configuration, as a result of the flood in September 2011, and vandalism that damaged the power and control conduit leading to the dredge pump. Additional automation and instrumentation were added with the return water tank that included a variable level control and high-level switch that assisted with balancing the system.

Figure 6. 2 ft (0.6 m) collector (left) and drop box (right) used to estimate production rates.

Table 1. Measured 2 ft (0.6 m) collector and estimated 30 ft (9 m) collector extraction rates.

Stream Flow		2 ft (0.6 m) Collector Bedload Extraction Rates		Estimated 30 ft (9 m) Collector Bedload Extraction Rate	
(ft^3/s)	(m^3/s)	(ft^3/min)	(m^3/min)	(yd^3/hr)	(m^3/hr)
120	3.4	3.0 ft^3/26 min	0.08 m^3/26 min	2.8	2.1
100	2.8	3.0 ft^3/38 min	0.08 m^3/38 min	2.6	2.0
600	17.0	3.0 ft^3/6 min	0.08 m^3/6 min	16.7	12.8

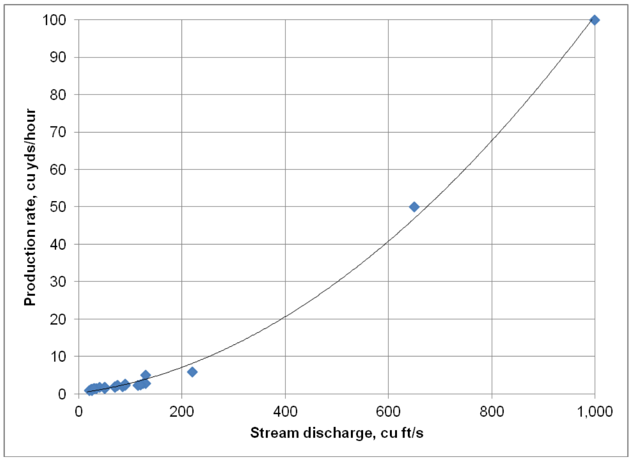

Figure 7. Fountain Creek Bedload Collector production curve.

Demonstration Project Cost

Component, installation, and total approximate cost of the system installed at Fountain Creek is shown in Table 2. The project was championed by the City of Pueblo and funded through EPA 319 (Colorado Department of Pueblo Health and Environment, Non-Point Source Office), Pueblo County, Natural Resources Conservation Service (NRCS), and Colorado Water Conservation Board (CWCB) in collaboration with Streamside LLC.

Costs shown in Table 2 are approximate and intended to be representative of the actual system cost. Various others have reported the cost to range from $600,000 to $1,000,000, although details associated with the higher estimates of cost are unavailable.

Table 2. Approximate Fountain Creek Bedload Collector cost.

Collector (pumps, controllers, pipe, etc.)	$419,000
Radial stacker	$39,000
Installation	$110,000
Approximate cost of contract documents	$50,000
Upgrades/repairs	$10,000
Total	$628,000

Cost of operating the system was minimal since it was only operated for a short period of time. While the system was capable of being operated remotely; however, because of potential risk to human safety associated with the sand washer and radial stacker, the system was only operated under direct supervision. The system used about 1,000 Watts per hour (1kWh) per minute of operation. If the system were run continuously for 1 year, electricity cost would have been approximately $52,560 (based on cost of $0.10/kWh).

CUYAHOGA RIVER, INDEPENDENCE, OHIO

The next Bedload Collector system was installed on the Cuyahoga River in Independence, Ohio (as indicated by the red arrow in Figure 8) by Kurtz Bros. Inc., The Port of Cleveland, and Streamside LLC. Kurtz Bros. Inc. is a Cleveland area company that supplies bulk landscape material and offers services related to recycling, construction waste disposal, and the environment. The Port of Cleveland received a grant from the Ohio Environmental Protection Agency and the Ohio Department of Natural Resources to facilitate installation of the system and collects a royalty on harvested material,

While this installation, installed 14 July 2015 also consists of a 30 ft (9.0 m) Bedload Collector, there are a number of modifications compared to the Fountain Creek plant. The same 50 hp (37 kW), submersible VFD 6 in (150 mm) diameter discharge pump is being used to transport slurry into the sand washer, but instead of being mounted inside the Bedload Collector, it is mounted in a land-based wet well pumping station (reducing static suction lift) to improve pump efficiency by increasing net positive suction head available and also reduce priming issues. Access to the precast concrete vault used to house this pump can be observed in Figure 9. This version of the Bedload Collector is also equipped with a screen deck flushing system. A separate water intake feeding a 3 in (76 mm) diameter discharge pump transports water to a screen deck flush manifold to provide a jetting array for minimizing blinding from oversized material laying on top of the screen.

