APPEAL DOCUMENTS

Appeal Letter from N. Livesay on behalf of Applicant Marion Stone

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VIA U.S. MAIL, E-MAIL, AND FAX

Susan Lessard, Chair
Board of Environmental Protection
c/o Department of Environmental Protection
17 State House Station
Augusta, ME 04333-0017

RE: Appeal of Natural Resources Protection Act Permit Application Denial
#L-24089-4H-A-N

Dear Ms. Lessard:

Enclosed, please find Marion Stone' appeal of the Department's denial of her Natural Resources Protection Act (NRPA) permit application (#L-24089-4H-A-N).

The basic question presented in this appeal is whether Mrs. Stone, pursuant to NRPA, should be granted a permit to construct a stone revetment in front of her coastal property in place of the former vertical bulkhead that was destroyed by a storm. A number of technical issues are in dispute. To fully and properly address these technical issues, Mrs. Stone request a public hearing so that the experts she has retained to assist her with her application may address these technical issues, answer the Board's questions, and be fully cross-examined.

Should you have any questions, please let me know.

Sincerely,

Nicholas D. Livesay

Enclosure

cc: Cynthia Bertocci
William Bullard

STATE OF MAINE
BOARD OF ENVIRONMENTAL PROTECTION

MARION STONE Scarborough, Cumberland County STONE REVETMENT L-24089-4H-A-N (denial)	APPLICANT'S APPEAL OF THE NATURAL RESOURCES PROTECTION ACT SAND DUNE ALTERATION FINDINGS OF FACTS AND ORDER

Appeal of Applicant Marion Stone

The timber bulkhead protecting Marion Stone's property was severely damaged during a 2007 storm and must be replaced. This bulkhead was only 15 years old, having been constructed in 1992 following the destruction of the prior wall by a 1991 storm. Mrs. Stone seeks to end this cycle of a storm destroying the bulkhead wall – and the sand dune behind it – followed by the reconstruction of the wall and then the man-made recreation of the dune, only to repeat the process little over a decade later.

Mrs. Stone believes there is an alternative to the timber bulkhead that not only will better withstand Maine storms, but also will better protect the environment – including the coastal sand dune system. Mrs. Stone seeks to install a stone revetment, a sloped structure better suited to absorb and dissipate wave energy and to protect the habitat in front of the revetment and the sand dune behind it.

On January 13, 2010, the Department[1] denied Mrs. Stone's Natural Resources Protection Act ("NRPA") permit application for the revetment, finding that the project did not satisfy all the applicable provisions in the Coastal Sand Dune Rules.[2] These rules, along with the

[1] The Department consists of the Commissioner and the Board. (38 M.R.S.A. § 341-A(2).) This appeal is of the decision of the Commissioner. However, the term Department commonly is used to refer to the Commissioner and his staff; that common usage of the term Department is used here.

[2] Pursuant to the Board's jurisdiction to hear appeals of Department decisions (38 M.R.S.A. § 341-D(4)(A) and Chapter 2, Section 24(B) of the Department's rules), Mrs. Stone appeals the January 13, 2010 denial of her NRPA permit application.

accompanying statutory provisions in NRPA, balance the general desire to protect the dynamic nature of coastal sand dune systems and the natural movement of sand within these systems, with the recognition that the replacement or alteration of certain structures that have long been in place in a dune system should be allowed as a matter of public policy, provided certain regulatory standards are met. The Department Order loses sight of this balance.

Some environmental impacts are acceptable. With regard to seawalls and structures such as the revetment proposed here, when the replacement structure is not identical to its predecessor, the central standard is that the proposed structure be "less damaging" than simply replacing the existing structure with a structure of the same dimensions and in the same location.

While the particular Department findings and conclusions with which Mrs. Stone disagrees are discussed in detail below, at a more fundamental level Mrs. Stone has two larger concerns. First, she does not want hypothetical impacts refuted by sound science to dictate the fate of her permit application. Second, she is concerned that any impacts associated with the proposed revetment be viewed in the proper context, with the recognition that – for better or for worse – the sand dune system along this part of Scarborough Beach has long been altered by development, including some form of seawall. The overarching question then is not whether the proposed revetment will interfere with or inhibit the natural movement of sand into or out of the sand dune system; such natural movement has not existed for more than 100 years. Nor is the question whether there should be some form of seawall at all; a structure of some sort will be rebuilt. Rather, the central question is whether the revetment proposed by Mrs. Stone is less damaging to the coastal sand dune system, existing wildlife habitat, and adjacent properties than a structure similar to its predecessor, a vertical bulkhead.

As is explained below, the revetment is the better, i.e., less damaging, option.

I. Background

A. Cyclical Destruction of the Bulkhead

Mrs. Stone owns oceanfront property along Scarborough Beach in Scarborough, Maine. (See Ex. A.) Dating back to the 1800s, some form of seawall or bulkhead has protected the properties along this beach from wave activity. (NRPA Application ("App.") at 20.) The bulkhead is located above the mean high tide line and intended to protect the upland property from erosion during storms. In between the homes and the bulkhead is a strip of sand dune supported by the vertical bulkhead. This dune, because of its limited size and the close proximity of residences, has limited nesting potential for shore birds. (App. at 24.) The dune, in concert with the coastal structure, however, does buffer the ocean shore from the developed upland. (App. at 24.)

In 1991, the vertical bulkhead on Mrs. Stone's property was severely damaged by a storm and replaced by a new bulkhead the following year. (App. at 20.) In 2007, the bulkhead again was destroyed by a storm. (App. at 19.) The sand dune in front of Mrs. Stone's home was largely washed away as well.

The series of photographs attached as Exhibit B shows the location of Mrs. Stone's property and the destroyed bulkhead. The aerial photo, taken before the 2007 storm, shows the dune along Scarborough Beach and provides helpful perspective. The photos in Exhibit B also reveal the significant damage to the sand dune that once was behind the bulkhead. Temporary riprap (the gray rocks in the photos), now stabilizes the remaining dune area on Mrs. Stone's property, protecting it from further erosion.

B. The Proposed Revetment – A Better Alternative

In March of 2008, Mrs. Stone applied to the Department for a NRPA permit to install a

stone revetment in place of the destroyed vertical bulkhead. While Mrs. Stone simply could have sought to replace the former bulkhead with a permit-by-rule (*see* DEP Rules, Ch. 305(16)), she believes the proposed revetment is a better option.

