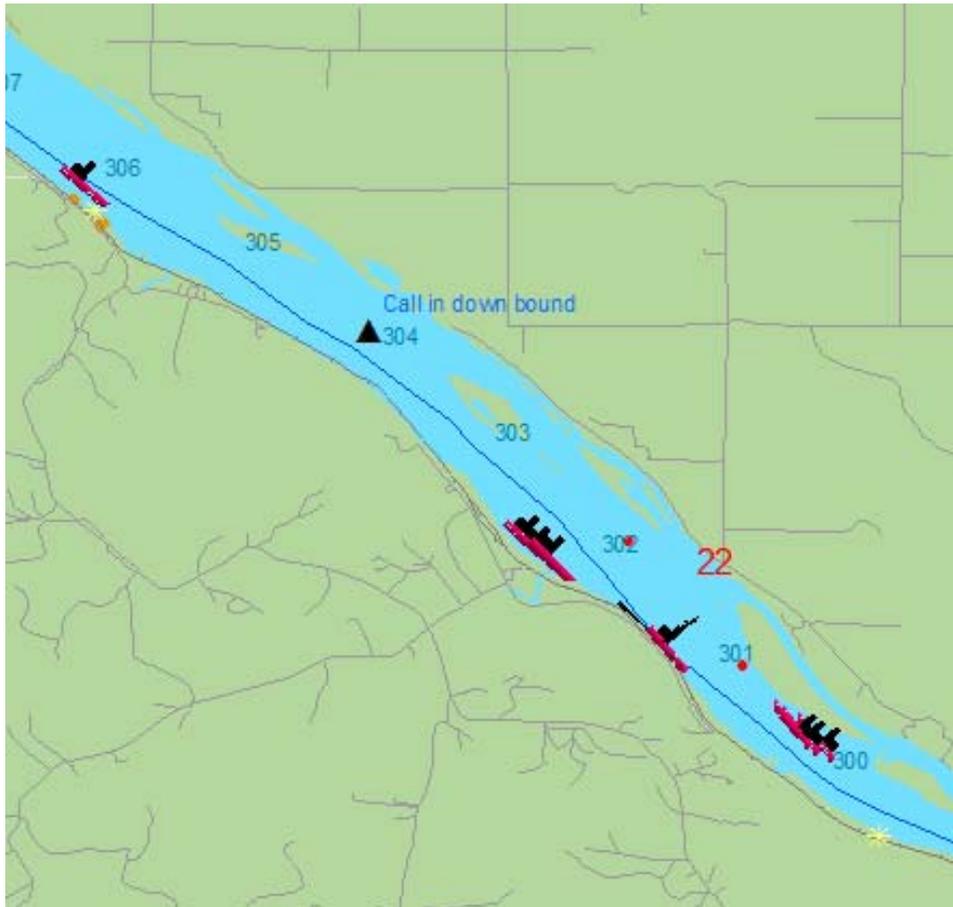


# User's Guide to the Prototype Vessel Tracking Geographic Information System for the Upper Mississippi River



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Center for Transportation Studies  
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# **User's Guide to the Prototype Vessel Tracking Geographic Information System for the Upper Mississippi River**

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## A. Installation and Set Up

### 1. Description of Prototype

This document provides a brief explanation of the prototype vessel tracking geographic information system (GIS) for the upper Mississippi River developed by the Center for Transportation Studies at the University of Missouri St. Louis. The prototype takes simulated tow and barge position data for the Upper Mississippi River (UMR) system, specifically for the region from Lock and Dam 20 through Lock and Dam 25, to demonstrate some of the visual aspects for how this data could be displayed in a real time environment. Additionally, the prototype uses a static view of the system to demonstrate how the system brings in relevant information, including vessel, lock, pool and queue information currently available on the U.S. Army Corps of Engineer's OMNI database, as well as simulated interactions with an lockage re-sequencing module to display suggested lockage sequences.

### 2. System Requirements

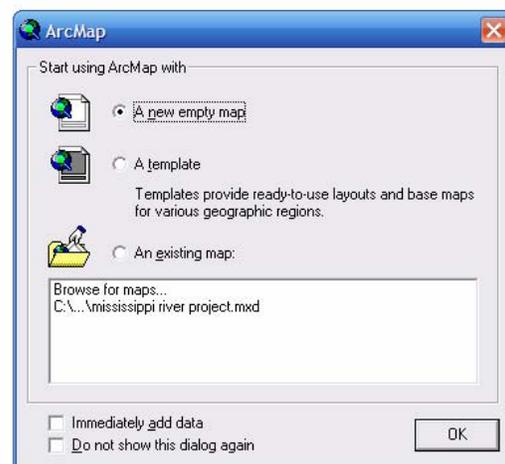
The prototype requires installation of ArcMap 9.0, or any subsequent version of the ArcMap program. ArcMap is a geographic information system created by ESRI Inc. Additionally, the prototype requires the installation of the Tracking Analyst extension. Tracking Analyst was developed by ESRI to allow for both the static display of sequenced spatial data, like tow positions, as well as connectivity in a more dynamic set-up to streamed information of spatial data. In its application in the prototype, the Tracking Analyst extension relies upon simulated tow positions created using past location data available from the Corps OMNI database. Additional information on ESRI products can be found at <http://www.esri.com>.

