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Horsham, Pennsylvania 19044
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Memorandum

October 11, 2021

To: Mayor Kathy Lock, Town of Slaughter Beach

From: Steven Bagnull, Zach Burcham, and Ram Mohan, PE, PhD, F. ASCE., Anchor QEA

cc: Tony Pratt, Consultant

Re: Town of Slaughter Beach: Shoreline Detritus Management Study

Introduction

Anchor QEA, LLC, was retained by the Town of Slaughter Beach (Town) to evaluate management options for the accumulation of organic detritus along the Town's shorelines along Delaware Bay. The presence of the detritus is a persistent issue along northern portions of the Slaughter Beach shoreline, which has been well-documented over the past 30+ years. The magnitude, extents, and accumulation patterns have varied over time and the buildup impairs sensitive beach habitat and restricts safe recreational use of the area. Our study began with a site visit and subsequent site topographic survey to determine the nature and extent of detritus material along the beach. We also conducted an extensive review of available site-specific literature, including prior studies on nearby waterbodies as well as regional hydrodynamic data. Using the existing literature, we formed a preliminary conceptual model of the hydrodynamics and detritus accumulation along the beach. We then evaluated options for detritus removal and disposal, as well as options for beneficial reuse, and identified specific requirements associated with the material management options. During investigation of beneficial reuse options, our coordination with a local composting facility identified a new disposal option capable of accepting the material and that is now fully permitted by Delaware Department of Natural Resources and Environmental Control (DNREC) to receive the detritus. A preliminary engineer's cost estimate is also included as part of this memorandum, and suggestions for next phase engineering studies are outlined. The Town of Slaughter Beach funded this evaluation, with a portion of the funding being provided by a DNREC Bayshore Initiative Grant.

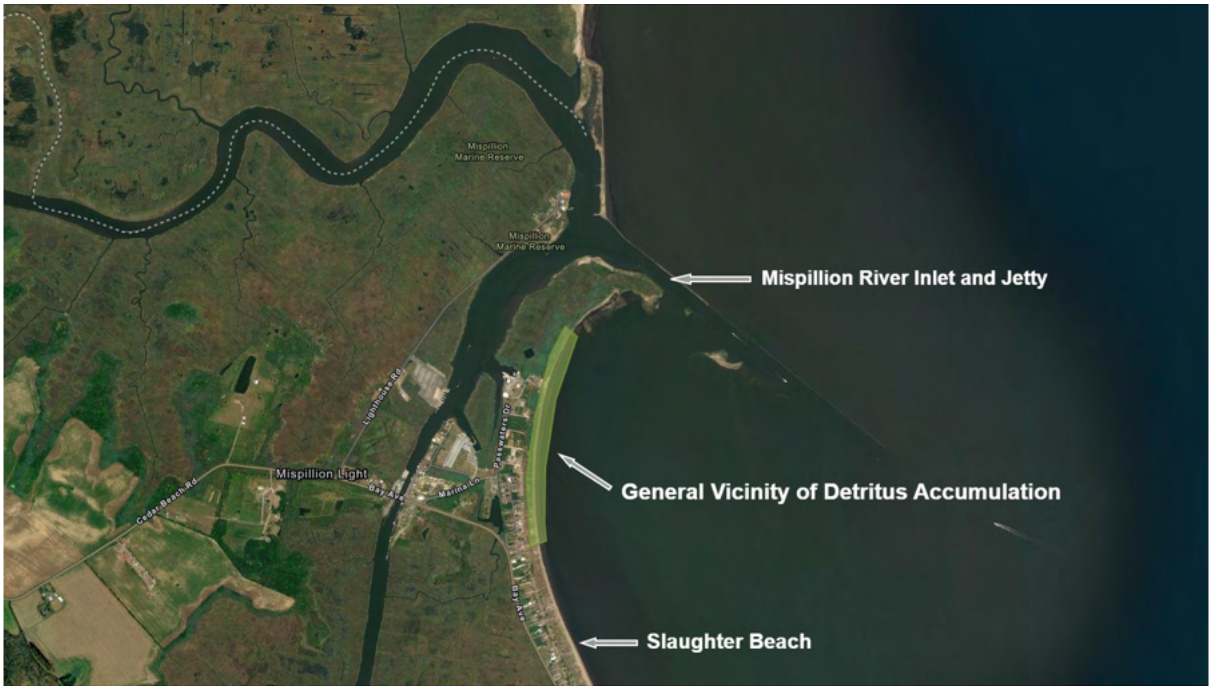
Site Conditions

Historical aerial imagery provided through the DNREC FirstMap database[1] suggests heavy accumulation of detritus along the northern portion of Slaughter Beach has been occurring for more than 30 years and has more recently expanded southward along the coastline. Just north of the accumulation area is the mouth of the Mispillion River and Cedar Creek. A timber jetty constructed by the U.S. Army Corps of Engineers in 1859 (North Jetty) and 1908 (South Jetty) exists along the Mispillion River's mouth and protects the navigation channel to the deeper waters of the Delaware

[1] DNREC, 2021. FirstMap. *Delaware.gov*. Accessed October 20201. Available at: https://firstmap.delaware.gov/

River. The jetty has subsequently been lengthened and repaired, most recently in 1987.[2] The general vicinity of detritus accumulation and overall project area is shown in Figure 1.

Figure 1
Site Vicinity and Organic Detritus Area



Source: Delaware FirstMap

The accumulated material is primarily fragmented marsh vegetation detritus and marine seaweed. Sparse anthropogenic debris was present throughout the accumulated material. The width of the material accumulation perpendicular to shoreline varied along the beach and generally included drier materials stacked at higher elevations, more saturated materials in intertidal areas, and fully saturated materials along the water's edge (see Figures 2 and 3). Underlying the detritus is natural sand beach material.

