

# Coastal examination

## Hervey Bay



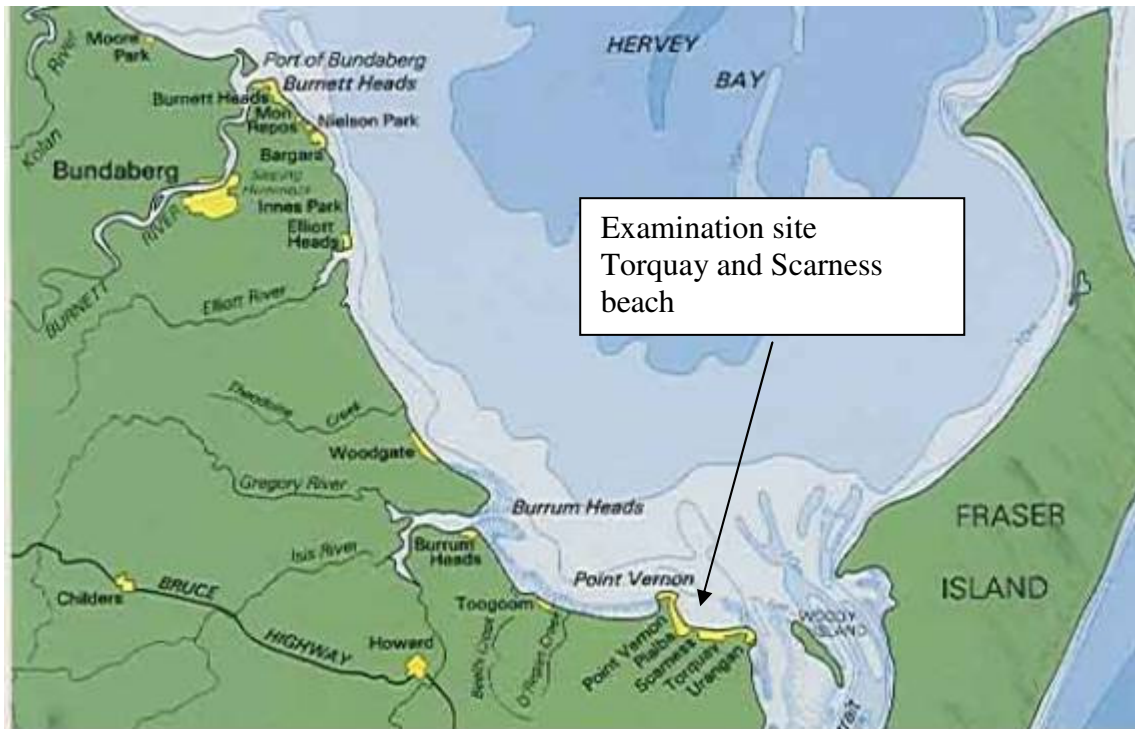
**Hervey Bay January 2002**

**This report must only be published in the full length of 32 pages**

**Confidential**

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Coastal examination.



**Status 1877 - 1982.**

**Torquay Beach**

The first survey plans for this beach are from 1877 and 1881. These plans indicate about 12 metres of erosion at the eastern end of the beach between 1881 and 1948 with relative stability along the remainder of the beach. After 1948 the beach has been generally stable with the exception of the area between Ann and Robert streets where a small local embayment has developed. By 1975, this embayment had resulted in loss of trees from the esplanade area.

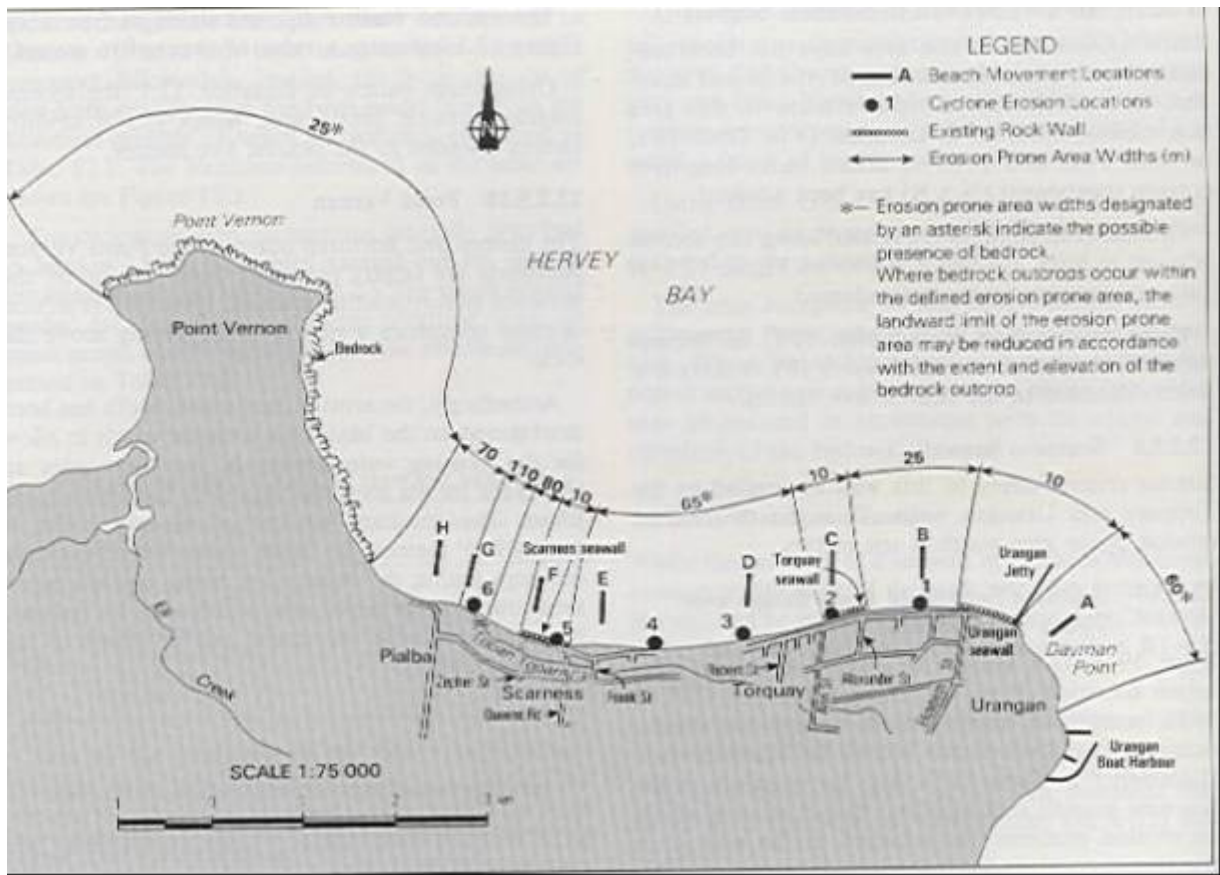
**Scarness.**

The first survey plans of this beach are dated 1871. From these plans it is estimated that the eastern end of this beach opposite Frank Street accreted some 35 metres between 1871 and 1948 and then remained stable except for seasonal fluctuations since that time. Further west between Queens Road and Zephyr street about 25 metres of erosion is indicated between 1871 and 1958.

This was followed by a period of relative stability and then some further minor erosion associated with a change in position of the mouth of Toon Creek in 1975.