Both ArcMap 9.0 and the Tracking Analyst extension should be installed and licensed prior to opening the prototype. All data files necessary for running the prototype must be located on a host computer in a directory named C:\UMRVTS. (Directions for acquiring the data for the prototype can be found at <http://www.cts-umsl.org/waterways>.) It is essential to maintain the subdirectory relationships under the directory UMRVTS allow the program to properly open the prototype.

### 3. Loading the Mississippi River Project

After installing and licensing ArcMap 9.0 and Tracking Analyst, launch ArcMap from the Program Start menu. From the Open file box select "An Existing Map" and under "Browse for Maps" select "Mississippi river project.mxd".

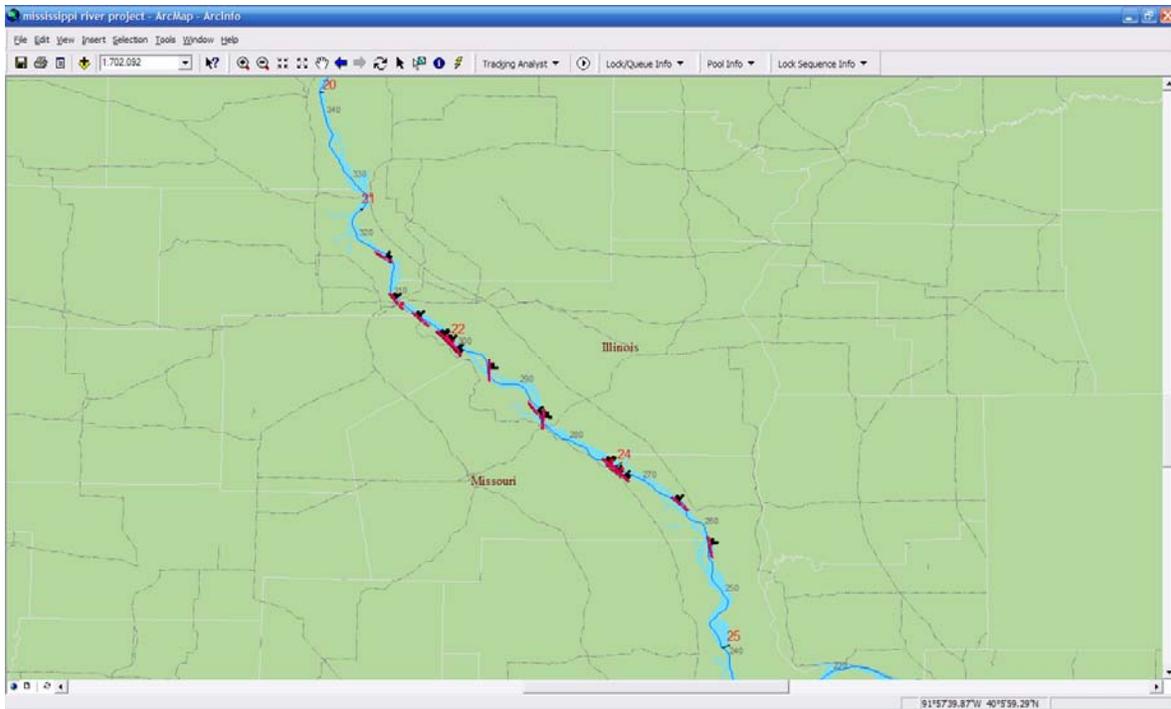
If the file name is not present, browse for the



file name in the directory C:\UMRVTS. The .mxd suffix indicates an ArcMap project file.

#### 4. Description of Program Layout, Menus and Toolbars

The main frame of ArcMap includes drop-down menus typical to most Window programs, program toolbars for loading and visualizing data, and a main layout for visual display.

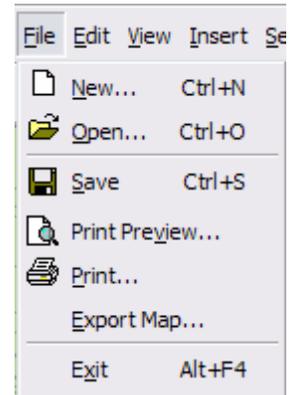


Other windows and dialogue boxes launched from menus and toolbars open over the main visual layout frame. Users can resize and move toolbars and accessory windows; the default setting maximizes the display extent.

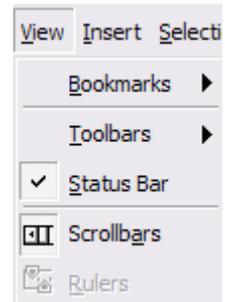
The main display frame shows the visual display of map layers. These layers contain predefined features that consist of polygons, points or lines. In general, each layer contains a set of similar features—for example, all river lights are contained in a light layer, the river is contained in another layer, locks are contained in a third layer, etc. Layers include specific instructions detailing the visual elements of a feature—icons to display for points, boundary colors and fill patterns for polygons—and data tables containing feature elements—for example, for lock features this includes the name of the lock, river mile location, operating capacity, etc.

