



DHI CASE STORY

LINKING DENMARK AND SWEDEN

Using environmental and hydraulic services to assess sediment spill risks of the Øresund Fixed Link

Øresundsbro Konsortiet had to ensure that works carried out during construction of the Øresund Fixed Link (which connects Sweden and Denmark) met strict environmental requirements. As such, they asked us to ensure the Fixed Link would not block water exchange between the North Sea and the Baltic Sea. In addition, we also conducted a monitoring campaign of local flora and fauna to ensure sediment plumes would not negatively impact them. Due to our work, Øresundsbro Konsortiet was able to finish the Fixed Link six months ahead of schedule.

ASSESSING POTENTIAL SPILLS AND OPTIMISING DESIGN

The Øresund Fixed Link is a combined road and train connection that links Denmark with Sweden across the Øresund (the strait that separates the two countries). It is made up of an 8 km bridge, a 4 km artificial island and a 4 km tunnel. Construction of the EUR 4 billion Fixed Link required dredging 7 million m³ of seabed material (limestone and glacial till).

Built under very stringent, legally binding environmental requirements, Øresundsbro Konsortiet had to ensure that the Fixed Link had zero impact on the environment – including hydrography (water flow through Øresund). At the same time, there had to be zero impact outside a 500 m zone on each side of the Fixed Link five years after construction ended.

To comply with the environmental requirements, Øresundsbro Konsortiet wanted to ensure that construction of the Fixed Link would not block the exchange of water from the North Sea to the Baltic Sea. To help them prevent this, we set up advanced hydrodynamic models to assess and optimise the design of the different elements of the Fixed Link. This included:

- calculating the blocking effect
- assessing possibilities for compensation dredging to reduce these effects



Shadowing experiment of eelgrass. © DHI

SUMMARY

CLIENT

Øresundsbro Konsortiet

CHALLENGE

- Gaining approval of the Øresund Fixed Link from stakeholders
- Ensuring compliance with environmental regulations during construction
- Mitigating possible blocking of water exchange due to construction
- Optimising compensation dredging in order to maintain the natural flow of water through the Øresund
- Minimising environmental impact from dredging and landfill operations on flora and fauna

SOLUTION

- A robust decision support tool developed using hydrodynamic modelling
- A state-of-the-art adaptive monitoring and environmental management systems

VALUE

- Enabled the client to gain approval of the Fixed Link from all stakeholders without delays
- Provided the client and the authorities with a unique online environmental information system that included all environmental parameters selected for monitoring
- Enabled the client to optimise project design and environmental mitigation measures
- Helped the client avoid legal action solutions
- Risk levels compliant with target values

LOCATION / COUNTRY

Øresund (strait between Denmark and Sweden) and the Baltic Sea

We also deployed a number of monitoring stations to measure water levels, currents, salinity, temperature and other variables to provide data for the numerical models.

We surveyed the waters and seabed in the construction area to describe the physio-chemical conditions in the sediments and the water column. This enabled us to better calculate settling velocities and the potential for fine sediment fractions to spread during dredging operations. We also used the information to assess potential spill scenarios – where spills could occur and the quantity. In addition, we provided survey technology to the contractor who built the Fixed Link so they could directly monitor spills during major dredging operations

FINISHING EARLY WHILE STILL PROTECTING THE ENVIRONMENT

In addition to modelling water quality, we conducted a wide range of field surveys on flora and fauna using remote equipment. Our monitoring focused on:

- coverage and biomass of eelgrass
- coverage of common mussel (which is a source of food for a number of species)

The construction site area was a very important feeding ground for swans and spawning grounds for herring. Both especially depend on the eelgrass meadows found in the shallow waters around Saltholm (a Danish island in the Øresund). Because of this, a large portion of the monitoring, both before and during construction, focused on measuring and modelling biomass and abundance of eelgrass. This was done to ensure that the eelgrass could survive the increased blockage of light caused by sediment plumes.



Sediment plume. © DHI

We provided Øresundsbro Konsortiet with a modelling tool that could predict the impact of the sediment plumes on the eelgrass biomass (sub- and above seabed). This allowed them to manage dredging operations according to impact.

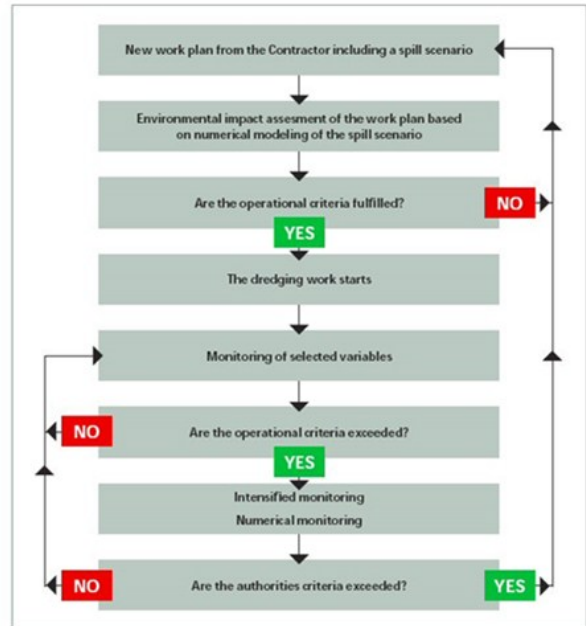
CLIENT TESTIMONIAL

“ Without DHI’s expertise, dedication and innovative skills, we would have faced serious delays and the possible requirement of continued monitoring years after opening the Fixed Link.
Sven Landelius—Former CEO of Øresundsbro Konsortiet

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As a result, contractors could increase dredging intensity throughout the project time, enabling the Fixed Link to open on budget six months ahead of schedule.

Our spill monitoring programme (which ran 24 hours a day, seven days a week, and 365 days a year) provided the contractors and the Øresundsbro Konsortiet with invaluable knowledge of sedimentation spill from dredging operations. It showed that future spill monitoring can and should be based on spot checks and computer simulations. This project also demonstrated that good planning and management can save resources by allowing a much shorter, if any, post-construction compliance monitoring period.



The diagram shows a typical feedback loop used in environmental management programs. It can also be used to assess possibilities for increased dredging activity.

USING PROPER PLANNING, MONITORING AND ADAPTIVE MANAGEMENT TO AVOID COSTLY CLAIMS

Approval of large marine construction projects often includes a set of required environmental criteria which those involved with the project must comply with and document. Exceeding the environmental criteria may result in legal actions against the holder of the approval, which can result in major financial losses and damaged credibility.

We have developed an adaptive environmental monitoring and management system. Combined with our unique software and Decision Support System (DSS), we can help you avoid these problems and prevent the shutdown of operations by enabling you to change plans well ahead of any environmental disasters.