A rock wall was built to protect the esplanade in this area in 1981/82.

Erosion rate.



		1871 1948	1948 1958	1958 1975	1975 1982	Average per Year
1948						
Urangan	B	+0	-8	+0	-2	-0,09
Torquay	C	-12	+2	+0	Seawall	-0,09
Torquay	D		+3	-10	+5	-0,05
Average metre per Year						-0,08
Scarness	E	+35	-2	+5	+8	+0,42
Scarness	F	-25		-5	Seawall	-0,27

**Examination site**



The examination site is 3000 metres on Torquay and Scarness beach. Station burr 505 is equal to station 1000 in the local SIC survey system.

It was first planned to establish the SIC system on 4000 meters on Urangan and Toquay beach to see the effect in big scale.

After press from Professor Peter Nielsen QLD University in cooperation with the Coastal manager Per Roed Jakobsen Denmark the test installation was changed to two systems on Torquay and Scarness beach with following configuration.

Station 0 – 500	no PEM
Station 500 – 1000	PEM
Station 1000 – 1500	no PEM
Station 1500 – 2500	PEM
Station 2500 – 3000	no PEM

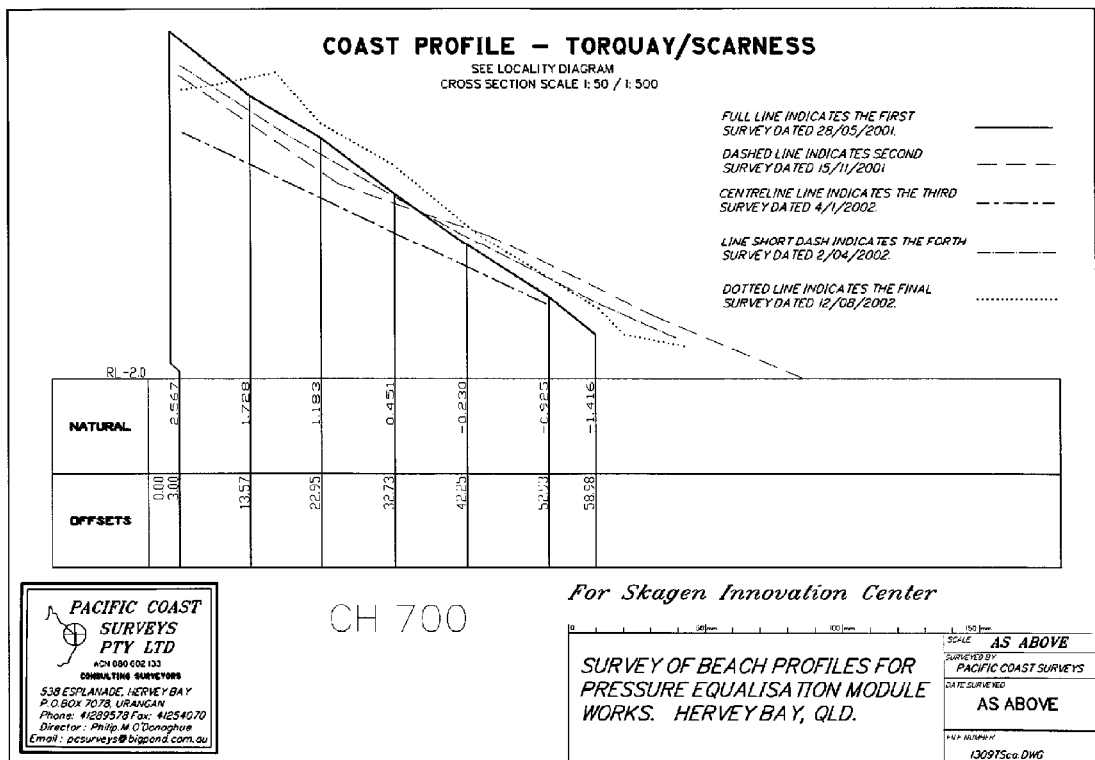
The problem with small systems is well known from Denmark because you have no effect in the first and the at last row of PEM.

If the site is reduced to 1000 metres the effect of the PEM is reduced with 35 %.

In agreement with EPA. SIC have installed 2 PEM Systems under different conditions in Hervey Bay.

## Survey

Survey was arranged with a local survey company and is done few days after installation in the end of may 2001 and in november 2001 and in August 2003.



The survey plans shows also survey of the area 4 January 2002 and 2 April 2002, but I know the survey the 4 January is not done, and I don't believe the survey is done the 2 April 2002. Therefore the survey from January and April have no value in this evaluation.

## Weather conditions.

Hervey Bay was hit of heavy storms in October and December 2001 and Scarness beach was lowered up to 1,0 metre.

It was necessary to replace the most of the pipes after this storms on Scarness beach.

In January we submerged the most of the pipes on Scarness Beach.

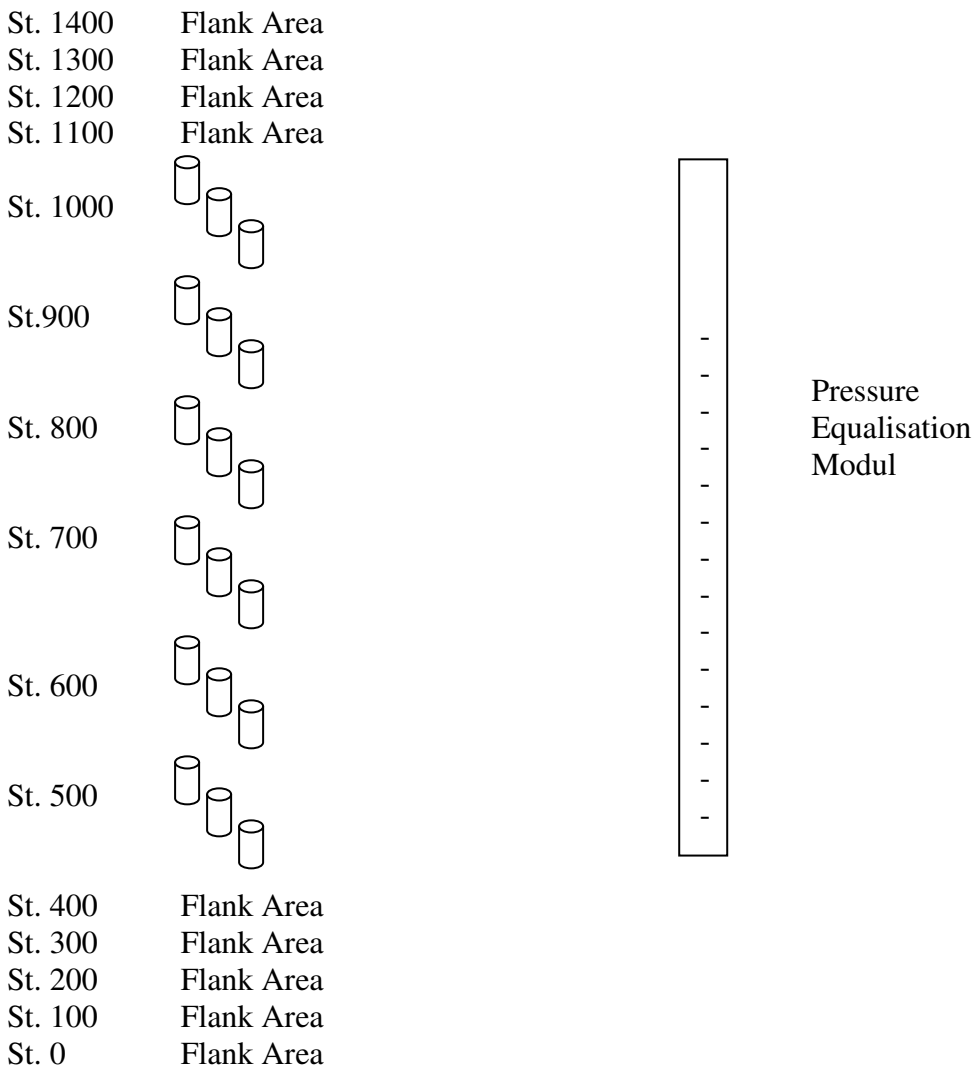
## System 1 - Torquay Beach.