The top line of the program window includes typical drop-down toolbars. The menu options have been customized for simplification of use for those not familiar with ArcMap functions. Among the menu features are:

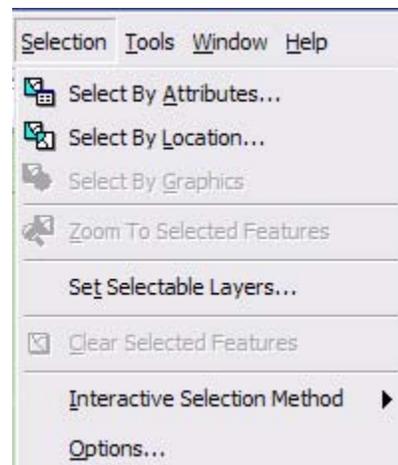
- *File menu:* Users can open and save map projects. The main layout window can be printed as well as exported as an image file for insertion into other documents.



- *View menu:* Users can jump to pre-selected spatial bookmarks containing views of specific locks or groups of locks, create new bookmarks, insert new toolbars, or change other general layout features. The spatial bookmarks includes preset bookmarks on the full view of the project study, views of each of the pools and close-in views of each of the locks.



- *Selection menu:* Users have a variety of methods to select certain feature values, a function to define layers for selection and a function to clear selected features.



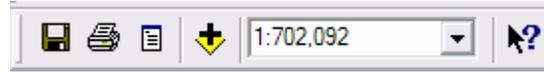
Below the menus are a series of program toolbars. They contain all of the main features necessary for using the prototype. Additional toolbars can be loaded under the View menu and custom toolbars and custom toolbar functions can be created under the Tools menu with the Customize button.

The toolbars include three built-in toolbars, the Standard toolbar, the Tools toolbar, and the Tracking Analyst toolbar. The program utilizes three other custom built toolbars containing UMR Information and Management functions: the Lock/Queue Info

toolbar, the Pool Info toolbar and the Lock Sequence toolbar. ArcMap contains a tool-tip function by which button names are displayed when the cursor is positioned over them.

Toolbar functions include:

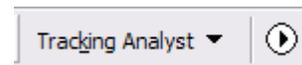
- *Standard toolbar:* The Standard toolbar contains icon for common ArcMap functions, including saving and printing map documents, showing/hiding the table of contents, adding additional layers, map scale information, and a help function. Of these, the most relevant is the Show/Hide Table of Contents icon. Clicking this icon displays a window that lists the available layers in the tracking system.



- *Tools toolbar:* The Tools toolbar contains icons for changing the extent of the display, including zoom, pan, returning to previous extents and refreshing the current view. Additionally, the toolbar contains functions for identification and selection of layer features, including a default select elements function, a select features function, an ID function, and a hyperlink function. The ID function brings up a secondary window displaying relevant identifying information on the selected feature. Layer selection for the ID function can be controlled under the Selection menu by clicking the Set Selectable Layers button.



- *Tracking Analyst toolbar:* The Tracking Analyst toolbar contains all the functions for dynamic display of data. Its features are discussed below in “Visualization of Dynamic Data using Tracking Analyst.”



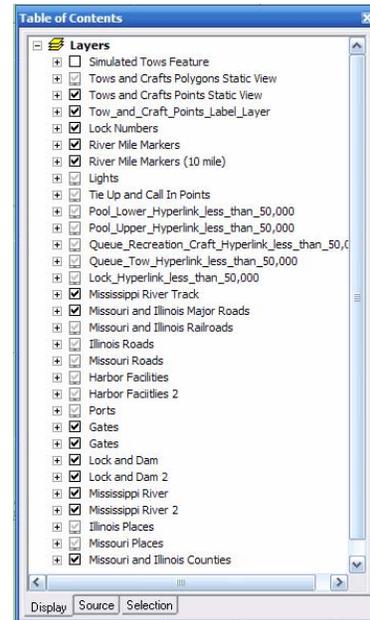
The three custom-built toolbars simulate functions that display relevant information for tracking vessels and managing lockages. Elements of the toolbars are discussed in “Exploring UMR Information and Management Features in the Static View” below.

## **B. Exploring UMR Information and Management Features in the Static View**

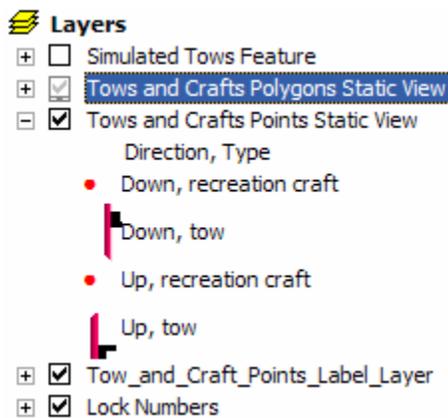
### *1. Switching on the Static View.*

The prototype contains a static view of the UMR study area to better explore some of the main features of the system, including accessing information and management features, changing the extent of the display frame and using identification, selection and hyperlink functions. These features are available in the prototype’s dynamic display using Tracking Analyst, but they may interfere with the display of data, as the playback rate of the dynamic data has been speeded up.