[2] Moffat & Nichol, 2008. *Coastal Engineering Assessment of Habitat Restoration Alternatives at Mispillion Inlet*. Prepared for DNREC. January 2008.

Figure 2
Site Conditions

Source: Anchor QEA

Figure 3
Detritus Materials

Source: Anchor QEA

Dozens of dead or partially buried, living horseshoe crabs were also observed throughout the accumulated material, (see Figure 4). Horseshoe crabs seek sheltered, sandy areas of coastlines for breeding[3] and the detritus matrix was visibly entangling the live organisms during an April 2021 site visit. These observations are consistent with those previously documented by the Town.[4] The mouth of the Mispillion River Harbor and immediately surrounding area is one of the most significant breeding grounds for horseshoe crabs in the world and impacts to these species also affect shorebirds that prey on the horseshoe crab eggs, such as the federally threatened red knot.[5] In certain locations, invasive Phragmites located along the shoreline dune system was also spreading to

[3] U.S. Fish and Wildlife Service, 2006. The Horseshoe Crab: Limulus polyphemus, A Living Fossil. Available at: https://www.fws.gov/northeast/pdf/horseshoe.fs.pdf.

[4] Town of Slaughter Beach, 2018. Town of Slaughter Beach Comprehensive Land Use Plan. August 2018. Available at: https://slaughterbeach.delaware.gov/files/2019/02/8-18-2018-Draft-CLUP-submission-August.pdf.

[5] DNREC, 2021. Horseshoe Crabs, Shorebirds and the Delaware Bay. *Delaware.gov*. Accessed October 2021. Available at: https://dnrec.alpha.delaware.gov/fish-wildlife/education-outreach/dupont-nature-center/horseshoe-crabs-and-shorebirds/

the accumulated material (see Figure 4). The Town is actively working to manage Phragmites along shoreline areas.[6]

Figure 4
Horseshoe Crab Impacts and Phragmites Conditions

Source: Anchor QEA

Detritus Survey and Volume Estimate

In order to quantify the limits, thickness, volume, and potential disposal weight of detritus, Anchor QEA utilized a surveying subcontractor, PLITKO, LLC, to perform a shoreline and intertidal topographic survey. In addition to providing necessary information for future management options and costs, the completed survey will also serve as a baseline for future detritus accumulation comparisons. The survey was performed at low tide on April 19, 2021, using Real-Time Kinematic (RTK) GPS. The limits of the survey generally extended from the toe of dune grasses to the shallow subtidal area where accumulated detritus dissipated into sedimentary shoreline materials (predominantly mucky fine grained materials overlying sand). Transects along which elevations were recorded were spaced approximately 100 feet apart. Elevations were obtained at both the top and bottom of detritus, where beach sand was met, to provide thickness measurements for volume calculations performed in CAD software. A topographic map depicting the limits, elevations, and thicknesses of the detritus is provided in Attachment 1.

At the time of survey, detritus was present across approximately 5 acres of the shoreline and was as much as 3.5 feet thick. The calculated total volume of material is approximately 5,000 to 5,500 cubic yards (CY). The corresponding total bulk weight of highly organic material can vary widely depending on the moisture content of the material. For the purposes of this analysis and the costing effort described later in this document, it has been assumed that any off-site management of material would follow a drying process during which material would be pushed to higher elevations of the

[6] Town of Slaughter Beach, 2021. Phragmite Eradication. Slaughter Beach Delaware. Accessed October 2021. Available at: https://slaughterbeach.delaware.gov/phragmite-eradication/.

beach to facilitate dewatering and reduction in tidal inundation or managed at a temporary staging location near Slaughter Beach. Allowing the material to dry and dewater can greatly decrease transport and disposal fees, which are based primarily on material weight. Assuming relatively dry material resulting from passive gravity drainage of free liquids, a bulk density of approximately 0.2 to 0.4 tons/CY (400 to 800 pounds/CY) is expected based on unit weights of comparable materials,[7] resulting in a total bulk detritus weight of approximately 1,000 to 2,000 tons. The project quantities described in this section are summarized in Table 1.

Table 1
Detritus Quantity Summary

Metric	Estimated Quantity
Surface Area	5 acres
Total Detritus Volume	5,000 to 5,500 CY
Total Detritus Bulk Weight[1]	1,000 to 2,200 tons

Note
1. Following gravity drainage of free liquids or other passive dewatering technique.

Material Characterization

During the investigation of material disposal options, we coordinated with representatives from Bioenergy Devco (Annapolis, Maryland) to sample and analyze the detritus material to further understand potential off-site use of the material for compost purposes. On May 24, 2021, a composite sample from the three general zones of accumulation (dry, intertidal, and inundated) was collected and sent to Midwest Laboratories (Omaha, Nebraska) for analysis. The material was analyzed for the following primary parameters: nitrogen, major and secondary nutrients, micronutrients, and other properties such as pH, organic content, and conductivity (soluble salts). A complete listing of the parameters and the corresponding results is provided in Attachment 2.

Visually, the material is a suitable compost material based on its particle size and material type. As described in the Midwest Laboratories report, the material meets acceptable ranges for compost for pH, major nutrients, and organic matter. Although the material met these parameters, the conductivity value (a measure of soluble salts [i.e., salinity]) of 28.8 millisiemens/centimeter does not meet typical criteria for use as a compost. High salt content in compost materials and soils is typically detrimental to vegetation and crops and is therefore closely monitored in such products.[8] For

[7] U.G. Geological Survey, 2018. 2018 Minerals Yearbook. Peat [Advance Release]. August 2021. Available at: https://prd-wret.s3.us-west-2.amazonaws.com/assets/palladium/production/atoms/files/myb1-2018-peat.pdf
[8] U.S. Department of Agriculture Natural Resources Conservation Service, 2021. Soil Electrical Conductivity. Accessed October 20201. Available at: 20https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_053280.pdf.

reference, the maximum conductivity level for material that could be accepted as compost at the Bioenergy Devco Facility in Seaford, Delaware, is 10 millisiemens/centimeter.

