Technical Documentation
Prior to Version 7.3

Prior Release Notes

CADSWES
Center for Advanced Decision Support for Water and Environmental Systems

Prior Release Notes

Table of Contents

Release Notes Version 1.0 1

Required Model File Updates 1
Special Attention Notes 1
Known Bugs and Work-Arounds 2

Model Loading and Saving 3

Name Enforcement 3
Quick Saving 4
Summary Info 4

Simulation 5

Table Interpolation 5
Read Only Slots 5
Invalid Timesteps 5

Run Control 6

Date Range 6
Yearly Timestep 6
Setting Run Times 6
Control Buttons 6
Loading State 7
Stop During Initialization 7

Engineering Objects 8

Reservoirs: Modifications were made as follows 8
Power Reservoirs: Modifications were made as follows 17
Pumped Storage Reservoirs 19
Ground Water Storage 19
Reaches 23
Diversions and Water Users 26

Water Quality 31

Rulebased Simulation 31
Distributed Annual Salt Loading 31
Minimum Flow Check 32
Minimum Concentration Check 33
Bank Storage Salt 33

Optimization 34

Spill Computation Methods 34
Power Computation Methods 37
Backwater Computation Methods 39
Infeasible Solution Output File 41
Optimization Output Files Directory 41
Optimization Parameters Files 42
Curvature Checks of Linearized Functions 43

RuleBased Simulation 44

Mass Balance Functions 44
Tcl Aggregation Functions 44
Tcl Unit Conversion Functions 47
Total Diversion to Meet Requests 48

GUI 49

Toolbar 49
Keyboard Shortcuts. 50
Pinnable Menus 55
Default Window Placement 56
Locator View 56
View Methods/Slots 56

SubBasins 57

SCT 59

Set Row Type Dialog 59
Toggle Row Detail in non-Edit Mode 59
Setting of Closed Detail Values 59

DMI 60

DMI Generated Error Messages 60
New Keyword=Value Pair: Flags 60
Values in User-defined Keyword=Value Pairs 60
Control File Object and Slot Wildcards 60

RCL and Batch Mode 62

Rulesets for Rulesbased Simulation 62

Expression Slots 63

Overview of Functionality 63
SubBasins 66
Linking 66

Dispatch Information 67

Workspace-level View 67
Dispatch Detail Dialogs 68

Diagnostics 70

Scrollable Windows in the Diagnostics Output Window 70
Diagnostics Output Efficiency 70
Enabling Diagnostics 70

Plotting and Snapshots 71

The Snapshot Management Dialog 71
The Plotter Management Dialog 72

Units 74

Display Units 74
Unit Converter Precision 74

Change Requests Completed 75

Release Notes Version 1.1 77

Required Model File Updates: 77
Special Attention Notes: 77

Known Bugs and Work-Arounds: 77

Model Loading and Saving 78

File Chooser Default Directory 78

Simulation 79

Tolerance in Dispatch Methods 79

Engineering Objects 80

Power Reservoirs 80
Water Users 80

Optimization 82

Final CPLEX Problem 82

Rulebased Simulation 83

Max Outflow 83
Precedence of Slots Directly Set by a Rule 84
Overwriting Higher Priority Slots 85

SCT 86

Date Header 86

Units 87

RiverWare Resource Database Message 87

Change Requests Completed 88

Release Notes Version 1.2 92

Required Model File Updates: 92
Special Attention Notes: 92

Simulation 93

Default Inflow 93
Slot Maximum Iterations 93

Engineering Objects 95

Reservoirs 95
Power Reservoirs 97
Storage Reservoirs 97

Rulebased Simulation 99

Maximum Rule Execution Iterations 99
Group Set of Slot Assignments 99
Simulation Errors During Rule Execution 99
Average Pool Elevation for Max Outflow Tcl Routines 101
getMaxOutflowGivenInflow Tcl Routine 101

Change Requests Completed 102

Release Notes Version 2.1 104

Required Model File Updates: 104
Special Attention Notes: 104

Model Loading 106

"MultiSlots" renamed "SimObjMultiSlots" 106

Simulation 107

Global Maximum Iterations 107
Diversion and Return Flow Defaults 107

Simulation Objects 108

Reservoir 108
Reach 109
Distribution Canal 111
Stream Gage 113
Groundwater Storage 113
Water User 114
Diversion Object 115

Rulebased Simulation 116

Iteration Checking ... 116
STRING == and != ... 116
GetObjectsInBasin() renamed ListSubbasin() ... 116
Predefined Functions ... 116

GUI (Graphical User Interface) ... 117

Diversion Object Icon ... 117

Subbasins ... 118

New Subbasin Manager ... 118

SCT (System Control Table) ... 120

Shaded Rules Flag Values ... 120
Outlined Target Ranges ... 120

RCL (RiverWare Command Language) ... 121

Model File to Load ... 121

Diagnostics ... 122

Accounting Diagnostics ... 122

Closed Bug Reports ... 123

Release Notes Version 3.0 ... 124

Special Attention Notes: ... 124

Required Model File Updates ... 126

Sequential Linking on AggDiversionSite ... 126
Muskingum Routing on Reaches ... 126
Time Lag Reaches ... 126
Variable Time Lag Routing ... 126
Seasonal GainLoss on Reaches ... 127
Pumped Storage Object ... 127
Conjunctive Use on Water Users and AggDiversionSites ... 127
Future Value Calculations ... 127

Lumped Linking on AggDiversionSites 128
Model Loading 129
Some "SeriesSlots" changed to "AggSeriesSlots" 129
Simulation Objects 130
Reach 130
Water User 131
AggDiversionSite 132
Groundwater Storage 133
Confluence 133
Diversion Object 134
Reservoir Objects 134
Pumped Storage Object 134
Rulebased Simulation 135
Closing a Ruleset 135
Print Statements 135
Units 135
Name Checking 135
Division By Zero 136
Rule Language Functions 136
Predefined Functions 137
Net Subbasin Diversion Requirement 137
Diversion Object with Rules 137
GUI (Graphical User Interface) 138
Menu Bar 138
Open Object Dialog 138
Closed Bug Reports 139
Release Notes Version 3.1 141
Special Attention Notes 141

Required Model File Updates 142

Future Value Calculation 142
Confluence Used for Bifurcation 142
Additional Error Checking in Rulesets 142
Max Outflow and Max Release 142
CRSSEvaporationCalc 143
Energy Cannot be Input with Max Capacity Outflow 143
Account Carryover Methods 143

General RiverWare 144

Enhancements to the SCT (Simulation Control Table) 144
Annual Timestep 144
"--norun" Command Line Option 144
Multiple Run Management 144
Table Slot Enhancement 145

Simulation Objects 146

AggDiversionSite 146
Sequential Linking Structure Changes 146
Reach 146
Seepage Calc Methods 146
Pre-simulation Dispatching for Impulse Response Reaches 146
Bifurcation Object 147
Reservoir Objects 147
MonthlyEvaporation Calc 147
SingleEvaporation Calc 147
Monthly Spill Calc 147
Max Flag on Outflow or Release 147
Future Value Calculations 148
Cumulative Storage Value Table Automation 148
Pumped Storage Reservoir 148
Pump and Release Accommodation 148
Thermal Object 148
Hydro Block Calculation 149
Allocated Preferred Customer 149

Rulebased Simulation **150**
Model Run Analysis Information 150
Yearly Units for Rule Expressions 150
Function Type Name Change 150
Internal Function and External Function 150
Predefined Function Modifications 150
GetMaxOutflowGivenInflow and GetMaxReleaseGivenInflow 150
NetSubBasinDiversionRequirement 151
SolveSubBasinDiversions 151
Predefined Functions 151
Important Bug Fixes 152
Copy/Paste in ForEach Statements 152
Copy/Paste of Parenthesized Expressions 152
Optimization **153**
General Enhancements/Fixes to Optimization 153
Smooth Energy Calculations 153
Purpose 153
Results 154
Policy Constraints 154
Closed Bug Reports **156**
Bug Fixes 156
Release Notes Version 3.2 .... **157**
Special Attention Notes **157**
Required Model File Updates **159**
Error Checking in PeakPowerCalc and PeakBasePowerCalc 159
Upgrade to Tcl 8.2.3 159
Minimum Efficiency Slot on the Water User 159
(Variable) GainLoss Coefficient Restriction 160
General RiverWare **161**

Printing an SCT (Simulation Control Table) 161
File Chooser Width 161
Model file vs. DMI Precision 161

Simulation Objects 162

Water User 162
Multiple Split Return Flows 162
Return Flow Routing 162
Split Return Flow Fraction/Efficiency 162
Minimum Efficiency Slot 162
Minimum Diversion Request 163
Reach 163
Impulse Response Slot Reconfiguration 163
Evaporation Category 163
Reach Bank Storage Calculation 163
(Variable) GainLoss Coefficient 163
Confluence Object 164
Confluence Solution Direction 164
Power Reservoirs 164
Power Capacity Slot 164
Input Energy Adjustment 164
Reservoirs 164
Input Outflow Adjustment 164
Inline Power Plant Object 164

Rulebased Simulation 166

Hypothetical Simulation 166

Water Accounting 167

User Defined Accounting Methods 167
Pre-Defined Accounting Methods 168
Zero Slot Inflows on Reach 168
Multiple Supplies Between Accounts 168

Optimization 169

Multiple Run Management 169

Lambda Cuts 169
Marginal Cost 169
Performance Improvement 169
Smoothed Energy 169
Spill Input 170
Linearization Zero Terms 170
Diagnostics 170
Bug Fix Highlights 170

Closed Bug Reports 171

Bug Fixes 171

Release Notes Version 4.0 173

Special Attention Notes 173

Required Model File Updates 174

Unit Ramping Cost Slot 174
Maximum Iterations on Account Slots 174

Model Loading 175

Local Inflow Solution Direction 175
Some “SeriesSlots” changed to “AggSeriesSlots” 175

RiverWare for Windows 2000 176

General RiverWare 177

Optional Keyword for AggSeries Slots in DMIs 177
Object Icon in Open Object/Slot Dialog 177
Resume Run 178
Command Line Options 178
Deleting Links with Quick Link Editor 178
Synchronize Workspace Objects to Specified Time Interval 178
Plot Directly to File 179

Simulation Objects 180

Reach 180
Local Inflow Solution Direction Category 180
LocalInflowDownstreamOnly method 180
Seepage and Riparian CU Loss method 180
Reservoir 180
Input Seepage method 180

Rulebased Simulation 181

Rule Agenda Order 181
Rules Formatting and Printing 181
New Palette Functions 181
WeightedSum 181
Hypothetical Target Simulation (HypTargetSim) 181
Hypothetical Target Simulation With Status (HypTargetSimWithStatus) 182

Water Accounting 183

Max Iterations Bug Fixed 183
Object Account Summary Dialog 183
Diversion Accounts 183
Inflow/Outflow and Diversion/Return Flow Supply Type 184
Linking Pass Though Accounts and Diversion Accounts 184
Account Demands 184
New User Defined Accounting Method Categories 184
Pass Through Acct Gain Loss 184
Agg Diversion and Water User Reconciliation 185
Supply Slots in the SCT 185

Optimization 186

Closed Bug Reports 189

Bug Fixes 189

Release Notes Version 4.1 191

Special Attention Notes 191

Negative Outflow Warnings Removed 192

Required Model File Updates 193
solveMB_givenInflowRelease 193
Inline Power 193
Reach GainLoss with Time Lag Routing 193
Name Conflicts in Rulesets 193
GainLoss Specification on Pass Through Accounts 194

Model Loading 195
Ruleset Loading 195
Name Conflicts in Rulesets 195
Unit Changes 195
Reach GainLoss with Time Lag Routing 196
Some “SeriesSlots” changed to “AggSeriesSlots” 196

RiverWare for Windows 2000 197
Differences in RiverWare for Windows 197
Problems/Bugs in RiverWare for Windows 197
Saving Model Files and Rulesets 197
Enhancements to RiverWare for Windows 197

General RiverWare 198
Multi-Object Method Selector 198
DMI Importing 199
Importing with New Start Date After Existing End Date 199
Importing to Aggregate Series Slots 199
Command Line Options 199

Simulation Objects 201
Data Objects Now Have Different Colors 201
Inline Power 201
Reach 201
Negative Outflow Warnings Removed 201
GainLoss Methods with Time Lag Routing 202
Reservoir 202
Plant Power Equation 202

Peak Power Equation 202
CurrentSurfaceAreaPanAndIce 202
Input Bank Storage 203
AggDistribution Canal Elements 203
Input Seepage 203

Rulebased Simulation 204

New Palette Functions 204
HypLimitSim 204
HypLimitSimWithStatus 204
TargetHWGivenInflow and TargetSlopeHWGivenInflow 204
Floor 204
Ceiling 205
Fraction 205
GetSlot 205
GetElementName 205
IntDivision 205
Modulus 205
NextDate 205
PreviousDate 205
AnnualEventStats, AnnualEventCount, and AnnualEventLastOccurance 206
TableInterpolation3D 207
Sum 207
SumByIndex 207
MaxItem and MinItem 207
DateMax and DateMin 207
LeapYear 207
GetDatesCentered 207
IsEven 207
IsOdd 207
GetNumbers 207
GetTableRowValsSkipNaN and GetTableColumnValsSkipNaN 208
New Palette Functions For Use With Accounting 208
WaterTypes 208
WaterOwners 208
ReleaseTypes 208

Destinations 208
ReleaseTypesFromObject 208
DestinationsFromObjectReleaseType 208
AccountNamesByWaterType 208
AccountNamesByWaterOwner 208
AccountNamesFromObjReleaseDestination 209
Functions Returning Supply Names 209
SupplyNamesFrom 209
SupplyNamesFromIntra 209
SupplyNamesTo 210
SupplyNamesToIntra 210
SupplyNamesFrom1to1 210
SupplyNamesFromIntra1to1 210
SupplyNamesTo1to1 210
SupplyNamesToIntra1to1 210
New Palette Buttons 211
FIND 211
STOP_RUN 211
IF ... ELSE 211
Changes to Existing Palette Functions 211
Log and Ln 211
Single Object SubBasins for HypSim Functions 211
Searching Within Rulesets and Policy Groups 212
Rearranging Rules Within the Group Editor 212
Compressing Rulesets 212
Rules Palette Redesign 212

Water Accounting 214

Supplies Manager 214
Transfer In and Transfer Out Slots 214
New Supply Attributes: Release Type and Destination Type 215
Accounts on Distribution Canals 215
GainLoss Specification on Pass Through Accounts 216
Supply Slots in the SCT 216

Optimization 217

Closed Bug Reports 219

Bug Fixes 219

Release Notes Version 4.2 221

Special Attention Notes 221

RiverWare for Windows 2000 and Windows XP 222

Differences in RiverWare for Windows 222
Problems/Bugs in RiverWare for Windows 222
Saving Model Files and Rulesets 222
New Plotting 222

General RiverWare 223

SCT 223
Enabling and Disabling Dispatching 223
Slot Statistics 223
Qt Integration for Graphical User Interface 223
New Plot Dialog 224
Periodic Slot 224
Scalar Slot 227

Simulation Objects 228

Groundwater Storage Object 228
Current Storage Linear Flow 228
Lagged Linear Flow 228
Impulse Response Outflow 228
Impulse Response Components 228
Inflow from Groundwater Slot 228
Water User 229
Input Diversion Requests 229
Input Depletion Requests 229
Pump Back Return Flows 229
Reach Object 229
Time Lag Downstream Only Dispatch Method 229

Leakage Slot Added 229
Reservoir Objects 230
Surcharge Release Calculation Category 230
Surcharge Release Flag 230
Control Point Object 230
Forecast Hydrology Methods 230
Forecast Hydrology on Reservoir Objects 231
Forecast Hydrology on Reach 231
Forecast Hydrology on Control Point 231

Rulebased Simulation 232

New Palette Functions 232
SolveSlopeStorageGivenInflowHW 232
SolveSlopeStorageGivenInflowOutflow 232
GetColMapVal 232
GetLinkedObj 232
AccountNamesByAccountType 232
Setting Flags with Rules 232
Performance Improvement to Hypothetical Simulation Functions 233

Accounting 234

Nambe Falls Loss Calculation 234
Exporting Data from Object Account Summary Dialog 234

Optimization 235

Bugs Fixed 236

Release Notes Version 4.3 237

Special Attention Notes 237

RiverWare for Windows 2000 and Windows XP 238

Differences in RiverWare for Windows 238
Problems/Bugs in RiverWare for Windows 238
Saving Model Files and Rulesets 238

New Plotting 238

General RiverWare 239

New Open Object Dialog 239
Exporting a Slot Now Includes Comments 240
Qt/Galaxy Integration (Solaris Only) 240

Simulation Objects 241

Reach Object 241
Impulse Response Routing for Seepage 241
Known Inflow Slot Changed to Deterministic Local Inflow 241
Distribution Canal 241
Impulse Response Routing for Seepage 241
Reservoir Objects 241
New Reservoir Convergence Algorithm 241
Changes to the Use of Minimum Power Elevation 242
Convergence of Mass Balance Solve Storage Near Zero 242
Minimum Pool Elevation Warning 243
Max Release Warning 243
Known Inflow Slot Changed to Hydrologic Inflow 243
Control Point Object 243
Regulation Discharge Category 243
Known Inflow Slot Changed to Deterministic Local Inflow 243

Rulebased Simulation 244

Performance Improvements 244
New Palette Expression 244
MAP LIST 244
New Palette Functions 245
RowLabel, ColumnLabel 245
AccountNamesFromObjReleaseDestinationIntra 245
DatesInPeriod 245
Split 245
Exp 245
SumSlotSkipNaN, SumFlowsToVolumeSkipNaN 246
FlattenList 246

ToCelsius, ToFahrenheit, ToKelvin 246
Changes to Temperature Units 246
New Rulebased Simulation Diagnostics Settings Categories 246
Hypothetical Simulation 246
Function Execution 246
Rules Analysis List Dialog 246
Rules Performance Analysis 247
Function Diagnostics Menu Items 247

Accounting 248

Plotting Account Slots 248
Plotting from Object Account Summary 248

Optimization 249

New Warning 249
Conditional Constraints 249
Performance Improvement and Numerical Stability 249

Bugs Fixed 251

Release Notes Version 4.4 253

Special Attention Notes 253

RiverWare for Windows 2000 and Windows XP 255

Differences in RiverWare for Windows 255
Problems/Bugs in RiverWare for Windows 255
Saving Model Files and Rulesets 255

General RiverWare 256

DMI 256
SCT 256
Computational Subbasin 256
Optional Elimination of Comment Lines in Exported Slots 256
Open Object Dialog 257
Slot Reordering 257

Plotting 257
Plotting Keyboard Accelerator 257
Plotting Contour Curves 257
Plotting TableSeries and AggSeries Slots 257
Scaling 257
DateAxis Toolbar 257
Hovering Over a Plot Point Displays Information 258
Accounting 258
AggSeries Slots on the Data Object 258
Numeric Keypad 258
Synchronizing With Run Control 258
Exclude Slots with Different Timestep from Run 258
End of Run Diagnostic 258
Periodic Slot 259
Change to Lookup Date on Periodic Slots with Irregular Intervals 259
Horizontal Scrollbar 259
Inverse Interpolation 259

Simulation Objects 260

Canal Object 260
Canal Flow Table Method 260
Control Point Object 260
Include Locals in Outflow Category 260
Regulation Discharge Methods 260
Key Control Point Balancing Methods 260
Change to the Forecasting Methods 261
Pipeline Object 261
Pipeline Solution Direction Category 261
Reach Object 261
Step Response Routing Method 261
Change to the Forecasting Methods 261
Reservoir Objects 262
Surcharge Release Category and Methods 262
Flood Control Release Calculation Category and Methods 262
Changes to the Forecasting Methods 263
Plant Efficiency Curve Power Method 263

Water User Object 263
Additions/ Changes to Pump Back Return Flow Method 263

Flood Control 264

Overview of Flood Control Algorithms 264
Model Configuration for Flood Control 264
Execution of Flood Control Algorithm in Simulation 265

Rulebased Simulation 267

Hypothetical Simulation 267
New Argument 267
Rules Palette Predefined Functions 267
FloodControl 267
Change to SumSlotsInARange 267
ResetRanDev 267
Rules Palette Buttons 268
New Regulation Discharge Flag Button 268
New Surcharge Release Flag Button 268
RPL Units 268
Rules Analysis Dialog 268
Close Window Keyboard Accelerator 268
Setting Specific Columns on the AggSeries Slot with a Rule 268

Accounting 270

New Accounting Method on the Reservoir Object 270
Change to Existing Storage Account Gain Loss Methods on the Reservoir 270

Closed Bug Reports 271

Release Notes Version 4.5 273

Special Attention Notes 273

RiverWare for Windows 2000 and Windows XP 274

Differences in RiverWare for Windows 274
Problems/Bugs in RiverWare for Windows 274

Saving Model Files and Rulesets 274

General RiverWare 275

DMI 275
DMI File Chooser Path Is More Intuitive 275
DMI File Chooser "All Files" 275
SCT 275
New Display Features 275
User Settable Fonts 275
Editing Target Operations 276
Opening Multiple Slots Directly From the SCT 276
Preservation of Height and Width 276
Printer Properties 276
Integrated Sum in Selection Info Area 276
Selecting Slots in New SCT 276
Optional Date/Time Spinner 276
General SCT Performance Enhancements 277
New Model Info Dialog 277
Expression Slots 277
Adding a New Expression Slot 277
Scalar and Series Expression Slots 278
Use of RPL 278
Timing of Expression Slot Evaluation 278
Periodic Slots 278
Plotting 278
Multiple Year Periods 278
Data Objects 279
New Slots 279
Data Objects in Subbasins 279
Simulation Run Parameters 279
Extended Model File Precision 279
Units 280
Units of "gal" (gallon) and "BG" (billion gallons) 280
RiverWare Command Language (RCL) 280
RIVERWARE_SITE Environment Variable 280

RiverWare Viewer **281**

Simulation Objects **282**

Control Point Object 282
Flood Control Methods 282
Additonal Peaking Flow Slot 282
Reservoir Objects 282
Changes to Plant Efficiency Curve Power Method 282
Changes to Peak Power Calc and Peak Base Power Calc 283
Changes to Physical Constraint Methods (affects HypSim) 283
Slope Power Reservoir 283
Stream Gage 283
Fractional Flow Method 283

Flood Control **285**

Overview of Flood Control Algorithms 285
Model Configuration for Flood Control 285
Execution of Flood Control Algorithm in Simulation 286

Rulebased Simulation **288**

RPL Analysis Dialog (“Rule Calling Tree”) 288
New Palette Buttons for Set Operations (where lists are sets) 288
Union 288
Intersection 288
<L> - <L> Set Difference 289
<L> ^ <L> Set Symmetric Difference 289
Rules Palette Predefined Functions 289
Modified Predefined Functions 289
Slot Sum Functions Now Accept Periodic Slots 289
AccountPriorityDate (STRING AccountName) 290
AccountNameFromPriorityDate (DATETIME PriorityDate) 290
SortPairsAscending (LIST pairs) SortPairsDescending (LIST pairs) 290
Sort (LIST) 290
Reverse (LIST) 290
GetDate (STRING dateText) 290
SolveOutflowGivenEnergyInflow 290

Inline Comments in Rules 291
Printing Rulesets 291

Accounting **292**

Automated Pass Through Account Creation Function 292
Account Manager Dialog 292
Supply Manager Dialog 292
Priority Date Fields 293
Plotting Account Multislot Data 293

Optimization **294**

Diagnostics 294
New Diagnostic reports in millions of dollars 294
Warning Messages Removed 294
Power Regulation 294
Objective Function 294
Thermal Object Avoided Operating Cost 294
Thermal Objective Reported in Simulation 295

SCT **296**

New Display Features 296
Optional Day and Year Dividers 296
Textless, Thick-Line Slot Divider Option in Horizontal Timestep Axis Orientation 297
User Settable Fonts 298
Selection Info Area: User Settable Background and Text Colors 299
Selection Info Area: Integrated Sums for “per-time” values (e.g. Flow) 299
Selection Info Area: Interval size indication for irregular time units (e.g. monthly) 300
Object Dispatching Ornamentation in Vertical Timestep Axis Orientation 300
New Editing Features 301
Changes to Target Operation Editing 301
Other New Features 302
Open Slot Dialogs shown from the SCT 302
Window Size Persistence 302
Printer Settings 302
Optional Date/Time Spinner for Timestep Navigation 302

Opening a new SCT, prompt to Add Slots 303
SCT Bug Fixes 304
Selection Info Area: “Obscured Timesteps” Description on Summary Cells 304
Target Operation setting operation: Expand slot’s time series 304
SCT Configuration Dialog Box fixes 304
Selection Information Area: Read Only 304
Saved “Lock” status not staying locked on loading an SCT from the Workspace... 304
Retaining window scroll position after adding slots and other reconfigurations. 304
Target Operation: Invalid state possible when pasting a new target operation over an existing one 305
Model name change not reflected in SCT window title. 305
Clicking OK in the Multiple Slot Selector does not always add the highlighted slots to the SCT. 305
Disable Dispatching cross-hatching is not updated in the SCT when selected from the Model Run Analysis dialog. 305
Bad Timeslice copying: Paste as Input into TableSeriesSlots 305
Can’t see data in high precision in SCT 305
Slot name changes not handled properly. 306

Bug Fixes 307

Release Notes Version 4.6 309

Full conversion to new SCT (2.0) 309
Flags set by rules 309
Partition BW Elevation method changed to Weighting Coefficients method 309
Hydro Capacity slot on Inline Power object 309
Check Iterations 309
RPL Expression Slots 310

General RiverWare 311

DMI 311
Calling DMIs from rules 311
Modification of the data_date keyword 311
DMI allows spaces in paths 311
Diagnostics 311

Batch Mode 311
Output during batch mode 311
Setting user parameters 312
Workspace 312
New implementation 312
Run Control Dialog 312
New implementation 312
Multiple Run Management 313
Multiple configurations 313
Output to multiple files 313
Output DMI after each run 313
Providing trace number to input/output DMIs 313
Portable MRM configurations 313
Classic configuration or Lite configuration 313
DMIs can be a DMI group 314
Diagnostics 314
Improved table interpolation diagnostics 314
CLEAR_STATE and RESET_STATE diagnostics removed 314
Table Slots 314
Configuring Units 314
Expression Slots 314
Display of RPL expression 314
Values in slots evaluated “Never” or “Only Interactively” not cleared 314
SCT 315
Export Copy 315
Go To Feature 315
Full conversion to new SCT (2.0) 315
No display of hours in timesteps of days or longer 315
Model File Information 315
Model File Timestamp 315
Model Save Backups 315
Backups of previous RiverWare versions automatically created 315
RiverWare Policy Language (RPL) Editor 316
RPL editor dialogs reimplemented in Qt 316
Multiple Object/ Slot/ Account Selector 316
Multiple Object/Slot/ Account Selector updated in Qt 316

Sedmtr file 317
sedmtr file updated 317

RiverWare Viewer 318

Scenario Manager 319

Creation of a baseline model 319
Creation of a scenario slot list 319
Creating, editing, and running scenarios 319
Comparing scenario runs 319

Simulation Objects 320

Computational Subbasin 320
Mead Flood Control Method 320
Reservoir Objects 320
Monthly Evap Calc Annual Timestep Method 320
Storage Reservoir 320
Tailwater Calculation Category 320
Slope Power Reservoir 321
Slope Storage Coefficients Category 321
Inline Power Reservoir 321
Computation of Hydro Capacity 321
Bifurcation Object 321
Fractionally Split Outflows method 321
Solve Downstream Only method 322

Rulebased Simulation 323

Calling DMIs from rules 323
Flags set by rules 323
Check Iterations 323
Rules Palette Predefined Functions 323
RunStartDate()
RunEndDate() 323
NumColumns (SLOT tableSlot/periodicSlot)
NumRows (SLOT tableSlot/periodicSlot) 323
TableLookup (SLOT tableSlot, NUMERIC lookupColumn, NUMERIC returnCol-

umn, NUMERIC lookupValue, DATETIME referenceDate, BOOLEAN roundDown)........ 323
SovleMonthlyStorageAnnualTimestep(OBJECT reservoir, SLOT res inflow, SLOT res outflow, SLOT res previous storage, DATETIME month at which to do the calculation) 324
SolveMonthlyOutflowAnnualTimestep(OBJECT reservoir, SLOT res inflow, SLOT res storage, SLOT res previous storage, DATETIME month at which to do the calculation)........ 324
MeadFloodFontrol(STRING name of subbasin, DATETIME current timestep, SLOT previous Powell storage, SLOT current Powell storage, SLOT previous Mead storage, NUMERIC flood control release month index) 324
SupplySlotsFrom (LIST object account pairs, STRING release type, STRING destination)
SupplySlotsFrom1to1(LIST object account pairs, STRING release type, STRING destination) 324
SupplySlotsFromIntra (LIST object account pairs, STRING release type, STRING destination)
SupplySlotsFromIntra1to1(LIST object account pairs, STRING release type, STRING destination)........ 324
SupplySlotsTo (LIST object account pairs, STRING release type, STRING destination)
SupplySlotsTo1to1(LIST object account pairs, STRING release type, STRING destination) 324
SupplySlotsToIntra(LIST object account pairs, STRING release type, STRING destination)
SupplySlotsToIntra11o1(LIST object account pairs, STRING release type, STRING destination)........ 325
Hypothetical Simulation 325
Diagnostic message changes........ 325
Performance improvements........ 325

Accounting........ 326

Supply Manager Dialog........ 326
Supply Role........ 326
Pass Through Accounts on Reservoirs 326
Solution with Diversion and Return Flow 326

Transfers 326
Transfers accept negative values 326

Optimization 327

Power Regulation 327
Computation of Hydro Capacity 327
Behavior Prior to Beginning of Run 327
Referencing variables prior to Beginning of Run 327

Closed Bug Reports 328

Release Notes Version 4.7 329

Optimization Slots 329

General RiverWare 330

Database DMI's: HEC-DSS connection 330
DMI 330
Multiple Run Management 330
Generate Excel Files from RiverWare 330
Index Sequential Rotate By Years 331
Output Data File 331
Output Manager 331
Output Manager Ported to Qt 331
Generate Excel Files from RiverWare 331
Plotting Accounting Slots 332
Environment Variables in the Output Manager 332
Scenario Manager 332
Scaling Scenario Slots 332
Statistical Table Slots 332
Flow Duration and Annual Max Frequency Curves 332
Run Control 333
Extended Time Series Range 333
Batch Mode and RiverWare Command Language (RCL) 333
New command line arguments 333
StartController Enhancement for MRM 333

Working with Models on Windows and Solaris 334

User Interface Enhancements 335

RiverWare Workspace 335
Object and Link Display Groups 335
Time Scroll Option on Abort 335
Show Workspace Option 335
Close All Objects and Open Selected Objects 336
New Sub menus in the Policy Menu 336
Open Object Dialog 336
New Open Slot Dialog 336
System Control Table (SCT) 337
Diagnostics Window and Run Status Window Imbedded in SCT 337
DMI Menu Now Appears in SCT Menu Bar 338
Slot Navigation with the Go To Menu 338
SCT File Menu 338
Diagnostics Output Window 339
Diagnostics Window Ported to Qt 339
Selector Dialog 339

Simulation Objects 341

Slope Power Reservoir 341
Weighting Coefficients Method 341
Power Reservoir Objects 341
Peak Power Equation with Off Peak Spill 341
Additional Hydropower Release 341
Load Calculation 341
Distribution Canal 342
Storage Calculation 342
Evaporation from Storage 342
Pipeline Object 342
Pipeline Hydraulics 342
Thermal Object 342
Regulation Calculation 342
New Objects: Pipe Junction and Inline Pump 342
Table Interpolation Error and Warning Messages 343

Water Quality / Salinity Enhancements 343

Rulebased Simulation and RiverWare Policy Language (RPL) 344

RPL User Interface 344
RPL Palette Dialog Ported to Qt and enhanced 344
New RPL Palette Buttons 345
Enable/Disable RPL Statements 345
Enable/Disable Items in a RPL LIST 345
Default Agenda Order 345
RPL Predefined Functions 345
HydropowerRelease 345
Random, RandomNormal 345

Accounting 346

New Accounting Workspace 346
Accounting System Configuration Dialog 347
Account Configuration Dialog - Open Account Dialog 348

Optimization 349

Stochastic Optimization 349
Power Efficiency Curve Method 349

Bugs 350

Closed Bug Reports 350

Release Notes Version 4.8 351

Special Attention Notes 351

Hydrologic Inflow Forecast 351
Changes to the Accounting system 351

General RiverWare 352

Multiple Run Management 352
Iterative MRM 352
Statistical Table Slots 352

New Statistical Functions 352
Filtering Input Data 352
Additional Statistics and Display 353
Batch Mode and RiverWare Command Language........ 354
Removed --noacctmin option 354
Modified --acctdata option 354
Data Management Interface 354
Import and Export of Database DMI Objects 354
riverwareDB file 354
License Expiration Warning 354

General User Interface Enhancements 356

Diagnostics Output Window 356
Expression Slots........ 356
Workspace........ 356

Simulation Objects 357

Reservoir Objects 357
Low Flow Releases Category........ 357
Operating Levels Category 357
Diversion Capacity Slot........ 357
Hydrologic Inflow Forecast 357
Bifurcation Object........ 357
Solution Direction........ 357
Negative Outflow Warnings........ 357
Control Point........ 358
Low Flow Requirement Category 358
Distribution Canal 358
Head Based Seepage 358
Diversion Object........ 358
Periodic Diversion Requests 358
Reservoir Level Lookup 358
Diversion Object Solution Direction........ 358
New SolveDiversionGivenOutflow Dispatch Method........ 358
Diversion Shortage as a general slot 359
Groundwater Storage Object........ 359

