

**Glen Canyon Dam Technical Work Group**  
**Agenda Item Information**  
**March 16-17, 2009**

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Agenda Item

River Stage and Archaeological Sites

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Action Requested

- ✓ Motion requested. (The following motion is recommended by CRAHG. However, no motion is presumed to be made unless and until a TWG member makes the motion in accordance with the TWG Operating Procedures.)

The TWG recommends to the AMWG that the existing virtual shorelines generated by HEC-RAS model are good predictors of river stage and are reliable predictors of the inundation of archaeological site surfaces. However, river stage is not the only consideration employed for determining which archaeological sites need to be treated. Other proximate, secondary and tertiary causes must be considered in determining archaeological site condition and the need for treatment. Additional modeling is necessary to evaluate which combination of variables has the most explanatory value in assessing current site condition. The current monitoring and treatment of archaeological sites should continue while the utility of alternative models is investigated. It should be noted though that further exploration of these models will most likely have budget implications.

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Presenter

Mary Barger, Chair, CRAHG

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Previous Action Taken

- ✓ By AMWG: AMWG passed the following motion at its September 2008 meeting by a vote of 12-6:

To direct the Technical Work Group to review the flow levels (as indicated by the currently available shorelines of the HEC-RAS model) associated with each of the 158 archaeological sites that have been identified for monitoring and/or mitigation of impacts, and to report this information and any recommendations with regard to how these data would fit into the process of making choices of sites to be monitored and/or impacts mitigated to the AMWG at its next meeting, with the provision that any recommendation will not alter the choice of sites selected for impacts mitigation in FY09.

- ✓ By TWG: TWG passed the following motion at its October 2008 meeting:

The CRAHG will review the revised virtual shoreline analysis, in relation to archaeological sites, and bring recommendations to the TWG at its next meeting focusing its review on the first part of the AMWG motion assessing the utility of flow lines as simulated (with uncertainty) by the HECRAS model and other error sources.

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Background Information

The CRAHG met on January 06, 2009, and were presented with a report on the virtual shorelines analysis (HEC-RAS) by Hoda Sondossi of the Grand Canyon Monitoring and Research Center and with an analysis by Mike Berry. As a result of those presentations and a subsequent discussion among CRAHG members, the assessment of the HEC-RAS model produced the following observations:

The existing virtual shorelines model (as generated by HEC-RAS) is a good predictor of river stage. The current analysis does not provide accurate velocity predictions. The existing virtual shorelines model is a good predictor of the inundation of site surfaces. Previous analyses have considered river stage using other models, to determine mitigation for impacts to sites. HEC-RAS appears to be a more accurate tool for this type of analysis. There may be other ways to analyze the HEC-RAS model data to help prioritize sites for treatment, but these have not yet been explored.

Mike Berry's analysis which was intended to test the usefulness of the HEC-RAS model in predicting archaeological site condition. Based on Mike's preliminary analysis, HEC-RAS, in combination with other variables, explains a negligible amount of variability in the data (site condition). Thus, based on this analysis, it may not be a good predictor of current archaeological site condition. Better predictors may be site slope, other geomorphological variables, weather, vegetation, etc. Additional modeling is necessary to evaluate which variables, and combination of variables, are good predictors of current site condition.

Stage is not the only consideration for the need to mitigate impacts to sites. Other considerations must be considered (as described above).

The CRAHG notes that this analysis does not resolve any issues regarding TCPs. The model could potentially be used to evaluate inundation of TCPs, but it is only one of many variables that still need to be considered.

The CRAHG also notes that the HEC-RAS model and the virtual shorelines is not an analysis of possible dam effects. It is merely an illustration of sites which may be inundated.

Recommendations:

Additional modeling is necessary to evaluate which variables, and/or combination of variables, are good predictors of current site condition.

There may be other ways to analyze the HEC-RAS model and virtual shorelines to help prioritize archaeological sites for treatment and monitoring, but these have not yet been explored. It is unclear how this new information would improve on the current prioritization process for treatment and monitoring. Further exploration of these models may have budget implications.

The current monitoring and treatment of archaeological sites should continue while the utility of these alternative models is investigated.

