

**WISCONSIN-LAKE MICHIGAN REVIEW CRITERIA
FOR
GROINS AND SOLID PIERS**

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THE WISCONSIN COASTAL MANAGEMENT PROGRAM part of the Wisconsin Department of Administration, and overseen by the **WISCONSIN COASTAL MANAGEMENT COUNCIL**, was established in 1978 to preserve, protect and manage the resources of the Lake Michigan and Lake Superior coastline for this and future generations

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PROJECT SUMMARY

The goal of this project was to provide the Wisconsin Department of Natural Resources (DNR) with scientifically sound methodologies for evaluating impacts of groins and solid piers along the State of Wisconsin's Lake Michigan shoreline and connecting bays. As part of this project the Institute for Wetland and Coastal Trainings and Research, Inc. (Institute) held two training sessions, one for the northeastern region of the state and one for the southeastern region. Prior to the training sessions, the Lake Michigan shoreline, and a number of pending and completed applications for groins and solid piers were reviewed. This information was used to develop the two training programs.

The training sessions presented factors necessary for conducting a scientifically sound review of applications for groins and solid piers. Special attention was given to addressing impacts on littoral drift, potential for increased erosion or deposition, and size and spacing of groins. The training also focused on the influence that bluff stratigraphy, profile shape, fetch length and sediment supply have on groin function. A copy of the training program is enclosed as part of this report. The Michigan Coastal Zone Management Program and the Bay-Lake Regional Planning Commission provided funding for this project.

PROBLEM DEFINITION

The Wisconsin DNR is responsible for reviewing applications to place groins and solid piers on the State of Wisconsin's lakebed. Presently there is no sound scientific methodology for DNR staff to use when evaluating applications for placement of groins and solid piers. In order to properly evaluate permit applications for these structures, it is necessary to develop criteria, guidelines and recommendations for their review. This study provides those criteria and guidelines. As a general rule placement of any shore protection structure will impact the shoreline. For example, seawalls and revetments impound material thereby preventing its movement from the bluff to the beach and bar system while groins impact the movement of sand along the shoreline.

PROJECT OBJECTIVES

The overall goal of this project was to develop and provide the DNR with tools necessary for staff to complete evaluations on impacts of placing groins or solid piers along the shoreline of Lake Michigan and connecting bays. To meet this goal the following objectives were accomplished:

1. Completion of a review of existing literature regarding the impacts of groins.
2. An on-site investigation of the Lake Michigan shoreline was conducted with assistance from DNR staff. The inspection provided a review of the nearshore, beach and bluff conditions both in areas where shore protection structures have been placed and along more natural shoreline areas.
3. Specific review criteria were developed that can be used by DNR staff in evaluating impacts of groins and solid piers.

It is the purpose of this report to summarize these objectives.

BACKGROUND

Groins have been used for the purpose of building recreational beaches and to retard beach and bluff erosion for centuries. During that time, design changes have resulted primarily from practical experience" Meadows (2001). Since the early 1900's and continuing today, groin research has been directed at the problem of effective groin design. However, even with the extensive research that has been completed, a great deal of controversy exists both in the literature and in practice over the effectiveness of groins as shore protection structures. In general, the purpose of groins along the Great Lakes has been to increase beach width, reduce wave energies and halt bluff erosion. They have not been used extensively to aid in extending the life of beach nourishments, as has been the case along the ocean coasts.

Solid piers, as a general rule are not a common feature along most Great Lake shorelines. As in Green Bay they are commonly used in areas of rocky substrates and moderate wave energies.

Very little if any research has been conducted on solid piers and their impacts on the coastal environment. However, for all practical purposes they function no differently and their impacts are the same as groins, therefore, they will be considered in the same context in this report.

LITERATURE REVIEW

In-Situ studies of groins have focused primarily along the east coast of the United States (Everts 1979 and 1983); (Sherman et al. 1990); (Galgano and Leatherman 1991); (Headland et al. 1987, Ludwick et al. 1987); (Posey and Seyle 1980); (Posey and Dick 1987). Meadows (2001) found that the overwhelming majority of these studies showed that, although the groin fields may have retarded erosion, they did not serve to stop it entirely.

