Facilities Monitoring and Asset Management for the Mid-Pacific Region of the U.S. Bureau of Reclamation

Authors

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Abstract

The U.S. Bureau of Reclamation Facilities Engineering Branch is responsible for managing the Safety Evaluation of Existing Dams program. This program provides Regional oversight of facility operation and maintenance practices including review of operation and maintenance, comprehensive facility review, and periodic facility review examinations. The Mid-Pacific GIS group has developed a facilities monitoring database and graphical user interface (GUI) in ArcGIS 9.0 to support the distributed efforts of this branch. This presentation will provide insights into the status of this project, the development of the facilities database, the organization of the associated data, and the GUI supporting this effort.

Introduction

The U.S. Bureau of Reclamation (Reclamation) manages many large federal dams and downstream conveyance systems. Recently MPGIS was tasked to develop a GIS-based application to assist in some of the monitoring operations of those conveyance systems. The first phase focused on data associated with milepost locations along Reclamation canals. Milepost information typically consists of geospatial location, distance along the canal, and the type of structure at that location. The interface is designed to handle different types of features (dams, etc.). This paper however, will focus on canals and structures along those canals.

The primary objective was to create a portal that allows the user to zoom to a canal, select a milepost and zoom to it. A key component of this interface is the use of a Visual Studio TreeView control to manage the system. A TreeView control presents a Windows-like folder hierarchy that is typically synchronized with folders on disk. This application extends this concept to allow events on TreeView folders to also link to GIS data and events in ArcMap. This allows the user to select a desired feature (canal or milepost) in the TreeView folder hierarchy and graphically zoom to it in ArcMap. As the user zooms, the background imagery is scale-dependent and changes to higher resolutions, if available. The user may also view information associated with a selected milepost. New observation features and associated data may be entered via the interface.

Data Collection

The focus of the data collection to date has been to obtain GPS (global positioning system) point locations and descriptions of structures at milepost locations along Reclamation canals, as well as high resolution digital imagery to support the interface. Field personnel typically carry a GPS unit containing a project specific data dictionary and a digital camera. After the data are collected, they are reviewed and put into a database area used by the application.

The GeoSpatial Library

Required and ancillary data are accessed by the application using Reclamation's GeoSpatial Library application (GSL). The GSL data are organized by theme. The GSL software presents a hierarchy (also using a TreeView control) to add various data layers. It also provides the ability to load a pre-developed data set consisting of layers pertaining to a given project. Figure 1 shows the GSL application. The 'Facility_Monitoring' node has been expanded to show the layers that can be group-selected and added to an ArcMap session.
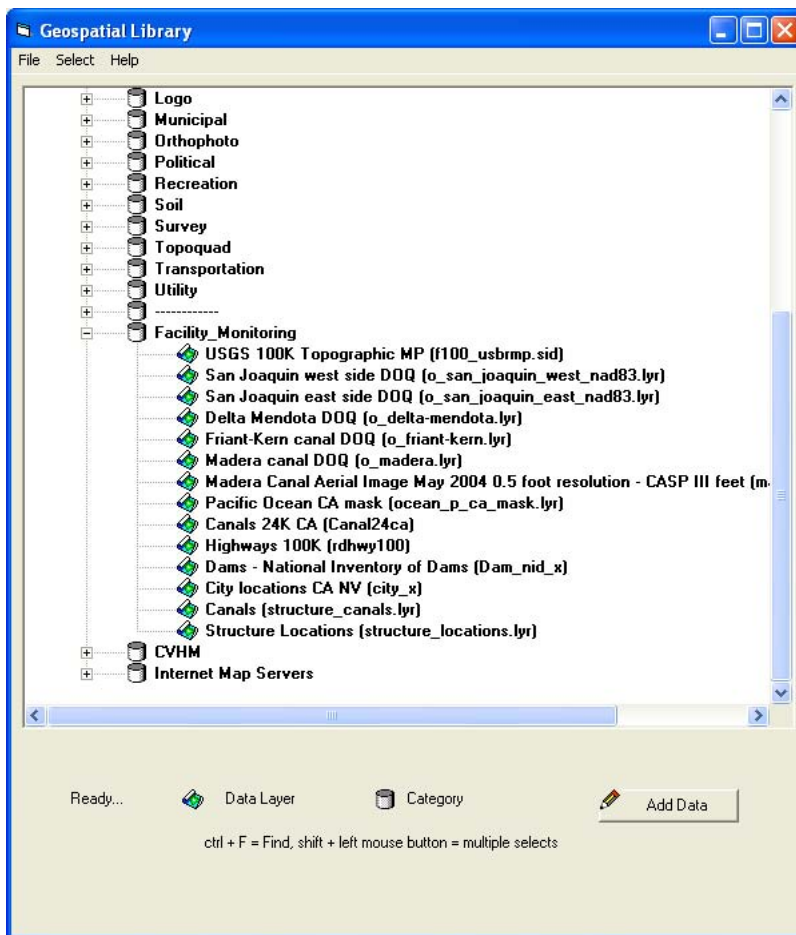