1. Refining the Design of the Revetment Has Been a Team Effort

The revetment Mrs. Stone proposes, which is described in detail below, has evolved through the two-year permitting process. Two peer reviewers contributed most significantly to this evolution. The Maine Geological Survey ("MGS") has provided three rounds of comments, through the Department, on the proposed revetment. While MGS has not conducted a technical evaluation involving any of its own modeling or made any independent calculation, the questions it has raised about the design and design alternatives have helped shape Mrs. Stone's proposal. The responses to these questions help highlight the advantages of the revetment.

To help answer the questions raised by MGS, at an August 12, 2008 site workshop meeting, both the Department and MGS agreed that it would be valuable if an independent, technical expert reviewed the project and conduct the type of technical analysis MGS had not. (See Meeting Minutes for Aug. 12, 2008; Email from B. Baker to S. Dickson of MGS, with copy to B. Bullard of DEP and others, re Beachfront Protection (Aug. 26, 2008).) Baker Design Consultants, the firm retained by Mrs. Stone to design the revetment, hired the Woods Hole Group[3] ("WHG") to provide an independent, third-party review of both the proposed revetment and an alternative to the revetment, a new, more highly engineered vertical bulkhead.[4] The scope of work for WHG was reviewed and approved by MGS. MGS also discussed the scope of the peer review directly with WHG prior to its finalization. (Email from S. Dickson of MGS to

[3] The Woods Hole Group is an international environmental, scientific, and engineering consulting organization.
[4] The bulkhead alternative WHG evaluated in its technical analysis was not an identical replacement of the vertical bulkhead that had been destroyed. The alternative bulkhead was designed to include fiberglass sheet piling

B. Baker, with copy to B. Bullard of DEP and others, re Beachfront Protection (Aug. 28, 2008).)

Consistent with its scope of work, WHG conducted a technical analysis of the revetment and alternative bulkhead, the coastal processes at Scarborough Beach, and the interaction of the coastal process with the two types of coastal structures. WHG presented its calculations, analysis, conclusions, and recommendations in its November 7, 2008 technical analysis memorandum (the "Technical Memorandum").

WHG's Technical Memorandum is significant because it not only explains the environmental impacts of a coastal structure on Mrs. Stone's property, but also compares the impacts of the revetment to the impacts of a vertical bulkhead. In addition, the Technical Memorandum provides calculations quantifying some of the differences between these two design alternatives. While the vertical bulkhead examined by WHG is more highly engineered than the bulkhead that was destroyed, the exposed face of this alternative has the same dimensions as the face of the former bulkhead and would function in the same manner when subject to wave activity (although the engineered bulkhead would be more durable than an in-kind replacement). Thus, when assessing what types of impacts should be expected if the vertical bulkhead is rebuilt, the Technical Memorandum provides answers.

Should there be any concerns about the independent nature of WHG's analysis, apart from the group's highly respected credentials, it should be noted that the Technical Memorandum, along with comparing the advantages and disadvantages of the two proposed structures, contained specific design recommendations that addressed MGS's concerns, reduced the size of the structure, and improved the overall engineering. (WHG Technical Memo at 20-24.) In addition, the Technical Memorandum recommended that mitigation be proposed for the

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extending 20 feet below the depth of the former bulkhead and have a stone mattress, which would be covered by sand, supporting it from behind. The bulkhead would be faced with pressure treated wood.

benefit of the sand dune system. (WHG Technical Memo at 24.) Mrs. Stone followed these recommendations and, impressed with the quality of the analysis, subsequently retained WHG to continue to provide technical advice on the project design. The result is that Baker Design Consultants, with technical input from WHG and feedback from the Department and MGS, incorporated WHG-suggested modifications to improve the original revetment design and beach nourishment program. With the refined design, there is no basis for any lingering technical concerns. The proposed revetment is superior to replacement of the vertical bulkhead in terms of its impact on the sand dune system and abutting properties, as well as its durability and overall ability to protect upland property.

2. The Revetment Proposed by Mrs. Stone Has Been Carefully Engineered

The top of the revetment proposed by Mrs. Stone, not including the sand covering the top portion of the structure, would reach an elevation 14.5 ft NGVD[5] (the same crest elevation as the former bulkhead). The revetment would measure 182 feet long along its landward edge, and consist of three layers of stones. The top layer would be covered by the largest "armor" stones, weighing in the range of 2 to 3 tons each. These interlocking stones would be carefully fitted into place to produce a durable, uniform surface. (Exhibit C contains the final plans for the revetment submitted to DEP. Sheet T-2 of this exhibit contains a photo of a finished revetment. Sheet C-6 contains a cross-section diagram showing the layers of stones.)[6]

The revetment would be aligned to more smoothly follow the contour of beach. (Ex. C, Sheets C-1 through C-3.) The former bulkhead bowed out towards the ocean in front of Mrs.

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[5] National Geodetic Vertical Datum ("NGVD") is a vertical control datum established for vertical control surveying and was established in 1929. The datum is used to measure elevation levels.

[6]Note, in the Order, the Department describes an earlier version of the revetment and not the final design. For example, the proposed revetment would have a cross-shore distance of 21 feet (not 24 ft.) and a footprint of 4,605

Stone residence. The revetment would eliminate this "bulge" with its seaward edge (the "toe") set back farther from the ocean than the bulge. (The bulge can be seen in the aerial photo in Exhibit B.) This positioning is consistent with the desire of both the Department and MGS. (MGS Comments, June 24, 2008 at ¶ vii.) While Mrs. Stone always proposed to eliminate the bulge and locate the revetment behind this bowed area (App. At 23), originally the revetment was to be six feet closer to the ocean than is presently proposed. The Department and MGS considered this original location to be unacceptable. (MGS Comments, June 24, 2008 at ¶ vi.) Mrs. Stone modified the design. (Compare App., Sheet C-3 with Ex. C, Sheet C-3.)

In addition, the revetment has been designed to minimize its footprint. The face of the revetment would be fitted with interlocking stones, allowing a slope of 1:1.5 (an increase in height of one foot for every one and one-half foot increase in depth). (Supp. No. 2 at 2.) This slope is as steep as can be soundly engineered[7] and steeper than most designed revetments. This steeper slope minimizes the area covered by the revetment.

