

Case study – *final draft*
SOCIO-ECONOMIC STUDY – Ystad Sandskog



COMPONENT 3
VALUATION OF THE SHORELINE
MESSINA PROJECT

PREFACE

This case study is made within the Messina project. The purpose is to demonstrate a practical application of economic analysis in coastal management. The case study is based on existing data and many shortcuts have been taken and simplifications have been made. This refers to the fundamental technical prognosis of the implications of erosion and sea level rise. However we hope that this first outline can serve as inspiration and guidance for further case studies.

Thanks and acknowledgement to everybody who have contributed to this case study.

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SUMMARY

Sandskogen is an important part of the city of Ystad. Over the last 100 years the coastline has moved about 50 meters inland. The coastline of Sandskogen consists of sandy beaches and the area directly above the shore is well visited for different kind of recreation activities. It is vital for Ystad that the erosion of the coast does not continue.

Large areas at Ystad sandskog are currently protected from erosion and possible flooding at high water levels by an existing seawall with promenade that needs constant maintenance. If the existing wall and other protective measures are not maintained and upgraded the weather situations will lead to flooding of the protected area and progressive erosion will lead to loss of large beach areas. Considering the predicted sea level rise over the next 100 years, due to global varming, protection of the shoreline and land areas close to the sea is becoming more acute.

A brief Social Cost-Benefit Analysis (CBA) of the area has been conducted. It has been conducted with scarce resources and is therefore only accurate as to give indications. The CBA indicates that the benefits of maintaining and protecting the present shoreline is 3 times larger than the cost. Of the investigated alternatives, beach nourishment is the best option. However, there should be additional technical and economical evaluation before final strategy is decided.

1 INTRODUCTION

Sandskogen is situated east of the city of Ystad and has an area of about 5 km². With a coastal strip of about 5 kilometres¹ it is an important site for the inhabitants of Ystad and for its tourists. The coastline of Sandskogen consists of sandy beaches and the area directly above the shore is well visited for different kind of recreation activities. In the last 50 – 100 years Sandskogen has lost about 50 meters of shoreline due to coastal erosion and it is vital for Ystad that this erosion does not continue.

Large areas at Ystad sandskog are currently protected from erosion and possible flooding at high water levels by an existing seawall with promenade that needs constant maintenance. Other measures taken to reduce the effects of coastal erosion in Sandskogen are a reverse filter, groins, draining pipes and vegetation stabilisation.

Failure of the existing wall and other protective measures will at extreme weather situations lead to flooding of the protected area, progressive erosion will lead to loss of the beach area with some 415 000 m² in the coming 100 years.

2 OVERVIEW OF COASTAL PROCESSES

2.1 The formation of Sandskogen²

2.1.1 Historical

Approximately 8 000 years ago the sea level in Ystad was about ten meters below the sea level today. At this time the Baltic Sea was a freshwater lake since it was separated from the North Sea. But as the water level in the oceans began to rise the water was forced from the west into the Baltic Sea, thereby forming water passages as for instance Öresund. Due to these changes, the sea level in Ystad started to change and about 7 000 years ago the sea level was 3-5 meters over the sea level that we can observe today. As a first step, this lead to the creation of swamps over large areas of Sandskogen and on top of these swamps peat was formed. As the water level continued to rise Sandskogen was more and more covered by water.

Due to waves and coast parallel streams sand was transported along the coastline. At this time the area around Ystad consisted of an open creek and as a result the sand could settle in long, bank shaped formations. A major accumulation of sand took place and this accumulation continued over thousands of years. The water level changed a lot during these years though, and at times the banks rose from the water, leaving them unprotected against the waves. The waves brought larger materials with them and because of this, stones and rocks could also accumulate together with the sand. When the area consisting of swamps and sand banks ultimately ended up above the sea level the area called Sandskogen had been formed.

¹ Ystads Fornminnesförening, p. 9

² Ystads Fornminnesförening, p. 16-20

In the early Middle Ages the city of Ystad began to grow. Along with the growing process one can imagine an increasing demand of timber, as fuel and in different constructions. The woods of Sandskogen were used for this purpose, leaving the grounds open as pastureland. At the same time grass from the pastures was harvested to be used as building material in different enclosures and this all together surely had a great negative effect on the grounds. Around this time seaweed from the coastline was also removed from the sandy beaches to be used as fertilizer, leaving the beaches wide open. As a grand total, the sand in Sandskogen was left unbound and easily accessible for wind transportation. Shifting sand hereby became a big problem for Ystad and its surroundings and sand hills were formed all over Sandskogen.

To reduce the negative effects of the shifting sand the idea to plant vegetation in Sandskogen is thought to have been acknowledged early on. For example, the well-known Swedish botanist Carl von Linné proposed in 1749 that the area should be planted with pine trees to obtain less windy conditions and avoid the shifting sand.

Many attempts were made to plant vegetation in Sandskogen. All of which proved useless since the conditions were too hard. In 1838 a Danish expert, mr Fintelmann, was called in and finally the problem became manageable. He proposed that an embankment should be built along the coastline and that this bank should be planted with sand oat grass and sand rye grass, thus protecting the area from the wind and the sand. After the construction was finished the real plantation could begin and through the 19th century and in the beginning of the 20th century trees, bushes and grasses were planted all over Sandskogen.

2.2 Active processes and future development

The studied area is mainly influenced by a coast parallel current going from west to east and the studied area is part of a larger but well defined coastal sediment cell³. The most extreme waves are developed with wind from south-east to west-south-west. The dominant wind direction is from the west, which also contains the hardest winds forces⁴.

Predictions based on evaluation of historical data show that the coastal erosion in Sandskogen will be about 0.5 meters per year if no action will be taken. Since different types of erosion protection already exists the erosion of today both act on the shoreline and on the underwater areas. Underwater erosion thereby undermines the ground and this erosion is therefore just as important as the more visible one. To maintain the coastal situation that exists today maintenance actions, mostly sand nourishment onto the beaches, must therefore be undertaken. A big problem is also to get a clear picture of what an erosion of 0.5 meters per year really means. Sandskogen consists of lowlands protected almost entirely by dunes situated very near the coastal line. If these dunes disappear large areas could be flooded, with or without continued erosion.

3 VALUES AFFECTED BY COASTAL PROCESSES

Sandskogen consists of sandy grounds covered with mostly pine-trees. North of Sandskogen a wetland area, around 3 km², is situated. Sandskogen is considered to be an important area for many different reasons and there are many stakeholders. First of all

³ Eurosion reports

⁴ Uppspolning och klittererosion längs Ystad kusten, p 24

the municipality of Ystad and different authorities all have an interest in preserving Sandskogen. Also all of those who have a money interest in the area, such as owners of houses, cottages, restaurants and different kinds of tourist establishments are dependent on the future of Sandskogen. Last but not least the area is well visited by tourists and inhabitants in and around Ystad. The values of Sandskogen listed below gives a general picture of what is at stake if the erosion is allowed to continue.

3.1 Archaeological values

The area within and around Sandskogen is of great archaeological interest. Many settlements and findings from the time called the Mesolithic (10 000 – 4 000 B.C.) have been found and it is clear that the area was attractive and well used by the people of this age⁵.

3.2 Values for the municipality of Ystad

As landowner the municipality of Ystad is anxious not to lose too much property. The Ystad saltsjöbad hotel is located directly by the shoreline and has 109 rooms, totally 224 beds. One congress auditorium, 17 conferences rooms of various shapes and sizes catering for groups up to 324 participants.



Picture of Ystad Salsjöbad hotel (photo from website)

East and north east of the hotel is an area of cottages located on land owned by the municipality and leased by the cottage owners. Relocating the hotel and cottages would be costly and represent a big loss of prestige and would be a difficult issue to handle political. The municipality has already investments in erosion protection that is maintained on a regular basis. Therefore the municipality is highly interested in finding solutions that gives as little turbulence as possible.

⁵ Ystads Fornminnesförening, p. 21

3.3 Infrastructure values

Both national road nr 9 and the local railway run through Sandskogen. These constructions, as well as water and sewage pipes, electrical and telephone cabling etc could be at stake if the erosion is allowed to continue.

3.4 Spare time values

In the 1930s the government in Sweden proposed a 40-hour working week and in its footsteps came holiday with pay for the Swedes. Already around 1850 the citizens of Ystad started to recognise what an asset Sandskogen was⁶ but the spare time activities really took off after this historic event. Since then Sandskogen has been an important recreation site for everyone in and around Ystad. A lot of people come to Sandskogen just for walks along the beach or in the forest and the place is of great value for people interested in nature and biology as well as for sport fishers, cyclists and runners. The fact that the beaches in Sandskogen attract a lot of people is of course given and the beaches importance to Ystad can hardly be overrated. In the summer the beaches are well visited for baths, sunbaths, beach volleyball and handball and in the wintertime the activities are instead winter baths and visits to the sauna. Many different sport associations are also located in Sandskogen with sports like soccer, track and fields, golf and tennis. A sports field is also situated very close to the beach.

3.5 Nature values⁷

Sandskogen consists of many different types of biotopes: swampy grounds, dry pine forests, deciduous forests, bushy grounds, thick fir and pine forests, older forests and summerhouses with lawns. The district is therefore important for many plants, herbs and animals and 205 out of the 450-hectare large area of Sandskogen is a Natura 2000-area. Sandskogen is, among other things, important for birds and during an inventory in 1999 69 different species were found. Eight of these are of specific interest since they are red listed in Sweden and are considered to be vulnerable (1 species) or near threatened (7 species)⁸. It is only fair to say that many important habitats are at risk because of the erosion.

3.6 Values in buildings and establishments

The colonisation of Sandskogen started as early as in the later half of the 19th century. Among the earliest buildings a shooting range and a dance pavilion can be mentioned. In 1897 Saltsjöbaden, a hotel and restaurant, was built right by the beach and this establishment still exists today, though different from the original building because of fires and rebuilding. In the 1880s the first villas were erected in Sandskogen and at the turn of the century 56 villas had already been built. Two large colonisation periods took place after that, in the 1930s and 1960s. Today there are about 550 villas and cottages in the area.

A significant event for the evolvement of Sandskogen was an exhibit in Ystad 1936 called *Fritiden* (translated Spare time) where the significance of spare time was illuminated. The first camping ground in Sandskogen was founded as a result of the

⁶ Ystads Fornminnesförening, p. 40

⁷ ANSER 2000 Nr 4, *Fåglarna i Ystads Sandskog – Ett försök till heltäckande inventering av häckande arter*

⁸ www.artdata.slu.se/rodlista/ 2005-07-05

exhibit and since then the interest for camping has only increased. Today Sandskogen contains villas, houses, cottages, tourist establishments, restaurants and cafés. Many of these buildings and establishments are at stake due to the erosion problem.