Figure 1. The GeoSpatial Library

Interface Development

The application was originally designed as an ArcMap application. As the project evolved, it became clear that an ArcEngine application offered a more viable solution, for reasons related to cost, portability and user experience. Since both technologies use the same fundamental object set, the general code sequence migration was straightforward. Additionally, using a development platform such as Visual Studio .NET provides the ability to customize the application with a more targeted look and feel.

ToolBar Control
Figure 2 depicts the interface entry point. A toolbar control is anchored on top. Most of the tools that reside on this control are provided in the ArcEngine application development framework (ADF). The only custom tool it contains is the identify tool. Implementing this custom tool was necessary as an identify tool was not provided in the ADF.
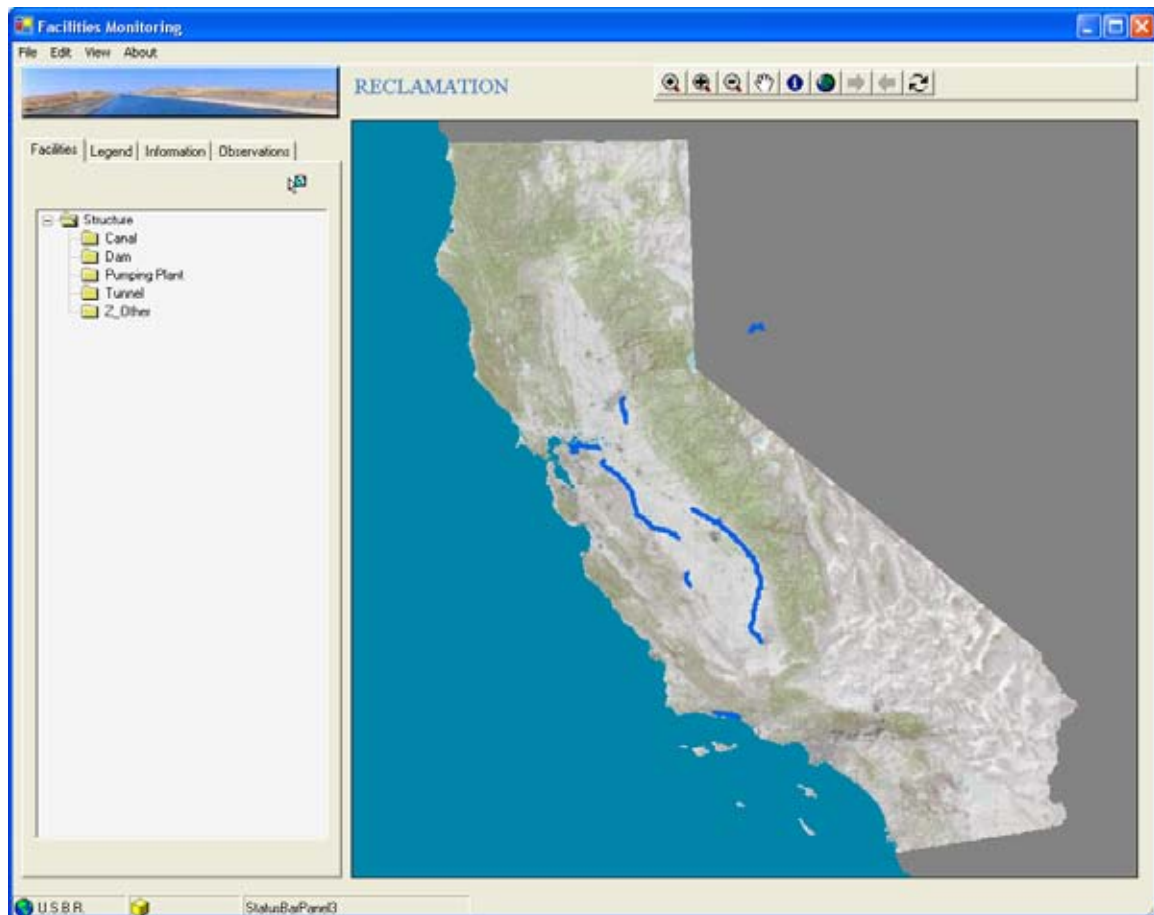
Figure 2. The Facilities Monitoring Interface

