Loading Simulation Program in C++ (LSPC)

LSPC is the Loading Simulation Program in C++, a watershed modeling system that includes streamlined Hydrologic Simulation Program Fortran (HSPF) algorithms for simulating hydrology, sediment, and general water quality on land as well as a simplified stream transport model. LSPC is derived from the Mining Data Analysis System (MDAS), which was developed by EPA Region 3 and has been widely used for mining applications and TMDLs. A key data management feature of this system is that it uses a Microsoft Access database to manage model data and weather text files for driving the simulation. The system also contains a module to assist in TMDL calculation and source allocations. For each model run, it automatically generates comprehensive text-file output by subwatershed for all land-layers, reaches, and simulated modules, which can be expressed on hourly or daily intervals. Output from LSPC has been linked to other model applications such as EFDC, WASP, and CE-QUAL-W2. LSPC has no inherent limitations in terms of modeling size or model operations. The Microsoft Visual C++ programming architecture allows for seamless integration with modern-day, widely available software such as Microsoft Access and Excel.

Key Considerations in the Design of LSPC

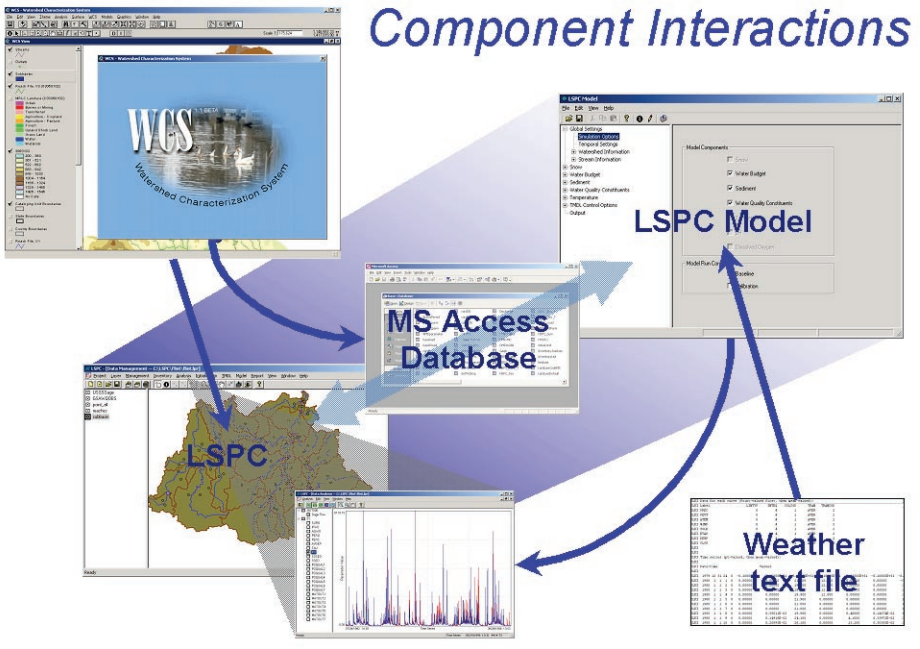
LSPC was designed to handle very large-scale watershed modeling applications. The model has been successfully used to model watershed systems composed of over 1,000 subwatersheds. Using the WCS extension increases the efficiency of model setup and execution by eliminating unnecessary, repetitive user-input, hence minimizes the chance of human error. The system is tailored for source representation and TMDL calculation. The highly adap design and programming architecture allo future modular additions and/or improven Furthermore, the entire system is design simplify transfer of information between els and users. The LSPC GIS interface, w is compatible with ArcView shapefiles, as the control center for launching wate model scenarios. This stand-alone inte easily communicates with both shap and the Microsoft Access database, but not directly rely on the main programs. Therefore, once a watershed application is created, it is easily transferable to users who may not have ArcView or MS Access installed on their computers.

LSPC Components

There are seven basic components of the LSPC system. They include: (1) a WCS extension for efficient model setup, (2) an interactive, stand-alone GIS control center, (3) data management tools, (4) data inventory tools, (5) data analysis tools, (6) a dynamic watershed model tailored for TMDL calculation, and (7) model results analysis.