3.7 Values of tourism

The tourism is immensely important to Ystad. Last year (2004) around one million tourists visited Ystad, spending 434 million SEK (~ 48 million Euro) there. The tourism in Ystad started in the 1920s and from the very beginning it was concentrated to Sandskogen. In the mid 1930s the first hostel and camping ground took shape and in the 1950s a tourist village was established. A trip to Ystad is an experience with many various elements and naturally it is hard to truly estimate the importance of Sandskogen in these contexts. It is however clear that the beaches and the recreation areas in Sandskogen is among the most tourist friendly in Ystad and its surroundings. The reduced beach area with a risk for flooding would have a gravely negative effect on the tourism and all its establishments.

4 IDENTIFICATION OF STAKEHOLDERS

There are numerous stakeholders with interests in Ystad sandskog. The following is a list of stakeholders concerned by coastal erosion in this area.

Authorities participating in decisions

Ystads kommun – Tourist department
 Technical and facilities department
 Children and education department
 Environment and construction department
 Länsstyrelsen (County administrative board)
 Naturvårdsverket (Swedish Environmental Protection Agency)
 SGI (Swedish Geotechnical Institute)

Landowners and infrastructure owners

The Municipality of Ystad
 Banverket (Swedish railway network)
 Telia (telephone cabling)
 Vägverket (Swedish road administration)
 Ystad energi (electrical cabling)
 Private landowners

Leaseholders

Villa and Cottage owners
 Owner of Bathing huts
 Hotel and Restaurants
 Camping ground
 Kiosks

Recreational stakeholders

Associations/clubs
 Beach handball
 Beach volleyball

Component 3

Boule
Football
Jet ski
Mini golf
Motor cycles
Riding
Sauna
Scouting
Shooting
Track and field
Tennis
Working dog

Individual

Angling
Bathing
Physical exercise
Jogging, bikers, strollers, dog walkers, riders, Nordic walking
Strollers, Passers by

5 TECHNICAL ASSESSMENT OF THE FUTURE AND ALTERNATIVE WAYS OF ACTION

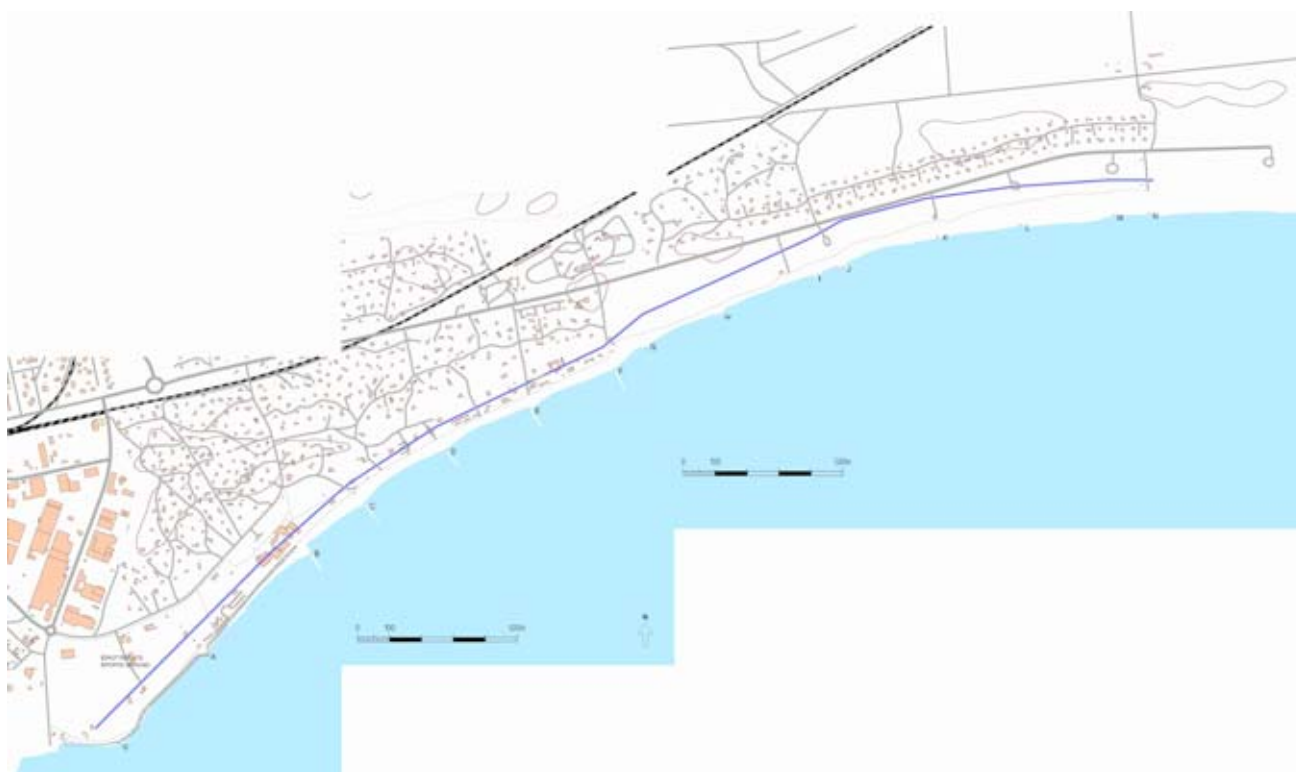
5.1 The technical assessment

The technical assessment of the future situation is based on:

Available maps from municipality (Geosecma) Appendix A
Report: Erosionsrapport over kusten i Ystad kommun, Ystad 2004
Report: Strandmorfologi. Studie av kuststräckan från Ystad till Sandhammaren
Rankka, K. et al.
Report: Uppspolning och klittererosion längs Ystads kusten – Situation idag och framtida scenarier Dahlerus, Carl-Johan, Egermayer Daniel
Discussions with Prof. Hans Hanson of Lund University
The assumption that sea level will rise by 0.5 m the next 100 years
Rule of thumb – 0.5 m sea level rise gives 50 m of coastal erosion
Historical data indicates erosion rate of 0.3-0.7 m per year

One problem for the technical assessment is that available maps only have altitude contour lines every 5 metres. Most of the area is below at an altitude of 1.5 to 2.5 m above sea level. Given a highest water level of plus 1.2 m and sea level rise of 0.5 m a large area is flooding prone. The available maps lack required accuracy to determine which areas might be flooded.

The prognosis regarding the position of the coastline in 100 years if nothing at all is done to protect the coastline is presented in Map1 and Table 1 (detailed maps are available in appendix A).



Map 1 – Map over Ystad sandskog coastline with estimated coastline retreat in 100 years if no actions are taken.

Table 1. Estimated coastline movement over the next 100 years if no measures are taken to hinder erosion. (Sections are described in Appendix A)

Section	Type	Length (m)	Coastline retreat (m)	
			due to erosion	due to sea level rise
0-A	Stone protection	400	-40	-50
A-B	Stone protection + gabion ±100 meter of B	450	-30	-50
B-C	Sand	230	-30	-50
C-D	Sand + gabion	310	-30	-50
D-E	Sand + gabion	290	-30	-50
E-F	Sand + gabion	300	-30	-50
F-G	Sand + Stone protection	150	-30	-50
G-H	Sand + Stone protection	300	-50	-50
H-I	Sand + Stone protection	400	-50	-50
I-J	Sand	100	-70	-50
J-K	Sand	380	-90	-50
K-L	Sand	300	-70	-50
L-M	Sand	450	-70	-50
M-N	Sand	140	-50	-50

The analysed coastline is 4 200 m long and the estimated loss of land in the “do nothing” alternative is 415 000 m² (an average 98 m of coastal retreat).

5.2 The strategy of the municipality

The present strategy of Ystad municipality is to “Hold the line” with “Limited intervention” to preserve the present position of the coastline. There is a yearly budget for maintaining the present erosion protection constructions and to test new methods. The municipality is also the sole landowner of the coast in Sandskogen. The municipality actually has applied for permission to extract sand from accumulating areas to the eroding parts of the beach in Sandskogen. Permission has been giving for sand nourishment in the water and on the beach but extracting of sand from the seafloor has been rejected.

5.3 Studied alternatives of coastal management

Several alternatives, that can be considered in order to mitigate the coastal erosion, have been evaluated.

The “Do nothing” alternative (No Project option) implies that land, properties, roads and utilities are successively lost to the sea. The protecting sand dunes will probably not move landward but erode and give space for flooding in times of high water levels. This is not really an option for the municipality. They will have to do something measures as roads are cut etc. This option is used in the analysis to demonstrate what values are at stake.

A “Managed realignment” of the coastline would mean that the municipality moves their facilities, hotel, the promenade/bike road etc as erosion and sea level rise evolves. *This alternative is not analysed!*

The “Move seaward” is really not one of the discussed options. However not many would mind if there was an accumulation of sand along the coast.

The two analysed options are “Hold the line”/ “Limited intervention” options.

Option 1 – Maintain existing seawall and groins and new breakwaters

The municipality is currently maintaining the shore protecting structures at place.

The municipality is also planning to install submerged breakwaters at location H-I. The groins at section B to F traps sand transported along the coast giving less available material to be deposited between section G and N. The submerged breakwaters at section H-I will protect the coastal bike road and a building situated only 50 meters from the present shoreline.

Option 2 - Beach nourishment

The municipality is investigating a beach nourishment alternative. At present a permission is given to deposit 20 000 m³ along the shores of Sandskogen. The municipality will also apply for a permission to extract sand from the sea floor 5 km south of Sandhammaren. This option also includes limited maintenance of existing erosion protection constructions.

6 SOCIO-ECONOMIC STUDY

6.1 Cost-Benefit Analysis

For this study Cost-Benefit Analysis (CBA) has been chosen as the method to use. With this it will be possible to evaluate the present strategy of the municipality and see if it is worthwhile or not. This mapping of the costs and benefits might also give indications on how to develop the strategy.

6.2 Valuation of effects

Two alternative combinations of preventive measures will be used in this study. The first alternative (Option 1) is to maintain existing groins and stone protection (seawall) and to establish new breakwaters. The second alternative (Option 2) involves beach nourishment and limited maintenance for existing groins and seawall and planned breakwaters. The estimated development of the shoreline if nothing is done and the two alternatives are shown in table 2

Table 2 – Estimated coastline movement for the alternatives “Do nothing”, “Maintenance” and “Beach nourishment”.