Two field studies on groin design and impacts were conducted along the shoreline of Lake Michigan were conducted by Meadows *et al.* (1997, 1998). The first study evaluated impacts of individual 50 and 100 foot long high and low profile groins. The second study evaluated affects of a groin field consisting of 50 foot long high profile groins and included a reevaluation of a high profile 100 foot long groin to compare results with the previous study. The studies were conducted along a natural beach shoreline on Lake Michigan with no shore protection structures. Purpose of the studies was to evaluate impacts of length, height and placement of groins. Results of these experiments showed that high profile groins have a more severe and sustained impact on shoreline morphology than do low profile groins. However, a faster response to changes in incident wave direction was observed with the 50 foot groins. The study showed that individual groins impacted the shoreline approximately 4 times the length of the groin while the groin field impacted the shoreline 6 times the groin length. The groin field also showed a cross-shore impact of approximately 1 to 2 groin lengths lakeward of the groins. During the study period, the 0.6 m bathymetric contour was displaced landward from the end of the groins extending approximately 4 groin lengths updrift and 6 groin lengths downdrift. Regardless of the structures length or height, the groin field study found that there was a net loss of beach as well as a net volumetric loss of material from the lakebed.

Savage (1959) also found that high profile groins have a greater initial and more sustained response than low profile groins. Savage showed that a high profile groin reduces longshore transport by approximately 25 to 60 percent, dependent upon groin length, and that accretion on the downdrift side of a low profile groin will occur due to beach material overtopping the groin. Conclusions from these studies show that greater groin heights result in less material available for downdrift beaches and subsequently result in a greater the impact.

The amount of material interrupted by a groin is also dependent on groin length as shown by Savage (1959); Meadows et al. (1997) and Meadows et al. (1998). Numerical model work conducted for the Michigan Department of Natural Resources by Baird and Associates (1994) along the shoreline of Lake Huron showed that for smaller wave conditions, with a significant wave height of 0.5m, a 30m long groin with a height of 0.5m would influence almost all of the longshore transport. During smaller significant wave heights, the majority of transport was modeled to occur near the shoreline. Under larger wave conditions, with a significant wave height of 1.5m, Baird determined that a groin of 30m in length would influence all transport along the shore and over the inner bar, out to a distance of 30m. A 1m high groin under these conditions would influence over half of the transport for the inner or outer bar. This study showed that majority of transport occurs on or near the lakebed, and that as wave height increases a greater amount of longshore transport occurs over the outer bars as a result of larger waves breaking further from shore. Therefore, it can be concluded that longer groins, influence greater amounts of sediment.

In addition to reducing the longshore flow, long groins have been shown to divert the flow offshore; creating curved longshore bars (Horikawa and Sonu 1958) and the potential for rip currents. However, with smaller wave conditions, more sediment is transported closer to shore and rip currents created by groins are less likely.

Bodge and Dean (1987), conducted a study measuring changes in profile resulting from a low profile shore perpendicular structure on a natural beach. This study, consistent with findings from Baird (1994), showed the presence of two peaks in the longshore transport; one in the outer

middle of the surf zone and one at the shoreline. Based on work by Baird (1994), Bodge and Dean (1987) and Meadows (1997, 1998), it can be seen that both short and long groins have potential to influence longshore transport and the amount of transport influenced is related to groin length, height and wave dynamics.

As noted above, groin height plays a role in amount of littoral drift material influenced or captured by groins. Under small wave conditions, even low groins with a maximum height of 0.5m have the potential to influence a large portion of longshore transport. As a general rule, the majority of longshore transport occurs as bedload. Therefore, even a low groin can impact a substantial portion of transport depending on its length and height. As wave height increases, greater amounts of material are lifted from the lakebed and transported in the water column as suspended load or transported by saltation. In both cases some transport can occur over a low profile groin while a higher groin will interrupt greater amounts of material. In addition, since the top elevation of a low profile groin is lower, it takes less material and time to build up a fillet on the updrift side. This means that the lower the profile of the groin, the sooner material can overtop the groin and supply material to downdrift beaches. Depending on top elevation of a high profile groin, there is the possibility that overtopping will never occur and that the only way material can bypass is around end of the structure. When bypassing does occur around the end of a groin, the material travels some distance before working back to the shoreline.. Therefore, the area immediately downdrift of the groin does not get re-supplied with material resulting in accelerated erosion.

During both small and large storm events, some amount of longshore transport will occur along the shoreline and, therefore, placement of any groin will impact longshore transport. Hence, when reviewing a proposed installation of a groin, the lower the profile, the less material it will influence and the less the impact it will have on downdrift beaches. A 0.5m high groin will influence less material than will a 1.0m high groin, under similar wave conditions and, as groin height increases the impact will increase.

