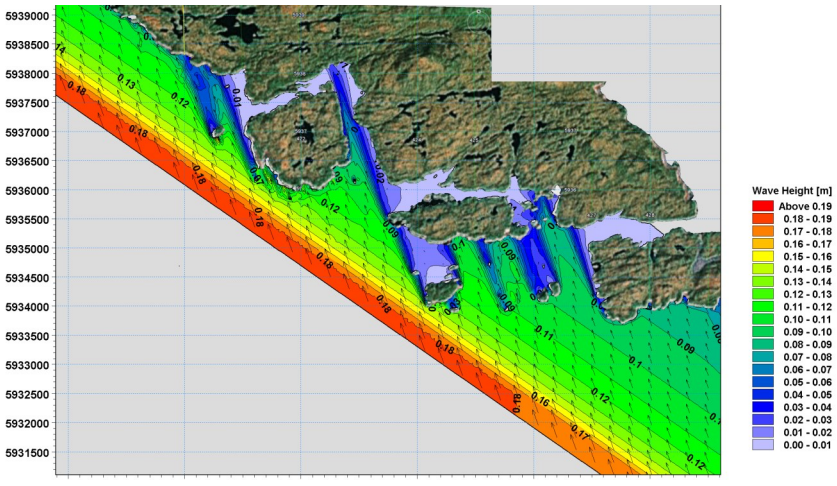
MODELLING SHIP WAVES IN UNIQUE NATURE RESERVES

Participating in a comprehensive environmental assessment

Enbridge Inc., an energy delivery company based in Canada, wishes to transport crude oil by ship from Edmonton, Alberta to a new marine terminal at Kitimat, British Columbia. Named 'The Northern Gateway', the project is expected to be in service in 2019. Kitimat is located at the bottom of the Douglas Channel, one of the widest and deepest inland waterways on North America's West Coast. To help ensure that all safety, navigational and environmental standards will be met during the ship voyage through the protected nature reserve, a team of over 200 experts and scientists conducted a comprehensive assessment of the route between the open sea and Kitimat. Taking into account the unique characteristics of the nature reserves and the indigenous population, a number of environmental and safety issues had to be observed during the voyage. As part of a required comprehensive environmental assessment, DHI was tasked to conduct an evaluation of ship waves generated along the route in order to assess its potential impact on the surrounding areas.

SAFETY AND ENVIRONMENTAL CONCERNS DURING VOYAGE

Concerns had been raised as to whether wake waves from the passing oil tankers might reach the shores with heights that could be critical for safety or for the environment. Wake waves have the potential to harm essential habitat features such as eelgrass beds and sensitive vegetation, as well as standing juvenile salmon in the near-shore environment.



Example of wave transformation towards the shores.

CLIENT

FORCE Technology, Denmark, on behalf of Enbridge Inc., Canada

CHALLENGE

Need to:

- conduct a comprehensive safety, navigational and environmental impact assessment in order to gain overall project approval
- assess if wake waves from passing vessels would adversely impact safety and the environment

SOLUTION

Development of a wave transformation model that predicts the spatial variation of characteristic wave heights, wave periods and wave directions – thereby describing the severity of the wake wash along the shores. For comparison, the naturally occurring wind-waves were also modelled.

VALUE

- Improved understanding of the generation and propagation of wake waves from tankers and tugs along the considered routes
- Led to the positive recommendation and overall approval of project

LOCATION / COUNTRY

Douglas Channel, British Columbia, Canada

SOFTWARE USED

MIKE 21

The safety of smaller boats – when exposed to impact from wave waves from the tankers – was also considered a potential risk.

In order to quantify and mitigate issues that could potentially arise during a ship voyage, we conducted transformation modelling of wake waves generated by tankers and tugs travelling towards the mainly rocky shores.

