

FastTABS Software for Evaluation of Wetlands Hydrodynamics

PURPOSE: This technical note documents how recent software developments (FastTABS) can be used in the evaluation of two-dimensional (2-D) wetland hydrodynamics.

BACKGROUND: Rivers, reservoirs, and estuaries have been modeled for a number of years using the U.S. Army Corps of Engineers TABS numerical modeling system. TABS is a family of numerical models that can simulate hydrodynamic, sediment, and constituent transport processes in these water bodies. One of the most attractive features of the TABS system is the ability to simulate wetting and drying of shallow areas caused by either discharge fluctuations in rivers or tidal fluctuations in estuaries. While this capability has existed for some time, it has only recently been used for applications where wetlands were the primary interest.

Recently, there has been an increased awareness of the impacts of Corps projects in neighboring wetland areas. It became imperative to determine the impacts of the projects, whether they were deepened navigation channels or hydraulic structures, on wetlands. In some cases, the Corps was asked to mitigate their projects by creating new wetland areas where they didn't previously exist or by renovating deteriorated wetlands. Based on the wetland type and function desired, suitable hydraulic conditions need to be designed into the created or renovated wetland. Given that hydraulic conditions are often not controllable, geometry of the wetland is the single controllable characteristic that can affect frequency and depth of inundation. The design of wetlands then becomes an iterative process that requires several trial geometries for a given set of hydraulic inputs. Since this iterative process can be time consuming, efficient model setup and boundary condition assignment is required.

EXISTING TOOLS: The TABS system consists of many separate programs that individually address different aspects of the modeling process (Thomas and McAnally, 1990). These include mesh development, geometry input file generation, boundary condition definition, hydrodynamic input file generation, job status monitoring, and post-processing of the results. Separate input files are needed for using each of the different flow and transport models within the system. TABS has historically been used in a batch-oriented mainframe computer environment but has recently been converted to personal computers and workstations.

SOFTWARE DEVELOPMENTS: A new graphical implementation of TABS (FastTABS) (Lin, et al, 1991) has been developed that successfully addresses the need for efficient model setup, execution, and analysis. It is mouse driven with pull down menus (Figure 1) and requires a minimum of manual data entry to complete an application from start to finish. FastTABS was designed to allow easy application of each of the models in the TABS system which include hydrodynamics, constituent and sediment transport. In this technical note, only hydrodynamic capabilities are addressed. Developments in constituent and sediment transport will be presented in future technical notes.

DEMONSTRATION SITE APPLICATIONS: Several demonstration sites in the WRP have been modeled using the TABS system with good results. Two of these include: Bodkin Island (a black duck habitat that was to be created from dredged material in Chesapeake Bay) and the Galilee Bird Sanctuary (a reclaimed brackish marsh in Rhode Island). The modeling of each site provides examples