Evapotranspiration Category 359
Groundwater Solution Type Category 359
Specify Connected Groundwater Objects Category 359
Head Based Percolation Method 359
Input Pumped Flow Method 359
New Dispatch Method SolveGWMB_GivenPreviousElevations 360
Reach 360
Stage Table Lookup Method 360
Head Based Seepage Method 360
Periodic Minimum Bypass Method 360
Diversion Capacity Slot 360
Water User 360
Irrigation Acreage and Evapotranspiration Rates Category 360
Irrigated Area GW Return Rate method 361
Multiple Supply Sources Category 361
New Diversion Request Calculations 361
Limit Diversion Category 361

Rulebased Simulation and RiverWare Policy Language (RPL) 362

RPL User Interface 362
Search and Replace 362
Import and Export of RPL blocks 362
Deleting RPL Blocks 363
Predefined Function Diagnostics and Display 363
RPL Predefined Functions 364
HasRuleFiredSuccessfully 364
ComputeReservoirDiversions 364
MeetLowFlowRequirement 364

Accounting 365

Changes to Passthrough Accounts 365
Legal Lag 365
Gain/Loss 365
Diversions and Return Flows 365
Transfers 365
Storage 365

Inline Power Plants 365
Linkage to offstream reservoirs 365
Changes to Storage Accounts 366
Changes to Diversion Accounts 366
Lag unit type 366
Open Slot Dialog Menus for Accounting Slots 366
Object Account Summary Dialogs 366
Edit Account Dialogs 369
Water Accounting System Configuration Dialog 369
Import and Export of Objects and Accounts 370
Future solution of Accounts 370

Closed Bug Reports 371

Release Notes Version 4.9 372

Special Attention Notes 372

Subslots default convergence 372
Slot name change 372
Deterministic Local Inflow and Deterministic Hydrologic Inflow 372
LengthPerTemperature unit type changed to LengthPerTemperature_F 373

General RiverWare 373

Documentation 373
Batch Mode/RCL 374
ListSlotDMI command 374
DateTime values in slots 374
Data Management Interface 375
Database DMI’s: HDB connection 375
DMI Import of Periodic Slots 375
Multiple Run Management (MRM) 375
Units 376
m^3/d 376

General User Interface Enhancements 376

Slots 376
Notes on Series Slots 376

Slot Adjust Values 376
Open Series in SCT 377
Global Time Scroll 377
Model Run Analysis port to Qt 378
Slot Selector Enhancements 379
Timestep size on SCT 380

Engineering Methods 380

Spatial, Temporal, and Incremental Flow Disaggregation 380
Spatial disaggregation methods 380
Specified Factors temporal disaggregation method 381
Calculate Incremental Local Inflows category 381

Simulation Objects 382

Reservoir Objects 382
Flashboard and Superboard Spill methods 382
Surcharge Error Check 382
Peak Power Equation with Off Peak Spill - Warning message removed 382
Compute Incremental Hydrologic Inflows on Subbasin category 382
Slot name change: Deterministic Hydrologic Inflow 382
Control Point 383
Variable Routing Coefficients category 383
Local Inflow Spatial Disaggregation on Subbasin category 383
Gage Control Point category 383
Local Inflow Temporal Disaggregation on Subbasin category 383
Compute Incremental Local Inflows on Subbasin category 383
Slot name change: Deterministic Local Inflow 384
Computational Subbasin 384
Control Point Variable Routing Coefficients category 384
Multiple downstream-most objects in flood basin 384
Local Inflow Spatial Disaggregation 384
Local Inflow Temporal Disaggregation 385
Compute Incremental Local Inflows 385
Reservoir Boundary for Incrementals Category 385
Diversion Object 385
Change to SolveMB_GivenOutflow dispatch method 385
Reach 385
Base Plus Fractional Loss Method in the GainLoss Calculation Category 385
Variable Step Response routing method 386
Water User 386

Fraction Return Flow Input category ... 386
RiverWare Policy Language ... 386
RPL User Interface ... 386
RPL Statements ... 386
RPL Palette ... 386
Operations in RPL set editor dialogs ... 387
RPL Parameters Dialog ... 388
IF and IF ELSE Statements ... 388
Stop Run Statement ... 388
Time Invariant Functions ... 389
RPL Diagnostics ... 389
FOREACH diagnostics ... 389
Modified Predefined Functions ... 389
HydropowerRelease ... 389
SolveOutflowGivenEnergyInflow ... 389
MeetLowFlowRequirement ... 390
New General Predefined Functions ... 390
DateToNumber and NumberToDate ... 390
New Accounting Predefined Functions ... 390
AccountAttributes ... 390
ObjAcctSupplyByWaterTypeRelTypeDestType ... 390
ObjectsFromAccountName ... 390
ObjectsFromWaterType ... 390
SourceAccountAndObject ... 390
SupplyAttributes ... 390
Accounting ... 391
Documentation ... 391
Water Rights Appropriation Solver ... 391
Exchange Balance Dialog Ported to Qt ... 391
Synchronizing the Accounting System when Enabling ... 392
Opening an Account from the Accounting View ... 392
Keyboard Accelerators ... 392
Clear All Operation on Orphaned Accounts ... 392
Diversion Account ... 392
Return Flow Lag Units Type Change ... 392
Diversion Account Solution Equation ... 392

Optimization ... 392
Upgrade to CPLEX 10.1 ... 392
Change in “Convolved” Table Calculation ... 393
Closed Bug Reports ... 393

Release Notes Version 5.0 ... 395

Special Attention Notes ... 395
Convergence ... 395
Checking Iterations when Convergence is None ... 395
Convergence Type and Min/Max on Accounting Slots ... 395
Convergence Slot Name Change ... 395
Muskingum Cunge routing method ... 396
Old-style Optimization is no longer supported ... 396
Removed support of TCL functions in RPL ... 396

General RiverWare ... 397
Data Object and Slot Descriptions ... 397
Description Tab Added ... 397
Description of Slots on Data Object ... 397
Diagnostics Manager Ported to Qt ... 397
File Loading ... 398
Dialogs modified ... 398
Re-open Model or Ruleset from File menu ... 398
Import/Export ... 399
Export/Import of Links, Accounts and Supplies ... 399
Import Object Location ... 399
Import Paste Slot Data ... 399
Link Editor ... 400
Performance ... 400
File loading of compressed files ... 400
Run Length Encoding ... 400
Plotting ... 401
Date Display Marker ... 401
Multi-layout Plots ... 401
Periodic Slot Plotting ... 401
Probability Scale ... 401

Time Labeling 402
Run Analysis 403
Selector 403
Account Priority data 403
Slot Type Filter 403
Scalar Values 403
Slots 403
Column widths 403
Convergence 403
Global Slot Configuration Dialog 403
Integer Indexed Series Slots 404
Periodic Slot re-implementation 404
Series Display Compression 405
Slot Configuration 405
Slot Order 405
Statistical Slots 406
Snapshot Manager 406
Software Technology Changes 407
Subbasin Manager 407
Units 408
Unit Converter 408
New Units 409
Workspace - Canvas Selection 409
Accounting 409
Exchange Manager and Exchange Configuration dialogs ported to Qt 409
Import/Export of Accounting Supplies 409
Slots 409
Instream Flow Account 409
Convergence Type and Min/Max on Accounting Slots 410
Slot Configuration 410
Water Rights Allocation 410
Account Subordination 410
Account Subordination Viewer 410
Disaggregation of Initial requests from Annual Values 410
Fill Conservation Pool and Meet Diversions from Storage Accounts 411
Percentage of Total Requirement to Meet Demand on Storage Accounts 411
Priority Slot on acct is recalculated when date is changed 411
Results of Turning Off a Water Right 412
SolveWaterRightsWithLags 412

Database DMI 412
Database DMI editor 412
HDB Datasets - User specified timeout value 413
Name Map Order 413
No Units 413
Table Series slots 414
Multiple Run Management 414
Accounting Slots using DMI's 414
Iterative Mode Configuration 414
MRM Output to RDF files 415
Spaces in Control File paths 415
Optimization 415
RPL Based Optimization 415
Documentation 416
Optimization Run Parameters 416
RiverWare Policy Language 417
RPL User Interface 417
Comments on Statements 417
DateTime Support Changes 417
Editing types in RPL Looping variables 417
Editing Values 417
Modified display of looping expressions 418
Open and Load 418
Policy Group Priority Range 418
RPL Function Argument Editor 419
RPL Value Inline Editor Changes 419
TCL user-defined functions are no longer supporter 420
RPL Palette 420
NanToZero Operator 420
Tool Tips 420
Predefined Functions 420
FloodControl 420
GetAccountFromSlot 421
GetObjectFromSlot Function 421
GetRowIndexByDate Function 421

GetSlotName Function ... 421
HasRuleFiredSuccessfully Function ... 421
HydropowerRelease ... 421
Run Time Function ... 421
Slot Functions now work on Table Series Slots ... 422
RPL Set Analysis - Find Next Button ... 422
Executing DMI's from Rules ... 422

SCT ... 422

Scalar and Other Slots tabs ... 422
SCT Column Width Adjustment ... 423
SCT configuration defaults ... 423
Supporting different timesteps ... 424

Simulation Objects ... 424

Computational Subbasin ... 424
Changes to Flood Control algorithm ... 424
Initialize Flow Slots for Routing ... 424
RiverWare - MODFLOW Link ... 425
Reservoirs Only Method ... 425
Control Point ... 425
Hydropower Flooding Exception Category ... 425
Regulation Discharge Methods ... 425
Reach ... 426
Local Inflow Adjust ... 426
Muskingum Cunge Improved Method ... 426
Muskingum Cunge routing method ... 426
Periodic GainLoss Method ... 426
Reservoirs ... 426
Operating Level Balancing Flood Control ... 426
Peak Power Eqn With Off Peak Spill ... 426
Seasonal Load Time method ... 427
Water User and Agg Diversion Site Objects ... 427
Dispatch method required knowns ... 427
Sequential Structure Modifications ... 427

Water Quality ... 428

Documentation ... 428
Predictor Corrector Salt Model ... 428

Closed Bug Reports 428

Release Notes Version 5.1 430

Special Attention Notes 430

Deprecated Expression Slots 430
Changes to the thermal object 431

Accounting 431

Exchange Configuration 431
Sharing of accounting linked slots 431
Supply Manager 431
Timing of certain Object Level Accounting Methods 431

Diagnostics 432

Expression Slots 432

DMI 432

Dataset Selector 432
Executing DMI's from RPL 432
Invocations and Clearing Values 432

Optimization 433

Mixed Integer Programming 433
Changes to the Thermal Object 433
CPLEX licensing 433
Automatic Ruleset Generation 434

Plotting and Output 434

Curve Configuration allows slot to be changed 434
Date Centering 434
Date Marker 434
Export/Import of Output Device Configuration 435
Ordering of Plots 435
Periodic Slot Plotting 435

Plotting statistical slots 436
Plot Page Selection List 436
Plotting invalid slots 436
RiverWare Policy Language........ 437
Executing DMI's from RPL 437
Individual DMI's vs Groups........ 437
Database DMI's 437
Link to External Documentation........ 437
New Predefined Functions- GetSeriesSlots 438
RPL Debugging........ 438
RPL File Menus 439
RPL Global Function Sets 440
RPL User Interface 440
Undo/Redo 440
Cut/Delete Operations........ 440
Numeric Syntax 440
Display of Brackets, Braces and Parenthesis........ 441
RPL Icons 441
RPL Dialog Set buttons 442
Sizing of Windows 442
Run Control 442
Abort Confirmation 442
Step and Initialization 443
SCT 443
Diagnostic Output 443
SCT Run Status Panel........ 443
Selector Filters........ 444
Expression Slot filters 444
Has Flag........ 444
Has Priority........ 444
Simulation Objects........ 444
Reach 444
Inflow Stage Table Look Up Method........ 444

Reach Seepage Routing method 444
Variable Time Lag Routing 445
Reservoirs 445
Spill Capacity Fractions: 445
Regulated Spill Overflow 445
Spill slots linked to Expression Slots 445
Slope Power Reservoir: Editing of Column labels on select slots 445
Power Reservoirs - Unit Power Methods 445
U Flag 446
Thermal Object 446
Economic Valuation Categories 446
Regulation Category 447
System Startup Cost 447
USACE - SWD Functionality 447
Slots 448
Expression Slots - RPL 448
Expression Slot - Old Style 448
Find Series Slots with Inputs 448
MultiSlot Dialogs: 449
Selection Statistics Area 449
Showing priority in series data 449
Statistical Slot Functions 449
Unit Defaults on Data Objects Slots 450
User Interface - Miscellaneous 450
Closing Workspace or RPL sets 450
File Loading 450
Icons on windows 451
Model Run Analysis 451
MRM Run Control 451
Open Object Dialog - Show slots in SCT 451
Workspace 452
About RiverWare dialog 452
Background Image 452
Close All Dialog 453

Lock and Unlock the workspace 453
Open Slots menu 453
Toolbar buttons for navigating 454

Closed Bug Reports 454

Release Notes Version 5.2 456

Special Attention Notes 456

Deprecated Expression Slots removed 456
Integer indexed slot display and synchronizing 456
Series Slots converted to Periodic Slots 456

Accounting 457

Data Object Exchange Utility 457
Diversion Account Enhancements 457
Return Flow Calculation - Variable Efficiency Return Flow 457
Return Flow Route or Split 457

Batch Mode and RCL 457

RCL specification of Machine\share paths 457

Diagnostics 458

New Information on start up 458
Diagnostic window on Solaris 458

DMI 458

Excel Database DMI Datasets 458
Line enders 458
RPL functions to specify Begin/End dates 459
Status Dialog 459

General RiverWare 459

RIVERWARE_HOME environment variables 459

Multiple Run Management 460

Iterative Mode Output Control File 460

Optimization 460

Constraints for Input Values 460
Modified definitions 460
Modified the substitution approximation code 460
Forward lags 461
Unconstrained slots 461

Plotting and Output 461

Table Slots - Reverse axes 461
Tabular Series Slot Report device 462

RiverWare Policy Language 463

Agenda order is not always shown 463
Enabled/Disabled Expressions 463
IsInput Predefined Function 463
Performance 463
Re-implementation of the List of Rules, Methods, Goals 463
RPL Debugging 464
RPL Diagnostics units 464
Save loaded RBS set with model 464

Run Control 465

Order of controllers 465
Pause before Timestep 465

SCT 465

Copy Slot lists from SCT to Output Device config 465
Export Copy optionally includes Column Headers 465
Flag letters and Rule Priority numbers 466
Four Hour Dividers 466
Import Paste 466
SCT on abort 467
Table Slots Column Labels 467

Selector 467
Integer Indexed Slot Filter 467
Simulation Objects........ 467
Power Reservoirs 467
Unit Power allows negative unit energy........ 467
Reservoirs 467
Conversion of series slots to Periodic........ 467
Periodic Net Evaporation Method 468
Single Value Seepage method........ 468
Reach 468
Pan Evaporation method........ 468
Reach Seepage........ 468
Groundwater Storage - Evaporation category and methods 468
Slots 469
Expression Slot Re-implementation........ 469
Notes on Series Slots re-implementation 470
Periodic Slot - Regular interval row headers........ 471
Workspace 471
Display Group Editor dialog 471
Font and Text Size 472
Loaded RBS ruleset and Opt Goal set buttons added to workspace 472
Policy menu reorganized........ 472
Links in status bar 472
Closed Bug Reports........ 473
Release Notes Version 6.0 474
Special Attention Notes........ 474
Accounting - Water Rights Solver Does Not default Slot Inflows to Zero 474
Accounting - Instream Flow Reference Level Removed from OLAMs........ 474
Accounting........ 474

Object Level Accounting Methods 474
Execution Times Are User Selectable 474
Copy Slot to Slot Inflow Method Added 475
Multi Object Method Selector Enhanced 475
Category Name Changes 475
Diversion Object Account Slot Inflow 476
Instream Flow Reference Level Removed 476
Supplies 476
Supplies Manager - Double Click on Supply Opens Supply Editor 476
Supplies Manager - Copy List to Clipboard 476
Supply Name Format 476
Water Rights Accounting 476
Performance improvement 476
Prior Appropriation No Longer Sets Zeros For Unknown Slot Inflows 477
Miscellaneous 477
Accounting Period Must Encompass Run 477
Accounts Manager - Copy List to Clipboard 477
Categories Require an Accounting Controller to be Selected 477
Creating Multiple Supplies on the Workspace 478
Lagged Return Flows At Beginning Of Run 478

Batch Mode and RCL 478
GetSlot and SetSlot Commands 478
Setting Environment Variables in Batch Mode 478

Data Management Interface 478
Excel DMIs Allow Environment Variable In Paths 478
Excel Worksheet Label Length and Excel DMIs 478
DMI’s Executed from RPL 479

General RiverWare 479
64 bit version 479
About Dialog 479
Licensing 479
Model File Icon 479
RiverWare Home Environment Variable 479

Model Run Analysis 480
Pre-simulation Timestep Separator 480

Miscellaneous Changes 480
Multiple Run Management 480
Iterative MRM configuration 480
MRM Controller - Removed Two Tier Editing 480
Optimization 481
CPLEX version 481
Optimization Diagnostics 481
Optimization Parameters 481
Location of Non-default Parameters 481
New Optimization Parameters 481
Miscellaneous 482
Performance 482
Run Time Reduced with Dialogs Open 482
String Re-implementation Improvements 482
Plotting and Output 483
Copy / Paste of Graphs 483
NaNs in Plots 483
Open Slot from a Plot 483
Plot Templates 484
Plot Page now Allows Any Type of Slot 484
RDF Single Run Output 484
Snapshot Plots 485
RiverWare Policy Language 485
Comments within Expression 485
Display of Optional Items 485
Initialization Rules 486
Palette 487
Button Labels and Reorganization 487
Equality Operators Support All Data Types 487
List Access 487
Performance 488
Predefined functions 488

ElevationToAreaAtDate, StorageToAreaAtDate, and StorageToElevationAtDate 488
Certain Date Functions no Longer Require Fully Specified Datetimes 488
Iterative Hypothetical Simulation 489
PercentRank and Percentile functions added 489
Predefined Function Automatic Dependent Slots... 489
Rule Execution 489
Sets.. 489
Close Dialog Versus Close Set.. 489
Modified Colors Of RPL Sets and Icons 490
RPL Display Settings and Display Of User-defined Function Calls.................................. 491
Sets Saved with Model Now Have Indicator Icon 491
Units 491

Run Control 492

Button labels 492
Execute Initialization Rules 492

Simulation Objects.. 492

Groundwater Storage object - Wetted Sand Evaporation.................................... 492
Reservoirs 493
Changing Elevation Volume and Elevation Area Methods 493
Convergence Percentage Slot.. 493
Method and Category Name Changes.. 493
Peak Base Power Calc... 494
Unregulated spill near the crest 494
Thermal Object - Load Evaluation 494

Slots 494

Clear Values 494
Editing of Values In Slot Dialogs.. 494
Initialization Flag 495
Scalar and List Slot modifications.. 495

Subbasins 495

Subbasins Containing Aggregate Objects... 495

System Control Table 496

Adding Dividers 496

Interpolation in multiple-slot selections 496
Adjust Values 496
Keyboard accelerators 496

Workspace 496

Geospatial Canvas 496
Images on the Simulation View 497

Closed Bug Reports 498

Release Notes Version 6.1 500

Special Attention Notes 500

Excel Database DMIs and Object Name Maps 500
Peak Base Power Calc 500
Power Plant Cap Fraction 500
Reservoir Hydrologic Inflow Calc 500
Uncertainty Methods, Slots, and Units 501
Unregulated Spill Slots 501
USACE-SWD Hydropower Function 501

Accounting 501

Gain Loss Coefficients on Passthrough Accounts 501
Object Level Accounting Method Diagnostics 501

Data Management Interface 502

Database DMI Editor 502
Excel Database DMIs and Name Maps 503
Excel Database DMI Performance 504
HDB - Oracle Client Version 504
Parameters 504
Notice Windows 504
Unique Temporary Directories 505

Diagnostics 505

Environment Variables in File Specification 505

Show in Popup Window 505

Multiple Run Management 505

Configuration Dialog Layout 505
Initialization DMI 506
Input DMIs and Traces 506
Iterative Pre-Run Rules 506
Iterative MRM flag 506
Output Slot Name options 506
Output to Excel 507

Objects 507

Agg Diversion Site 507
MODFLOW connection 507
Reach 507
Autoregressive Outflow 507
Stage Adjustment Category 507
Uncertainty Methods, Slots, and Units removed 508
Reservoir 508
Conditional Operating Levels 508
Elevation Maximum Duration Constraints 508
Hydrologic Inflow Calculation 508
Inflow Sum Slot 508
Max Flag on Outflow when linked to Canal 509
Operating Level Storage Table 509
Power Plant Failure methods 509
Sloped Reservoir - Weighting Coefficients method 509
Uncertainty Methods, Slots, and Units removed 509
Unregulated Spill Nomenclature 509
Water User 510
Water User Groups 510

Optimization 510

Improved Data Checking 510
Infeasible Problem Handling 510
Unregulated Spill in Optimization 510
User Defined Optimization Variables 510

Plotting and Output 511

Create Similar Plot Pages 511
Output to Excel 511
Time Axis Control 511

RiverWare Policy Language 511

Expression Font Colors 511
Initialization Rules 512
New Predefined Functions 512
CompletePartialDate 512
DispatchEndDate 512
GetRunCycleIndex 512
GetYearAsString 512
HasFlag 512
Palette Functions Tab 513
RPL Debugging Indicator 513
RPL Set Navigation 513

Run Range 514

Post run dispatching 514
Run Range Display 514

Rulebased Simulation 515

Run Cycles 515

SCT 516

Aggregation Functions 516
Interpolate Shortcut 516
Lock is Preserved 516
Series List tab 517

Slots 517

Collected Notes for Slots with Expression 517
Derived Slots 518
Interpolate Shortcut 518
Read Only Indication 518
Slot Description 518
Statistical Slot analysis Range 519

Units and Display of Numbers 519
Display of Commas in Numbers 519
Uncertainty Unit Types removed 519
User Unit Additions 519
USACE-SWD Methods 520
USACE Special Results 520
Hydropower Modifications 521
Workspace 522
Accounting canvas re-implemented 522
Add Item to Workspace Group 522
Workspace Navigation changes 522
World File Image Registration 523
Closed Bug Reports 523
Release Notes Version 6.2 525
Special Attention Notes 525
Energy in Storage category name changes 525
Reservoir Single Value Seepage 525
Unit Conversions for Area per Time 525
Solaris is no longer a supported platform 525
Accounting 526
Diversion Account Max Legal Request 526
Passthrough Account Outflow Limitation 526
Batch Mode 526
RCL Commands 526
Data Management Interface 526
Database DMIs 526
Dataset Selector 526
HDB Datasets 526

Missing value Diagnostic.......... 527
User Parameters in DSS File Names.......... 527
Diagnostics 527
Output window.......... 527
Multiple Run Management.......... 527
Excel DMIs 527
Distributed MRM 527
Objects.......... 528
Control Point Regulation Discharge.......... 528
Conductance Computations.......... 528
Distribution Canal 528
Groundwater Storage 528
Reach 529
Reservoirs 529
Energy in Storage Methods 529
Evaporation Rates 529
Flood Control Minimum Release.......... 529
Operating Level slots.......... 530
Single Value Seepage.......... 530
Slope Power Reservoir 530
3D Tables Allow NaNs.......... 530
Max Outflow Computation 531
Segment Storage.......... 531
Plotting and Output 531
Model Report.......... 531
Pie Charts.......... 532
Plot Dialog - Move Arrows.......... 533
Temporary Directory 533
XMGR Output Devices Removed.......... 534
RiverWare Policy Language.......... 534
Initialization Rules 534
RPL Editor Displays.......... 534
FOR EACH changed to FOR.......... 534
New Display Colors 534

Open Slots and Objects from RPL dialogs ... 535
RPL WITH Statement ... 535

SCT ... 535

Object Grid ... 535

Slots ... 537

Mass Balance Summary ... 537

Units ... 538

Conversion factors for Area per Time ... 538

Closed Bug Reports ... 538

Release Notes Version 6.3 ... 540

Special Attention Notes ... 540

Unit Schemes ... 540
Slot Name changes ... 540
Water Quality ... 541
Accounting Clearing Values ... 541
Optimization Licensing ... 541

Accounting ... 541

Water Rights Shared Priority ... 541

Data Management Interface ... 542

Database DMI Interface improvements ... 542

Diagnostics ... 543

Diagnostic Output Filtering ... 543
Diagnostic Manager Usability ... 543

Help and Documentation ... 543

PDF Reader Location ... 543
Video Demonstrations ... 543

Linking 543
Smart Linker 543
Model Files 544
Save and Load Progress 544
Multiple Run Management 545
Distributed Runs 545
Objects 545
Groundwater Storage Object 545
Pipe Junction 545
Pipe Junction Solution Direction methods 545
Reach 545
Step Response Seepage Routing 545
Water User 546
Return Flow Routing method enhancements 546
Open Object Dialog 546
Description Tab 546
Sorting and Filtering Slots 547
Optimization 547
CPLEX LIcensing 547
CPLEX File Type 548
Diagnostics 548
Run Sequence Checks 548
Pool Elevation Approximation 548
Opt Input Evaporation Method 549
Output and Plotting 549
Model Report 549
Plotting 550
Axis Labels and Precision 550
AutoScale includes markers 550
Pie Chart Precision 550

RiverWare Policy Language 550
Editing RPL Expressions 550
Expression Slots 551
Function Argument Editor 551
Hypothetical Simulation 551
Maximum Rule Executions per Timestep 551
New RPL Predefined Functions 552
DispatchTime and DispatchCount 552
GetSlotValsNanToZero and GetSlotValsByColNanToZero 552
ListDownstreamObjects 552
SlotWeightedAverageOverTime 552
SolveTurbineRelGivenEnergyInflow 552
Report Groups 553
RPL Analysis Tool 553
Scenario Manager 554
General Enhancements 554
Scenario Sandbox 554
SCT 555
Warning on Close 555
Slots 556
Configuration Dialogs 556
Configure Existing Slots Dialog 556
Multi-column Slot Configuration 557
New Types of Slots 558
Series Slots with Periodic Input 558
Time Aggregation Series Slot 559
Notes on Accounting Multi Slots 559
Changed Slot Types 559
Mass Balance Summary Slot 560
Interpolate between Inputs 560
Snapshots 560
Export/Import of Snapshots 560

Units 560

Unit Schemes 560
Units ksfd added 561

Water Quality - Salinity 562

Additional Salt Mass Slots 562
Linking on Aggregate Objects 562
Layered / Discretized Salinity only..................... 562

Workspace 564

Geospatial View..................... 564

Closed Bug Reports..................... 565

Release Notes Version 6.4 566

Special Attention Notes..................... 566

Modified Names..................... 566
Canal Object: Canal Flow Solution 567
Power Reservoir: Peak Power Methods..................... 567
Reach: Kinematic Routing Method 567
Priorities Saved for all Slots 567
Water Quality - Reach - Simple Well-Mixed Salinity 567
Thermal Object - Number of Hydro Blocks slot 568
Weekly Timestep Removed..................... 568

Accounting..................... 568

Multi-Account Method Selector..................... 568
Object Account Summary Dialog Improvements 568
Renaming Accounts..................... 568
OLAM Methods - Basin Specific..................... 568

Data Management Interface 569

Year Mapping Groups 569

Diagnostics 570

Initialization Rules Filtering 570
Model Files 571
File Choosers 571
Save As Confirmation 571
Multiple Run Management 571
Improved Distributed Run Interface 571
Objects 572
Canal 572
Canal Flow Solution 572
Power Reservoir 572
Peak Power Equation with Off Peak Spill 572
Peak Power Equation 572
Reach 573
Local Inflow Solution Direction methods 573
Reach Kinematic Routing Method 573
Reach Default Routing Method 573
Thermal Object 573
Calculate Block Economic Value: Number of Hydro Blocks slot 573
Optimization 574
Priority-Oriented Optimization Solution Analysis Tool 574
Output, Plotting, and Model Reports 574
Model Reports now include Plot Pages 574
Plot Marker Configuration 575
Printing Enhancements 576
RiverWare Policy Language 576
Editing RPL Expressions 576
Initialization Rule Diagnostics 576
Global Function Sets Embedded in Model 577
Saving Sets in Model File 577
New RPL Predefined Functions 577
IntegerToString 577
NumberToYear 577

OptValuePiecewise 578
RPL Palette Access 578
RPL Search and Replace 578
WARNING Statement 578

Run Control 578

Aggregate Inputs during Timestep Change 578
Weekly Timestep 578

SCT 579

Color for Z flags 579

Slots 579

Notes on Series slots 579
Export/Import of Note Groups 579
Accounting Multislots Now Display Notes from Linked Supplies 579
Statistical Table Slot Export Copy 579

Subbasins 579

Subbasin Manager Navigation 579

Water Quality - Salinity 579

Simple Well-Mixed Salinity Enhancements 579
Aggregate Diversion Site 579
Reach 580

Workspace 581

Icon Colors 581
Image Loading 581
Object List Navigation 581

Closed Bug Reports 582

Release Notes Version 6.5 583

Special Attention Notes 583

Category and Method Name Changes 583

Heron Inflow calculation 583
K Factor Unit Type 583
Workspace Background Colors 583
Modifications to Water User and Agg Diversion Site Dispatch conditions 583

Accounting 584

Open Account Dialog 584
Water Rights Solver 584
Improved Performance 584
Negative Flow Appropriation 584

Batch Mode 585

Output to Console 585
RequireVersion RCL Command 585

Data Management Interface 585

HDB Server 585
Control File-Executable - Limit Output to Run Range 585

Diagnostics 585

Output Window 585
Filter Statistics 585
Open Dialogs from Context 586
Performance Improvements 586
Tool Tips are Wrapped 586
Dispatch Solution Diagnostics 586

Multiple Run Management 587

Distributed MRM 587
Batch mode 587
Environment Variables 587
Iterative MRM 587
Ensembles in MRM 587

Object Interface 587

Export Object 587

Objects 588

Agg Diversion Site 588
Inline Power Plant 588
Inline Turbine Release and Bypass method 588
Power Reservoir 588
Peak Power with Off Peak Spill - New Slots 588
Plant Power Equation - Additional Functionality 589
Reach 589
Default Routing Method - No Routing 589
Kinematic Reach Routing 589
Reservoir 590
Allow Excess Specified Outflows 590
Anticipated Storage Calculation 590
Heron Inflow calculation 590
K Factor Unit Type 591
Water User 591
Dispatch methods 591
Specify Scheduled Requests 591

Optimization 591

Documentation and Help 591
Table Data Verification 592
Priority Oriented Optimization Solution Analysis Tool 592

Output, Plotting, and Model Reports 593

Model Reports 593
Periodic Slot Improved Plotting of Time Range 593
Pie Charts 593
Printing and Exporting 594
Redundant Plots 594
Scale to Specified Time Range 594

RiverWare Policy Language 595

Diagnostics and Debugging 595
WITH Statement Diagnostics 595
Index vs Priority 595
Initialization Rule Changes 595
RPL Expression Editing 596
Canceling Empty Expression 596

Slot Lookups are Easier to Edit ... 596
Slot Name Selector ... 596
RPL Comment Wrapping ... 596
RPL Object Display ... 596
Predefined Functions ... 596
ColumnLabels and RowLabels ... 596
GetColumnIndex and ColumnLabel ... 597
Get3DTableVals ... 597
HasRuleFiredSuccessfully ... 597
RPL User Interface ... 597
Add to Report Group ... 597
Move RPL item to the first priority ... 597
RPL Object Selector ... 597
RPL Set Analysis Tool ... 598
RPL Set Name Colors ... 598
Run Control ... 599
Resume Run Functionality Removed ... 599
Script Management ... 600
SCT ... 601
6-hour Time Dividers ... 601
Aggregation Label Row Alignment ... 601
Confirmation dialog during Close ... 601
Flag button appearance ... 602
Flag Letters for Accounting Slots ... 602
Navigation and Import Paste for Horizontal Orientation ... 602
Series Slot Value Information ... 602
Show Slot Descriptions ... 602
Timestep Size ... 603
Selector ... 603
Filters ... 603
Copy List of Slots from the Selector ... 603
Slots ... 603
Agg Series Slot Columns ... 603
Series Slot Value Information ... 604

Table Slot Row/Column Labels 604
Timestep Navigation 605
Datetime Controls and Global Time Scroll 605
Units 605
Units Added 605
Water Quality 606
Reach Simple Well-Mixed Salinity 606
Workspace 606
Arrows on Links 606
Background Colors Saved with Model File 606
Export Full Workspace Image 606
Extended Selection 607
Icon Colors Saved with Model File 607
Object Clusters 607
Text / Images on the Canvas 608
Appendix - Category and Method Name Changes 608
Name Changes on All Reservoir Object Types 609
Name Changes on All Power Reservoir Object Types 611
Name Changes on Storage, Slope and Pumped Storage Reservoir Objects 612
Name Changes on Reach Objects 613
Name Changes on Other Objects 615
Name Changes on Accounts 619
Closed Bug Reports 620
Release Notes Version 6.6 621
Special Attention Notes 621
Water Quality Method Selection and Names 621
Reimplemented DSS connectivity 621

Accounting 621
Accounting Dialogs - Show Only Non-Zero slots 621
Batch Mode 622
Reorder an Optimization Goal Set 622
Data Management Interface 622
Reimplemented DSS connectivity 622
Control File-Executable DMIs 622
Table row label import 622
Control Files allow Quoted Values 622
Model Files 622
RiverWare Model Package Functionality 622
Multiple Run Management 623
netCDF and CSV output from MRM 623
Object Interface 624
Object Attributes 624
Objects 625
Inline Power Plants 625
Level Power and Storage Reservoirs 625
Unregulated Conditions 625
Water User 625
Optimization 626
Power Reservoir 626
Power Surface Approximation method 626
Optimization Reserves Category and Method 626
Output, Plotting, and Model Reports 627
Model Reports 627
Optional PE/Storage column 627
Output Canvas and Teacups 628
Plotting 628