Map Control
Below the toolbar control is the map control where spatial data are displayed. This control is 'buddied' with the toolbar controls in the application to allow communication between them.
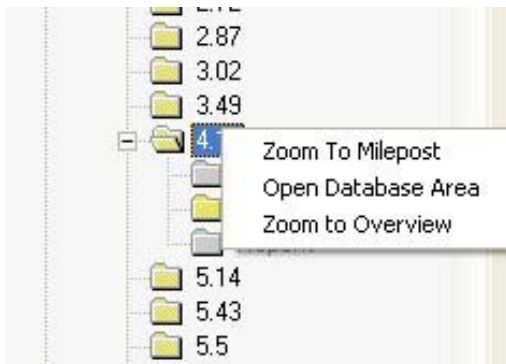
Tab Control
The left side of the application contains a tab control. This control has multiple tabs which allow for a more efficient use of space. Each tab may contain additional controls and functionality. This application contains four tabs: Facilities, Legend, Information and Observations.

Tab Control>Facilities Tab
The Facilities tab contains a TreeView control. The folders on the TreeView are called 'nodes'. The nodes of the control are populated when the application is fired. The code first searches a predefined directory area (enterprise, then local). It then loads the first level directory structure that resides there. Subdirectory levels are recursively populated when a node is selected. For example, clicking the 'Canal' node expands that node to present all of the canals by name; clicking one of the canals presents mileposts, and so on.

Context menus are provided at various node levels. For example, a right-click on a canal or milepost node, allows the user to zoom to the selected feature, zoom to an overview of the area, or open the associated database area in an Explorer window (Figure 3).

Figure 3. Context menu.