The cross-shore distance of the revetment, measured from its toe to its landward edge, would be 21 feet, with between two to six feet at the toe of the revetment buried by the beach and approximately six feet at the top of the revetment covered by the sand dune. (See Ex. C, Sheet C-6.) As a result, 40 to 60 percent of the revetment's footprint would be topped by sand either from the dune or beach. These figures account for the seasonal fluctuation in the amount of sand on the beach that would cover the revetment's toe.

At either end of the revetment, the transition of the revetment to the existing bulkhead on the abutting properties has been carefully designed to prevent any adverse impact to abutting

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square feet (not 4,800 sq. ft.). See Exhibit C containing the revetment plans for the actual dimensions, as opposed to the Order.

[7] *See* U.S. Army Corps of Engineers, Coastal Engineering Manual, EM 1110-2-1100, pt. 6, ch. 5 (2006).

property. Incorporating comments provided by MGS and WHG[8], at each end of the revetment a thirty foot long section of fiberglass sheet pile, to be faced with timber and backed by a layer of stone topped with sand and beach grass, would serve as the transition to the neighboring bulkheads. (See Ex. C, Sheet C-7.) Each 30 foot section would be curved (the face would be convex) to provide a gradual transition. Exhibit C, Sheet C-2 shows how the sloped revetment fits with these walls. Water reflecting off these transition walls first would travel up the exposed face of the revetment, except at the most seaward end of the sections where the revetment toe joining with the transition sections would be buried by beach sand.

Overall, the revetment would be located approximately in the area of the sand dune washed away in the 2007 storm. (See the photos in Ex. B; Ex. C Sheets C-2, C-3.) That storm washed away a 3,030 square foot area. The total footprint of the revetment, including those portions that would be covered by sand, would be 4,605 square feet. (Ex C, Sheet C-2.)

3. The Environmental Advantages of the Proposed Revetment

As a general matter, revetments are preferable to vertical walls because sloped revetments are better at dissipating wave energy, and thus reflect less such energy. Both the Department and Army Corps have recognized this in their regulations. There are three main advantages associated with a revetment's ability to dissipate wave energy.

First, revetments tend to minimize scour of the beach because less energy is reflected

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[8] Originally, a granite abutment was proposed to transition the revetment to the vertical bulkhead at either end. (App. at 24.) MGS, in its initial comments, expressed concern about wave activity in the transition areas. (MGS Comments, June 24, 2009.) WHG expressed similar concern, concluding in its independent review:

> As currently designed, the transitional areas will produce increased wave energy and may result in increased overtopping and erosion (both the local beach area and the upland dune resources). Therefore, consideration should be given to redesigning these transitional areas to reduce the angle of the transition, improve wave energy dissipation, and bolster protection of the neighboring properties.

back onto the beach. Unlike a vertical structure, revetments dissipate wave energy on their face, which reduces the amount of energy reflected back on the beach. As a result, revetments are less damaging to the beach than a vertical structure, helping to protect the beach environment.

Second, compared to a vertical seawall of the same height, revetments are less likely to be overtopped. At one level this may seem counter intuitive since a revetment resembles a ramp. The revetment, however, dissipates wave energy on the rough-faced, sloped surface of armor units. When a wave is reflected off a surface, the wave's energy is added to the incoming wave, increasing that incoming wave's energy. Wave energy directly influences wave height. Therefore, a vertical wall, which reflects more energy, increases wave height more than a sloped revetment, leading to an increased likelihood of overtopping and a comparative increase in the volume of water overtopping the structure. Overtopping, in turn, leads to upland flooding and crest erosion. By reducing overtopping, revetments better control erosion behind the structure.

Third, revetments' ability to dissipate (i.e., absorb) wave energy, combined with their simple yet sturdy design, has earned them the reputation of being durable coastal structures.[9]

These basic benefits are well understood and recognized by the Department. Typically when considering replacement structures, the Department favors sloped structures, such as riprap or revetments, over vertical bulkheads. (DEP Rules, Ch. 305(4)(C) (explaining in the note that "riprap is preferred over retaining walls because it dissipates wave action and is a more stable structure over the long term. The DEP encourages the replacement of retaining walls with riprap, unless the presence of large trees or structures makes its use impractical."). The Army

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(WHG Technical Memo at 24.) The final design of the revetment, with the curved transition areas, addresses these concerns.

[9] Another benefit of revetments, although not directly linked to their ability to dissipate wave energy, is that revetments typically are easier to repair than bulkheads. Whereas revetments commonly can be quickly patched using recycled material, damaged bulkheads often require the replacement of entire sections. This type of replacement often involves greater construction impacts and increases the time of the repair, during which the upland property is more vulnerable to erosion.

Corps, with its considerable engineering experience, has reached a similar conclusion. Corps regulations expressly note the advantages of revetments for the environment, the property owner, and abutters, alike. (U.S. Army Corps of Engineers, Programmatic General Permit, Maine, § V(20)[10] (Oct. 11, 2005).)

These same benefits are relevant here as have been verified by WHG's Technical Memorandum.

a. The Revetment Protects the Beach by Reducing Reflection and Associated Scour

Compared to a vertical bulkhead of the same height, WHG's analysis shows that the proposed revetment would reduce wave reflection, and subsequently wave energy, by approximately 35 percent. (WHG Technical Memo at 14.) This reduction in wave energy translates to a significant reduction in scour or beach erosion. WHG quantified this reduction by comparing the depth of scour during storm events and the approximate volume of beach material that would be eroded. WHG focused on storm events because under typical tide and weather conditions the structure (either the revetment or bulkhead) is not located in the intertidal area and waves do not reach the location of the structure, thus there is no interaction between the structure and the water. The results of WHG's analysis show that with the revetment, as opposed to a vertical bulkhead, the depth of scour often would be more than one foot less and more than three

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[10] Section V(20) of the Programmatic General Permit provides:

> Projects involving construction or reconstruction/maintenance of bank stabilization structures within Corps jurisdiction should be designed to minimize environmental effects, effects to neighboring properties, scour, etc. to the maximum extent practicable. For example, vertical bulkheads should only be used in situations where reflected wave energy can be tolerated. This generally eliminates bodies of water where the reflected wave energy may interfere with or impact on harbors, marinas, or other developed shore areas. A revetment is a sloped and is typically employed to absorb the direct impact of waves more effectively than a vertical seawall. It typically has a less adverse effect on the beach in front of it, abutting properties and wildlife.