Show Markers in the Legend 628
Toggle off curves on a graph. 629
Plot Print Preview and Margin Settings 629

RiverWare Policy Language 629

Initialization Rules - Setting Table Slots 629
Predefined Functions 629
RPL Statement Names 630
Performance Improvement in RPL 630

Script Management 630

Changes to Existing Actions 630
Memo action 630
Set Method 631
Save Model Action 631
New Actions 631
Reorder RPL Set 631
Enable RPL Item 631
Create Snapshot 631
User interface Changes 631
Improved Error and Warning handling 632

SCT 632

Series Sheets 632
Custom Time Aggregation Summary Rows 632
Navigation from the Diagnostics Output 633

Water Quality 633

Constituent Selection, Method Structure, and Names 633
Run Analysis for Water Quality Dispatching 634

Closed Bug Reports 635

Release Notes Version 6.7 636

Special Attention Notes 636

Earliest Dispatch Timestep - Stream Gage changes 636

License Manager Upgrade 636
Inline Power, Flow Tables and Flow Power 636
Series Slot Bounds Terminology and Warnings 636
Time Aggregation Series Slot Computations 636

Accounting 637

Negative Transfers Out allowed 637

Batch Mode 637

New RCL Commands 637

Data Management Interface 637

Excel Dataset Run Name List 637
Trace Directory DMI 637
Export RBS and Opt Run Analysis information 638

Diagnostics 638

Output Window - Copy Formats 638

Licensing 638

License Manager Upgrade 638

Model Files 639

Locking Model while Open 639

Multiple Run Management 639

HDB Ensembles 639
MRM Descriptors 639
netCDF File Size Improvement 640

Objects 640

Inline Power Plant - Flow Tables and Flow vs Power Tables method 640
Stream Gage - Stage Methods 640
Earliest Dispatch Timestep 640
Power Reservoirs 640
Power Method: Plant Efficiency Curve modifications 640

Tailwater Method: new Coefficients Table method ... 641
Water User - Soil Moisture Methods ... 641

Optimization ... 641

Optimization Solution Analysis Export ... 641
Power Reservoir Methods ... 641
Optimization Power method: Power Surface Approximation modifications ... 641
Optimization Tailwater method: new Opt Coefficients Table method ... 641
Slot Tool Tips show Optimization Solution Information ... 642

Output, Plotting, and Model Reports ... 642

Charts - Timestep Size ... 642
Comma-Separated Values Output Device ... 642
Model Reports ... 643
Date/Time Overrides on Output Items ... 643
Images in Model Reports ... 644
Rich Text in Model Reports ... 644
Output Canvas ... 645
Flow Lines ... 645
Object Icons ... 645

RiverWare Policy Language ... 645

Initialization Rules - Setting Scalar Slots ... 645
Predefined Functions ... 646
Predefined Function Documentation ... 646
RPL Parameters ... 647

Script Management ... 647

New Actions ... 647

SCT ... 648

Custom Summary Rows ... 648

Slots ... 648

Import Paste Negative Values from Excel ... 648
Min/Max Changed to Bounds ... 648
Table Slot - Move Columns and Rows. ... 648

Time Aggregation Series Slots 649
Daily Aggregation 649
Configuration Dialog 649
Modifications to Aggregation Computations 649
Workspace 650
Initial Workspace Appearance 650
Closed Bug Reports 651
Release Notes Version 6.8 652
Data Management Interface 652
Excel DMIs for DateTime values 652
Licensing 652
Licensing for 32 bit RiverWare 652
Objects 652
Reach 652
New Routing method: Modified Puls 652
Table Series Slots are now Temporary 652
Pan Evaporation 653
Reservoir 653
Power Reservoirs 653
Plant Power Table with Units method 653
Power method slots incorrectly displayed 653
Dispatch Slot: LCR Input Efficiency 653
Groundwater Storage 654
Optimization 654
Power Reservoir Power Coefficient Method 654
Output: Model Reports, Output Canvas and Plotting 654
Model Reports 654
Output Canvas 654
Trapezoidal Teacups 655
Additional Settings 655

Plotting - Appearance 655

RiverWare Policy Language 656

Expression Editing 656

Logical Operator Replacement 656

Function Argument Reuse 656

User-Defined Function Renaming 656

Initialization Rules Set Management 656

New Predefined Function - GetSelectedUserMethod 657

RPL Search and Replace 657

Search in All Sets at Once 657

Change Object/Slot names 657

Display of Rule Names 657

Script Management 658

New Actions 658

SCT 658

SCT Custom Cell Colors 658

Script Menu 659

Slots 659

Improved Copy/Paste of Slots to Data Objects 659

Slot Groups on Data Objects 659

Display Preferences 660

Find Slot References 660

USACE-SWD Algorithms 661

Improved Debugging Diagnostics 661

Alternative Routing on Subbasin 661

Water Quality 662

Reservoir method for Salinity 662

Two Layer Segmented 662

Specify Outflow Fraction 662

Specify Fraction changes 662

Closed Bug Reports 663

Release Notes Version 6.9 664
Documentation Searching 664
Data Management Interface 664
Year Mapping Groups 664
Objects 664
Control Point 664
Soil Moisture Method Improvements 664
Agg Diversion Site 664
Water User 665
Optimization 665
With Reward Table Statement 665
Improved Percent Satisfaction Reporting 666
Tailwater Base Value Infeasibility Fixed 666
Output: Charts, Model Reports, and Plotting 667
Charts 667
Configuration Dialog Reorganization 667
Stacked Bar Chart 667
Labels or Legend Location 667
Model Reports 668
Plotting 668
Axis Label Rotation 668
Date Time Formats 668
Legend Reorder 669
Script Management 669
Set Dataset File Action 669
SCT 669
Color Alerts / Conditional Formatting 669
Water Quality 670
Total Dissolved Gas (TDG) modeling 670

Workspace 670
Import Cluster Configuration 670
Improved Zooming 670
Closed Bug Reports 671

Release Notes Version 7.0 672

Special Attention Notes 672
Batch Mode 672
RCL changes 672
Data Management Interface 673
Configure Datasets Utility 673
Database DMI Copy/Paste 673
Database DMI Export/Import 673
Excel Database DMI supports Table, Periodic and Scalar slots. 673
Multiple Run Management 674
Input DMI Repeat Count 674
Ordering of Slots in an RDF file 674
Saved Distributed MRM Run Configurations 674
Objects 674
Reach - Solve Outflow method with Lagged Inflows 674
Reservoirs 674
Dispatch Slots 674
Max Outflow Calculation on the Slope Power Reservoir 674
Reservoir Accounting Methods 675
Reach and Reservoir - Coeff and Exponent and Forecast methods 675
Water User 675
Soil Moisture Modifications 675
Water User Performance Improvement 676
Object Dialogs 676

Custom Slots on Simulation Objects 676
Move Slots Utility 677

Optimization 677

Negative Hydrologic Inflows 677
Preferred Units 677
Improved Performance for Shrinking Constraints 677

Output Devices 677

Charts: Video File Animation Generation 677
Output Canvas 678
Canvas Lines 678
Charts on an Output Canvas 678
Miscellaneous Enhancements 678
Plotting 679
New approach to View and Edit Plot Pages 679
Plotting Scalars 680
Time Scaling 681
Tabular Series Slot Reports - Environment Variables 681

RPL 682

RPL Set Comparison Tool 682
RPL Set Name vs Path 683
RPL Search and Replace Utility 683
Next / Previous buttons 683
Scroll To and Select Match 683
Expression Slot Descriptions are Searched 683
RPL Editing 684
Auto-correct of Typed Values 684
Common Values 684
Copy and Paste from Variable and Argument Declaration 685
Improved History 685
Improved Pasting of Statements with Variables 685
RPL Item Delete Confirmation 686
Stop on NaN for Initialization Rules 686
RPL Predefined Functions - New IntegerWithUnitsToString function 686
RPL WHILE Expression Maximum Iterations 687

Script Management 687

Disabling Actions 687
New Action Types 687
Set Slot Value Actions 688
Setting DateTime values 688
Initial/Default Value 688
Show Dialog Settings 688
Improved status and execution buttons 688
Improved Navigation 688
Removal of Obsolete Settings 689
SCT 689
Column Width 689
Slots 689
Custom Slots on any Object 689
Units 689
Unit Schemes and Slot Copy Paste 689
Water Quality 689
Pipe Junction 689
Water User 689
Workspace 690
Tool Tips 690
Closed Bug Reports 691
Release Notes Version 7.1 692
Batch Mode 692
InvokeDssDMI RCL Command 692
Data Management Interface 692
HDB: Reading and displaying of Metadata 692
Status and Progress Dialog 692

Multiple Run Management 693

HDB Output Ensemble Names for MRM 693

Model Files 693

Auto Backup Save 693
Model Info and Run History 693

Objects 693

Canal - Dispatching 693
Inline Power Plant - Specify Units Generating 693
Power Reservoirs - Specified Power Coefficient 693
Reach Routing Method - Muskingum with Segments 694
Slope Power Reservoir - Weighting Coefficients Interpolation 694

Object Dialogs 694

Object Viewer 694

Optimization 694

Impulse Response Reach Routing 694
Slope Power Backwater Lambda Approximation 695

Output Devices 695

File Size Reduction of Generated Images 695
Charts 695
Model Reports 695
Embed Images in HTML 695
Ensure HTML and add HTML to File chooser 696
Text Items 696
Show/Hide individual Descriptions and Comments 696
Run History Item 696
Output Canvas 697
Resizable charts, icons, and images 697
Printing to Paper and to PDF 697
Teacups / Charts / Text shown on workspace 697
Coordinated Animation 698
Plotting 698
Inconsistency for Patterned Line Appearance 698

Marker Labels ... 698
Editing Multiple Curves and Graphs ... 698
User Specified Axis Units ... 699
Copy/Paste of slots to/from the slot clipboard ... 699
Tabular Series Slot Reports ... 699
Omit Slots Behavior ... 699

RPL ... 700

Diagnostics for Rules/Goals ... 700
Display Settings ... 700
Element Numbering ... 700
ELSE IF Branches ... 700
RPL Debugger ... 701
Rename Variable or Argument ... 701
RPL Set Comparison Tool ... 701
RPL Notes ... 702
RPL Dialog - Description and Notes Indicators ... 702

Run Control ... 703

Run Status Panel ... 703

Script Management ... 703

New Actions ... 703
Execute Script ... 703
Set Run Timestep ... 703
Script Manager Enhancements ... 704
Script Groups ... 704
Show Descriptions ... 704
Open on Model load ... 704
Export/Import Multiple Scripts and Groups ... 704

SCT ... 704

Column Widths per sheet ... 704
Font Specification ... 705
Go To Next NaN ... 705
Go To Menu improvements ... 705
Navigation at bottom of the Sheet ... 705
Show Sheet in New SCT ... 705

Slots 706
Expression Slot Evaluation Keyboard Shortcut 706
Expression Slot Evaluation Range 706
Go To Next NaN 706
Slot Description Indicator 706
Text Series Slots 706
Snapshots 707
New Icon for Snapshots 707
USACE-SWD Methods 707
New Debugging Slots 707
Units 707
New Units: Billion Cubic Meters 707
FlowPerTime RPL Units 707
Unit Converter with DateTime Units 707
Workspace 708
Custom Object Order Dialog 708
Output Canvas Items Shown on Workspace 708
Closed Bug Reports 709
Release Notes Version 7.2 710
Special Attention Notes 710
Data Management Interface 711
DSS Database DMI Reliability 711
Database DMI On/Off States 711
HDB Database DMI Importing Series Slot Notes 711
Model Files 711
Precision of Values Saved in Model files 711

Objects 712
Distribution Canal: Request Routing 712
Groundwater 712
Linking to a Reservoir 712
Preventing Negative Storage 712
Specified Inflows 713
Inline Power 713
Pre-simulation Dispatching 713
Specify Units Generating: Unit Turbine Release is Now Included 713
Power Plant Diversion and Generator Object 714
Reservoirs 714
Linking to Groundwater 714
Diversion Power 714
Max Iterations - Default Value 714
Water User 715
.... Dispatch Slots 715
Removal of Unused Optimization Categories 715
Object Dialogs 715
Object Viewer 715
Custom Slots on Element Objects 715
Optimization 715
Summation Satisfaction Scaling - Numerical Stability Improvement 715
Single Derived Objective per Goal 716
Incompatible Units in Constraints and Objectives 716
New Message for Skipped Goals 716
Simplified Objective for Seed-postponed Problem 716
POSAT Display Improved 717
Save CPLEX Problems Selectively 717
Output Devices 717
Model Reports - Slot Selections Support Wildcards 717
Output Canvas - Flow Lines and Canvas Lines Shown on Workspace 717
RDF Files - Improved Performance 718
RiverWISE 718

RPL 721
RPL Viewer 721
New RPL Predefined Function: ListSlotSet 721
Rule Execution of DMIs 721
CompletePartialDate with Offset 721
Run Control 722
Aggregate Inputs During Timestep Size Change 722
Scenario Manager 722
Script Management 722
New Action: Global Time Scroll 722
Progress Indicators and Display of Actions 723
Slot Selections support wildcards 723
SCT 724
Edit Text Series Slots 724
Set Slot Labels 724
Set Values over Time Range 724
Selector 725
Accessing Slot Sets 725
Slots 726
Slot Viewer 726
Slot Sets 726
Expression Slot - Symbolic Date Ranges 727
Series Slot Notes on Accounting Slots 727
Selection Statistics: Sum Flows to Volume 728
Periodic Slot - Base Year Symbolic Dates 728
Time Aggregation Series Slot: NaN Behavior 728
3D Table Interpolation 728
Units 728
New Unit Type: VolumePerEnergy 728

New Flow and Volume Units 728
Workspace 729
Initial Workspace Timestep 729
Middle Button Pans Workspace 729
Showing Flow Lines and Canvas Lines on the Workspace 729
Closed Bug Reports 730

Release Notes Version 1.0

RiverWare is a new river basin modeling software tool which can load and run models built with PRSYM. This document describes new features, enhancements and changes that are included in RiverWare Version 1.0, released on May 7, 1997.

These changes are new to the executable since the release of PRSYM Version 3.1 on July 29, 1996.

Please direct questions to CADSWES Technical Support at (303) 492-0908 or e-mail: usersupport@cadswes.colorado.edu

A. Required Model File Updates

Aggregate Diversion Site and Water User slot name changes

Many slots on Aggregate Diversion Site and Water User Objects have been renamed. In order to preserve the data in Aggregate Diversions of existing models, a conversion script, included with this release, must be run. The Perl language script is called modelConvert1.0, which is executed by typing the script name followed by the file name to be converted. Until the script is run or the model file is saved under the new executable, a confirmation window will be generated at load time warning that conversion may be necessary. For more details on this procedure, *See "Renaming of Slots" on page 26.*

B. Special Attention Notes

Name Enforcement

Names of objects, slots, and DMIs are now limited to lowercase and capital letters, spaces, and underscores. Existing models which contain illegal characters in object and/or slot names will have these characters automatically converted to a legal text representation when the model is loaded. Expression slots, DMIs, and rules, however, will not automatically be updated to reflect the new names. Explicit updating of these references may be necessary.

solveMB_givenEnergyInflow dispatch method

A bug which prevented Level Power Reservoirs dispatching given Energy and Inflow from iterating to a proper Outflow has been fixed. Reservoirs dispatching under this dispatch method may also have incorrectly mass balanced. Differences in solutions should be expected between RiverWare Version 1.0 and versions of PRSYM when models contain any Reservoirs dispatching under this condition.

C. Known Bugs and Work-Arounds

Locator View Refresh

The Locator View, described in detail below, does not properly refresh the view of the workspace outside of the highlighted rectangle when objects or links are rearranged on the workspace with the **Locator View** dialog open. The dialog may be forced to refresh by closing and then re-opening it.

SCT Menu Bar

The menus at the top of the SCT can be made to "freeze" through a specific series of steps. This results in the menus' sub-items not being displayed when the heading is selected. This situation will only occur if a run is initiated by dragging from the **Run** menu down to **Start Run...** before releasing the mouse and highlighting a cell during the run. When model execution ends, the menus will be frozen. To restore the use of the menus, click on any heading and drag the mouse laterally to another heading. This is a GUI environment bug and may not manifest itself with all X window systems.

Confirmation Dialogs Running Open Windows

Running RiverWare under the Open Look environment causes several GUI peculiarities. The most notable problem is that confirmation dialogs are generated with only one option, the **Yes** button. In order for the GUI to behave similarly to XWindows, Galaxy users should launch the executable with an OpenLook "look and feel" command line argument:

% RiverWare[t] -laf ol

1. Model Loading and Saving

A. Name Enforcement

Names of objects and slots are now limited to lowercase letters (**a** through **z**), capital letters (**A** through **Z**), spaces ( ), and underscores (_). Models previously built under versions of PRSYM may contain illegal characters in their slot or object names. These characters are now converted to legal text representations during model loading. A **List Notice** window is generated to indicate the illegal names detected.

The converted names are displayed in the **Diagnostics Output Window** next to the old names. The RiverWare assigned names may be changed to any other legal name once the model is loaded. Renaming automatically updates expression slots, but will not update constraints, DMIs, or rules. A regular expression search-and-replace is recommended to easily update external files. Illegal characters are converted to the character name surrounded by underscores as below:

!	converts to	_exclamation_		converts to	_at_sign_
#	converts to	_pound_sign_	$	converts to	_dollar_sign_
%	converts to	_percent_	^	converts to	_carrot_
&	converts to	_ampersand_	*	converts to	_asterisk_
(	converts to	_left_parenthesis_	)	converts to	_right_parenthesis_
-	converts to	_dash_	+	converts to	_plus_
=	converts to	_equal_	|	converts to	_pipe_
\	converts to	_backslash_	~	converts to	_tilde_
{	converts to	_left_bracket_	}	converts to	_right_bracket_
[	converts to	_left_square_bracket_	]	converts to	_right_square_bracket_
:	converts to	_colon_	;	converts to	_semicolon_
<	converts to	_left_arrow_	>	converts to	_right_arrow_

,	converts to	_comma_	.	converts to	_dot_
?	converts to	_question_mark_	/	converts to	_slash_

B. Quick Saving

The **Model ➥ Save** command now saves the workspace over the currently loaded file without invoking a file chooser. Output values are saved with the model by default. To save the model under a different name, or to prevent output values from being included in the model file, select **Model ➥ Save As...**, and follow the Saving procedure as in previous versions of PRSYM. The last **Save As...** parameters are then used for all subsequent **Save** commands. This new behavior is consistent with other standard software packages, but may confuse long-time users of PRSYM. It is recommended to write-protect important model files to protect them from accidental loss.

C. Summary Info

A new **Summary Info...** command is available from the **Model** menu in the main RiverWare workspace window. The command generates slot instantiation diagnostics and memory usage statistics in the **Diagnostics Output Window**. The messages provide information on the number and visibility status of instantiated slots as well as the number of slot proxies for each object on the workspace. **Summary Info** also provides total model memory usage statistics for each type of slot, including their total number and the memory required for an empty slot.

2. Simulation

A. Table Interpolation

Failed table interpolations now abort the simulation run in addition to producing a diagnostic warning message. Previously, table interpolation errors allowed the run to continue, often causing fatal errors later in the simulation. A diagnostic warning message provides the interpolation lookup value, the table column at which the lookup failed, the data range of this column, and the row number where missing data was expected.

B. Read Only Slots

Values in Data Object slots marked **Read Only** are no longer cleared at the beginning of a run. Previously, values at timesteps flagged as OUTPUT were automatically reset to NaN. In order to preserve values which may be needed for future scenarios, slots marked as **Read Only** no longer have their outputs cleared.

C. Invalid Timesteps

RiverWare now aborts a simulation with an error when an attempt is made to write a value to an invalid timestep. This occurred most commonly in the Thermal Object's Adjusted Load slot. The Thermal Object calculations write data to this slot at hourly intervals regardless of the model run timestep. This bug has been fixed, but there may be other instances where an attempt is made to write a value to an invalid timestep. When such an attempt is made, RiverWare will now abort simulation with the message "**Failed to set value to: value because the date is not contained within the time series.**" This error may be prevented by setting a single input value in the erroneous slot at the initial timestep. The input value will ensure that the user-configured timeseries is not reset to match the run control during run initialization.

3. Run Control

A. Date Range

The range of allowable timeseries dates has been expanded to include all years between 1800 and 2300 A.D. All simulation calculations and/or value assignments performed within this range are valid.

B. Yearly Timestep

The **Yearly** timestep has been enabled as a valid simulation timestep. This step may be selected in the **Run Control** and slot **Time Series Range** dialogs.

C. Setting Run Times

The results of changing run times in the **Run Control** dialog have been updated to be more consistent. A change to the **Initial**, **Finish**, or **Duration** parameter now affects the run times as follows:

A change to the **Initial** time modifies the **Finish** time accordingly.
Duration remains the same.

A change to the **Finish** time modifies the **Duration** accordingly.
Initial time remains the same.

A change to the **Duration** modifies the **Finish** time accordingly.
Initial time remains the same.

D. Control Buttons

The behavior of the **Run Control** buttons has been revised. The **Start** button is no longer active during a paused run, and the **Start** and **Step** buttons now execute from the initial timestep when a run is stopped. The current behavior of all of the buttons is:

Start:	Execute a run from the initial timestep.
Step:	Execute the next timestep only. (If no run is in progress or a run is stopped, execute the first timestep.)
Pause:	Interrupt execution after the current timestep.
Continue:	Resume execution from the current timestep.
Stop:	Abort execution after the current timestep.

E. Loading State

The Simulation Run Status window has been expanded to include the execution state **Loading**. This state is displayed if the Run Status window is open while a model is loading. Once the model has completed loading, the status reverts to **Loaded**.

F. Stop During Initialization

A run may now be stopped during the initialization timestep. Previously, the **Stop** command would only be processed at the end of the timestep. In large models, this initialization could often take a significant amount of time to execute. The **Stop** command now intervenes to abort the run during this timestep.

4. Engineering Objects

A. Reservoirs: Modifications were made as follows

- **Beginning of Target Operation**

The Target Operation code was rewritten to include a flag marking the Beginning of Target. A user-defined Beginning of Target timestep is marked with a **TB**, or Target Begin, flag in the Storage or **Pool Elevation Edit Slot** dialog. When solving a target operation, RiverWare searches backwards from the Target time until it finds a valid Target Begin flag. The Target Operation is solved using the value from the timestep prior to the Target Begin flag as an initial condition. If the timestep prior to the Target Begin does not have a valid Storage or Pool Elevation, or a valid input value exists between the Target Begin and the Target, the simulation aborts with an error. Likewise, if the Target Begin or Target timestep is already determined, simulation aborts. If no Target Begin flag is specified, RiverWare searches backwards to the first valid value and solves the Target Operation with this initial condition.

When a beginning of target is assumed in this manner, RiverWare marks the timestep where the Target Operation actually begins with a **tb** (lowercase) flag in the Open Slot dialog. This flag is treated as an output, and is automatically cleared at the start of the next run. Setting a Target Operation from an SCT generates both the Target and Target Begin flags, and clears any previous Target Operations which overlapped with the new range.

		Target Begin				Target
Storage:	*900,000*	*NaN*	*NaN*	*NaN*	*NaN*	*1,000,000*
	5/1/95	*5/2/95*	*5/3/95*	*5/4/95*	*5/5/95*	*5/6/95*
	I or **O** (known)	**TB** or **O**	**O**	**O**	**O**	**T** (known)

Figure: 1 Prior to Target Operation

Storage:	*900,000*	*921,236*	*942,571*	*961,652*	*980,712*	*1,000,000*
	5/1/95	*5/2/95*	*5/3/95*	*5/4/95*	*5/5/95*	*5/6/95*
	I or **O**	**TB** or **tb**	**O**	**O**	**O**	**T**

Figure: 2 After Target Operation

Models previously built under PRSYM do not have Target Begin flags. These models will solve as they did before. RiverWare searches backwards until it finds a valid value and assumes a Beginning of Target time immediately after the valid value. In certain cases, however, models may have previously been overdetermined. Some older models may be overwriting Inflows or Outflows set by a Target Operation earlier in the run. This is caused by the Target Operation searching backwards too far for a beginning of target value which is not yet known. Due to dispatching order and other Target Operations, new Inflows or Outflows may be calculated which invalidate the original Target Operation. These modeling errors will now produce a "Setting Slot from multiple sources" message and abort simulation. The Target Operation may be corrected by explicitly setting a Target Begin flag at a timestep following the overdetermination.

- **Target Operation Calculation Category**

The **TargetOperationCalculationCategory** has been expanded to all Reservoir objects. This Category was previously available only on Power Reservoirs. The **noTargetCalc** Method, which performs no calculations, has also been added to the two existing Methods and is now the default Method for this Category. Setting a Target Operation with the **noTargetCalc** Method selected will produce an error and abort simulation.

- **Hydrologic Inflows**

A new User Method called **noHydrologicInflow** has been added to all Reservoirs. This is now the default Method for the **HydrologicInflowCalculationCategory**. This Method is used to model Reservoirs without the influence of hydrologic inflows, instantiates no slots, and requires no data.

The **solveHydrologicInflow** Method is no longer available on SlopePowerReservoirs and PumpedStorageReservoirs. Although the Method was previously selectable, it would not solve for timesteps where Hydrologic Inflow was not given on these Reservoirs.

The **inputHydrologicInflow** User Method has been modified not to initialize any linked slots at the Beginning of Run. The method previously initialized any unspecified Hydrologic Inflows and Hydrologic Inflow Adjust values to zero, and calculated the Hydrologic Inflow Net. It now checks that these slots are not linked prior to making any assignments. This allows values to propagate from other objects before dispatching.

- **Sediment Calculation**

A new User Method Category called **Sediment Calculation** has been added to all Reservoirs. The Category is used to enable algorithms which adjust reservoir Elevation Volume and Elevation Area relationships in response to sediment inflow. There are two Methods available for selection within this Category, the default **No Sediment Calc** and **CRSS Sediment Calc**. The default Method performs no computations. Models previously saved under PRSYM will produce identical results when the default **No Sediment Calc** Method is selected.

The **CRSS Sediment Calc** Method is a reservoir sediment distribution algorithm based on the US Bureau of Reclamation's Empirical Area Reduction Method. Sediment distribution is calculated by an iterative loop in which a total volume loss is derived from an assumed top of sediment elevation. The volume loss and top of sediment elevation are recalculated at each iteration, until the volume loss is equal to the given sediment inflow. The loss at each iteration is determined by an algorithm which utilizes elevation/area and elevation/volume data for the reservoir in conjunction with an empirical equation. This equation requires user-specified parameters to indicate the portion of total area which is taken up by sediment at any given elevation. The equation dictates the shape of the accumulated sediment and has a close relationship to the elevation-volume and elevation-area characteristics of the reservoir. The new elevation/area and elevation/volume data is stored in a polynomial coefficient table. This table is recalculated after each timestep. The actual Elevation-Area and Elevation-Volume tables used by RiverWare are adjusted following convergence of the solution, but prior to the hydrologic simulation.

The **CRSS Sediment Calc** Method is modeled after sedimentation calculations performed by the US Bureau of Reclamation's Colorado River Simulation System (CRSS) model. The Method is initialized during TIMESTEPBEGINRUN. The User Input Elev Area Data is used to create the initial Elevation Volume and Elevation Area Tables which are required by the simulation. The elevation increments at which the two tables' values are generated are determined by the Elevation Vol_Area Table Increment slot value. The Method initialization also uses the User Input Elev Area Data to create the Elevation Area Table Used and Elevation Volume Table Used. These tables are used solely for recalculating sediment distribution in later timesteps. The elevation increments for these tables are equal to those of the User Input Elev Area Table. Variable table increments allow sedimentation parameters to be calculated with a different precision than that used for the general Elevation Area and Elevation Volume Tables.

Input data is critically important for this Method. The close relationship between the empirical area reduction equation and the shape of the reservoir (reflected in the elevAreaTableInput table) makes this Method very sensitive to input data. The physical characteristics of the given reservoir must be considered when choosing empirical parameters for this Method. The Bureau of Reclamation currently considers four types of reservoirs, each having a corresponding set of empirical area reduction parameters. The reservoir type classification is based on shape, the manner in which the reservoir is to be operated, and the size of the sediment particles to be deposited, with the primary emphasis on shape. Tables are used to classify the reservoirs based on these characteristics. Once the type has been established, the parameter values for that type can also be taken from tables in the literature. An incorrect set of parameters for a given reservoir will lead to an inability to achieve convergence on the sediment distribution.

It is also important to note that this Method does not recalculate Elevation Area or Elevation Volume Tables during time horizon dispatching such as Target Operations. Models which do not solve chronologically may produce errors due to incorrect Elevation Area and Elevation Volume Tables. Please contact CASDWES staff for additional information before implementing this new Method.

Following is a list of slots relevant to this method, which includes the **slot name** in bold type, the (slot) as it appears in the code in parentheses, the slot type (Multislot, etc.), the unit type(s) in all caps (LENGTH, FLOW, etc.), a *brief description* of the slot in italics, and additional comments in plain type.

☞ **Slots with Required Input Data**

- Sediment Inflow(sedimentInflow)
  SeriesSlot
  VOLUME
  volume of sediment flowing into the reservoir each timestep

- User Input Elev Area Data(elevAreaTableInput)
  TableSlot
  LENGTH vs. AREA
  initial Elevation Area relationship
  These values are initial conditions for the first timestep of the simulation. The table’s elevation increments will be used for all internal sedimentation calculations.

- Elevation Vol_Area Table Increment(tableIncrement)
  ScalarSlot
  LENGTH
  elevation increments for the generated Elevation Volume and Elevation Area Tables
  These tables often need more precise elevation increments than the sediment calculation tables.

- Sediment Distribution Coefficients(distributionReductionCoeff)
  TableSlot
  NOUNITS
  parameters for empirical equation governing sediment distribution

☞ **Output Slots**

- Initial Elevation Area Table (initElevAreaTable)
  TableSlot
  LENGTH vs. AREA
  initial elevation area table
  This table is provided for comparison with initial data.

- Initial Elevation Volume Table (initElevVolTable)
  TableSlot
  LENGTH vs. VOLUME

initial elevation volume table
This table is provided for comparison with initial data.

- Elevation Area Table Used (elevAreaTableUsed)
  TableSlot
  LENGTH vs. AREA
  generated elevation area table for calculating sediment distribution
- Elevation Volume Table Used (elevVolTableUsed)
  TableSlot
  LENGTH vs. VOLUME
  generated elevation volume table for calculating sediment distribution

Sediment Functions

The following function is called within TIMESTEPBEGINRUN on the Reservoir object.

getInitialTable() This function performs initialization of the tables to be used in sediment calculations. The user-input elevAreaTableInput table is used in conjunction with the function simple_poly (see page -14) to generate a series of coefficient arrays. These coefficient values are then used in the following polynomial equation to calculate incremental volumes at given elevation points:

$$Vol_i = (Coeff_{[i-1]}a_0) + (Coeff_{[i-1]}a_1 \times \Delta Elev) + (Coeff_{[i-1]}a_2 \times \Delta Elev^2)$$

where $\Delta Elev$ is the change in elevation between points in the elevAreaTableInput table. These volume values are used to create the initial Elevation Volume Table, required for initialization calculations in RiverWare. For consistency, incremental area values are recalculated using the same coefficient values in the function area_from_coeff (see below). These area values are then used to create the initial Elevation Area table, also required for initialization calculations.

The following functions are called within TIMESTEPBEGINTIMESTEP on the Reservoir object.

create_area_reduction() This function is called at the beginning of the area_reduction function (see below). It allocates memory storage for the local arrays used in subsequent calculations and copies elevation-area and elevation-volume data from the existing slots to these arrays. Slots are not used in the iterative calculations. This function then calls the relative_sediment (see below) function to calculate the proportion of the reservoir slice which consists of sediment for each elevation point.

area_from_coeff() This function is used to calculate areas at given elevations using the coefficients calculated in simple_poly (see page -14). It is called in both getInitialTable and area_reduction. The polynomial for calculating area values at elevation *i* is:

$$Area = (Coeff_{[i]}a_1) + (2.0 \times Coeff_{[i]}a_2 \times \Delta Elev) + Area\ Correction\ Term$$

The area correction term is calculated within this function based on the elevation increment size and the coefficient values.

relative_sediment() This short function applies the empirical area reduction equation, using the user-input parameters, to calculate the proportion of the total area at a given elevation which is taken up by sediment. The equation uses a relative depth (*depth of the given slice* / *total depth of the reservoir*) passed in from the external call.

area_reduction() This function is the heart of the sedimentation calculations. It contains the iterative loop which distributes sediment in the reservoir until the estimated additional volume of sediment is equal to the sediment inflow at the current timestep.

create_area_reduction is first called to create and initialize the local variable arrays. Once elevation-area and elevation-volume data is in local arrays and relative sediment values are calculated for each elevation, the iterative convergence begins. A sediment elevation equal to the middle of the reservoir is used to seed the iteration for each timestep. This sediment elevation corresponds to the base of the distributed sediment load in the reservoir. A total area for this elevation is then calculated by the function area_from_coeff. For each elevation point above the sediment elevation, sediment areas are calculated. These sediment areas are determined from the relative sediment values previously solved in create_area_reduction, normalized to the relative sediment of the current base elevation guess. All area slices above the base elevation are adjusted to account for the space taken up by the current sediment load in the reservoir. All area slices below the base elevation are set equal to their total area.

Once the sediment has been distributed for the current sediment base elevation guess, the total volume of sediment is calculated using incremental elevation differences multiplied by the average sediment area for each increment. The estimated total sediment volume for the given timestep is equal to the sum of the incremental sediment volumes. This total volume is compared to the sediment inflow volume for the current timestep (the previous timestep's sediment load). If the difference between the two volumes is within the convergence criterion, the iterative loop is exited. If the difference is not within the convergence criterion, the sediment elevation estimate is adjusted. If the calculated volume is greater than the actual volume, the sediment elevation is reduced by a fraction; if it is less than the actual volume, the sediment elevation is increased by a fraction. The steps described above are then repeated with the new sediment elevation.