The sand washer, as shown in Figures 9 and 10, was also modified. This version is skid-mounted with a scalping box added to minimize slurry entrance velocities into the washer tub to enhance separation efficiency. A 1,200 gallon (4.5 m^3) overflow sump was added to collect effluent water from the washer tub. This water is pumped through a separate 6 in (150 mm) diameter pump powered by an overhead-mounted electric motor (as shown in Figures 9 and 10) and is used to provide injection water back into the Bedload Collector to create a closed cycle operation. A similar-sized (compared to Fountain Creek) radial stacker is used to stockpile sand output from the sand washer.

The system control panel is mounted under the sand washer inside a stainless-steel enclosure. Operation can be fully automated with auto sequencing and cycle operation features without an onsite operator based on input of river stage from a United State Geological Survey (USGS) gauging station. A budget of approximately $1.2 M covers plant engineering, equipment, installation and operation and maintenance for a two year pilot project. Production has seen events with removal of sand at 8,600 lbs/min (3,900 kg/min), or assuming 2,620 lbs/yd^3 for dry sand (1,555 kg/m^3) is approximately 3.3 yd^3/min (2.5 m^3/min).

Figure 8. Cuyahoga River Bedload Collector location map.

Figure 9. Cuyahoga River shore-based plant with concrete access port to pump wet well in foreground.

Figure 10. Skid-mounted sand washer with scalping box, overflow sump, injection water pump, and control panel.

GALVESTON ISLAND, TEXAS

Galveston Island is a tourism driven economy, primarily a beach tourism economy with over 6.4 million visitors a year to Galveston’s sand starved beaches. The majority of Galveston’s beaches are eroding with erosion rates approaching -5 to -10 ft/yr (-1.5 to -3.0 m/yr). Due to its proximity to the Houston metro area - the 4th largest population center in the country the barrier island is experiencing an ever-increasing demand for recreational experiences on Texas’s public beaches.

The Fountain Creek and Cuyahoga River harvesting projects both applied the Bedload Collector in riverine flow applications where unidirectional flow is the primary sediment transport driver. This section describes an ongoing investigation being conducted on Galveston Island to evaluate this technology’s performance as a beach sediment bypass and/or backpass management option where directionally variable waves and currents drive sediment transport processes. Participants in this investigation include the Galveston Park Board of Trustees, Streamside LLC, Freese and Nichols Inc., USACE Galveston District (SWG) and Engineer Research and Development Center (ERDC), and Texas A&M University. Objectives of this Galveston Island project are to demonstrate this system’s capability to excavate sand being transported by waves and longshore currents, select a harvesting location, and design a Bedload Collector system that would provide dewatered sand for use by the Galveston Park Board of Trustees to help maintain the quality of Galveston Island’s beaches. Field data, including scale sampling of bedload transport rates and wave and current data, were collected during summer and winter conditions in support of this effort.

Galveston Island Field Data Collection

Scale Sampling of Bedload Transport Harvesting Rates

Similar to Fountain Creek, a 2 ft (0.6 m) long Bedload Collector was temporarily deployed at various times in three locations on Galveston Island to demonstrate this technology’s proof of concept and estimate bedload transport harvest rates. But, because the Bedload Collector was deployed in a coastal environment where directionally variable waves and currents drive sediment transport processes instead of riverine unidirectional flow, a significant number of observations were made on the collector’s operational performance relative to the changed (and more complex) hydrodynamic environment.