Torquay beach from st. 500 - st. 1000 with rock revetment in the background.

Flank area 1 from st. 0 - st. 500 with Rock revetment in the background.

Flank area 2 from st. 1000 - st. 1500 with vegetation in the background.

Torquay



PEM System -Torquay

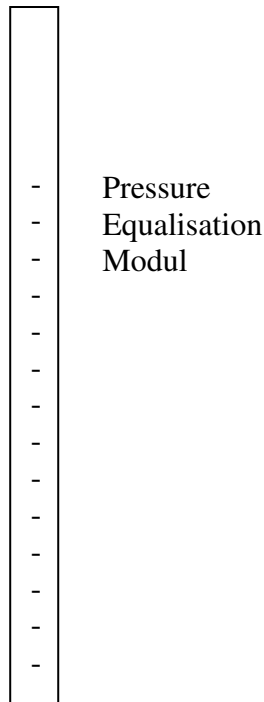
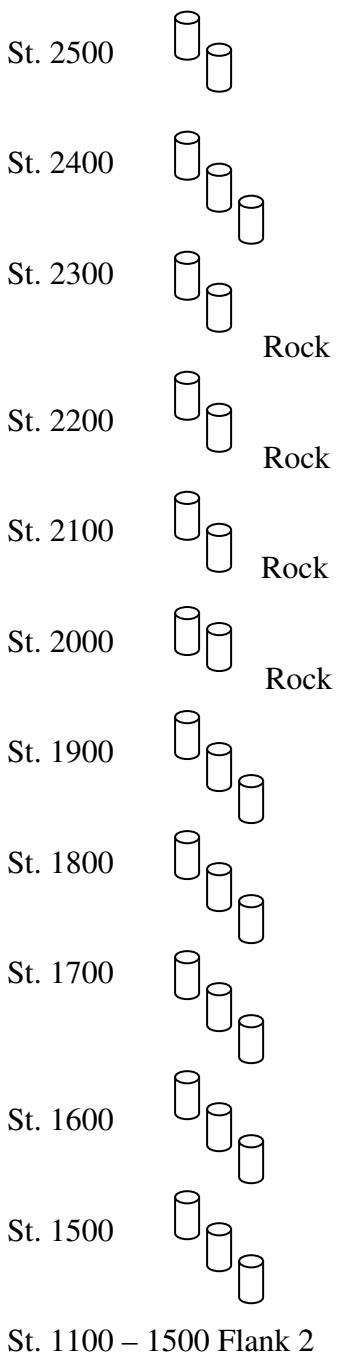


	Beach Width	Erosion/ Accumulation
Station 1400	-195 cm	-4,1
Station 1300	-130 cm	-7,5
Station 1200	0 cm	0,0
Station 1100	65 cm	3,0
<b>Average</b>	<b>-78 cm</b>	<b>-2,2</b>
Station 1000	0 cm	0,0
Station 925	30 cm	-2,4
Station 850	130 cm	0,0
Station 775	130 cm	+4,1
Station 700	325 cm	+13,5
Station 625	390 cm	+10,0
Station 550	0 cm	+0,6
Station 500	0 cm	+0,9
<b>Average</b>	<b>126 cm</b>	<b>3,3</b>
Station 400	0 cm	-0,6
Station 300	-100 cm	-4,0
Station 200	-65 cm	-2,7
Station 100	-130 cm	-2,5
Station 0	-130 cm	-2,5
<b>Average</b>	<b>-85 cm</b>	<b>-2,7</b>

System 2 - Scarness



St. 2600 – 3000 Flank 3



Scarness



Station 3000	0 cm	-1,8
Station 2900	0 cm	0,0
Station 2800	0 cm	-1,3
Station 2700	-65 cm	-14,4
Station 2600	-65 cm	-5,0
<b>Average</b>	<b>-26 cm</b>	<b>-4,5</b>
Station 2500	0 cm	0,0
Station 2475	130 cm	4,9
Station 2400	0 cm	10,8
Station 2325	0 cm	3,0
Station 2250	0 cm	0,0
Station 2175	-65 cm	-1,0
Station 2100	-130 cm	-6,0
Station 2025	-130 cm	-4,0
Station 1950	0 cm	-0,0
Station 1875	-65 cm	-1,3
Station 1800	65 cm	3,5
Station 1725	-130 cm	-4,0
Station 1650	-130 cm	-5,0
Station 1575	-130 cm	-6,0
Station 1500	-130 cm	-5,0
<b>Average</b>	<b>-48 cm</b>	<b>-0,7</b>
Station 1400	-195 cm	-4,1
Station 1300	-130 cm	-7,5
Station 1200	0 cm	0,0
Station 1100	65 cm	3,0
<b>Average</b>	<b>-97 cm</b>	<b>-2,2</b>



Flank 1 St. 1100 – 1500 January 2002  
**The waves have taken materials 2 metre behind the survey area**



Flank 3 Station 2500 – 3000 – January 2002  
**The fence is fallen. The dune foot is lowered more than 1 metre**



**Testarea - The fence is still standing**



**Test area – The beach is wide and dry.**



1. June 2001.  
The beach is very wet in the front.



October 2001  
The Beach is now dry in the front



1. June 2001  
The beach is very wet in the front.



January 2002  
The jetty stay now inside on a dry sandy beach

## *SIC*

### **Result**

Flank 3 st. 2600 – 3000 600 metre	-4,5 cubic m/m	-2700	
PEM Torquay st. 1500 - 2500 1100 metre	-0,7 cubic m/m		-847
Flank 2 st. 1100 – 1400 500 metre	-2,2 cubic m/m	-1100	
PEM Torquay st. 500 – 1000 600 metre	3,3 cubic m/m		1980
Flank 1 st. 0 – 400 600 metre	-2,7 cubic m/m	-1620	
<b>Areas without PEM</b>		<b>-5420</b>	
<b>Areas with PEM</b>			<b>1133</b>

### **Conclusion.**

The SIC system works very well on all locations, because the system is based on a vertical drain system, but the increase of sand dependent on the sediment input in the area or the sediment is available outside in a flat profile.

The sediment input to Scarness and Torquay beach is very low and I will say 0, and we can see the sediment from the flank areas built up in the areas with the SIC system.

The result on Scarness beach is under influence of the great rock formation in station 2000 to station 2300.

Another parameter is the small test sites and vandalism on Scarness.

The vandalism is less at Torquay beach and we see a very clear result on this site.