Reduction in soluble salts content is feasible through methods that involve washing of the material through either natural or managed actions (e.g., precipitation or active irrigation). Additional laboratory or field sampling of the material at different elevations along the beach profile, rather than as a composite across multiple ones, may provide further insight on the feasibility of soluble salts reduction. Material at higher elevations that is less saturated with bay water and that has been exposed to direct precipitation may be more representative of materials actively managed to reduce salinity.

Site Conceptual Model

Slaughter Beach is a barrier beach with widths ranging from 350 feet to 500 feet and bordered by wetlands (southwest) and the Delaware Bay (northeast). The current of detritus accumulation is prevalent along the northern beach and extends to the southern beach due to the continued action of waves. Detritus material is present in suspension in the water column along the shallow nearshore areas of the bay, and the incoming tides and waves continue to push the detritus onto the beach, where they eventually settle. This ongoing presence of suspended detritus continues to be one of the major challenges in maintaining a clean sand beach into the future.

Prior studies[9] indicate that the dominant transport direction is northerly towards the Mispillion Inlet (see Figure 5). This transport has since been altered by the construction of the jetties, which interrupts the transport pattern into the inlet. The detritus material likely originates from nearby marshes inland of Delaware Bay (from sources such as Milford Neck Wildlife Area and Marvel Tract Salt Marsh, Prime Hook National Wildlife Refuge, and the State Wildlife Management Area) and is transported via Cedar Creek and Mispillion River into the Delaware Bay. The transported material either exits at the terminus of the jetty or through the gaps within the jetty, and the low-energy conditions created by the sheltering effect of the jetty creates ideal conditions for the detritus material to settle along the northern portion of Slaughter Beach shoreline. The prevailing winds and currents further aid this pattern, and the net result is a southerly expansion of the detritus field over time, as the Town has been experiencing. Detritus material may also be originating from elsewhere in the Bay where northernly transport carries the material until the curved embayment created by the existence of the jetty traps the material.

[9] Maurmeyer E.M., 1978. Geomorphology and Evolution of Transgressive Estuarine Washover Barriers Along the Western Shore of Delaware Bay. PhD Thesis, University of Delaware. June 1978.

The PBS&J study[10] notes that the jetties along the Mispillion River alter the incoming wave climate and create a sheltering effect along the northern shoreline of Slaughter Beach. This seems to support the predominant detritus field present along those shorelines, and the seemingly southerly expansion of the detritus field over time. However, a study by Moffatt & Nichol,[11] which included a wave and hydrodynamic model as well as a sediment transport model, concludes that the south jetty would not have a quantifiable effect on habitat conditions along the surrounding environs. Notably, the study did not closely examine conditions along Slaughter Beach. The subsequent 2010 Delaware Bay Beach Management Study conducted by PBS&J examined current patterns and sediment transport along Slaughter Beach and concluded that prevailing currents would transport sediments and detritus in a general northerly direction, with the jetty influencing that transport (See Figure 6). This could explain why the material, once built up along the northern area, is continuing to travel south, from that location.

Summarily, several hydrodynamic and local conditions affect the potential creation, transport, and deposition of detritus material along Slaughter Beach, with some uncertainties present in all studies and associated theories. We recommend that an updated hydrodynamic model, specific to Slaughter Beach and nearby environs, be created as part of the detailed engineering design phase of this project to incorporate the latest field data and other studies, including updated topography and a more refined grid encompassing the study area. An updated model would be beneficial for developing a long-term detritus management plan for the Town.

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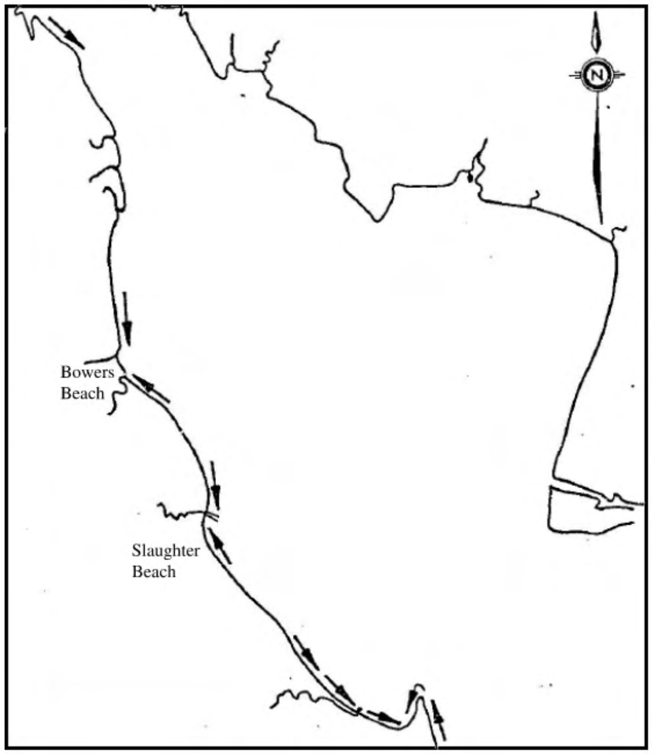
[10] PBS&J, 2010. Management Plan for the Delaware Bay Beaches. Final Report. Prepared for Delaware Department of Natural Resources and Environmental Control, Division of Soil and Water Conservation, Shoreline and Maritime Management Section. March 2010.

