6 Summary and Conclusions

Ambient flow conditions in both the Clark's Ferry physical model and the prototype had significant variations, which made extraction of the tow effects difficult. This was less of a problem in the previous Kampsville study (Maynord and Martin 1997) because the cross section was smaller, which caused the return velocity and drawdown to be larger. A fast Fourier transform filtered information above 0.02 Hz, but ambient fluctuations were present at the same frequency as the tow impact. Analysis of the Clark's Ferry prototype data show that the ambient fluctuations having about the same period as the tow impact average 15 percent of the mean ambient velocity.

Prototype return velocity was compared to physical model return velocity and showed that the Froude model with geometric scaling of vessel size resulted in model values greater than the prototype. The physical model draft had to be reduced from purely geometric scaling for agreement between model and prototype. The physical model also generated a wave and flow at the bow which was greater than the prototype data. This bow effect was likely related to the rapid acceleration that must be used in the physical model because of the limited flume length.

One of the primary purposes of this report was to provide data for a wide range of conditions. Return velocity and drawdown data were collected for several pool elevations, tow speeds, and upbound versus downbound vessels.

The vertical profile of return velocity was investigated to determine how to interpret and compare return velocities taken at different distances from the bottom. During passage of a tow, the flow depth can be separated into a lower zone in which the boundary layer growth can inhibit maximum return velocity and an upper zone in which the return velocity is nearly uniform. From the Kampsville study (Maynord and Martin 1997), the lower zone is generally confined to the lower 0.3 to 1.0 m of the depth and velocities are less in the lower zone. Measurements reported herein show a uniform velocity change at and above 20 percent of the depth from the bottom, which was the lowest position measured.

Tow length effects showed that the return velocity for tows one and two barges long (10 and 20 percent of the channel width) is high near the tow and low away from the vessel, compared to longer tows. Return velocity for tows three

barges long (29 percent of channel width), is similar in magnitude to tows four or five barges long. Drawdown for tows four barges long (39 percent of channel width), is similar in magnitude to five-barge-long tows.

Return velocity and drawdown were compared for a vessel having a 26-deg and a 45-deg rake angle. Return velocity was similar for both angles. Scatter in the drawdown data for the two angles prevented a conclusion.

Velocity measurements near dikes were conducted for both upbound and downbound tows and show the change in velocity that occurs during tow passage.

Open river experiments were conducted by adding vertical walls along the banks of the Clark's Ferry channel to simulate the deeper depths found in the open river section. Return velocity and drawdown were measured with a low ambient velocity to allow extraction of the tow effect from ambient fluctuations. Use of typical open river ambient velocities would have made it difficult to extract return velocity and drawdown.