Information on map layers is contained in a Table of Contents window displayed by clicking the Show/Hide Table of Contents button on the Standard toolbar. Resize the table of contents to show the names of the layers if they are truncated. The table of contents displays all layers associated with the project. (Table 1 lists the layers loaded on the project and their source.) The layers include tows represented by point icons; lights, harbors and other river features represented by point icons and polygons; land features such as roads, county boundaries and municipal boundaries represented by lines and polygons; and locks, gates, recommended navigational channels and river boundaries represented by polygons.



When the display tab on the bottom of the table of contents is active, the order of the layers in the table of contents provides the order of display from top to bottom. Preceding the name is a plus sign/minus sign and a checked or unchecked box. Clicking the plus sign to a minus sign unfolds additional information about the layer, primarily how the layer's features are displayed. Double clicking a layer brings up a layer properties box with additional controls for scale settings for display of



the layer features, labeling features and symbolizing features. The prototype is configured to label certain features at various scales. For example, locks are labeled at every scale, and river miles are variously labeled either every ten river miles or every river mile at smaller scales. Right clicking on a layer's name brings up an additional menu with other layer-related functions. It is recommended that users do not reorder the layers or change their visual features.

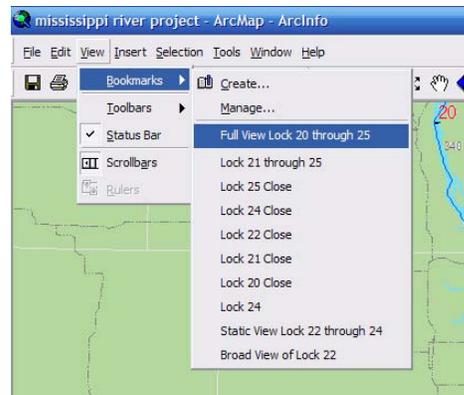
The check box to the left of the layer name clicks on and off the layer. To view layers associated with the static view, click on the three static view layers (the second, third and fourth layer in the layer list) and ensure that the layer called Simulated Tows Features is clicked off. Shrink or hide the table of contents when ready to continue.

## 2. Zooming, Panning and Other Toolbar Functions

The program redraws the map as new layers are added, clicked on, or as the extent of the display frame is changed by zooming, panning or jumping to a new spatial bookmark. The layers have been set to display at various scales. Thus, at the broadest view of the study area, the frame displays land/river boundaries, lock locations and

numbers, river channels and tows. Zooming in brings up additional layers, including river features such as lights and harbors and land features such as roads, railroads and municipal names.

If the program is set to a different extent, use the Bookmarks button on the View menu to click to “Full View of Locks 21 through 25.” The display frame should show a series of tow icons clustered between Locks 21 and 25. Other bookmarks take users to views of specific pools and locks at various map scales. Using the zoom-in function (from the Tools toolbar) will redraw the frame layout to the specified box size by holding down the mouse and drawing a box.



Zooming-in can also be accomplished by clicking on the zoom-in button (in the Tools toolbar). Map properties are set so that different layers will turn on and turn off as the scale of the map changes; generally more information is shown as the map scale decreases. Harbors and other docks will display as orange polygons, lights as yellow asterisks, and call in points as black triangles. Zooming-in past a scale of 1:200,000 will turn on land features such as municipal boundaries and names. Zooming-in to a scale under 1:100,000 will display streets and rail lines. The display of names of streets, harbors and docks occurs at a scale below 1:50,000.

In the static view, commercial tows are symbolized as a point feature at scales above 1:100,000, but as a polygon feature at scales below this. This allows for a more accurate display of tows at closer in views—at scales below 1:100,000 the size of displayed tows is more or less accurately scaled to the map. This also allows for viewing the location of tows at broader scales where accurately sized tows would not be available. Both the point and polygon tow features have been created to indicate the direction of tow travel. In addition, tow icons are rotated according their river mile location to mimic the shift of the river channel.

Different views of Lock and Dam 22 demonstrate how these layer and label elements work in practice. Use the spatial bookmark “View of Lock 22” to jump to a relatively broad view of Lock and Dam 22 and the pools adjacent to it. At this scale, the tows are symbolized by a boat icon and recreational craft are represented as a red dot. Zooming-in to a scale less than 1:100,000 turns off the tow point layer and turns on the tow polygon layer, and brings up additional land and river features. The project also includes a book mark “Lock 22 Close” that jumps to a view of the lock at a scale below 1:35,000. At this view, the display frame shows not just features of the lock, tows, river and land, but also orange ovals containing custom river management and information functions.

