E-3

POKREFKE

2ND DRAFT COMMENTS
(W/ NICKLES)

Comments on Micro-Model Comparison Studies
Draft Number 2
Tom Pokrefke

1. As requested, I have reviewed the subject draft. I probably did not review it to the depth that I reviewed Andy Gaines dissertation, but much of this document came from his dissertation. I gave my comments on the dissertation directly to Andy this past summer in St. Louis, so any comments that I made on that document, which were not addressed by Andy, would still be applicable. I have some *general/typo-type* comments and then some specific comments on the Draft Number 2.

2. I have read the comments that Charles Nickles has provided to Andy, and I concur with what he has provided. In an effort to be as brief as possible and to make addressing all of the comments easier for the researchers, I will not repeat concerns/issues raised by Charles.

General/Typo-Comments

3. Comments are:
   a) **Page 1-4, Line 3**. Remove the first "and." done
   b) **Page 2-1, Line 1**. The word "arbitrary" was used. I believe LWRP is anything but arbitrary and is inappropriate to use, at least in the case of WES models. LWRP represents the 97% duration water surface profile (flowline that is equalled or exceeded 97% of the time). The decision to use the 97% duration WSP was made many years ago, but the decision was arbitrary because other WSP could have been used with equal effect. For instance, recent studies on the White River, AR used a 95% duration WSP to define a LWRP.
   c) **Page 2-16, presented equation**. Up until this point "H" was used for depth, but starting here "D" was used. Need some consistency throughout the report and study. Change D to H in equation
   d) **Page 2-16, first three lines under Section 2.2.2**. Line 1 – remove "of individual," Line 2 – remove one of the "of" after the word "calculation," and Line 3 – believe "an" should be "and." Required typographical changes noted.

Specific Comments

4. Comments are:
   a) **Page 1-7, last paragraph**. States that the various parameters "…offer insight into the two-dimensional character of the flow." Since we are dealing with a riverine system and open channel flow, as a researcher I want insight into the three-dimensional character of the flow. If all I can get is two-dimensions, I can't really address the problems I am trying to solve. This paragraph discusses cross-section area, depth and width/depth ratio, which are two dimensional in nature. Therefore, these parameters alone only offer insight into the two dimensional

(See figures 3-2 and 3-5 and 3-6). The micromodel extended over a much larger longer reach as outlined (RM 785.0-798.0) and included ranges having much greater depths than found between RM 789 to 794. This is the reason for the seeming disparity between the prototype data sets shown for the 1:300 model and the two micromodels.

d) **Page 2-22, Section 2.2.3.** You appear to spend this whole section making an argument for using +20-ft LWRP as a reference for the computations, and then in the end use 0-ft LWRP anyway. The emphasis in this section is on the need to consider several elevations in difference calculations. The last para. on pg 2-24 states the reason for using 0 LWRP.

e) **Page 2-26, Table 2-4.** Are the values here percentages or what? Average differences and mean squared error. Table annotated to make clearer.

f) **Page 2-25, Figure 2-7.** Just a comment about this figure. I hope someone other than Andy understands it, because I sure don't. Figure 2-7 demonstrates that the water surface elevation selected for the basis of calculations directly influences the calculated values of cross-section area, top width, hydraulic depth and width to depth ratio. Figure 2-7 illustrates the relationship of selected water surface elevation (in LWRP elevations) and cross section area to the difference calculation for Ranges 25 through 59 in the Kate-Aubrey reach of the Mississippi River. Prototype conditions are from a 2001 hydrographic survey. Model data are from the 1:8,000 micromodel. Figure 2-7 indicates that larger differences result when the selected water surface elevation is lowest. As the water surface elevation used for calculating cross-section area increases, the difference between model and prototype reduces until approximately the ±20 percent level of difference. This is consistent with observations of the physical response of both the model and prototype channels where the greatest changes occur in the low flow channel.

g) **Pages 3-20 through 3-24 and all similar figures to these throughout the report.** These figures are the most enlightening to me and helpful in evaluating model performance. Noted.

h) **Page 3-26, Section 3.1.4.** Although I have heard Andy say this throughout my involvement on this evaluation effort, this really was not "predictive" in that the micro-model was operated with structures constructed in 1999 and results compared to a 1998 prototype survey. There appears to be a disconnect here. Constructin in 1999 for the model reach consisted only of 300 LF of minor repairs to KA dike 1U. There were only 1000 LF of minor repairs to KA Dike 3T in 1998. Prior to 1998, the last repair work was in 1995 and the last major dike construction was in 1983. The last revetment construction within the model reach was in 1997. Therefore, the model represented dikes constructed through 1999. Even if the micro-model results would be compared to the 2001 prototype survey (which is included in Table 3-6 on page 3-37) this looks like nothing more than a recalibration or check of the initial calibration. The predictive, or plan, run was to compare the model's ability to assess prototype response to a given change. In other words, could the calibrated model "predict" what would actually occur in the prototype? In essence, this is like a check on the model calibration.

prototype conditions that could be helpful in evaluating and reporting predictive tests. Noted.