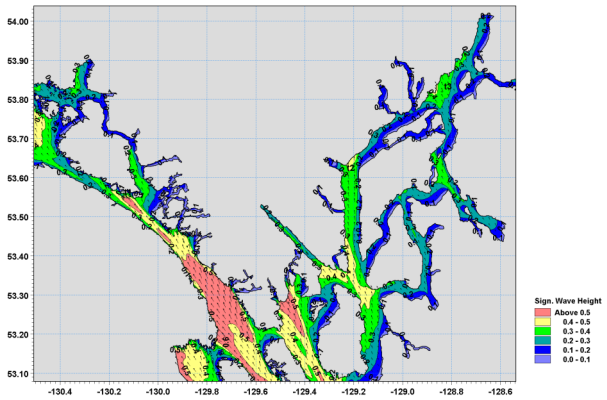
WAVE TRANSFORMATION MODEL TO PREDICT WAVE CHARACTERISTICS

To assess the wake impact in exposed coastal areas and shallow water environments, we have developed a computational efficient and robust method which has been used in numerous projects. The method is based on the Spectral Wave (SW) module of MIKE Powered by DHI's 2D modelling software MIKE 21. The model is based on a phase-averaged energy conservation approach. This modelling technique has the advantage of being applicable even to large coastal areas. The model includes the effects of wave refraction and shoaling due to varying depth and currents, as well as energy dissipation due to bottom friction and wave breaking.

Even though this wave transformation model neglects the transient effect of the ship waves, it predicts the spatial variation of characteristic wave heights, wave periods and wave directions in large domains – thereby describing the strength or severity of the wake wash in shallow water.

MODEL SIMULATIONS WITH COMPUTATIONAL FLUID DYNAMICS AND MIKE 21 SW

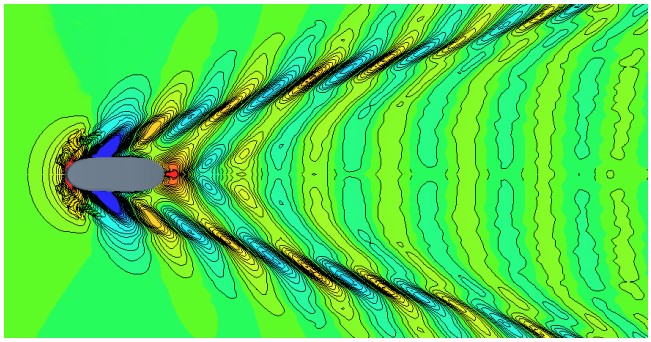
Wave transformation modelling was carried out to investigate the transformation of wake waves generated by a 334 m tanker and a 45 m tug travelling towards the shore at selected locations – Kitkiata Inlet in the Douglas Channel and at Dixon Island in Principe Channel in British Columbia.



Example of calculated wind-generated waves.

The modelling included simulations for a loaded VLCC and for tugs. The waves generated by the vessels were modelled by FORCE Technology using Computational Fluid Dynamics (CFD) modelling, and the wave transformation towards the shore was modelled by MIKE 21 SW.

For comparison of the estimated wake waves with the wind-generated waves, a model study of the wind-generated waves was also conducted, where the wave conditions for the relevant wind speeds and directions were estimated.



Waves generated by a tug calculated using Computational Fluid Dynamics.

THE MOST COMPREHENSIVE AND SCIENTIFIC REVIEW IN CANADIAN HISTORY

Our detailed vessel wake study helped to demonstrate the propagation of waves generated by tankers and tugs through areas like the Douglas Channel. Our study showed that the wake waves at the shores were smaller and less frequent than the waves occurring in the area due to wind.

The work we did was part of a comprehensive environmental impact assessment made to support the approval of the overall project. After weighing all the findings of this most comprehensive environmental and scientific review in Canadian history, a Joint Review Panel of the National Energy Board and the Canadian Environmental Assessment Agency provided its positive recommendation of the project.

THE NORTHERN GATEWAY PROJECT

The planned project consists of two parallel pipelines between an inland terminal at Bruderheim, Alberta, and a marine terminal near Kitimat, British Columbia, each with a length of 1,177 km. The Kitimat terminal will comprise two tanker berth platforms, one serving Very Large Crude Carriers and another serving Suezmax-type condensate tankers. For more information about this project, please refer to http://www.gatewayfacts.ca/.

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For more information, visit: www.dhigroup.com