Section	Type	Length (m)	Coastline movement (m) “-“ = retreat “+” = extension		
			No Project Do nothing	Option 1 Maintain	Option 2 Beach nourishment
0-A	Stone protection	400	-90	-0	-0
A-B	Stone protection + gabion ± 100 meter of B	450	-80	-0	-0
B-C	Sand	230	-80	-0	+5
C-D	Sand + gabion	310	-80	-0	+5
D-E	Sand + gabion	290	-80	-0	+2
E-F	Sand + gabion	300	-80	-0	+2
F-G	Sand + Stone protection	150	-80	-0	+2
G-H	Sand + Stone protection	300	-100	-0	+2
H-I	Sand + Stone protection	400	-100	-0	+2
I-J	Sand	100	-120	-50	-1
J-K	Sand	380	-140	-90	-7
K-L	Sand	300	-120	-90	-4
L-M	Sand	450	-120	-90	-3
M-N	Sand	140	-100	-70	-2

Properties at danger are

- **House** – villas, summer cottages, a hotel, a couple of restaurants, rent cabins and cottages.
- **Road** – a road of local and regional importance, railroad and about ten parking areas, a system of smaller roads that leads to the summerhouses.
- **Industry** – there is no industry except tourism industry in the area.
- **Other** – the municipality athletic stadium.

Other values affected are tourism, recreation and nature life. The municipality owns approximately 90 % of the land in the area. The effects are summarized in table 3.

Table 3 – Effects table for the Ystad sandskog case

	Units	Alternatives		
		Do nothing	Option 1 Maintain & Repair	Option 2 Beach nourishment
Direct effects				
Investment costs		0	Yes	Yes
Maintenance costs		0	Yes	Yes
Direct/indirect effects				
Damage to property and infrastructure		Yes	Some	Some
Agriculture		0	0	0
Recreation/Tourism		Yes	0	0
Other damages		Yes	0	0

6.3 Values lost in “Do nothing” case (No project)

Estimated values, that may be lost, in the “Do nothing” alternative.

Hotel: $2000 \text{ m}^2 * 20,000 \text{ SEK/ m}^2 = 40 \text{ MSEK}$

Football area: (estimated value) = 4 MSEK

Summer villa area: $200,000 \text{ square metres} * 2000 \text{ SEK/ m}^2 = 400 \text{ MSEK}$

(properties in this area are at present sold for 1,5-2 MSEK each)

Forest Area: $200,000 \text{ m}^2 * 200 \text{ SEK/ m}^2 = 40 \text{ MSEK}$

Annual loss due to less tourism etc: 1% of tourism turnover (434) = 4MSEK/year.

Data sources:

Quantity data is collected from drawing shown in Appendix A. Cost data is estimated from historical data and past experience.

6.4 Cost of implementing protecting measures

Cost of option 1 (maintain existing seawall and groins and new breakwaters)

Repair of 5 groins 100,000-120,000 SEK per groin and year

Repair of seawall 500,000 SEK every 5:th year

Repair of breakwaters 100,000 SEK every 5:th year starting year 10

Cost of option 2 (beach nourishment)

Sand nourishment $20\,000 \text{ m}^3$ at a cost of 40-80 SEK per m^3 every fifth year

$20,000 \text{ m}^3 * 60 \text{ SEK/ m}^3 = 1.2 \text{ MSEK}$

Repair of 5 groins 50,000-60,000 SEK per groin and year

Repair of seawall 500,000 every 15 years

Repair of breakwaters 50,000 every 5 years

Data sources:

Quantity and cost data are collected from the Municipality of Ystad and are based on analogous estimate and historical data.

6.5 Evaluation model

The CBA is done using a modified version of spreadsheets developed by British authorities⁹. The modification concerns only layout of the spreadsheets that have been adjusted to suit this particular case study. Formulas and calculations are original. The whole calculation is presented with Present Values (PV) in Appendix B.

The basic way of working with the CBA model is to start with estimating total damage and loss of the “Do Nothing”-alternative (No Project), see table B-2. This value is later used as the Benefit (or avoided damage) for the investigated options of preventive actions. Next step is to estimate the schedule and Cost of implementing the options see Table B6. Finally there is still risk of damages for the investigated options, the cost of this is calculated, see table 3 and 4. The results are summarized in Table 4.

7 RESULTS AND DISCUSSION

The calculations from chapter 6.3 and 6.4 have been entered in the spreadsheets see Appendix B. The summary table (Table 4) of the analysis shows a summary of the calculations. For a CBA the selection criterion is that if the ratio between benefits and costs is greater than 1 (benefits divided by costs >1) the option is worth doing. The option with highest benefit cost ratio gives “best value for money”.

In this case study both Option 1 and Option 2 are worth doing. They both have a cost benefit ratio greater than 1. Option 2, Beach nourishment, has the highest b/c ratio – 3.6.

Table 4 - Summary table of Ystad sandskog case study evaluation. (Values from Appendix B has been rounded to two digit precision) (PV=Present Value)

Costs and benefits of options					
PV costs from estimates Optimism bias adjustment Total PV Costs for appraisal PVc PV damage PVd PV damage avoided PV assets PVa PV asset protection benefits Total PV benefits PVb Net Present Value NPV Average benefit/cost ratio Incremental benefit/cost ratio	Costs and benefits MSEK				
	No Project	Option 1	Option 2		
	0	38	31		
		23	19		
		60	50		
	235	53	56		
		182	180		
		0	0		
		182	180		
		122	130		
		3,0	3,6		
			0.24		
Highest b/c					
-					
Brief description of options:					
Option 1		Minimum investment, maintain existing seawall			
Option 2		Beach nourishment			

Table 4 shows that the present value of investment is about 60 MSEK for option 1 and 50 MSEK for option 2. The value of avoided damage if the options are implemented is

⁹ <http://www.defra.gov.uk/envirom/fcd/pubs/pagn/fcdpag3/default.htm>

182 and 180 MSEK respectively. This means for option 1 that if we invest 10 MSEK extra, compared to option 2, we will avoid 2MSEK.

A decision maker can use the b/c ratio to select the best alternative. One possible way of reacting to this is to ask for better alternatives. Can we accept the predicted damage level of the case study? Is there an option that reduces predicted damages even better?

Further investigation

It is always possible to improve an appraisal, in this case specifically

- Data used in the case study mainly considering infrastructure cost. Are there omitted items that should be included in the CBA? Environment, heritage etc.
- Accuracy of result – Calculations in spreadsheets are made with many digits but results should only be presented with justifiable number of digits. In this case at least not more than two.
- Quantities – can they be better measured? Possibility to obtain data from Land Survey authority?
- Cost data – better basic data? Could be bettered with data from government real estate assessed value. Real estate agents can be interviewed
- Risk and sensitivity – Different scenarios can be used when appraising future damage and loss, optimistic and pessimistic. What happens if sea level rise is not 50 cm but 100 cm in 100 years? What technical measures will have to be implemented then?

8 CONCLUSIONS

By making a case study for an area a good background and technical involved persons are activated and questions are put on the agenda. With a CBA a long-term perspective is generated and the influence over time of natural change and manmade intervention is evaluated in one context.

In a case like Ystad sandskog where land is lost to the sea it is of direct interest for the landowner to evaluate future possibilities. It is therefore suitable for a municipality like Ystad. The neighbouring areas to the one investigated are reasonably stable and do not carry any bigger uncertainties to the project.

When CBA is adopted on higher levels, regional national etc. to choose priority between projects additional care should be taken that the different projects are analysed using the same methods to estimate quantities and to establish cost data. In the case of single project analysis, over- or underestimating may be more systematic and may not pose a big problem as long as the options are treated equal.

Technical evaluation and models for evaluating shoreline development and impact of manmade activities on erosion and the shoreline are fundamental for good analysis.

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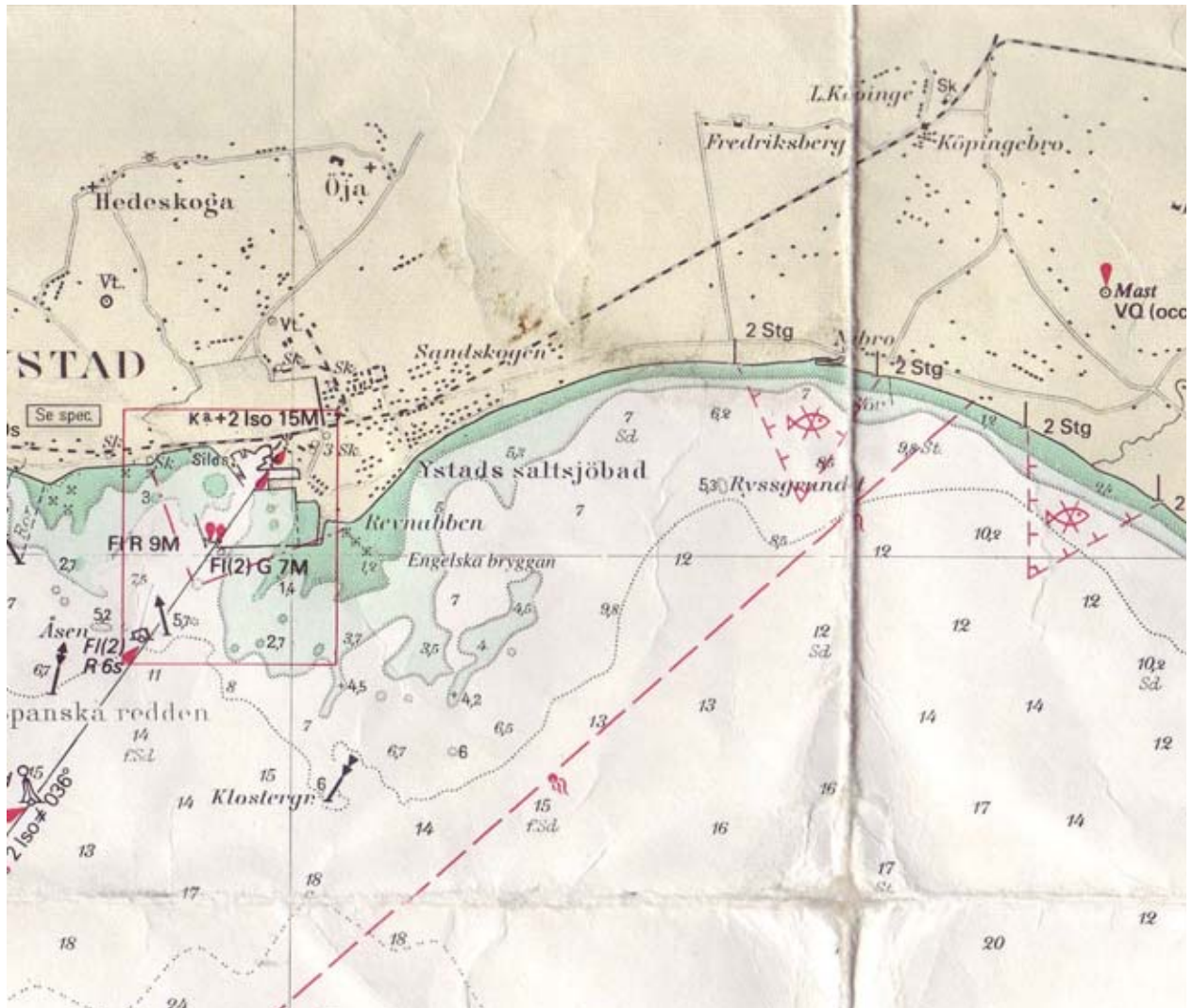
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State-of-the-art, Messina project Component 3, 2005