Tab Control>Facilities Tab>Milepost Select Tool
The Facilities tab also contains a select tool. This is a custom tool which was designed in Visual Basic outside of this application and imported. Since it uses the ICommand and ITool COM (Component Object Model) interfaces, it can be imported into the framework along with its custom implementation. This tool allows the user to graphically select a milepost (Figure 4). The selection event then triggers the related node on the TreeView control to be visible.
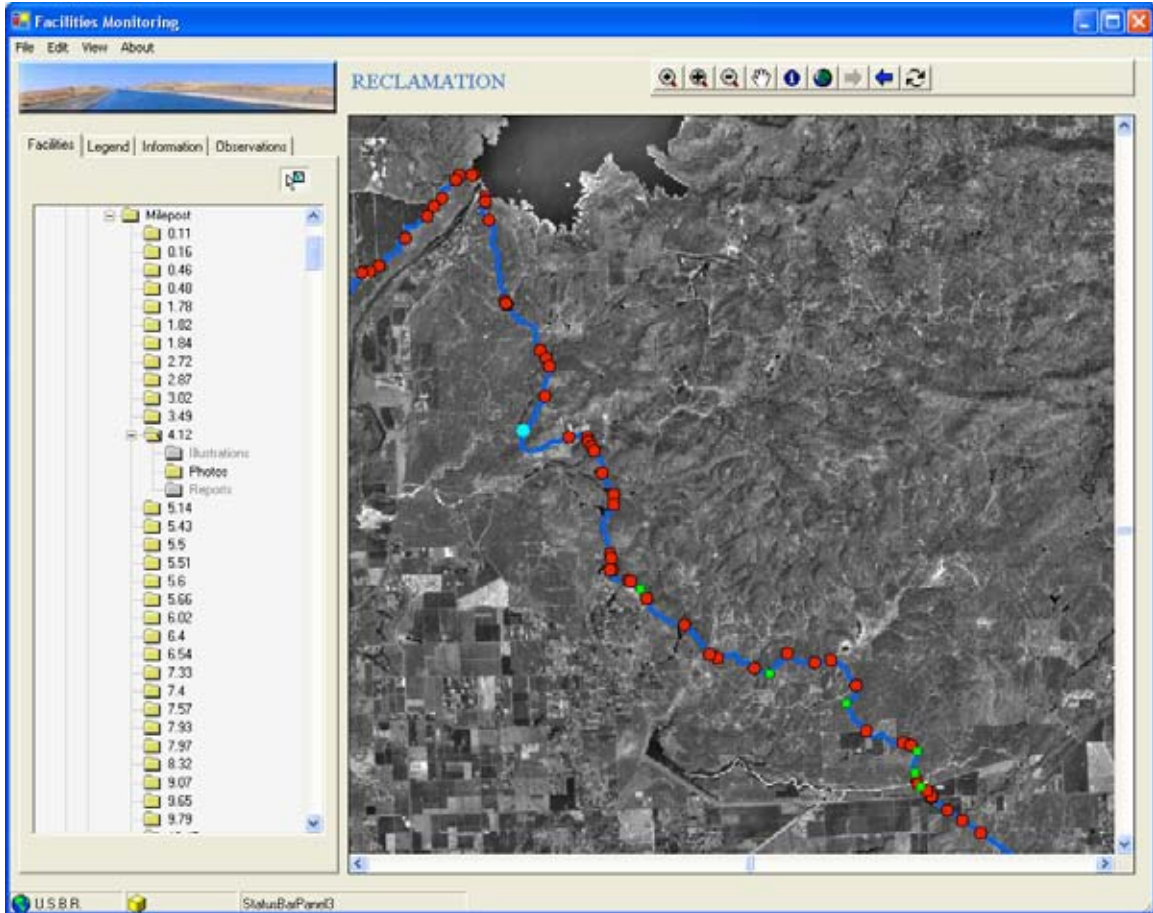
Figure 4. Node expansion and milepost selection.

In Figure 5, the user has selected milepost 5.14 (a bridge structure) and zoomed to its location. The milepost node in the TreeView control has been expanded. Each milepost node contains three folders: Illustrations, Photos and Reports. The Photos folder has been opened to reveal its contents, in this case a photo of the bridge. The Illustrations and Reports folders are grayed out because they do not contain any files.