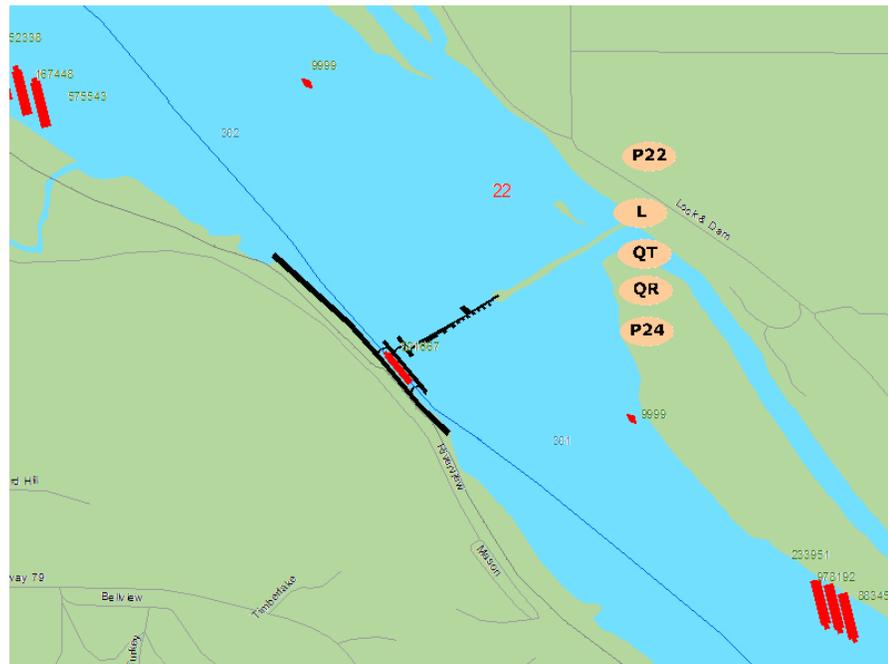
### 3. Using the Hyperlink Function

The ID function on the Tools toolbar can be used at any scale and will show attributes of the top visible layer. For example at the broad view of Lock and Dam 22, clicking on the orange polygons around river mile 306 displays a table of information on the ports. The prototype does not include a layer for river ports, as this data was not readily available. Instead, this information is contained in a series of files that can be accessed in two ways: using the Hyperlink button on the Tools toolbar or using functions associated with the custom built UMR River Management and Information toolbars. In contrast to the ID function which only displays attribute information currently associated with layers, these two functions link project features to external tables that in a real time application could be updated dynamically as additional data is received.



Both the hyperlink and the custom buttons rely upon additional programming code which calls up information and displays it as a text file in the center of the main display window.

For the hyperlink function, linking to this information is made possible through a data field that points to an external field and application; in the custom buttons, clicking the button activates the application. While any layer feature can be hyperlinked, the prototype provides hyperlink functions on tows and on a series of



icons loaded into the map. These icons are orange ovals located adjacent to locks, and are available only at displays below the scale of 1:40,000. Clicking on these icons brings up the type of information on locks, pools and queues that is currently available from the Corp's OMNI system. These icons are different from toolbar buttons in that they are tied to specific locations on the map, and will only be available when the view of the main display frame is focused on the locks at the proper scale.

To utilize the hyperlink buttons, click on the spatial bookmark "Lock 22 Close." The buttons are marked L for the lock, QT for the queue of commercial tows, QR for the queue of recreation craft, and Pnn for the upper and lower pools of the lock. The hyperlink function is turned on by clicking the



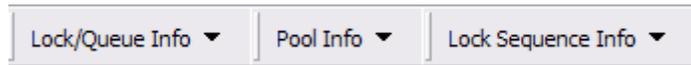
Hyperlink icon on the Tools toolbar, which changes the default arrow pointer into a lightning bolt. All features with hyperlinks will display as a blue dot (for point features) or a blue outline (for polygon features). Positioning the lightning bolt pointer over a hyperlink feature will change it to a finger pointer and display a hyperlink name. Clicking this will activate a text file with the relevant information.

The lock information displayed with the prototype includes name, position, capacity, past tonnage information, personnel names, etc. The pool and queue tables displayed in the prototype include information similar to that available from the OMNI system: pool information shows all vessels currently in the pool with relevant information; queue information shows similar information for vessels in the queue or in the lock chamber. After displaying the information, the information window should be closed to continue working in the ArcMap program.

The prototype also includes hyperlinks from vessel polygons in views below scales of 1:50,000. Similar to the hyperlink buttons, positioning the pointer over the tow icons changes the pointer and shows a name of the hyperlink file; clicking the file opens up a new table window with vessel information.

#### 4. Using Custom Built UMR Information and Management Toolbars

The hyperlink functions provide one way to access relevant information in a form that can be continually updated as additional information is received. Another method of accessing this information is through UMR Management and Information functions on custom toolbars located at the top of the program screen. These include a Lock/Queue Info



Queue 22

QUEUE 22 Table:  
Current Time 4/11/05 11:30:05

Vessel Name	Vessel#	Date Time	Direction U/D	Total Barges	Lock Type	Vessel Type	# of Cuts
Queue 22							
JOHNNY LATER	521667	SOL 04-11-05 10:30 CDT	U	12	S	T	2
RIVER SPECIAL	233951	ARR 04-11-05 8:00 CDT	U	15	S	T	2
EA POE IRON CO	252338	ARR 04-11-05 9:00 CDT	D	15	S	T	2
GO JOHNNY	978192	ARR 04-11-05 10:15 CDT	U	15	S	T	2
BRUCE HAHN	167448	ARR 04-11-05 10:30 CDT	D	15	S	T	2
RIVER RAT	883452	ARR 04-11-05 10:45 CDT	U	1	S	T	1
EASY SAILOR	575543	ARR 04-11-05 11:00 CDT	D	15	S	T	2
RIVER RAT	883452	ARR 04-11-05 10:00 CDT	UP	1	S	T	1

toolbar, a Pool Info toolbar and a Locking Sequence toolbar. Each of these contains drop down menus to access the relevant information. For example, clicking the down arrow on the Lock/Queue Info toolbar displays two separate menus, one for Locks and one for Queues; clicking either opens a second menu with the relevant lock numbers. The Pool Info toolbar similarly opens a second menu with the relevant pool numbers. Selecting any of these buttons activates a custom built function that returns a text box with the relevant information. (Note that in the prototype the custom toolbar functions open text windows in the center of the program window; these text windows will remain on top of the program frame until they are closed.)