The 2 ft (0.6 m) long Bedload Collector (see Figure 11) was deployed on Big Reef Beach from 19 - 24 July 2017, San Luis Pass 25 - 27 July 2017, and on Stewart Beach 4 - 6 December 2017 (see locations 1, 2, and 3 respectively in Figure 12). Personnel from the Park Board of Trustees of the City of Galveston, Streamside LLC, Freese and Nichols, SWG, and ERDC, were in attendance during all these deployments. To investigate the optimization of harvest rates, the Bedload Collector was positioned; 1) at various locations in the cross shore profile ranging from as deep as physical labor would safely allow up to the swash zone, 2) at different elevations relative to the sand surface, and 3) because this particular collector has a preferred orientation in a riverine unidirectional flow (end of collector with ruler in Figure 11 is oriented facing into current flow) it was deployed at various compass orientations as well.

After the collector was positioned as described above, its suction port was connected to a 2 in (50 mm) diameter slurry pump’s suction via a non-collapsible suction hose (see Figure 13). The pump’s discharge was then connected to a sediment settling tank via another 2 in (50 mm) diameter hose. When the pump was turned on, sediment inside the collector’s hopper was entrained and transported through the pump as a slurry and subsequently deposited in the settling tank where the sand’s relatively higher density caused it to settle to the bottom of the tank while carrier water was discharged as overflow from a separate port at the tank’s top. After a timed pumping duration, settled sediment was removed from the bottom of the tank through a ball valve-controlled port and its volume subsequently measured. During the initial summer runs on Big Reef Beach, the pump was intermittently turned on and off to allow the collector’s hopper to fill with sand in between active pumping cycles, but this pumping schema was soon changed to keeping the pump constantly on and it’s discharge inserted into the settling tank for a one-minute duration (approximate time it took to fill the tank completely with slurry).

Figure 11. 2 ft (0.6 m) long Bedload Collector deployed on Galveston Island with harvested sand.

Figure 12. Deployment sites of the 2 ft (0.6 m) long Bedload Collector during summer and winter test periods with stars indicating location of hydrodynamic instrumentation array. Big Reef (summer) at site 1, San Luis Pass (summer) at site 2, and Stewart Beach (winter) at site 3.

Figure 13. Scaled Bedload Collector pumping circuit (this trial being conducted at Big Reef Beach).

This procedure was continued throughout the remainder of the rest of the field deployments. The manner with which sediment was collected from the tank also changed. Initially the settled sediment was collected in 5 gallon (3.8 liter) buckets but as the fine-grain sand on Galveston beach (d_{50} of 0.178 mm) flowed through the ball valve, noticeable sediment losses occurred when the overlying free water (in the tank) surged out of the tank and buckets. Filter cloth containment was subsequently employed in conjunction with the buckets to minimize these losses. Sand sample volumes collected during the one minute harvesting durations at San Luis Pass (indicated in orange) and Stewart Beach (indicated in green) are presented in Figure 14.