GENERAL CONCLUSIONS ON GROIN RESEARCH

A comprehensive review of groin literature conducted by Meadows (2001) found:

“That the majority of the research indicates that the effectiveness of groin structures relies on the availability of littoral material with which to fill the groin compartments, and/or a plan for nourishment of these compartments as conditions allow. Groin structures can be expected to adversely impact the downdrift property if the supply of sediment is low. Also, the existence of oblique waves approaching from a predominant direction and a relatively low sloping profile will improve the effectiveness of a structure. Most investigators also indicate that groins should be used only to maintain existing conditions, rather than enhancing beach volume or eliminating erosion. Based upon this summary, it can be seen that the process of groin design has not evolved significantly over the publication history. The concepts, which were important in 1939, remain important today. And controversy continues to exist over the extent to which groin structures will enhance the shoreline.”

Review of the literature completed by this author has shown that the vast majority of research on impacts of groins, that when groins function, assuming no beach nourishment, there will be a corresponding adverse impact on downdrift shorelines. This is true whether the research was conducted in the field, through numerical models, or in a laboratory setting. A few of the many field studies, which have shown downdrift erosion as a result of groin placement include:

(Macdonald and Patterson 1984); (Nersesian et al.1992); (Spataru and Negru 1977); (Everts 1983); (Lee 1961); (Brunn 1999), and (Robinson and Patterson 1975). In each of these studies there was updrift accretion and corresponding erosion on the downdrift side. Field studies conducted by Brunn (1999), and Robinson and Patterson (1975) showed a greater loss of material on the downdrift side of groins than was accumulated on the updrift side. These results

are consistent with results from Meadows (1997 & 1998), which showed a net loss of shoreland and net volumetric loss of bottom material.

There are also references within the literature that identify positive impacts associated with installation of groins. Some of these studies include (Overton et al. 1992); (Price et al. 1972); (Quigley et al. 1974), and (Moutzouris 1992). However, as is often the case where a positive impact is shown by the installation of groins, there are other factors which must be examined. For example, in the Overton et al (1992) study approximately 1.4 million cubic yards of nourishment had been provided during two years of the three year study thereby increasing success of the groin field and reducing the impacts to downdrift beaches. Results of this study also demonstrate the value of placing beach nourishment in conjunction with a groin system. Price et al (1972) indicates that the constructed groins resulted in a build-up of the beach in the immediate vicinity. However, they continue and state, "Although erosion would be expected downdrift, it is not immediately obvious." Quigley et al. (1974) completed their analysis without the benefit of either a detailed topographic or bathymetric analysis. In addition, they based success of the groins on whether the groins collected sand, created a wide beach, stored sand, and refilled rapidly. Their criteria for success did not mention "no adverse impacts" to down drift properties, which is essential to determining groin success. Of all the research reviewed in preparation of this paper, few studies showed a positive effect of the groin with no negative impact, unless mitigation such as beach nourishment was associated with the study site.

Price and Tomlinson (1968, 1970) made the following observations concerning the use of groins as shore protection based upon the results of several laboratory experiments. They found that groins installed on previously stable beach profiles resulted in a build up of sediment seaward of the groins. In contrast, groins placed on a previously eroded profile resulted in accretion within the groin field and a reduced level of offshore build up, which did not exceed the stable profile. This study supports the concept of identifying a stable beach elevation prior to groin construction. If groins are constructed, top elevations should be at the designed beach elevation.

Today coastal experts have become acutely aware and sensitive to adverse impacts associated with placement of shore protection structures such as groins. Along most coastal areas in the world, sand available for beach development is a finite resource and placement of shore protection structures substantially reduces, and in some instances halts the supply of sand to downdrift beaches. It has therefore become imperative that when considering installation of shore protection that impacts to downdrift beaches be considered.

The Federal Government, along with many states, are presently evaluating their practices regarding the issuance of permits for groins and the need to reduce impacts associated with placement of groins. One of the main topics of discussion is the idea of placement of beach fill. This is not a new concept; Lee (1961) identified the need for placement of beach fill with the installation of groins to reduce downdrift erosion. Lee was extremely sensitive to the potential for downdrift erosion and stated:

“The use of groins should be recommended only after a thorough study of their applicability in the specific area, their effect on adjacent shore areas, the need for the concurrent placement of sand fill, and the economics of periodic nourishment of the beach without groins.”