(Emphasis added.)

times less beach material would be eroded. (WHG Technical Memo at 15-16.)

Wave energy reflection, and subsequently wave energy, would not be reduced at the revetment transition walls to as great an extent. (Supp. No. 8 at 2-3.) The curved transition walls at both ends of the revetment would be vertical, as was the former bulkhead. Nevertheless, less energy would reflect from these end walls than would reflect off a vertical bulkhead. This is because before reaching the vertical transition wall a wave would travel over some portion of the sloped revetment, providing energy dissipation before it reaches the vertical transition wall.

WHG estimated reflection from the transition walls would be between 0 and 0.5 times greater than the reflection from just the revetment. (Supp No. 8 at 2.) In calculating how the transition areas would compare to the portion of the revetment running along the beach essentially parallel to the ocean, WHG specifically considered the curved shape of the transition areas and the more complex reflection that occurs in corners:

> [T]he reflection coefficient for the transitions area includes both the standard reflection (reflected off the structure) and the increased reflection caused by the concave corner that is created by the integration of the two structural types (e.g., side reflection, wave agitation, etc.) This results in an increase in the coefficient due to the effects of the corner and transition.

(Supp. No. 8 at 3.)

The following table, also presented in NRPA Supplement No. 8, compares the reflection coefficient and maximum increase in wave energy resulting from reflection of wave energy for different structure elements, including the transition areas.

Structural Element	**Reflection Coefficient**	**Maximum Increase in Wave Energy**
Sloped Revetment	0.58	58%
Vertical Wall	0.90	90%
Transitional Area	0.87 (1.5 times 0.58)	87%

For the transition area, the reflection coefficient used in the table calculations is from the upper-most end of the range, 0.5 times greater than the reflection coefficient for the revetment. Even assuming the greatest reflection off the transition wall, less energy would be reflected than by a vertical bulkhead. Although the benefit of the revetment at these end sections is not as great as elsewhere along the revetment, even along the end walls less reflective energy translates to less scour and beach erosion than would be associated with a bulkhead. (Supp. No. 8 at 3-4.)

b. A Revetment Protects the Sand Dune from Erosion by Reducing Overtopping and the Likelihood of Structure Failure

WHG's analysis shows that for typical storm events the amount of overtopping would be less for the revetment than for a bulkhead. (WHG Technical Memo at 12.) Due to the relatively low crest elevation of either structure, as storms get larger both types of structures would be overtopped. During 10-year storms or greater this would be the case. (WHG Technical Memo at 12.) The rate of overtopping during larger storm events, however, would not be equal:

> For example, during a 50-yr storm event, both alternative structures would be overtopped; however, the rate of overtopping of the revetment would be 0.2 l/s-ft, while the bulkhead would be overtopped at a rate of 0.9 l/s-ft. This represents over 4 times more water spilling into the upland area for bulkhead versus a revetment.

(WHG Technical Memo at 12.)

At the transition walls the difference in overtopping would not be as great as elsewhere along the revetment. Nevertheless, as shown in the table in the preceding subsection the maximum increase in wave energy in the transitional areas still would be less than the increase associated with a vertical bulkhead. As a result, even in these areas overtopping would be slightly less compared to a bulkhead that extends along the shoreline. (Supp. No. 8 at 3.)

Due to its ability to reduce overtopping, there are several important advantages to the revetment. Less overtopping means the sand dune behind the revetment is less likely to be

eroded and upland property is less likely to be flooded. (WHG Technical Memo at 11.) This is a benefit not just to Mrs. Stone and the dune on her property, but also to her neighbors and the broader sand dune system. Once water overtops the revetment or neighboring bulkhead, factors such as topography and wind direction, not property lines, influence its movement. By reducing overtopping, and therefore the amount of water behind the seawall structures that line Scarborough Beach, Mrs. Stone's revetment would do more to protect the environment and her neighbors from storm impacts than would a new vertical bulkhead.

Finally, the erosion and flooding that can cause damage behind a revetment or bulkhead also can contribute to structure failure. By reducing overtopping the revetment would reduce one of the key factors that contribute to structure failure. (WHG Technical Memo at 12.) Structure failure, as demonstrated by the bulkhead in 2007, can lead to washout of the sand dune altogether. This is the worst case result Mrs. Stone seeks to avoid. The revetment she proposes not only would reduce overtopping, but would be much better engineered and much more durable than the wooden bulkhead it would replace, reducing the damage to the dunes during storm events and the likelihood of a complete washout.

c. A Revetment Facilitates Windborne Movement of Sand into the Dune

Sand dunes in their natural state are dynamic, at times being replenished with sand and at times serving as a source of sand for the beach. The sand dune along Scarborough Beach no longer functions in its natural state. Natural forces, however, continue to influence the dune. Another advantage of the revetment is that this sloped structure, compared to a vertical bulkhead, improves windborne transfer of sand from the beach to the dune system. (Supp. No. 3 at 1.)

4. Mitigation Further Enhances Mrs. Stone's Proposal

Mrs. Stone proposes three forms of mitigation of particular note. First, she proposes to

restore the dune area behind the revetment to its pre-storm condition. This would be done by using any materials disturbed during construction of the revetment and supplemented with additional sand. (Supp. No. 5 at 7.) Dune grass would then be replanted. (App. at 23.)

Second, Mrs. Stone proposes not just to restore the dune behind the revetment to its pre-storm conditions, but also to elevate the crest of the dune one foot above the base (100-year) flood elevation (15.0 ft.). (Supp. No. 6 at 1.) This results in the top of the revetment being covered by sand. (See Ex. C, Sheet C-6.) This form of mitigation not only enhances the dune's flood protection abilities by raising its level, but facilities the movement of sand from the dune to the beach. Sand covering the top of the revetment (as opposed to sand simply being retained behind the revetment) would move more freely than sand behind a vertical wall. As part of this mitigation measure, if the crest elevation drops below one foot above base flood elevation, Mrs. Stone would replenish the sand to ensure that this design feature is retained. This is a significant improvement over a replacement bulkhead, where the bulkhead essentially retains the sand. Notably, this form of mitigation is favored by MGS, the Department, and the Department's Rules. (MGS Comments, Feb. 25, 2009 at 4; Supp. No. 6 at 1; DEP Rules, Ch. 355(5)(I).)