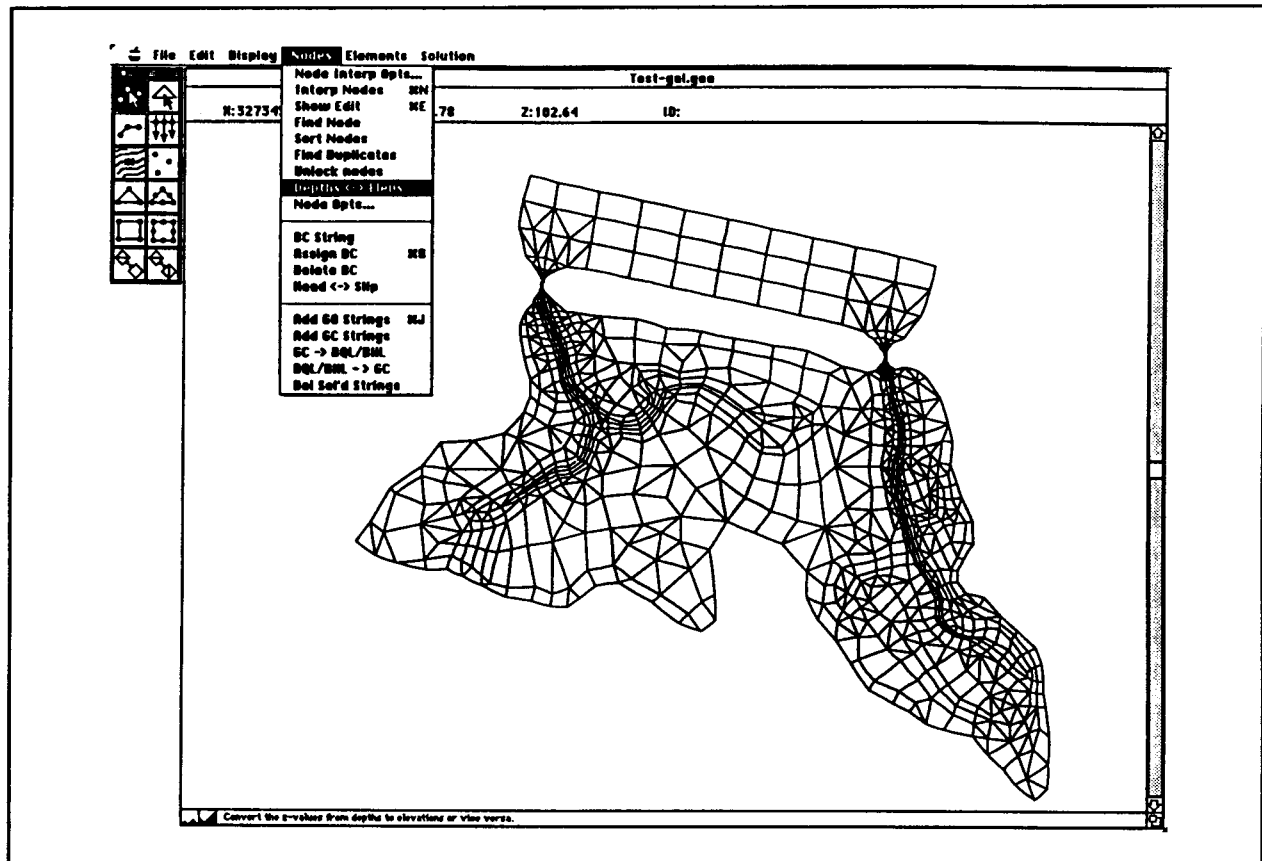


Figure 1. FastTABS Graphical User Interface showing Galilee Bird Sanctuary model mesh

by which hydrodynamic modeling could be accomplished for other renovated or created wetlands. Although each application involves tidal flows in estuarine wetlands, this application type is often more difficult than typical riverine applications. Therefore, the models can be used for most wetland problems.

The Bodkin Island wetland model provides an example of how future wetlands could be created since there is an abundance of clean dredged material in both rivers and estuaries. Bodkin Island is a one-acre island located in Eastern Bay which is a sub-estuary of Chesapeake Bay (Figure 2). Bodkin Island is subjected to accelerated erosion by wind waves and to a lesser extent, tidal currents. The proposed plan to save and expand Bodkin Island involved using clean dredged material and riprap to expand the island to six acres (Figure 3).

The island exterior was designed to be hardened against wave attack and the interior to provide nesting, shelter, and feeding areas for juvenile black ducks. This required designing ponds, intertidal marsh areas, and uplands in the interior. All of these geographic features were modeled hydrodynamically using FastTABS to ensure that wetting and drying of the interior marsh was accomplished as required for the plant and wildlife and that the newly created larger island did not adversely impact shellfish beds nearby. Typical results for a single time step are shown in Figure 4.