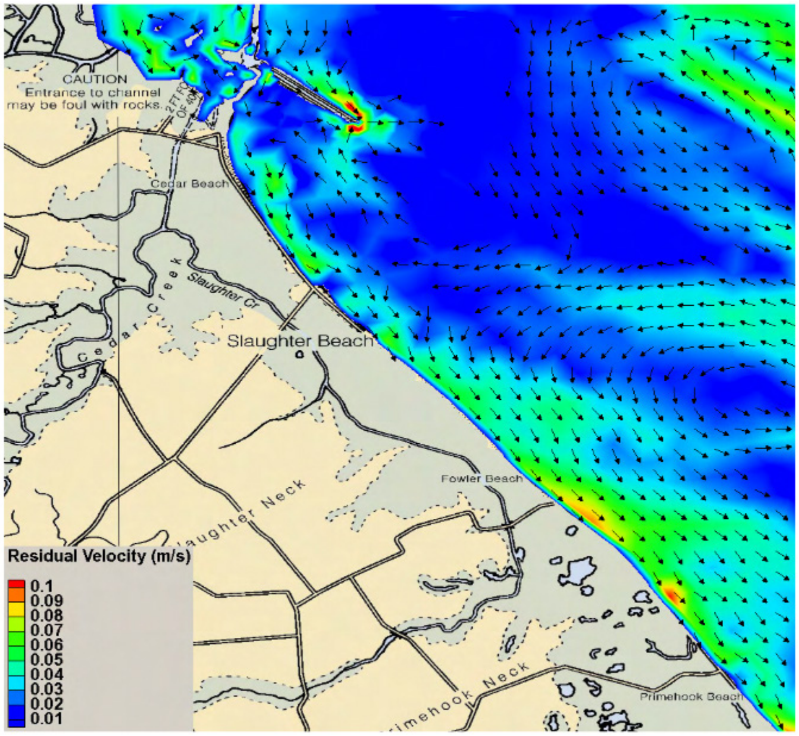
[11] Moffatt & Nichol, 2008. Coastal Engineering Assessment of Habitation Restoration Alternatives at Mispillion Inlet. Mispillion Inlet. Sussex County, Delaware. Prepared for Delaware Department of Natural Resources and Environmental Control (DNREC). Final Report. January 22, 2008.

Figure 5
Observed Longshore Sediment Transport Directions (Maurmeyer 1978)



Source: PBS&J 2010

Figure 6
Residual Currents in the Slaughter Beach Area; Modeled Average Conditions (PBS&J 2010)



Source: PBS&J 2010

Preliminary Evaluation of Removal and Disposal Options

Following assessment of site conditions and available literature, Anchor QEA explored options for initial removal operations, material disposal, off-site beneficial reuse, and on-site beneficial reuse. Identification of potential off-site disposal options included review of currently permitted solid waste facilities[12] and coordination with composting/recycling facilities in the region. Under off-site disposal options, material would need to be consolidated on the beach using typical beach maintenance construction equipment such as front loaders and bulldozers, loaded into haul trucks, and then transported to off-site facilities. As previously mentioned, under any off-site disposal alternative, material should be dewatered and dried to the maximum extent practical to limit moisture/water content in the material, both for receiving facility acceptance and transportation cost optimization.

For the purposes of this project approach and cost evaluation, it has been assumed that an initial clearing program will be sought by the Town to re-establish the desired sandy beach condition. Subsequent maintenance clearing activities should be anticipated, though at a smaller scale and per

[12] DNREC, 2021. Solid Waste Facilities. *Delaware.gov*. Accessed October 2021. Available at: https://dnrec.alpha.delaware.gov/waste-hazardous/management/solid/facilities//

event cost, assuming more routine management is feasible in the future. The potential to reduce future accumulation is discussed later in this memorandum and requires extensive evaluation before a determination on feasibility, practicality, and/or regulatory acceptability can be assessed.

Solid Waste Facilities

The nearest solid waste facility to Slaughter Beach that the material could be disposed at is the Jones Crossroads Landfill, located at 28560 Landfill Lane, Georgetown, Delaware. It is approximately 30 miles east of Slaughter Beach and is the major solid waste landfill for Sussex County. Communications with the Delaware Solid Waste Authority, which operates the landfill, indicated that the detritus material would be assessed at the standard solid waste disposal rate of $85/ton.

Beneficial Use Facilities

Anchor QEA researched several off-site compost options and other pathways for beneficial use. Two off-site local facilities were determined to provide practical opportunities for reuse of the removed detritus.

Bioenergy Devco Facility

Bioenergy Devco operates the Bioenergy Innovation Center located at 28338 Enviro Way, Seaford, Delaware, which is approximately 34 miles southwest of Slaughter Beach. The facility currently accepts various organic materials, primarily wood waste, to use in its compost products. Anchor QEA engaged in extensive conversations and coordination with the facility representatives between May and September 2021 to sample and analyze the detritus material, establish an updated DNREC permit for the facility that specifically identifies the Slaughter Beach material as an acceptable material source, and identify costs for receiving the material. Material can be received at the facility at a rate of $30/ton. Material receipt at the facility would be conditional on meeting analytical requirements including soluble salts levels. The facility also noted that care would be needed when handling the material to limit sand content from the removal process from the beach. Facility acceptance criteria are provided as Attachment 3.

In an effort to achieve allowable soluble salt levels for material receipt at this facility, temporary spreading and staging of the material either along high elevations areas of the beach or other off-site areas may be needed. Further analysis of the drier, exposed materials from higher elevations along the beach or piloting of a natural, precipitation-based rinsing approach would be useful to assess the feasibility of this beneficial use option more fully.

