Basalt International™

Coastal Stabilization Proof of Concept

Documented Great Lakes Case Studies & Client Installation Framework

Prepared in Basalt International brand style for client review

Nature + Technology | **Documented Restoration** | **Installation Pathway**

The Cost of an Eroded Shoreline

OWNER ECONOMICS

Erosion is priced into the asset long before any land is lost.

$1.5T

Coastal tourism

Direct revenue and 52M jobs supported by coastal and marine tourism — roughly half of all global tourist spending.

25–35%

Valuation discount

The spread at which erosion-impaired beachfront trades against comparable protected shorefront.

$65B

Adaptation gap

Estimated annual investment required to protect coastal tourism destinations worldwide.

Retreat

Insurability

Lenders and insurers now price erosion exposure directly, impairing values in the present.

An eroded beach has no room for towels and no tourist value. It stops earning, it stops protecting the real estate behind it, and it is repriced by every lender, insurer and appraiser who looks at it.

Why Hard Structures Fail

THE CONVENTIONAL APPROACH

Seawalls, revetments and jetties transfer the problem rather than solving it.

1. **Reflected wave energy**

   A vertical wall returns incoming energy to the water column instead of attenuating it, intensifying wave action at the wall face.

2. **Toe scour and undermining**

   Reflected energy excavates sediment at the base of the structure. The wall survives; the beach in front of it does not.

3. **Downdrift starvation**

   Jetties and T-groins interrupt longshore sediment transport — protecting one property by starving the next.

4. **Continuous failure mode**

   A hard structure behaves as a single continuous element, so localized storm damage can propagate along its length.

Documented at Grand Haven

Six layers of failed seawall were removed from the Grand Haven site before the recovery system was installed. Each layer was a prior attempt to hold the shoreline with a hard structure, and each had been overtaken by the same erosion it was built to stop.

The site is now a vegetated dune. The system that recovered it is buried beneath the sand it captured.

The conventional approach was tried here six times before it worked once.

The Recovery Process

FIVE STAGES, ONE METHOD

Every installation follows the same sequence; every design is site-specific.

1 Assess

Scientific review of wave climate, sediment supply, bathymetry, longshore transport and environmental conditions.

2 Design

Site-specific Coastal Accretion Design: structure geometry, spacing, crest elevation and offset, set to measured hydrodynamics.

3 Permit

Federal, state and local approvals. The nature-aligned approach is positioned favourably against continuous hard structures.

4 Install

Basalt composite system placed by the field team. Lightweight, corrosion-free, no deep foundations required.

5 Accrete

Wave action re-deposits suspended sand in stable layers. The berm widens, the beach face softens, the system is buried.

Recovery is measured in months, not days. Documented accretion is typically observed over a 12–24 month horizon, with the shoreline continuing to build thereafter.

How Accretion Works

THE MECHANISM

The sand stays because it is continuously re-deposited, not because it was placed.

1	**Suspension**	Wave action lifts sand into the water column across the active profile.
2	**Settling**	As the water slows, coarse grains settle first, then finer grains behind them.
3	**Layering**	Each wave cycle lays down a thin, graded deposit of sand.
4	**Accumulation**	Over days to weeks the layers build a wider berm and a gentler beach face.
5	**Burial**	The system disappears beneath the sand it captured. The beach is recovered.

Versus barge nourishment

Mass-deposited sand persists only until the next storm removes it. Re-deposition is driven by the wave climate itself, which is why the recovery holds.

What the recovered beach delivers

Restored usable width and tourist value · protection of the real estate behind it · habitat and fishery return · a storm and sea-level buffer that rebuilds itself.

Installation

DELIVERY SEQUENCE

What happens on site, who performs it, and how long it takes.

1 Mobilization

- Site access and staging
- Marine plant and equipment
- Crew composition and size
- Seasonal working window

2 Placement

- Survey control and set-out
- Structure positioning
- Anchoring and tensioning
- Tolerance and verification

3 Completion

- As-built survey
- Site restoration
- Handover documentation
- Monitoring programme

INSTALLATION SEQUENCE Placement through recovered beach to mature vegetated dune, with the Coastal Accretion System shown in section.

Permitting Pathway

APPROVALS

Sequenced, scoped and initiated before mobilization.

1	**Federal**	U.S. Army Corps of Engineers authorization under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act for work in navigable waters.
2	**State**	State environmental and coastal-zone authorization, including submerged lands consent where the structure sits below the ordinary high-water mark.
3	**Local**	Municipal and county approvals, shoreline setback review, and any applicable coastal construction control line permitting.
4	**Environmental**	Habitat, protected-species and water-quality review. The nature-aligned approach is generally received more favourably than continuous hard structures.