Upon convergence, the Elevation Volume and Elevation Area Table slots are adjusted to reflect the new sediment distribution. This is done by subtracting the sediment areas and sediment incremental volumes from the existing areas and volumes in the tables.

revise_table() This function eliminates meaningless rows below the sediment elevation from the Elevation Volume and Elevation Area Tables.

simple_poly() This function calculates the polynomial coefficients (e.g. $coeff_{[i]}a1$) that are used to determine area and volume values at given elevations. These coefficients are calculated based on elevation-area data, initially supplied by the User InputElev Area Data table and subsequently supplied by the existing Elevation Area Table slot.

area_table_increment() / vol_table_increment() These functions use interpolation to adjust the Elevation Area and Elevation Volume Table slots to the elevation increment specified by the user. It is generally expected that this increment will be smaller than that used in the calculations described above; the above calculations use the Elevation Volume Table Used and Elevation Area Table Used, which are incremented according to the User Input Elev Area Data table. The option of specifying a finer increment to be used by all other RiverWare hydrologic calculations saves computing time in the more approximate sedimentation calculations.

- **Outflow Maximum Capacity**

A new flag has been added to compute the maximum possible Outflow from a Reservoir on a given timestep. Setting the **Max Capacity** flag on a Reservoir Outflow slot forces the Outflow to equal the sum of the maximum (Turbine) Release and the maximum Spill. This flag should be used with great care, as its effects may cause downstream reservoirs to exceed their operating ranges. The use of this flag also depends heavily on having a reliable and accurate Regulated Spill Table and Max Turbine Q or Max Release table in order to attain reasonable Outflow values.

The **Max Capacity** flag is set by highlighting a simulation timestep on the Outflow slot of a Reservoir and selecting **Timestep I/O ➥ Max Capacity**. RiverWare places an **M** at the selected timestep to indicate that the flag is active. This flag is treated as an INPUT, but does not require a value. If a valid Outflow value is present at the flagged timestep, it is ignored in the simulation; a new Outflow value is calculated and displayed at that timestep. This behavior is similar to the Max Capacity and Best Efficiency flags of the Energy slot and the Drift flags of the Regulated Spill and Bypass slots. A Reservoir which has the Outflow Max Capacity flag set may dispatch under any of the “givenOutflow” dispatch methods:

solveMB_givenOutflowHW for Level Power, Slope Power, and Storage Reservoirs.

solveMB_givenOutflowStorage for Level Power, Slope Power, and Storage Reservoirs.

solveMB_givenInflowOutflow for Level Power, Slope Power, and Storage Reservoirs.

solveMB_givenOutflow for Pumped Storage Reservoirs.

The Outflow Max Capacity flag may NOT be used on Reservoirs linked to a Canal, when solving for Hydrologic Inflow, or when solving a Target Operation.

The Outflow Max Capacity solution is iterative. The exact sequence of calculations in each iterative loop is dependent on the type of Reservoir and the selected Spill Calculation Method. In all cases, the maximum Spill and maximum controlled Release are calculated individually, then summed. If the selected Spill Method includes Regulated Spill, the current or previous Pool Elevation is used to look up the maximum Regulated Spill from the Regulated Spill Table. This value is set in the Regulated Spill slot, and the selected Spill Calculation Method is called. Any input Bypass and/or required Unregulated Spill are considered within the Spill Method. Next, the maximum release is calculated. If the Reservoir is a Power Reservoir, the selected Tailwater Calculation Method is executed to determine the Operating Head. This Operating Head or the Pool Elevation (in the case of Storage Reservoirs) is used to look up the maximum release from the Max Turbine Q or the Max Release table, respectively. Finally, the maximum release and the calculated Spill are added to determine the total maximum Outflow. This Outflow is used to mass balance the Reservoir. The iteration is repeated until Convergence is met or Max Iterations is exceeded.

- **CRSS Bank Storage**

The **CRSSBankStorageCalc** User Method has been modified so that negative Bank Storage values are reset to zero. This change was made to more precisely match the Bureau of Reclamation's CRSS solution method. Users should be aware that the Change in Bank Storage slot is NOT adjusted when the Bank Storage is reset to zero. Since the Change in Bank Storage is used in the Reservoir mass balance, the reported Bank Storage value may not agree with Reservoir conditions.

- **Pan and Ice Evaporation**

A new User Method, called **PanAndIceEvaporation** has been added to the **Evaporation and Precipitation** Method Category of all Reservoirs. The Method is used to calculate evaporation from a reservoir whose surface may be partially covered with ice. The Method uses the Pan Ice Switch slot as an indicator of whether ice is present on the surface of the reservoir. A default **0.0** value in the Pan Ice Switch triggers the Method to solve for Evaporation as the product of the Pan Evaporation Coefficient, Pan Evaporation, and average Surface Area over the timestep. A value of **1.0** in the Pan Ice Switch triggers the Method to solve for Evaporation as the product of the Surface Area not blocked by Surface Ice Coverage, the average of the Min and Max Air Temperature, and the K Factor. In both cases, the

Precipitation is calculated as the product of the Precipitation Rate and the average Surface Area over the timestep.

Following is a list of slots relevant to this method, which includes the **slot name** in bold type, the (slot) as it appears in the code in parentheses, the slot type (Multislot, etc.), the unit type(s) in all caps (LENGTH, FLOW, etc.), a *brief description* of the slot in italics, and additional comments in plain type.

☞ **Slots with Required Input Data**

- Elevation Area Table(elevAreaTable)
  TableSlot
  LENGTH vs. AREA
  surface area of the reservoir for each given elevation

☞ **Slots with Optional Input Data**

- Pan Ice Switch(panIceSwitch)
  SeriesSlot
  NOUNITS
  indicator of surface ice coverage for each timestep; **0.0** *= no ice,* **1.0** *= ice*
  This slot's values default to **0.0** for any timesteps not specified by the user.

- Precipitation Rate(precipRate)
  SeriesSlot
  VELOCITY
  precipitation rate onto surface
  This slot's values default to **0.0** for any timesteps not specified by the user.

- Pan Evaporation(panEvaporation)
  SeriesSlot
  VELOCITY
  evaporation rate from surface
  This slot is only required if the Pan Ice Switch is **0.0**.

- Pan Evaporation Coefficient(panCoeff)
  TableSlot
  FRACTION
  weighing factor for pan evaporation rate
  This slot is only required if the Pan Ice Switch is **0.0**.

- Surface Ice Coverage(iceCoverage)
  SeriesSlot
  FRACTION
  fraction of surface area which is covered by ice
  This slot is only used if the Pan Ice Switch is **1.0**, and defaults to a value of **0.0** for any time-

steps not specified by the user.

- Min Air Temperature(minTemperature)
  SeriesSlot
  TEMPERATURE
  minimum air temperature during the timestep
  This slot is only required if the Pan Ice Switch is **1.0**.
- Max Air Temperature(maxTemperature)
  SeriesSlot
  TEMPERATURE
  maximum air temperature during the timestep
  This slot is only required if the Pan Ice Switch is **1.0**.
- K Factor(kFactor)
  SeriesSlot
  LENGTHperTEMPERATURE
  factor relating average temperature to evaporation rate
  This slot is only required if the Pan Ice Switch is **1.0**.

☞ **Output Slots**

- Surface Area(surfaceArea)
  SeriesSlot
  AREA
  surface area of the reservoir at the end of the timestep
- Evaporation(evaporation)
  SeriesSlot
  VOLUME
  volume of water lost to evaporation

B. Power Reservoirs: Modifications were made as follows

❑ **Hydro Capacity**

A new getHydroCap utility has been designed to calculate Hydro Capacity more accurately. Previously, HydroCapacity was calculated as the product of the Maximum Power Coefficient and the maximum Turbine Release at the current Operating Head. A shortcoming of this approach was that the Operating Head used to determine the Power Coefficient and maximum Turbine Release did not reflect the changes brought about by the Turbine Release itself. For the purpose of computing Hydro Capacity, an iterative solution accounting for the changes in Operating Head as a result of the Turbine Release-affected Tailwater Elevation is necessary.

The iterative solution uses the maximum Turbine Release at the current Operating Head to calculate the Tailwater Elevation. This value is then used to compute a new potential Operating Head. The iteration continues until the difference in Operating Head is less than Convergence or the Maximum number of Iterations is reached. The Maximum Power Coefficient is then looked up in the Max Power Coefficient table using the new theoretical value for Operating Head. The advantage to using this potential value for Operating Head compared to using the actual Operating Head of the current reservoir at that timestep should now be apparent. In addition, if the current reservoir's Tailwater Base Value is linked to the Backwater Elevation of a downstream Slope Power Reservoir, getHydroCap will now solve for the Backwater Elevation of the downstream reservoir and use that value as the Tailwater Base Value when calculating Tailwater Elevation. Finally, if the Turbine Release prior to the start of Hydro Capacity calculations is equal to the value in the Max Turbine Q table for the current Operating Head, or if Energy is flagged as MaxCapacity, Hydro Capacity is explicitly set to the value in the Power slot.

As might be expected, this iterative solution process may produce significantly different Hydro Capacity values than the PRSYM executables. These differences are most pronounced in cases where Hydro Capacity is explicitly set to the value in the Power slot and when the Tailwater Base Value of the current reservoir is linked to a downstream Slope Power Reservoir's Backwater Elevation. The user will not notice any changes in the GUI as a result of this modification. This utility requires no new data.

❑ **Unit Generator Power Limits**

The **unitGeneratorPowerCalc** Method now allows a maximum Power generation Limit for each generator type to be specified. The power calculated for the generator type(s) using this method may not exceed the user-specified Power production Limits for that type(s). Power is calculated in the same manner it was before; however, turbine power may be reduced to remain within the Limit. Reductions in power have no effect on Turbine Release. Flow is routed through the turbines regardless of the maximum Power generation Limit. The Generators Available table series slot has been modified to accommodate the new data: it is now an aggregate series slot named Generators Available and Limit. This slot contains two columns for each unit—one for the availability and one for the power limit of the particular generator type.

☞ **Slots with Required Input Data**

- Generators Available and Limit(generatorsAvailableLimitTable)
  AggSeriesSlot
  NOUNITS, POWER
  generator unit availability and power production limit
  This slot is a Series slot with two columns available for each unit.

❑ **Pump/Generator Unit Types**

The way in which individual Pump and Generator Unit Types are defined has been modified for Pumped Storage and Power Reservoirs, respectively. The Pump Unit Types table and Generator Unit Types table now contain a single column. The Pump/

Generator Number is no longer input into the first column; it is now automatically specified by the row label. The Pump/Generator Type is now specified in the first column. As rows are appended, the type of each new unit may be defined.

Checks are now performed during run intitialization to ensure that the number of units in the Pump/Generator Unit Types table matches the number of blocks in the Available Pumps/Generators Available and Limit tables. The number of unit types must also match the number of blocks in the Head vs. Pump Flow, Head vs. Pump Power, Best Generator Flow, Best Generator Power, Full Generator Flow, and Full Generator Power tables. If any of these criteria are violated, RiverWare aborts the run with a diagnostic error message.

C. Pumped Storage Reservoirs

Modifications were made as follows:

❑ **Gate Setting**

A new User Method Category called **Gate Setting** has been added to Pumped Storage Reservoirs. The new Category is used to enable a Method which looks up a Gate Setting based on the current Operating Head. There are two Methods available for selection within this Category: the default **No Gate Setting Calc** and **Calculate Gate Setting**. The default Method performs no computations. Models previously saved under PRSYM will produce identical results when the **Calculate Gate Setting** Method is selected.

Two slots are instantiated for the **Calculate Gate Setting** Method:

☞ **Slots with Required Input Data**

- Best Gate Setting(headBestGateSettingTable)
  TableSlot
  LENGTH vs. NOUNITS
  relationship between operating head and gate setting

☞ **Slots with Output Data**

- Gate Setting(gateSetting)
  SeriesSlot
  NOUNITS
  index representing gate setting

D. Ground Water Storage

A new GroundWaterStorage object has been added to allow modeling of groundwater recharge, storage, and flow due to irrigation activities. The object is a simple underground storage container which fills with the groundwater portion of WaterUser return flow and spills based on a selected User Method. No attempt is made to account for Darcyian or aquifer properties. The Groundwater Object may be created by selecting its icon in the Palette and dragging it onto the workspace.

There are three general, or non-Method specific slots on the GroundWaterStorage object. Following is a list of slots relevant to this method, which includes the **slot name** in bold type, the (slot) as it appears in the code in parentheses, the slot type (Multislot, etc.), the unit type(s) in all caps (LENGTH, FLOW, etc.), a *brief description* of the slot in italics, and additional comments in plain type. They are:

- Inflow(inflow)
  MultiSlot
  FLOW
  groundwater recharge from water user diversions
- Outflow(outflow)
  SeriesSlot
  FLOW
  groundwater return to surface water
- Storage(storage)
  SeriesSlot
  VOLUME
  volume of groundwater stored
  An initial (beginning of run) value must be input.

The GroundWaterStorage object currently solves under one dispatch method only, solveGWMB_givenInflow. This dispatch requires that the current Inflow be known to solve. The Inflow may be input or linked to the GW Return Flow slot on a Water User Element. The calculated Outflow may be linked to the Return Flow or Local/Hydrologic Inflow slot on a Reach or Reservoir.

A User Method Category called **GWOutflowCalc** is available on the GroundWaterStorage object, used to enable algorithms which calculate Outflow. There are four Methods available for selection within this Category: the default **none**, **TableFlow**, **LinearFlow**, and **ExponentialFlow**. The default Method performs no computations and is not a valid selection.

The **Table Flow** Method iterates a mass balance calculation and a table lookup for Outflow based on the Storage, seen below, during the timestep. The iteration continues until Max Iterations is surpassed or the outflows found by both methods differ by less than Convergence.

$$Storage = Storage(t-1) + (Inflow \times timestep\ length) - (Outflow \times timestep\ length)$$
$$Outflow = Storage\ Outflow\ Table\ Lookup(Storage)$$

☞ Slots with Required Input Data

- Storage Outflow Table(storOutflowTable)
  TableSlot
  VOLUME vs. FLOW
  relationship between storage and outflow

☞ Slots with Optional Input Data

- Max Iterations(maxIterations)
  TableSlot
  NOUNITS
  maximum number of times to iterate mass balance and table lookup
- Convergence(convergence)
  TableSlot
  NOUNITS
  stopping criteria for iterative solutions

☞ Slots with Output Data

- Outflow(outflow)
  SeriesSlot
  FLOW
  outflow from groundwater storage

The **Linear Flow** User Method calculates Outflow as a linear function of the previous timestep's Storage. This Outflow is then used in a mass balance to determine the new Storage. If a Max GW Capacity has been entered and the new Storage exceeds it, the excess Storage is reallocated. Any excess volume of water is added to the previously computed Outflow.

$$Outflow = GW\ Alpha\ Param \times Storage(t-1)$$

The GW Alpha Param has no units. The value input into this slot must be in terms of the proper units to convert from Storage to Outflow (unit type of $TIME^{-1}$), given the user units for each of these slots. For example, when Storage and Outflow are displayed with user units of acre-ft and cfs, respectively, the GW Alpha Param value must be in units of cfs/acre-ft. No enforcement of units is performed in this Method.

☞ Slots with Required Input Data

- GW Alpha Param(gwAlphaTable)
  TableSlot
  NOUNITS
  linear relationship between storage and outflow

☞ Slots with Optional Input Data

- Max GW Capacity(maxGWCapacity)
  TableSlot
  VOLUME
  maximum groundwater storage

☞ Slots with Output Data

- Outflow(outflow)
  SeriesSlot
  FLOW
  outflow from groundwater storage

The **Exponential Flow** User Method calculates Outflow as an exponential function of the previous timestep's Storage. This Outflow is then used in a mass balance to determine the new Storage. If a Max GW Capacity has been entered and the new Storage exceeds it, the excess Storage is reallocated. Any excess volume of water is added to the previously computed Outflow.

$$outflow = gwAlphaTable \times storage(t-1)^{gwBetaTable}$$

The GW Alpha Param has no units. The value input into this slot must be in terms of the proper units to convert from Storage to Outflow (unit type of $TIME^{-1}$ x $(LENGTH^3)^{\beta-1}$), given the user units for each of these slots. For example, when Storage and Outflow are displayed with user units of acre-ft and cfs, respectively, and the GW Beta Param is 2, the GW Alpha Param must be in units of cfs/acre-ft^2. No enforcement of units is performed in this Method.

☞ Slots with Required Input Data

- GW Alpha Param(gwAlphaTable)
  TableSlot
  NOUNITS (scalar)
  linear portion of relationship between storage and outflow

- GW Beta Param(gwBetaTable)
  TableSlot
  NOUNITS
  exponential portion of relationship between storage and outflow

☞ Slots with Optional Input Data

- Max GW Capacity(maxGWCapacity)
  TableSlot
  VOLUME
  maximum groundwater storage

☞ Slots with Output Data

- Outflow(outflow)
  SeriesSlot
  FLOW
  outflow from groundwater storage

E. Reaches

The existing Reach code has been revised to improve efficiency, structure, and readability. Most changes relate to the internal structure of the Reach object and will be completely invisible to users. The visible changes and enhancements which are of concern to users are listed below:

❑ **Slot Dependencies**

Slots are now dependent on the user-selected routing Method. Only the slots required by the chosen routing Method will now appear in the Open Object slot list. This alleviates some previous confusion caused by unused slots in the object. Reaches are now consistent with all other RiverWare objects in only displaying slots which are required input or calculated within the method.

❑ **Local Inflow Calculation**

The hydrologicInflowCalculationCategory, its User Methods, and the slot Hydrologic Inflow, have all been changed from “hydrologic” to “local” Inflow. This was done to be consistent with Reservoir objects which already used the “local” nomenclature. The User Methods are now named **inputLocalInflow** and **calcLocalInflow**. The renamed **localInflowCalculationCategory** is now dependent on the **NoRouting** User Method, since it is the only Routing Method which accounts for local inflows.

❑ **Stability in Routing Methods**

Certain Routing Methods are inherently stable in their numerical schemes while others may be subject to considerable error. For conditionally unstable solution techniques, acceptable operating ranges may be determined analytically. Both the Muskingum-Cunge and the Macormack Methods now have stability checks based on user input parameters. An error message appears if the user has input values which could lead to instability.

❑ **Drying up due to Diversion**

A new check has been added to prevent Reaches from drying up due to large Diversions in the kinematicRouting, muskingumCungeRouting, and macCormackRouting methods. RiverWare now aborts simulation with an error message when the Diversion from a Reach is equal to its Inflow in any of these Methods.

❑ **Time Lag Over determination**

Potential overdetermination is now being checked in TimeLagRouting. The checks compare the mass balance calculated values against the existing input slot value. If the values differ, this is taken as an indication of competing solutions. An overdetermination error message appears, and the simulation is aborted. The checks take place after each mass balance calculation in the TimeLag User Method.

Variable Time Lag Routing Initialization

When solving for Outflow in the variableTimeLagRouting Method, unknown Diversion and Local Inflow values prior to the first simulation timestep are now assumed to be zero. These values are required to solve for the side flow contribution to the Reach Outflow. Consistent with the Diversion and Local Inflow of Reservoirs, these side flows now default to zero if not input.

SSARR Routing Method

A new routing Method, **SSARRrouting**, has been created for Reaches. This routing Method is a simple storage routing with storage time calculated based on a user-input polynomial. It calculates outflow based only on user input or linked inflow values. It does not use local inflow, diversion, or return flow for the calculation.

☞ **Slots with Required Input Data**

- storage time exponent(powr)
  TableSlot
  NOUNITS
  exponent value for calculating storage time with simple polynomial
  This slot is used to calculate storage time in SSARR routing method.
- storage time coefficient (kts)
  TableSlot
  NOUNITS
  coefficient value for calculating storage time with simple polynomial
  This slot is used to calculate storage time in SSARR routing method.
- number of segments in reach (nseg)
  TableSlot
  NOUNITS
  number of segmental divisions along the length of the reach
  This slot is used to subdivide reach into segments for routing calculations.

Impulse Response Routing Method

The Impulse Response Routing Method now flags an error and aborts the run if the Inflow at the previous timestep is not known. A previous Inflow is required by this routing solution type and should be input or calculated.

Stage and Volume Calculation

A new User Method Category called **stageVolumeCalculation** has been added to Reaches objects. The Category is used to enable algorithms which calculate the water surface elevation at the top and bottom of a Reach as well as the volume of water contained in that reach. It is anticipated that this calculation will be used to determine the maximum diversion from gravity flow structures. The Category is only available when the **timeLagRouting** Method has been selected. There are two Methods available for selection within this Category, the default **noCalc** and **tableLookUp**. The default Method performs no computations. This Method

Category is executed after the Reach Routing Methods and currently does not influence mass balance in any way.

The tableLookUp User Method calculates the Inflow Stage and Outflow Stage of a reach if these values are neither linked nor INPUT. The Inflow Stage Table and Outflow Stage Table are used to look up the water surface elevation based on the flow through the channel at that point. Once both Inflow and Outflow Stages have been computed, the Reach Volume is calculated based on the previous volume of water in the reach and the difference in Inflow and Outflow over the current timestep. An initial Reach Volume must be specified to solve this Method.

☞ **Slots with Required Input Data**

- Reach Volume(reachVolume)
  SeriesSlot
  VOLUME
  volume of water contained in the reach
  An initial volume is required at the Initial timestep of the simulation. All other timesteps will be computed.

☞ **Slots with Optional Input Data**

- Inflow Stage(inflowStage)
  SeriesSlot
  LENGTH
  water surface elevation at the top of the reach
  This slot may be input or calculated.

- Outflow Stage(outflowStage)
  SeriesSlot
  LENGTH
  water surface elevation at the bottom of the reach
  This slot may be input or calculated.

- Inflow Stage Table(inflowStageTable)
  TableSlot
  FLOW vs. LENGTH
  relationship between flow in channel and water elevation
  This table is not required if Inflow Stage is linked or input.

- Outflow Stage Table(outflowStageTable)
  TableSlot
  FLOW vs. LENGTH
  relationship between flow in channel and water elevation
  This table is not required if Outflow Stage is linked or input.

Mannings *n* and Energy Slope display precision

The default display precision for values in the Mannings Roughness n and Energy Slope slots has been increased to 5. These parameters are traditionally on the order of 10^{-2} and 10^{-3}. The 5 digits beyond the decimal point are necessary to view the full precision of these parameters.

F. Diversions and Water Users

The Aggregate Diversion Site and Water Users have been extensively modified. Models previously built under PRSYM which contain Aggregate Diversions will need to be converted before running correctly under RiverWare Version 1.0. Several modifications are necessary.

Renaming of Slots

Seven slots on the Aggregate Diversion Site Object and the Water User Object have been renamed. In order to preserve the data in models previously built under PRSYM, a conversion script must be run before loading these model in this release. The Perl script, called modelConvert1.0, is included in the executable package for RiverWare Release 1.0. A Perl language interpreter is required to run this script. If you do not have Perl on your system, please contact CADSWES for assistance in converting model files. The conversion script changes the following slots:

Object Type	Old Slot Name		New Slot Name
AggregateDiversionSite	Total Diversion Delivered	‘	Total Diversion
AggregateDiversionSite	Total Consumed Flow	‘	Total Depletion Requested
AggregateDiversionSite	Total Return Flows	‘	Total Return Flow
Water User	Diversion Delivered	‘	Diversion
Water User	Consumed Flow	‘	Depletion Requested
Water User	Return Flows	‘	Return Flow
Water User	Percent Return Flow	‘	Fractional Return Flow

The script is executed by running it with the name of the model file to be converted as an argument. For example, to convert the model MyModel, simply type:

```
% modelConvert1.0 MyModel
```

The model is converted, and a backup of MyModel is created with the name MyModel.old.

Return Flow Calculation

A new User Method Category called **returnFlowCalculation** has been added to Aggregate Diversion Site Water User elements. The Category is used to enable algorithms which calculate the quantity of Return Flow from Water Users when the **noStructure** or **sequentialStructure** LinkStructures are selected. When the **lumpedStructure** LinkStructure is selected, Return Flow is not calculated for each Water User element; it is calculated on the Aggregate Object by subtracting the Total Depletion Requested from the Total Diversion Requested. There are four Methods available for selection within the returnFlowCalculation Category: the default **None**, **Fraction Return Flow**, **Proportional Shortage**, and **Variable Efficiency**. The default Method performs no computations, and no Return Flow is generated. It is not a valid selection.

The **Fraction Return Flow** Method calculates Return Flow as a fraction of the Diversion delivered.

Slots with Required Input Data

- Fractional Return Flow (fractionalReturnFlow)
  SeriesSlot
  NOUNITS
  portion of diversion returned as return flow
  This must be input as a fractional value between 0 and 1.

Output Slots

- Return Flow (returnFlow)
  SeriesSlot
  FLOW
  flow returning from the water user

The **Proportional Shortage** Method calculates Return Flow as the difference between the Diversion delivered and the Depletion Requested, scaled if a shortage exists. If the entire Diversion Requested is delivered, the Depletion is simply the Depletion Requested. If the Diversion Requested cannot be met, the Depletion is the Depletion Requested, scaled by the percentage of shortage in Diversion. The Depletion is a constant proportion of the Diversion, regardless of shortage. The Return Flow is the difference between the Diversion and the Depletion.

Slots with Optional Input Data

- Depletion Requested (depletionRequested)
  SeriesSlot
  FLOW
  requested amount of water to be completely consumed
  This slot does not require a value if Diversion Requested is zero.

Output Slots

- Depletion (depletion)
  SeriesSlot
  FLOW
  actual amount of water completely consumed
  This value is less than or equal to the Depletion Requested.
- Return Flow (returnFlow)
  SeriesSlot
  FLOW
  flow returning from the water user

The **Variable Efficiency** Method calculates Return Flow as the difference between the Diversion delivered and the Depletion Requested, up to a Maximum Efficiency. The theoretical efficiency of the requested depletion is the ratio of the Depletion Requested to the Diversion. If this theoretical efficiency is less than the Maximum Efficiency, the Depletion is granted. If the theoretical efficiency is greater than the Maximum Efficiency, the actual Depletion is reduced to exactly correspond to the Maximum Efficiency. Return Flow is the difference between the Diversion and the Depletion.

☞ Slots with Required Input Data

- Depletion Requested (depletionRequested)
  SeriesSlot
  FLOW
  requested amount of water to be completely consumed
- Maximum Efficiency (maxEfficiency)
  TableSlot
  NOUNITS
  maximum portion of diversion to be completely consumed
  This must be input as a fractional value between 0 and 1.

☞ Output Slots

- Efficiency (efficiency)
  SeriesSlot
  NOUNITS
  actual portion of diversion which is completely consumed
- Depletion (depletion)
  SeriesSlot
  FLOW
  actual amount of water completely consumed
  This value is equal to the Diversion times the Efficiency.
- Return Flow (returnFlow)

SeriesSlot
FLOW
flow returning from the water user

Groundwater Return Flow

A new User Method Category called **returnFlowSplitCalculation** has been added to Aggregate Diversion Site Water User elements. The Category is used to enable algorithms which calculate the proportions of Surface Return Flow and GW Return Flow. This Category is only valid when a **returnFlowCalculation** Method is selected. There are three Methods available for selection within the returnFlowSplitCalculation Category: the default **No Split**, **Split Return Flow Fraction**, and **Split Return Flow Efficiency**. The default Method performs no computations. The **Split Return Flow Efficiency** Method is only valid when the **Variable Efficiency** returnFlowCalculation Method is selected.

The **Split Return Flow Fraction** Method splits Return Flow into surface and groundwater components according to the Fraction GW Return Flow.

Slots with Required Input Data

- Fraction GW Return Flow (fractionGw)
  SeriesSlot
  NOUNITS
  portion of return flow which seeps into groundwater
  This must be input as a fractional value between 0 and 1.

Output Slots

- GW Return Flow (gwReturnFlow)
  SeriesSlot
  FLOW
  actual amount of return flow which seeps into groundwater
- Surface Return Flow (swReturnFlow)
  SeriesSlot
  FLOW
  actual amount of return flow which remains on the surface

The **Split Return Flow Efficiency** Method splits Return Flow into surface and groundwater components according to the computed Efficiency, Maximum Efficiency, and the GW Split Adjustment Factor. This method is based on the USBR return flow split calculation. The groundwater portion of the Return Flow is found by:

$$GW\ Return\ Flow = Return\ Flow \times (\text{Efficiency} / \text{Maximum Efficiency}) \times \text{GW Split Adjust Factor}$$

Slots with Required Input Data

- GW Split Adjust Factor (gwSplitAdjust)

TableSlot
NOUNITS
adjustment to efficiency of return flow seeping into groundwater
This must be input as a fractional value between 0 and 1.

Output Slots

- GW Return Flow(gwReturnFlow)
  SeriesSlot
  FLOW
  actual amount of return flow which seeps into groundwater
- Surface Return Flow(swReturnFlow)
  SeriesSlot
  FLOW
  actual amount of return flow which remains on the surface

Diversion Request

Water Users and lumped structure Aggregate Diversion Sites now assume a Diversion Requested of zero if not set by the user. This allows the object to dispatch in cases where the user has not supplied enough data.

Negative Water User Return Flows

Negative Return Flow values may now be calculated for Water Users when their Diversion Requested is zero. This situation occurs when the Consumed Flow is set to a value larger than the Diversion Delivered. Negative Return Flows were previously calculated only when Diversion Requested was non-zero.

Total Diversion Requested, Total Depletion Requested, and Total Depletion

The slots Total Diversion Requested and Total Depletion Requested have been added to Aggregate Diversion Sites for all Linking Structures. These MultiSlots sum the diversion and depletion requests from individual Water User elements. The slots will not contain a value if any of the element values at that timestep are invalid. The slot values are not adjusted during shortages, when the diversion and depletion requests may not be met.

The slot Total Depletion has been added to Aggregate Diversion Sites for Lumped and Sequential Structures. This SeriesSlot is set equal to the sum of the Depletion slots of individual Water User elements. The Total Depletion slot will not contain a value for any timestep at which any of the element Depletion values are invalid. The slot value reflects any adjustments made to individual Depletions in time of shortage.

5. Water Quality

A. Rulebased Simulation

Water Quality may now be enabled as a **Post Process** when the Rulebased Simulation Controller is active. The same WQ Constituents, WQ Solution Approaches, and User Methods which are available with the Simulation Controller may be selected for Rulebased Simulation. To invoke the window for enabling Water Quality, click on the **View Controller Specific Parameters** button in the **Run Control** dialog.

B. Distributed Annual Salt Loading

The **Distributed Annual Salt Loading** User Method has been modified to internally calculate the annual mass and monthly non-shortage return flow salt mass. Previously, the monthly data was calculated by the user and input directly into the Non Shortage Return Flow Salt Mass slot through the data management interface (DMI).

Three new slots have been added to implement the change. The annual salt mass for the current year is stored in the new Non Shortage Annual Return Flow Salt Mass slot. This value is calculated in January by summing the products of each month’s Return Flow volume and Return Flow Salinity Pickup. Since this value is only valid for the current year of the simulation, it has been made invisible to the user. A monthly non shortage salt mass is calculated each month by multiplying the annual salt mass by the percentage for that month specified in the new Percent of Annual Mass table. The monthly value is stored as a local variable during execution of the method. The monthly diversion demand has also been converted from a user input series slot to an internally calculated value. The equivalent annual shortage is computed by dividing the percent of shortage in a month’s diversion by the percentage of annual demand for that month. This value is specified in the new Percent of Annual Demand table. The remainder of the method is unchanged.

☞ **Slots with Required Input Data**

- Return Flow Salinity Pickup (returnFlowSalinityPickup)
  SeriesSlot
  CONCENTRATION
  additional salt concentration due to the diversion
  This slot is used to calculate the annual non-shortage salt mass.
- Percent of Annual Mass (percentAnnualMass)

SeriesSlot
FRACTION
the monthly fraction of annual salt mass
This slot requires a percentage for each of the 12 months to calculate the monthly non-shortage salt mass.

- Percent of Annual Demand (percentAnnualDemand)
  SeriesSlot
  FRACTION
  the monthly fraction of annual diversion demand
  This slot requires a percentage for each of the 12 months to calculate the equivalent annual shortage.

☞ **Invisible Slots**

- Non Shortage Annual Return Flow Salt Mass (nonShortAnnualRFSaltMass)
  ScalarSlot
  MASS
  annually redistributed return flow salt mass
  Stores the salt mass for the current year.

☞ **Output Slots**

- Return Flow Salt Mass (returnFlowSaltMass)
  SeriesSlot
  MASS
  mass of salt in return flow

- Return Flow Salt Concentration (returnFlowSaltConc)
  SeriesSlot
  CONCENTRATION
  salt concentration of return flow

C. Minimum Flow Check

The check for minimum flow in the **Distribute Annual Salt Loading** is no longer hard wired at 10 acre-feet per month. It now uses the Min value on the Outflow slot of the Reach to which the Diversion is linked. This value is scaled from its acre-feet/month units based on the number of days in the current month. Simulation aborts with an error if this value has not been set by the user.

D. Minimum Concentration Check

The check for outflow minimum salt concentration in Variable Salt Pickup With Debting is no longer hard wired at 50 mg/L. It now uses the Min value on the Outflow Salt Concentration slot of the Reach to which the Diversion is linked. Simulation aborts with an error if this value is needed and has not been set by the user.

E. Bank Storage Salt

A new **Bank Storage Salt** User Method Category is available to specify whether or not to account for Bank Storage effects in Salinity calculations. The two user-selectable Methods in this Category are **No Bank Storage Salt** and **Bank Storage Salt**. No Bank Storage Salt may be selected regardless of whether or not Bank Storage is calculated for the Reservoir. Bank Storage Salt may only be selected if Bank Storage is calculated for the reservoir.