Blessings Blends

Blessings Blends (also called Blessings Greenhouses) is a locally owned composting facility located approximately 5 miles south of the Slaughter Beach (9372 Draper Road, Milford, Delaware 19963). One of its services is a beneficial use program, where waste can be taken in and used as part of compost. The materials must fall within acceptable ranges of several parameters (e.g., pH, total nitrogen, moisture, and soluble salts). Although detailed acceptance parameters for the detritus were not immediately available, though based on preliminary discussion with the facility operator, criteria are expected to be comparable to those required by Bioenergy Devco, which produces compost material for similar uses. For material that meets the facility acceptance criteria, Blessings Blends can receive the material at a rate of $65/ton. Permitting and acceptance criteria at this facility will need further evaluation if the next phase design considers this option.

On-Site Beneficial Use

As an alternative to off-site disposal or composting, one management option that deserves further investigation for technical and regulatory feasibility is to reuse the material as a component of the existing dune system along Slaughter Beach. One such approach could involve placing and compacting the detritus along the shoreward (waterward) side of the existing dunes and covering the material with imported sand. Limited sand excavation near the dune toe to avoid import of sand is assumed to be unacceptable to project regulators. This approach could be used within the municipal limits of Slaughter Beach or negotiated with DNREC to be used along the state-owned Mispillion Harbor Reserve land located between the northern limit of the Town and the Mispillion Inlet. The placement approach would not include disturbance to the existing dune system and would be intended to augment its function (i.e., by widening the dune field, which would also provide increased storm protection to the Town). There is evidence that this process may provide enhanced dune resiliency. A 2015 study by researchers at Texas A&M University (2015) showed that building or restoring dunes with organic matter provided a viable beach management alternative along a coastal area with both short- and long-term benefits. The initial material removal at the studied beach, provided for a wider, recreational beach and improved access as well. In the longer term, the dunes exhibited continued stability, increased erosion resistance, and spurred vegetation growth.[13] Images from the study showing the general dune enhancement approach with organic materials are shown in Figure 7. Although the results of this approach are promising, on-site beneficial use approaches such as dune enhancement would be best incorporated as a pilot component of an initial material removal event to demonstrate proof of concept within the Delaware Bay system and with the detritus materials present in Slaughter Beach. Monitoring of the pilot area would provide further data necessary to seek this approach as part of a large-scale, sustainable strategy for future maintenance events.

[13] Texas A&M University, 2015. Innovative Technology Seaweed Prototype Dunes Demonstration Project – Final Technical Report. September 2015.

Figure 7
Innovative Technology – Seaweed Prototype Dunes Demonstration Project

Source: Texas A&M University

Opinion of Probable Cost

Our review of the multiple material management options determined that the most readily implementable and feasible options for an initial full-scale detritus removal event would be disposal at a solid waste facility or beneficial use at the Bioenergy Devco facility; cost estimates for both approaches were developed accordingly.

Under both alternatives, construction equipment would need to be mobilized to the Slaughter Beach shoreline. Such equipment is anticipated to include front loaders and bulldozers capable of stockpiling the material while separating it from the underlying sand layer. Work would be conducted outside of the late spring/early summer period to avoid impacts to sensitive species (i.e., horseshoe crabs and, red knot). The stockpiling activity should result in temporary staging of the material in higher elevation areas to facilitate drying and dewatering for disposal weight reduction. For the solid waste facility disposal option, the material would then be loaded into on-road haul trucks and transported to the facility.

For the beneficial use facility option, additional handling of the material would be required to facilitate soluble salts reduction. Though this approach requires further exploration of specific handling locations, the material could be managed within available properties at Slaughter Beach, or other nearby areas such as state-owned parcels or facilities (e.g., Slaughter Beach Public Boat Ramp or Dupont Nature Center vacant parcel areas). Material would need to be sampled following adequate precipitation events that provide rinsing of salts to confirm acceptance criteria are met prior to off-site transport. The cost of this additional handling process needs to be less than the cost difference in disposal costs of the available options to make the approach economical. Table 2 summarizes planning level costs for the approaches based on the aforementioned assumptions. Both options conservatively assume the higher end estimate of calculated material weight (2,200 tons) and associated volume (5,500 CY). Costs are based on professional judgement, available data from comparable projects, and the quoted disposal costs from the facilities.

Table 2
Opinion of Probable Cost for Detritus Removal Project

Project Component	Qty	Unit	Solid Waste Disposal		Off-Site Beneficial Use	
			Unit Rate	Total	Unit Rate	Total
Mobilization	1	Lump Sum	$17,000	$17,000	$26,000 to $30,000	$26,000 to $30,000
Recovery and Loading From Beach	2,200	Tons	$15	$33,000	$15	$33,000
Secondary Temporary Staging and Loading*	2,200	Tons	--	--	$10 to $40	$22,000 to $88,000
Transportation	5,500	Cubic Yards	$6	$33,000	$6	$33,000
Disposal Fees	2,200	Tons	$85	$187,000	$30	$66,000
Construction Subtotal (Rounded)	**--**	**--**	**--**	**$270,000**	**--**	**$180,000 to $250,000**
Engineering, Permitting, and Construction Management **	1	Lump Sum	--	$45,000	--	$65,000
Long-Term Beach Management Plan, including Hydrodynamic Model ***	1	Lump Sum	--	$75,000 to $100,000	--	$75,000 to $100,000

Notes:
* Costs associated with secondary temporary staging and loading to be refined following completion recommended bench-scale testing to evaluated efficiency and time requirements of various salt reduction approaches to meet facility acceptance criteria.
** Includes engineering specifications and plan drawings to bid out the project for construction purposes. Does not include further development of the CSM.
*** Includes development of a long-term beach management plan for the Town, including a hydrodynamic model to further refine the CSM so that the mechanics of detritus movement and buildup along the beach, and its relationship to maintenance of the Mispillion jetty, can be evaluated further.
Qty: quantity

Short-Term Management Considerations and Recommendations

Several considerations are provided in this section to further aid the Town in monitoring and managing its beach. They vary from field surveys, observations, to beach management planning involving a numerical model. Finally, opportunities for grant funding are also discussed.