Note on the Army Corps relationship

Basalt International's military-specification composite formulation was designed, tested and accepted in collaboration with the U.S. Army Corps of Engineers. That acceptance relates to the **composite seawall material**. It is not a permit and not an endorsement of any shoreline design. Permitting is required for every project.

Proof of Concept Overview

Documented. Nature-Aligned. Client Ready.

Purpose

Demonstrate a client-ready pathway for shoreline stabilization using documented historical case studies.

Evidence Base

Before-and-after outcomes across multiple Lake Michigan sites show durable performance over decades.

Client Value

Reduced erosion risk, restored beach and dune profile, and a nature-aligned installation concept.

Package Components

- Site review & data analysis
- Concept layout & design
- Installation planning
- Performance monitoring

Grand Haven, Michigan

Federal Harbor Adjacent Beach & Dune Restoration

Nature and technology work together to restore the beach and dunes next to a federal harbor

Six layers of negative sea-walls removed prior to installation of positive energy system

Patented undercurrent stabilizers that helped reverse beach erosion are now buried by rising sand levels

Nature + Technology

Working together to restore dunes and beaches.

Documented Restoration

Six layers of negative sea-walls removed prior to installation of the positive energy system.

Installation Pathway

Patented undercurrent stabilizers help reverse erosion and are now buried by rising sand levels.

Manistee, Michigan

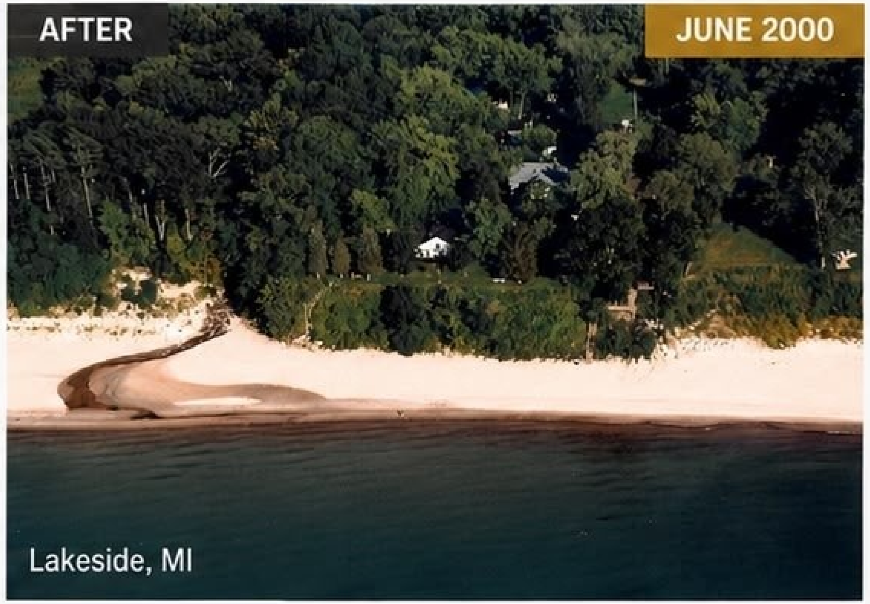
State Project North of Federal Harbor

1993 → 1999

- State of Michigan project located north of the federal harbor at Manistee, Michigan.
- Patented undercurrent stabilizers installed north of Scotland Yard Cottages.
- Project reversed beach erosion north of Orchard Beach State Park.

Lakeside, Michigan

Aerial Before-and-After Documentation



Aerial shoreline documentation
Lakeside, Michigan.

1987 Before
Narrower beach with limited dune width and exposed shoreline pressures.

June 2000 After
Substantial beach widening and vegetative recovery with an improved dune and beach profile.

Nature + Technology | **Documented Restoration** | **Installation Pathway**

Muskegon County, Michigan

Public Beach and Dune Restoration

Nature and technology work together to restore public beaches and dunes

Meinert Park, Muskegon County, Michigan

Nature and technology work together to restore public beaches and dunes.

✓ Visible improvement in dune grass, beach width, and shoreline condition.

Duck Lake State of Michigan Project

Shoreline stabilization next to negative rip-rap.

✓ Severe erosion next to negative rip-rap.

✓ Erosion reversed after Stabilizer System installed next to rock revetment.