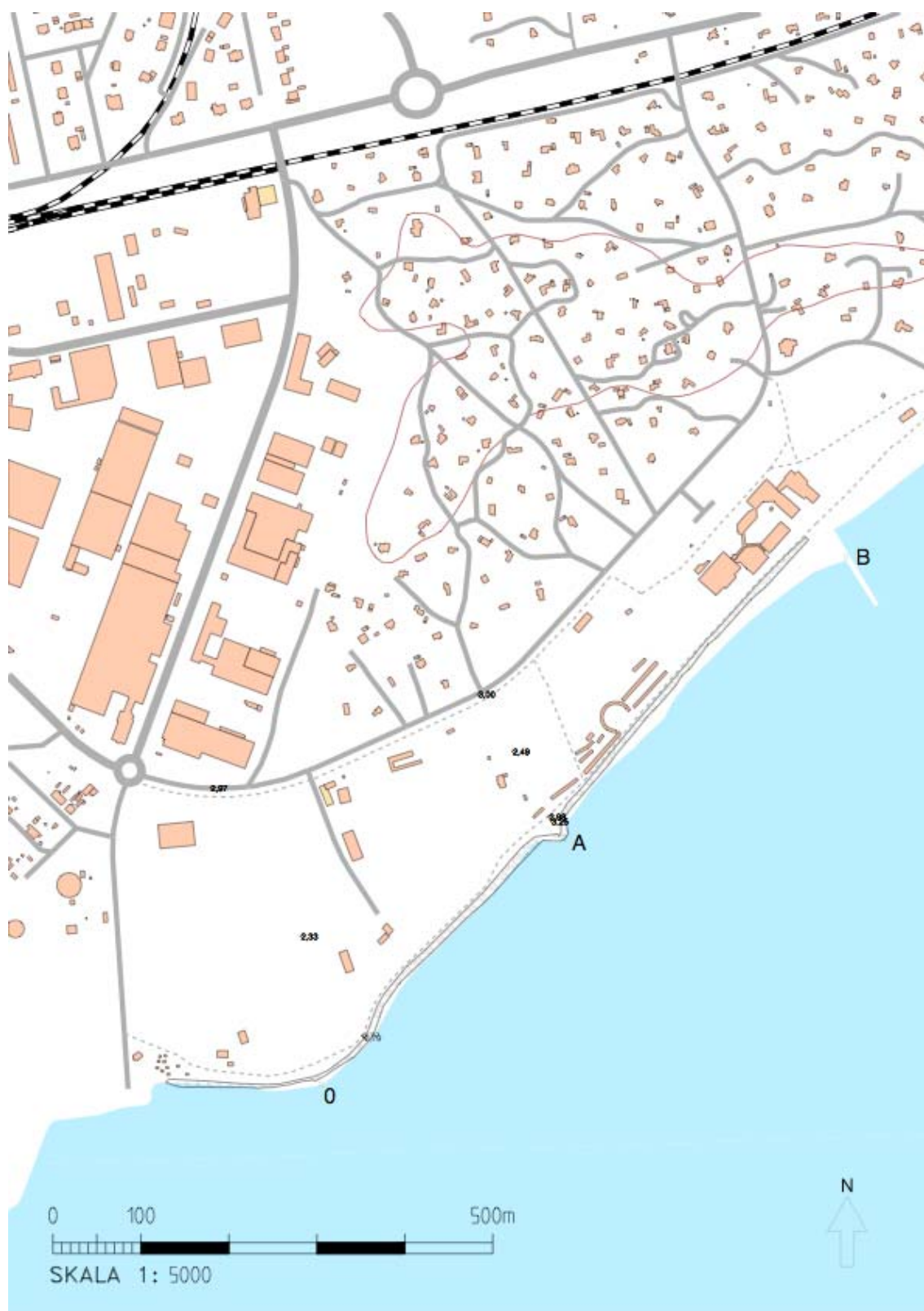
Dahlerus, Carl-Johan, Egermayer Daniel. Uppspolning och klittererosion längs Ystads
kusten – Situation idag och framtida scenarier,

Blomgren, S. & Hanson, H. (1993). Kusterosion i nio skånska kommuner – Skador och
förslag till åtgärder. Inst. för teknisk vattenresurslära, Lunds Universitet, Lund.

APPENDIX A – MAPS SHOWING THE EVALUATED COASTLINE AND INTERSECTION POINTS



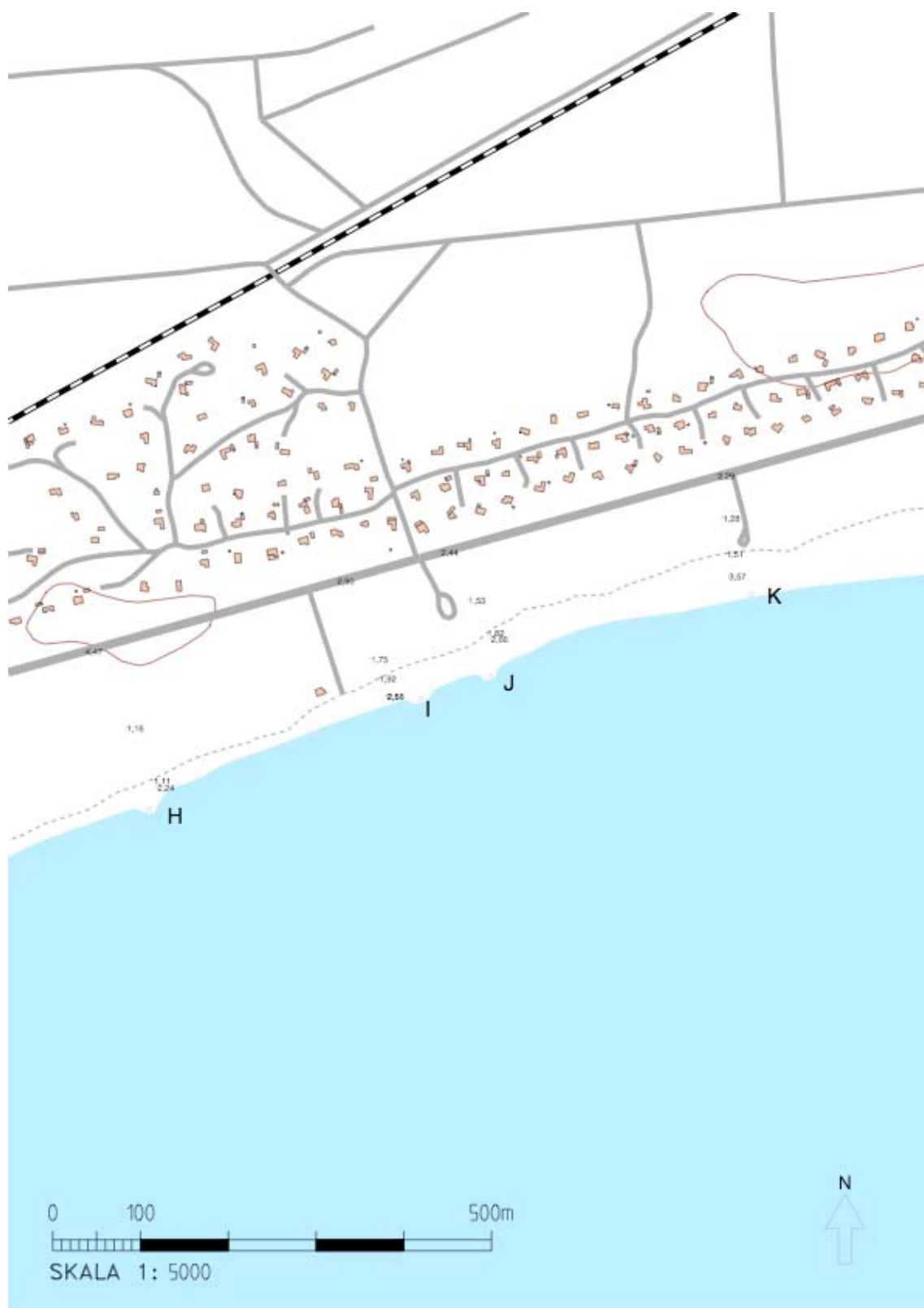
Map A-1: - The total area of Ystad Sandskogen