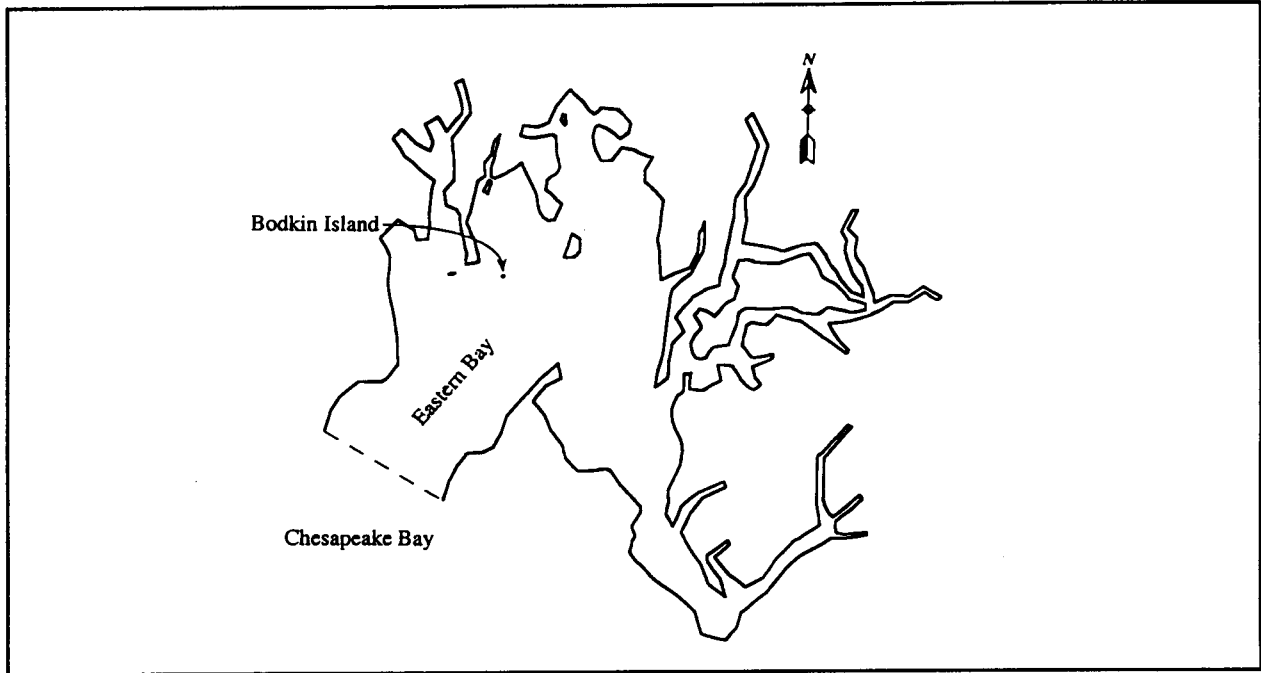


Figure 2. Modeled portion of Eastern Bay including Bodkin Island

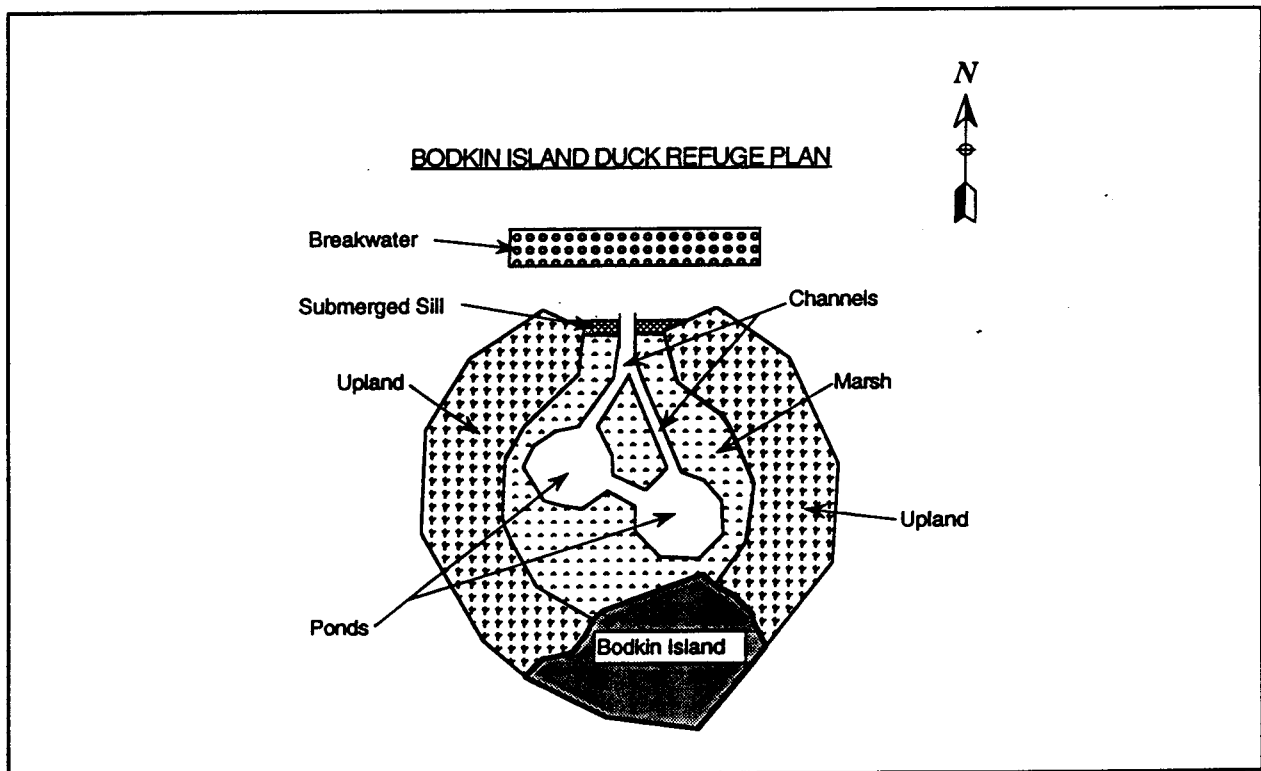


Figure 3. The proposed plan for Bodkin Island

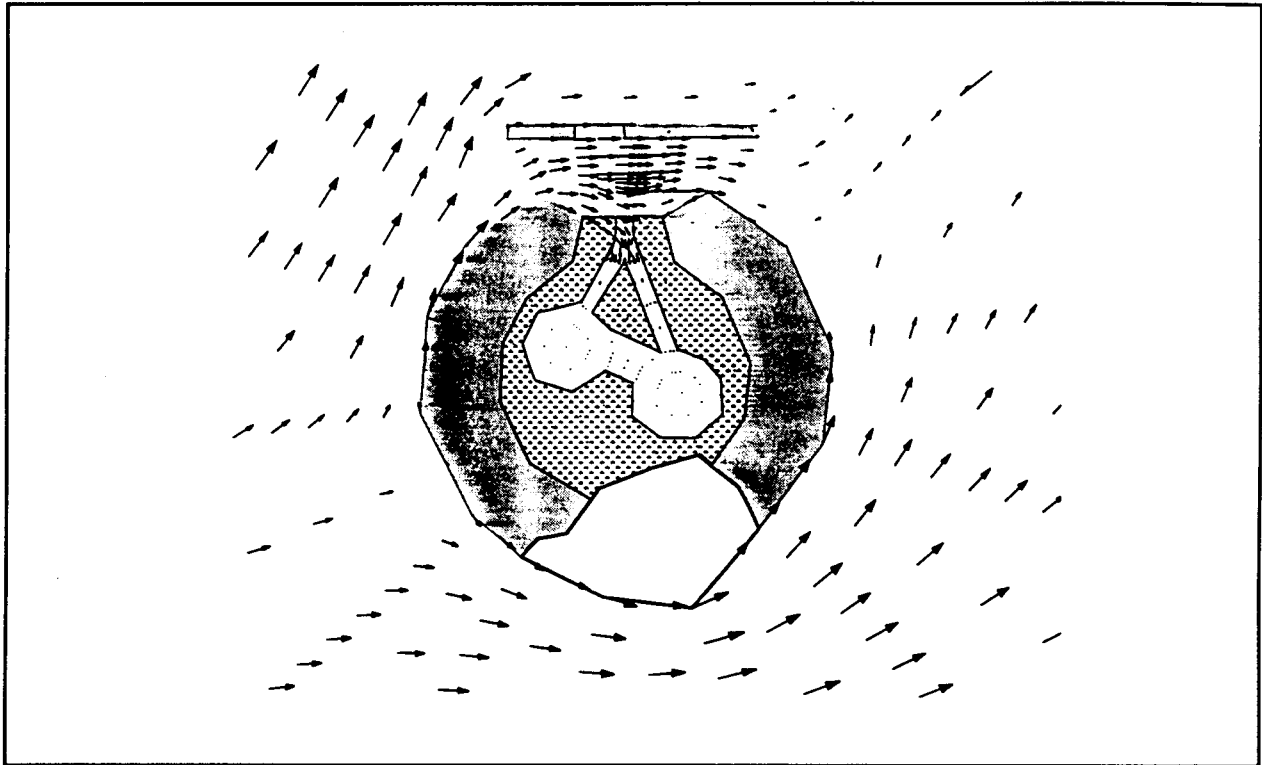


Figure 4. Bodkin Island velocity plot from FastTABS

The Galilee Bird Sanctuary is typical of many deteriorated wetlands. Previously, it was a brackish marsh until it was filled and cut off from tidal circulation by a road and undersize culverts. This application could be typical of many similar wetland renovation studies where brackish marshes are reclaimed from freshwater marshes created by manmade obstructions such as roads with undersized bridge openings or culverts.

In the Galilee application, FastTABS was used to determine the culvert size needed to provide sufficient circulation upstream of the culvert without causing scour problems in narrow channels within the renovated wetland. Figure 5 shows a velocity contour map that indicates the percentage of time the velocity magnitude exceeds 0.5 feet per second. It is apparent that velocities are much slower than those which would cause scour within the wetland. Figure 6 shows the wetted area within the marsh at high tide (max) and low tide (min). With each high tide, the entire wetland is exposed to brackish water. Previously, only a small area near the culverts was exposed to brackish water leaving the remainder wetted only by rain water. Figure 7 shows velocity vectors through one of the two culverts along with time histories of velocity and head (water surface elevation) at a selected point.

COMPUTER INFORMATION: The FastTABS software runs on Macintosh and DOS-based personal computers as well as most UNIX workstations. A primer, user's manual, and tutorial are available.

The FastTABS software was written by and is copyright to the Engineering Computer Graphics Laboratory of Brigham Young University in Provo, Utah, in cooperation with the Hydraulics Laboratory at WES. A limited government license allows Corps office use of the software supplied through WES. Other than Corps users may obtain the software from Brigham Young University, 801-378-5713.