Nature + Technology | Documented Restoration | Installation Pathway

Douglas, Michigan

Vanderplas Beach Restoration

Site located at Lakeshore along Lake Michigan south of Douglas, Michigan

Site condition at Vanderplas before treatment

Vanderplas's beach restoration project

Shoreline Stabilization
Reinforced shoreline with natural stone and structural elements to reduce erosion and protect the bluff.

Improved Beach Conditions
Restored a stable, functional beach with improved access and recreational value.

Natural + Sustainable Approach
Integrated nature and technology for durable, environmentally responsible restoration.

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Additional Shoreline Evidence

Field Documentation of Recovery

Additional before-and-after field views show widened beaches, increased dune vegetation, and improved shoreline continuity.

Wider Beaches
Significant increase in usable beach width and sand volume.

Increased Dune Vegetation
Natural dune plant communities established and expanding.

Improved Shoreline Continuity
Smoother transitions and more continuous, resilient shoreline.

These additional field views reinforce the documented trend of shoreline recovery and support the overall case-study narrative.

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Independent Engineering Validation

Progressive Architecture Engineering Letter

July 25, 2003

ProgressiveAE

Mr. Dick Holmberg
Holmberg Technologies, Inc.
1775 Chadwick Road
Englewood, FL 34223

Re: Douglas Michigan
Lakeshore Drive Study
November 1988

Dear Dick:

It was a pleasure to talk with you last month and I thank you for the updated information that you sent me on your projects in Michigan, Florida, and Saudi Arabia.

Since I was the licensed civil engineer on the Lakeshore Drive Study in Allegan County, Michigan in 1988 and recommended in the report that the "Undercurrent Stabilizer" technology be used as the preferred solution for the project, I have periodically visited the area since then to observe what has happened. Although the county could not afford the recommended solution, I was glad at the time that they had you install the smaller system to try to save the section of road that was in jeopardy of being lost just north of 130th Avenue on Lakeshore Drive.

Based upon the documented surveys done by WBDC, Inc. and Dr. Straw, at Western Michigan University (WMU), it was apparent in 1990 and 1991 that the system was a success and my personal observations since have visually confirmed the system over time has performed as predicted. The shoreline has expanded, the beach has elevated and vegetation on the slope has been re-established. I would hope at some future date, that the studies by WMU could be continued to document the success of the system.

Please stay in touch, we work on many inland lakes, occasionally on the Great Lakes and there may be future opportunity to use your technology on severe erosion sites that we run across in the future.

Sincerely,

PROGRESSIVE ARCHITECTURE ENGINEERING

Ronald J. Kadelski

Ronald J. Kadelski, P.E.
Senior Project Manager

July 25, 2003
Letter to Mr. Dick Holmberg, Holmberg Technologies, Inc.

From Ronald J. Kadelski, P.E., Senior Project Manager
Licensed civil engineer on the Lakeshore Drive Study in Allegan County, Michigan in 1988.

> ***the shoreline has expanded, the beach has elevated and vegetation on the slope has been re-established.***

- Documented surveys by WBDC, Inc. and Dr. Straw, at Western Michigan University, indicated the system was a success in 1990 and 1991.
- Personal observations confirmed the system has performed as predicted over time.
- Positive outcomes include shoreline expansion, beach elevation, and re-established slope vegetation.
- Supports the effectiveness and long-term performance of the Basalt system.

Nature + Technology | **Documented Restoration** | **Installation Pathway**

Independent Supporting Documents

THIRD-PARTY EVIDENCE

Beach Recovery Foundation summary incorporated into the proof-of-concept package.

Concern	Representative Study / Source	Key Finding
1 **Performance**	Orchard Beach Park Demonstration Project — Undercurrent Stabilization / Accretion Program, Interim Report on 1993–1994 Surveys An Evaluation of Undercurrent Stabilization Anchor System Installation at Douglas, MI Soft Protection Using Submerged Groin Arrangements — Dynamic Analysis of Systems Stability and Review of Application Impacts	Consistent profile volume gain near the experimental shore protection structure, measured against the regional trend of profile volume loss at an analogous control site, with significant foreshore and backshore accretion and no apparent downdrift impact. Increase in beach width over the entire site and the area immediately north and south. Across three years of monitoring at all sites, submerged groin systems showed no adverse impact and in no case was shoreline recession observed; accretion of sand or fine gravel occurred to varying degree, and in one case was massive.
2 **Sand Migration**	Beach Monitoring Report, October 1987	Beach frontage just north of R-97 recorded a net gain of 10,100 cubic yards; the stretch immediately north gained 7,640 cubic yards and the area to the south approximately 10,850 cubic yards.
3 **Aquatic Environment**	Captiva Erosion Prevention District Benthic Monitoring	Results consistent with May 1986 observations: large numbers of coquinas (Donax variabilis) were found.
4 **Water Quality**	Captiva Erosion Prevention District Benthic Monitoring	An amphioxus was recovered in one sample; this primitive chordate is regarded as an indicator of excellent water quality.
5 **Maintenance / Durability**	Soft Protection Using Submerged Groin Arrangements — Dynamic Analysis of Systems Stability and Review of Application Impacts	ANSYS analysis indicates a factor of safety of the order of 3.0 under fifty-year return wave characteristics, with no failure risk under the extreme wave climate assumed.