### **Recommendation.**

The system was at the first time ordered for a distance on 4,0 km from Aquarium to Scarness and the results show us that the SIC system will work and reduce the erosion in this area.

We recommend the system extended to the ordinary site with the modules submerged and monthly inspection and service.

We know today that groynes and breakwaters is a bad and very expensive solution.

The optimal solution for Hervey Bay Council is implementation of the SIC system combined with beach nourishment on 50 – 75 cubic metre per metre and Hervey bay will have a beach again by high tide like the beach for 100 years ago.

This solution is already implemented in Ängelholm in Sweden in a pocket bay like Hervey Bay.

Ängelholm Council

Appendix 1.

Primary current

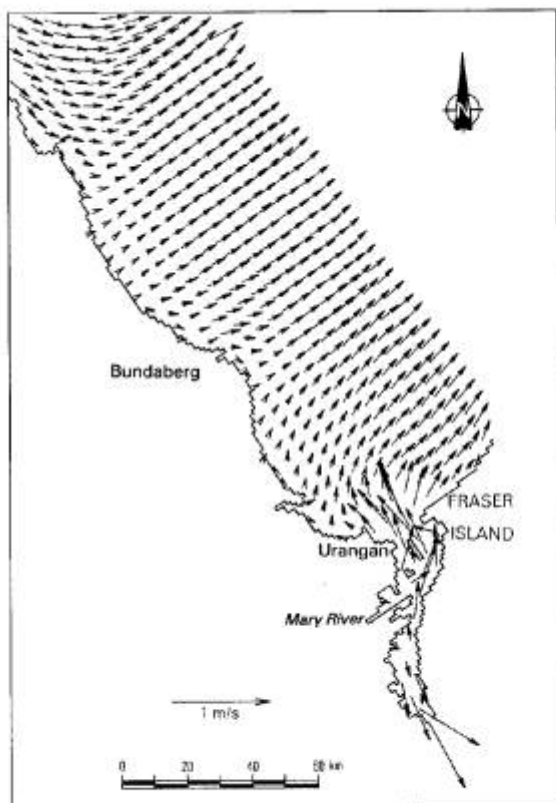


FIGURE 9.6  
VECTOR PLOT OF TIDAL VELOCITIES—EBB TIDE

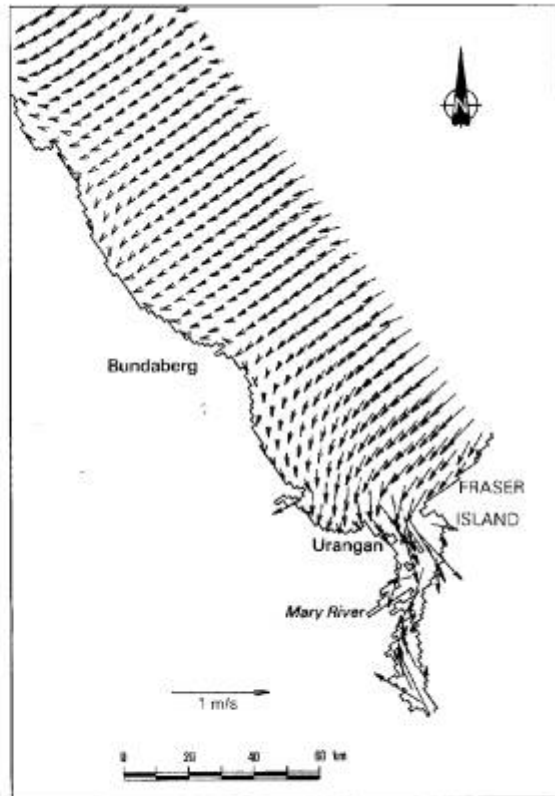
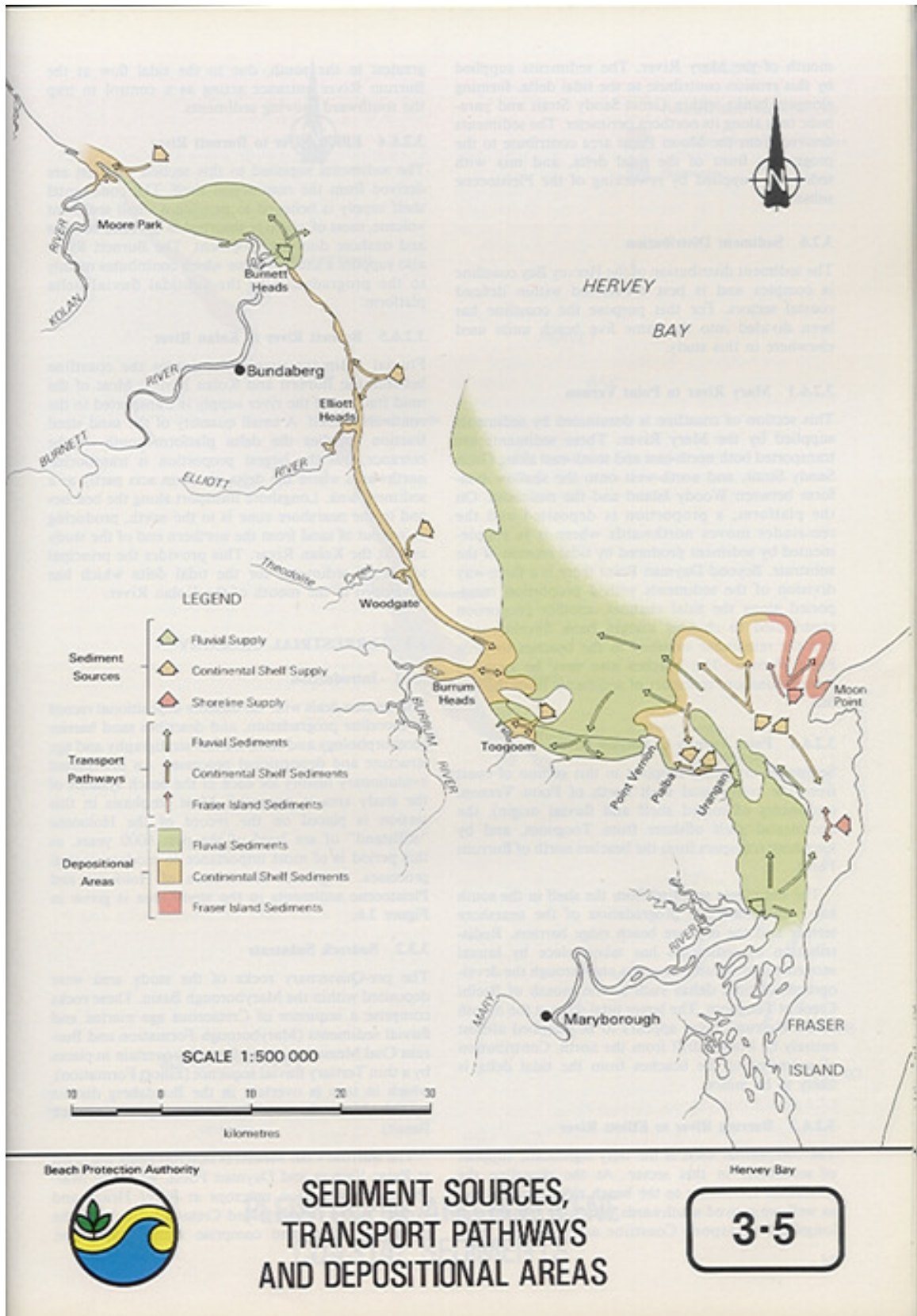


FIGURE 9.7  
VECTOR PLOT OF TIDAL VELOCITIES—FLOOD TIDE

## Appendix 2.

### Sediment input



Appendix 3.