Lee's (1961) work was one of the earlier references to placement of beach fill when installing groins, but since that time other prominent coastal researchers including: (Brunn 1999); (Kraus et al. 1994); (Nersesian et a. 1992); (Komar 2000) have echoed the need for filling. Komar (2000) states:

“It should be mandatory that when society makes changes in the environment that adversely affect the budget of littoral sediments, the resulting beach erosion be dealt with by returning an equal volume of sand to the system in the form of beach nourishment. We are morally obliged to restore the beach by replacing the lost sand.”

Bruun (1999) listed six requirements that he believes are adamant for shore protection in, and they include:

- 1) The protection shall stabilize and improve beaches and dunes.
- 2) The protection must not have any adverse effects on neighboring shores.
- 3) The protection shall provide good aesthetics and a pleasing recreational beach.
- 4) Artificial nourishment of the beach shall be by suitable material, no pollutants accepted.
Grains must be as coarse or coarser - up to a limit - as the existing beach sand.
- 5) The material used for nourishment shall be secured without causing any damage to the environment.
- 6) The artificial nourishment operation shall be as economic as possible considering advanced experiences, as they become available.

Functional Groin Design

Prior to placement of groin(s) along the shoreline, a number of factors must be reviewed. Kraus et al. (1994), indicates that at least 27 parameters could effect a shoreline's response to placement of a groin structure. Brown (1939) made an early attempt to distinguish parameters important to coastal erosion control design. He identified nine principle characteristics of the past history of the beach that should be investigated and they included:

- geology of the beach,
- shoreline changes,
- offshore changes,
- wind records,
- storm effects,
- type of protective works installed and effectiveness,

- volume of sand moved,
- tides, and
- direction of littoral drift.

Berg and Watts (1965 and 1967), similar to Kraus et al.(1994) believed that a large measure of uncertainty exists in groin design and identified a number of factors that need to be addressed prior to construction. These factors include:

- littoral processes at the site as discussed by Brown (1939),
- groin type,
- groin height,
- groin length,
- groin permeability,
- construction materials, construction technique,
- maintenance,
- spacing of groins in a groin field, and
- beach material.

He further states that unless there is an adequate understanding of the littoral processes, the planning and utilization of groins will be subject to a high degree of uncertainty, (Meadows 2001).

Meadows (2001) reviewed several laboratory studies that focused on examining the effects of structure length, orientation and spacing within a field. The results consistently showed:

“Shore perpendicular orientation is the most effective configuration (Nagai, 1956; Nagai and Kobu, 1958; Barcelo, 1968 and 1970). A structure length of approximately 40 to 60 percent of the distance to the breaker zone proved to maximize accretion and minimize loss around the structure (Nagai, 1956; Nagai and Kobu,

1958; Horikawa and Sonu, 1958; Savage, 1959; Badiei et al, 1994). In fact, Fulord (1987) showed that the maximum longshore transport rate exists approximately 33% of the distance to the surf zone. In addition, groin spacing was consistently recommended at 3 times the structure length (Nagai, 1956; Nagai and Kobu, 1958; Horikawa and Sonu, 1958).”

With respect to structure length, it is important to remember that the more effective the structure is in holding material and reducing bypassing, the less material that will be available for transport to the adjacent shoreline.

The use of groins in erosion control was investigated by Silvester (1978, 1979 and 1990). He points Out that groins have no influence on erosion of the bed above the head of the groin and seaward of the groins, the bed will both deepen and steepen, thereby allowing larger waves to attack the shoreline. Consistent with other research, he notes that groins are only effective in building a beach when persistent waves are arriving at an oblique angle to the coast. Silvester also suggests that groins should be spaced at two to three times the groin length.

The limit of sand transport in groin design has been looked at by Hallermeir (1983). He found, similar to Meadows (1998) that longshore transport is usually retarded more by multiple groins rather than single groins and by high groins rather than low groins.

Kraus et al.(1994) identified instances where groins might not function well specifically identifying the Great Lakes as a location because “strong winds and relatively small fetches make steep (erosive) waves”. Silvester (1978, 1979 and 1990) also suggests that material retained by groins is often not retained because of storm induced rip currents which transport sediment offshore. These findings are consistent with observations of the author.