Performance
Multiple studies document beach gain and profile improvement.

Sand Migration
Measured volumetric sand gains demonstrate accretion, not loss.

Aquatic Environment
Benthic monitoring found healthy marine life presence.

Water Quality
Biological indicators support excellent water quality.

Maintenance / Durability
Engineering analysis supports long-term structural reliability.

Evidence Register — Citation Detail

INDEPENDENT SUPPORTING DOCUMENTS

Author, sponsoring institution and recorded finding for each document summarized on the preceding slide.

Concern	Document / Study	Author	Sponsor Organization	Position / Findings
1 **Performance**	Orchard Beach Park Demonstration Project — Undercurrent Stabilization / Accretion Program, Interim Report on 1993–1994 Surveys An Evaluation of Undercurrent Stabilization Anchor System Installation at Douglas, MI Soft Protection Using Submerged Groin Arrangements — Dynamic Analysis of Systems Stability and Review of Application Impacts	David A. Barnes, Associate Professor of Geology; Coastal Monitoring Project Manager Dr. Thomas Straw, Head of Research; Chairman, Department of Geology C. L. Goudas, G. A. Katsiaris, G. Labeas, G. Karahalios, G. Pnevmatikos	Western Michigan University — Great Lakes Coastal Research Program Western Michigan University Departments of Mathematics and Physics, University of Patras, Greece	Consistent profile volume gain near the experimental shore protection structure, measured against the regional trend of profile volume loss at an analogous control site, with significant foreshore and backshore accretion and no apparent downdrift impact. Increase in beach width over the entire site and the area immediately north and south. Across three years of monitoring at all sites, submerged groin systems showed no adverse impact and in no case was shoreline recession observed; accretion of sand or fine gravel occurred to varying degree, and in one case was massive.
2 **Sand Migration**	Beach Monitoring Report, October 1987	George F. Young, Inc.	Captiva Erosion Prevention District	Beach frontage just north of R-97 recorded a net gain of 10,100 cubic yards; the stretch immediately north gained 7,640 cubic yards and the area to the south approximately 10,850 cubic yards.
3 **Aquatic Environment**	Captiva Erosion Prevention District Benthic Monitoring	Peter K. Gottfried	Natural Systems Analysts, Inc. for the Florida Department of Environmental Regulation	Results consistent with May 1986 observations: large numbers of coquinas (Donax variabilis) were found.
4 **Water Quality**	Captiva Erosion Prevention District Benthic Monitoring	Peter K. Gottfried	Natural Systems Analysts, Inc. for the Florida Department of Environmental Regulation	An amphioxus was recovered in one sample; this primitive chordate is regarded as an indicator of excellent water quality.
5 **Maintenance / Durability**	Soft Protection Using Submerged Groin Arrangements — Dynamic Analysis of Systems Stability and Review of Application Impacts	C. L. Goudas, G. A. Katsiaris, G. Labeas, G. Karahalios, G. Pnevmatikos	Departments of Mathematics and Physics, University of Patras, Greece	ANSYS analysis indicates a factor of safety of the order of 3.0 under fifty-year return wave characteristics, with no failure risk under the extreme wave climate assumed.

Delivery and Engagement

WHY BASALT INTERNATIONAL

Vertically integrated from quarry to installed system.

1 Vertical integration

Quarry, fiber production and finished systems under one company. Cost certainty, quality control and schedule reliability without third-party supply risk.

2 Material performance

100+ year service life. Non-corrosive in seawater, no rot, no rust, no cathodic protection. Marine-life compatible, sustainable and recyclable.

3 Engineering bench

The AIT Composites and Bridge teams joined Basalt International in 2024, adding more than fifty completed composite structures and university-tested design capability.

ENGAGEMENT PATHWAY

1. Site assessment
2. Concept and design
3. Permit support
4. Installation
5. Monitoring

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