Third, Mrs. Stone proposes to permanently protect 0.35 acres of buildable, undeveloped land, with 91 feet of frontage on Scarborough Beach, through the granting of a conservation easement to the Prouts Neck Association or other suitable easement holder. (Supp. 6 at 2; Supp. No. 9 (containing the draft easement).) This easement would compensate for the loss of area within the footprint of the revetment.

These mitigation measures, combined with the benefits of the revetment over a vertical bulkhead, would result in a significantly better protected shoreline and better functioning sand dune system than before the 2007 storm, or than would follow reconstruction of the bulkhead.

II. The Applicable Statutory and Regulatory Standards

The Natural Resources Protection Act and the Department's Coastal Sand Dune Rules (the "Rules") (DEP Rules, Chapter 355) govern this project. Only those provisions directly applicable to this appeal are discussed here.

NRPA contains a set of standards that all applicants for a permit must satisfy. (38 M.R.S.A. § 480-D.) Three of these standards are relevant to this appeal:

> **1. Existing uses.** The activity will not unreasonably interfere with existing scenic, aesthetic, recreational or navigational uses.
>
> **2. Soil erosion.** The activity will not cause unreasonable erosion of soil or sediment nor unreasonably inhibit the natural transfer of soil from the terrestrial to the marine or freshwater environment.
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> . . . .
>
> **7. Sand or gravel supply.** If the activity is on or adjacent to a sand dune, it will not unreasonably interfere with the natural supply or movement of sand or gravel within or to the sand dune system or unreasonably increase the erosion hazard to the sand dune system.

(38 M.R.S.A. § 480-D.)

As these standards state, some impacts are allowed; only unreasonable impacts are prohibited. In the context of the replacement or alteration of a vertical bulkhead in a coastal sand dune, the Rules provide further guidance as to what types of impacts are reasonable and what types are not.

Where a bulkhead exists in a sand dune, that dune no longer functions naturally; the dune and surrounding area have been impacted. Thus, an unreasonable impact associated with the replacement of a bulkhead is not one that simply alters the area from its pre-development or natural state, or one that interferes with the natural movement of sand and sediment. Reasonableness is assessed by comparing the impacts of the proposed replacement or alteration to the impacts associated with the existing or recently damaged structure. The Rules provide:

> With a permit from the department, a seawall or similar structure may be replaced with a structure of different dimensions or in a different location that is farther landward if the department determines that the replacement structure would be less damaging to the coastal sand dune system, existing wildlife habitat and adjacent properties than replacing the existing structure with a structure of the same dimensions and in the same location.

(Rules, Ch. 355(5)(E).)

> The Rules also allow for mitigation of project impacts:
>
> To mitigate for on site project impacts that interfere with the natural supply or movement of sand or gravel or may increase the erosion hazard to the sand dune system, the department may require sand dune mitigation and enhancement measures, including: restoring the dune topography and elevating the crest of the sand dune to at least one foot above the 100 year flood/wave run up level; and provisions to enhance with native vegetation the portions of the lot not covered by buildings or parking areas.

(Rules, Ch. 355(5)(I).)

III. Discussion – The Department Erred in Denying Mrs. Stone's Permit Application

In its Order, the Department finds that the proposed revetment does not satisfy Section 5(E) of the Rules, stating that "the applicant has not demonstrated conclusively that the proposed project will be less damaging to the coastal sand dune system and to adjacent properties." (Order, Finding No. 3 at 5.) The Department also finds that the mitigation Mrs. Stone proposes is insufficient, noting that "the proposed measures do not adequately mitigate for the proposed project's potential to interfere with the natural supply and movement of sand or gravel within the sand dune system." (Order, Finding No. 2(D) at 3.)

Based on these two findings, the Department concludes in its Order that the revetment would violate three of NRPA's statutory standards, 38 M.R.S.A. § 480-D(1), (2), & (7). (Order, Conclusions A, B, & G.)

As explained below, the Department erred in these two findings and three conclusions.

A. The Revetment Would be Less Damaging than a New Bulkhead – Department Finding #3 Should Be Corrected

Section 5(E) of the Rules requires the revetment to be less damaging to (a) the coastal sand dune system, (b) existing wildlife habitat, and (c) adjacent properties than a new vertical bulkhead with the same dimensions and in the same location as the one that was destroyed in 2007. There is no dispute that the revetment would be less damaging to existing wildlife habitat. The first and third categories are discussed in more detail.

1. The Revetment Benefits the Coastal Sand Dune System

As noted above, compared to a vertical bulkhead, the proposed revetment would reduce overtopping and significantly reduce scour and beach erosion. In finding that the revetment would not be less damaging to the coastal sand dune system than a replacement bulkhead, the Department suggests the reduction in overtopping might be detrimental because overtopping can add sand to the dune (Order, Finding No. 3, at 5-6), and also echoes concerns expressed by MGS that the revetment would "increase potential for erosion." (Order, Finding No. 3, at 6.) In addition, the Department questions the size of the revetment's footprint in making its finding.

a. Technical Analysis Shows Overtopping Would Continue But at a Reduce Volume and Frequency

Overtopping of the revetment or bulkhead is one way sediment can be transported from the beach to the sand dune, or vice versa. This is also how sand dunes behind such structures are eroded and how such structures are completely destroyed. The revetment strikes a better balance than replacement of the vertical bulkhead. Overtopping still would occur during larger storm events, allowing for sediment movement into the dune, but at the same time minimizing the likelihood of erosion or structure failure. In addition, the slope revetment would better facilitate windborne sand being added to the dune and the mitigation measures proposed by Mrs. Stone

would ensure the elevated crest requested by the Department and MGS is maintained.

b. Technical Analysis Shows the Revetment Would Reduce Erosion

Seemingly inconsistent with the question of whether the revetment would allow too little overtopping is MGS's concern that the revetment would lead to increased erosion of the sand dune system. This concern is unsupported. WHG's analysis clearly shows that overtopping of the revetment would be less than the overtopping of the bulkhead. With this comes less, not more erosion of the dune system. And with this also comes less of a likelihood of structure failure, the type of failure that can lead to the massive erosion experienced in 2007. The same is true of erosion of the beach. There would considerably be less erosion or scour with the revetment. These factors are not in dispute. There would be less erosion to the coastal sand dune system if the revetment is constructed than if a replacement bulkhead is constructed.