Variations in groin and pier design exist along the Great Lakes and include both “T” and “L” shaped designs and groins with openings. Very little research has been conducted relative to

these designs, but some general conclusions can be drawn. In general, both ~"T" and "L" structures will function similar to a straight groin and cause accretion on the updrift side and erosion downdrift. These structures will also cause scour at the lakeward end of the groin as a result of wave reflection off from the shore parallel end of the dock or groin. Therefore, there is potential for these structures to cause equal if not greater erosion downdrift as a result of both a blockage to longshore transport and also deepening of the nearshore profile. Relative to design of these structures, the same criteria apply to that of groins concerning the height, length and spacing of the structures.

If beach nourishment is used along with a field of "T" structures, sediment can be retained within the compartments. However, the profile will generally be steeper within the compartments than along the natural beach and bypassing of sediment will still be required to reduce impacts to downdrift properties.

The effectiveness of groins constructed with openings is extremely difficult to qualify, and of all the research reviewed for this report none addressed the physics of a gap-hole groin. Clearly, construction of a groin with more open space than closed will allow most of the sediment to bypass, however, such a groin will provide virtually no benefit to the property owner. In this case there is no value of the structure and issuance of a permit should be questioned. As open space is reduced the effectiveness of the groin in capturing material will increase as will erosion caused by the groin. There will be a point however, at which the holes become too small and material will not be transported through efficiently. It is all a question of what is an acceptable amount of erosion caused by the structure to downdrift properties and whether a permit can be issued for a structure that will not function. Due to the number of variables that can affect the function of a groin it would be extremely difficult to determine the size of the openings necessary to reduce erosion caused by the structure yet still provide protection to the property owner. It is therefore, recommended that serious consideration be given before issuing a permit for such a structure.

It is the authors opinion that if the intent of the DNR is to reduce impacts of placing a groin then the best way to do so is to lower the maximum elevation of the groin. The elevation should not

exceed elevation of the natural beach. In addition, beach nourishment will be much more effective with a low profile groin than with a gap-hole groin.

PERSONAL EXPERIENCE FROM THE STATE OF WISCONSIN'S LAKE MICHIGAN SHORELINE

As part of this study, a shoreline investigation was conducted for the Northeast and Southeast Regions of the Wisconsin Department of Natural Resources. For both regions it is apparent that there is a need to allow for bypassing of material captured on the updrift side of shore perpendicular structures extending into Lake Michigan and Green Bay. As noted in the report, beach available sand is a finite resource and blockage or removal of that sand from the system only reduces sand available for beach and sand bar building, both of which are necessary for dissipation of incident wave energy. It is therefore strongly recommended that all non-contaminated, beach compatible material that is dredged from fillets updrift of structures be deposited along the shoreline on the downdrift side, and not be removed from the system by depositing the material to an upland site. In addition, there are numerous projections extending hundreds of feet into Lake Michigan, which are presently blocking thousands of cubic yards of material that could be bypassed to the downdrift shoreline to reduce the severity of erosion occurring as a result of the blockage.

For small groins and piers, usually associated with single families, the least expensive method of moving sediment from the fillet to the other side of the groin is by dredging. There are also small hydraulic dredgers that can be used for sand size particles. However, most local contractors do not own a hydraulic dredge. Material any larger than sand size must be removed by a dredge. Numerous groin design problems were identified along the Lake Michigan shoreline in the southeast region. First, is the practice of installing massive groins having widths and heights in the range of 5 to 8 feet. Groins having such large dimensions occupy substantial state lakebed and are a total block to all transport moving along the shoreline landward of the lakeward end of the groins. In addition, the lakeward end of these large groins acts similar to any shore parallel structure and causes reflection and scour at the lakeward end. The placement of groins having a spacing of approximately 1 groin length away from adjacent groins was also identified as a

problem. Based on substantial research, a spacing of 3 groin lengths is optimum. Spacing groins a single groin length apart causes sand to bypass the groin compartment and makes the groins virtually ineffective in accumulating a beach. The material is then transported lakeward around the groins, still resulting in some impact on downdrift properties. Lastly, many of the groins observed were located on the downdrift property lines. Therefore, if there was an adverse impact, it will occur almost totally on the adjacent property.

