# E-8

# MAYNORD

## MAYNORD CASE STUDIES

Maynord Case Studies



**Aug 02 draft**

**Case Studies**

In addition to the comparisons based on averaging the 4 parameters at each cross section over the length of the model, the reports from previous micro models were evaluated to determine details that could be missed in the reach averaging process. This evaluation is primarily based on the verification test. To this writer, an adequate verification has the following characteristics:

1) Reproduces the problem that led to the study being conducted
2) Has an adequate simulation of the planform, which is often based on the thalweg alignment, upstream of and within the problem area.
3) Has no extreme departures in depth and channel shape within and upstream of problem area.
4) Reproduces flow splits.

The evaluation of previous studies considers these 4 characteristics of an adequate verification as well as other factors. Evaluation of these studies is given in chronological order in the following paragraphs.

1) New Madrid, Mississippi River (1996)- This is a complex reach with a bar in the middle of a mild bend. This report stated that the base test was the average of 5 surveys. Considering the differences in the 5 Kate Aubrey surveys in the traditional model presented previously, this appears to be a good idea for the base and the plan conditions. No mention of the 5 survey average was found in later reports. This report also states one of the differences ~~mentioned above~~ between the micro model and most other qualitative movable bed models when it states "An important point to consider is that the model results were reflective of low water conditions, while the comparative prototype survey was reflective of high water conditions". Of the 4 requirements of an adequate verification given above, this verification has large departures in depth just upstream of the problem area. Scour in the model about 1-2 channel widths upstream of the bar reached an elevation of about –70 in the prototype compared to –20 in the model. This much deviation in the bed must adversely affect the flow

distribution in the problem area. Some of the structures used in alternative tests were placed in the area having large departures in depth.

2) Sante Fe Chute, Doolan Chute, Mississippi River (1996)- The main channel reach is not complex. The Sante Fe verification was subject to a constraint not present in traditional micro models. In traditional micro models the maximum discharge is limited by when the energy in the model is visually excessive. This typically results in a maximum stage of about +15 to +20 ft LWRP. At Sante Fe chute, the additional constraint on the micro model was that the stage had to overtop the closure dike, which was at +20 LWRP. Although stages are not given in the report it seems likely that the dike would have to be overtopped by at least 10 ft (0.008 ft in model) to provide enough flow in the chute to test chute alternatives. The report gives no information on this topic. This added constraint of stages of about +30 ft LWRP would require more discharge than in traditional micro models. This additional discharge may have been the reasons for deviations in the base test where model bed elevations at RM 37.8 reached –70 LWRP whereas bed elevations in the prototype were between –20 and –30 LWRP. Of the 4 requirements of an adequate verification given above, this verification has large departures in depth in the problem area. However planform reproduction in the main channel was acceptable. Model approach length appears low. ~~Unknown flow split in model is another weakness of this calibration.~~ The distribution of flow between main and side channels is unknown for this model.

3) Marquette Chute (1997)- The main channel reach at Marquette Chute is a mild bend and not complex. Both verifications (with and without weirs) were good.

4) Mouth of the White River (1998)- The low radius bend just upstream of the confluence with the White River makes this a complex reach. Problem leading to model study was adequately represented in the model. The micromodel verification test comparison with the prototype was satisfactory upstream of the mouth but at and downstream of the mouth the model bathymetry differed significantly from the prototype. At one mile below the confluence of the White River at RM 598, lowest model bed elevations were –20 to –30 LWRP whereas the prototype bed elevations were –80 LWRP. These differences made it impossible to use the micro model bathymetry in a navigation model at ERDC.

5) Savannah Bay, Pool 13, Mississippi River (1998)- This is a complex reach with a flow split upstream and in the test reach. This report provided a plot showing the differences in bed

elevation between the base test and the prototype which would be helpful in all MBM reports. The base test has some large differences from the prototype. Significant differences in the upstream transition reach would make it all but impossible for the flow distribution to be correct in the calibrated reach. Figure __ shows a plot of micromodel and 1996 prototype cross section at RM 538.9 in the main channel only. RM 538.9 is the center of the problem reach requiring dredging in the prototype. Figures _ and _ are plots of the actual cross section shape in model and prototype. The two cross sections are far different as will be the velocity distribution. The area behind the islands in the model was significantly deeper than the prototype indicating that the amount of flow behind the islands exceeded the actual flow. This was a case where there needed to be some measure of flow split in the model to make certain that the amount of water behind the islands was approximately correct. This model exhibited little similarity to the prototype.

6) Lock and Dam 24 (1998)- This is a complex reach. The critical issue in this study is the similarity of surface currents in model and prototype. None of the data provided demonstrated agreement of model and prototype. Consultant Parker stated of the studies shown to him, this type of study concerned him the most because it looked at the details of the flow.