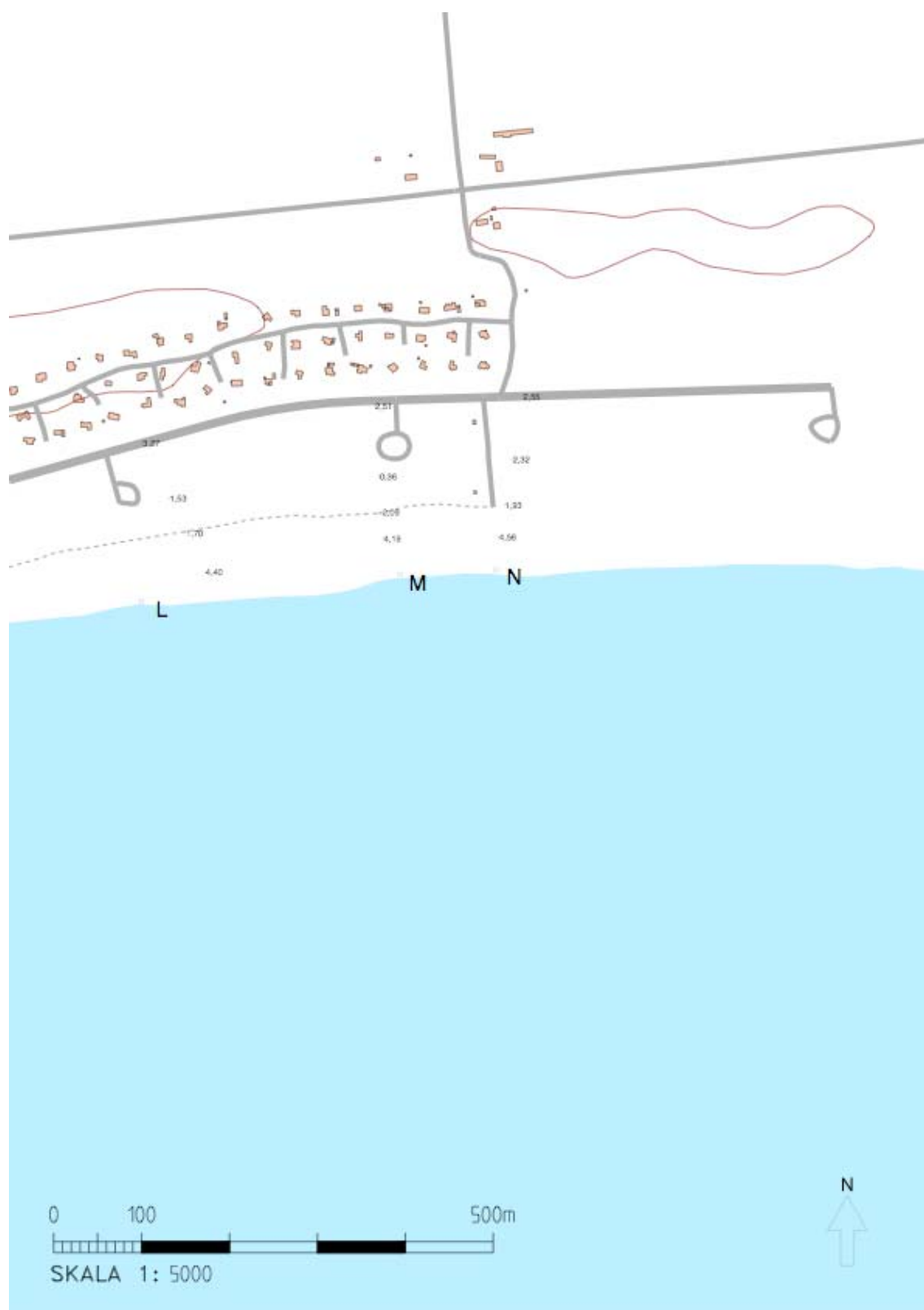
Map A-2. Intersection parts 0-B

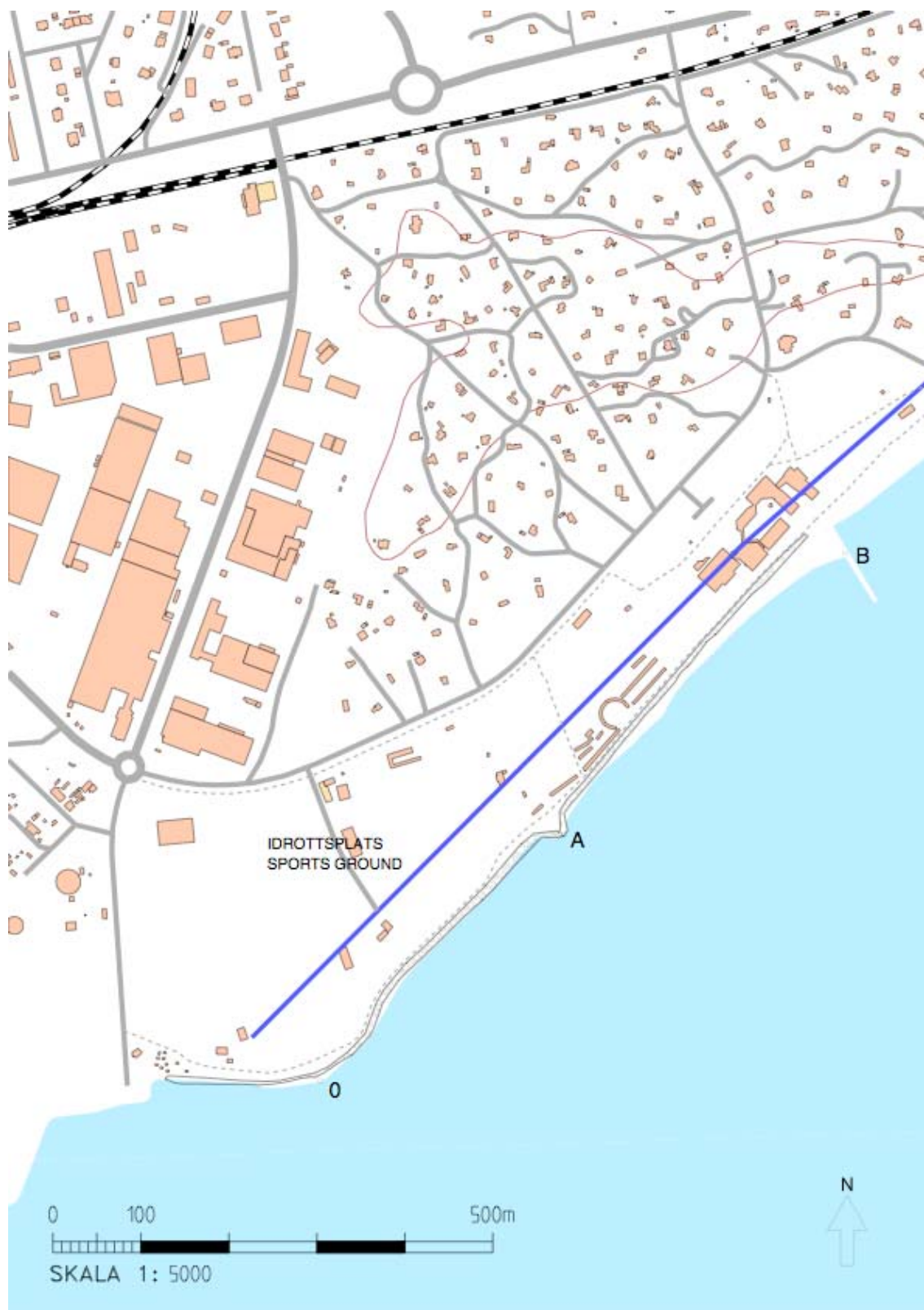


Map A-3. Intersection parts C-G

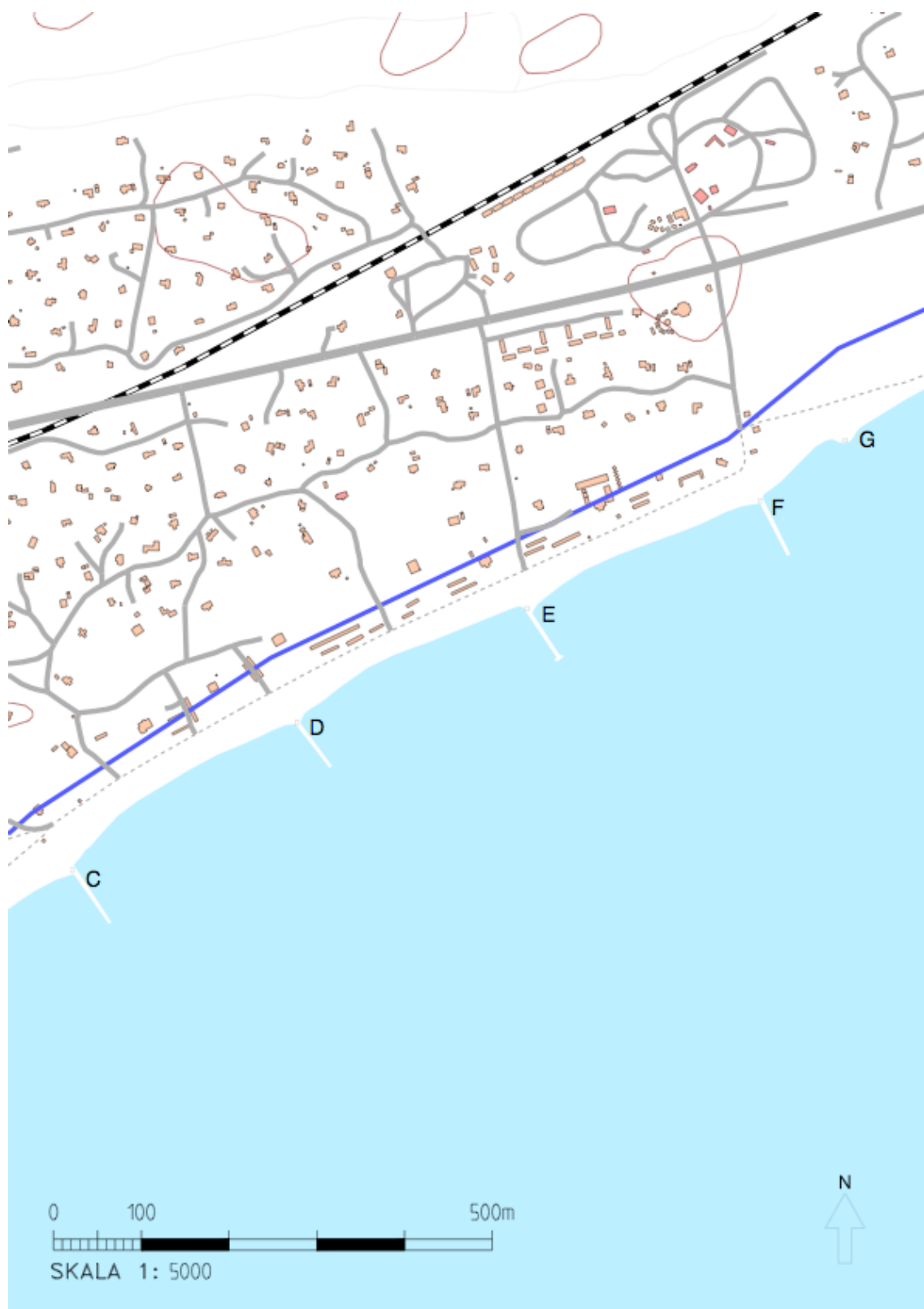


Map A-4. Intersection parts H-K

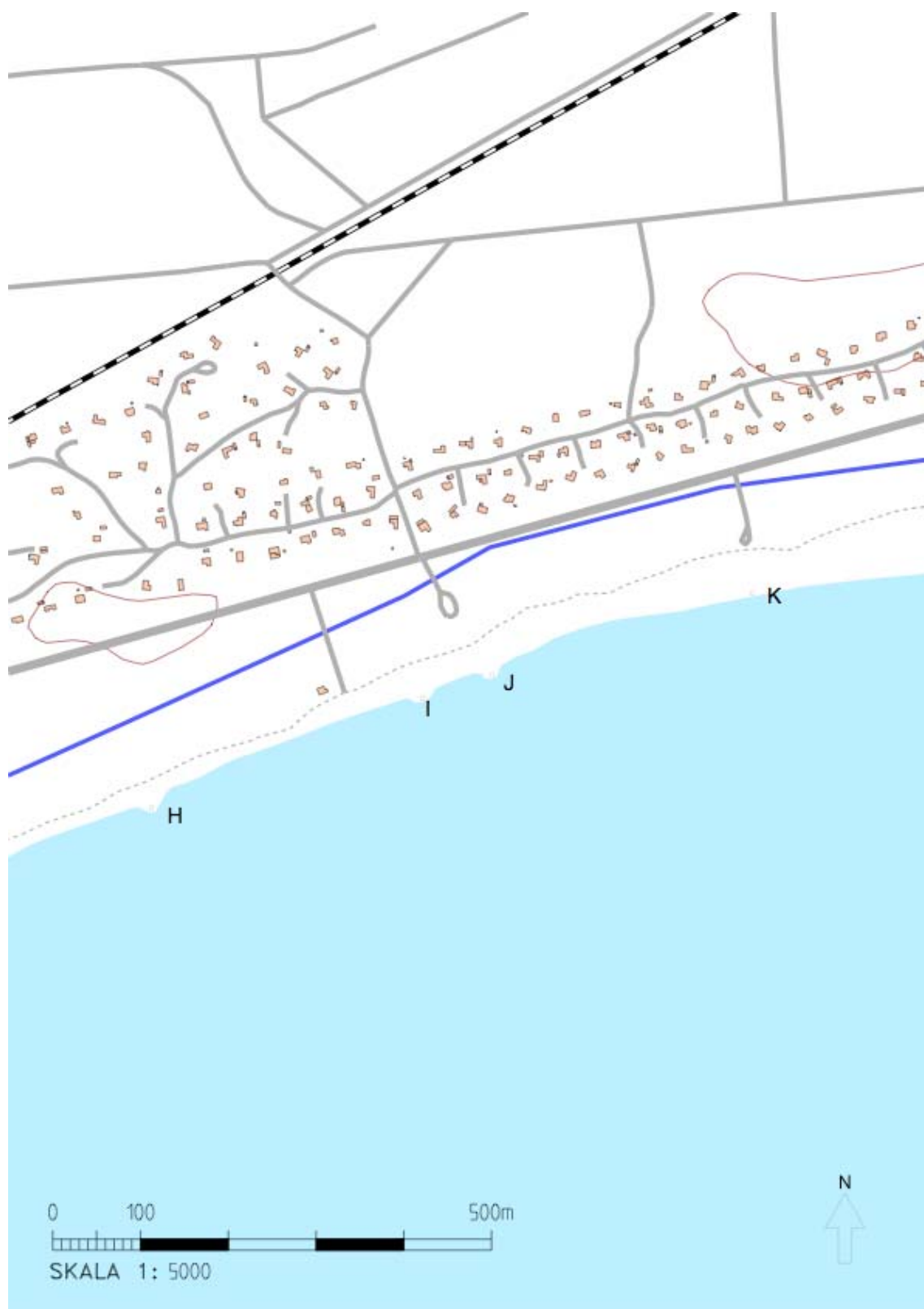




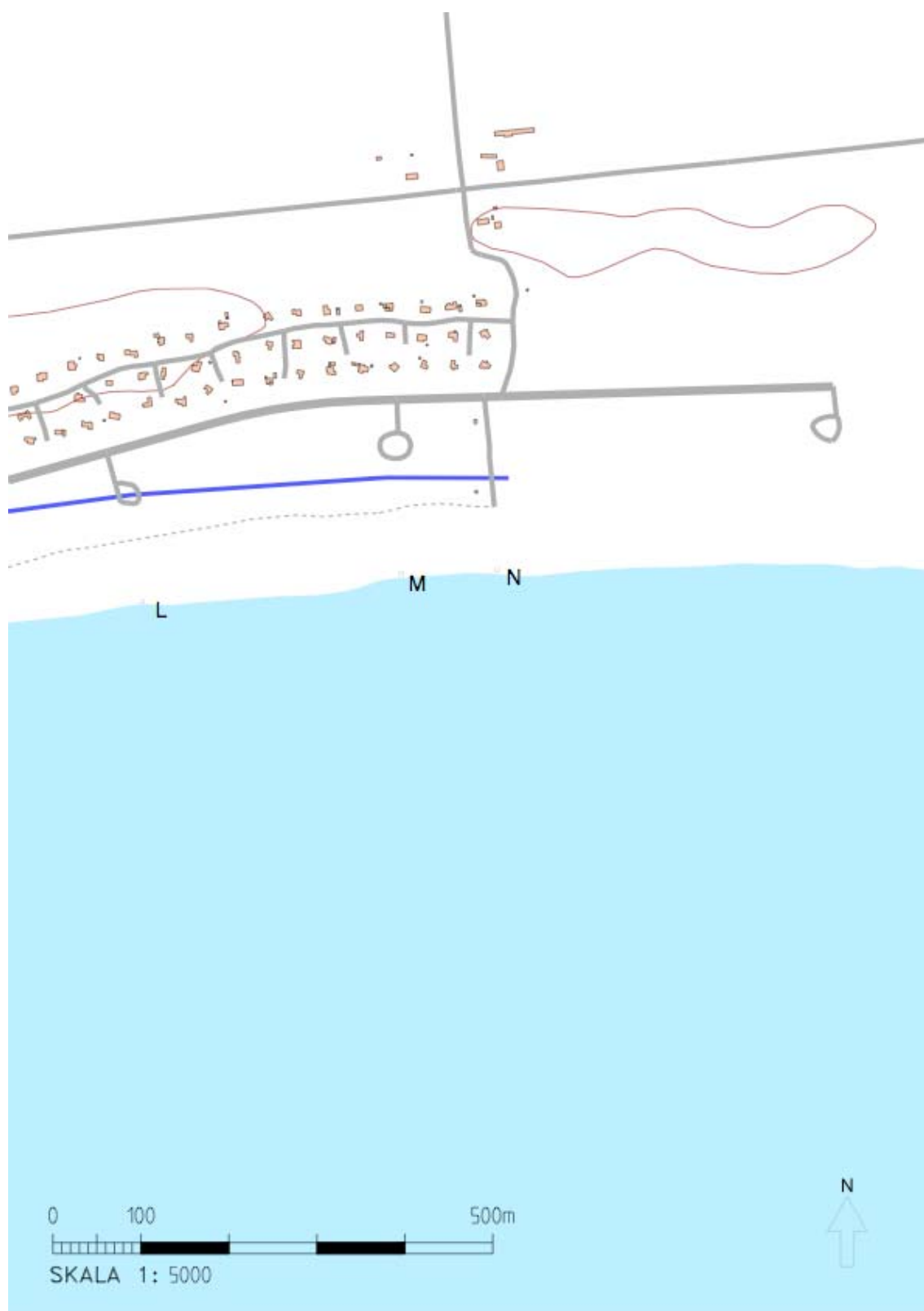
Map A-6. Estimated coastline year 2100 without any measures to protect the coast.