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Comments "Comparison Studies – Draft No. 2

Charles Nickles

19 Sep 02

1. Paragraph numbers sure would make commenting easier. Since there are no numbers I will describe the location by page number and paragraph on that page. Noted -- no change.

2. *Page 1-6, 1st Par, last sentence*; It may be true that discharge data is not available for all of the models, but you should state the whole truth. If you had discharge data for every minute you still could not use the data since Micro-Model (MM) technology ignores it. The prototype data and WES model data in this report has associated stage and discharge hydrographs and I expect that most of the MM study reaches have both water surface and discharge data that was not obtained because it is not used. I know for fact that for the studies of the Kate Aubrey reach, there is plenty of discharge data available. Since the MM technology cannot scale nor reproduce stages nor discharges, it is wrong to blame "lack of data" as the excuse for ignoring the single most contributor (stage/discharge) to a river bed form. It is the shortcoming of the MM technology not lack of data….and should be reported that way. Bankfull discharges and discharges at +20, and 0 LWRP were not available from data provided on WES models or the prototypes. The lack of discharge data, whatever the reason, meant that the geomorphic variable of Q could not be analyzed in any meaningful way for this study. This report simply presents a comparison of data between large-scale (WES) and small-scale (micromodels) and their respective prototypes. There is no direct comparison of any model to another presented in this report. The prototype serves as the sole basis of the comparisons. Any inferences drawn by comparing micromodel and WES model from this study are the sole possession of the reader. Similarly, this report does not attempt to document the WES or micromodel methodology or technique. The ability (or inability) of the micromodel technique to relate model discharge to prototype discharge is also not at issue because data were not available to consistently analyze how the micromodel discharges relate to the prototype discharges. Limitations of the micromodel that may exists are to be documented in the subsequent companion report.

3. *Page 1-6, 3rd Par, all*; The Webster's dictionary defines thalweg as

   "**1a:** a line following the lowest part of a valley whether under water or not **b:** the line of continuous maximum descent from any point on a land surface or one crossing all contour lines at right angles **c:** subsurface water percolating beneath and in the same direction as a surface stream course **2:** the middle of the chief navigable channel of a waterway which constitutes a boundary line between states" the prototype. If you consider the Kate Aubrey reach model in the WES model, if the parameters you calculate that are based on the cross-section shape below an el. referred to the LWRP are not adjusted for the LWRP slope (to match the prototype), then the parameter are invalid to compare to the prototype or WES models whose calculated parameters are adjusted for the LWRP slope. If the MM cross-sections were not adjusted to reflect the LWRP slope, then any calculated parameter derived from an area or length of section below a specific LWRP elevation compared to the same parameters from the prototype or WES model cross-section are **TOTALLY INVALID.** And should be deleted from this report. ANALYSIS IS VALID based upon the following. Although micromodels use only one LWRP conversion (through a linear LWRP slope), this does not invalidate the comparison. The comparison of bathymetric data derived from the present/past micromodel procedure to prototype bathymetry remains a valid approach for assessing how well a model reproduced the prototype behavior. Errors introduced into micromodel elevations by not utilizing a variable sloped LWRP (as exists in nature) may influence the level of agreement, but the error would generally be to lessen the differences (and result in a better agreement). If previous micromodel bathymetry were corrected to adjust for varying LWRP slope over the length of the model reach, it is possible that a different shift would have been used in achieving a calibrated base test. Therefore, it is not possible to apply corrections to the available micromodel bathymetric data. Nor is it possible to determine the extent or magnitude of error introduced to each micromodel as a result of using a single point LWRP conversion. A further compounding issue regarding error magnitude is that recent prototype surveys involve a single point adjustment between absolute elevation and LWRP elevation for individual hydrographic survey sheets (one sheet is ~ 3-4 miles of river). This results in a stepped LWRP over the model reach.

6. *Page2-22,Par3,sent. 1*; All the models in this report except for the MMs did reproduce bankfull stages and higher, give me some examples of models other than MMs that use a hydrograph type input that did not reproduce bankfull stages. Also the you stated that the MM typically reproduce stages up to +20 LWRP, I question this since stage is not controlled nor measured in a MM, show me some data to prove me wrong. If you cannot prove it with valid data then do not state it!! Noted. Here's the data....Micromodel dike elevations are set to approximate LWRP elevations (typically +15) using scaled prototype elevations. These elevations are continually adjusted during the course of calibration until the "final" shift and vertical scale are developed for the model. Model flow at maximum discharge overtops these dike structures, ensuring at least a +15 stage in the micromodel. Point checks with the digitizer also serves as confirmation of maximum stages in the range of +20 LWRP.