7) Copeland Bend (1999)- This is not a complex reach because it contains a relatively mild bend and closely spaced structures that are relatively short. The micro model did a good job of replicating the prototype main channel bathymetry in the base test. One concern of this study is the evaluation of dike notching. At the scale of 1:3600, the 50 ft wide notch would be about 0.014 ft wide or about 0.4 cm. These same notches had a maximum head of 10 ft. At a vertical scale of 1:240, the head on the notch was 0.042 ft or 1.3 cm. Add scale effects from these small notch dimensions to what appeared to be porous screen dikes in the model makes it impossible to say whether the flow in the model through the dike was too high or too low, and the magnitude of the error. By not knowing the magnitude of flow through these structures, it would not be possible to use the model to predict if dike notching would have an adverse effect on the navigation channel, which was one of the purposes of the study. Also, this study was to address the stability of the Missouri River bank lines, which is inappropriate for a micro model study.

8) White River (2000)- Two separate models were conducted, Augusta and Clarendon. With the exceptions of the sharp bends, these reaches are not complex because of mild curvature and no dikes. Augusta base test looked fairly good with the exception that point bars were generally lower in model than in prototype and the sharpest bend at RM 192-193 exhibited too much scour of the bed ~~and had to be~~ which required the addition of armored in the model. Augusta bends were milder than Clarendon bends. The Clarendon model base test was also fairly good until the bend at RM 96.3 which had a radius / width of about 2. This bend also had too much scour of the model bed ~~and had to be armored in the model~~ which required the addition of armor material in the model. In this bend, the micro model channel was degraded across the channel width with little indication of point bar development, as opposed to the prototype which had substantial point bar development. The next bend downstream at RM 95.8 also had to be armored and exhibited the same trend in the model. The models did not indicate the correct trends at these bends.

9) Wolf Island Bar (2000)- This is a very complex reach. Of the 4 requirements of a verification, this model is deficient in two areas. At RM 936.5 just upstream of the problem navigation reach at RM 935-936, model scour reached an elevation of –40 LWRP whereas prototype scour reached an elevation of –80 LWRP. Figure _ shows a cross section plot from model and prototype. Figures _ and _ show the actual cross section shape and dimensions in model and prototype. The velocity distribution into the problem reach can not be correct with this much deviation in cross section. The second problem with the verification is the flow split. The micromodel report presents data showing the flow split is about 60% side channel and 40% main channel. This is a case where obtaining a reasonable flow split around the bar is necessary. The greater scour in the micromodel main channel and the higher bed elevations in the micromodel side channel strongly suggest that too much flow was going down the main channel in the micromodel.

10) SEMO Port (2000)- It is difficult to see what value was added by this study since the problem is one of suspended load and the model moves as bed load. The verification was conducted with and without bendway weirs. The verification was weakest at the mouth of the harbor, particularly for the with weir verification where the region of bed elevations below –30 was much greater than in the prototype. The verification upstream and downstream of the mouth looked reasonable. Of the 4 requirements for a verification, the

model did not reproduce the problem. It is also difficult for this author to believe the micromodel can simulate eddies such as the eddy at the entrance to the harbor. The use of dye in the micromodel to infer anything about the movement of suspended sediment is not correct.

11) Schenimann Chute (2000)- This reach is complex only because it has many dikes and weirs. The entrance region of the model was much too close to the problem area. The pool crossing sequence in the downstream portion of the main channel in the verification test was out of phase compared to the prototype. At RM 59.8, the thalweg was on the left bank in the prototype and on the right bank in the model. At RM 58.7 the thalweg was on the right bank in the prototype and on the left bank in the micromodel. The 200 ft wide chute in the prototype was 0.5 inch wide in the model. Wall effects in such a narrow channel are far greater in the model than in the prototype.

12) **Vicksburg Front (2000)** – Andy, insert Estes Park paper and my comments to rebuttal

13) Ballard's Island, Illinois River (2001)- Calibration of the main channel looked good in the micro model. This reach is relatively straight and not complex. This study and several others contained the following statement "Clay was placed in the bed of the model to better approximate prototype conditions. This indicates that non-erodible materials may be present at this point in the river." Parker points out "The high distortion, and resulting nearly vertical banks may exaggerate the tendency of the thread of high velocity to collide with the banks, so shifting somewhat the points of bank attack and exaggerating the scour." The combination of the micromodel with a numerical simulation allowed the study to evaluate the potential for velocity changes that could impact navigation at the upstream and downstream entrances to the island.

14) Bolters Bar/ Iowa Island (2001)- Extremely complex reach. The micro model provided a fairly good simulation of bed topography in the main channel. Chute channel bathymetry varied in model and prototype. Dardenne Chute was too shallow. A portion of Bolter Chute between Dardenne and Bolter Islands was also too shallow. After Bolter and Dardenne Chutes combined, the channel continued to be too shallow all the way to the confluence with Iowa Chute. The entrance and portion of Iowa Chute between Bolter and Iowa Islands in the micro-model represented prototype conditions very well, but the Chute channel downstream

of the confluence tended to shoal more than the prototype. These differences in depth are most likely tied to the micro-model not reproducing the flow splits. ~~Since~~ Because flow splits ~~is~~ are a critical issue in this study, the verification was insufficient.