Intersection 0-B.



Map A-7. Estimated coastline year 2100 without any measures to protect the coast.
Intersection C-G.



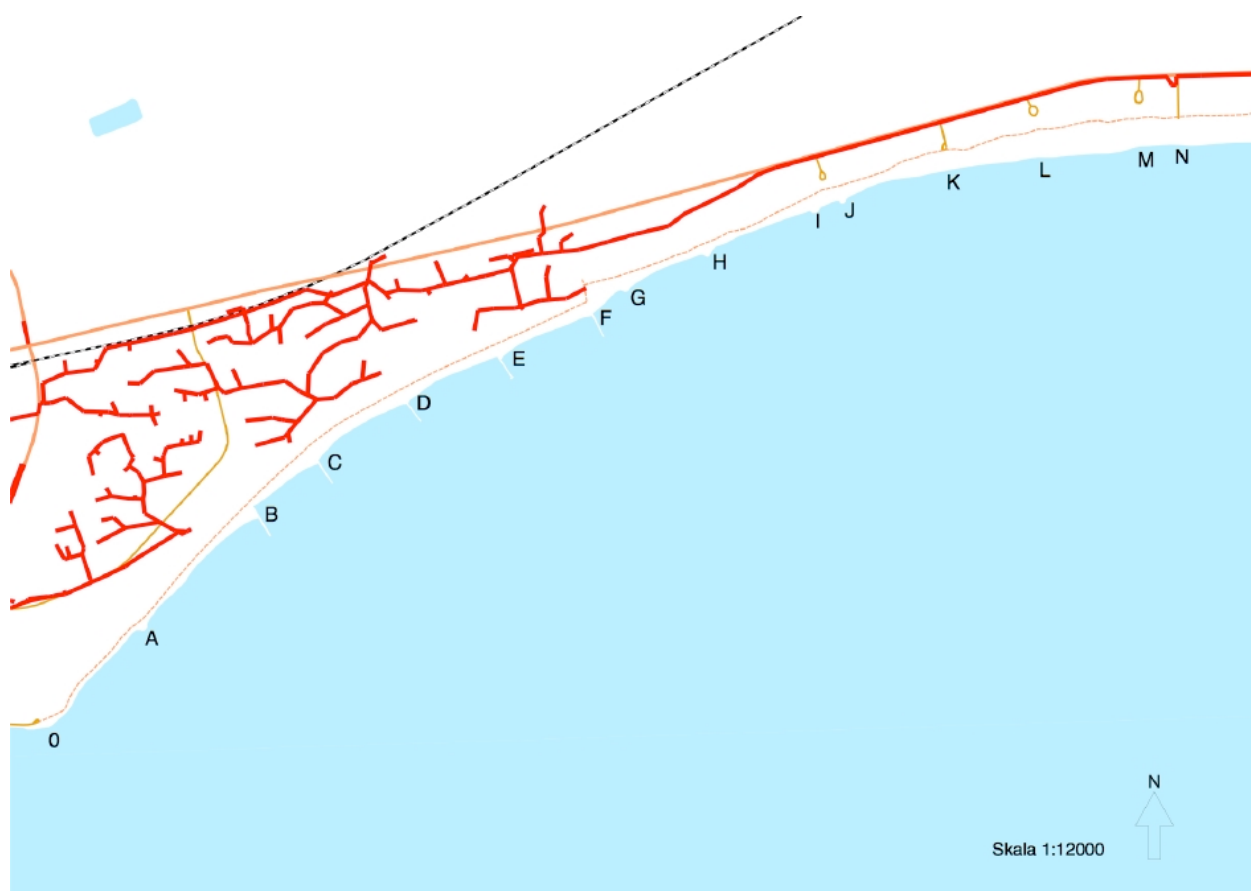
Map A-8. Estimated coastline year 2100 without any measures to protect the coast.
Intersection H-K.



Map A-9. Estimated coastline year 2100 without any measures to protect the coast.
Intersection L-N.