Additional Sampling and Studies

As an immediate next step, we recommend performing additional sampling of higher elevation, relatively dry detritus to further assess the soluble salts content of material that is less frequently inundated and that has had greater exposure to precipitation and flushing. Samples should be collected both at the surface of the accumulation and separately, at depth near the interface with underlying sand. This sampling will provide information that will be useful in evaluating the feasibility of soluble salts reduction (desalination) through spreading of the material for purposes of precipitation flushing at higher elevations either on site or at off-site areas. Samples from more saturated areas of the detritus should also be sampled to understand if any differences in soluble salts content exists across the elevation gradient. Analysis can be conducted at an agricultural laboratory such as Agrolab in Harrington, Delaware (https://www.agrolab.us/home.htm). Reviewing this data against the Bioenergy Devco facility acceptance criteria will provide better understanding of the feasibility of this beneficial use alternative.

This testing may be combined with additional field piloting and/or laboratory bench-scale testing to evaluate desalination methods. This testing is recommended to determine if the required additional material handling effort to meet facility acceptance criteria will be cost-effective compared to disposal at a solid waste facility. Field piloting would involve spreading the material in a relatively thin layer (i.e., 1 foot) in an upland test plot and sampling the material following significant rainfall events to determine if soluble salt content reduction is achieved.

Benchscale testing would provide comparable information to a field pilot and would involve artificially flushing a small amount of material with water to mimic rainfall events.

Initial Removal Project

Following the determination of the ultimate off-site disposal option (landfill or beneficial use), pending results of the sampling and potential follow-up studies, we recommend the Town undertake a removal project to clear the beaches of detritus for habitat restoration purposes and so that the residents can enjoy a clean, recreational beach. See post-removal monitoring and maintenance activities recommendations.

On-Site Beneficial Use Pilot

The Town may want to consider designating a portion of its beach to evaluate the dune enhancement pilot concept using the detritus to build up new dune core systems and testing its performance over time (particularly pre- and post-storms) to see how they hold up over time. Based on monitoring data, this approach could offer a cost-effective way to manage future detritus accumulation as part of an overall beach management plan (see recommendation below).

Grant Opportunities

In order to support funding of future engineering analysis and removal efforts, Anchor QEA recommends that the Town consider opportunities from grant programs focused on ecological habitat restoration that a detritus clearing project would provide. The restoration of critical habitats is supported by several grants, including the following:

- Restore America's Estuaries provides annual grants totaling approximately $1.3 million through the Coastal Watersheds Grant Program (https://estuaries.org/initiatives/watershedgrants/). In past years, a letter of intent must be submitted by July and formal proposals are accepted in September.
- The National Fish and Wildlife Foundation also awards grants through two local funding opportunities: Delaware Watershed Conservation Fund and Delaware River Restoration Fund (https://www.nfwf.org/programs/delaware-river-program). The total annual grant value is approximately $12 million. The most recent applications for these funds opened in February and closed in April of 2021. Barring major schedule changes, the grant window will most likely open again in February 2022.

Long-Term Management Considerations and Recommendations

Monitoring and Maintenance

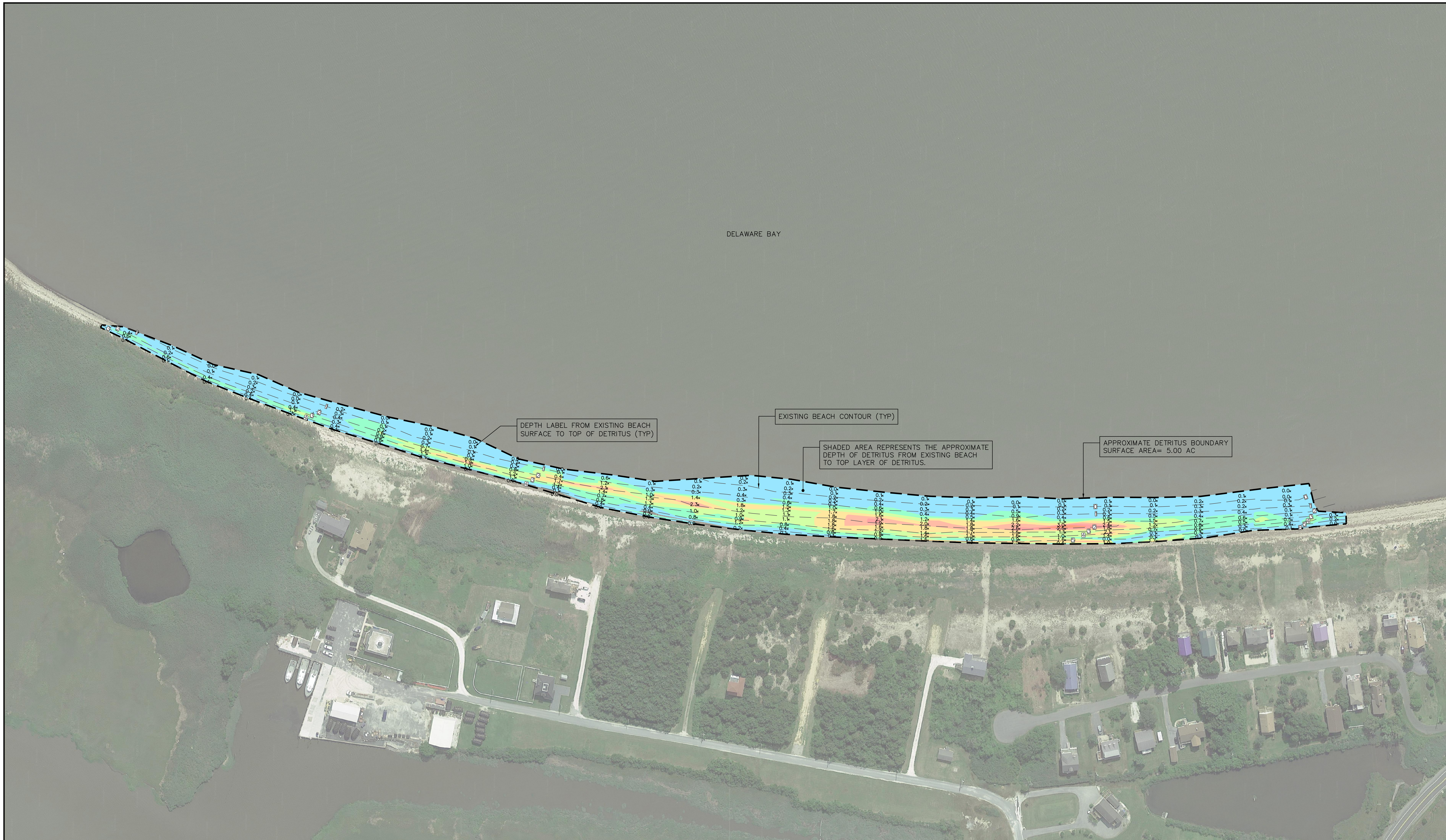
Anchor QEA recommends annual beach surveys, extending from the dune to the wading water depths to understand future beach profile changes and detritus buildup. Survey spacing will vary, but generally for planning purposes a transect every 100 feet should suffice for monitoring. Depending on the frequency of detritus buildup, these surveys could be spaced biannually (i.e., once every 2 years). Anchor QEA recommends a flexible maintenance approach, consisting of a review of the field data over time and then deciding when would be the most efficient time to undertake future detritus clearance activities.