6. Optimization

A. Spill Computation Methods

A new User Method Category called **Optimization Spill Computation** has been added to all Reservoir objects. This Category is only available when the **independentLinearizations** Method is selected in the **Optimization Power Computation** Category. The **Optimization Spill Computation Category** contains six Methods for the linearization of spillway physical constraints. The selected Method should reflect the number and types of spillways being modeled and must be the same as the selected Method in Simulation. The physical data for all selected spillways is combined into a single Storage vs. Spill table. This table is then linearized according to the linearization Method selected in the **Spill Lower Bound MTLE** Category and the **Spill Upper Bound MTGE** Category. The available Methods for the **Spill Lower Bound MTLE** Category are **Piecewise** and **Line**. The only available Method for the **Spill Upper Bound MTGE** Category is **Line**.

All of the Methods solve by generating a composite **Spill Bounds Linearization Table** from the points in the Unregulated, Regulated, and/or Bypass Spill Tables. The first column of the Spill Bounds Linearization Table contains monotonically increasing Storage values. These values correspond to the combined set of Pool Elevation data points in the Spill Tables relevant to the selected Method. The second and third columns are the Spill Lower Bound and Spill Upper Bound at each of these Storage values. The Spill Lower Bound is equal to the required Unregulated Spill at the given Storage, or zero, if the selected Method does not include Unregulated Spill. The Spill Upper Bound is equal to the sum of the required Unregulated Spill, the maximum Regulated Spill, and the maximum Bypass at the given Storage, whichever apply.

Spill Lower Bound: $Spill \geq 0 + Unregulated\ Spill$

Spill Upper Bound: $Spill \leq 0 + Unregulated\ Spill + maximum\ Regulated\ Spill + maximum\ Bypass$

Since the Storage data points are taken from the combined set of Pool Elevations in all applicable tables, some of the Storage points may not have a corresponding Pool Elevation in one or more of the individual tables. In these cases, a spill value for the table is linearly interpolated from the two Pool Elevations which most nearly correspond to the given Storage. This ensures that the resolution of the Spill Bounds Linearization Table is at least as fine as that of the most precise individual Spill Table.

The Spill Bounds Linearization Table is linearized according to the parameters specified in the **Spill Upper Bound LP Param** and **Spill Lower Bound LP Param** tables. The Spill Upper Bound LP Param table requires two Storage values (in rows) to linearize with the **Line** Method. The Spill Lower Bound LP Param table requires either two Storage values to linearize with the **Line** Method or more than two Storage values (in rows) to linearize with the **Piecewise** Method. The optimization physical constraints for Spill are generated from these linearizations in terms of reservoir Storage. The slots which require inputs or receive output for all Spill methods are:

☞ Slots with Required Input Data

- Spill Upper Bound LP Param (spillUpperBoundLPParms)
  TableSlot
  VOLUME
  storage value at which to linearize the spill bounds table
  A single value must be entered.

- Spill Lower Bound LP Param (spillLowerBoundLPParms)
  TableSlot
  VOLUME, VOLUME
  storage value(s) at which to linearize spill bounds table
  The value in the first row of the Line column is used if Line is the selected linearization Method. The values in the first two rows of the Piecewise column are used if Piecewise is the selected linearization Method.

☞ Slots with Output Data

- Spill Bounds Linearization Table (spillBoundsLinearizationTable)
  TableSlot
  VOLUME vs. FLOW and FLOW
  reservoir storage vs. minimum and maximum spill

In addition, the slots which require inputs for individual spill Methods are:

optNoSpillCalc

This Method requires no input and generates constraints for zero Spill.

optUnregulatedSpillCalc

This Method generates constraints for total Spill equal to the required Unregulated Spill.

☞ Slots with Required Input Data

- Unregulated Spill Table (unregulatedSpillTable)
  TableSlot
  LENGTH vs. FLOW
  reservoir elevation vs. required unregulated spill

optRegulatedSpillCalc

This Method generates a constraint for total Spill less than the maximum Regulated Spill.

☞ Slots with Required Input Data

- Regulated Spill Table (regulatedSpillTable)
  TableSlot
  LENGTH vs. FLOW
  reservoir elevation vs. maximum regulated spill

◗ optRegPlusUnregSpillCalc

This Method generates two constraints: total Spill greater than the required Unregulated Spill, and total Spill less than the sum of the Unregulated Spill and the maximum Regulated Spill.

☞ Slots with Required Input Data

- Regulated Spill Table (regulatedSpillTable)
  TableSlot
  LENGTH vs. FLOW
  reservoir elevation vs. maximum regulated spill
- Unregulated Spill Table (unregulatedSpillTable)
  TableSlot
  LENGTH vs. FLOW
  reservoir elevation vs. required unregulated spill

◗ optRegPlusBypassSpillCalc

This Method generates a constraint for total Spill less than the sum of the maximum Regulated and Bypass Spills.

☞ Slots with Required Input Data

- Regulated Spill Table (regulatedSpillTable)
  TableSlot
  LENGTH vs. FLOW
  reservoir elevation vs. maximum regulated spill
- Bypass Table (bypassTable)
  TableSlot
  LENGTH vs. FLOW
  reservoir elevation vs. maximum bypass spill

◗ optRegPlusBypassPlusUnregSpillCalc

This Method generates two constraints: total Spill greater than the required Unregulated Spill, and total Spill less than the sum of the Unregulated Spill, maximum Regulated Spill, and maximum Bypass Spill.

☞ **Slots with Required Input Data**

- Regulated Spill Table (regulatedSpillTable)
  TableSlot
  LENGTH vs. FLOW
  reservoir elevation vs. maximum regulated spill
- Bypass Table (bypassTable)
  TableSlot
  LENGTH vs. FLOW
  reservoir elevation vs. maximum bypass spill
- Unregulated Spill Table (unregulatedSpillTable)
  TableSlot
  LENGTH vs. FLOW
  reservoir elevation vs. required unregulated spill

B. Power Computation Methods

A new User Method Category called **Optimization Power Computation** has been added to Power Reservoir objects. This Category contains two Methods for the generation of power production optimization constraints, the default **independentLinearizations** and **lambdaMethod**. Both Methods are used to optimize the Outflow and Power (Energy). **independentLinearization** was the only available solution in PRSYM executables.

independentLinearization optimizes power production through linearizations of Turbine Capacity, Best Turbine Flow, and Power. Each of these parameters may be linearized differently depending on the context in which they appear within a constraint. The possible constraint contexts for each of the three parameters are: **STLE** (single term less than or equal to), **STGE** (single term greater than or equal to), **MTLE** (multi-term less than or equal to), and **MTGE** (multi-term greater than or equal to). These combinations give rise to 12 new User Method Categories for which a linearization Method must be selected. The available Methods for each Category may include: **Line**, **Tangent**, **Piecewise**, and **Substitution**, depending on the Category. For more information on Independent Linearization solutions, please refer to the *Technical Reference Manual* or contact CADSWES staff.

Selection of the new **lambdaMethod** User Method also requires selection of a tailwater calculation Method. The **Optimization Tailwater Computation Category** contains four User Methods: the default **optTWValueOnly**, **optTWBaseValueOnly**, **optTWBaseValuePlusLookupTable**, and **optTWStageFlowLookupTable**. These Methods are analagous to the existing Simulation Methods with the same names, and require the same data. If a Simulation run is to follow Optimization, both should use the same tailwater Method to guarantee accurate results.

The Power Lambda calculation selects the maximum Turbine Release within the region defined by legal operating points called lambda points, which consist of a combination of values (called Lambda Coefficients) for Pool Elevation, OperatingHead, Turbine Release and other related quantities corresponding to a physically realizable scenario. The lambda points are implicitly specified by the user through values in the Power Lambda Coefficients Params table and explicitly computed during the Optimization Beginning of Run. A set of physical constraints is generated by multiplying each Coefficient with a lambda variable. These lambda constraints are used by CPLEX to force the lambda variables to coincide with the other model variables.

The **Power Lambda Coefficients Params** (PLCP) table is the only slot requiring user input, other than the physical data normally required to solve plantPowerCalc with the Simulation controller. At least one realistic Pool Elevation and Tailwater Base Value must be specified in the PLCP table. Outflow values may be optionally specified. An Outflow is implicitly supplemented with zero, the Best Turbine Q, and the Max Turbine Q. A lambda point is computed by RiverWare for every possible combination of parameter values in the table columns. Each of the combinations corresponds to a unique operating state, whose other parameters may be calculated by iterating plantPowerCalc with the selected Optimization Tailwater Calculation Category. If a combination of values does not correspond to a feasible operational state, it is omitted from consideration.

The computed Lambda Points are stored in the **Power Lambda Coefficients** (PLC) table. The first two columns of the table correspond to the Coefficients from the first two columns of the PLCP table. The remaining columns in the PLC table are the calculated Optimization parameters: Tailwater Elevation, Operating Head, Spill, Turbine Release, Power, Best Turbine Flow, and Hydro Capacity. Every row in the PLC table represents a valid lambda point.

The **lambdaMethod** uses the following slots in addition to those required for the selected Optimization Tailwater Calculation Method and plantPowerCalc:

☞ **Slots with Required Input Data**

- Power Lambda Coefficients Params (powerLambdaLPParms)
  TableSlot
  LENGTH, LENGTH, FLOW
  valid operating points
  At least one Pool Elevation and Tailwater Base Value are required.

☞ **Slots with Output Data**

- Power Lambda Coefficients (powerLambdaCoeffs)

TableSlot
LENGTH, LENGTH, LENGTH, LENGTH, FLOW, FLOW, POWER, FLOW, POWER
a list of every combination of the valid operating points including computed parameters

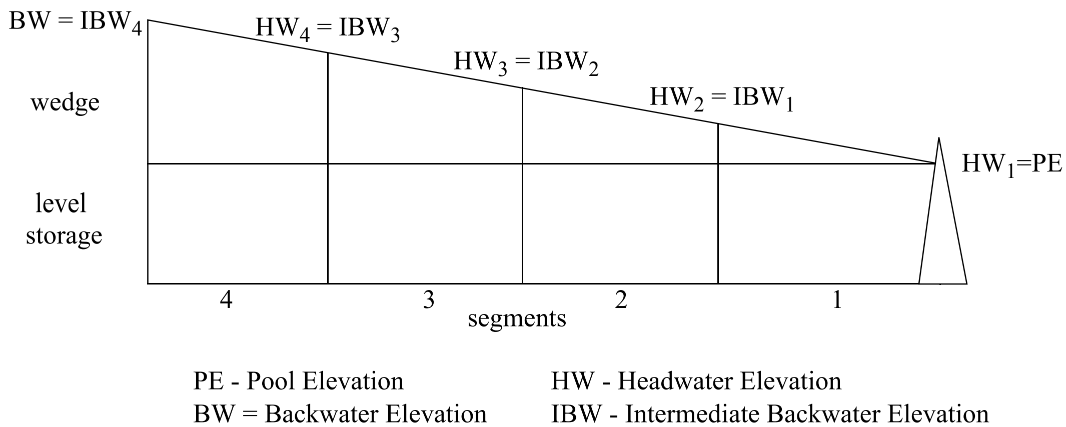
C. Backwater Computation Methods

A new User Method Category called **Optimization Backwater Computation** has been added to Slope Power Reservoir objects. The Category contains two Methods for the generation of backwater curve optimization constraints: the default **independentLinearizations** and **lambdaMethod**. Both Methods are used to optimize Storage, Backwater Elevation, and Intermediate Backwater Elevation. **independentLinearizations** was the only available solution for PRSYM executables.

This method optimizes the reservoir backwater by linearizing Backwater Elevation and Wedge Storage. Each of these parameters may be linearized differently depending on the context in which they appear within a constraint. The possible constraint contexts for Wedge storage are: **STLE** (single term less than or equal to), **STGE** (single term greater than or equal to), **MTLE** (multi-term less than or equal to), and **MTGE** (multi-term greater than or equal to). The possible constraint contexts for Backwater Elevation are: **STLE** (single term less than or equal to) and **STGE** (single term greater than or equal to). A linearization Method must be selected for each of the six resulting User Method Categories. The available Methods may include: **Line**, **Tangent**, **Piecewise**, and **Substitution**, depending on the Category. For more information on Independent Linearization solutions, please refer to the *Technical Reference Manual* or contact CADSWES staff.

The new **lambdaMethod** User Method optimizes Storage and Backwater Elevations within the region defined by legal operating points called lambda points. A lambda point consists of a combination of values (called Lambda Coefficients) for Backwater Elevation and other related quantities which corresponds to a physically realizable scenario. The lambda points are implicitly specified by the user through values in the Backwater Lambda LP Parameters table and explicitly computed during the Optimization Beginning of Run. A set of physical constraints is generated by multiplying each Coefficient with a lambda variable. The lambda constraints are used by CPLEX to solve for reservoir Storage and Outflow.

The **Backwater Lambda LP Parameters** (BLLPP) table is the only slot requiring user input, other than the physical data required to solve SlopePowerReservoirs with the Simulation controller. At least one realistic Headwater Elevation must be specified in the BLLPP table. Also at least one Inflow and/or Outflow for each segment is required, depending on the Reservoir’s configuration. The maximum and



minimum Hydrologic Inflows during the run are automatically considered as potential Lambda Coefficients in addition to any user input Hydrologic Inflows in the BLLPP table. A lambda point is computed by RiverWare for every possible combination of Parameter values in the table columns. If a combination of values does not correspond to a feasible operational state, it is omitted from consideration. In certain cases, however, Inflow, Outflow, or Hydrologic Inflow values may not be required; the irrelevant columns in the BLLPP table are then omitted from the lambda point calculation. If any values are input into irrelevant columns, a warning message is issued at run time. The cases for which values are not required are:

Inflow is unnecessary if the **a** Profile Coeff Table parameter is zero for all segments. In this case, Inflow does not influence the backwater curve.

Outflow is unnecessary if the **b** Profile Coeff Table parameter is zero for all segments. In this case, Outflow does not influence the backwater curve.

Hydrologic Inflows are unnecessary if either the **a** or the **wc** Profile Coeff Table parameters are zero for all segments. In this case, Hydrologic Inflows do not influence the backwater curve. The minimum and maximum values are not treated as Lambda Coefficients.

The computed Lambda Points are stored in the **Backwater Lambda Coefficients** (BLC) table. The first columns of the table correspond to the Coefficients from the BLLPP table plus additional columns for time lagged Inflows and Outflows. The number of Inflow and Outflow columns is determined by the number of impulse response coefficients in the Profile Coeff Table. The remaining columns in the BLC table are the calculated Optimization parameters: Storage, Backwater Elevation, and Intermediate Backwater Elevations for each reservoir segment. Every row in the BLC table represents a valid lambda point. There is a row for each possible combination of Lambda Coefficients, including the lagged flows. The number of lambda point rows grows very quickly when multiple time lag columns compound the combinations. Since an excessive number of lambda points is unnecessary and affects performance, the number of lambda points is limited to 1,000.

The **lambdaMethod** uses the following slots in addition to those required for backwater calculation with the Simulation Controller:

☞ Slots with Required Input Data

- Backwater Lambda LP Parameters (backwaterLambdaLPParms)
  TableSlot
  LENGTH, FLOW, FLOW, FLOW for each segment...
  valid operating points
  At least one Headwater Elevation is required. Inflow, Outflow, and Hydrologic Inflows may be required dependent on Reservoir configuration.

☞ Slots with Output Data

- Backwater Lambda Coefficients (backwaterLambdaCoeffs)
  TableSlot
  LENGTH, FLOW for each irc..., FLOW for each irc..., FLOW for each segment..., LENGTH, LENGTH for each segment-1..., VOLUME
  a list of every combination of the valid operating points

D. Infeasible Solution Output File

RiverWare now automatically creates an output file when an infeasible optimization model is run. The file, called OPT_cplex_prob.*.iis, contains the "irreducibly inconsistent set" which represents the smallest infeasible problem from the failed run. This is typically a small set of inconsistent equations from which the erroneous constraint(s) can be deduced. The generation of this file is accompanied by a message window, indicating the exact name and path of the output file.

E. Optimization Output Files Directory

RiverWare-generated optimization files which begin with OPT_ are no longer saved in the RiverWare executable directory. All of these files, including those selected in the **Optimization Controller Parameters** dialog, are now saved in a sub-directory tree designed to facilitate management of this important debugging information.

The directory into which the files are saved is determined as follows:

- The top-most directory below which files are saved is either:
  the directory specified by the RiverWare_OPT_DIR environment variable,

- or the /tmp directory of the machine on which RiverWare is running.

Within this directory, a sub-directory is created as:

- the prefix “opt-” followed by the login name of the user.
  (User johndoe would automatically generate a directory called opt-johndoe.)

Within this directory, an optional sub-directory may be created as:

- the **File Directory:** specified in the **Optimization Controller Parameters** dialog, if any.

For example: user johndoe running optimization with the RiverWare_OPT_DIR environment variable set to /RiverWare/Optimization, and the **File Directory:** set to **run1**, would generate OPT_ files as:

/RiverWare/Optimization/opt-johndoe/run1/OPT_*

If the **File Directory:** were then deselected, and the RiverWare_OPT_DIR environment variable were unset, OPT_ files would be generated as:

/tmp/opt-johndoe/OPT_*

In all cases, the directory to which optimization files are written is displayed as a green highlighted message in the **Diagnostics Output Window**.

F. Optimization Parameters Files

The PrsymOptParams file which contained optimization parameters for versions of PRSYM, has been divided into two files. The optimization parameters which are used exclusively by RiverWare are now contained in a file called goals.par. The optimization parameters which are required by the CPLEX solver are now contained in a file called cplex.par. The cplex.par file is passed directly to the solver as a command line argument, allowing a solution to be duplicated outside of the RiverWare executable. This is useful to access solver debugging capabilities which are unavailable during a RiverWare run.

The CPLEXPARFILE environment variable must be set as the path to the cplex.par file in order for this file to be located by the CPLEX solver. The path may be specified as an absolute path or a relative path from the directory set as the RiverWare_HOME environment variable.

G. Curvature Checks of Linearized Functions

Multiple term (**MTLE** & **MTGE**) **Piecewise** linearized functions are now checked for consistent curvature during Optimization runs. Violation of concavity or convexity is indicated by a warning message of the type:

SLOT(S): BlueRidge.Spill Bounds Linearization Table
"The value in row 48 column 1 (1796.703916) is outside the range of the approximation points and should be greater than the piecewise approximation (y = 9486.820540) for convex functions."

The check to ensure that convexity or concavity is preserved is performed given the user approximation points, piecewise slopes, intercept, number of user approximation points, and the linearization context class of each table. The appropriate curvature is dependent upon the context, where **MTLE** and **MTGE** cases should yield convex and concave functions, respectively.

Two dimensional table values are checked by substituting the independent value into the piecewise function where the corresponding dependent value is computed. Since three-dimensional tables are linearized with respect to only one z point, their values are checked by examining independent values which are greater and less than the specified z point wherever an interpolation for the z approximation point is required. This provides a means with which to check for erroneous data which could potentially be used during actual interpolation. The appropriate independent values are then checked by substitution into the piecewise function where the corresponding dependent value is computed.

For both two-dimensional and three-dimensional tables, the dependent value is then compared to the table value to determine if the expected curvature is violated. In addition, piecewise slopes are checked relative to one another; convex and concave functions should yield slopes which are increasing and decreasing relative to one another, respectively.

7. RuleBased Simulation

A. Mass Balance Functions

There is now the ability for Rulebased Simulation to solve mass balances on Reservoir objects at any timestep. This was accomplished by adding three new mass balance methods on the Reservoir class that can be called from within a rule:

Reservoir:massBalanceSolveInflow *(*double *out,* double *stor,* double *storPrev,* Date_Time **dateTime,* double *&in)*

Reservoir:massBalanceSolveOutflow (double *in*, double *stor*, double *storPrev*, Date_Time **dateTime*, double *&out*)

Reservoir:massBalanceSolveStorage (double *in*, double *out*, double *storPrev*, Date_Time **dateTime*, double *&stor*)

These functions differ from the standard massBalance functions in that they solve for the desired value in two steps. First, the given Inflow, Outflow, or Storage, as well as the Previous storage, and the time step (variables *in, out, stor, storPrev, dateTime*) provided by the Rulebased Simulation are converted to local variables of the MethodInfo class. Then, these functions execute the standard **Reservoir:massBalanceSolve... (MethodInfo *LocalInfo)** function which solves the mass balance. This standard method is the one used in the regular Simulation mode. The value computed by the **massBalanceSolve... (MethodInfo *LocalInfo)** function is then passed back to the rule as the desired *&in*, *&out*, or *&stor.*

B. Tcl Aggregation Functions

Several new Tcl-based functions have been added to the RuleBased Simulation language which access the new SubBasin functionality from within rules. They are:

C_GetAllNamedBasins

- This function returns a list of all user-defined SubBasins for the current model.

C_GetObjectsInBasin *basinDesignator*

- This function returns a list of all Objects in the SubBasin *basinDesignator*.

C_AggOverTime *basinDesignator slotName aggFunc aggFilter scale units*
<startDate
<endDate>>

- This function returns a list of values and their context(s). Each object in the designated basin is individually aggregated over time, yielding one item of the list. The type of the values, and the number of contexts returned, are determined by the Aggregation Function.

C_AggOverObj *basinDesignator slotName aggFunc aggFilter scale units <startDate*
<endDate>>

- This function returns a list of values and their context(s). All of the objects in the designated basin are aggregated for each time, yielding one item of the list. The type of the values, and the number of contexts returned are determined by the Aggregation Function.

C_AggOverTimeObj *basinDesignator slotName aggFunc1 aggFunc2 aggFilter scale units*
<startDate <endDate>>

- This function returns a single value and appropriate context. Each object in the designated basin is individually aggregated over time according to *aggFunc1*. The resulting list of objects are then aggregated according to *aggFunc2*. The value and number of contexts returned are determined by the Aggregation Functions (see table below).

C_AggOverObjTime *basinDesignator slotName aggFunc1 aggFunc2 aggFilter scale units*
<startDate <endDate>>

- This function returns a single value and appropriate context. All of the objects in the designated basin are aggregated according to *aggFunc1* for each time. The resulting list of times are then aggregated according to *aggFunc2*. The value and number of contexts returned are determined by the Aggregation Functions.

Where the arguments to the above functions are specified as:

basinDesignator:

{basinName}

{basinName {classType}}

{direction refObject}

{direction refObject {classTypes}}

{direction refObject {classTypes} {terminators}}

{direction refObject {classTypes} {terminators} {in/excludedBasins}}

basinName:

Any user-defined or RiverWare-*defined basin.*

classTypes:

AggDiversionSite

AggReach

Canal

Confluence

GroundWaterStorage

LevelPowerReservoir

PowerReservoir

PumpedStorage

Reach

Reservoir

SlopePowerReservoir

StandAloneWU

StorageReservoir

Thermal

WaterUser

direction:

UPSTREAM

DOWNSTREAM

refObject:

An object name.

terminators:

Object name(s).

in/excludedBasins:

Any user-defined or RiverWare*-defined basin(s)*

aggFunc:

SUM

AVG

MIN

MAX

aggFilter (filters out all which are not flagged):

IN_OUT

INPUT

OUTPUT

<startDate>:

An optional starting dateTime. If not specified, defaults to the current dateTime.

<endDate>:

An optional ending dateTime, only valid if <startDate> is also specified. This also defaults to the current dateTime.

AggFunc	C_AggOverObj	C_AggOverTime
MIN or MAX	Returns {objectName dateTime value} for each dateTime in the range	Returns {objectName dateTime value} for each object in the SubBasin
SUM or AVG	Returns {dateTime value} for each dateTime in the range	Returns {objectName value} for each object in the SubBasin

AggFuncs	C_AggOverObjTime	C_AggOverTimeObj
MIN or MAX, then MIN or MAX	Returns a single {objectName dateTime value}	Returns a single {objectName dateTime value}
MIN or MAX, then SUM or AVG	Returns a single {value}	Returns a single {value}
SUM or AVG, then MIN or MAX	Returns a single {dateTime value}	Returns a single {objectName value}
SUM or AVG, then SUM or AVG	Returns a single {value}	Returns a single {value}

Note: If an aggregate cannot be computed due to an invalid value in one of its items, the returned value will be "NaN" and the returned date, if applicable, will be "NO_DATE." All aggregations are done in standard units. Values in units of acre-feet/month are NOT scaled to the length of each dateTime in the range. As such, their results will be invalid for any dateTimes which are not 31 days long.

C. Tcl Unit Conversion Functions

Two new functions have been added to facilitate unit conversions. They are:

C_GetStepSeconds <*dateTime*>

- This function returns the number of seconds in the timestep referenced by <*dateTime*>. If no <*dateTime*> is specified, the current dateTime is used. The number of seconds in the timestep may be used to convert between units of FLOW and VOLUME within rules.

C_ConvertValue *fromValue fromScale fromUnits toScale toUnits* <*dateTime*>

- This function converts a given *fromValue* with scale and units of *fromScale* and *fromUnits*, to a value in the scale and units of *toScale* and *toUnits*. All conversions must be within a single unit type; e.g., FLOW. The optional <*dateTime*> specification indicates the timestep who's length will be used for conversions from/to units of acre-feet/month. If no <*dateTime*> is specified, the current dateTime is used.

D. Total Diversion to Meet Requests

A new function has been added which computes the Diversion required to satisfy the Diversion Requests of all WaterUsers of an AggDiversionSite at any timestep of the simulation. This function may be called from within a rule for AggDiversionSites using the Sequential Linking Structure only. In order to perform the calculation, the algorithm executes the selected **returnFlowCalculation** and **returnFlowSplitCalculation** Methods on each WaterUser. These account for all possibilities of Return Flow linking and quantities when computing the variable totalReq, which represents the Diversion requirement for satisfaction of all WaterUser requests. The function is defined as:

int nonShortDiversionReq(double &totalReq, Date_Time *when)

- where totalReq is the calculated total Diversion and when is a pointer to the timestep at which the calculation is to be performed. The function returns 0 upon success and 1 upon failure.

8. GUI

A. Toolbar

A toolbar has been added to the main RiverWare Workspace window. It contains buttons for accessing commonly used commands and dialogs. The buttons are:

Load Model File
This button is equivalent to **Model ➥ Load...** or <Ctrl> L.

Save Model File
This button is equivalent to **Model ➥ Save...** or <Ctrl> S.
*(See **Model Loading and Saving** for details on the new implementation of the Save command.)*

Run Control Panel
This button is equivalent to **Control ➥ Run Control Panel...** or <Ctrl> R.

MRM Control Panel
This button is equivalent to **Control ➥ MRM Control Panel...** or <Ctrl> M.

Object Palette
This button is equivalent to **Workspace ➥ Object Palette...** or <Ctrl> P.

Link Editor
This button is equivalent to **Workspace ➥ Link Editor...** or <Shift> E.

Locator View
This button is equivalent to **Workspace ➥ Locator View...** or <Shift> V.

Edit SCT
This button is equivalent to **Utilities ➥ Edit SCT...**.

Unit Converter
This button is equivalent to **Utilities ➥ Unit Converter...**.

Snapshot Management
This button is equivalent to **Utilities ➥ Snapshot Management...**.

Plotting Management
This button is equivalent to **Utilities ➥ Plotting Management...**.

Dispatch Information
This button is equivalent to **Utilities ➥ Dispatch Information...**.

B. Keyboard Shortcuts.

Many of the keyboard shortcuts for commonly used commands have been modified to be consistent between different RiverWare dialogs, to conform to accepted software standards, and to eliminate conflicts arising from duplicate shortcuts. In dialog menus, keyboard shortcuts appear to the right of the commands they execute. The shortcuts are:

Shortcut	Corresponding Menu Function
Ctrl + L	**Model ➥ Load...**
Ctrl + S	**Model ➥ Save**
Ctrl + Shift + S	**Model ➥ Save As...**
Ctrl + R	**Control ➥ Run Control Panel...**
Ctrl + M	**Control ➥ MRM Control Panel...**
Ctrl + Shift + E	**Control ➥ Reevaluate Expression Slots**
Ctrl + O	**Workspace ➥ Open Object(s)**
Ctrl + -	**Workspace ➥ Delete Object(s)**
Shift + P	**Workspace ➥ Object Palette...**
Ctrl + Shift + L	**Workspace ➥ Link Editor...**
Ctrl + Shift + B	**Workspace ➥ Edit SubBasins...**
Ctrl + B	**Workspace ➥ List SubBasin Membership**
Shift + L	**Workspace ➥ Locator View...**
Ctrl + Shift + R	Policy ➥ Rules Interface...
Ctrl + Shift + C	Policy ➥ Constraint Editor...

Shortcut	Corresponding Menu Function
Ctrl + H	**Special ➥ Home**
Ctrl + M	**Special ➥ Mark**

Shortcut	Corresponding Menu Function
Ctrl + W	**File ➥ Close Window**

Shortcut	Corresponding Menu Function
Ctrl + S	**View ➥ Run Status Dialog**

Shortcut	Corresponding Menu Function
Ctrl + Shift + S	**View ➥ Slot Lists**

Shortcut	Corresponding Menu Function
Ctrl + L	**File ➥ Load Slot List**
Ctrl + S	**File ➥ Save Slot List**
Ctrl + Shift + S	**File ➥ Save As**

Shortcut	Corresponding Menu Function
Ctrl + L	**File ➥ Load Run List**
Alt + Plus	**Edit ➥ Insert Run Before**
Ctrl + Plus	**Edit ➥ Append Run**
Ctrl + Minus	**Edit ➥ Delete Run**

Shortcut	Corresponding Menu Function
Alt + A	**Edit ➥ Add Time Horizon**
Alt + Plus	**Edit ➥ Insert Time Horizon**
Ctrl + Minus	**Edit ➥ Delete Time Horizon**
Alt + D	**Edit ➥ Clear**

Shortcut	Corresponding Menu Function
Ctrl + Shift + S	**View ➥ Slots**
Ctrl + Shift + M	**View ➥ Methods**
Ctrl + O	**Slots ➥ Open Slot**

Shortcut	Corresponding Menu Function
Ctrl + I	**File ➥ Import (Resize)**
Ctrl + Shift + I	**File ➥ Import (Fixed Size)**
Ctrl + E	**File ➥ Export**
Ctrl + X	Edit ➥ Cut Row or Edit ➥ Cut Cell
Ctrl + C	Edit ➥ Copy Row or Edit ➥ Copy Cell
Ctrl + Minus	Edit ➥ Delete Row or Edit ➥ Delete Cell
Ctrl + Shift + V	Edit ➥ Insert Cut/Copied Row
Ctrl + V	Edit ➥ Paste Cut/Copied Cell
Alt + Plus	Edit ➥ Insert New Row Before or Edit ➥ Insert New Cell Before
Ctrl + Plus	Edit ➥ Append New Row or Edit ➥ Append New Cell
Ctrl + D	Edit ➥ Fill Values Below
Ctrl + Shift + D	Edit ➥ Set Dimensions
Ctrl + A	Edit ➥ Select All

Shortcut	Corresponding Menu Function
Ctrl + U	Edit ➥ Unselect All
Alt + Shift + C	View ➥ Configuration
Ctrl + Shift + E	View ➥ Expression Editor
Alt + I	TimeStep I/O ➥ Input
Alt + O	TimeStep I/O ➥ Output
Ctrl + T	TimeStep I/O ➥ Target
Ctrl + B	TimeStep I/O ➥ Best Efficiency
Ctrl + M	TimeStep I/O ➥ Max Capacity
Ctrl + Tilde	TimeStep I/O ➥ Drift

Shortcut	Corresponding Menu Function
Alt + Plus	**SubBasin ➥ Insert New Before**
Ctrl + Plus	**SubBasin ➥ Append New**
Ctrl + U	**SubBasin ➥ Update From Workspace**
Ctrl + L	Object ➥ List SubBasin Membership

Shortcut	Corresponding Menu Function
Ctrl + L	**Rule Set ➥ Clean Load**
Ctrl + B	**Rule Set ➥ Clear**
Ctrl + C	**Rule Set ➥ Close**
Ctrl + S	Edit/View ➥ Rule Set
Ctrl + R	Edit/View ➥ Rules
Ctrl + A	Edit/View ➥ Agenda
Ctrl + D	Edit/View ➥ Dependencies
Ctrl + P	Interact ➥ Breakpoints
Ctrl + X	Interact ➥ Execute Rule

Shortcut	Corresponding Menu Function
Ctrl + O	**Edit ➥ Display/Hide Sub-rows**
Ctrl + E	**Edit ➥ Edit File**

Shortcut	Corresponding Menu Function
Ctrl + R	**Edit ➥ Reset Agenda**
Ctrl + E	**Edit ➥ Edit File On Agenda**
Ctrl + F	**Edit ➥ Edit File Off Agenda**

Shortcut	Corresponding Menu Function
Ctrl + E	Breakpoints ➥ Edit/Add
Del	Breakpoints ➥ Delete
Ctrl +B	Breakpoints ➥ Delete All

Shortcut	Corresponding Menu Function
Ctrl + L	**File ➥ Load Constraint Set**
Ctrl + Plus	**File ➥ Append Constraint Set**
Ctrl + S	**File ➥ Save Constraint Set**
Ctrl + N	**Edit ➥ Add Constraint**
Alt + Plus	**Edit ➥ Insert Goal**
Ctrl + A	**Edit ➥ Add Goal**
Ctrl + G	**Edit ➥ Add Group**
Ctrl + Minus	**Edit ➥ Delete**
Ctrl + H	**Edit ➥ Change Priority Level**
Alt + P	**Edit ➥ Pack Constraint Set**
Ctrl + Shift + E	View ➥ Open Expression Editor

Shortcut	Corresponding Menu Function
Ctrl + I	**Values ➥ Set Input**
Ctrl + V	**Values ➥ Set Input Values**
Ctrl + T	**Values ➥ Set Detail Values**
Ctrl + O	**Values ➥ Set Output**
Ctrl + C	**Values ➥ Clear Output**
Ctrl + Z	**Values ➥ Target Operation**
Ctrl + B	**Values ➥ Best Efficiency**
Ctrl + M	**Values ➥ Max Capacity**
Ctrl + Tilde	**Values ➥ Drift**
Ctrl + S	**Values ➥ Summary Type...**
Ctrl + F	**View ➥ Refresh**
Ctrl + D	**Run ➥ Run Control Dialog...**
Ctrl + R	**Run ➥ Start Run...**

Shortcut	Corresponding Menu Function
Ctrl + X	**Data ➥ Cut**
Ctrl + C	**Data ➥ Copy**
Ctrl + V	**Data ➥ Paste**

Shortcut	Corresponding Menu Function
Alt +D	**Data ➥ Clear**
Ctrl + A	**Data ➥ Select All**
Alt + A	**Data ➥ Add Data...**

Shortcut	Corresponding Menu Function
Ctrl + N	**Plot Page ➥ New...**
Ctrl + O	**Plot Page ➥ Open...**
Ctrl + Minus	**Plot Page ➥ Delete**
Ctrl + F	**Refresh ➥ Refresh Plot Page**
Ctrl + A	**Refresh ➥ Refresh All Plot Page**

Shortcut	Corresponding Menu Function
Ctrl + N	**Plot Page ➥ New...**
Ctrl + O	**Plot Page ➥ Open...**
Ctrl + Shift + S	**Plot Page ➥ Save As...**
Ctrl + F	**Plot Page ➥ Refresh**
Ctrl + X	**Data ➥ Cut**
Ctrl + C	**Data ➥ Copy**
Ctrl + V	**Data ➥ Paste**
Alt + D	**Data ➥ Clear**
Ctrl + A	**Data ➥ Graph All**
Ctrl + Shift + S	**Data ➥ Select Slots...**

Shortcut	Corresponding Menu Function
Ctrl + E	**Object ➥ Enable Dispatching**
Ctrl + D	**Object ➥ Disable Dispatching**

Shortcut	Corresponding Menu Function
Ctrl + L	**File ➥ Load Settings...**
Ctrl + S	**File ➥ Save Settings...**

Shortcut	Corresponding Menu Function
Ctrl + L	**File ➥ Load Settings...**
Ctrl + S	**File ➥ Save Settings...**

Shortcut	Corresponding Menu Function
Alt + O	**Select All ➥ Objects**
Alt + S	**Select All ➥ Slots**

Shortcut	Corresponding Menu Function
Alt + R	**Select All ➥ Rules**
Alt + N	**Select All ➥ Constraints**
Alt + G	**Select All ➥ Goals**
Alt + T	**Select All ➥ Times**
Alt + D	**Select All ➥ Diagnostics Groups**
Alt + A	**Select All ➥ All**
Shift + O	**Revert ➥ Objects**
Shift + S	**Revert ➥ Slots**
Shift + R	**Revert ➥ Rules**
Shift + N	**Revert ➥ Constraints**
Shift + G	**Revert ➥ Goals**
Shift + T	**Revert ➥ Times**
Shift + D	**Revert ➥ Diagnostics Groups**
Shift + A	**Revert ➥ All**
Ctrl + O	**Clear ➥ Objects**
Ctrl + S	**Clear ➥ Slots**
Ctrl + R	**Clear ➥ Rules**
Ctrl + N	**Clear ➥ Constraints**
Ctrl + D	**Clear ➥ Diagnostics Groups**
Ctrl + A	**Clear ➥ All**

Shortcut	Corresponding Menu Function
Ctrl + S	**File ➥ Save To File...**
Ctrl + L	**File ➥ Legend**
Ctrl + R	**File ➥ Clear**
Ctrl + I	**Find ➥ String...**

C. Pinnable Menus

The main RiverWare Workspace menus are now pinnable. Clicking on the dashed line at the top of an open menu converts the menu into a free window. This allows repeated commands to be executed without first having to re-open the menu. To close a pinned menu, kill the Xwindows frame in which it resides by clicking twice on the upper left corner of the window.