Table A-1. Sections and preliminary values used for evaluation

Section	Type of shoreline	Length (m)	Coastline 100 years (m) erosion	Coastline 100 years (m) sea level rise	Coastline 100 years (m) combined	Area lost sq.m. Erosion	Area lost sq.m. Sea level rise	Area lost sq.m. Total	Beach nourishment	
									m	sq. m
0-A	Stone protection	400	-40	-50	-90	-16,000	-20,000	-36,000	0	0
A-B	Stone protection + gabion ±100 meter of B	450	-30	-50	-80	-13,500	-22,500	-36,000	0	0
B-C	Sand	230	-30	-50	-80	-6,900	-11,500	-18,400	5	1150
C-D	Sand + gabion	310	-30	-50	-80	-9,300	-15,500	-24,800	5	1550
D-E	Sand + gabion	290	-30	-50	-80	-8,700	-14,500	-23,200	2	580
E-F	Sand + gabion	300	-30	-50	-80	-9,000	-15,000	-24,000	2	600
F-G	Sand + Stone protection	150	-30	-50	-80	-4,500	-7,500	-12,000	2	300
G-H	Sand + Stone protection	300	-50	-50	-100	-15,000	-15,000	-30,000	2	600
H-I	Sand + Stone protection	400	-50	-50	-100	-20,000	-20,000	-40,000	2	800
I-J	Sand	100	-70	-50	-120	-7,000	-5,000	-12,000	-1	-100
J-K	Sand	380	-90	-50	-140	-34,200	-19,000	-53,200	-7	-2660
K-L	Sand	300	-70	-50	-120	-21,000	-15,000	-36,000	-4	-1200
L-M	Sand	450	-70	-50	-120	-31,500	-22,500	-54,000	-3	-1350
M-N	Sand	140	-50	-50	-100	-7,000	-7,000	-14,000	-2	-280
		4200	-48.5	-50.0	-98.5	-203,600	-210,000	-413,600	-10	



Map A-10. Main water supply pipes in the area.

APPENDIX B – COST BENEFIT ANALYSIS

Table B-1. Summary of Cost-Benefit Analysis

Project Summary Sheet					
Client/Authority			Prepared (date)		
Ystad kommun - Teknik och fastigheter			2005-10-15		
Project name			Printed		
Ystad Strandskog			2005-11-29		
Project reference			Prepared by		
Messina Case			MP		
Base date for estimates (year 0)			Checked by		
Oct-2005			Checked date		
Scaling factor (e.g. MSEK, KSEK, SEK, M€, K€, €)			(used for all costs, losses and benefits)		
MSEK					
Initial discount rate			1.5%		
Optimism bias factor			60.0%		
Costs and benefits of options					
Costs and benefits MSEK					
	No Project	Option 1	Option 2		
PV costs from estimates		37.77	31.31		
Optimism bias adjustment		22.66	18.79		
Total PV Costs for appraisal PVc		60.43	50.09		
PV damage PVd	235.18	53.12	55.62		
PV damage avoided		182.06	179.56		
PV assets PVa					
PV asset protection benefits		0.00	0.00		
Total PV benefits PVb		182.06	179.56		
Net Present Value NPV		121.63	129.47		
Average benefit/cost ratio		3.01	3.58		
Incremental benefit/cost ratio			0.24		
- Highest b/c					
Brief description of options:					
Option 1	Minimum investment, maintain existing seawall and repair				
Option 2	Beach nourishment				
Option 3					
Option 4					
Original notes:					
1) Benefits will normally be expressed either in terms of damage avoided or asset values protected. Care is needed to avoid double counting					
2) PV damage avoided is calculated as PV damage (No Project) - PV damage (Option)					
PV asset protection benefits are calculated as PVa (Option) - PVa (No Project)					
PV benefits calculated as PV damage avoided + PV asset protection benefits					
3) Incremental benefit/cost ratio is calculated as:					
$(PVb(\text{current option}) - PVb(\text{previous option})) / (PVc(\text{current option}) - PVc(\text{previous option}))$					

Table B-2. Damage cost of “Do Nothing”-alternative (Option 1)

Damage Cost Calculation Sheet - Do Nothing (Exponential)							Sheet Nr	2
Client/Authority		Ystad kommun - Teknik och fastigheter						
Project name		Ystad Strandskog						
Project reference		Messina Case						
Base date for estimates (year 0)		Oct-2005					Prepared (date)	2005-10-15
Scaling factor (e.g. MSEK, KSEK, S)		MSEK					Printed	2005-11-29
Initial discount rate		1.5%					Prepared by	MP
Remaining structure life		30					Checked by	
Initial probability of failure		0.010					Checked date	
Calculations assume		0.99 prob of failure in year 30						
Calculated factors:		-0.01005 -1.35103						
		PV breach/failure Ave Annual Damage (overtopping) MSEK 320.58 MSEK 0.00 /yr						
		PV Total Damage MSEK 235.18 (calculated below)						
Year	Discount factor	Prob of a breach/failure	Prob that breach/failure occurs in year	has not occurred	PV damage due to: breach or failure	PV damage due to: overtopping	Other damage (specify)	PV total damage
0	1.000	0.010	0.010	0.990	3.21	0.00		3.21
1	0.985	0.010	0.010	0.980	3.27	0.00		3.27
2	0.971	0.011	0.011	0.969	3.35	0.00		3.35
3	0.956	0.012	0.011	0.958	3.42	0.00		3.42
4	0.942	0.012	0.012	0.946	3.51	0.00		3.51
5	0.928	0.013	0.012	0.934	3.60	0.00		3.60
6	0.915	0.014	0.013	0.921	3.70	0.00		3.70
7	0.901	0.014	0.013	0.908	3.81	0.00		3.81
8	0.888	0.015	0.014	0.894	3.93	0.00		3.93
9	0.875	0.016	0.014	0.880	4.06	0.00		4.06
10	0.862	0.017	0.015	0.865	4.20	0.00		4.20
11	0.849	0.019	0.016	0.849	4.36	0.00		4.36
12	0.836	0.020	0.017	0.832	4.54	0.00		4.54
13	0.824	0.022	0.018	0.814	4.73	0.00		4.73
14	0.812	0.023	0.019	0.795	4.95	0.00		4.95
15	0.800	0.026	0.020	0.774	5.20	0.00		5.20
16	0.788	0.028	0.022	0.753	5.48	0.00		5.48
17	0.776	0.031	0.023	0.730	5.80	0.00		5.80
18	0.765	0.034	0.025	0.704	6.17	0.00		6.17
19	0.754	0.039	0.027	0.677	6.60	0.00		6.60
20	0.742	0.044	0.030	0.647	7.11	0.00		7.11
21	0.731	0.051	0.033	0.614	7.72	0.00		7.72
22	0.721	0.060	0.037	0.578	8.46	0.00		8.46
23	0.710	0.071	0.041	0.536	9.39	0.00		9.39
24	0.700	0.088	0.047	0.489	10.58	0.00		10.58
25	0.689	0.113	0.055	0.434	12.16	0.00		12.16
26	0.679	0.152	0.066	0.368	14.38	0.00		14.38
27	0.669	0.224	0.083	0.285	17.71	0.00		17.71
28	0.659	0.388	0.111	0.175	23.41	0.00		23.41
29	0.649	0.990	0.173	0.002	36.00	0.00		36.00
30	0.640	1.000	0.002	0.000	0.36	0.00		0.36
31	0.633	1.000	0.000	0.000	0.00	0.00		0.00
32	0.627	1.000	0.000	0.000	0.00	0.00		0.00
33	0.621	1.000	0.000	0.000	0.00	0.00		0.00
34	0.615	1.000	0.000	0.000	0.00	0.00		0.00
35	0.609	1.000	0.000	0.000	0.00	0.00		0.00
36	0.603	1.000	0.000	0.000	0.00	0.00		0.00
37	0.597	1.000	0.000	0.000	0.00	0.00		0.00
38	0.591	1.000	0.000	0.000	0.00	0.00		0.00
39	0.585	1.000	0.000	0.000	0.00	0.00		0.00
40	0.579	1.000	0.000	0.000	0.00	0.00		0.00
41	0.573	1.000	0.000	0.000	0.00	0.00		0.00
42	0.568	1.000	0.000	0.000	0.00	0.00		0.00
43	0.562	1.000	0.000	0.000	0.00	0.00		0.00
44	0.557	1.000	0.000	0.000	0.00	0.00		0.00
45	0.551	1.000	0.000	0.000	0.00	0.00		0.00
46	0.546	1.000	0.000	0.000	0.00	0.00		0.00
47	0.540	1.000	0.000	0.000	0.00	0.00		0.00
48	0.535	1.000	0.000	0.000	0.00	0.00		0.00
49	0.530	1.000	0.000	0.000	0.00	0.00		0.00

Table B-3. Damage cost of “Maintain and repair”-alternative (Option 1)