Beach Management Plan and Site Hydrodynamic Model

In order for the Town to more efficiently plan out and budget future beach maintenance activities, Anchor QEA recommends the development of a beach management plan, which would outline future monitoring and maintenance activities and proposed durations. We strongly recommend that the Town consider the development of a hydrodynamic model, as part of this effort to further refine the conceptual site model (CSM). This would allow for an evaluation of the mechanics of detritus movement and buildup along the beach, and the mechanics' relationship to the maintenance of the Mispillion Jetty.

Attachment 1

Topographic Map



DETRITUS DEPTH TABLE

NUMBER	MINIMUM DEPTH	MAXIMUM DEPTH	COLOR
1	0.00	0.50	
2	0.50	1.00	
3	1.00	1.50	
4	1.50	2.00	
5	2.00	2.50	
6	2.50	3.00	
7	3.00	3.52	

DETRITUS APPROXIMATE SURFACE AREA = 5.00 AC
DETRITUS APPROXIMATE VOLUME = 5,300 CY

NOTE:
1- VERTICAL REFERENCE: NAVD 88
2- HORIZONTAL REFERENCE: NAD83, DE STATE PLANE, US. FOOT
3- DATA COLLECTION USING GPS RTK/CORS DICARLO PRECISION INSTRUMENT, INC NETWORK.
4- THE DATA ON THIS MAP REPRESENT THE GENERAL CONDITIONS EXISTING ON 4-19-2021.

GRAPHIC SCALE
0 100 200 Feet
SCALE: 1"= 100 ft.

BEACH SHORELINE TOPOGRAPHIC SURVEY

REVISIONS

REVISION	DATE	DESCRIPTION

PLITKO, LLC
ENGINEERING
53 ATLANTIC AVE., STE 3
OCEAN VIEW, DE 19970
Phone (302)-222-2075

BEACH SHORELINE TOPOGRAPHIC SURVEY
FOR
TOWN OF SLAUGHTER BEACH
TOWN OF SLAUGHTER BEACH
SUSSEX COUNTY, DE

ROBERT PLITKO JR. LICENSE No. 14093 DELAWARE PROFESSIONAL ENGINEER

4-19-2021

Scale: 1'=100'
Designed:
Planned:
Drawn:
Approved: RP 4/19/21
Sheet No. V100

4/21/2021 11:29:47 AM

Attachment 2

Laboratory Report

Midwest Laboratories, Inc.
13611 B Street • Omaha, Nebraska 68144-3693 • (402) 334-7770 • FAX (402) 334-9121 • www.midwestlabs.com

Lab # 8916972	**Report of Analysis**	Report Number: 21-160-4025
Account: 45767	Vinnie Bevivino BTS BioEnergy MCE, 9250 Bendix Rd Columbia MD 21045	Robert Ferris Account Manager 402-829-9871
Date Sampled:	2021-05-24	
Date Received:	2021-06-01	Bioenergy DevCo Feedstock Analys
Sample ID:	Slaughter Beach	BIC Phase 1

		Analysis (as rec'd)	Analysis (dry weight)	Total content, lbs per ton (as rec'd)
NUTRIENTS				
Nitrogen				
Total Nitrogen	%	0.32	1.62	6.4
Organic Nitrogen	%	0.32	1.62	6.4
Ammonium Nitrogen	%	< 0.001	----	----
Nitrate Nitrogen	%	< 0.01	----	----
Major and Secondary Nutrients				
Phosphorus	%	0.05	0.25	1.0
Phosphorus as P2O5	%	0.11	0.56	2.2
Potassium	%	0.05	0.25	1.0
Potassium as K2O	%	< 0.1	----	----
Sulfur	%	0.22	1.12	4.4
Calcium	%	0.20	1.02	4.0
Magnesium	%	0.15	0.76	3.0
Sodium	%	0.330	1.675	6.6
Micronutrients				
Zinc	ppm	25.4	129	----
Iron	ppm	4100	20812	8.2
Manganese	ppm	161	817	0.3
Copper	ppm	< 20	----	----
Boron	ppm	< 100	----	----
OTHER PROPERTIES				
Moisture	%	80.30		
Total Solids	%	19.70		394.0
Organic Matter	%	10.50	53.30	210.0
Ash	%	9.00	45.69	180.0
C:N Ratio		14 : 1		
Total Carbon	%	4.50	22.84	
Chloride	%	0.59	2.99	
pH		6.7		
Conductivity 1:5 (Soluble Salts)	mS/cm	28.8		