The Lock Sequence toolbar simulates a new lockage management tool currently unavailable to river personnel. Clicking on this displays a table showing a suggested lock sequence based on re-sequencing the tows in the “extended queue” for Lock 22. The prototype provides a fixed re-sequencing of the tows to demonstrate the type of display possible. In a real time application, this function would contain a significantly more sophisticated application that inputs relevant queue, pool and tow information; executes an algorithm to arrive at the recommended sequence; and outputs the suggested sequence to the map display.

Lock Sequence 22 Table:  
CurrentTime 4/11/05 11:30:10

Vessel Name	Vessel#	Date Time	ETSL	Direction	Barges	Lockage Type	Vessel Type	# of Cuts
JOHNNY LATER	521667	SOL 04-11-05 10:30 CDT		U	12	S	T	2
1. RIVER RAT	883452	ARR 04-11-05 10:45 CDT	04-11-05 12:40 CDT	U	1	S	T	1
2. RIVER SPECIAL	233951	ARR 04-11-05 8:00 CDT	04-11-05 13:15 CDT	U	15	S	T	2
3. MEMCO #1312	653122	EOL 04-11-05 7:30 CDT	04-11-05 15:15 CDT	D	8	S	T	1
4. EA POE IRON CO	252338	ARR 04-11-05 9:00 CDT	04-11-05 16:00 CDT	D	15	S	T	2
5. GO JOHNNY	978192	ARR 04-11-05 10:15 CDT	04-11-05 18:00 CDT	U	15	S	T	2
6. BRUCE HAHN	167448	ARR 04-11-05 10:30 CDT	04-11-05 20:00 CDT	D	15	S	T	2
7. EASY SAILOR	575543	ARR 04-11-05 11:00 CDT	04-11-05 22:00 CDT	D	15	S	T	2
8. FERMI'S #2	145763	EOL 04-11-05 8:30 CDT	04-11-05 24:00 CDT	D	15	S	T	2

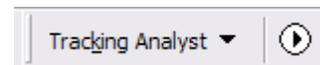
### C. Visualization of Dynamic Data using Tracking Analyst

#### 1. Description of Tracking Analyst Toolbar

The static view in the prototype demonstrates some of the functionality of the prototype in terms of changing the extent, identifying features, accessing the hyperlink feature and utilizing the custom toolbars. These functions are best tested in a static view of data because using them in a playback with dynamic data will interrupt the functionality of the playback. This is because the Tracking Analyst extension functions differently and uses archived data that is essentially imported and spatially located as a text file. In a real time application, the dynamic display of data will be based on a link to a vessel tracking system that provides tow positions on a continuous basis, with Tracking Analyst prompting ArcMap to redraw the map with updated locations of tows and vessels as data is received.

In the prototype, the time speed of the playback has been modified to speed up the prototype and demonstrate how the program shows the tows traveling along the river. Functions such as identification, changing the extent, hyperlink and custom buttons will work in the dynamic view of the prototype, but may cause the playback to stop or interrupt the redraw of the map. Using these sorts of features in the dynamic display will require restarting Tracking Analyst’s playback manager or redrawing the map by using the Refresh button on the Tools toolbar.

The Tracking Analyst toolbar includes all of the functions necessary both for playing archived position data and for configuring a link to a real time data source. As customized for the prototype, the Tracking Analyst toolbar contains the Playback Manager function and an animation tool available by clicking down the toolbar; other functions relating to adding data and creating real time links have been archived.



## 2. Switching on Playback Layers

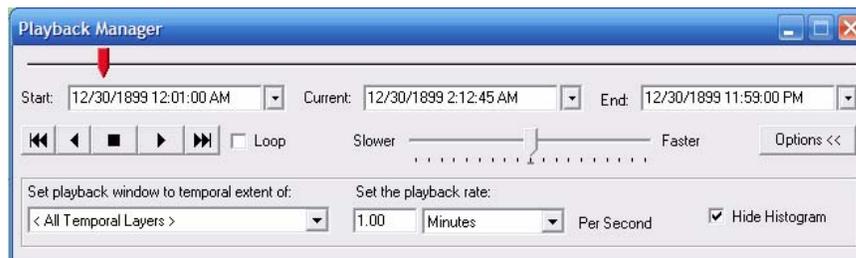
In order to show the dynamic display, relevant layer files must be activated from the Table of Contents menu. Clicking the Show/Hide Table of Contents button on the Standard toolbar brings up the list of layers (if it is not already visible). In the prototype, dynamic data is contained in the top layer, Simulated Tow Feature. (Be sure to click off the three static tow layers if they are still active.) The Simulated Tow Feature has been configured to properly display the tows, including different types of icons for up-bound and down-bound vessels and for vessels at docks or ports.