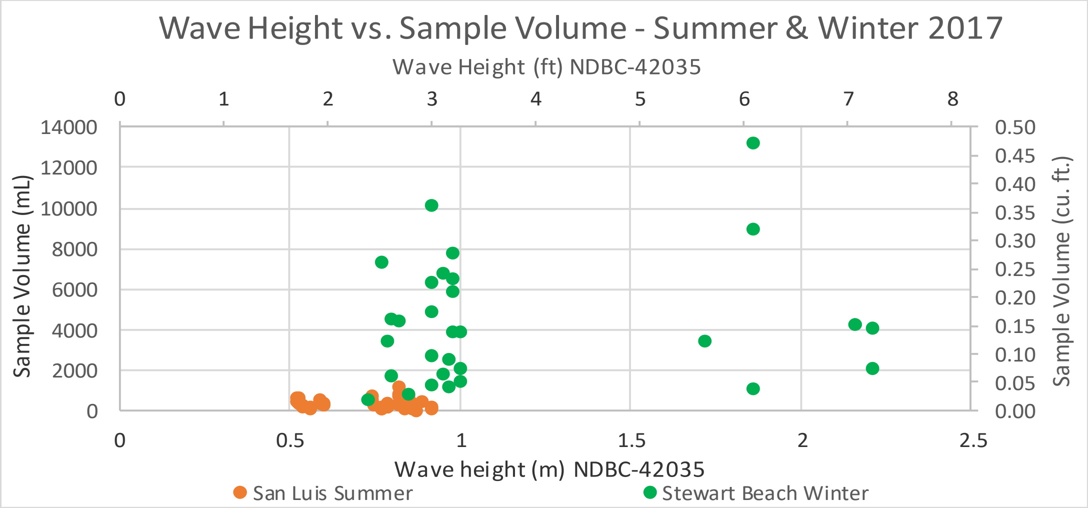

Figure 14. Sand sample volumes collected during one-minute harvesting durations at San Luis Pass (summer) and Stewart Beach (winter).

Nearshore Hydrodynamic Data Collection

Nearshore hydrodynamic data were collected by Texas A&M University during both the summer and winter tests. These data were collected by a Nortek Vector acoustic Doppler velocimeter (ADV) mounted vertically in the inner surf zone of Galveston Island (see Figure 15) during concurrent and collocated bedload collection efforts. Measured surf zone hydrodynamics were correlated with bedload collection rates to facilitate any future efforts in upscaling to a prototype sand back-passing system for Galveston Island. The ADV provides three-dimensional current velocity information at a single point in the water column. The system also includes an internal pressure sensor located at the bottom of the instrument housing, approximately 20 cm above the velocity measuring volume. The summer deployments included two Campbell OBS-3+ optical backscatter sensors (OBS) placed at different elevations in the water column to track suspended sediment concentration (SSC). All measurements were obtained with a sampling frequency of 16 Hz. While advantageous to collect hydrodynamic data at locations collocated with the bedload collection system, it is noted that such data collection comes with added difficulty ensuing from inner surf zone dynamics. Very shallow water depths, turbulent bores from broken waves, irregular short-crested wave fields, and generally, dynamic conditions with high probability of bubble entrainment and potential subaerial sensor exposure combine to make this a difficult spot to collect the desired information.

These data, in conjunction with National Oceanographic and Atmospheric Administration (NOAA) Meteorological Observation stations wind velocity and direction data, and NOAA Tides and Currents stations tide data, were analyzed to provide a comprehensive comparison of hydrodynamic conditions and collector configurations with bedload sediment collection as measured during various tests.

Figure 14. Doppler velocimeter (ADV) and optical backscatter sensor array collecting data at Big Reef Beach.

An example of reduced hydrodynamic data, coupled with (NOAA) data is illustrated in Figure 15 that consists of a summary of direction and magnitude data for currents and winds at Stewart Beach on 6 December 2017. Current direction and magnitude were calculated from measured cross-shore and alongshore velocity components, and wind direction and magnitude were provided by NOAA Station 8771972.

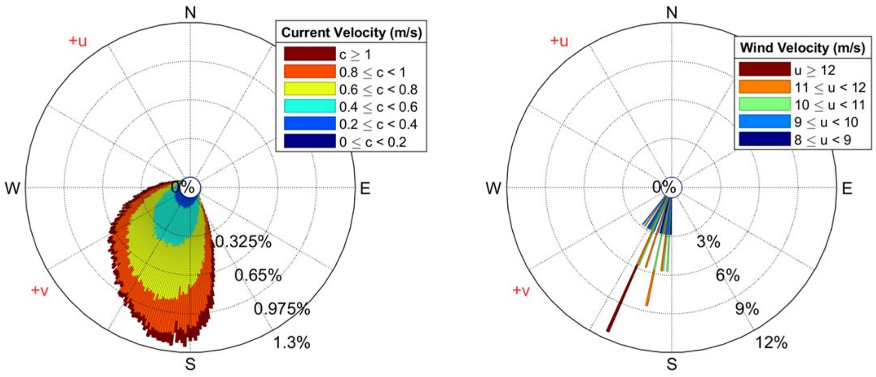

Figure 15. Current (left) and wind (right) rose data for the third day of the Stewart Beach deployment 6 December 2017.