15) Lower Atchafalaya River (2001)- Complex reach because of junctions and distributaries. Tom Pokrefke of ERDC was asked by the New Orleans District, project sponsor, to provide a review of the micro model. In his unpublished review he stated "The Base Test micro model bathymetry appeared to provide a very reasonable replication of the 1999 Prototype survey. Overall the trends and meandering of the Atchafalaya River were adequately replicated in the micro model." Pokrefke also stated "Generally speaking, the micro model adequately replicated the pool-crossing-pool sequences of the prototype in the area under study." Pokrefke also noted concerning the flow visualizations "This reviewer personally questions the validity or usefulness of such. The reviewer does not feel that such flow visualizations are indicative or able to be related to any prototype condition, nor are they meaningful in any way evaluating the effects of a plan on navigation conditions. In the Morgan City/Berwick Bay Reach the currents upstream, through, and downstream of the three bridges are critical, and as such need to be addressed in another type of study."

16) Lower Peoria Lake (2002)- This is a complex reach with flow entering a wide lake containing a dredged channel. From the base test and Alternatives 1, 2, and 4, the main navigation channel is being filled with sediment. If this reflects the trends in the river, one would expect more dredging than the amount listed in the report. Flow visualization from micromodel confetti and prototype ADCP appear to have no resemblance. With the main channel filling with sediment incorrectly and the flow patterns differing in model and prototype, the model is not reproducing the trends of the prototype.

**17) Kate Aubrey Base and Plan Tests, Traditional and 2X Micromodel (2002)**

a) **General-** Bathymetry maps were compared in micromodel and prototype of base and plan tests. Comparison of the bathymetry in the verification/base tests was based on the 1975 and 1976 prototype data because these years showed the consistent left-right-left-right sequence of thalweg movement observed in the prototype. Prototype data from 1973 was not considered because it represented an anomalous condition on the river due to the high

replicate the thalweg pattern. At RM 793, the lateral extent of deep water in the micromodel is far greater than the prototype. Had this been an attempt at verification of the micromodel, this outcome would have certainly been rejected as an adequate representation of prototype trends. Based on these differences, the 1:16000 micromodel did not predict prototype trends.

e) **1:8000 Micromodel Plan Test-** The 1:8000 micromodel showed shoaling at RM 791.5 that was not present in the prototype. The 1:8000 plan micromodel does not replicate the thalweg pattern. Had this been an attempt at verification of the micromodel, this outcome would have certainly been rejected as an adequate representation of prototype trends. Based on these differences, the 1:8000 micromodel did not predict prototype trends.

f) **Summary-** This comparison is important to this evaluation for the following two reasons:

1) This comparison demonstrates the difficulty of the using reach averaged cross-section parameters to assess model performance. The reach averaged parameters generally showed the plan Kate Aubrey micromodel tests to be in better agreement with the prototype than the verification when evaluating thalweg position, cross section area, and hydraulic depth. When comparing width and width/depth, the verification test was in better agreement with the prototype than the plan tests. The evaluation of a bathymetry map, which has been the subjective method used for many years, show the plan test to be far weaker than the verification test.

2) Far more importantly, this comparison represents the most extensive evaluation of the micromodel's predictive performance when using detailed before and after bathymetry data. Results show that a model can be calibrated to existing conditions but not predict prototype performance. This is exactly what Professor Yalin stated when he said "I regret such a 'model' can not be used for predictive purposes."

flows. In the plan tests, the dike arrangement as existed in 1998 was placed in the micromodel. Comparison of the bathymetry in the plan tests was based on the 1998 ~~and 2001 prototype data~~. Data from 1999 ~~and~~ 2000 ~~was~~ ~~limited to low water and were not~~ used in the comparison. The traditional and 2X micromodels will be addressed separately.

b) **1:16000 Micromodel Verification/Base Test-** The verification test was evaluated based on the 4 criteria given subsequently for an adequate verification. The 1:16000 micromodel tended to reproduce the shallow crossing at about RM 792.4 which was the problem being addressed in the model. The micromodel reproduced the left-right-left-right thalweg sequence. The micromodel had no large departures in depth within and upstream of the problem area. Flow splits were not an issue in the Kate Aubrey model. Although not an exact reproduction of the prototype trends, the verification of the 1:16000 micromodel is considered adequate based on meeting the 4 requirements for verification.

c) **1:8000 Micromodel Verification/Base Test** As in the 1:16000 micromodel, the 1:8000 micromodel verification is considered adequate based on meeting the 4 requirements for verification.

d) **1:16000 Micromodel Plan Test-** Both the 1998 ~~and 2001~~ surveys had a continuous navigation channel through the problem area. The 1998 survey had a middle bar located within the contracted channel at about RM 790.9. The 1998 survey may have been indicative of the development of the navigation channel and the 2001 survey presents a channel with some additional development time. Both 1998 and 2001 prototype surveys continue to show the left-right-left-right thalweg pattern present in 1975 and 1976, although it was within the contracted channel limits. Since this is an evaluation of the plan test, the first of the 4 criteria for an adequate verification, reproduction of the problem, is not applicable. However, the micromodel showed that shoaling occurred in the contracted reach that was not present in the prototype. The 1:16000 plan micromodel does not