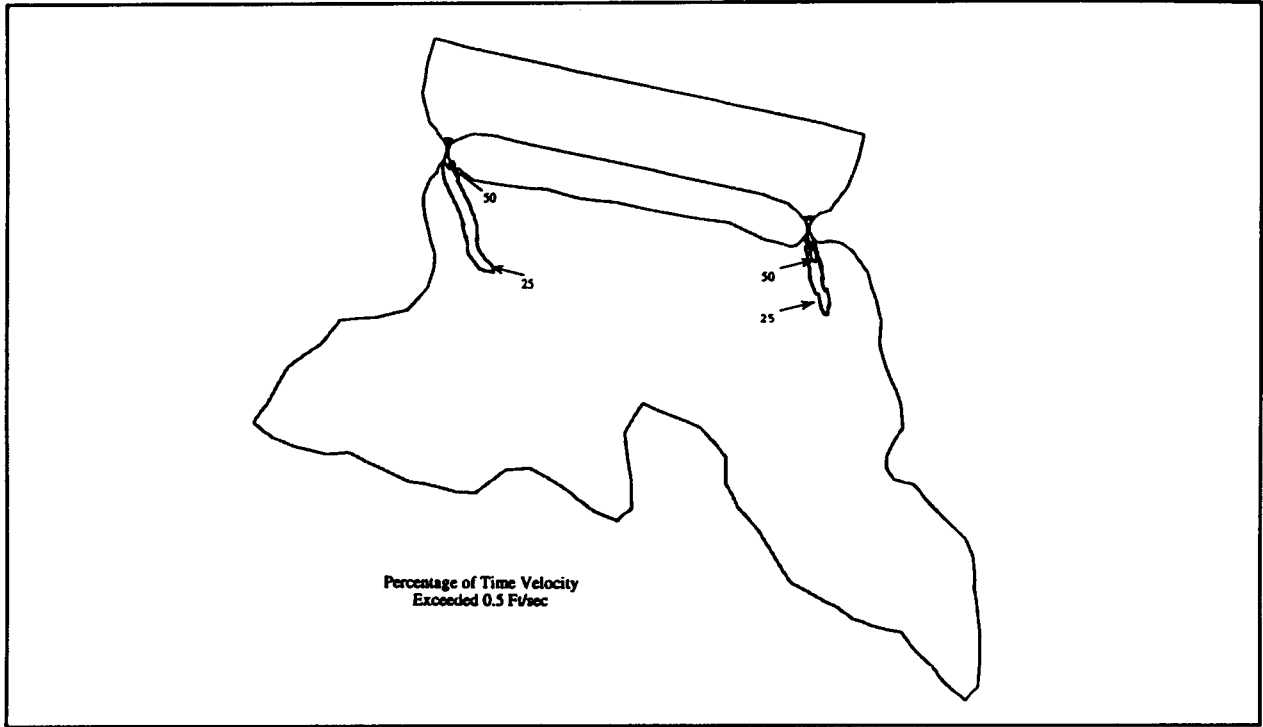


Figure 5. Galilee Bird Sanctuary current magnitude contours

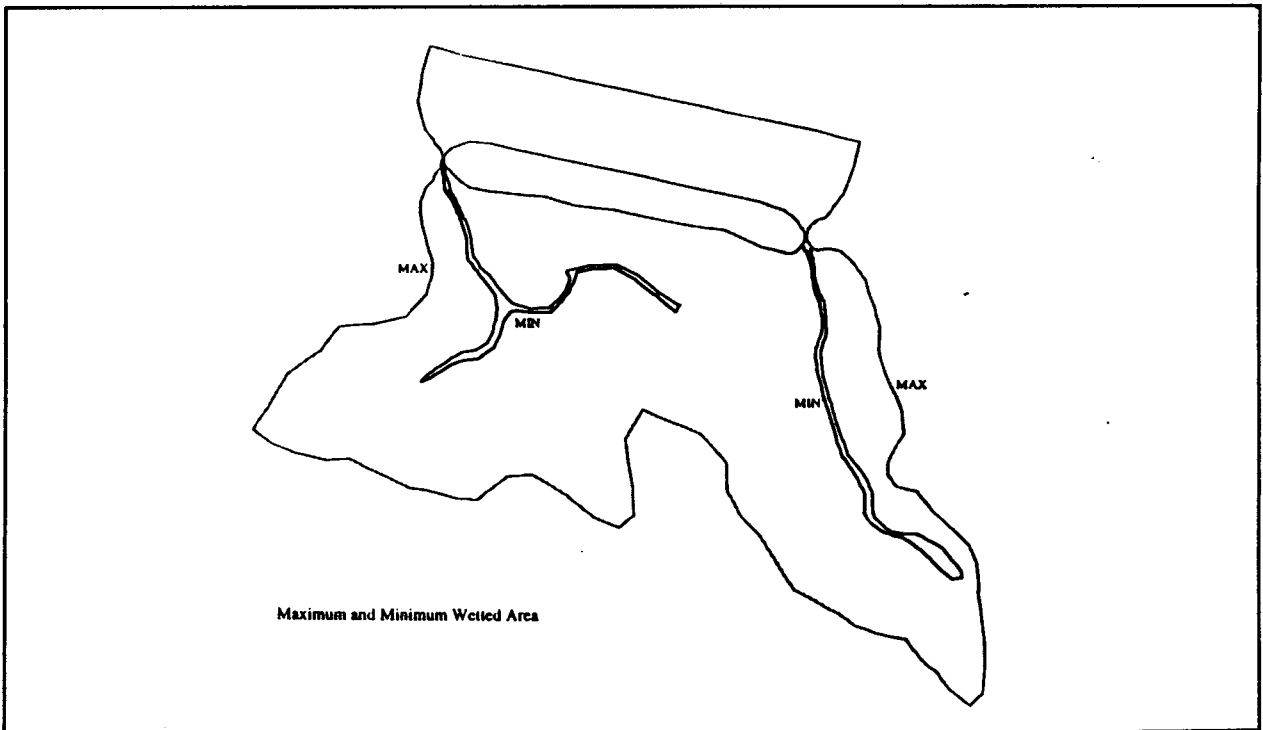


Figure 6. Galilee Bird Sanctuary maximum and minimum wetted area contours

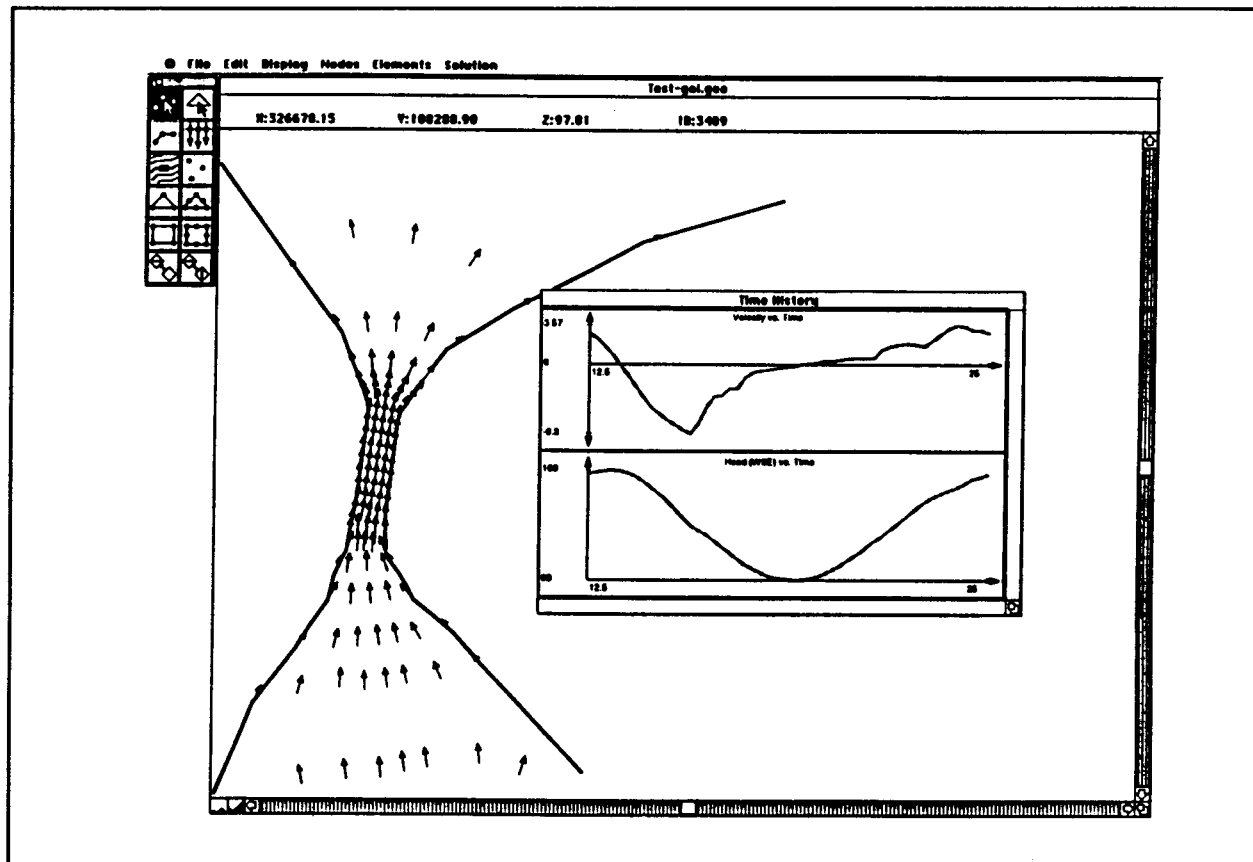


Figure 7. Galilee Bird Sanctuary velocity results near a culvert along with time histories of velocity magnitude and head

REFERENCES:

Lin, H. J., Jones, N. L., and Richards, D. R. 1991. "A Microcomputer-Based System for Two-Dimensional Flow Modeling," Proceedings of the 1991 National Conference on Hydraulic Engineering, ASCE, Nashville, TN.

Thomas, W. A., and McAnally, W. H., Jr. 1990. "User's Manual for the Generalized Computer Program System: Open-Channel Flow and Sedimentation, TABS-2." U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

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