**The Cultural Resource Ad Hoc Group's Report  
To the Technical Work Group Regarding the  
Hydrologic Engineering Centers River Analysis System (HEC-RAS)  
Model's Applicability to Archaeological Sites**

**March 2009**

The Cultural Resource Ad Hoc Group (CRAHG) prepared this report and recommendations in response to a charge from the Technical Work Group concerning the applicability of the Hydrologic Engineering Centers River Analysis System (HEC-RAS) model's virtual shoreline analysis to archaeological site location along the Colorado River within the Grand Canyon.

The specific charge to CRAHG from the Technical Work Group stated:

*The CRAHG will review the revised virtual shoreline analysis, in relation to archaeological sites, and bring recommendations to the TWG at its next meeting focusing its review on the first part of the AMWG motion assessing the utility of flow lines as simulated (with uncertainty) by the HECRAS model and other error sources.*

The TWG charged the CRAHG in response to a motion from the AMWG passed on 10 August 2008. In this motion the AMWG directed the TWG:

*To review the flow levels (as indicated by the currently available shorelines of the HEC-RAS model) associated with each of the 158 archaeological sites that have been identified for monitoring and/or mitigation of impacts, and to report this information and any recommendations with regard to how these data would fit into the process of making choices of sites to be monitored and/or impacts mitigated to the AMWG at its next meeting, with the provision that any recommendation will not alter the choice of sites selected for impacts mitigation in FY09.*

The CRAHG met on 06 January 2009 and were presented with a report on the virtual shorelines analysis (HEC-RAS) by Hoda Sondossi of the Grand Canyon Monitoring and Research Center. As a result of that presentation and a subsequent discussion among CRAHG members, the assessment of the HEC-RAS model produced the following observations:

The existing virtual shorelines model (as generated by HEC-RAS) is a good predictor of river stage. The current analysis does not provide accurate velocity predictions. The existing virtual shorelines model is a good predictor of the inundation of site surfaces. Previous analyses have considered river stage using other models, to determine mitigation for impacts to sites. HEC-RAS appears to be a more accurate tool for this type of analysis. There may be other ways to analyze the HEC-RAS model data to help prioritize sites for treatment, but these have not yet been explored.

Mike Berry's analysis was intended to test the usefulness of the HEC-RAS model in predicting archaeological site condition. Based on Mike's preliminary analysis, HEC-RAS, in combination with other variables, explains a negligible amount of variability in the data (site condition). Thus, based on this analysis, it may not be a good predictor of current archaeological site condition. Better predictors may be site slope, other geomorphological variables, weather, vegetation, etc. Additional modeling is necessary to evaluate which variables, and combination of variables, are good predictors of current site condition.

Stage is not the only consideration for the need to mitigate impacts to sites. Other considerations must be considered (as described above).

The CRAHG notes that this analysis does not resolve any issues regarding TCPs. The model could potentially be used to evaluate inundation of TCPs, but it is only one of many variables that still need to be considered.

The CRAHG also notes that the HEC-RAS model and the virtual shorelines is not an analysis of possible dam effects. It is merely an illustration of sites which may be inundated.

#### Recommendations:

Additional modeling is necessary to evaluate which variables, and/or combination of variables, are good predictors of current site condition.

There may be other ways to analyze the HEC-RAS model and virtual shorelines to help prioritize archaeological sites for treatment and monitoring, but these have not yet been explored. It is unclear how this new information would improve on the current prioritization process for treatment and monitoring. Further exploration of these models may have budget implications.

The current monitoring and treatment of archaeological sites should continue while the utility of these alternative models is investigated.

Draft TWG Motion: The TWG recommends to the AMWG that the existing virtual shorelines generated by HEC-RAS model are good predictors of river stage and are reliable predictors of the inundation of archaeological site surfaces. However, river stage is not the only consideration employed for determining which archaeological sites need to be treated. Other proximate, secondary and tertiary causes must be considered in determining archaeological site condition and the need for treatment. Additional modeling is necessary to evaluate which combination of variables has the most explanatory value in assessing current site condition. The current monitoring and treatment of archaeological sites should continue while the utility of alternative models is investigated. It should be noted though that further exploration of these models will most likely have budget implications.