Publications

TR-160

Natural Salt Pollution and Water Supply Reliability in the Brazos River Basin

Ralph A. Wurbs, Awes S. Karama, Ishtiaque Saleh, C. Keith Ganze

- Full Text

Statement of the Problem

The Brazos River Basin is representative of several major river basins in the Southwestern United States in regard to natural salt pollution. Geologic formations underlying portions of the upper watersheds of the Brazos, Colorado, Pecos, Canadian, Red, and Arkansas Rivers, in the states of Texas, Oklahoma, New Mexico, Kansas, and Colorado, are sources of salt emissions to the rivers. Millions of years ago, this region was covered by a shallow inland sea. The salt-bearing geologic formations were formed by salts precipitated from evaporating sea water. Salt springs and seeps and salt flats in upstream areas of the basins now contribute large salt loads to the rivers. The natural salt contamination significantly impacts water resources development and management.

Water quality in the Brazos River is seriously degraded by natural contamination by salts consisting largely of sodium chloride with moderate amounts of calcium sulfate and other dissolved solids. The primary source of the salinity is groundwater emissions in an area of the upper basin consisting of the Salt Fork Brazos River watershed and portions of the adjacent Double Mountain Fork Brazos River and North Croton Creek watersheds. High salt concentrations significantly affect water management and utilization. Water in the three main stream reservoirs is unsuitable for municipal use without costly desalinization processes. The quality of the river improves significantly in the lower basin with dilution from good quality tributaries.

Population and economic growth combined with depleting groundwater reserves are resulting in ever-increasing demands on the surface water resources of Texas and the Brazos River Basin. Effective management of the highly stochastic water resources of a river basin requires an understanding of the amount of suitable quality water which can be provided under various conditions. Reservoir system reliability analyses support planning studies and management decisions regarding (1) improvements in reservoir system operating policies, water rights allocations, and water supply contracts, (2) facility expansions and construction of new water supply projects, and (3) projects and strategies for dealing with salt pollution. Consideration of water quality as well as quantity is important in evaluating reservoir system reliability in the Brazos River Basin.

Scope of the Study

The primary objectives of the investigation documented by this report are:

1. to develop a better understanding of the natural salt pollution problem and its impact on water management in the Brazos River Basin,
2. to develop expanded generalized reservoir system simulation modeling capabilities which incorporate salinity considerations,
3. to formulate and evaluate approaches for improving reservoir system yields and reliabilities while dealing with high salt concentrations, and
4. to perform a water supply reliability study for the major system of reservoirs

operated by the Corps of Engineers and Brazos River Authority, which reflects constraints imposed by water quality.

The investigation involved a number of tasks including: (1) compiling and analyzing available information, including prior studies and measured data, characterizing the natural salt pollution problem in the Brazos River Basin; (2) developing a generalized reservoir system simulation model called RESSALT; (3) formulating methodologies for performing reservoir system reliability studies, using RESSALT, which incorporate salt concentration considerations, (4) developing the necessary RESSALT input data files; and (5) performing various reservoir system simulation analyses. The study focused on sensitivity analyses of the effects that alternative water management scenarios and modeling assumptions have on estimates of salinity levels and water supply reliabilities. Alternative reservoir system operating policies were formulated and evaluated. The impacts of a previously proposed salt control plan on reservoir system yields and reliabilities were also analyzed. Thus, study results provide an enhanced understanding of the impacts on water supply capabilities of both the natural salt pollution problem and alternative resource management strategies.

Although focusing on a particular reservoir system in the Brazos River Basin, the study hopefully contributes to an enhanced understanding of the interactions between natural salt pollution and reservoir system reliability in general. Study findings are, to a significant extent, pertinent to similar problems in a number of other river basins in Texas and neighboring states. The RESSALT model is generalized for application to any reservoir system regardless of location. The general analysis methodology could be readily applied to other river basins and reservoir systems.

The studies documented by this report are a component of a larger research effort. The relationship between the work reported here and past and ongoing studies is outlined later in this introductory chapter.

Organization of the Report

Chapters 2 and 3 describe the Brazos River Basin, the reservoir system, and the natural salt pollution problem. Reductions in salinity which can be achieved by controlling runoff from the primary salt source area are estimated in Chapter 4. Salt concentrations are analyzed in Chapters 3 and 4 based on published field data without reference to the RESSALT simulation model. Chapter 5 outlines the computational adjustments to the measured salt data, described in Chapter 3, which were made to develop the salt load input data file required for RESSALT. The same salt load input file is being used in the salt version of the Water Rights Analysis Program (TAMUWRAP) cited later in this chapter. The reservoir system reliability study, using the RESSALT simulation model, is reported in Chapters 6, 7, and 8. The summary and conclusions are presented in Chapter 9.

Texas Water Resources Institute

1500 Research Parkway A110
2260 TAMU
College Station, TX 77843-2260

Phone: 979.845.1851
Fax: 979.845.0662
Email: twri@tamu.edu