User-level Data Control
The photo in Figure 5 is an example of a file that can be added to the TreeView control with the 'Open Database Area' context menu option (Figure 3). This option allows the user to use Windows-style cut and paste or drag and drop to associate files (photos, .pdfs, etc.) with a given milepost.
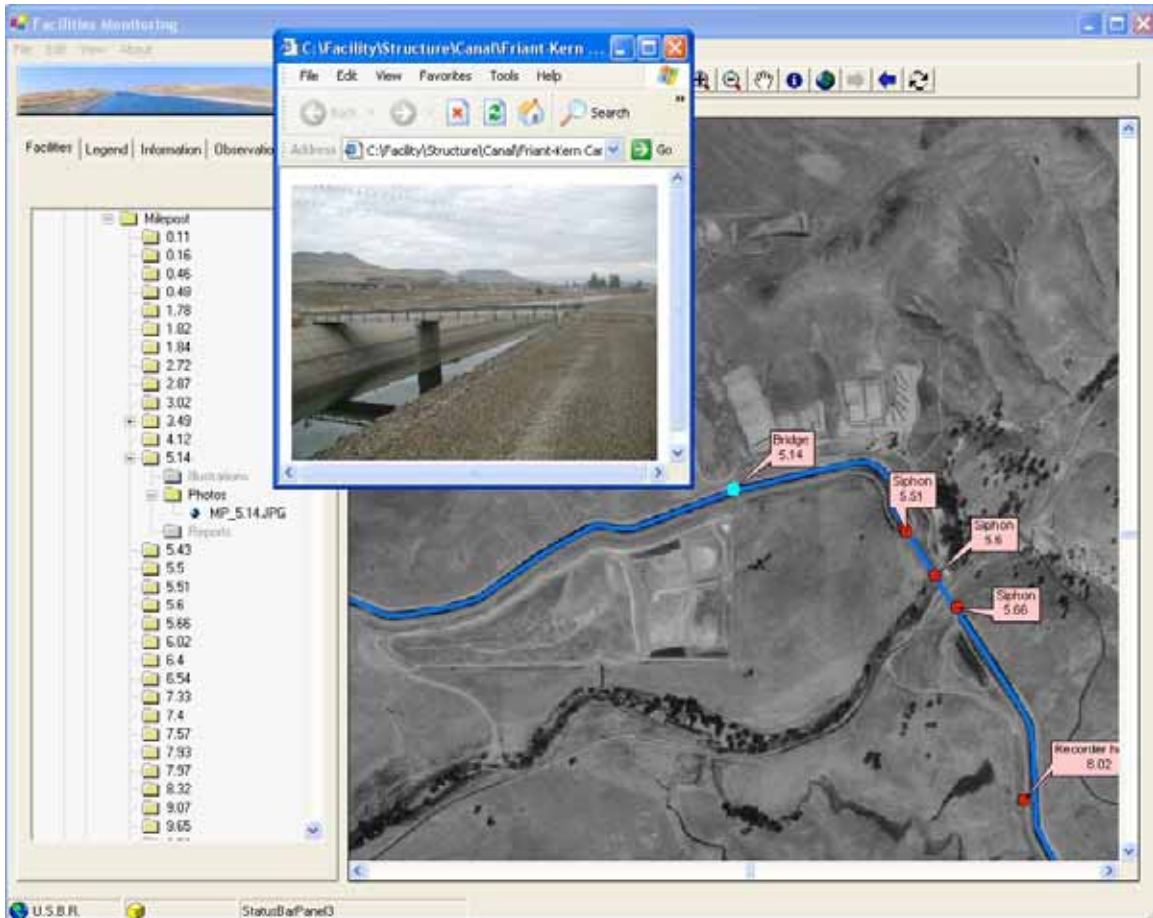
Figure 5. Selected milepost and associated photo.

*Tab Control>*Legend Tab
The Legend tab contains a TOC (Table of Contents) control. The legend includes layer names, symbology and visibility. The user can alter the visibility by turning the layer on or off.

*Tab Control>*Information Tab
The Information tab contains a listing of attribute names and values for the selected milepost. Current attributes were obtained from the GPS data dictionary.

*Tab Control>*Observations Tab
The Observations tab (Figure 6) contains tools that allow the user to graphically add, select or delete observation points. When a point is added, the user is prompted to enter a name for the observation. The date field is automatically populated with the current date. The user may also enter his/her name as well as any comments regarding the observation point. The select tool allows the user to drag a box over one or more observation points. Point information may be edited for individually selected observations. The delete tool deletes all selected observations (one or many). A context menu is available (similar to