This conclusion about the impact of erosion within the sand dune system takes into account the entire revetment, including the transition ends. Although these ends would reflect waves with nearly the same energy as the bulkhead, the ends would still reduce overtopping and the erosion that comes with it, as well as beach scour.

Despite the reduction in wave energy by the transition areas, MGS provided the following comment on overtopping, which directly bears on the potential for erosion:

> As we see it, the [reflection coefficient] value was originally established to describe wave energy reflection perpendicular to the shoreline and not the complex side reflection and interaction of waves at the ends of the structure. In fact, one might argue that with less reflection there is more wave energy (and hence water) propagating in a shoreward direction. It seems possible that this condition could potentially result in **more water overtopping the riprap or the curved seawall**.

(MGS Comments, Sept. 2, 2009 (emphasis in original).)

The first part of this statement appears to follow from a misunderstanding about how

WHG calculated wave reflection for the transition area. As already explained in Section I(B)(3)(a) of this appeal, WHG did account for the impact of the corner where the revetment transitions to the bulkhead and side reflection. The second part of this comment is correct only in that someone could make the argument MGS outlines. Such an argument, however, would lack any technical basis. *Less* reflection cannot create *more* wave energy, and the revetment, including the transition areas, "can only result in less overtopping on the neighboring properties as well." (Supp. No. 8 at 3.) This translates to less erosion.

MGS also expressed concern that because the transition ends are curved "the direction of wave activity would no longer be straight offshore but rather redirected at an angle to the beach." (MGS Comments, Sept. 2, 2009.) MGS theorized this angled reflection could create "rip-current type flow" across the beach. The facts do not support this theory of redirected currents (whether or not called rip-currents) increasing erosion.

The angle at with a wave is reflected depends on two factors, the approach angle of the wave and the angle of the structure (picture a ball bounding off a wall). All waves would not hit the revetment, either the ends or the middle section, having approached at the same angle. Waves will reflect at different angles at different times all along the structure. Nevertheless, it has been extensively shown that the amount of erosion and scour occurring along the beach fronting the revetment would be significantly less than the erosion and scour along the beach fronting a vertical wall. (Supp. No. 8 at 4; WHG Technical Memo at 15-17.) The transitional areas, even considering the increased reflection compared to the other portions of the revetment, still would have less energy returning to the beach. (Supp. No. 8 at 2, 4.) The bottom line is that less erosion would occur in front of both the revetment and transition areas – regardless of the approach angle of the incoming wave and angle of reflection – than would occur in front of a

vertical bulkhead. (Supp. No. 8 at 4.) This is a direct function of the reduction in wave energy.

In sum, while Section 5(E) focuses on the overall impact of the project on the sand dune system, and not on isolated impacts potentially associated with a small part of the project, even focusing on these small parts – e.g., the transition ends – these parts are less damaging than simply rebuilding the bulkhead. This is confirmed by the technical analysis of WHG.

c. The Advantages of the Revetment Outweigh Concerns About the Size of its Footprint

When evaluating the significance of the size of the revetment's footprint and how this relates to whether the revetment would be less damaging to the sand dune system than replacement of the bulkhead, we must do so in the proper context.[11] This requires factoring in the reduction in erosion and scour that would be associated with the revetment. This also requires acknowledging that where Mrs. Stone proposes to place the revetment, much of the previously existing sand dune has been washed away. This is significant because when the Department speaks of displacing functional sand dune area (Order, Finding #3 at 5), largely what is being referred to is that area where a sand dune could be rebuilt by man behind a new bulkhead. Without intervention the dune will not be restored. If this sand dune is rebuilt behind a similar vertical bulkhead, it also must be acknowledged that it almost certainly will be destroyed by wave activity as a result of future structure failure. The only question is when, and unfortunately the answer is all too soon if all that protects it is a rebuilt bulkhead.

Contrary to what the Order suggests, failure of the replacement bulkhead is likely to come much sooner than would failure of the revetment. The Order provides: "The WHG analysis showed that both design alternative were expected to receive significant damage in a 10-year storm event at high tide with both experiencing structural failure during a 50-year storm

event at high tide." This statement is accurate as far as it goes, but it is misleading in its brevity. The two high tide storm events referenced here are both severe and rare.[12] Over a wider range of storms, the revetment would be more durable than the bulkhead alternative evaluated by WHG, including 50- and 100-year storms (non-high tide), during which the bulkhead, but not the revetment, would be damaged. (WHG Technical Memo at 13.)

This statement in the Order also either is misleading in the context in which it is provided, or reveals a misunderstanding of WHG's technical assessment. Presented in the discussion of whether the proposed revetment would be less damaging than replacing the former bulkhead with a structure of the same dimensions and in the same location, the statement suggests that the revetment would be no more durable than the replacement bulkhead. The bulkhead evaluated by WHG, however, was the engineered alternative considered by Mrs. Stone, not an in-kind replacement. Although the visible portions of the engineered bulkhead would have the same basic dimensions as the former bulkhead, based on MGS's comments, the added engineering features qualify as a change in dimension. (MGS Comments, Sept. 2, 2009; *see also* Order, Finding No. 3 at 4 (noting neither design alternative examined by WHG "was an in-kind replacement of the existing structure").) As a result, when comparing the durability of the proposed revetment with a replacement bulkhead in the context of Section 5(E), the suggestion in the Order that both types of structures would be similarly durable is not accurate.

A replacement bulkhead would be much more susceptible to failure than the revetment. This is a key point. Apart from the added erosion and scour such a vertical bulkhead would cause, the bulkhead would fail much more readily, washing away the dune, and necessitating its

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[11] The proper dimensions of the revetment also should be considered. The dimensions listed in the Order are for a slightly larger, preliminary design.

[12] On any given year, there is a 1 percent chance of a 10-year storm at high tide and just a 0.4 percent chance of a 50-year storm at high tide. (WHG Technical Memo at 13.)

reconstruction. Continual intervention would be required to support existence of this dune.