Figure 16 provides another example of reduced data; at the cross-shore velocity (panel a), longshore velocity (panel b), combined current velocity (panel c), combined current average direction (panel d), wind velocity (panel e), and wind direction (panel f) for the Stewart Beach deployment 4 - 6 December 2017.

Some preliminary results from analyses of these types of data indicate that bedload collection rates appear to be linked with configuring collector orientation orthogonal to the longshore current. This recommendation stems from the shore-perpendicular trials performing slightly better than shore-parallel (5-10% higher bedload collection rates), coinciding with stronger longshore velocities corresponding to higher bedload collection rates. The collector burial depth aspect is another parameter to consider, although there were obvious physical limitations with taking the collector to depth during trials and results from these two deployments were not conclusive.

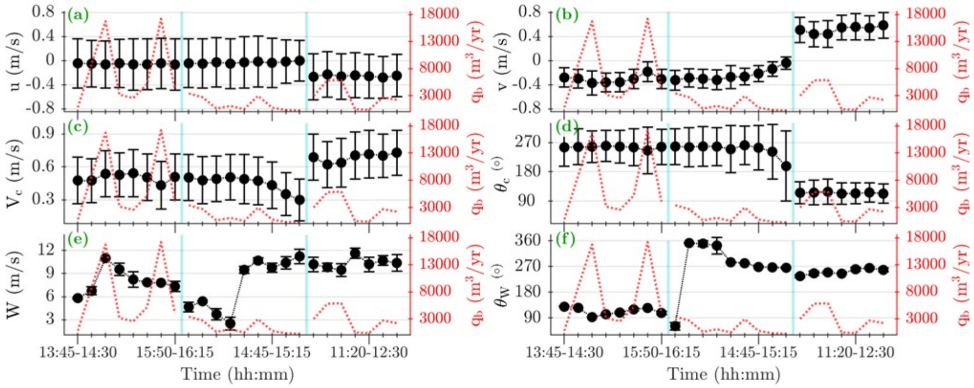

Figure 16. Wind and current statistics for 4 - 6 December 2017 of the Stewart Beach deployment. Days separated by a vertical blue line.

Preliminary Design of the Galveston Island Bedload Collector System

This section describes the preliminary design of the Galveston Island Bedload Collector system as of the date that this paper was submitted. Upon consideration of the reduced field data collection results to gain insight on sand transport processes and respective collector harvest rates, coupled with the logistical requirements of shore-based equipment, sand storage, and subsequent transport, it was decided that the location of a sand bypassing/backpassing plant would be located at East Beach. East Beach, as indicated by the red star in Figure 12, is situated between Stewart Beach and Big Reef Beach

During the field data collection efforts (particularly in the winter period), a number of physical phenomena were observed on how the 2 ft (0.6 m) collector interacted with the surf and swash zone sediment transport processes. These observations provided insights on ways to potentially improve its harvesting rates. The hydrodynamic forces imposed on the fine sand particles by waves and tidal currents caused a very significant volume of this suspended sediment to pass over (as opposed to depositing inside) the collector's hopper. To try to optimize capture efficiency of a full-scale Bedload Collector, Streamside LLC redesigned the marine unit that increased the grate width distance by a factor of 6.6 times that of the riverine units previously described. An engineering drawing of the modified 20 ft (6 m) long marine design is provided in Figure 17. Based on the 2 ft (0.6 m) collector harvesting rates measured at Stewart Beach, the annual harvesting rate of the 20 ft (6 m) long marine Bedload Collector deployed at East Beach is currently estimated to range between 30,000 yd^3/yr to 50,000 yd^3/yr.

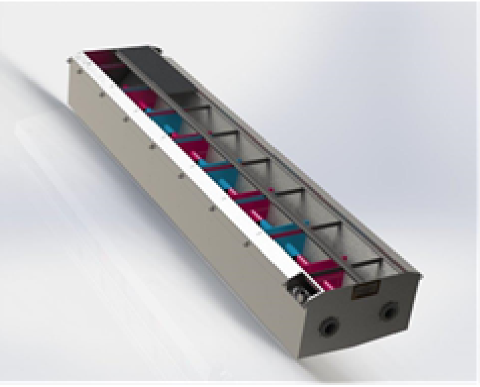

Figure 17. Bedload Collector marine design for Galveston Island.

