NATIONAL WEATHER SERVICE
OFFICE of HYDROLOGIC DEVELOPMENT

SOLUTION EVALUATION

National Weather Service River Forecast System (NWSRFS) Reservoir Tools Enhancement (LOOKUP3, RES-J MAXSTAGE)

Version 3.1

Revision History

Date	Version	Description	Author
3/30/2007	3.1	Split into a separate document from the 3.1 Project Plan.	S. Malers (RTi)

TABLE OF CONTENTS

Page

1.INTRODUCTION

This document supports the HOSIP Stage 3 Project Plan for the NWSRFS Reservoir Tools Enhancement. Information is provided related to the proposed solution and is based on investigation of the current code base and similar enhancements that have been recently implemented by RTi. See the Project Plan and CONOPS for background information.

2. LOOKUP3 Solution

It is useful to utilize a lookup table to implement operational decisions, for example, estimating a diversion or reservoir operation based on a rule curve or physical condition (e.g., soil moisture). The LOOKUP and LOOKUP3 operations provided by NWSRFS, and the LOOKUP3 method within the RES-J operation provide existing capabilities. However, the existing software does not meet the requirements noted in the CONOPS, in particular to utilize multi-value time series and allow using the date as a parameter in the lookup. The following solutions were investigated.

1. **Add multi-value time series capability to LOOKUP3**. Adding this capability to the NWSRFS operation will provide the ability for a modeler to generate a new time series by utilizing a three-variable lookup table with multi-value time series. An implementation of this capability was previously evaluated for MBRFC streamflow regulation accounting modeling, for the LOOKUP operation. RTi determined which software modules would need to be modified. However, these changes were not made in the operational NWSRFS software, and standard tests were not implemented. Modifications to the LOOKUP3 operation code will be similar.
2. **Add ability to look up dependent variable based on day of year.** This capability has been implemented in the LOOKUP3 method in RES-J, in previous enhancements related to streamflow regulation accounting. Consequently, the solution has been determined in some form, although a variation will be needed to implement in the FORTRAN LOOKUP3 operation code (the RES-J implementation is in C++).

Consequently, the science necessary to implement the requested functionality has already been proven in some form. Implementation in the LOOKUP3 operation will be implemented similarly, with specific design considerations determined in Stage 4.

3. RES-J MAXSTAGE Solution

The basic enhancement to be implemented is to move specification of the rating curve/table information from the RES-J MAXSTAGE method to the controlling node. An evaluation of the current software by RES-J developers occurred in order to evaluate approaches to the solution. The following considerations are important to development. Note that due to the slow performance of the MAXSTAGE method, RTi calibrators often try to utilize other RES-J methods (e.g., lookup tables) during implementation. The use of discharge for control checks (second item below), will improve performance some; however, the fundamental concept of solving for MAXSTAGE (or flow) at each iteration is computationally intensive and would benefit from additional optimization.

1. **Store rating curve/table information at the node**. Storing the rating curve/table information at the node will provide more physically appropriate definition of data

because the information is specific to the node. Storing the NWSRFS rating curve identifier will allow a direct connection to operational NWSRFS data. The rating table can subsequently be retrieved using the curve identifier (similar to how the STAGE-Q operation retrieves information) and used in computations. The subroutines used by STAGE-Q can likely be used in some form.

A major limitation in the system is the lack of rating table information in the calibration database files, in particular to reflect the change in tables over time. This limitation may be most severe for streamflow stage to discharge conversions (because stream ratings can change frequently); however, it also may impact reservoir modeling. Calibrators can work around this limitation by converting all historical stage time series to discharge or other data types, eliminating the need for NWSRFS operations to perform the conversion. However, this then requires that the operational system definition be modified to use slightly a slightly different operations table. In order to work around the limitation, the updated software will support specifying the rating table at the node (for calibration purposes), and implementing checks based on "MAXDISCHARGE" (see next item) can also be utilized. As NWSRFS is migrated to CHPS (e.g., using Delft FEWS or another solution), it would be beneficial to use Service Oriented Architecture (SOA) to allow reading the rating table in both the calibration and forecast system, using a curve identifier and date(s).

Note that the current NWSRFS documentation (see on-line) is somewhat inconsistent – section VIII.3.2-1 says STAGE-Q can be used in both the calibration and forecast system; however, the operation documentation (section V.3.3-STAGE-Q) indicates that STAGE-Q is to be used only in the forecast system.

2. **Specify controlling information as discharge**. Allowing the MAXSTAGE method to utilize a "MAXDISCHARGE" parameter will allow discharge-based operating rules to be implemented, rather than stage-based rules that are dependent on stages that change over time because of rating changes. The enhancement will also provide some improvement in performance in that the controlling discharge will only need to be determined once by software (no need for repetitive and computationally expensive conversion from stage).

The solutions described above will address the requirements in the CONOPS and should also increase usability and performance. Details of the implementation will be finalized in HOSIP Stage 4.