The solid piers in the northeast region clearly showed signs of impounding drift material, and similar to groins in the southeast region, they occupied substantial lakebed. Accelerated erosion on the downdrift side, and substantial fillet formation on the updrift side were observed at many of the solid piers. As noted above, it is strongly recommended that bypassing of material from the fillets occur to reduce erosion on downdrift beaches.

One additional concern was observed along the shoreline in the southeast region related to the continual filling of debris over the bluff. Large fills were observed over the bluff along much of the southern Lake Michigan shoreline. In most cases, the fill material consisted of construction debris such as concrete, asphalt, rebar and soil, and was placed lakeward of the existing bluff. At some locations, the fill extended over 50 feet from the bluff, which already consisted of fill material. This fill material is easily eroded because it has no structural stability to withstand wave energies, and, aesthetically, it is a poor representation of the Lake Michigan shoreline. Erosion of the shoreline begins with downcutting of the lakebed. By continuing to fill lakeward, the property owners are exposing the bluff to greater and greater wave energies, which results in more rapid slumping of the fill material.

GROIN REVIEW FACTORS

The following groin review factors have been developed by the author from many years of personal experience in reviewing shore protection structures along the Great Lakes, and information gathered from the literature. These review factors are intended as a guide for review and not intended to be limiting.

1. If there are other groins in the area of the proposed structure answer the following questions:
 - Are they functioning, accumulating sand?
 - Are the groins filled to capacity?
 - Are they having an adverse impact, such as accelerated bluff erosion or foreshore scour?
 - Have they succeeded in protecting the backshore from erosion (solved the erosion problem)?
 - Are they having an impact on natural resources?
2. Is there an erosion problem along the shoreline that the structures are going to solve?
3. Is there a sediment supply that is available for capture?
4. Will length of proposed groin(s) result in intersection of the 1st and or 2nd bar?
5. What is the composition of the lakebed?
6. Is the property presently protected?
7. Is the proposal mitigated to maximum extent possible?
 - a. Groin length
 - b. Groin height
 - c. Groin spacing
 - d. Total number of groin(s)
 - e. Width of groin(s)
 - f. Proposed location of groin(s) on property
8. Consider all possible alternatives. You do not have to accept the applicant's proposal as the only alternative.
9. Are groins necessary?

10. What impact will issuing this permit have on the surrounding area and future applications (cumulative impacts)?

11. Maintain consistency between staff Contractors work along the entire shoreline, staff do not.

If issuance of a permit is being considered after completing a thorough review of the site conditions, the potential downdrift impacts must be evaluated and mitigation options included. Options include installation of low profile groins that extend no higher than the designed/natural beach elevation. This position has been supported by Meadows (1997), Savage (1959), Wang (1979), Brown (1939) and Hallermier (1983) who found that low profile groins resulted in less adverse, impact on downdrift beaches than high profile groins. Low profile groins will allow for overtopping and bypassing of material to the adjacent shoreline. A second mitigation option includes pre-filling of the groin compartment to allow for immediate bypassing of material. However, it is important to understand that, given the frequent changes in drift direction and the erosive nature of storm waves on the Great Lakes, the groin compartments will empty and nourishment must be supplied on an ongoing basis.

When reviewing a proposed groin field, one mitigation option, which has been reviewed by Bruun (1952), is tapering groins in the downdrift direction at a 6 degree angle. Bruun's numerical model work showed that a 6 degree angle will allow for bypassing of material and a smooth transition from the field back to the downdrift beach. From strictly a coastal processes standpoint, this design shows some merit. However, there has been no documented evaluation of this design within the literature. In addition, from a practical standpoint, regulatory staff seldom have the opportunity to review an entire groin field; they are usually faced with individual groin applications from single property owners. Therefore, from a practical standpoint, tapering of groins may not be viable in regulatory decision making.

The United States Army Corps of Engineers published a section in their Technical Notes a section entitled "Groins-Their Applications and Limitations". A copy of the document is enclosed with this report and is a useful tool in evaluating proposed groin installations. The

majority of the information contained in the document has been referenced in the literature and in most cases can be scientifically supported.

GROIN REVIEW CRITERIA

It is strongly recommended that the WDNR consider a policy statement indicating that groins are to be used as a measure to hold an existing beach and not create a beach. This position will be a major step toward reducing impacts on downdrift properties. At times, assuming appropriate mitigation measures are taken, groins may be used to create a public beach.

When reviewing an application for construction of a groin(s) one of the first factors to review is the need for shore protection. If there is no need for the protection it may be inappropriate to permit placement of groins.