To build flexibility into the full scale harvesting plant’s operational methodology, a semi-mobile sand bypassing/backpassing plant design approach is being taken. In consideration of that approach, Streamside LLC’s re-design included controllable buoyancy and self-jetting capacities to facilitate its installation into, and retrieval from, the surf and swash zone.

At the present time, it is envisioned that two independent Bedload Collector pumping subsystems would transport slurry into a common sand washer/radial stacker terminal as indicated in the Figure 18. This plan view with one collector oriented shore-parallel, and the other shore-normal, illustrates an advantage inherent to the semi-mobile design approach. As the relationships between harvest rates and collector parameters such as location/orientation/and burial depth are established relative to the respective hydrodynamic regime, implementation of active adaptive management (AM) will optimize sand throughput rates because the collectors can be (within limits) moved around and reoriented. The pumping stations (consisting of two submersible pumps each to provide collector suction and water injection) would be installed in wet wells enclosed in precast concrete vaults. Like the Cuyahoga River plant, this configuration will reduce static suction lift to optimize effective suction pumping lengths. This configuration will also help protect these plant components in the event of a hurricane.

Due to concern for potential clogging of suction and/or injection ports and pipelines, each Bedload Collector subsystem is designed with cleanout ports and back-flushing capabilities. The conceptual diagram shown in Figure 19 provides a graphical view of these design aspects as well as others that are currently being addressed in more detail in the preliminary design process.

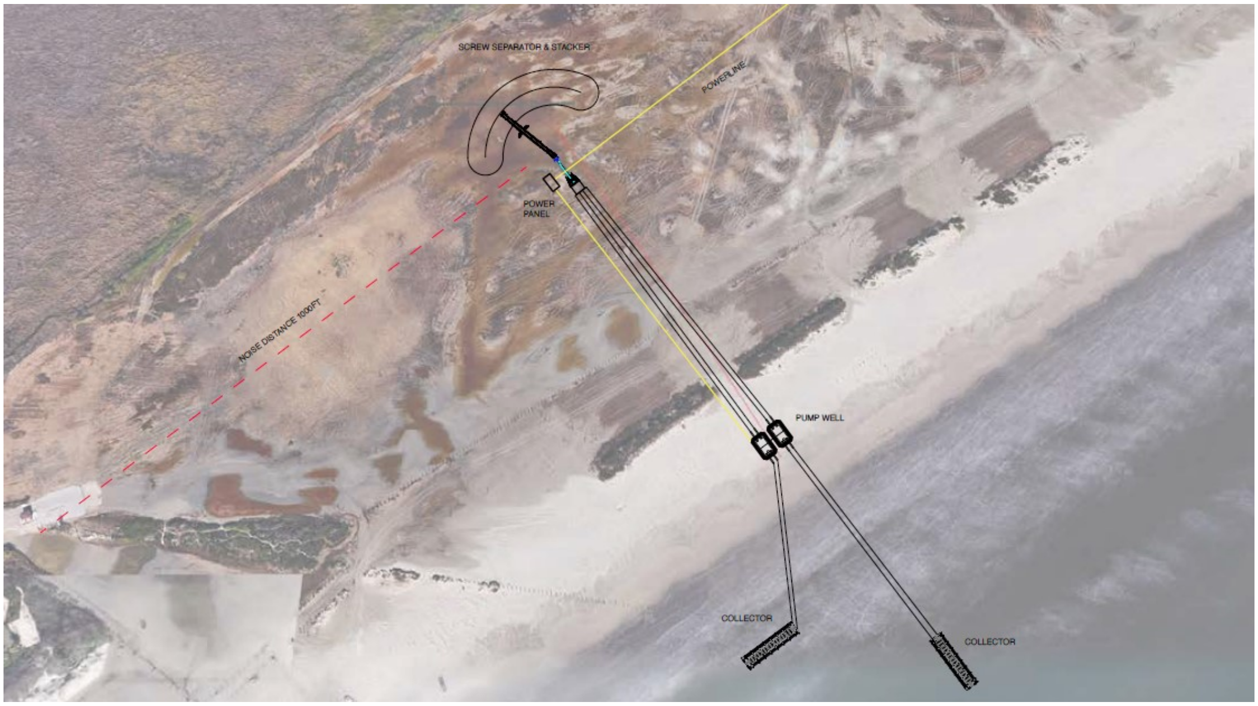

Figure 18. Preliminary design plan view of the Galveston Island Bedload Collector sand harvesting plant.