D. Default Window Placement

The placement and size of the main Workspace window is now preserved from one RiverWare session to the next. The location in the Xwindows monitor and the size of the window are saved in the.vgalaxy.1.vr file in the user's home directory. The placement and location are applied when the RiverWare executable is initially launched and are then automatically saved from the current configuration when the session is ended.

E. Locator View

A new function has been added to facilitate movement around the workspace of large models. Selecting the **Locator View...** command from the **Workspace** menu creates a miniature representation of the entire workspace in a new window. A highlighted frame indicates the portion of the workspace over which the main RiverWare window is currently located. Dragging this frame to a different part of the workspace shifts the main RiverWare window's field of view to match the locator. A specific object may be also be brought into view by selecting it from the **Locate** menu heading on the locator window.

F. View Methods/Slots

The **View Methods** and **View Slots** buttons on the **Open Object** dialog have been converted to an option menu. This menu is labeled as **View:**. It indicates the currently selected dialog view from two options, **Slots** and **Methods**. **Slots** view is the default.

9. SubBasins

A SubBasin is a collection of workspace simulation objects which are grouped under a single name. For example, it may be convenient to specify a SubBasin named “Main River” whose members are all of the Reach and Reservoir objects along the main stem of a riverbasin. The name of the SubBasin may then be used to efficiently represent all of its member objects in calculations. Currently, the use of SubBasin names is only supported for Expression Slots and Optimization Constraints. This functionality will be expanded to the Rulebased Simulation Structured Editor in upcoming releases.

SubBasins and their memberships are set through the SubBasin Manager. This dialog is invoked by selecting **Edit SubBasins...** from the **Workspace** menu heading. The default SubBasin is the “**Entire Network.**” This SubBasin may not be deleted, modified, or renamed. It contains all of the objects on the workspace with the exception of Data Objects. Data Objects may never be included in any SubBasin membership.

Clicking on the tree-view arrow to the left of a SubBasin name will display the list of its members. If any Aggregate Objects are members of the SubBasin, clicking on the tree-view arrow to the left of their name(s) will display a list of their member Elements. Each of these Aggregate Elements is included in the SubBasin. Elements may not be individually included or excluded from a SubBasin definition. The name of a SubBasin may be changed by clicking on its existing name and typing a new name into the resulting edit window. The commands available from the **Edit SubBasins** dialog are:

File ➥ Close to close the SubBasin Manager dialog. This is the same as clicking the **Close** button at the bottom of the dialog.

SubBasin ➥ Insert New Before to define a new SubBasin with the selected objects on the workspace and to insert the name before the currently highlighted SubBasin name.

SubBasin ➥ Insert New After to define a new SubBasin with the selected objects on the workspace and to insert the name after the currently highlighted SubBasin name.

SubBasin ➥ Append New to define a new SubBasin with the selected objects on the workspace and to insert the name at the end of the SubBasin list.

SubBasin ➥ Update From Workspace to redefine the currently highlighted SubBasin. The membership will be cleared and replaced by the selected objects on the workspace.

SubBasin ➥ Select on Workspace to highlight the members of the currently selected SubBasin on the workspace.

Object ➥ List SubBasin Membership to bring up a new window displaying the SubBasin(s) to which the selected object belongs.

The **Remove** button will delete the currently selected SubBasin or member.

The **Close** button closes the SubBasin Manager dialog.

An object's membership may also be directly displayed without invoking the **Edit SubBasins** dialog. To do this, first highlight a single object on the workspace. Next, select **Workspace ➥ List SubBasin Membership** from the main RiverWare menu bar. A new window appears listing all SubBasins to which the selected object belongs.

10. SCT

A. Set Row Type Dialog

The dialog for determining which slot is displayed in an SCT row has been updated. Selecting **Rows ➥) Set Slot...** now brings up the **SCT Row Type** slot selector only if there are objects on the workspace. The **Object types:** option menu has been improved to list only the object types of which at least one member exists on the workspace. These object types are listed in alphabetical order. To facilitate building an SCT, the **SCT Row Type** dialog is invoked with a default selection corresponding to the object and slot of the last row to have been configured. This allows many rows to be assigned to slots on the same object without having to reselect the object type and object for each occurrence.

B. Toggle Row Detail in non-Edit Mode

The view of row detail values may now be toggled when **Editing:** is turned **OFF**. This provides access to detail timesteps for changing their values. The summary type of a row's detail values may also be changed by selecting **Values ➥ Summary Type...**. These additional functions provide flexibility in non-Edit mode, while safeguarding the configuration of the original SCT.

C. Setting of Closed Detail Values

Setting detail values in a closed row through the **Values ➥ Set Detail Values** command is no longer supported. This functionality was dangerous, as it allowed values and flags to be overwritten without any visual confirmation of the effects. Detail rows must now be open for this command to be enabled. The old behavior will continue to exist in SCTs until the first time their rows are toggled and the SCT is saved.

11. DMI

A. DMI Generated Error Messages

Although DMIs may now exit with a **-1** return status, DMI generated error messages will not be properly interpreted by RiverWare. For proper handling of errors and messages, the accepted exit codes are:

0 Success

1 - 127Error

B. New Keyword=Value Pair: Flags

Valid keyword=value pairs have been expanded to include **flags**. This keyword can enable the importing or exporting of the SeriesSlot flags at every timestep, in addition to the slot values. The possible values for this keyword are **true** and **false**.

A keyword=value of the type:

flags=true

will cause SeriesSlot flags (INPUT, OUTPUT, TARGET, TARGET_BEGIN, BEST_EFFICIENCY, MAX_CAPACITY, and DRIFT) to be imported or exported with the data. This is an optional keyword=value pair which defaults to **false** if not specified.

C. Values in User-defined Keyword=Value Pairs

Values may no longer include spaces ( ), colons (**:**), or exclamation points (**!**). Due to changes in the parsing of DMI control files, these characters are now used as delimiters. Their use within a value field will cause a syntax error and prevent proper execution of the DMI. As there are no known DMIs currently using this punctuation, the change should not affect any existing models.

D. Control File Object and Slot Wildcards

Control File Object and Slot Wildcards have been expanded to include subBasins and dispatch slots, respectively. An object.slot specification of the type:

<basinname>.<slot>

will match any <slot(s)> within the subBasin <basinname>. Similarly, an object.slot specification of the type:

<object>.dispatch

will match any dispatching slot in the given <object(s)>. These new object.slot wildcards may be used in conjunction with the flags=true optional keyword=value to import or export all of the values and flags for the dispatching slots of a subBasin. This type of DMI allows the information required to uniquely reproduce a scenario to be moved between subBasins of different models. For more information on using DMI's towards this end, please contact CADSWES staff.

12. RCL and Batch Mode

A. Rulesets for Rulesbased Simulation

Rulesets for Rulebased Simulation may now be loaded using the RiverWare Command Language. The syntax for this new command is:

LoadRules ruleset

where ruleset is a valid file pathname to a ruleset.

13. Expression Slots

A. Overview of Functionality

Functionality has grown extensively over the past several releases. In order to put new features into perspective, an overview of the existing state of the expression slot is presented here.

To create a new expression slot, open a Data Object and select **Slots ➥ Add Expression Slot**. The new slot is appended to the slot list with the name **ExpressionX** (where **X** is the smallest integer needed to make this name unique, beginning with **00000**), and marked with the expression icon above. To open an expression slot, double-click on its name.

Expression Slots may be renamed through the **Name:** field in the Open Slot dialog. Expression Slots are initially created with the **Run Control's Initial:** time only. When the expression is evaluated, the time range of the slot is expanded to mirror the time horizon in the **Run Control** dialog.

The units and **Display Units** label, scale, and precision of values displayed as the result of an Expression Slot may be changed through the **Configuration** menu. Expression Slots may display all RiverWare defined unit types, but default to a unit type of **NONE**. When the **NONE** unit type is selected, a **Display Units** field is available to enter a display label. This label is saved in the model file, but is not exported through DMIs in the same manner as RiverWare defined units. Any Expression Slots with Unit Type of **NONE** is written to DMIs with **User Units** of **NONE**. The label is only cosmetic, and in no way affects the calculation of the expression or scaling of the display value. When a unit type other than **NONE** is selected, an option menu appears for the user to select a RiverWare defined unit. These units ensure a consistency of labeling for exported data.

Expressions are only calculated based on the display values of the slots they reference. No attempt is made to reconcile varied units or carry them through an expression. The user is responsible for verifying that display values in referenced slots are consistent with the nature of the expression. Unit conversions may be performed after an Expression Slot has computed, by changing the Expression Slot's units in the **Configuration** menu. Any such conversion will only be performed when changing from one RiverWare defined unit to another. The converted value is retained only as long as the Expression is not recalculated. When the expression is recalculated, the computed value will be assumed to be in the currently selected units.

The expression itself is displayed in the scrollable **Expression:** window. To create a new expression, click on the **Editor** button or select **View ➥ Expression Editor**. The

Expression Editor is a syntax-directed editor designed to assist in the construction of complex syntactically correct expressions within the RiverWare environment. The editor works by maintaining a partially constructed expression and allowing the user to manipulate unfinished portions using a collection of selection lists and text entry boxes. To use this dialog effectively, it is important to formulate the expression in its entirety (perhaps on paper) before beginning. The Expression Editor does not allow editing of previously determined portions of the expression. Errors in specifying an expression must be corrected by clearing the existing expression and beginning anew.

Initially, the editor contains a single **?** indicating a portion of an expression which has not yet been completed. Clicking, without releasing, on the **?** brings up a term selection list. Scrolling down to a term and releasing the mouse, inserts the selected term in place of the **?**. Terms may contain additional **?**s, to expand the complexity of the expression. One of two selection lists is available from any **?**. These fall into two categories: General Terms and Range Terms. General Terms include algebraic manipulations, variables (slots and user-defined variables), and actual values. Range Terms indicate the range over which an expression is computed. This may be a collection of slots, a SubBasin, or a set of timesteps.

Term	Significance
? + ?	Addition
? - ?	Subtraction
? * ?	Multiplication
? / ?	Division
(?) ^ (?)	Exponentiation
(?)	Parenthetical grouping
NUMBER	Numerical input; Clicking on **NUMBER** opens a text entry field.

Note: Operator precedence is as follows (greatest to least): **()**, **^**, ***** and **/**, and **+** and **-**. Parenthetical notation is automatically added to an expression when it is committed. This alleviates any later confusion regarding under-specified operator precedence.

Term	Significance
“SLOT” [@t]	Slot value at time of expression.
“SLOT” [@t - NUMBER]	Slot value at offset from time of expression; the offset should be an integer number.
“SLOT” [?]	Slot value at time **?**. Clicking on **?** opens an entry field for a variable.

Note: Clicking on **"SLOT"** opens a slot selector dialog for selection of Object-Slot combinations in one of three ways:
Clicking on a black-lettered object in the Objects: column generates a list of all of its slots in the Slots: column. Selecting one of these slots and pressing the OK button concludes the selection. The chosen slot, referenced according to standard "object.slot" notation, is visible in the Selected Slot: field.
Clicking on a blue-lettered object type in the Objects: column generates a list of slots in the Slots: column which exist for every object of that type. Selecting one of these slots and pressing the OK button concludes the selection. The chosen slot(s) will appear as "@Var.slot" in the Selected Slot: field, where "Var" is a three letter variable representing the object type. This style of entry is useful for expressions which require iterating over every object of a given type.
An "object.slot" may be typed directly into, or a partial selection may be edited directly in, the Selected Slot: field. This style of entry is useful to specify custom variables for iterations such as "@Var.slot." In this case, **Var** must be defined elsewhere in the expression.

Term	Significance
S [? , ?]	Sum second **?** over range of first **?**.
X [? , ?]	Average second **?** over range of first **?**.
S [? IN ? , ?]	Sum last **?** over subset of first **?** in range of second **?**.
X [? IN ? , ?]	Average last **?** over subset of first **?** in range of second **?**.

Note: The final ? of summation and average terms may be replaced by any Algebraic Terms, Slot References, or Iteration Operators. The latter results in nested loops. The ? IN ? range terms are useful for specifying a different variable than that automatically provided by a simple ? Range Term. If ? IN ? is selected as a term, the first ? opens a text entry field for entering a user variables, while the second ? produces a list of terms "over which" to range.

Term	Significance
t IN Time	**t** ranges over all simulation timesteps
t IN Time ?	**t** ranges over the Time Subset **?** of all simulation timesteps.
i IN Integer FROM ? TO ?	**i** ranges over all integers from **?** to **?**.
i IN Integer FROM ? TO ? INC ?	**i** ranges over all integers from **?** to **?** in increments of **?**.
Var IN "*SubBasin*"	**Var** ranges over all the objects within **SubBasin.**

Note: If the difference between the FROM and TO values is not an integer multiple of the INCrement, the TO value will not be considered within the range. Multiple Var IN "SubBasin" Range Terms are automatically appended to the list to represent every SubBasin on the workspace. Both user-defined and internally-defined SubBasins appear in the list. The Var variable name is composed of the first three letters of the SubBasin name.

Term	Significance
BY "SLOT"	Includes only timesteps where **"SLOT"** has a valid value.
FROM ? TO ?	Includes all integers from **?** to **?**.

Term	Significance
FROM ? TO ? INC ?	Includes all integers from **?** to **?** in increments of **?.**
FROM ?	Includes all integers from **?.**
TO ?	Includes all integers to **?.**
? ?	Creates multiple Time Subsets.

Note: Multiple Time Subsets may be used to increment over integers which are themselves increments.

Term	Significance
@?	Value at variable time **?;** Clicking on **?** opens an entry field for the variable name.

Note: All variables used in expressions must be defined within that expression.

B. SubBasins

Expression slots have been expanded to utilize the new SubBasin functionality previously described. It is now possible to iterate over user-defined SubBasins as well as object types. SubBasins will appear in the expression editor's menu list when summing or averaging values. Please note that any change in the membership of a SubBasin will be reflected in the calculations of any Expression Slots which reference it.

C. Linking

Expression slots may now be linked to other slots on the workspace. This is useful for propagating a set of calculated values into a dispatching Series Slot prior to simulation. Propagation across a link occurs every time an Expression slot is reevaluated, which may be done outside of a run by selecting **Control ➥ Reevaluate Expression Slots** from the main workspace menu bar, or by using the <Control>-e keyboard shortcut. Reevaluation of Expression slots may not be forced during a simulation run, but will still be done automatically at the conclusion of the run. Linking an Expression slot to a Simulation slot which receives a computed value during a run will cause an error and abort the run when the value propagates to the expression slot.

14. Dispatch Information

A new **Dispatch Information** utility has been created to provide post-run diagnostics regarding object dispatching and known values of dispatching slots for every timestep of the simulation. The **Dispatch Information** dialog is invoked by selecting **Dispatch Information...** from the **Utilities** menu heading in the main RiverWare workspace window or by clicking on the Dispatch Information shortcut button on the toolbar.

The Dispatch Information tool provides dispatch information at two levels of detail. At the workspace level, the dispatch state of each object for each timestep of the model run is visible. At a more detailed level, the tool allows an object's dispatch table entries and known slot values at the end of each timestep to be viewed.

A. Workspace-level View

The **Dispatch Information** dialog displays the workspace-level view of dispatch conditions. This dialog consists of a two-dimensional matrix with workspace objects on one axis and model run timesteps on the other axis. Each cell in the matrix shows the dispatch state of an object at the indicated timestep. Dispatch entries are made automatically during run initialization, so no dispatch information is available until a run is completed. Because they never dispatch, Data Objects and Snapshot Objects are not included in the list of Objects. An Object has one of four possible dispatch states:

Not Dispatched. The known and unknown slots for the timestep did not meet the requirements of any method on the dispatch table for the Object.

Dispatched. Conditions of a single method on the dispatch table were met; the method dispatched, and the Object solved.

Dispatched But Not Solved. Conditions of a single method on the dispatch table were met; the method dispatched, but the Object did not solve completely.

No Dispatch Entries. The Object has no entries on its dispatch table; the Object is a Thermal Object, or the model has not been run.

Clicking on an Object/timestep cell displays its dispatch state in text form at the bottom of the Dispatch Information dialog. If the Object dispatched at that timestep, then the name of the method under which it dispatched is also displayed.

The Dispatch Information dialog may be reformatted from its original configuration. If the lists holding the names of Objects and timestep are too narrow to read, they may be expanded by clicking on the double-arrow buttons. This will alternately increase and decrease the size of the headers between an abbreviated length and one which accommodates the longest Object/timestep name. The view in the Dispatch Information dialog can also be transposed so that timesteps appear along the side of the dialog and Object names appear along the top. To transpose the view, select **View ➥ Time On Side** or **View ➥ Time On Top** from the menu bar.

Finally, the order in which Objects appear in the dialog may be rearranged from its original alphabetical order. This is useful to match the river topology or any order with which you are more familiar. To rearrange an Object, click on its name with the middle mouse button and drag the resulting frame to a new location. Releasing the middle mouse button will place the Object just beyond the Object over which the frame is located; above when moving an Object up, below when moving an Object down.

Please note: new formats are only saved with the model file, so be sure to re-save the model after changing the Dispatch Information.

The Dispatch Information dialog may be used to disable or enable dispatching for individual Objects. Disabling dispatching prevents the object from dispatching at any timestep, regardless of what slots are known. This functionality is useful to debug models. To disable dispatching for an Object, click on its name and select **Object ➥ Disable Dispatching** from the **Dispatch Information** dialog menu bar. The Object name is shaded with red diagonal lines to indicate that it will no longer dispatch. The Object's Beginning of Run behavior, however, may never be disabled. To re-enable dispatching, click on the name of the Object for which dispatching has been disabled and select the **Object ➥ Enable Dispatching**. The red diagonal lines disappear from the Object name, and it is allowed to dispatch when the model is run.

B. Dispatch Detail Dialogs

The **Dispatch Detail** dialogs allow the entries in the dispatch table and the known slots at the end of each timestep to be viewed for each object. To open a **Dispatch Detail** dialog, double-click on a cell in the **Dispatch Information** dialog which represents the desired object and timestep. One of the following occurs, depending on the dispatch state of the selection.

If the Object *has no dispatch* conditions, or the model has not yet been run, a warning message is displayed.

If the Object *did not dispatch* during the selected timestep, the **Dispatch Detail** dialog appears showing a list of slots. Each of the displayed slots is a required known and/or a required unknown for an entrie(s) in the Object's dispatch table. The checkmarks indicate which slots were known at the end of the selected timestep.

- To view the entries in the dispatch table for this object, select **Methods** from the view option menu. The methods view lists all of the methods in the Object's dispatch table, each marked with a symbol indicating whether the method dispatched. Since the object did not dispatch, none of the methods have a green D symbol. Clicking on the, and sots in the list with a box to their left are required knowns for the method to dispatch. Slots with no box are required unknowns. Checkmarks indicate which slots were known at the end of the timestep.

If the object did dispatch during the selected timestep, the **Dispatch Detail** dialog appears showing a list of methods from that Object's dispatch table. The method which dispatched at the selected timestep is marked with the dispatched symbol and is opened to show its dispatch conditions. Notice that all of the slots are checked as known, even those required to be unknown. This occurs because the object solved correctly for all slots, making them known by the end of the timestep. We know that the dispatch conditions requiring unknowns were met at the time of dispatching because the method could not have dispatched otherwise. This may seem slightly confusing, but remember that the known/unknown status of particular slots is truly of interest only if the object failed to dispatch at the selected timestep. If the object did indeed dispatch, all of the conditions must have been met.

In models with hourly, daily, or monthly timesteps, the **Dispatch Detail** dialog contains a date spinner which moves the detail view forward and backward over the range of the model run. Clicking on the up arrow of the date field spinner moves the dialog view one timestep forward in the run. Clicking on the down arrow moves the view one timestep backwards in time. This is useful to determine how the set of known slots changes from timestep to timestep.

15. Diagnostics

A. Scrollable Windows in the Diagnostics Output Window

The **Diagnostics Output Window** now contains windows for **Contexts** and **Messages** that are independently scrollable. The scroll bars along the bottom of each window may be used to view information which extends beyond their right borders. The scroll bar along the right side of the dialog scrolls both windows simultaneously. The width of each window may be modified by clicking in the space between the two headings and dragging the outline of the heading bars to the new desired location. Message lines are now separated by a horizontal rule to increase their legibility.

B. Diagnostics Output Efficiency

The **Diagnostics Output Window** has been reformatted to be more efficient. Display allocation in the window is now done in increments of 50 lines. This significantly decreases model run time when many diagnostics are enabled. This does not, however, completely alleviate the potential for “freezing” RiverWare when too many diagnostics are enabled. Users should still exercise prudence in selecting only the appropriate categories and filters for diagnostics.

C. Enabling Diagnostics

The name of the toggle for enabling diagnostics information has been changed from **Include General Information** to **Enable Informational Diagnostics**. As before, this toggle has no effect on Errors and Warnings produced during a run. Errors and Warnings are not user-configurable. They are always displayed in the **Diagnostics Output Window**, regardless of whether Informational Diagnostics are enabled.

16. Plotting and Snapshots

New functionality exists for saving and combining plots of output values from several different slots and runs. The **Snapshot Management** dialog is used to create and review snapshots of selected slot values over multiple runs.The **Plotter Management** dialog is used to create composite plots for display or printing.

A. The Snapshot Management Dialog

The **Snapshot Management** dialog is invoked by selecting **Utilities ➡ Snapshot Management...**. It allows snapshots of selected slot values to be taken after different runs. This tool is useful for saving the values to compare the effects of various operating strategies or reproduce a particular run.

Slots to be included in a snapshot are selected by clicking on the **Add Data...** button, which invokes a **Slot Selector** dialog. Newly selected slots are added to any existing slots in the **Data Available:** window. These selections may be cut, copied, pasted, and cleared through the **Data** menu. Slot selections may also be copied between the **Snapshot Management** and the **Plotter Management** dialogs. This greatly facilitates configuration of plots and preparation of snapshots for preconfigured plots.

Snapshots of the selected slots' current values are taken by clicking on the **Take Snapshot** button. Each time a snapshot is taken, the Snapshot Manager creates a new Snapshot Data Object to contain its data. The new object is added to the bottom right of the workspace, and its name appears in the **Snapshots Taken:** window. Snapshot Objects are initialized with the name **Snapshotn**, where **n** is the smallest number, beginning with **0000,** which makes the object name unique. The selected slots are copied into the Snapshot Object, retaining their unit and display configurations. These slots are initialized with the name of the object and the name of the slot from which they were copied, separated by an underscore. For example, a snapshot of the Inflow slot on the Big River Reach appears as "Big River_Inflow." While snapshot slot names may not be changed, Snapshot Object names may be changed by entering a new name in their **Name:** field.

Clicking on a selected slot name in the **Data Available:** window highlights any snapshot objects in the **Snapshots Taken:** window, which contain a snapshot of that slot. Double-clicking on a Snapshot Object name in the **Snapshots Taken:** window automatically brings up that Snapshot Object. Double-clicking on a selected slot name in the **Data Available:** window brings up that object and the slot's current model values.

B. The Plotter Management Dialog

The **Plotter Management** dialog is invoked by selecting **Utilities ➥ Plotting Management...**.

The Plotter Manager maintains a list of all existing Plot Pages, which may be created, opened, deleted and refreshed from this dialog. To create a new Plot Page, select **Plot Page ➥ New...**, or click on the **New...** button. To open an existing Plot Page, highlight it and select **Plot Page ➥ Open...** or click on the **Open...** button.

The **Plotter** dialog is used to select the number and orientation of graphs to be displayed on one page, as well as what slot data will appear in each individual graph. Plot Pages are initialized with the name **Plottern**, where **n** is the smallest number, beginning with **00000**, which makes the Plot Page name unique.The plotter name is changed by typing into the **Plot Page:** field. The number and layout of graphs is selected through the **Graph Layout:** selector bar. Up to nine graphs may be generated on a single page, with graph layout referenced according to row-column notation. For example, a 2 x 1 layout consists of two rows with one graph per row. The layout is represented graphically in the **Select Graph:** region.

Individual graphs are selected by clicking on their icon in the **Select Graph:** region. Graphs which contain at least one set of data, display a data line in their icon, and the names of the included slots appear in the **Slots to Graph:** window. Empty graphs display only axis lines in their icon and **<no data exists>** in the **Slots to Graph:** window. To add data to a selected graph, select **Data ➥ Select Slots...** or click on the **Select Slots...** button. This invokes a standard RiverWare Slot Selector with which to chose the slots to display. Newly selected slots are added to any existing slots in the **Slots to Graph:** window.

A graph may show current values of selected slots only, or current and previous values of selected slots for which a snapshot(s) exists. This is determined by the **For Selected Graph, Show:** toggle. Selected slots of which a snapshot image exists are indicated by a blue snapshot icon to the left of their name. Selected slots which are selected in the **Snapshot Management's Data Available:** list but are not part of a snapshot, are indicated by a grey snapshot icon to the left of their name. Clicking on a selected slot name in the **Slots to Graph:** window highlights any snapshots in the **Snapshots of Slots to Graph:** window which contain an image of that slot.

The XMgr session which displays the Plot Page may be invoked by clicking on the **Show Plotter Page** button. Once the XMgr window appears, it must be populated with the selected data by clicking on the **Refresh All Graphs** button. If new snapshots are taken, or the data in the Plot Page is changed, the existing Plot Page may be updated by re-clicking on the **Refresh All Graphs** button.

Note: The modified XMgr executable which displays plots is named pxmgr. In order for RiverWare to locate this executable, it must reside in a directory which is part of the user's default search PATH or be set as a full path and name in the XMGR_PATH environment variable. To set this environment variable, type:
% setenv XMGR_PATH /yourRiverWareDirectoryPath/pxmgr

17. Units

A. Display Units

Display Units for any slot may now be changed without converting the slot's values. This feature allows data which were mistakenly imported with the wrong display units or scale, to be reassigned without having to re-import them. The **Configuration** menu for each slot now contains a toggle to "**Convert slot values to new User Units and Scale.**" The toggle is ON by default. When the toggle is ON and User Units and/or scale are changed, the displayed values are converted and scaled so that the underlying internal values remain the same. This was the traditional behavior for previous PRSYM versions. When the toggle is OFF, the displayed values are not converted or scaled. This new behavior actually changes the internally stored values so that the displayed values appear the same.

The automatic conversion and scaling should only be turned OFF to rectify improperly imported data. Normal changing of display units with the toggle OFF will corrupt the slot's data. This toggle is column specific and resets to ON any time a different column is selected or the **Configuration** dialog is re-opened.

B. Unit Converter Precision

The Unit Converter has been modified to display only twelve significant digits in calculated values. All slot values in RiverWare memory and model files are stored with twelve significant digits of precision. The previously unscaled Unit Converter results could have implied a greater precision in calculated values than was actually possible. Results have also been reformatted to display in either floating point notation or scientific notation, whichever is shorter.

18. Change Requests Completed

The following is a list of the bugs which were fixed for this release. If you wish to view the details for a specific bug, please browse to http://cadswes.colorado.edu/users/gnats-query.html and search our bug database. You will need a RiverWare user login and password.

195	217	322	337	348	399	408
422	432	441	462	465	467	469
471	550	574	559	564	610	615
636	642	648	658	659	660	666
667	673	683	692	694	695	696
698	699	704	705	706	707	708
709	710	713	714	716	717	718
719	720	721	722	723	724	725
727	728	729	730	732	733	734
735	738	745	748	750	751	753
754	755	756	757	758	759	762
763	764	765	768	769	770	771
772	773	774	776	777	778	779
780	782	783	784	785	786	787
788	789	790	791	794	795	796
798	799	800	801	804	806	808
810	811	812	813	814	815	816
817	818	819	821	822	823	824
825	833	842	844	846	847	848
849	851	853	855	857	858	860
861	862	863	864	865	867	868
869	870	872	874	875	876	877
878	879	880	881	882	883	884
886	890	891	892	893	894	895
897	900	903	904	905	908	910
911	913	914	919	921	922	924
925	926	929	939	941	943	947
954	955	958	960	962	964	965

966	968	969	970	971	972	973
974	975	976	977	978	979	980
983	984	985	986	990	991	992
993	995	996	997	998	1001	1002
1003	1004	1006	1009	1012	1013	1014
1015	1017	1019	1020	1022	1023	1024
1026	1029	1031	1032	1033	1034	1036
1037	1038	1039	1040	1041	1082	1083
1084	1088	1089	1090	1091	1092	1093
1094	1095	1096	1098	1099	1100	1101
1102	1103	1105	1106	1107	1109	1110
1111	1112	1117	1119	1120	1122	1123
1125	1127	1128	1129	1130	1131	1132
1133	1134	1135	1136	1137	1139	1140
1141	1142	1143	1144	1145	1149	1155
1157	1158	1159	1160	1161	1165	1167
1168	1169	1170	1171	1172	1173	1174
1175	1177	1178	1179	1180	1182	1183
1184	1185	1186	1188	1189	1191	1192
1193	1194	1195	1196	1197	1201	1202
1203	1204	1205	1206	1207	1210	1214
1217	1218	1220	1221	1222	1224	1230
1247	1250	1253	1254	1261	1262	1263
1264	1268	1271	1272	1279	1280	1284
1287	1289	1300	1303	1304	1305	1307

Release Notes Version 1.1

This document describes new features, enhancements and changes that are included in RiverWare Version 1.1, released on July 7, 1997. These changes are new to the executable since the release of RiverWare Version 1.0 on May 7, 1997.

Please direct questions to CADSWES Technical Support at (303) 492-7956 or dumonta@colorado.edu

A. Required Model File Updates:

- There are no changes since Version 1.0 requiring model file updates.

B. Special Attention Notes:

- Resource Database. The name of the RiverWare Resource Database has been changed from “RiverWareDB” to “RiverWareDB.” All files in the executable directory which contain the name “RiverWare” are now consistent with the lowercase spelling of the executable name.

C. Known Bugs and Work-Arounds:

- Rulebased Simulation. Slots which are directly set by rules do not have their **R** priority flags reset when a new value is calculated during redispatching. This bug has already been fixed in RiverWare version 1.1; patchlevel 1, available via the CADSWES ftp site.