Damage Cost Calculation Sheet - Do Something (Exponential)							Sheet Nr.	3
Client/Authority Ystad kommun - Teknik och fastigheter								
Project name Ystad Strandskog							Option: Option 1 - Maintain and repair	
Project reference Base date for estimates (year 0) Scaling factor (e.g. MSEK, KSEK, SEK, Discount rate							Messina Case Oct-2005 MSEK 1.5%	
Remaining structure life Initial probability of failure Calculations assume							Prepared (date) Printed Prepared by Checked by Checked date	
Calculated factors:							2005-10-15 2005-11-29 MP	
0.99 prob of failure in year 15							15 0.080	
-0.01005 -0.92896							PV breach/failure Ave Annual Damage (overtopping)	
							MSEK 10.00 MSEK 0.00 /yr	
							PV Total Damage MSEK 53.12 (calculated below)	
Year	Discount factor	Prob of a breach/failure	Prob that breach/failure occurs in year	Prob that breach/failure does not occur	PV damage due to: breach or failure	PV damage due to: overtopping	Other damage (specify)	PV total damage
0	1.000	0.080	0.080	0.920	0.80	0.00	repairs carried out	0.80
1	0.985	0.085	0.085	0.915	0.84	0.00		0.84
2	0.971	0.091	0.091	0.909	0.89	0.00		0.89
3	0.956	0.098	0.098	0.902	0.94	0.00		0.94
4	0.942	0.107	0.107	0.893	1.01	0.00		1.01
5	0.928	0.080	0.080	0.920	0.74	0.00	repairs carried out	0.74
6	0.915	0.085	0.085	0.915	0.78	0.00		0.78
7	0.901	0.091	0.091	0.909	0.82	0.00		0.82
8	0.888	0.098	0.098	0.902	0.87	0.00		0.87
9	0.875	0.107	0.107	0.893	0.93	0.00		0.93
10	0.862	0.080	0.080	0.920	0.69	0.00	repairs carried out	0.69
11	0.849	0.085	0.085	0.915	0.72	0.00		0.72
12	0.836	0.091	0.091	0.909	0.76	0.00		0.76
13	0.824	0.098	0.098	0.902	0.81	0.00		0.81
14	0.812	0.107	0.107	0.893	0.87	0.00		0.87
15	0.800	0.080	0.080	0.920	0.64	0.00	repairs carried out	0.64
16	0.788	0.085	0.085	0.915	0.67	0.00		0.67
17	0.776	0.091	0.091	0.909	0.71	0.00		0.71
18	0.765	0.098	0.098	0.902	0.75	0.00		0.75
19	0.754	0.107	0.107	0.893	0.80	0.00		0.80
20	0.742	0.080	0.080	0.920	0.59	0.00	repairs carried out	0.59
21	0.731	0.085	0.085	0.915	0.62	0.00		0.62
22	0.721	0.091	0.091	0.909	0.66	0.00		0.66
23	0.710	0.098	0.098	0.902	0.70	0.00		0.70
24	0.700	0.107	0.107	0.893	0.75	0.00		0.75
25	0.689	0.080	0.080	0.920	0.55	0.00	repairs carried out	0.55
26	0.679	0.085	0.085	0.915	0.58	0.00		0.58
27	0.669	0.091	0.091	0.909	0.61	0.00		0.61
28	0.659	0.098	0.098	0.902	0.65	0.00		0.65
29	0.649	0.107	0.107	0.893	0.69	0.00		0.69
30	0.640	0.080	0.080	0.920	0.51	0.00	repairs carried out	0.51
31	0.633	0.085	0.085	0.915	0.54	0.00		0.54
32	0.627	0.091	0.091	0.909	0.57	0.00		0.57
33	0.621	0.098	0.098	0.902	0.61	0.00		0.61
34	0.615	0.107	0.107	0.893	0.66	0.00		0.66
35	0.609	0.080	0.080	0.920	0.49	0.00	repairs carried out	0.49
36	0.603	0.085	0.085	0.915	0.51	0.00		0.51
37	0.597	0.091	0.091	0.909	0.54	0.00		0.54
38	0.591	0.098	0.098	0.902	0.58	0.00		0.58
39	0.585	0.107	0.107	0.893	0.62	0.00		0.62
40	0.579	0.080	0.080	0.920	0.46	0.00	repairs carried out	0.46
41	0.573	0.085	0.085	0.915	0.49	0.00		0.49
42	0.568	0.091	0.091	0.909	0.52	0.00		0.52
43	0.562	0.098	0.098	0.902	0.55	0.00		0.55
44	0.557	0.107	0.107	0.893	0.59	0.00		0.59
45	0.551	0.080	0.080	0.920	0.44	0.00	repairs carried out	0.44
46	0.546	0.085	0.085	0.915	0.47	0.00		0.47
47	0.540	0.091	0.091	0.909	0.49	0.00		0.49
48	0.535	0.098	0.098	0.902	0.53	0.00		0.53
49	0.530	0.107	0.107	0.893	0.56	0.00		0.56
50	0.524	0.080	0.080	0.920	0.42	0.00	repairs carried out	0.42
51	0.519	0.085	0.085	0.915	0.44	0.00		0.44
52	0.514	0.091	0.091	0.909	0.47	0.00		0.47
53	0.509	0.098	0.098	0.902	0.50	0.00		0.50
54	0.504	0.107	0.107	0.893	0.54	0.00		0.54
55	0.499	0.080	0.080	0.920	0.40	0.00	repairs carried out	0.40
56	0.494	0.085	0.085	0.915	0.42	0.00		0.42
57	0.489	0.091	0.091	0.909	0.45	0.00		0.45
58	0.484	0.098	0.098	0.902	0.48	0.00		0.48
59	0.479	0.107	0.107	0.893	0.51	0.00		0.51
60	0.475	0.080	0.080	0.920	0.38	0.00	repairs carried out	0.38
61	0.470	0.085	0.085	0.915	0.40	0.00		0.40
62	0.465	0.091	0.091	0.909	0.42	0.00		0.42
63	0.461	0.098	0.098	0.902	0.45	0.00		0.45
64	0.456	0.107	0.107	0.893	0.49	0.00		0.49
65	0.452	0.080	0.080	0.920	0.36	0.00	repairs carried out	0.36
66	0.447	0.085	0.085	0.915	0.38	0.00		0.38
67	0.443	0.091	0.091	0.909	0.40	0.00		0.40
68	0.438	0.098	0.098	0.902	0.43	0.00		0.43
69	0.434	0.107	0.107	0.893	0.46	0.00		0.46

Damage Cost Calculation Sheet - Do Something (Exponential)										Sheet Nr.	4
Client/Authority											
Ystad kommun - Teknik och fastigheter											
Project name						Option:					
Ystad Strandskog						Option 2 - Beach nourishment					
Project reference				Messina Case							
Base date for estimates (year 0)				Oct-2005							
Scaling factor (e.g. MSEK, KSEK, SEK,				MSEK							
Discount rate				1.5%							
Remaining structure life				15		PV breach/failure		MSEK		10.00	
Initial probability of failure				0.080		Ave Annual Damage				Prepared by	
Calculations assume				0.99		(overtopping)		MSEK		0.00 /yr	
Calculated factors:				-0.01005				MSEK		55.62 (calculated below)	
Year	Discount factor	Prob of a breach/failure	Prob that breach/failure: occurs in year does not occur		breach or	PV damage due to: over-topping		Other damage (specify)		PV total damage	
0	1.000	0.080	0.080	0.920	0.80	0.00	repairs carried out			0.80	
1	0.985	0.085	0.085	0.915	0.84	0.00				0.84	
2	0.971	0.091	0.091	0.909	0.89	0.00				0.89	
3	0.956	0.098	0.098	0.902	0.94	0.00				0.94	
4	0.942	0.107	0.107	0.893	1.01	0.00				1.01	
5	0.928	0.117	0.117	0.883	1.08	0.00				1.08	
6	0.915	0.129	0.129	0.871	1.18	0.00				1.18	
7	0.901	0.143	0.143	0.857	1.29	0.00				1.29	
8	0.888	0.162	0.162	0.838	1.44	0.00				1.44	
9	0.875	0.187	0.187	0.813	1.64	0.00				1.64	
10	0.862	0.080	0.080	0.920	0.69	0.00	repairs carried out			0.69	
11	0.849	0.085	0.085	0.915	0.72	0.00				0.72	
12	0.836	0.091	0.091	0.909	0.76	0.00				0.76	
13	0.824	0.098	0.098	0.902	0.81	0.00				0.81	
14	0.812	0.107	0.107	0.893	0.87	0.00				0.87	
15	0.800	0.080	0.080	0.920	0.64	0.00	repairs carried out			0.64	
16	0.788	0.085	0.085	0.915	0.67	0.00				0.67	
17	0.776	0.091	0.091	0.909	0.71	0.00				0.71	
18	0.765	0.098	0.098	0.902	0.75	0.00				0.75	
19	0.754	0.107	0.107	0.893	0.80	0.00				0.80	
20	0.742	0.080	0.080	0.920	0.59	0.00	repairs carried out			0.59	
21	0.731	0.085	0.085	0.915	0.62	0.00				0.62	
22	0.721	0.091	0.091	0.909	0.66	0.00				0.66	
23	0.710	0.098	0.098	0.902	0.70	0.00				0.70	
24	0.700	0.107	0.107	0.893	0.75	0.00				0.75	
25	0.689	0.080	0.080	0.920	0.55	0.00	repairs carried out			0.55	
26	0.679	0.085	0.085	0.915	0.58	0.00				0.58	
27	0.669	0.091	0.091	0.909	0.61	0.00				0.61	
28	0.659	0.098	0.098	0.902	0.65	0.00				0.65	
29	0.649	0.107	0.107	0.893	0.69	0.00				0.69	
30	0.640	0.080	0.080	0.920	0.51	0.00	repairs carried out			0.51	
31	0.633	0.085	0.085	0.915	0.54	0.00				0.54	
32	0.627	0.091	0.091	0.909	0.57	0.00				0.57	
33	0.621	0.098	0.098	0.902	0.61	0.00				0.61	
34	0.615	0.107	0.107	0.893	0.66	0.00				0.66	
35	0.609	0.080	0.080	0.920	0.49	0.00	repairs carried out			0.49	
36	0.603	0.085	0.085	0.915	0.51	0.00				0.51	
37	0.597	0.091	0.091	0.909	0.55	0.00				0.55	
38	0.591	0.098</									

Table B-5. Erosion value calculation of “Do Nothing”-alternative (No Project)

Erosion Value Calculation Sheet with delay options						Sheet Nr. 6	
Client/Authority Ystad kommun - Teknik och fastigheter			Option:		Delay (yrs)	Prepared (date)	2005-10-15
Project name Ystad Strandskog						Printed	2005-11-29
Project reference Base date for estimates (year 0) Scaling factor (e.g. MSEK, KSEK, SEI) Discount rate			Messina Case Oct-2005 MSEK 1.5%			Prepared by Checked by Checked date	MP
Ref	Asset Description	MV MSEK	Year	Prob of loss without project in year	Without Project	Expected value of asset losses MSEK	
0	Hotell	40.00	10	0.3	10.34		
1		40.00	20	0.4	11.88		
2		40.00	30	0.3	7.68		
3	Fotball area (part of)	4.00	20	0.25	0.74		
4		4.00	21	0.25	0.73		
5		4.00	22	0.25	0.72		
6		4.00	23	0.25	0.71		
7	Summer villa area	400.00	10	0.2	68.93		
8		400.00	20	0.2	59.40		
9		400.00	30	0.2	51.18		
10		400.00	40	0.2	44.10		
11		400.00	50	0.2	38.00		
12	Forest	40.00	10	0.2	6.89		
13		40.00	20	0.2	5.94		
14		40.00	30	0.2	5.12		
15		40.00	40	0.2	4.41		
16		40.00	50	0.2	3.80		
17					-		
18					-		
19					-		
20					-		
21					-		
22					-		
23					-		
24					-		
25					-		
26					-		
27					-		
28					-		
29					-		
30					-		
31					-		
32					-		
33					-		
34					-		
35					-		
36					-		
37					-		
38					-		
39					-		
40					-		
41					-		
42					-		
43					-		
44					-		
45					-		
46					-		
47					-		
48					-		
49					-		
50					-		
Totals		484.00			320.58		
Notes Make one entry in the description column for each property (or group of properties) as this determines subsequent calculation MV = risk free market value at base date for estimate - must be entered on each line when probability distribution is used Equivalent annual value = MV x discount rate (assumes infinite life) Year is year by which there is the cumulative probability of loss shown If no distribution is used enter year after expected year of loss and enter 1.0 in probability column (i.e. certainty of loss before start of year so year must be 1.0 or greater) (e.g. If certain of loss in year 5 enter 6 in year column and 1 in probability column) Asset value in first year for each property (or group) shown is cumulative to the year of first loss Asset value in subsequent years for each property is additional value for that property if life extended							

Component 3



Table B-6. Present Value Costs for all Option

Present Value Costs for all options																	Sheet Nr. 7	
Client/Authority																	Prepared (date) 2005-10-15 Printed 2005-11-29 Prepared by MP Checked by Checked date	
Ystad kommun - Teknik och fastigheter																		
Project name																		
Ystad Strandskog																		
Project reference																		
Base date for estimates (year 0)																		
Scaling factor (e.g. MSEK, KSEK, MSEK)																		
Discount rate																		