SUMMARY

The Bedload Collector is a new technology that operates on the principle that bedload sediment can be harvested by gravity and excavated at the natural rate of transport. This technology has been successfully used in riverine flow applications in Fountain Creek, Pueblo, CO, and Cuyahoga River, Independence, OH, where unidirectional water current is the primary sediment transport driver. This paper presented an update on these riverine applications and describes some preliminary results of an investigation conducted on Galveston Island to evaluate this technology’s performance as a beach sediment bypass and/or backpass management option where directionally variable waves and currents drive sediment transport processes in the nearshore zone. Field data, including scale sampling of bedload transport rates and wave and current data, were collected during summer and winter conditions in support of this effort. Details of a preliminary design (as of the time this paper was submitted) for a Galveston Island Bedload Collector sand harvesting plant were also presented to illustrate the evolution of this technology from riverine to marine applications.

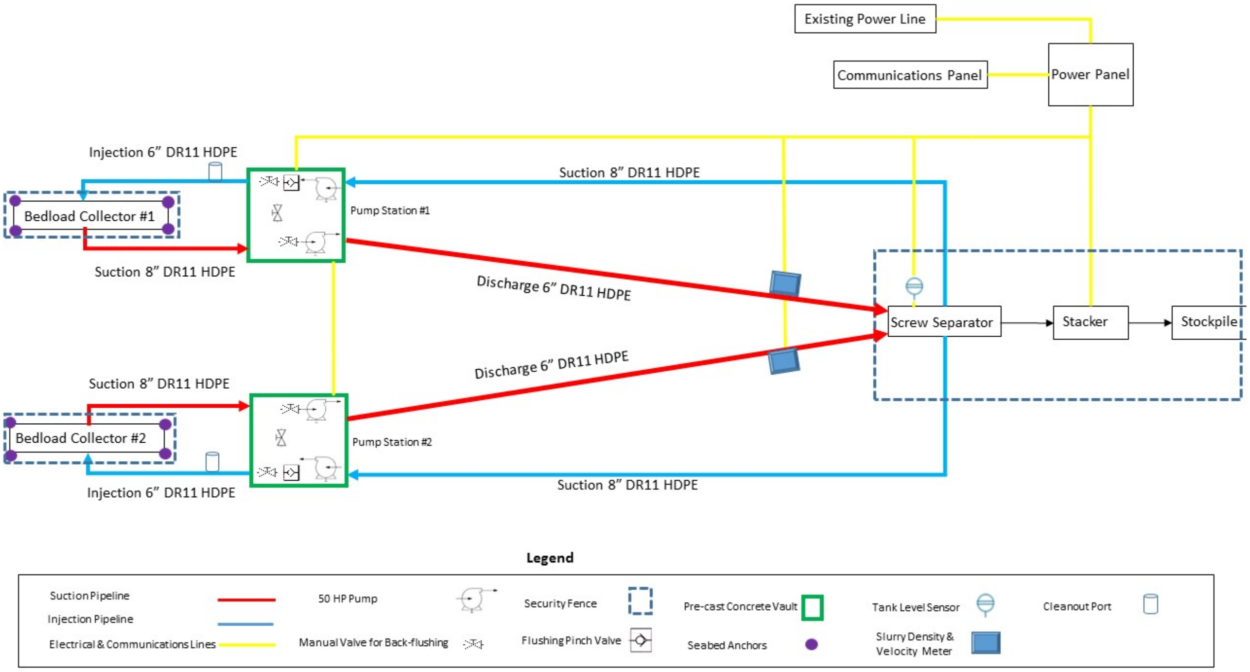

Figure 19. Conceptual diagram of the Galveston Island Bedload Collector sand harvesting plant.

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CITATION

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