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Compost Results Interpretations
Page 1

Report #: 21-160-4025
DATE RECEIVED: 2021-06-01

Organic Matter %

10.50	As Received
53.30	Dry Weight

Greater than 20% indicates a desirable range for compost on a dry weight basis.

Compost is a significant source of Organic Matter, which is an important supplier of carbon. Organic Matter improves soil and plant efficiency by improving soil physical properties, providing a source of energy to beneficial organisms, and enhancing the reservoir of soil nutrients.

C/N Ratio

14.1:1

20-30 indicates an ideal range for the initial compost process.
10-20 indicates an ideal range for a finished compost.

All organic matter is made up of substantial amounts of carbon with lesser amounts of nitrogen. The balance of these two elements is called the Carbon/Nitrogen Ratio. For the best performance, the compost pile requires the correct proportion of carbon for energy and nitrogen for protein production. If the C:N ratio is too high (excess carbon) decomposition slows down. If the C:N ratio is too low (excess Nitrogen) the compost pile could be difficult to manage.

Moisture %

80.30

<35% = Indicates overly dry compost

>55% = Indicates overly wet compost

Moisture Percent is the measure of water present in the compost and expressed as a percentage of total weight. Moisture present affects handling and transport. Overly dry will be light and dusty while overly wet will be heavy and clumpy. A desirable moisture content of finished compost will range between 40 to 50%.

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Compost Results Interpretations

Page 2

Report #:	21-160-4025
DATE RECEIVED:	2021-06-01

Conductivity or Soluble Salts measures the conductance of electrical current in a liquid compost slurry. Excessive soluble salt content in a compost can prevent or delay seed germination and proper root growth. Conductivity analysis is done on a 1:5 basis.

Conductivity 1:5
28.8

Conductivity Level	Interpretation
Greater than 10	Very High nutrient content. Use for Ag Applications
5 - 10	High nutrient content. Use for Ag Applications
3 - 5	Higher than desirable for salt sensitive plants, some loss of vigor
0.6 - 3	Desirable range for most plants
0.3 - 0.6	Ideal range for greenhouse growth media
0.0 - 0.3	Very Low: Indicates very low nutrient status: plants may show deficiencies.

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Compost Results Interpretations

Page 3

Report #:	21-160-4025
DATE RECEIVED:	2021-06-01

pH Value

6.7

0 to 14 scale with 6 to 8 as normal pH levels for compost

A pH in the 6 to 8 pH range indicates a more mature compost

pH measures the acidity or alkalinity of the compost, and is a measurement of the hydrogen ion activity of a soil or compost on a logarithmic scale. The pH scale ranges from 0 to 14 and 7 indicates a neutral pH. Growing media with a higher pH or pH greater than 7 can benefit from a compost that has a more acidic pH or pH below 7. This type of application will possibly lower the soil pH making the soil more conducive to plants that thrive in a more acidic soil condition.

Nutrient Index (Ag Index)

0.5

The Nutrient Index normally runs between 1 and 10.

The Nutrient Index is obtained by dividing the total nutrients (N,P,K) by the amount of salt (Sodium and Chloride). The higher the Nutrient Index the less chance of having a toxic buildup of Sodium (salt) in the soil.

AG INDEX CHART

salt injury possible	*use on soils with excellent drainage characteristics, good water quality and low salts*				*you may use on soils with poor drainage, poor water quality, or high salts*					*for all soils*
1	2	3	4	5	6	7	8	9	10	> 10

Nutrients (N+P205+K20)

2.18	Average Nutrient Content Dry Weight	<2 = Low, >5 = High
0.5-0-0	Rating As Received	

The most commonly used compost data is the amount of Nitrogen, Phosphate, and Potash (abbreviated as N,P,K) present and the information is similar to that found in common fertilizers. If a compost result has the rating 1-2-2 it means that the compost has 1% Nitrogen, 2% Phosphate and 2% Potash. Most compost tests will have a average nutrient level (N+P+K) of < 5%.

Attachment 3
Bioenergy Devco Facility Acceptance Criteria

Table 1
Bioenergy Innovation Center Organic Material Performance and Analytical Criteria

Parameter	Criteria
Maturity & Stability	≥ 6 based on Solvita® Compost Maturity Index
Soluble Salts (Conductivity)	≤ 10 mmhos/cm (mS/cm)
Salmonella	< 3 MPN per 4 g dry wt.
Fecal Coliform	< 1,000 MPN/g dry wt.
pH	5 – 8.5
Total Inerts	< 1%, not to exceed 0.5% plastic
Carbon to Nitrogen Ratio	<20 : 1
Arsenic, Total	< 11 mg/kg[2]
Cadmium, Total	< 7 mg/kg
Chromium VI	0.29 mg/kg[3]
Chromium, Total	< 214 mg/kg
Copper, Total	< 1,000 mg/kg[4]
Lead, Total	< 400 mg/kg
Mercury, Total	< 1 mg/kg
Molybdenum, Total	< 39 mg/kg
Nickel, Total	< 150 mg/kg

Source: Bioenergy Devco