

6 Discussion and Conclusions

Discussion

The numerical model is an effective tool for quantifying the flow conditions in a navigation channel due to a moving tow traveling a predetermined sailing line. Velocities and water-surface fluctuations calculated using the depth-averaged flow equations provide a detailed determination of the magnitude and distribution of the flow field. Time-history comparisons capture the magnitude, flow reversals, and timing of these phenomena.

Advantages of this method over traditional one-dimensional analytical approaches for the quantification of tow-induced current and drawdown are many. Solution of the energy and continuity equations, as presented by Jansen and Schijf (1953), provides only a cross-sectional average return current and drawdown at midship in a uniform channel. The numerical model generates wave movement and gradients in two dimensions in a channel of arbitrary shape. The numerical model can be used to evaluate scenarios that are difficult to measure in the field or in a physical model. These scenarios include two tows passing and tows navigating channel bends. Finally, the numerical model provides visualization products that enable understanding of the complicated effects produced by vessels moving in a navigation channel.

Conclusions

The model is limited to flows that are adequately described by the shallow-water equations; that is, three-dimensional flow near the vessel, where the vertical accelerations are significant, is not simulated. Vertical acceleration beneath the bow and stern may be so great that the shallow-water model is not applicable to the flow beneath the vessel. Another limitation of shallow-water models is that they cannot simulate short-period waves composing the divergent and stern wave field produced by a moving vessel. Also, no attempt has been made to reproduce the effects of a towboat propeller jet.

The shallow-water equations coupled with a moving pressure field representing the displacement of a vessel effectively model the far-field (area greater than about 2 to 2.5 vessel widths from the sailing line) currents and drawdown produced by a tow in an irregular channel section. The results of the "blind" tests comparing the physical model and prototype measurements to the numerical model calculations support this conclusion.