## 3. Using the Playback Manager and Modifying Playback Features

Clicking on the Playback Manager button on the Tracking Analyst toolbar opens up a second window that controls the playback function. The window can be resized and placed anywhere over the main frame for use when viewing the dynamic display. Clicking options on the bottom right of the frame opens up additional features of the function, including the Hide Histogram box which opens and closes a histogram showing the frequency of observations over the playback time frame.



The top portion of the frame contains information on the time frame of the playback. The Start, Current and End date and time fields are set by the time extent of the



layer, but also can be modified to view specific times. The red pointer icon above these fields shows the relative time position of the display. Below the

time frame fields are buttons to control the playback (move forward, move backward, pause, jump to the beginning and jump to the end). A check box allows the playback to be looped, with the display returning to the starting point when the end point is reached. Additionally, a slider can be used slow down or speed up the rate of playback.

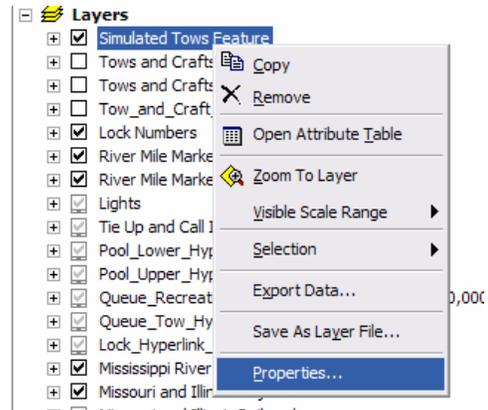
The bottom line of the frame, controlled by the Options button, contains options integral to the selection of the layer to display as well as the rate of display. The Set Playback Window to Temporal Extent Of pull-down tab should be left at the default setting of All Temporal Layers. The Set the Playback Rate function controls the frequency of the dynamic display; the default setting is to set the playback rate to 1 minute per second. With these options set, the option button can be clicked to hide the functions.

Zooming back to the full view of the study area (using the spatial bookmark) shows the simulated tow features in their starting position. Users will note the time delay as the program redraws the map to this scale; the speed of redraw will depend on the specifications of the user system and amount of memory dedicated to the program. With

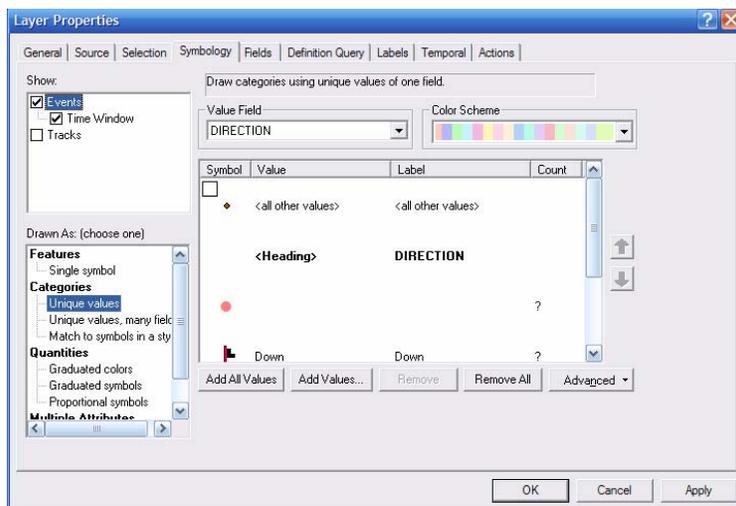
the top frame icon of the Playback Manager at the beginning position, pushing the Playback Manager’s play forward button starts the dynamic display. Users can zoom to particular locks using either the spatial bookmarks or the Zoom in or Zoom out buttons, or pan across the map. With changes in the extent, the program will redraw the map showing the relevant elements at a speed dependent on user conditions. Note that some features involving changing the extent of the display frame may require restarting the Playback Manager, as well as refreshing the map extent.

#### 4. Modifying Visualization Features

The Playback Manager function utilizes features of the relevant layer that identify which icon to display and the conditions under which the icon is changed. Under most conditions these features should not be changed, but describing them identifies some of the other features of the system that could be relevant to river management in a real time setting. These features can be found by right clicking on the layer name in the Table of Contents window, and then clicking on the Properties button to bring up a Layer Properties window.



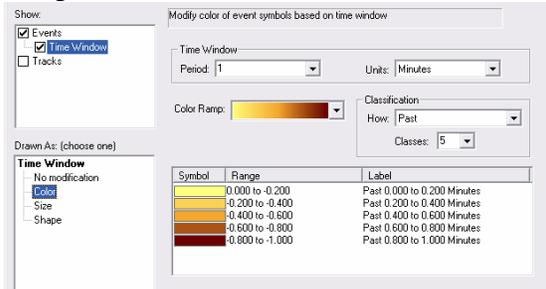
Clicking on the Symbology tab shows features related to the Tracking Analyst



function. In the prototype the event and time window boxes should be checked with values added; double-clicking the event feature either turns on the time window feature or displays information on how the tows are displayed. Double click to hide the time window feature and show tow features. The prototype distinguishes the display of tow icons based on their direction—either up river,

down river or stationary. This is based on features of the archived data used to create the dynamic display, which contains a field indicating the direction of travel. Depending upon data available in a real time application, the tows can be distinguished by a number of factors in the display—not just direction, but type of load, destination, place in queue, etc.