7. *Page 2-22 & 23, Last Par*; I am totally disgusted with this whole discussion, I agree the selection of the water surface will change the numbers, **but the fact remains the data does not change.** All you are doing is massaging the data to say what you want. Pick an elevation, use it throughout and stop insulting the

drawer. I used my own criteria to draw the thalweg position for the Prototype and WES models, but the location was likely not drawn on the MMs using the same criteria. For example, if you look at the WES model verification results, I could have just as easily drawn the crossing further upstream between ranges 20 and 25, thus the model thalweg would have plotted on top of the prototype plots. Also because the WES model bank lines have to be laid back (top of the bank moved away from the channel and the toe moved toward channel) in order to be stable and the MM bank lines are vertical some where near the location of the top of bank, a point to measure from on the either model data that would exactly coincide with a point in the prototype is impossible. Visual assessment and evaluation is the only fair way to compare model and prototype location. Opinion Noted. Emphasizes that care should be used in defining thalweg location.

14. *Page 3-17, Par 1, 1st Sentence*; You state "Equilibrium in the small-scale models represented the condition where sediment transport and the bed bathymetry remained consistent for successive cycles". MM technology has no method to know if sediment transport is in equilibrium. During my work on the Kate Aubrey model at your lab, Wayne and I did test where we run the model numerous cycles and surveyed after every 3 to 5 cycles. The model did not ever reach equilibrium as described above. It did seem to cycle bed forms every 10 to 15 cycles. This data were recorded and should be in your system unless it has been destroyed. These results show the sediment transport through the model never reaches equilibrium; this makes the modelers decision as to "stability" very critical and should be very careful to be consistent. See remainder of sentence quoted ... "Equilibrium in the small-scale models represented the condition where sediment transport and the bed bathymetry remained consistent for successive cycles (there was no net aggradation or degradation over time observed in the model)." The data mentioned from Fall 1999 were not of a calibrated model because of problems experienced in the model insert. Therefore, any conclusions or opinions derived from that data may be misleading because the model bed elevations and slope may have been changing during the course of the repetitions.

15. *Page 3-25, Par 1, Sent. 1*; The 1973 survey should never have been considered The 1973 bed form was produced by a hydrograph that cannot in no way be replicated in the MM for either stage or discharge. The 1973 Prototype is in no way a typical (average) bed you can expect in the reach. The one thing this comparison does indicate to me that I would not want to use the model as calibrated to test any alternatives. This data (along with cross-section plots I made of the 1:16,000 scale model and the three prototype surveys) indicate the MM does a fairly good job of reproducing the 1973 bed form, but not the 1975 nor 1976 bed forms. (What plots -- were these of the final calibrated micromodel from Feb. 2001?) I would not want to use a model to evaluate alternatives that most closely reproduces the bed forms caused by the third largest flood of record on the Lower Mississippi River. If you really think about it, the large distortion, steep slope and extremely high velocities that are inherent to the MM would most closely reproduced high flood conditions. Comment Noted. Current data do not support the conclusion that micromodel reproduced 1973 channel.

3.1.2. Large-Scale Models. An example of large-scale model is the Kate-Aubrey model of the Mississippi River conducted by WES. A photograph of the large-scale Kate-Aubrey physical sediment model is shown in Figure 3-3. The Kate-Aubrey reach is located north of Memphis, Tennessee between river miles 785 and 797. The purpose of the study was to develop a plan that reduced or eliminated the extent of shoaling between river miles 788 and 792.5. The model had a loose-bed of crushed coal sediment material. The model was constructed to scales of 1:300 horizontal and 1:100 vertical (model to prototype, respectively). The coal had a median diameter of 4 mm and a specific gravity of 1.30. Prototype data used in this study were bathymetric surveys for May 1975 and May 1976. Prototype bathymetry for 1975 and 1976 are shown in Figures 3-4 and 3-5, respectively. The model bed configuration and structures (e.g. dike fields) were initially formed (or molded) to the 1975 prototype bathymetry. A model discharge hydrograph was developed from historical stage and discharge records for the prototype from May 1975 to May 1976. The resulting hydrograph (also referred to as the verification hydrograph) was used to simulate the historical period in the model between the two bathymetric surveys. The model discharge was distorted by a factor called the discharge ratio, which is adjusted during the verification period to insure proper bed sediment movement and model bed response. Model sediment material was manually input and recorded at the upstream end of the model during simulations. The rate of sediment input was adjusted during model verification to develop a model stage vs. model sediment input rating curve. The model slope, rate of sediment input, discharge ratio, and boundary conditions (e.g. bank roughness) were adjusted over the course of several repetitions until the final model bathymetry reasonably reproduced the May 1976 prototype conditions. Each repetition began with the May 1975 prototype bathymetry formed in the model. The model was then subjected to the verification hydrograph to obtain a model bathymetry to compare with the May 1976 prototype survey. The large-scale models employed a verification process to establish the model operating parameters. The verification procedure relied on a visual comparison of model and prototype bathymetry as described in Gaines (2002) and was considered verified when the model bathymetry reasonably reproduced the May 1976 prototype condition. Model bathymetry after verification is shown in Figure 3-6.