Longshore sediment transport calculated.



Using C O P E Data

STATION	LOCATION	TRANSPORT (m <sup>2</sup> /yr)
A	Urangan	400 d
B	Torquay	200 d
C	Scarness	100 u
D	Scarness Jetty	2000 u
E	Point Vernon	700 u
F	Toogoom	8000 u
G	Burrum Heads	2500 u
H	Woodgate	7000 u
I	Theodolite Creek	1000 u
J	Bargara	4000 u
K	Moore Park	15000 u

u—upcoast transport  
d—downcoast transport

Using Bijker Method

SITE NO.	LOCATION	CALCULATED TRANSPORT (m <sup>2</sup> /yr)
1	Urangan	300 d
2	Torquay	500 d
3	Scarness	500 d
4	Dunlawran	2500 d
5	Toogoom	1500 d
6	Burrum Heads	500 d
7	Woodgate	100 d
8	Woodgate	800 d
9	Woodgate	800 d
10	Theodolite Creek	400 d
11	Palm Beach	500 d
12	Palm Beach	2000 d
13	Coonarr	2000 d
14	Coonarr	4000 d
15	Moore Park	10000 u
16	Moore Park	5000 u
17	Moore Park	2000 u
18	Kolan River	4000 u

u—upcoast transport  
d—downcoast transport

**Appendix 4.**

# Cost Efficient & Environmentally Friendly Coastal Protection

With

## Pressure Equalization Modules



An old groyne has become part of a broad sandy beach since 1997 – when the Pressure Equalization Modules were established by SIC.

This is one of many locations where the superiority of the SIC system over traditional coastal protection is clearly demonstrated.

# *SIC*

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**Abstract**

In many locations, coastal erosion is a significant problem with dramatic effects on the coastline. The impact on coast-near infrastructures and property can be massive. Until now the urgent need for coastal erosion protection, has forced society to use costly solutions with bulky constructions and beach nourishment, where the dredging part of the process is very hostile to the marine environment.

Skagen Innovation Center (SIC) has invented an environmental-friendly, cost-efficient solution to this problem with a technology called Pressure Equalization Modules (PEM).

The PEM system is based on vertical drain tubes, draining the beach, so the saline water circulation in the wash-zone increases and deposits the sediment from the sea in form of an equilibrium profile. This paper describes the results obtained in Gl. Skagen after an official three-year field test in relation to traditional coastal protection based on groynes and breakwaters combined with beach nourishment.

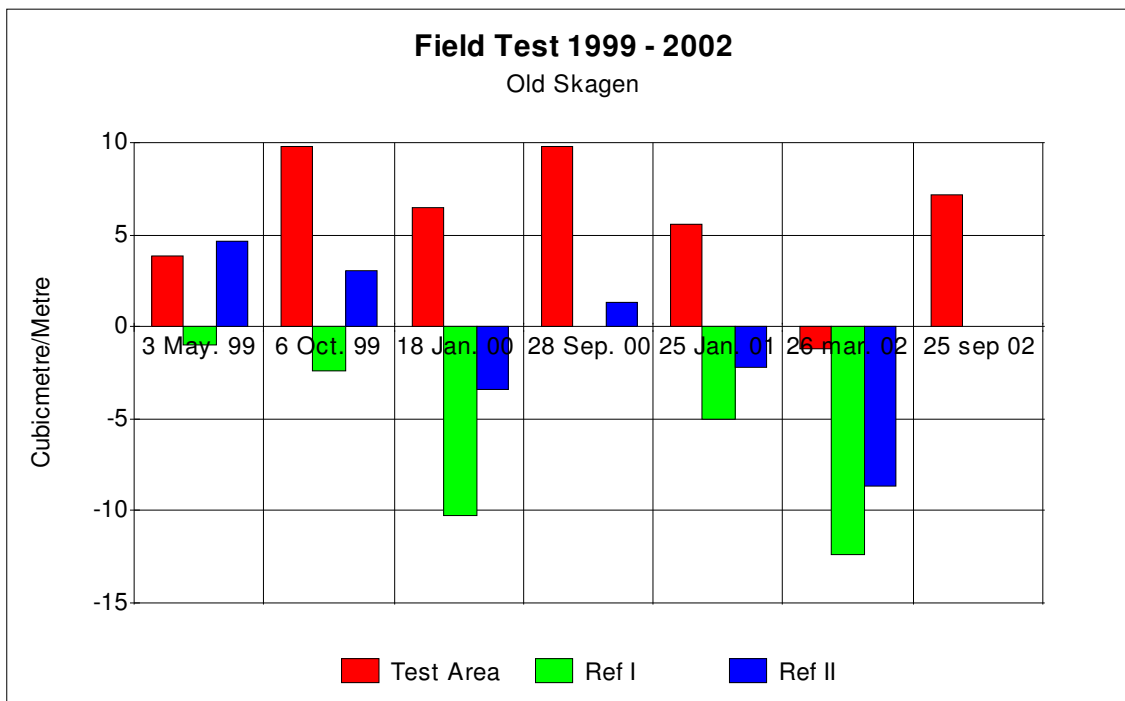


Fig. 1

The official three-year field test has proved, that the PEM system is a very efficient way to establish coastal protection. The average increase/erosion in the test area with PEM's - and reference areas 1 and 2 without PEM - are shown in the fig. 1.

As shown the average accumulation of sediment inside the test area is 5,5 – 9,5 cubic metre per metre in the period 1999 – 2002 and we can conclude the profile is stable.

On other locations (e.g. coastlines in Ghana) with bigger tides (up to 2,0 metre) we have registered an increase of 17,0 cubic metre on average along the coast line.

The survey in January 2002 was delayed to the end of March against a background of high water level and gale in the area.

During the period from 1999 - 2002 the nearest reference area 1 has lost 12,4 cubic metres per metre. The difference is so significant that it is beyond any doubt, that the new PEM method is producing extraordinary results.

## **Introduction**

With a five-year test period (including an official three-year field test), SIC has demonstrated that the technology and methodology, developed by the company, can create outstanding results. The pressure equalizer technique has been proven to be an efficient method for coastal protection. From an economical as well as an environmental point of view, it is the preferred solution against coastal erosion.

The result from the first test with the Pressure Equalizer Modules (PEM) is clearly seen on the photo in Fig. 2. below. This picture from Gl. Skagen beach shows an old sand covered groyne, which has been placed – inshore and passive on a new broad sandy Beach, in the five years the PEM system has been installed.



Fig.2 SIC test area Gl. Skagen North

The PEM protection was established on this site in November 1997. Shortly hereafter, it was possible to walk outside the groynes in periods with normal tides.

At low tides it was observed, that a sand groyne was building up outside the PEM. With this observation, it was realized that the PEM technology could be developed into a new method of protecting the coastline from erosion. Further information about this test installation is found in Appendix 2. "Gl. Skagen North Test Installation".

The PEM system has now been tested on several locations in Denmark and abroad. The development work and test locations have consistently shown very positive results.