Other playback functions available under the Symbology tab include the ability to add tracks to events (as it includes a track only from one event to the other, it is not useful in this application). The Time Window function under the event function indicates the temporal extent to which tow icons should be displayed. The default setting of 1 period



and 1 minute means that only the current event will be displayed. With a display of more than one event at a time, additional Time Windows options can be accessed by double clicking on the Time Window text in the Drawn As box (on the left), including distinguishing current, past and future events by color, size or shape.

Another function relevant to the display of tow information is ArcMap's layer properties, found on the Label tab of the Layer Properties window. Users can designate one of the database fields associated with the feature layer as a label, specify the size and position of the label and specify at which scale the label will be displayed. For labels to display, the label function must be activated by right-clicking on the layer name in the table of contents. Label fields can be found by turning on the identification function and clicking on the tow icon. Drawing labels will slow down the ability of the map to redraw.

## D. Extensions to a Real Time Setting

### 1. Additional System Requirements

The prototype is designed to show the application of the system to tracking the position of tows and to making basic lockage management decisions. On the one hand, the extension of the system into a real time setting has significant additional requirements that are driven by the use of dynamic vessel data (i.e., by the type of lockage management to be implemented). In some regards though, the frequency of data capture is irrelevant to a geographical display system's basic operations. The sort of prototype demonstrated here has the capacity to operate within the current constraints (e.g., where tow positions are available only at the locks or at call-in points), as well as to grow in the context of using better (more detailed) tow position data.

There are a number of scenarios by which ArcMap can be linked to a data source to display real time data. Besides hardware requirements involving a server set-up, ESRI recommends installation of a related product ArcIMS and a Tracking Server system in order to send data to a desktop system. ArcIMS also allows a system to be divided into three interrelated components—a system for capturing and analyzing streamed data, a display system for visualizing data, and a query system for modifying data. These systems can function at a desktop setting or through a web-based network.

For more information about using ArcIMS, see the ESRI White Paper "What is the ArcIMS Tracking Server". Basic information on configuring a real time connection

in Tracking Analyst can be found on “Using ArcGIS Tracking Analyst.” Both can be found in the Documentation subdirectory under the UMRVTS directory.

## *2. Extensions to the Functionality of the River Management Features*

The prototype demonstrates only a few of the custom functions of ArcMap. However, most aspects of the program can be extended through custom programming involving Visual Basic. Additional extensions to the basic setup could involve multiple views of the display frame—for example, set views of particular locks or pools, as well as the whole river system—as well as preset selection and query functions.

Custom programming in a real time setting involving the use of ArcIMS and a Tracking Server system could significantly increase the power of the system. Real time applications of Tracking Analyst both display current positions and archive tow data for query and analysis. The custom-built applications that currently exist in the prototype rely upon relatively a simple Visual Basic form that displays text boxes with relevant information regarding locks, tows, queues and pools. In a real time application, these functions could be replaced by a more sophisticated application accessing log files of current data, querying those files based on feature attributes and returning with requested information. The application could rely not just upon streamed real time data, but could join real time data with archived data files. For example, a query system could utilize data on existing tows within a pool to show vessel lockage information for the current trip. In another application, the query could seek and display tows or barges whose travel paths have been within a certain portion of the river system over a selected time frame. These sorts of applications could exist as custom menus and tools within ArcMap, or in a stand-alone application that links to ArcMap by receiving information about tow locations and sending back real time or queried information to ArcMap for display.

<b>Layer</b>	<b>Description</b>	<b>Source</b>
Simulated Tow Positions Tows and Crafts Static View	Locations of tows Location of tows	Created from OMNI Data Created from OMNI Data
Lights Call-in Points Harbor Facilities and Ports River Mile Markers Recommended River Track	Point/polygon files concerning location and various attributes. Files were cleaned and repositioned as needed	U.S. Army Corps of Engineers ENC Charts <sup>1</sup> and U.S.G.S. Upper Mississippi Science Center <sup>2</sup>
Lock and Dam Gates	Polygon files detailing approximate location.	U.S. Army Corps of Engineers ENC Charts
Land Cover River Channel	Polygon files detailing land characteristics	U.S.G.S. Upper Mississippi Science Center
Roads Railroads City Boundaries County Boundaries	Line and polygon features	U.S. Census Bureau TIGER files (2000) <sup>3</sup>

Table 1 Data Layers Available in the Prototype Vessel Tracking Application

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<sup>1</sup> ENC shape files are available from <http://www.tec.army.mil/echarts>.

<sup>2</sup> USGS shape files are available from [http://www.umesc.usgs.gov/data\\_library/data\\_library.html](http://www.umesc.usgs.gov/data_library/data_library.html).

<sup>3</sup> TIGER shape files are available from [http://arcdata.esri.com/data/tiger2000/tiger\\_download.cfm](http://arcdata.esri.com/data/tiger2000/tiger_download.cfm).