the mileposts) that allows the user to use Windows-style cut and paste or drag and drop to associate files (photos, .pdfs, etc.) with a given observation.
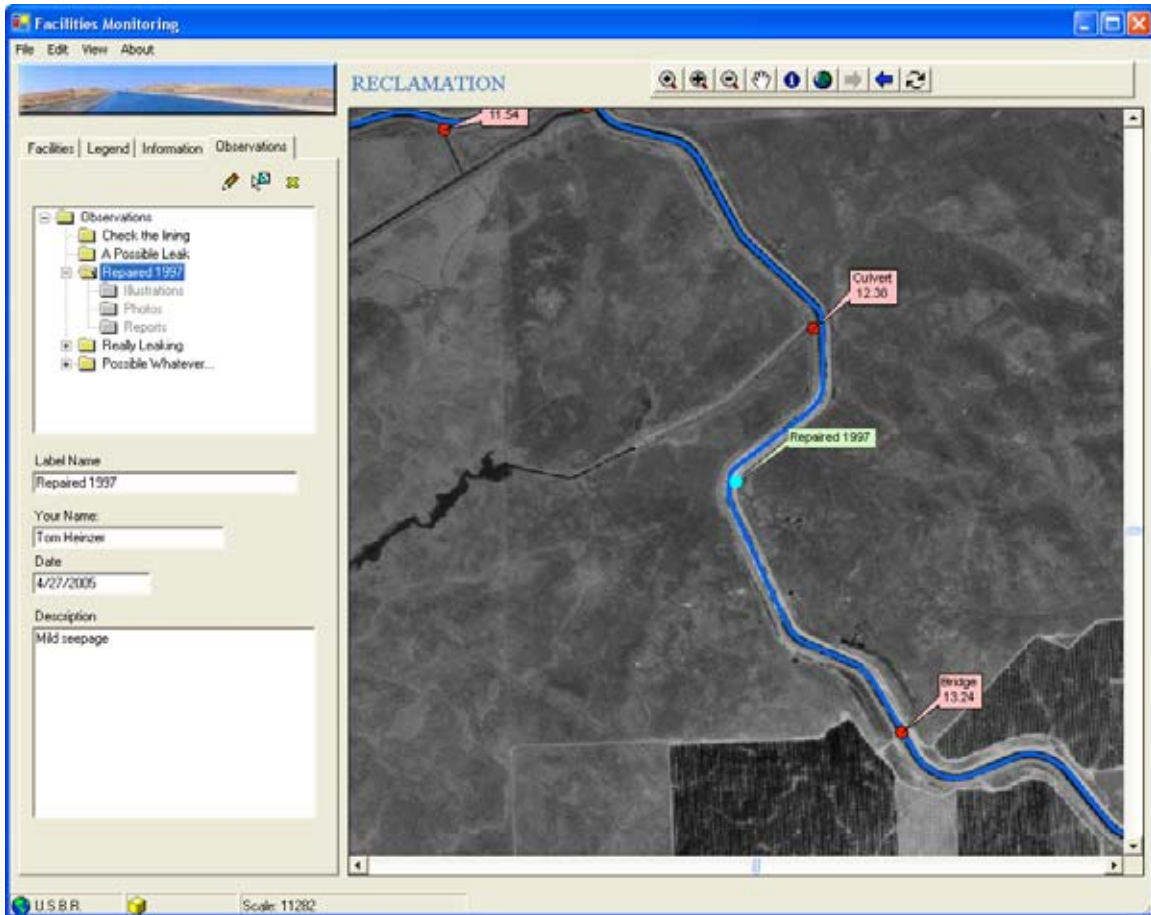

Figure 6. Observations tab

Conclusion

This software was developed to assist Reclamation with its task of monitoring information related to conveyance systems below its reservoirs. The GeoSpatial Library software was used in conjunction with ArcEngine technology to create an application targeted to facility monitoring requirements.

The original application was designed using ArcObjects components inserted into the ArcMap framework. The components were subsequently ported to the .NET platform to develop an ArcEngine application. The use of ArcEngine technology enabled us to provide a lighter weight product with the option of using an ArcEngine license instead of a more costly higher level ESRI license. ArcEngine applications are also more flexible

with respect to location and interaction of components, thereby creating a better experience for the end user. The facilities monitoring application is a good example of interfacing Microsoft objects with ESRI objects and the messaging that can be set up between them.

This software is currently in beta mode within Reclamation.

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