LSPC Application for Hurricane Creek, Alabama

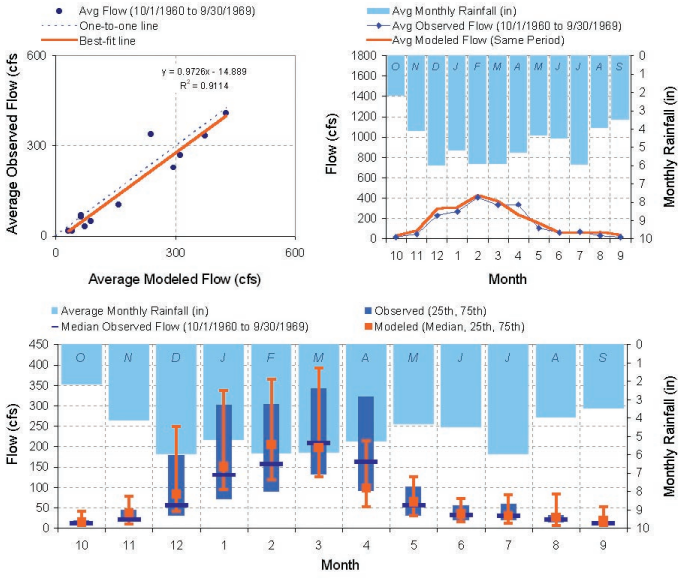
Hurricane Creek flows from the town of Vance to the city of Tuscaloosa in central Tuscaloosa County, Alabama. The creek is approximately 31 miles long and drains a predominantly forested 128 square mile area. Geology and land practices play an important role in the water quality characteristics exhibited by Hurricane Creek. Coal seams are located throughout the watershed, which contains a portion of the Pottsville Formation. Over the years, these seams have been mined extensively, leading to overall degradation of surface water quality,

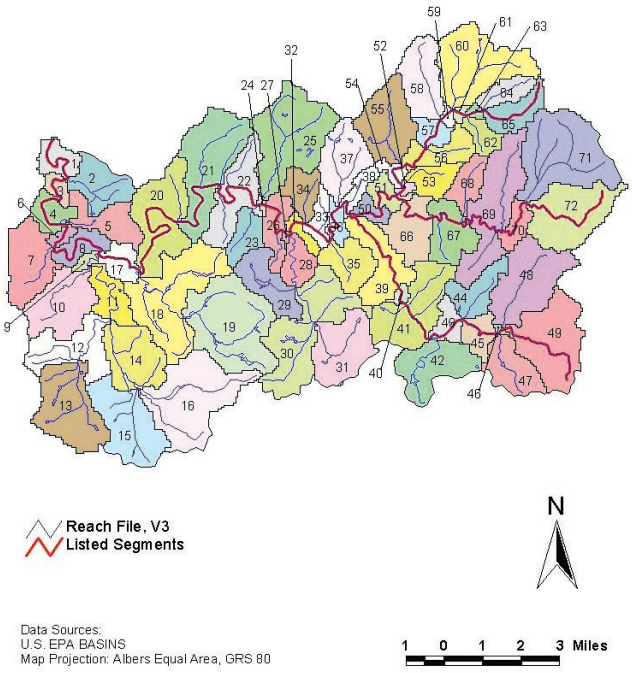


particularly through acid mine drainage. Additionally, portions of the watershed near Tuscaloosa have undergone rapid urban development in recent years.

The entire length of Hurricane Creek and most of its two major tributaries, Little Hurricane Creek and North Fork Hurricane Creek, are included on Alabama's 1998 303(d) list due to non-attainment of fish and wildlife uses. All three creeks exhibit aluminum impairments. Little Hurricane Creek also exhibits pathogen, arsenic, copper, and chromium impairments while Hurricane Creek itself has pathogen and turbidity impairments. Excessive metals concentrations are related to current and historical mining operations in the watershed. Pathogen impairments stem from urban, agricultural, and natural influences. Disturbance of land through mining and development has resulted in excessive turbidity levels in the creeks.

Due to the variety of pollutants impairing the creeks, Alabama's water quality criteria for these pollutants, and the presence of both point and nonpoint sources, LSPC was applied for TMDL development. The model was configured to simulate point and





nonpoint source contributions to impaired and unimpaired streams in the Hurricane Creek watershed for an extended time period. Processes for a range of landuse categories are simultaneously simulated to account for contributions from the wide variety of nonpoint sources. Non-permitted mining-related sources, for example, are represented through abandoned mine, disturbed land, and high wall categories. Pathogen sources are represented using different agricultural, urban, and forest categories, as well as through direct representation of septic system influences and livestock and wildlife with direct stream access. Discrete point sources are used to simulate 25 permitted mining facilities (in various phases of reclamation), 3 municipal point sources, and a number of stormwater permits. Allocations were developed separately for individual point sources and for each nonpoint source category. The TMDL targets vary by pollutant and are based on different acute and chronic numeric criteria. Given the nested configuration of the impaired segments, upstream loading contributions have a cascading effect as allocations are assigned to sources in an upstream to downstream fashion.

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