The issues

The Kinnickinnic River (KKR) watershed and its mainstem and tributary channels have undergone significant man-induced changes since the 1850’s (Figure 1). These include:

- Urbanization of about 97 percent of the watershed;
- Conversion of hardwood forests to farmland (1858-1870);
- Drainage of the valley-bottom marshes;
- Elimination of riparian vegetation;
- Construction of small dams and reservoirs on some of the tributaries;
- Channelization, straightening, concrete lining (38 percent; 9.6 miles) and enclosure (25 percent; 6.4 miles) of watershed channels (Figure 2); and
- Installation of infrastructure (bed and bank protection structures as well as bridges and culverts) (Figure 3).

Objectives

The objective of the study conducted by Tetra Tech was to provide a supplementary planning tool for flood management, channel stabilization, and rehabilitation activities within the KKR watershed, primarily within MMSD’s jurisdiction. Specific objectives included:

- Collecting and evaluating relevant sediment and geomorphic data in the context of channel stability, flood management, and overall watershed management;
- Identifying existing problem areas and opportunities for improvement of watershed condition, to be integrated with flood management initiatives;
- Providing a comprehensive database of geomorphic and sediment-transport characteristics to enable effective watershed management and decision making;
- Providing guidance and prioritization of identified projects within MMSD jurisdiction.

Analytical Methods

An extensive field reconnaissance was carried to evaluate the existing morphology of the channel system, assess the condition of the channel infrastructure, identify hydraulic and geomorphic controls, and characterize channel and sub-reach sediments (Figure 4). During the field reconnaissance, areas exhibiting bed or bank erosion were mapped to identify potential areas for rehabilitation. Representative cross sections were surveyed as part of this study to facilitate development of the hydraulic model.

Hydrology

USGS gage information was used in conjunction with HSPF hydrologic modeling to assess the more frequently occurring flows that will be the basis for the design of the rehabilitated low flow channels and the extreme flood events that are the basis for the design of the overall flood conveyance channels under existing and future (2030 planned land use) conditions. The existing conditions analysis indicates that 10 percent mean daily flow exceedence levels from about 4.4 cfs in the upstream portion of the KKR to about 48 cfs at the downstream limit of the study reach, while the 100-year peak flow ranges from 1,960 cfs to 8,050 cfs at these two locations (Figure 7).

Hydraulics

HEC-RAS modeling was used to identify the channel capacity along the KKR (Figure 8), and to provide input to the sediment transport analysis. The HEC-RAS model was initially developed by the Southeast Wisconsin Regional Planning Commission (SWERPC), and was updated for this study using the most recent topographic mapping and survey data. The unlined portions of the KKR, the channel capacity ranges from the 2- to 10-yr RI flows. In the concrete-lined portions of the KKR, the channel capacity is generally greater than the 100-yr RI peak flow, except in areas that are affected by localized backwater zones created by bridges and in one reach with heavy residential encumbrance where the channel capacity is less than the 25-yr RI peak flow.

Analytical Methods (cont.)

Sediment-transport

For purposes of this analysis, the KKR and its tributaries were divided into 47 subreaches. Reach-averaged hydraulics from the HEC-RAS model and bed material gradations for the individual subreaches were used to conduct a sediment continuity analysis of the KKR for existing and future conditions. The results indicate that the most significant erosion will occur in the unlined reaches of the KKR and Lynns Park Creek, and that aggradation in the lined reaches is unlikely (Figure 9).

Rehabilitation Opportunities

The primary problems identified within the KKR and tributaries by this study and the identified opportunities for rehabilitation are:

- Problem: Lack of hydraulic capacity (<100-year peak flow), primarily in the concrete-lined subreaches of the KKR between South 43rd Street and South 6th Avenue.

Rehabilitation Opportunity: Replacement of the existing, concrete-lined channel with a larger channel geometry to provide increased flood conveyance. Successful replacement could be achieved with a compound channel, sized to convey the 100-yr RI design flow without eroding, including a low-flow, rock-lined channel sized to convey about the 0.1-percent mean daily exceedence flow (Figures 10 and 11). Appropriate vertical and lateral variability could be incorporated to provide fish passage and resting areas.

Rehabilitation Opportunities (cont.)

- Problem: Sedimentation in the Lake Michigan estuary.

Rehabilitation Opportunity: Stabilization of the currently eroding banks and installation of grade control structures would reduce sediment loads delivered to the estuary by about 50 percent.