Downdrift Impacts - Based on research conducted in Lake Michigan regarding the zone of impact of groins, one can anticipate accelerated erosion downdrift and accretion updrift of approximately 4 groin lengths. This distance exceeded the conventional wisdom that the effect is between 2 and 3 groin lengths. For groin fields the affected area was measured at 6 groin lengths. It is therefore recommended that for applications proposing to install groins which extend above the existing beach, that the groin be placed sufficient, 2.5 to 4 groin lengths, distance from adjacent property lines to reduce impacts to adjacent beaches.

Groin Height - Groin height, as stated in the report above, plays a major role on the impact a groin will have on a shoreline. As a general rule the greater the groin height the greater the impact the groin will have on the shoreline. It is the opinion of this author and consistent with findings of Price and Tomlinson (1968, 1970) that it is important to identify a stable beach elevation prior to groin construction. Therefore, a designed beach elevation has to be identified. Structures exceeding the natural beach or designed beach elevation pose a greater erosion risk than do groins which do not exceed the natural beach elevation. Further study is required to identify a natural or designed beach elevation along the State of Wisconsin's Lake Michigan

Shoreline. Until further work is completed in the area of establishing a designed beach elevation it is recommended that groins not extend greater than 18 inches above the average water level on Lake Michigan. It is important to realize, that under many circumstances even groins extending only 18 inches above average water level may cause accelerated erosion on downdrift beaches.

Groin Width - When reviewing groins the minimum width necessary for structural stability should be considered. The Army Corps of Engineers Technical Report on Groins, copy enclosed provides design examples. Groins having widths as narrow as 6" have been constructed using sheet pile along the shorelines of the Great Lakes and wood groins having widths from 12 to 16 inches are also common. Groins having excessive widths occupy state owned lakebed and may impact aquatic habitat and should therefore be discouraged.

Maintenance/Erosion Mitigation - When it is determined that a permit can be issued, provisions should be made to assure that mitigation of future erosion on downdrift beaches is considered. The initial mitigation measure that should be considered is beach nourishment of downdrift beaches. Even when groins are constructed with a top elevation at the natural beach elevation there may be future adverse impacts associated with the groins. It is therefore important to consider future mitigation requirements.

Groin Functionality - When it is determined that groins will not function it may be inappropriate to issue a permit to occupy state lakebed for a structure which will serve no purpose. Circumstances when a groin(s) may not function include: 1) When groins are located less than two groin lengths apart; 2) When there is insufficient material in transport along the shoreline to build a beach; 3) When the beach profile is too steep to hold a sand beach; and 4) when existing groins have blocked transport adjacent to the proposed groin.

Alternatives - Consideration of other shore protection alternatives should be given for every application to install groins. These may include placement of the following: beach nourishment, rubble mound revetment, seawall, or do nothing.

RESOURCES THAT WILL AID IN REVIEW OF SHORE PROTECTION STRUCTURES.

In completing a review of an application for placement of groins, always review aerial photographs, preferably photographs taken from different years. Aerial photographs can provide the following information:

1. An inventory of other groins along the shoreline
2. How well groins have functioned or are functioning
3. What impact existing groins have had or are having on the shoreline
4. Shape of the shoreline
5. Presence of bars

NOAA Navigational Charts can provide valuable information. If there is little sand in transport, and the offshore profile is oversteepened and too deep for cross-shore transport, groins will function poorly if at all.

Geologic maps can provide a preliminary indication of the bluff stratigraphy and composition of the lakebed. It is critical to know the lakebed composition because of the potential for downcutting in the foreshore.

Always conduct an on-site investigation for all groin applications. Some areas are simply not suitable locations for groins and an on-site review may be the only way to tell.

The applicant should supply the following items to aid in the review:

- a. Total length of the proposed pier or groin
- b. Total width of the proposed pier or groin
- c. Elevation of the proposed pier or groin along the entire length
- d. Potential longshore transport calculation including direction of net transport

- e. Distance groin or pier is proposed from the property lines
- f. Proposed spacing between groins
- g. Type of construction including materials proposed to be used

- h. Proposed alternatives considered
- i. Is there existing shore protection in place
- j. Statement of why the groin(s) or pier(s) is proposed, what is its purpose
- k. Distance from permanent structure to top of bluff
- l. Site plan showing proposed groin(s) or pier(s), top of bluff, property lines and measurements

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