During the test period it has been possible to compare SIC's PEM method with the traditional protection methods like groynes, breakwaters, sand dredging / beach nourishment. From an environmental and economical point of view, the PEM method is far superior to the traditional methods.

## **The Official Field Test**

Based on the promising results observed in the first test installation, it was decided to establish an official field test in order to verify and document the results obtained with the PEM modules. The official test site was established in January 28th. 1999, at Gl. Skagen beach, where a 1050-metre long well defined part of the beach was selected as the PEM test area. A project group was appointed, to supervise and monitor the work, and a independent consultant was chosen to perform the measurement and survey work at the site.

## **The Project Group**

The following people are participating in the project group:

Mr. Hans Falk Burcharth	Professor Dr. Tech., Aalborg University
Mr. Frede Jensen	State Forester, State Forestry North Jutland
Mr. Bjarke Jensen	Surveyor, North Jutland County
Mr. John Jensen	Engineer, M.Sc. The Danish Coastal Authorities
Mr. Poul O. Jørgensen	Engineer, M.Sc. Carl Bro Consulting Engineers A/S
Mr. Stig Trollebø	Danish Technological Institute, Innovation A/S
Mr. Poul Jakobsen	Managing Director, SIC

## **Controlled Test**

The field test was executed under controlled conditions. Professor dr. tech. Hans Falk Burcharth has served as supervisor for SIC and the project group. He and the other team members have participated in the project throughout the entire field test period. The team members have participated in the conferences concerning the test project and have agreed that professor dr. tech. Hans Falk Burcharth, as an independent scientific expert, should evaluate the procedures and the obtained data from the field test program, on behalf of the team. During the field test program, all measurements were recorded and controlled by a reputable independent consulting company; Carl Bro Consulting Engineers, Denmark.

## **Field Test Area**

The field test was performed along an 8 km long coastline S.W of Gl. Skagen (please see Fig.3) Before the Pressure Equalizing Modules was implemented, a baseline survey of the selected coastline was performed. Modern laser equipment was used for the measurements.

## **PEM Test Area**

The distance between each line of PEMs is 100 metres, within the line a PEM is installed for each 10-metre. Initially the width of the beach made room for two PEMs only in each line, as the beach over time got wider, additional PEM were installed. The total distance from station 113200 to 114250 is 1050 metre.

## **Flank Areas**

Adjacent flank areas, without PEM, on either side of the test area, were monitored with the same procedures as the test area.

## **Reference Area I.**

Reference area I was located 3,0 km SW of the test area, ranging from station 117000 to station 118000. The objective of this reference area was to compare the development during the field test period of the coastal profile in a nearby site without PEM.



## The Survey Schedule

The project group established the survey schedule during the first year of operation. The coast profile in the test area has a cyclic nature, with accumulation in the summer time and erosion during the winter. With this in mind, the measurements are scheduled to be performed late September and late January each year.

### The actual dates were:

- 28. January 1999 reference level survey and start of field test
- 3. May 1999 initial survey to verify that the installation is working
- 6. October 1999
- 18. January 2000
- 28. September 2000
- 25. January 2001
- xx. January 2002 (impossible because of storm in the area)
- 26. Marts 2002 (substitute for planed survey)
- 25. September 2002 (extra survey in the test area.)

## Field Test Results

### Test Area

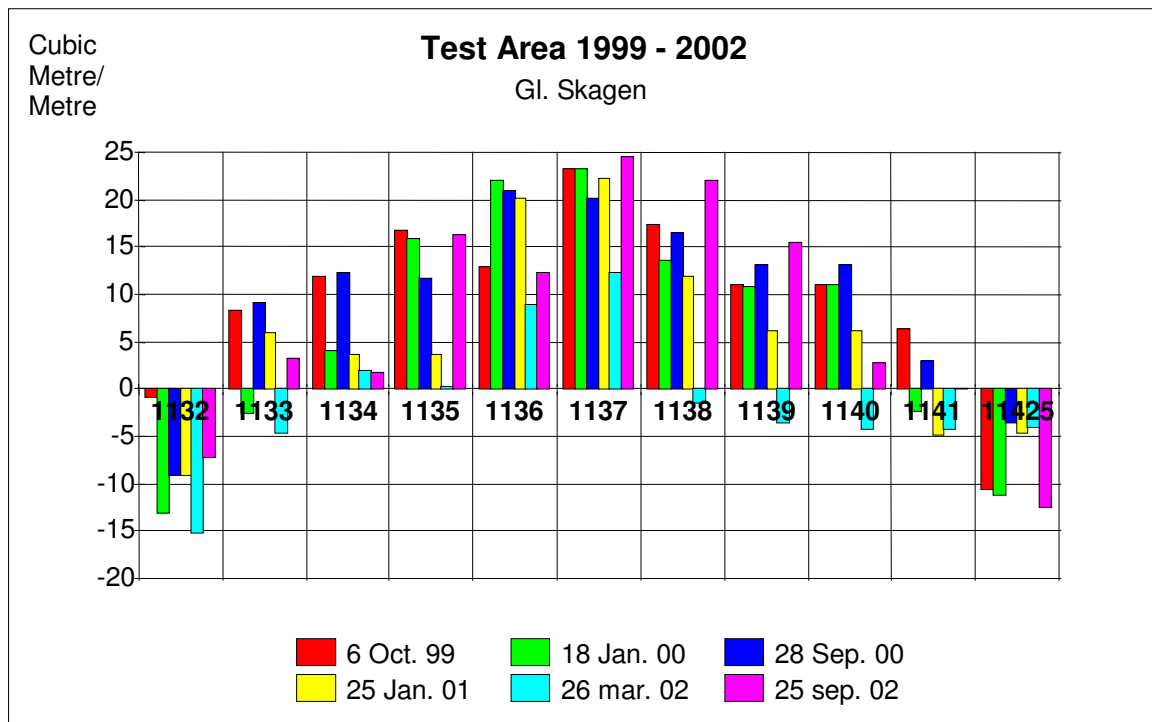


Fig. 4  
Test Area Sediment Accumulation

In fig. 4. the results from the test area are shown for each survey. The result is significant, the beach profile is in equilibrium and it recovers fast after storm and flood periods. The average sand accumulation in the area is app. 5,5 – 9,8 cubic metre per metre.