1. Model Loading and Saving

A. File Chooser Default Directory

By default, RiverWare file choosers now display the directory of the last file to have been read or written. This applies independently to Loading and Saving model files, Importing and Exporting Data, and Loading, Editing, and Saving SCT files. This feature minimizes the amount of directory traversing required for repeated file actions. For example, importing several sets of data from a common directory will only require changing to that directory once; any subsequent invocation of the file chooser will come up in the same directory.

The default paths for each type of filechooser are saved in the.vgalaxy.1.vr file of the user's home directory at the conclusion of each RiverWare session. If no .vgalaxy.1.vr file exists when a RiverWare session is launched, the default file chooser paths are the user's home directory path. In order to "freeze" a desired set of default paths indefinitely, the .vgalaxy.1.vr file may be write protected with the desired settings.

2. Simulation

A. Tolerance in Dispatch Methods

The hard-wired tolerance for error checks within dispatch methods has been changed from an absolute value of $1x10^{-8}$ to a value based on the Convergence slot of the Object. The checks are used to verify the validity of computed Spills against (Turbine) Release and Outflow. The new tolerance is expressed in the form:

Convergence * Outflow / 100

The new tolerance computation is consistent with the epsilon calculation used for the convergence of iterative loops, and ensures that all values computed within a dispatch method are subject to the same convergence. This change does not affect model results, but may relax error criteria in some cases.

3. Engineering Objects

A. Power Reservoirs

Listed below are all modifications made to Power Reservoirs.

Best Hydro Capacity

The utility method which calculates the Hydro Capacity of PowerReservoirs for the plantPowerCalc and unitGeneratorPowerCalc Methods has been expanded to calculate Best Hydro Capacity. Best Hydro Capacity is the hypothetical power generation of a Reservoir based on operating the turbines at the most efficient flow rate at each timestep. It is calculated as the product of the most efficient flow rate through the turbines and the power coefficient taken from the Best Power Coefficient table for the current Operating Head. This value is now reported in addition to Hydro Capacity, which is based on a maximum flow rate and Max Power Coefficient for the current Operating Head.

☞ **Output Slots**

- **Best Hydro Capacity** (`bestHydroCap`)

  SeriesSlot
  POWER
  hypothetical most efficient power production

Min and Max Operating Head for peakPowerCalc and peakBasePowerCalc

The Minimum and Maximum fields in the Operating Head Configuration menu are now required inputs for both the peakPowerCalc and peakBasePowerCalc User Methods. These Methods previously calculated Energy between the maximum and minimum Operating Head values in the Best Generator Flow and Best Generator Power tables. Due to the occasional need for operating beyond the maximum or minimum Operating Head, these values must now be input separately from the table values. These Methods will produce an error and abort the run if Max and Min Operating Heads are not specified.

B. Water Users

Listed below are all modifications made to Water Users.

Depletion Requested Default Value

When it is not input, the Depletion Requested slot now defaults to the value in the Diversion Requested slot. Water Users which do not have a specified Depletion Request will deplete the entire amount of their Diversion. Return Flow, in this case, is zero.

The default Depletion Requested applies for all Linking Structures except the Lumped Structure with Diversion Requested equal to zero. In this special case, the Depletion Requested is left as NaN.

4. Optimization

A. Final CPLEX Problem

The Optimization-generated “OPT_cplex_prob.final” file is now saved in the same directory as the other Optimization output files. As before, this directory is determined according to the following logic:

/($ RiverWare_OPT_DIR or /tmp) / opt-(user name) / (optional File Directory in the Optimization Controller Parameters dialog)/

5. Rulebased Simulation

A. Max Outflow

Rulebased Simulation may now access the Max Outflow functions of Reservoir Objects used in Simulation. Three new functions have been added to Reservoirs which can be called from within Rulebased Simulation. These functions initialize a local data structure with current Reservoir data required for the Max Outflow calculations. The new functions are:

- C_getMaxOutflowGivenInflow reservoir inflow inflowScale
  inflowUnits poolSeed
  poolSeedScale poolSeedUnits
  outflowReturnScale
  outflowReturnUnits

The getMaxOutflowGivenInflow function takes the values for the Inflow, and an optional Pool Elevation seed value, and stores this information in a LocalInfo data structure. LocalInfo is then passed into the given Reservoir's Simulation function, getMaxOutGivenIn, where the calculations for Max Outflow are actually performed. C_getMaxOutflowGivenInflow returns this Maximum Outflow value in the specified units and scale.

- C_getMaxOutflowGivenStorage reservoir stor storScale storUnits
  outflowReturnScale outflowReturnUnits

The getMaxOutflowGivenStorage function takes the value for the Storage, computes a corresponding Pool Elevation, and stores this information in a LocalInfo data structure. LocalInfo is then passed into the given Reservoir's Simulation function, getMaxOutGivenStorage for SlopePowerReservoirs or getMaxOutGivenStorHW for all other Reservoirs, where the calculations for Max Outflow are actually performed. C_getMaxOutflowGivenStorage returns this Maximum Outflow value in the specified units and scale.

- C_getMaxOutflowGivenHW reservoir pool poolScale
  poolUnits outflowReturnScale
  outflowReturnUnits

The getMaxOutflowGivenHW function takes the value for the Pool Elevation, computes a corresponding Storage, and stores this information in a LocalInfo data structure. LocalInfo is then passed into the given Reservoir's Simulation function, getMaxOutGivenHW for SlopePowerReservoirs or getMaxOutGivenStorHW for all other Reservoirs, where the calculations for Max Outflow are actually performed.

C_getMaxOutflowGivenHW returns this Maximum Outflow value in the specified units and scale.

B. Precedence of Slots Directly Set by a Rule

Slots which are directly set by a rule are now marked by an **R** flag in the Edit Slot dialog. These slots are now given preference within a priority level when determining the dispatch method with which an Object will redispatch. The Rulebased Simulation Controller adds slots to the known set in the groups shown below. Slots are added to the known set one group at a time until the known set exactly matches one of the Object's dispatch conditions. Slots are considered for dispatching in the following order:

1. All slots flagged as user Inputs (**Priority 0**).
2. All slots which were set by default in TIMESTEPBEGINRUN and TIMESTEPBEGINTIMESTEP (**Priority -1**).
3. For each rule priority, in descending order:
   - If any known slots of the given priority contain the **R** flag, only those slots are added.
   - If no slots contain the **R** flag, however, all known slots of the given priority are added.
4. For each rule priority, in descending order:
   - Any known slots of the given priority which were not added in step 3 are added.

For example, the following list of known slots and priority levels would be added to the known set and checked against the Object's dispatching criteria, in the sequence on the following page.

Slot	Priority
Hydrologic Inflow	-1
Inflow	1
Outflow	1**R**
Pool Elevation	2**R**
Diversion	2**R**
Return Flow	3

Step 1 No slots are user Input, so none are added to the known set.

Step 2 Hydrologic Inflow was set in TIMESTEPBEGINRUN; add it to the known set.

Step 3 Priority Level 1: Both Inflow and Outflow are known, but Outflow contains an **R** flag; add it to the known set.
Priority Level 2: Both Pool Elevation and Diversion are known with **R** flags; add them both to the known set.
Priority Level 3: Return Flow is known without any **R** flags; add it to the known set.

Note: At this point, the known set contains slots which exactly match the required conditions of a dispatch method. The Object would be placed on the queue for this dispatch method, and no further slots would be added to the known set. If, for the sake of example, this dispatch method did not exist, the next known slot would be added to the set as follows:

Step 4 Priority Level 1: Inflow was not set in Step 3) due to an **R** flag on another slot; add it to the known set now.
Priority Level 2: All known slots were already added in Step 3).
Priority Level 3: All known slots were already added in Step 3).

The resulting known set would then be:

Known Set
Hydrologic Inflow
Outflow
Pool Elevation
Diversion
Return Flow
Inflow

In this scenario, the Object would redispatch with the solveMB_givenOutflowHW dispatch method, whose known slots are: Outflow, Pool Elevation, Hydrologic Inflow, Diversion, and Return Flow.

C. Overwriting Higher Priority Slots

Slot values computed during a lower priority redispatch will now overwrite any higher priority values already in the slots. This places the burden of enforcing rule priorities on the proper selection of which dispatch method to use. When an Object redispatches, any computed slot value will be set, regardless of the relative priority of the slot and the current dispatch. This change allows solution-independent parameters such as Tailwater Base Value to force a redispatch of Objects regardless of the priority of the last value.

6. SCT

A. Date Header

The format of the date header which appears at the top of a printed SCT has been changed. The header previously displayed the current date as Day/Month/Year. It now displays this information as Month/Day/Year.

7. Units

A. RiverWare Resource Database Message

The message that is displayed when a Resource Database file is not found during the initialization of RiverWare has been changed. The new message reads:

Unable to locate the Resource Database “RiverWareDB”;
Objects added to the Workspace from the Palette will have standard units.

The old message did not explain the consequence of not having a Resource Database file, which caused concern over the validity of models run without it. The RiverWareDB file is *only* used to initialize the default display units for new Objects when they are placed on the workspace from the Palette. The lack of a RiverWareDB file means that new Objects are created with RiverWare standard units as the default display units. Previously created models are completely unaffected by the lack, or presence, of a RiverWare Resource Database.

RiverWare always stores internal values and performs calculations in RiverWare standard units, regardless of the presence, or lack, of a Resource Database. Display units, as always, are simply a user-configurable GUI representation of the internal values. Model run results are not affected by the Resource Database or the user’s choice of display units.

8. Change Requests Completed

The following is a list of the bugs which were fixed for this release. If you wish to view the details for a specific bug, please browse to http://cadswes.colorado.edu/users/gnats-query.html and search our bug database. You will need a RiverWare user login and password.

1020	1300	1315	1319	1320	1322	1347
1349	1351	1352				

Release Notes Version 1.2

This document describes new features, enhancements, and changes included in RiverWare
Version 1.2, released on October 27, 1997.

These changes are new to the executable since the release of RiverWare Version 1.1 on July 7, 1997.

Please direct questions to CADSWES Technical Support at (303) 492-0908 or support@cadswes.colorado.edu

A. Required Model File Updates:

- Models using the **Peak Power Calc** or **Peak Base Power Calc** must be modified. The minimum and maximum Operating Head data which were input in the **Min** and **Max** fields of the Operating Head slot configuration must now be set on a new slot added for this purpose. See section 2B for more details.

B. Special Attention Notes:

- Unlinked Inflow slots of Reservoir objects no longer default to zero if not input by the user. All Reservoirs which are at the upstream boundaries of riverbasin models should be checked for proper inputs. If Inflow is an intended known value for dispatching of a Reservoir, it must either be propagated from an upstream link or directly input on the Inflow slot. Similarly, Water Quality Inflow Mass parameters no longer default to zero if the Reservoir Inflow is unlinked and not input. See section 1A for more details.

1. Simulation

A. Default Inflow

Unlinked **Inflow** slots of Reservoirs no longer default to zero for timesteps where they do not have user input values. This previous behavior had some undesirable effects on simulation and often caused confusion in the modeling approach. Existing models which rely on Inflow slot default values of zero for dispatching of uppermost reservoirs must be updated to produce the same results under RiverWare 1.2. For both Simulation and Rulebased Simulation, previously defaulted **Inflow** slots should be explicitly set to "**0**" for all simulation timesteps.

Models which perform water quality computations will also need to be updated. Water quality constituent Inflow quantities no longer default to zero when the Reservoir Inflow is unlinked. The following slots will now need user input of "**0**" for all simulation timesteps to produce the same results as previous RiverWare versions:

- **Inflow Heat**
- **Inflow Salt Mass**
- **Inflow Detritus Mass**
- **Inflow Dissolved Organics Mass**
- **Inflow Ammonia Mass**
- **Inflow Dissolved Oxygen Mass**

B. Slot Maximum Iterations

Exceeding the user-specified maximum iterations when setting a slot value now aborts the simulation run. This occurs when, during iteration, a slot's value is set too many times. Normally, the iteration is terminated when the new slot value and the old slot value differ by less than the specified convergence value. Previously, when the maximum iterations was exceeded, a diagnostic warning message was posted, the new slot value was not set, and simulation proceeded. Since this could result in a violation of mass balance beyond the limits of the user-specified convergence value, the behavior was eliminated.

The iteration count of a slot is incremented every time a new value is set. There is a different iteration count for each timestep of the simulation and for each series slot of a model. Maximum iterations are set to 20 by default, but may be changed in each series slot's **Configuration** menu. Exceeding maximum iterations is rare. Slow convergence of the solution can indicate a modeling problem. The cause of excessive iterations should be determined before arbitrarily increasing the maximum. In certain cases, the problem can also be solved by relaxing the slot's convergence criteria.

This change applies both to Simulation and Rulebased Simulation. In Rulebased Simulation, however, iteration counting is turned off by default. To enable the checking of maximum iterations in Rulebased Simulation, turn on the **Check Iterations** checkbox in the **Run Control Panel**'s **View Controller Specific Parameters** Dialog. Rulebased slot iteration counters for all slots are reset each time a rule begins to execute.

2. Engineering Objects

A. Reservoirs

Listed below are all modifications made to Reservoir Objects.

Seepage Calculation Category

A new User Method Category called **Seepage Calc** has been added to all Reservoirs. The new Category is used to account for seepage through and around the face of a dam. There are two User Methods available for selection in this Category: the default **No Seepage** and **Linear Seepage Calc**. The default Method performs no computations and instantiates no slots.

The **Linear Seepage Calc** method calculates dam seepage based on the Pool Elevation of the Reservoir and a set of coefficients. The coefficients are a seepage base elevation, a linear slope coefficient, and a linear intercept coefficient. All three are input into the Seepage Coefficients table slot. The seepage is computed as:

Seepage = (average Pool Elevation - base elevation) x slope + intercept

Coefficients may be specified which produce a negative seepage; however, since seepage is not permitted to be less than zero, negative seepage values are automatically reset to zero. Seepage is a Reservoir loss in the mass balance, but is not considered part of any Outflows or Spills. Seepage may be linked to another slot if desired. The Inputs and Outputs for this Method are:

☞ **Slots with Required Input Data**

- **Seepage Coefficients** (`seepageCoeff`)
  TableSlot
  LENGTH, AREAperTIME, FLOW
  base elevation, slope, and intercept of the linear equation

☞ **Slots with Output Data**

- **Seepage** (`seepage`)
  SeriesSlot
  FLOW
  flow of water through and around the dam face

Hydrologic Inflow and Loss

A new User Method, **Hydrologic Inflow and Loss**, has been added to Level Power

Reservoirs and Storage Reservoirs. This Method is selected in the **Hydrologic Inflow Calculation Category**. The Method allows Hydrologic Inflow and Hydrologic Inflow Adjust to be input by the user. If these slots are not linked, any timesteps which do not have input values default to zero. Hydrologic Inflow Net is then computed as the sum of the Hydrologic Inflow and the Hydrologic Inflow Adjust. All of this behavior occurs during the beginning of run, and is identical to the existing **Input Hydrologic Inflow** User Method.

The **Hydrologic Inflow and Loss** Method has special behavior when solving for Inflow using one of the following dispatch methods:

- solveMB_givenOutflowStorage
- solveMB_givenOutflowHW
- solveMB_givenEnergyStorage
- solveMB_givenEnergyHW

In these cases, the dispatching slot values may force the computation of a negative Inflow. If the dispatch method calculates a negative Inflow, the **Hydrologic Inflow and Loss Method** is invoked a second time. When the Method is invoked from a dispatch, it sets the Hydrologic Inflow Adjust to the value of the Inflow (a negative value), sets Inflow to zero, and recalculates the Hydrologic Inflow Net. If Hydrologic Inflow Adjust or Hydrologic Inflow Net are user input at this timestep, the run aborts with an error.

☞ **Slots with Optional Input Data**

- **Hydrologic Inflow** (`hydrologicInflow`)
  SeriesSlot
  FLOW
  additional flow gain to the reservoir
  This value defaults to zero for any timesteps where it is not input.

- **Hydrologic Inflow Adjust** (`hydrologicInflowAdjust`)
  SeriesSlot
  FLOW
  adjustment to the additional flow gain to the reservoir
  This value defaults to zero for any timesteps where it is not input. The slot is set to a negative value for any timesteps where a negative Inflow would otherwise result. Under this circumstance, there may not be a user input value at the same timestep.

☞ **Slots with Output Data**

- **Hydrologic Inflow Net**(`hydrologicInflowNet`)

SeriesSlot
FLOW
net additional flow gain to the reservoir
This slot value is the sum of the Hydrologic Inflow and Hydrologic Inflow Net.

B. Power Reservoirs

Listed below are all modifications made to Power Reservoir Objects.

Peak Power Calc and Peak Base Power Calc

The **Peak Power Calc** and **Peak Base Power Calc** User Methods have two modifications. A warning is no longer posted in the Diagnostics Output Window when the reservoir Pool Elevation is too low to generate power. The low Pool Elevation is not considered a modeling or system error. The Method accurately models this case, and simulation is unaffected.

The second modification concerns the minimum and maximum Operating Head. Previously, these values were set in the **Min** and **Max** fields of the Operating Head slot's **Configuration** Dialog. This resulted in a warning message every time these criteria were violated. Since violation of the minimum or maximum Operating Head is common and acceptable for these Methods, the values are not the true minimum and maximum for the slot itself. These values are in fact Method parameters, and are now set on the Min and Max Operating Head slot. The new table slot has two rows, the first for minimum Operating Head, and the second for maximum Operating Head.

☞ **New Slot with Required Input Data**

- **Min and Max Operating Head** (`minMaxOpHead`)

TableSlot
LENGTH, LENGTH
the minimum and maximum recommended operating head

C. Storage Reservoirs

Listed below are all modifications made to Storage Reservoirs.

Cubic Bank Storage Calc

A new User Method, called **Cubic Bank Storage Calc**, has been added to the **Bank Storage Calc Category** of Storage Reservoirs. This Method has been developed to duplicate historical reservoir loss calculations for Brantley Reservoir. The calculated Change in Bank Storage is the volume of "net overall loss" including seepage, bank storage, and other unaccounted losses. Empirical coefficients are used to calculate a flow loss according to the following equation:

$$y = a + bx^3$$

where *y* is the Reservoir flow loss, *a* and *b* are specific constants, and *x* is the current reservoir Pool Elevation. A different set of equation constants are used depending on whether the Reservoir Pool Elevation is rising or falling during the current timestep. The coefficients corresponding to rising and falling elevations are specified in the Cubic Bank Storage Rising Coeffs table and the Cubic Bank Storage Falling Coeffs table, respectively. If the Pool Elevation remains constant over the timestep, the coefficients corresponding to the last Pool Elevation change are used. If the Pool Elevation is constant during the first timestep(s) of the simulation, the falling coefficients table is used by default. Finally, the computed flow loss is converted to a volume loss for the timestep.

☞ **Slots with Required Input Data**

- **Cubic Bank Storage Falling Coefficients** (cubicFallingCoeffs)

TableSlot
FLOW, PER_TIME
constants for equation when reservoir level is falling
The first coefficient is the constant term, and the second is the cubic coefficient.

- **Cubic Bank Storage Rising Coefficients** (`cubicRisingCoeffs`)

TableSlot
FLOW, PER_TIME
constants for equation when reservoir level is rising
The first coefficient (column zero) is the constant term, and the second is the cubic coefficient.

☞ **Slots with Output Data**

- **Change in Bank Storage** (deltaBankStorage)

SeriesSlot
VOLUME
change in volume of water stored in the reservoir banks

3. Rulebased Simulation

Due to many changes in the Rulebased Simulation Controller and Rule Processor over the past several releases, an overview is included at the end of these release notes. Please refer to the overview for a complete picture of the current Rulesbased Simulation logic.

A. Maximum Rule Execution Iterations

The Rulebased Simulation controller now keeps track of Rule execution iterations. The iteration count is used to interrupt a run if a Rule executes more than 50 times in a single timestep. Previously, there was no way to interrupt infinite loops in the iteration between Rules and Simulation.

B. Group Set of Slot Assignments

Checking of dispatch conditions is now delayed until all of a Rule's slot assignments have been made. Previously, objects checked their dispatch conditions whenever a dispatching slot value was set. For Rules which only set a single slot, this created no ambiguity. For Rules which set multiple slots, however, this allowed objects to be placed on the dispatch queue even if the Rule had other slots yet to be set on this object. In some cases, the slots remaining to be set would have forced a different dispatch method to be selected. To alleviate any ambiguity, dispatch conditions are no longer checked until all of a Rule's slot assignments have been made.

C. Simulation Errors During Rule Execution

Errors generated during Rule execution calls to Simulation functions no longer abort the run. Errors are now returned to the Rule Processor for interpretation. Previously, any error generated in a Simulation engineering function which was called during the execution of a Rule automatically posted a message and aborted the run (the Simulation Controller still behaves this way). The Rule Processor, however, now catches simulation errors and terminates the executing rule instead. The rule does not continue, and no slot assignments are made. The rule may re-fire at a later time.

RiverWare Tcl procedures which invoke methods on the Engineering Objects are prevented from aborting the run. Since these functions solve hypothetical problems for the rules only and do not set slots, their failure should only impact the currently executing rule. All Tcl procedures, however, will continue to abort the run if fundamental errors are detected (incomplete arguments, invalid dates/times, etc.). The effects of errors in each of the currently defined Tcl procedures included in RiverWare are as follows:

RiverWare Tcl Procedure	Effect of Error	RiverWare Tcl Procedure	Effect of Error
C_SolveInflow	Terminate Rule	*all* C_*<Get/Set><Value/List>*	Abort Run
C_SolveOutflow	Terminate Rule	C_IsNaN	Abort Run
C_SolveStorage	Terminate Rule	*all* C_Sum*<Table/Object>*List	Abort Run
C_TableInterpolate	Terminate Rule	C_Exit	Abort Run
C_StorageToArea	Terminate Rule	C_GetAllNamedBasins	Abort Run
C_ElevationToArea	Terminate Rule	C_GetObjectsInBasin	Abort Run
C_ElevationToStorage	Terminate Rule	*all* C_AggOver*<Obj/Time>*	Abort Run
C_ElevationToMaxRegulatedSpill	Terminate Rule	C_ConvertValue	Abort Run
C_ElevationToUnregulatedSpill	Terminate Rule	C_FlowToVolume	Abort Run
C_OperatingHeadToMaxRelease	Terminate Rule	C_VolumeToFlow	Abort Run
C_GetMaxOutflowGivenInflow	Terminate Rule	*all* C_CopySlot*<s>*	Abort Run
C_GetMaxOutflowGivenStorage	Terminate Rule	*all* C_ConstrainSlot	Abort Run
C_GetMaxOutflowGivenHW	Terminate Rule	*all* C_Get*<Date/Time>*	Abort Run
C_NetNonShortDiversionRequirement	Terminate Rule	*all* C_Incr*<Date/Time>*	Abort Run
C_Six02a	Terminate Rule	*all* C_Decr*<Date/Time>*	Abort Run
C_CriticalPeriodUBDepletions	Terminate Rule	*all* C_*<reset>*RandDev	Abort Run

RiverWare Tcl Procedure	Effect of Error	RiverWare Tcl Procedure	Effect of Error
C_TargetSpace	Terminate Rule	C_GetStepSeconds	Abort Run
C_MaxAllowableStorage	Terminate Rule	C_Min	Abort Run
C_ReleaseNeeded	Terminate Rule	C_Max	Abort Run
C_InflowAbove	Terminate Rule	C_Print	Abort Run
C_ConsumptionAbove	Terminate Rule	C_Trace	Abort Run
C_PredictedInflow	Terminate Rule		

D. Average Pool Elevation for Max Outflow Tcl Routines

The average Pool Elevation over the current timestep is now used to determine the maximum Release and Spill for **C_getMaxOutflowGiven<Inflow/Storage/HW>** Custom Tcl Routines. Previously, the Pool Elevation at the end of the current timestep (current Pool Elevation) was used. Now, the Pool Elevation at the beginning of the current timestep (previous Pool Elevation) is averaged with the most recent estimate of the Pool Elevation at the end of the current timestep. This average elevation is used in the **Max Release**/**Max Turbine Q**, **Unregulated Spill Table**, and **Regulated Spill Table** (if applicable) to determine the maximum Outflow.

E. getMaxOutflowGivenInflow Tcl Routine

The **getMaxOutflowGivenInflow** Custom Tcl Routine has been modified to not require a Pool Elevation value as a seed to the iterative solution. The new arguments for this function are as follows:

- C_getMaxOutflowGivenInflow reservoir inflow inflowScale inflowUnits outflowReturnScale
outflowReturnUnits

4. Change Requests Completed

The following is a list of the bugs which were fixed for this release. If you wish to view the details for a specific bug, please browse to http://cadswes.colorado.edu/users/gnats-query.html and search our bug database. You will need a RiverWare user login and password.

959	1014	1269	1274	1285	1286	1302
1309	1317	1321	1324	1325	1340	1345
1347	1349	1351	1352	1357	1359	1360
1362	1363	1364	1365	1367	1368	1374
1375	1379	1380	1381	1389	1396	1397
1399	1404	1407	1408	1419	1420	

Release Notes Version 2.1

This document describes new features, enhancements, and changes included in RiverWare Version 2.1, released on March 10, 1999. These changes are new to the executable since the release of RiverWare Version 2.0.3 on August 3, 1998.

Please direct questions to RiverWare Technical Support at (303) 492-0908 or support@cadswes.colorado.edu.

A. Required Model File Updates:

- Water User **Diversion Requested** and **Depletion Requested** no longer default to 0.0 if not input in the **Input Requests** Method. If one of the slots is input, RiverWare will continue to default the other slot to the input value. Models which depend on the defaults must be updated with input(s) of 0.0 to solve for the same results as prior versions of RiverWare.
- Gainloss calculations which were specific to individual Reach routing Methods are now performed in a new User Method Category called **GainLoss Calculation**. There are four User Methods in this new Category to cover all previous gain/loss calculations. Models saved under earlier versions of RiverWare will have slot names automatically converted to their new names, but will NOT have the appropriate GainLoss method selected. If any Reaches previously calculated gains or losses (there were non-zero values in any of the old gain/loss slots), the appropriate Method must be selected in the **GainLoss Calculation** Category. Please refer to “Gain Loss” on page -109 for more information.

B. Special Attention Notes:

▲ When loading old models, several diagnostics messages may be generated as old slot types are automatically converted to new slot types:

▲ Trying to convert former slot type (“MultiSlot”) to new slot type (“SimObjMultiSlot”). Trying to convert former slot type (“SeriesSlot”) to new slot type (“AggSeriesSlot”). Do not be concerned by these messages. You do not need to make any changes to your model.

- The names of the User Methods in the **Diversion from Reach** and **Diversion from Reservoir** User Method Categories have been changed from **AggDiversionSite Linked** to **Available Flow Based Diversion** and from

Diversion Object Linked to **Head Based Diversion**. Models which contain any of these Methods will automatically be updated upon loading.

1. Model Loading

A. “MultiSlots” renamed “SimObjMultiSlots”

All MultiSlots have been renamed SimObjMultiSlots to accommodate a software class reorganization. Additionally, some SeriesSlots have been converted to AggSeriesSlots. When loading old models, diagnostics messages may be generated as old slot types are automatically converted to new slot types:

Trying to convert former slot type (“MultiSlot”) to new slot type (“SimObjMultiSlot”).
Trying to convert former slot type (“SeriesSlot”) to new slot type (“AggSeriesSlot”).

Do not be concerned by these messages. You do not need to make any changes to your model. The use and functionality of these slots has not changed.

2. Simulation

A. Global Maximum Iterations

The maximum iterations for simulation dispatch slots is now set globally in the **Simulation Controller Parameters** dialog. This dialog is invoked by selecting **View ➥ Controller Specific Parameters...** in the **Run Control** dialog's menu bar. Whereas the default maximum iterations in prior versions of RiverWare was 20, the new default for a clear workspace is 40. The maximum iterations is valid for all dispatch slots, and may no longer be set independently in each slot's **Configuration** dialog.

When models saved under earlier versions of RiverWare are loaded with 2.1, the global maximum iterations value will be set to the largest maximum iterations value which was set on any of the individual slots. This ensures that maximum iterations will be large enough to allow all objects to solve as they did before.

B. Diversion and Return Flow Defaults

Prior to RiverWare 2.1, Reservoirs were often prevented from dispatching until the controller clock had reached the dispatch timestep. This was due to the setting of default **Diversion** and **Return Flow** (when these slots were not linked) at the beginning of each controller timestep. As a result, unknown Diversion and Return Flow values were not defaulted until the controller had executed the beginning of timestep behavior for the given timestep. Since Diversion and Return Flow are required knowns for all Reservoir dispatch methods, Reservoirs often had to wait, even though all other data was available to dispatch.

Unknown and unlinked **Diversion** and **Return Flow** slots are now set to 0.0 at the Beginning of Run. Depending on the model data, this may allow a majority of Reservoirs to go on the dispatch queue from the very first timestep. In some cases, this change may improve model run times.

3. Simulation Objects

A. Reservoir

Spillway Flashboards and Superboards

A new User Method Category, **Unregulated Spill Type**, has been added to Reservoir objects to model the effects of breakaway "flashboards" on unregulated spillways. The **Unregulated Spill Type** User Method Category is only available when a Method containing an unregulated spillway is selected in the **spillCalculationCategory**. There are three User Methods available for selection within this Category: the default **Bare Crest Only**, **Flashboards**, and **Flashboards and Superboards**.

The default Method performs no computations and existing models need not be modified. The **Flashboards** Method calculates **Unregulated Spill** based on a flashboard availability table, a flashboard spill table (for the flashboards which are up), and the unregulated spill table (for the flashboards which are down). The **Flashboards and Superboards** Method calculates **Unregulated Spill** based on the availability of flashboards and superboards (mounted on top of the flashboards), a superboard spill table (for the superboards which are up), a flashboard spill table (for the flashboards which are up), and the unregulated spill table (for the flashboards which are down). Both Methods adjust the availability of flashboards and superboards at each timestep based on user-input flashboard and superboard failure elevations. Due to drastic changes in spill volume when boards fail, the failure time of boards is calculated and modeled at a finer time resolution than the model run timestep. Detailed documentation of the two Methods may be found in the Simulation Objects Online Documentation.

Uncertainty Calculation

A new User Method Category, **Uncertainty Calculation**, has been added to Storage Reservoir and Level Power Reservoir objects. There are two User Methods available for selection within this Category: the default **No Uncertainty**, and **FOSM Uncertainty**.

The default Method performs no computations and existing models need not be modified. The **FOSM Uncertainty** Method is first-order second-moment approximation for modeling system uncertainties. The uncertainty computations are executed at the end of the dispatch routines for all dispatch methods which do not have **Energy** or **Spill** as input slots. The slots for which uncertainties may be specified are **Inflow**, **Outflow**, **Storage**, **Pool Elevation**, **Hydrologic Inflow**, **Evaporation**, and **Bank Storage**. Detailed documentation of this Method may be found in the Simulation Objects Online Documentation.

B. Reach

Gain Loss

Gainloss calculations which were specific to individual routing Methods in earlier versions of RiverWare are now available to all routing Methods. A new User Method Category called **GainLoss Calculation**, has been added to Reach objects. There are four User Methods available for selection within this Category: the default **No GainLoss**, **Constant GainLoss**, **Variable GainLoss**, and **Seasonal GainLoss Flow Table**. The default method performs no computations. Detailed documentation of the three other Methods may be found in the Simulation Objects On-line Documentation.

Models saved under earlier versions of RiverWare will have slot names automatically converted to their new names, but will NOT have the appropriate GainLoss method selected. If any Reaches previously calculated gains or losses (there were non-zero values in any of the old gain/loss slots), the appropriate Method must be selected in the **GainLoss Calculation** Category.

Old Slot Name		New Slot Name
Constant GainLoss	->	GainLoss
GainLoss Coefficient	->	GainLoss Coefficient (no change)
Constant GainLoss Coefficient Interpolated	->	Variable GainLoss
Variable GainLoss Coefficient Interpolated	->	Variable GainLoss Coeff
Constant GainLoss Coefficients	->	Variable GainLoss Table
Variable GainLoss Coefficients	->	Variable GainLoss Coeff Table
Constant Loss	->	Variable GainLoss (SIGN CHANGE: positive value is now a gain)
Fractional Loss	->	Variable GainLoss Coeff (SIGN CHANGE: positive value is now a gain)
Variable Lag Time Interpolated	->	Variable Lag Time
Variable Lag Times	->	Variable Lag Time Table

If a model was previously using the **Constant GainLoss** slot to compute reach loss, the data within this slot will be automatically converted to the new slot (**GainLoss**) but the user must select **Constant GainLoss** within the **GainLoss Calculation** category for the new slot to be active.

If a model was previously calculating gains or losses in a routing Method which used only the **Variable GainLoss Coefficients** and **Variable GainLoss Coefficient Interpolated** slots (**Muskingum Cunge**, **Kinematic Routing**, or **MacCormack Routing**), the **Seasonal GainLoss Flow Table** method must be selected. The data within the slots will be automatically transferred to **Variable GainLoss Coeff Table** and **Variable GainLoss Coeff**, however the **Variable GainLoss Table** will also be added. This table must contain values for the simulation to run. The table can be filled with zeros for the simulation to run identical to the previous model.

If the user was using either the **Variable Muskingum** or **Muskingum Cunge** routing methods, and **Previous Flow Average** was selected in the **Apply Fractional Loss** User Method Category, the following changes must be made: The proper Method must be selected in the **GainLoss Calculation** Category since the **Fractional Loss** Category no longer exists and P**revious Flow Average** must be selected in the **Apply GainLoss** Category. This Method works exactly the same as the previous method, however, it will not be selected by default because the name of the Method Category has changed.

"ssarrRouting" renamed "Storage Routing"

The **ssarr** User Method in the **routingMethodCategory** User Method Category of Reach objects has been renamed **Storage Routing**. There is no functional difference between the two User Methods. Models saved under earlier versions of RiverWare will have the Method name changed automatically and will solve the same way as they did before.