Even putting the greater likelihood of bulkhead failure aside and assuming the dune area where the revetment would be placed had not been largely destroyed in 2007, the sediment budget analysis prepared by WHG shows the revetment still would be less damaging to the coastal dune system. (WHG Technical Memo at 17-19.) In this analysis, WHG calculated both the immediate loss of material resulting from construction of a new bulkhead or revetment (assuming the material was there), as well as the long-term loss of sediment caused by the wave-induced scour. While the footprints of the revetment and bulkhead in this analysis differ slightly from the revetment finally proposed by Mrs. Stone and the former bulkhead, so the exact calculations would change if the analysis were repeated today with these slightly different footprint numbers, the conclusions would remain the same. Overtime, the loss of dune and beach material associated with the vertical bulkhead (material displaced by the structure plus the loss from beach scour) exceeds the corresponding loss of material associated with the revetment. (WHG Technical Memo at 17; Supp. No. 5 at 3, 5.) Based on this result, the long term health of the dune system, including the beach, is better served by the revetment than the bulkhead.

The longer term benefits revealed by the sand budget analysis become more immediate when mitigation proposed by Mrs. Stone is considered. In constructing the revetment, she is committed to maintaining any disturbed material on site so that there is no net removal of material. (Supp. No. 5 at 5.) This benefit is not captured in WHG's sand budget analysis. She also would add material to the crest of the dune, beyond that which was there prior to the storm, and replenish this sand, if necessary, to maintain this higher crest. (Supp. No. 6 at 1.) These measures further offset any immediate loss associated with the larger footprint of the revetment.

2. The Revetment Benefits Adjacent Properties

How the transition areas would reflect wave energy has created more confusion than any other component of the proposed project. Because the transition areas would be located closer to abutting properties than other portions of the project, understanding how these areas would function bears on whether or not the revetment would be less damaging to adjacent properties.

The Department has relied heavily on MGS's opinions. In support of its finding that Mrs. Stone has not shown the revetment will be less damaging to adjacent properties, the Department refers to "MGS's determination of the increased potential for erosion on the dune and abutting properties." (Order, Finding #3 at 5.) Elsewhere, the Department references three other types of damages MGS indicates *may* occur to adjacent properties: "increased flooding" (Order at 5), "increased hydrostatic loading with a likely increase in seaward-directed forces imparted to neighboring sea walls" (Order at 5), and dislodged revetment stones "carried to abutting properties with unknown results." (Order at 4.) No data or quantitative analysis supports these three suppositions or the "determination" regarding increased erosion. MGS has not undertaken such analysis; WHG has, finding no basis for these concerns.

With regard to erosion, WHG's Technical Memorandum, and its subsequent analysis provided in conjunction with Baker Design Consultants in NRPA Supplement Number 8, explains the analytical results showing that erosion, both on the beach and in the sand dune, and both on Mrs. Stone' property and on her neighbors' properties, will decrease if the revetment is installed as opposed to rebuilding the vertical bulkhead. Section III(A)(1)(b) of this appeal discusses MGS's concerns regarding erosion and why these concerns are unfounded. This discussion is not rehashed here.

Flooding generally and flooding on adjacent properties will not be increased by the

revetment. This is a direct result of the reduction of overtopping. This has been discussed above and the Department concluded as much in its Order. (Order, Finding F.)

Increased hydrostatic loading will not occur either, since there will be a reduction of overtopping during storm events. (See Section III(A)(1)(b) above.) Therefore, there cannot be increased hydrostatic loading if less water is landward of the structures.[13]

The potential concern over stones from the revetment lacks any basis in fact. This concern, never raised by MGS during the lengthy application process, borders on being irresponsible in the context of a technical review.

First, the revetment will be capped with armor stones weighing between two and three tons and these stones will be carefully fitted in place. Once fitted, such stones are not easily moved. In the most violent of storms these stones would not move more than a few feet, if at all.

Second, a replacement bulkhead, which MGS appears to favor, is more likely to be damaged and its lighter and more easily transportable prices cast about with "unknown results."

Third, the existing 15 pound cobbles in the natural environment are more likely to be pushed around by a storm, yet there is no history of notable damage or interference with existing uses of adjacent properties caused by these stones.

Fourth, in the type of apocalyptic event MGS seems to contemplate, any damage caused by components of the revetment would be inconsequential compared to the damage caused by the ocean and whatever type of other debris is swept up by the ocean.

Fifth and finally, the very purpose of the revetment is to protect property and the sand

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[13] It is not clear that MGS remains concerned with the potential for hydrostatic loading. This concern was raised by MGS in its February 25, 2009 comments (the language in the Order is lifted from those comments), but not subsequently. Those February comments were on the originally proposed granite transition ends, not the curved transition areas currently proposed. MGS quoted WHG's Technical Memorandum, in which WHG concluded the granite ends would increase overtopping that "may result in significantly increased flooding of abutting property." (MGS Comments, Feb. 25, 2009 (quoting WHG Technical Memo at 20).) Since that time, the transition areas have

dune system from damage in the event of a storm. This is what Mrs. Stone's revetment would be designed to do and what those revetments currently in place across New England have done. To the extent safety and the protection of property – whether Mrs. Stone's or her neighbors' – is a goal, there is no better option than the revetment. If safety and property protection were the only goal, a permit for the revetment surely would have been issued long ago.

In sum, compared to replacement of the vertical bulkhead, the revetment will not be more damaging to adjacent property; it will be beneficial. The concerns to the contrary have been fully addressed by the technical information contained in WHG's peer review and subsequent design modifications and technical submissions. Concerns of hypothetical impacts with no technical basis should not trump science and fundamentals of coastal engineering.

B. Mrs. Stone Proposes a Robust Mitigation Package – Department Finding #2(D) Should Be Corrected

The Rules do not contain a mitigation standard, per se, but rather provide that the Department may require mitigation for on site project impacts that "interfere with the [1] natural supply or movement of sand or gravel or [2] may increase the erosion hazard to the sand dune system." (Rules, Ch. 355(5)(I).) In the Order, the Department finds that more mitigation with regard to this first category of impacts is needed, although the Order does not say how the supply and movement of sand and gravel would be impermissibly impacted by the revetment. The Order also fails to acknowledge the full range of mitigation proposed by Mrs. Stone.