### Reference Area 1

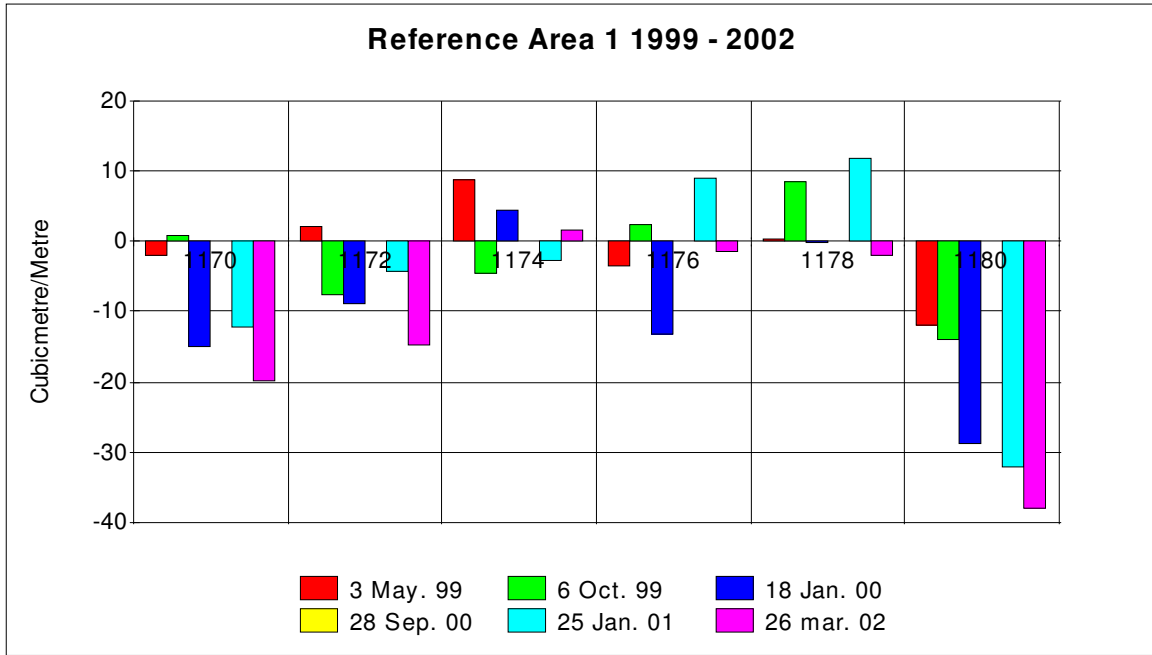


Fig. 5 Reference Area 1

In the test period, Reference area 1 had erosion of 12 cubic metre per metre and a shoreline decline of 9,2 metres.

### Reference Area 2

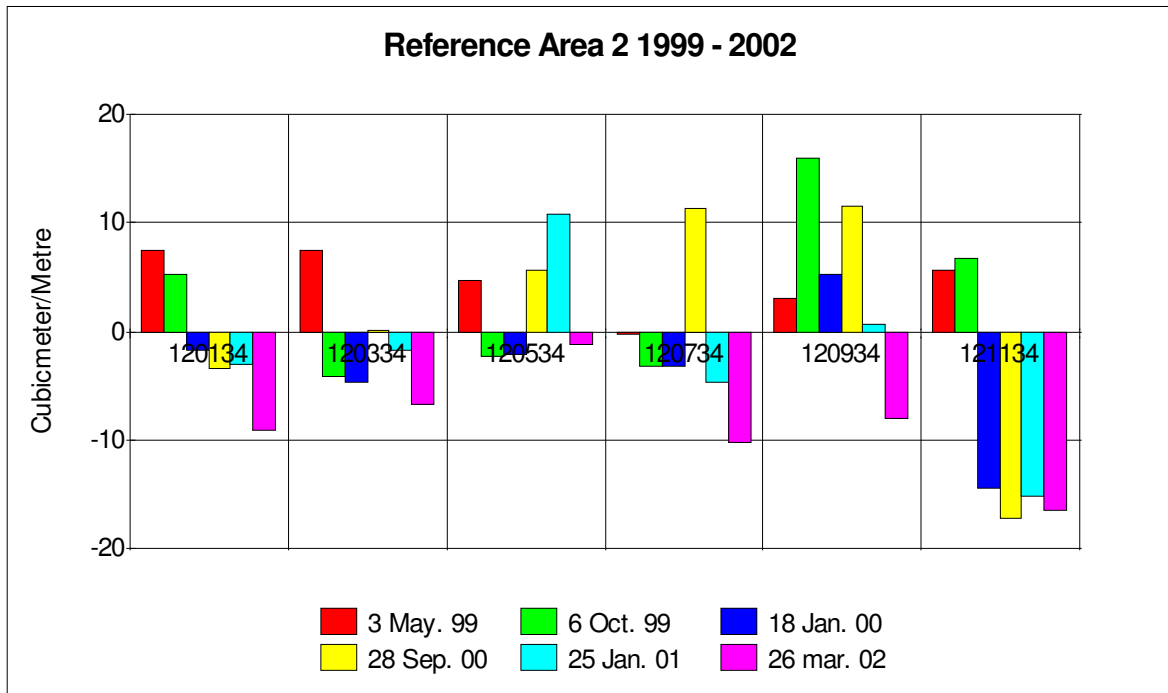


Fig. 6 Reference Area 2

During the test period. Reference area 2 result was erosion of 8,6 cubic metre per metre and a decline of the coastline of 14 metres.

## **Comments on the Results**

The accumulation of sediment in the test area is observed to be consistent. The accumulation is not found in the reference areas or flank areas. The most extreme values found were erosion of 40 cubic metre per metre in Reference area 1 and accumulation of 24 cubic metre per metre in the test area.

With three years of uninterrupted service of the PEM installation, the beach profile has developed significant in the test area. The Reference areas have in the same period followed the average erosion seen over the last 150 years, with a decline of the coastline of 1,5 metre per year.

The beach profile stabilized itself and was in equilibrium after the first 7 month of the field test. The resulting accumulation of sediment was 5,5 - 9,8 cubic metre per metre.

The beach profile has been stable in the field test period of three years. The coastline has gained 2,1 metre in the test area.

The reference area coastline has lost 3,9 metres average during the period. This is more that the general average and is caused by unusually rough weather in the test period.

A 100 year storm hit the west coast of Denmark in December 1999.

## **Conclusion**

The conclusion from this three-year of field test and the previous years of tests is unambiguous. The PEM system from SIC is an environmental-friendly and very efficient solution to protect against coastal erosion.

12<sup>th</sup> November 2002.

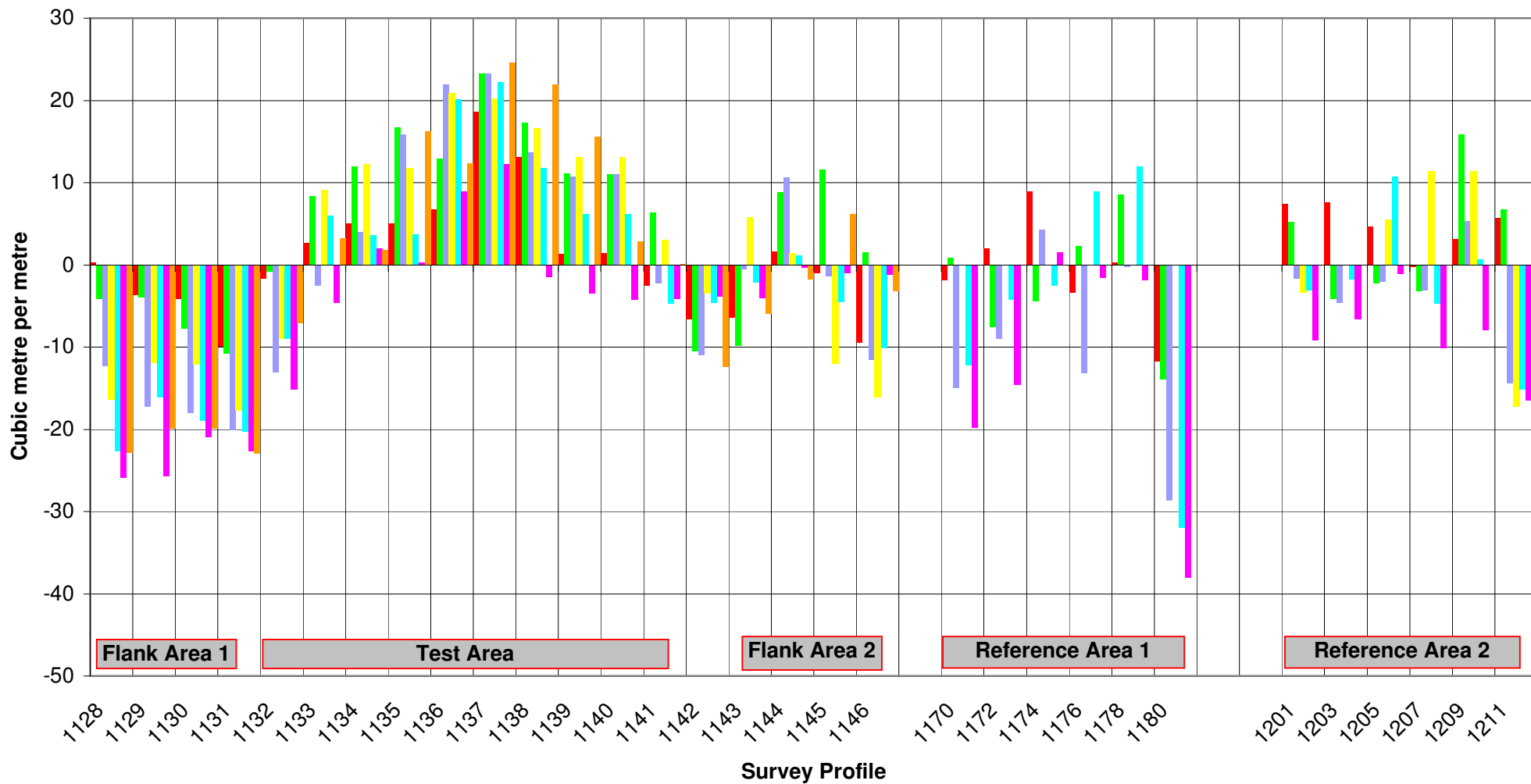
Poul Jakobsen  
Managing Director, SIC

*SIC*

Appendix 1. Field Test Data

<i>Profile</i>	<i>May-99</i>	<i>Oct-99</i>	<i>Jan-00</i>	<i>Sep-00</i>	<i>Jan-01</i>	<i>Mar-02</i>	<i>Sep-02</i>	<i>Notes</i>
1128	0	-4	-12	-16	-23	-26	-23	Flank 1
1129	-4	-4	-17	-12	-16	-26	-20	
1130	-4	-8	-18	-12	-19	-21	-20	
1131	-10	-11	-20	-18	-20	-23	-23	
1132	-2	-1	-13	-9	-9	-15	-7	Test Area
1133	3	8	-3	9	6	-5	3	
1134	5	12	4	12	4	2	2	
1135	5	17	16	12	4	0	16	
1136	7	13	22	21	20	9	12	
1137	19	23	23	20	22	12	25	
1138	13	17	14	17	12	-1	22	
1139	1	11	11	13	6	-4	16	
1140	1	11	11	13	6	-4	3	
1141	-3	6	-2	3	-5	-4	0	
1142	-7	-10	-11	-3	-5	-4	-12	
1143	-6	-10	-1	6	-2	-4	-6	Flank 2
1144	2	9	11	1	1	0	-2	
1145	-1	12	-1	-12	-5	-1	6	
1146	-9	2	-12	-16	-10	-1	-3	
1170	-2	1	-15		-12	-20		Ref. 1
1172	2	-8	-9		-4	-15		
1174	9	-4	4		-3	2		
1176	-3	2	-13		9	-2		
1178	0	9	0		12	-2		
1180	-12	-14	-29		-32	-38		
1201	7	5	-2	-3	-3	-9		Ref. 2
1203	8	-4	-5	0	-2	-7		
1205	5	-2	-2	6	11	-1		
1207	0	-3	-3	11	-5	-10		
1209	3	16	5	11	1	-8		
1211	6	7	-14	-17	-15	-17		

Field Test GI. Skagen 1999 - 2002



■ May-99 ■ Oct-99 ■ Jan-00 ■ Sep-00 ■ Jan-01 ■ Mar-02 ■ Sep-02

## **Appendix 2. Other Results with Pressure Equalization Modules**

### **Location Gl. Skagen North**

Just North of the official Field Test Area in Gl. Skagen, SIC made one of the first PEM installation. The groynes reached 10 – 15 metres out from the shoreline before installation



Fig 9

The groynes at Gl. Skagen before installation of PEM system by SIC



Fig 10

The groynes at Gl. Skagen 1 year after PEM installation.

As the aerial photo illustrates the groynes are completely covered in sand 5 to 10 metres inshore, one year after installation of the pressure equalization modules.

**Gl. Skagen North (cont.)**



Fig. 11 Gl. Skagen PEM installation removed in 2001

After a dispute with the local authority SIC was ordered to remove the PEM installation in November 2001. The photo from July 2002 shows erosion has moved the coastline 15 to 25 metres back. The groyne are out in the sea and the sand has disappeared between the groyne.



Fig. 12  
Gl. Skagen one PEM was accidentally left

SIC forgot to remove one set of PEM from the site in November 2001. On this photo from July 2002 the effect is seen there has been no erosion right on this spot. This is maybe the best proof of concept for SIC's unique coastal protection system

## Location Lønstrup



Fig. 13  
Lønstrup after PEM installation 1999

SIC installed a PEM system at Lønstrup beach in April 1999. Shortly after the breakwaters are completely covered in sand as seen on the photo from 1999 in Fig 13. The beach recovered with up to 90 cm over the area.



Fig. 14 Lønstrup 2002

The PEM installation was removed in August 1999, and the beach is back to the previous stage, with serious erosion.

The breakwaters are nourished with beach nourishment for Dkk. 1.2 mio. and 30.000 cubic metre sand every year.

**Lønstrup (cont.)**



Fig.15 Lønstrup, July 1999

When the beach was protected by a SIC PEM installation, you could drive with cars on the beach. As you can see on the photo the local authority has placed dustbins on the beach to support the heavy traffic of visitors.



Fig.16 Lønstrup, eastern 2002.

The same beaches after the PEM installation was removed. It is no longer possible to drive with cars on the beach. We just lost a company car trying to drive here.

**Reference list**

Hervey Beaches - Beach Protection Authority Queensland.  
Professor Hans Falk Burcharths rapport nr. 1 about the effect of vertical drainpipes  
Professor Hans Falk Burcharths rapport nr. 2 about the effect of vertical drainpipes  
Rapport nr. 1 Marstal Denmark  
Rapport nr. 1 Ålsgårde Hellebæk Denmark  
Rapport nr. 1 Skallerup Klit Nørlev Strand Denmark  
Rapport nr. 1 Environmentally Friendly Coastal Protection  
Rapport nr 2 Cost Efficient & Environmentally Friendly Coastal protection.  
Rapport nr. 1 Ystad Sweden  
Rapport nr. 2 Ystad Sweden  
Rapport nr. 1 Ribersborg Sweden  
Rapport nr. 1 Ängelholm Sweden  
Evaluation report Accra Beach Ghana  
Evaluation report Ada Ghana