While the Order notes that Mrs. Stone proposes to reconstruct the dune "behind" the revetment, it does not acknowledge that she also proposes to add sand to the top of the revetment, increasing the crest of the dune. This specific form of mitigation, specifically identified in Section 5(I) of the Rules as desirable, increases the sand in the dune and positions it

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been redesigned so that overtopping, and thus flooding, would be less than with a vertical bulkhead. The basis for

so that it may be transported to the beach by the wind or when water that overlapped the revetment flows back to the beach. In either case, after sand is transported to the beach it will be replenished by Mrs. Stone. For sand moving in the opposite direction, the sloped face of the revetment better facilitates windborne movement than the bulkhead. With less scour and more sand on the beach, there would be more material available for this form of transport. With the design and mitigation measures proposed by Mrs. Stone, there will be a better supply of sand for movement than there was before the 2007 storm. In fact, compared to pre-2007 storm conditions, the revetment and associated mitigation proposed by Mrs. Stone would result in a net increase in sand available to the dune system; this can only be a benefit.

In the mitigation section of the Order, the Department also expresses concern that the negative impacts on the frontal dune from the placement of the revetment are not outweighed by the reconstruction of the dune behind the revetment. The benefits of the revetment, and they are not limited solely to the benefits associate with the reconstruction of the dune, are discussed at length above, as is why these benefits outweigh the costs. What should be added here in the discussion of mitigation proposed by Mrs. Stone, however, is that she also proposes to protect neighboring undeveloped property, which includes a coastal dune, with a conservation easement. No mention of this mitigation is provided in the Order either.

When the full range of mitigation and full range of benefits associated with the revetment are considered and compared to the costs, the benefits more than exceed the costs and reflect an overall improvement to the coastal sand dune system. No additional mitigation is needed.

MGS's comment regarding hydrostatic loading no longer exists.

C. The Revetment Will Not Unreasonably Interfere with Existing Scenic, Aesthetic, Recreational, or Navigational Uses – Department Conclusion A Should Be Corrected

The Department concludes in the Order:

> The proposed activity would unreasonably interfere with existing scenic, aesthetic, recreational or navigational uses in that adjacent properties may be damaged by construction of the proposed project.

(Order, Conclusion A.) This conclusion is based on MGS's opinion about what impacts may occur to adjacent properties. As discussed at length above in Section III(A)(1)(b) and (A)(2), there is no technical foundation for MGS's concerns. The proposed revetment will not adversely affect Mrs. Stone's neighbors, nor will it interfere, in an unreasonable manner or otherwise, with existing scenic, aesthetic, recreational, or navigational uses.

D. The Revetment Will Not Cause Unreasonable Erosion of Soil or Sediment or Unreasonably Inhibit the Natural Transfer of Soil from the Terrestrial to the Marine Environment – Department Conclusion B Should Be Corrected

The Department concludes in the Order:

> The proposed activity [1] would cause unreasonable erosion of soil or sediment and [2] will unreasonably inhibit the natural transfer of soil from the terrestrial to the marine environment.

(Order, Conclusion B.)

With regard to the first portion of this conclusion, the revetment, in fact, will minimize erosion compared to a replacement bulkhead. Scour on the beach will be significantly reduced and erosion behind the revetment will be reduced as a result of a reduction in overtopping. Because of the durability of the revetment, the likelihood of massive erosion resulting from structure failure also is minimized by this structure. These benefits of revetments, or similarly sloped structures such as riprap, are well known and have been recognized by the Department. (*See* DEP Rules, Ch. 305(4)(C).) When it comes to the prevention of erosion, there is no better

design alternative than the revetment. And if no structure were rebuilt at all (although this is a hypothetical scenario), erosion of the remaining sand dune would only be exacerbated.

With regard to the second portion of this conclusion, the mitigation proposed by Mrs. Stone ensures that the transfer of material from the dune to the beach will not be unreasonably inhibited. Whether the revetment or a replacement bulkhead is constructed, the natural movement of material will be impeded, as it has been for over 100 years. Admittedly, by reducing overtopping there will be less erosion, but this means there will be less material transport as well. Mrs. Stone believes she has struck the proper balance between minimizing erosion and ensuring nourishment of the beach. By building up the crest of the sand dune so that it covers the top of the revetment, and replenishing this sand as necessary, the dune will not be contained solely behind the revetment, the movement of sand will be facilitated through its exposure to the elements, and there will be sufficient sand to ensure adequate beach nourishment.

Neither the impact of the revetment on erosion nor the transport of material from the dune to the beach is unreasonable.

E. The Revetment Will Not Unreasonably Interfere with the Natural Supply or Movement of Sand or Gravel Within or to the Sand Dune System or Unreasonably Increase the Erosion Hazard to the Sand Dune System – Department Conclusion G Should be Corrected

The Department concludes in the Order:

> The proposed activity [1] would unreasonably interfere with the natural supply or movement of sand within or to the sand dune system and [2] would unreasonably increase the erosion hazard to the sand dune system in that the curved wall could redirect wave reflection at an angle to the beach potentially creating a rip-current type of flow across the sandy beach resulting in the preferential erosion on the seaward side of the proposed revetment.

(Order, Conclusion G.)

The concern articulated in this conclusion is that the reflection of wave energy from the

curved end wall could potentially have adverse consequences to the beach. With regard to the first portion of this conclusion, as explained above, compared to a bulkhead the revetment will significantly reduce scour on the beach. This means the supply of sand will be greater with the revetment and the unnatural movement of sand will be reduced. These benefits are greatest along the sloped edge of the revetment, but also will be realized along the revetment ends.

With regard to the second portion of this conclusion, regardless of the angle of reflection less scour would be associated with the revetment, including the transition areas, than with a vertical bulkhead. This is discussed at great length above in Section III(A)(1)(b).

As the technical information presented to the Department and summarized in this appeal shows, the revetment will not unreasonably interfere with the supply or movement of sand within the dune, nor will it increase erosion, unreasonably or otherwise.

IV. Stone's Standing

The preceding discussion demonstrates that Marion Stone, the applicant, is aggrieved by the Department's order denying her NRPA permit application.

V. Conclusion

The vertical bulkhead in front of Mrs. Stone's property has been destroyed and must be replaced. Whether it will be replaced with another bulkhead similar to one destroyed twice in the last 15 years or with the proposed revetment will be determined by the outcome of this appeal. Mrs. Stone believes the revetment is the better option – better for the protection of the coastal sand dune system, her property, and her neighbors' property. The technical information supports her beliefs. Mrs. Stone respectfully requests that the Board reverse the Department's denial of her permit application and approve the revetment.

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