Variable Storage Routing

A new User Method, **Variable Storage Routing**, has been added to the **routingMethodCategory** of Reach objects. This routing Method is identical to the Storage Routing Method except that its storage time exponent and storage time coefficient vary over time rather than being constant values. The exponent and coefficient are determined at each timestep from a table lookup given the flow at that timestep. Detailed documentation of this Method may be found in the Simulation Objects Online Documentation.

Contingent Local Inflow

A new User Method, **contingentLocalInflow**, has been added to the **localInflowCalculationCategory** of Reach objects. The **contingentLocalInflow** User Method Category is only available when **noRouting** is selected as the **routingMethodCategory**. This local inflow Method changes the way in which the Reach solves depending on the known slots. If **Local Inflow** is known, it is used with the other known slot (**Inflow** or **Outflow**) to solve for the unknown (**Outflow** or **Inflow**). If **Local Inflow** is not known and only one of **Inflow** or **Outflow** is known,

Local Inflow is set to 0.0 and the unknown slot is solved for. If **Local Inflow** is not known but both **Inflow** and **Outflow** are, **Local Inflow** is solved for. Detailed documentation of this Method may be found in the Simulation Objects Online Documentation.

Knowns	Assumption	Solve For
Inflow, Local Inflow	none	Outflow
Outflow, Local Inflow	none	Inflow
Inflow	Local Inflow = 0.0	Outflow
Outflow	Local Inflow = 0.0	Inflow
Inflow, Outflow	none	Local Inflow

Seepage

A new User Method Category, **Seepage Calc**, has been added to Reach objects to model losses into groundwater. The **Seepage Calc** User Method Category is only available when **noRouting** is selected as the **routingMethodCategory**. This alleviates any confusion as to whether the seepage loss is applied before or after routing. There are three User Methods available for selection within this Category: the default **No Seepage**, **Proportional Seepage**, and **Variable Seepage**.

The default Method performs no computations. The **Proportional Seepage** Method calculates **Seepage** using a single **Seepage Flow Fraction**. The **Variable Seepage** Method calculates **Seepage** using a timeseries of **Variable Seepage Flow Fractions**. Seepage losses are applied at the top of a Reach, prior to any diversion, return flow, and/or gainloss.The calculated **Seepage** slot may be linked to a GroundWater Storage object. Detailed documentation of the two Methods may be found in the Simulation Objects Online Documentation.

Time Lag Routing Upstream

The timeLagRouting Method has been enhanced to allow solving for Inflow based solely on Outflows. In prior releases of RiverWare, at least one Inflow was required for this Method to solve upstream. It will now dispatch and solve with Outflow only.

C. Distribution Canal

Request Routing

A new User Method, **No Routing**, has been added to the **Request Routing** Category of Aggregate Distribution Canal objects. The new Method allows a Distribution Canal network to be modeled in a non-request routing mode. In this mode, the Inflow into the top portion of the Canal system must be set in a different way (user input, linked from a Diversion Object, or return flow from another Canal or a Water User). The advantage to this Method, is the ability to operate a Canal system from the top down, rather than the bottom up (supply-driven rather than demand-driven). The new **No Routing** Method is the default Method for the **Request Routing** Category and performs no computations. Detailed documentation of this Method may be found in the Simulation Objects Online Documentation.

Flow Routing

Three new User Methods have been added to the **Flow Routing** Category of Distribution Canal element objects. These User Methods are only available when **No Routing** is selected as the **Request Routing** Method in the Aggregate Distribution Canal object. In this case, the canal system is being operated in a top-down manner. This allows additional flexibility in routing algorithms because they only need to solve downstream. The three new F**low Routing** Methods are the default **No Routing**, **Storage Time**, and **Variable Storage Time**.

The default Method performs no routing computations. The **Storage Time** Method is similar to the **Storage Routing** Method of Reach objects. The **Variable Storage Time** Method is similar to the **Variable Storage Routing** Method of Reach objects. Detailed documentation of these Methods may be found in the Simulation Objects Online Documentation.

Canal Seepage

A new User Method Category, **Canal Seepage**, has been added to Distribution Canal element objects to model losses into groundwater. There are three User Methods available for selection within this Category: the default **None**, **Seepage Calc**, and **Variable Seepage Calc**.

The default Method performs no computations. The **Seepage Calc** Method calculates **Canal Seepage** using a single **Seepage Flow Fraction** and a **Maximum Seepage**. The **Variable Seepage Calc** Method calculates **Canal Seepage** using a timeseries of **Variable Seepage Flow Fractions** and a **Maximum Seepage**. In both cases, the seepage is subtracted from the canal's flow before any routing is done. The calculated **Canal Seepage** slot may be linked to a GroundWater Storage object. Detailed documentation of these Methods may be found in the Simulation Objects Online Documentation.

Canal Maximum Capacity

A new User Method Category, **Canal Maximum Capacity**, has been added to Distribution Canal element objects to model surface overflow at canal structures. There are two User Methods available for selection within this Category: the default **None**, and **Maximum Capacity**.

The default Method performs no computations. The **Maximum Capacity** Method calculates **Canal Spillover** as any portion of the canal element **Inflow** which is greater than the **Maximum Capacity**. The calculated **Canal Spillover** slot may be linked to a lateral Distribution Canal's Inflow, or a Reach or Reservoir's local Inflow. Detailed documentation of the two Methods may be found in the Simulation Objects Online Documentation.

D. Stream Gage

Internal Link

The Stream Gage object no longer dispatches. Instead, flow values propagate across a link between the Inflow and Outflow slots. The link is automatically created when the Stream Gage is pulled off of the palette. Older models which contain Stream Gage objects will automatically be updated to include the link when the model is loaded.

E. Groundwater Storage

Excess GW Storage

A new User Method Category, called **Excess GW Storage**, has been added to Groundwater Storage objects to model groundwater saturation. The Method determines what to do with groundwater which is beyond the limits of the maximum groundwater capacity. There are three User Methods available for selection within this Category: the default **No Excess Storage**, **Excess Storage to Outflow**, and **Excess Storage Divert**.

The default Method performs no computations. The **Excess Storage to Outflow** Method adds any end-of-timestep storage greater than the **Max GW Capacity** to the **Outflow** slot. This simulates a situation where a full aquifer “spills” in the normal downgradient direction. The **Excess Storage Divert** Method allocates any end-of-timestep storage greater than the **Max GW Capacity** to the linkable **Excess GW Outflow** slot. This simulates a situation where a full aquifer “spills” by recharging another object such as a river or reservoir. Excess storage is determined only after the mass balance with **Inflow**, Deep Percolation, and **Outflow** has been calculated. Detailed documentation of the two Methods may be found in the Simulation Objects Online Documentation.

Deep Percolation

A new User Method Category, called **GW Deep Percolation**, has been added to Groundwater Storage objects to model the vertical movement of groundwater into deeper aquifers. The Method calculates a vertical seepage using similar algorithms to the horizontal outflow calculation. There are four User Methods available for selection within this Category: the default **No Percolation**, **Input Percolation**, **Linear Percolation**, and **Exponential Percolation**. The default Method performs no computations and existing model files need not be modified.

In low **Storage** situations, deep percolation is the preferred mechanism of **Storage** loss. If there is not enough **Storage** to satisfy **Pumping Calc** pumping requests, **GWOutflowCalc** outflow requirements, and **GW Deep Percolation** percolation requirements, the calculated values of the Methods are shorted in the order just listed. Detailed documentation of the three Methods may be found in the Simulation Objects Online Documentation.

Pumping Calc

A new User Method Category, called **Pumping Calc**, has been added to Groundwater Storage objects to allow pumping of groundwater by Water User objects. The Method calculates a maximum **Available for Pumping** value and lets the Water User object determine the amount of **Pumped Flow**. There are two User Methods available for selection within this Category: the default **No Pumping**, and **Input Pumping**. The default Method performs no computations and existing model files need not be modified.

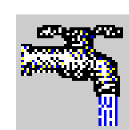
The **Input Pumping** Method calculates **Available for Pumping** at the next timestep based on the end of timestep **Storage** and the projected **Outflow** and **Percolation** at the next timestep, such that **Storage** is never allowed to become negative. The **Available for Pumping** propagates across a link to a Water User object which determines the amount to pump and propagates this value back to the **Pumped Flow** slot. Detailed documentation of this Method may be found in the Simulation Objects Online Documentation.

GW Alpha Param

The **GW Alpha Param** slot, which is used by the **LinearFlow** and **ExponentialFlow** Methods of the **GWOutflowCalc** Category has been changed. The units for this slot are now in "per time" [1/t]. This is the correct unit type for this slot, given the algorithm it is used in. Old models which contain this slot should be modified. The only way to change the slot units is to delete the object from the model, then pull a new object from the object Palette. Models which are not modified will continue to solve in the same way they did before, but the potential for confusion in the use of this slot will continue to be great.

F. Water User

"Stand Alone" Water User Object



The Water User object, which was previously available only as a member of an Aggregate Diversion Site, is now available as a "stand-alone." The new object is created by dragging its icon off of the object Palette onto the workspace. The new Water User object contains all of the User Method Categories and User Methods which are available for Water User elements of Aggregate Diversion Sites linked with the **noStructure** Link Structure. Individual Water Users linked to a Diversion Object provide similar modeling capabilities to an Aggregate Diversion Site with considerably more flexibility.

Water User Conjunctive Use

A new User Method Category called **Conjunctive Use**, has been added to Water User objects. There are two User Methods available for selection within this Category: the default **No Conjunctive Use** and **Supplement Diversion**. The default method performs no computations. Models saved under earlier versions of RiverWare do not require any modifications and will solve the same way as they did before.

The new **Supplement Diversion** Method pumps water from a Groundwater Storage object to supplement surface water deliveries in time of shortage. The allocation of pumped water is contingent on pumping availability and may be allocated to Water Users in an Aggregate Diversion Site in accordance with their groundwater rights priorities. This Method Category is also available to Aggregate Diversion Sites using the **lumpedStructure** Link Structure. Complete documentation for this Method and Category are available in the Simulation Objects Online Documentation.

G. Diversion Object

Available Flow Diversion

A new User Method, **Available Flow Diversion**, has been added to the **Available Flow Calculation** Category of Diversion Objects. This Method allows a Diversion Object to divert water from a Reservoir or Reach based on the water available for diversion from that object, rather than the objects elevation or stage. This flow-based diversion (as opposed to a head-based diversion) nearly replicates the behavior of the Aggregate Diversion Site. The diverted amount is calculated as the lesser of the **Diversion Request**, **Available For Diversion**, and **Max Diversion**. A **Min Diversion**, the smallest diversion possible, is also specified. Detailed documentation of this Method may be found in the Simulation Objects Online Documentation.

4. Rulebased Simulation

A. Iteration Checking

The efficiency of slot iteration checking has been greatly improved. Iteration checking occurs when the **Check Iterations** box is selected in the **Controller Parameters** dialog. Checking is now done only for dispatching slots and only at the current controller timestep. This improvement can result in run time savings of up to 15% on some models where slot iteration checking is turned on.

B. STRING == and !=

Equality (**==**) and inequality (**!=**) comparisons of STRING expression types are now permitted within rule expressions. The comparisons evaluate to the BOOLEAN expression types TRUE or FALSE. Comparison is exact and case-sensitive.

C. GetObjectsInBasin() renamed ListSubbasin()

The **GetObjectsInBasin()** predefined function has been renamed **ListSubbasin()**. Rulesets with the old name will continue to work, but only the new name appears in the predefined function selector. There is no computational difference between the two functions.

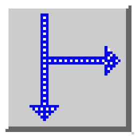
D. Predefined Functions

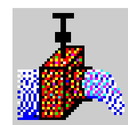
Many predefined functions have been added to the Rulebased Simulation Palette. The new functions, as well as all of the existing functions, are currently being documented. This document will soon be available online. Meanwhile, contact RiverWare Technical Support if you have any questions about specific functions in the Palette.

5. GUI (Graphical User Interface)

A. Diversion Object Icon

The Diversion Object Icon has been changed from the image at left to the image at right. This is only a cosmetic change.

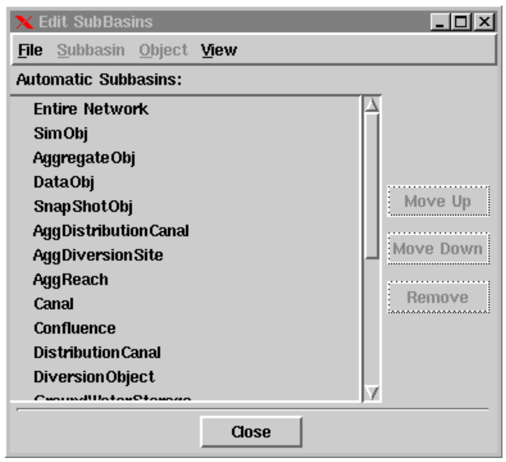




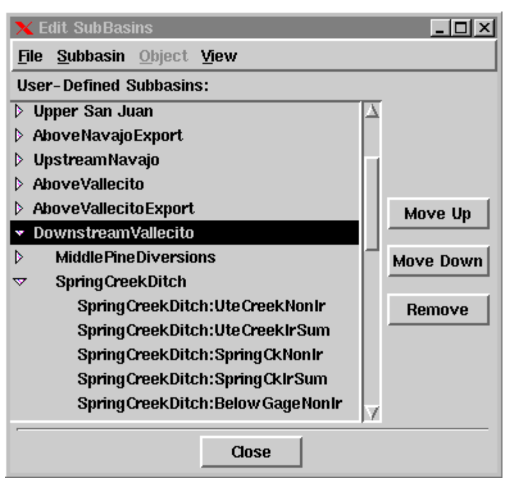
6. Subbasins

A. New Subbasin Manager

The Subbasin Manager has been completely redesigned to facilitate growing needs, but no changes to existing models are necessary. The Subbasin Manager, invoked by selecting **Workspace ➥ Edit SubBasins...** from the main RiverWare menu bar, now has two views, **User-Defined SubBasins** and **Automatic SubBasins**. The views are selected in the SubBasin Manager's **View** menu. The default view is the automatic subbasins view shown below:



Automatic subbasins are generated by RiverWare and may not be renamed or reordered, or have their members modified or reordered. User-defined subbasins are defined by the user and saved in the model file. They may be renamed and reordered, and their member objects may be modified and reordered. A sample user-defined subbasin view is shown below:



The triangles to the left of each subbasin are used to open (and close) the list of member objects in that subbasin. Member objects are indented one level. The triangles to the left of aggregate member objects are used to open (and close) the list of element objects. Element objects are indented one additional level from their aggregate "parent" object.

Subbasin names are modified by clicking on their existing name and typing a new name into the resulting textfield. The other commands available are:

Subbasin ➥ Delete Subbasin Deletes the currently highlighted subbasin.

Subbasin ➥ Insert New Subbasin Before Creates a new subbasin, which includes any objects currently highlighted on the workspace, and inserts it before the currently highlighted subbasin.

Subbasin ➥ Append New Subbasin Creates a new subbasin, which includes any objects currently highlighted on the workspace, and appends it to the end of the subbasin list.

Subbasin ➥ Invoke Member Selector Brings up an object selector dialog and adds any selected objects to the currently highlighted subbasin's membership.

Subbasin ➥ Replace Members from Workspace Removes the selected subbasin's members and replaces them with any objects currently highlighted on the workspace.

Subbasin ➥ Append Members from Workspace Retains the selected subbasin's members and adds to them any objects currently highlighted on the workspace.

Subbasin ➥ Select Members on Workspace Highlights the selected subbasin's members on the workspace.

Object ➥ List Subbasin Membership Brings up a dialog with a list of the subbasins to which the highlighted object belongs.

Object ➥ Select Object on Workspace Highlights the selected object on the workspace.

Move Up Moves the currently highlighted subbasin or member object up one level.

Move Down Moves the currently highlighted subbasin or member object down one level.

Remove Deletes the currently highlighted subbasin or member object.

7. SCT (System Control Table)

A. Shaded Rules Flag Values

Slot values which have an **R** (Rule) flag are now shaded light green in the SCT. This flag information was previously available only in the open slot dialog and Model Run Analysis dialog. The new shading appears in the SCT legend as shown below:

All of the shading possibilities are now:

O	=	Output (any series slot)
I	=	Input (any series slot)
B	=	Best Efficiency (Energy slot)
M	=	Max Capacity (Energy and Outflow slots)
D	=	Drift (Regulated Spill and Bypass slots)
R	=	Rule (any series slot)

Unlike the other flags, the Rule flag may not be set directly by the user.

B. Outlined Target Ranges

All target ranges are now outlined in the SCT. The outline is drawn from each **tb** or **TB** flag (Target Begin) to the corresponding **T** flag (Target) on Storage and Pool Elevation slots. Prior versions of RiverWare only outlined target ranges which began with an explicit **TB** flag. While we still recommend that you mark the beginnings of target ranges with explicit **TB** flags, there are situations in which this may not be possible.

8. RCL (RiverWare Command Language)

A. Model File to Load

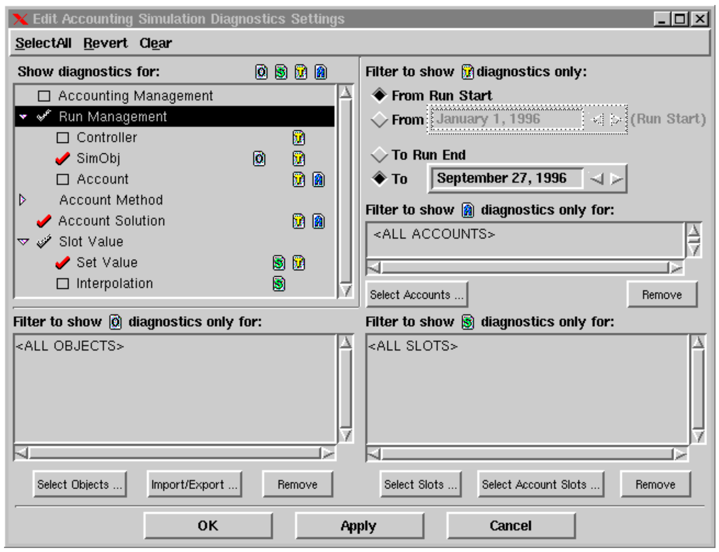
RiverWare may now take a command line argument to indicate a model file to load upon starting. The executable comes up in the normal interactive mode, but immediately begins loading the specified model file. The syntax is:

```
riverware --file <model file>
```

9. Diagnostics

A. Accounting Diagnostics

A diagnostics settings dialog has been added to allow generation and filtering of Accounting run information in the same way as Simulation, Rulebased Simulation, and Optimization. The dialog is invoked by clicking on the **Accounting** button in the **Diagnostics Manager**:



10. Closed Bug Reports

The following is a list of the bugs which were fixed for this release. If you wish to view the details for a specific bug, please browse to http://cadswes.colorado.edu/users/gnats-query.html and search our bug database. You will need a RiverWare user login and password.

665	731	901	944	945	1027	1030
1035	1152	1273	1339	1342	1371	1466
1471	1552	1664	1692	1695	1699	1713
1798	1812	1836	1842	1847	1848	1851
1857	1863	1888	1891	1904	1913	1914
1920	1923	1924	1930	1931	1938	1940
1943	1945	1947	1948	1949	1950	1951
1952	1953	1954	1955	1956	1957	1959
1960	1961	1962	1964	1965	1967	1970
1972	1974	1975	1981	1986	1988	1989
1991	1994	1995	1996	1997	1999	2000
2003	2004	2007	2008	2010	2013	2014
2016	2030	2034	2035	2037	2038	2040
2041	2045	2046	2051	2052	2053	2055
2060	2064	2065	2066	2068	2069	2073
2076	2078	2079	2080	2085	2086	2088
2091	2092	2093	2097	2098	2107	2110
2111	2112	2113	2114	2116	2119	2120
2121	2122	2124	2131	2133	2134	2135
2136	2140	2149	2150	2151	2155	2159
2160	2163					

Release Notes Version 3.0

This document describes new features, enhancements, and changes included in RiverWare Version 3.0, released on February 18, 2000.
These changes are new to the executable since the release of RiverWare Version 2.1 on March 10, 1999.

Please direct questions to RiverWare Technical Support at (303) 492-0908 or support@cadswes.colorado.edu.

A. Special Attention Notes:

- The Accounting calculations in RiverWare are still under development. Accounting should only be used by sponsors directly involved with the development process.
- The Optimization solver is available to non-sponsors for the first time in this release. It is a beta version. Please report any problems to CADSWES. Online documents for optimization will be released soon.
- Rulesets saved in the new release CANNOT be used in older executables. There is no message to warn the user about this. Rulesets saved under previous executables CAN be used with the new release however.
- It is important that users do not use the **Confluence** as a bifurcation object. Specifically, the **Inflow** slot on a **Confluence** object should not be linked to the **Inflow** slot on any other object. A bifurcation object will be available in RiverWare soon.
- For **Reach** objects solving downstream with the **noRouting** method, **Seepage** is now removed before **Reach Bank Storage** and **Gain/Loss calculations** when dispatching. Previously **Seepage** had been removed after **Total Gain/Loss** was calculated so different values for **Total Gain/Loss** will now be computed. When solving upstream, **Return Flow** is now removed before computing **Total Gain/Loss** resulting in different values for **Total Gain/Loss**.
- On the **Water User** object, the name of the **Agricultural Requests** method in the **Diversion and Depletion Request** calculation category has been changed to **Irrigation Requests**. The **Agricultural Requests** method used in old models is automatically replaced by the **Irrigation Requests** method.
- On the **Reach** object, the method category **Uncertainty Calculation** was changed to **Reach Uncertainty Calculation**.

- Confluences are now allowed to dispatch before the start of the run. This can result in an overdetermination error before the start of the run if a confluence solves and receives information across a link from another object or if its information propagates to another object.
- The **spilledEnergyCalc** category is no longer available. Therefore, the **Spilled Energy**, **Spilled Power**, and **Spilled Energy Power Coefficient** slots no longer exist.
- The following slots are converted from type **SeriesSlot** to **AggSeriesSlot**:
  On **Reservoir Objects**: Tailwater Elevation, Evaporation, Precipitation Volume, Surface Area, Available For Diversion, Change in Bank Storage
  On **Water User** and **AggDiversionSites**: Total Diversion, Total Depletion, Total Return Flow, Total Unused Water, Incoming Available Water, Outgoing Available Water, Diversion, Inflow, and Outflow.
  These changes will not adversely affect models saved in an older version of RiverWare.

1. Required Model File Updates

A. Sequential Linking on AggDiversionSite

Users moving from RiverWare 2.1 or earlier must make the following changes for models using the sequential linking structure on the **Aggregate Diversion Site** object (changes have already been incorporated in RiverWare 2.1.1, 2.1.2 and 2.1.3. Users of these versions may disregard this notice):

1. The **Total Unused Water** slot must be linked to the **Return Flow** slot on the object from which water is being diverted.

2. The link between **Total Available Water** and the **Incoming Available Water** slot on the first **Water User** element must be removed.

If a large number of objects require these changes, ModelConvert_2.2 (located in the same directory as the RiverWare executable) can automatically perform the tasks.

B. Muskingum Routing on Reaches

Models using the **muskingumRouting** method on **Reach** objects must use the **Input K and X Values** method in the **Routing Parameters** method category. Users of the **variable Muskingum Routing** method should note that this method has been automatically changed to **muskingumRouting**. This is due to the creation of a new method category, **Routing Parameters**, which eliminates the need for the **variable Muskingum Routing** method.

C. Time Lag Reaches

TimeLagRouting on **Reach** objects now accommodates monthly lag times. This change requires the following:

1. If the timestep is monthly the lag time must be in months.

2. If the timestep is not monthly the lag time cannot be in months.

D. Variable Time Lag Routing

The **variable TimeLagRouting** method on **Reach** objects was modified to calculate **Variable Lag Time** using 3-D table interpolation. This requires only one table slot, the **Variable LagTime Table** (older models required four slots for this calculation: **Date Range, Flow Range, Number of Seasons** and **Variable Lag Time Table**). Models using this method need to add data to this new slot. The old slot used in this method, **Variable Lag**

Time Table, no longer exists. This is conveyed by use of a warning message posted during model loading. More information about these changes can be found under the **Reach** heading below.

E. Seasonal GainLoss on Reaches

The Date Range slot on the Reach object has been changed to allow a range of days from 1 - 366 rather than the 0 - 365 range found in earlier versions of RiverWare. To obtain the same results, models using the Date Range table slot in the Seasonal GainLoss Flow Table method in the GainLoss Calculation category will need to add 1 to each value in the Date Range slot.

F. Pumped Storage Object

A new slot, **Pumped Flow**, was added to the **Pumped Storage** object. Models using this object must delete the link between the **Reservoir** object's **Flow TO Pumped Storage** slot and the **Pumped Storage** object's **Inflow** slot. This link must be replaced by a new link between **Flow TO Pumped Storage** and the new **Pumped Flow** slot. In addition, the **Inflow** slot (a required known) needs to be set to zero to achieve the same results.

G. Conjunctive Use on Water Users and AggDiversionSites

The **Maximum (Total) Supplemental Request** slots on **Water User** and lumped **AggDiversionSite** objects are now dependent on a method selected in the **Maximum Supplemental Request** category. If using these slots, the user must select the **Input Maximum Request** method in the **Maximum Supplemental Request** category (which is dependent on the **Supplement Diversion** method of the **Conjunctive Use** calculation category) to get the same model results.

H. Future Value Calculations

The **calculateFutureValue** method in the **FutureValueCalcCategory** on **Reservoir** and **Pumped Storage** objects has been altered to use a different set of slots. The **Future Value of Water** slot has been replaced by a slot called **Marginal Storage Value Table**. The calculation of **Spill Cost** and **Future Value of Used Energy** use this new slot. Models using the **calculateFutureValue** method must assign values to the **Marginal Storage Value Table** to avoid a table interpolation error.

I. Lumped Linking on AggDiversionSites

AggDiversionSites operating under the **Lumped** linking structure no longer set the **Total Diversion Requested** to 0.0 by default. All existing models that were using this default must now input zeros for the models to run correctly.

2. Model Loading

A. Some “SeriesSlots” changed to “AggSeriesSlots”

Some SeriesSlots have been converted to AggSeriesSlots. When loading old models, diagnostics messages may be generated as old slot types are automatically converted to new slot types:

Trying to convert former slot type (“SeriesSlot”) to new slot type (“AggSeriesSlot”).

Do not be concerned by these messages. You do not need to make any changes to your model. The use and functionality of these slots has not changed.

3. Simulation Objects

The following enhancements to the RiverWare simulation objects are described briefly. The user is encouraged to consult the Simulation Objects Documentation in the online help for more detailed descriptions of the enhancements to the objects and their methods.

A. Reach

Variable TimeLag Routing

The **variableTimeLagRouting** method has been modified to use a 3-D table interpolation to determine the **Lag Time** instead of a table lookup. This is accomplished through the use of a new tableslot, **Variable LagTime Table**. The **Lag Time** is computed based on a double interpolation involving the day of the year and the flow rate in the reach. Previous models using this method will no longer calculate **Lag Time**. New data is required in the **Variable LagTime Table** slot. Detailed documentation of this method may be found in the Simulation Objects Documentation online.

Gain Loss

A new user method, **Interpolated Flow GainLoss**, was added to the **Gain Loss Calculation** category. This method (which is similar to the **Seasonal GainLoss Flow Table** method) uses values input according to the day of the year. Gain Loss is then determined by a three-dimensional table interpolation. Detailed documentation of this method may be found in the Simulation Objects Documentation online.

Routing Parameters

A new method category, **Routing Parameters**, is available when **muskingumRouting** is selected in the **routingMethodCategory**. This new category contains methods for inputting muskingum coefficient data as either K and X values or C0, C1, and C2 coefficients (scalar or time series). The **variableMuskingum** routing method has been eliminated. Users of this method should select **muskingumRouting** and the **Input Time Series K and X** method in the **Routing Parameters** category to attain the same results. Detailed documentation of these methods may be found in the Simulation Objects Documentation online.

TimeLag Routing

Changes were made to **timeLagRouting** to conserve volume when using a monthly timestep and a monthly lag time. These changes require the user to use a monthly lag time if the timestep is monthly. Conversely, if the timestep is not monthly, a monthly lag time cannot be used.

Reach Bank Storage

A new method category, **Reach Bank Storage Calculation**, was added. Two methods are available: **No Bank Storage** and **Average Flow Bank Storage**. The Average Flow Bank Storage method is used to simulate hyporheic zone storage and return based on the flow rate in the reach. Detailed documentation of this method may be found in the Simulation Objects Documentation online.

Seasonal GainLoss

The **Date Range** slot, used in the **Seasonal GainLoss Flow Table** method, is now one-based instead of zero-based. Users are required to increase the values in this slot by an integer of one to attain the same answers as in older models.

Interpolated GainLoss Uncertainty

A new method, **Interpolated GainLoss Uncertainty**, was added to the **Reach Uncertainty Calculation** category. This method enables users to perform uncertainty calculations based on the uncertainty of the gain/loss coefficients and is available only when the **Interpolated Flow GainLoss** method is selected in the **GainLoss Calculation** category. Detailed documentation of this method may be found in the Simulation Objects Documentation online.

B. Water User

Input Diversion

Diversions may now be input on the **Water User**. This allows the object to solve given either **Diversion** or **Diversion Requested**. An additional dispatch method was added to accommodate these changes. The object may now dispatch with one of the following two methods: **solveStandAlone_givenDivReqDepReq** or **solveStandAlone_givenDiversion**.

There are some limitations to this design. If the user is using rules to set both **Diversion** and **Diversion Requested** at different priorities (for the same timestep), the object must always resolve using the same dispatch method. For example, suppose that **Diversion Requested** is set by a rule and the object dispatches given Diversion Requested. Then, a higher priority rule sets **Diversion**. The object should re-dispatch given Diversion. However, it will be forced to re-solve with the same dispatch method. Detailed documentation of these methods may be found in the Simulation Objects Documentation online.

Return Flow Split Calculations

The **returnFlowSplitCalculation** methods now include the **Supplement Return Flow** as well as the **Return Flow** if **Supplement Diversion** is selected in the **Conjunctive Use** category. If **Supplement Return Flow** is being calculated, a new slot, **Total Return Flow**, is used to represent the sum of the **Return Flow** and **Supplement Return Flow**. It is the **Total Return Flow** that is split into surface and groundwater components. If **Supplement Return Flow** is not being calculated, the **Total Return Flow** slot is not visible and only the **Return Flow** is split. Detailed documentation of these methods may be found in the Simulation Objects Documentation online.

Diversion and Depletion Request

Two new user methods, **Population Requests** and **Regional Requests,** were added to the **Diversion and Depletion Request** category. **Population Requests** is used to compute **Diversion Requested** and **Depletion Requested** based on the number of individuals in a population and the use rate per individual. **Regional Requests** is used to compute **Diversion Requested** and **Depletion Requested** based on the rate of water use for a region and the percentage of the region that applies to that particular rate. Detailed documentation of these methods may be found in the Simulation Objects Documentation online.

Also, the name of the **Agricultural Requests** method was changed to **Irrigation Requests**.

Max Supplemental Request

A new method category, **Max Supplemental Request**, was added to enable the user to calculate values for the **Maximum Supplement Request** slot based on groundwater elevation. Three methods are contained within this Category: **None**, **Input Maximum Request**, and **GW Elevation Maximum Request**. The new method category is dependent on the **Supplement Diversion** method in the **Conjunctive Use** method category. Models previously using the **Maximum Supplement Request** slot must use the **Input Maximum Request** method to get the same results. Detailed documentation of these methods may be found in the Simulation Objects Documentation online.

C. AggDiversionSite

Input Diversion

Diversion may now be input on the **AggDiversionSite**. This allows the object to solve given either **Total Diversion** or **Total Diversion Requested**. An additional dispatch method was added for both the lumped and sequential linking structures to accommodate these changes. For the sequential structure, the object may now dispatch with one of the following two methods: **processSequential_givenDivReq** or **processSequential_givenDiversion**. For the lumped linking structure the two dispatch methods are: **processLumped_givenDivReq** and **processLumped_givenDiversion**. As a result of these modifications, an **AggDiversionSite** object operating under the lumped linking structure no longer sets the **Total Diversion Requested** to 0.0 by default. All existing models that were using this default must now input zeros for the models to run correctly.

There are some limitations to this design. If the user is using rules to set both **Total Diversion** and **Total Diversion Requested** at different priorities (for the same timestep), the object must always resolve using the same dispatch method. For example, suppose that **Total Diversion Requested** is set by a rule and the object dispatches given Diversion Requested. Then, a higher priority rule sets **Total Diversion**. The object should re-dispatch given Diversion. However, it will be forced to re-solve with the same dispatch method. Detailed documentation of these methods may be found in the Simulation Objects Documentation online.

Total Diversion

The **Sequential** linking structure was modified so that **Total Diversion** is calculated as the lower value of **Total Diversion Requested** and **Total Available Water**. The **Total Diversion** is now propagated to the **Incoming Available Water** slot on the first **WaterUser** element. The **Total Unused Water** slot now represents the return flow from the **Water User** elements. Therefore old models must be updated in the following manner: 1.) **Total Unused Water** must be linked to the **Return Flow** slot on the object from which water is being diverted, 2) The link between **Total Available Water** and **Incoming Available Water** on the first WaterUser element must be deleted.

Maximum Supplemental Request

A new method category, **Max Supplemental Request**, was added to the **AggDiversion Site** for the lumped linking structure. This method category enables the user to calculate values for the **Maximum Total Supplement Request** slot based on groundwater elevation. Three methods are contained within this Category: **None**, **Input Maximum Request**, and **GW Elevation Maximum Request**. The new method category is dependent on the **Supplement Diversion** method in the **Conjunctive Use** method category. Models previously using the **Maximum Supplement Request** slot must use the **Input Maximum Request** method to get the same results. Detailed documentation of these methods may be found in the Simulation Objects Documentation online.

D. Groundwater Storage

Storage Calculations

The storage calculations on the **Groundwater Storage** object were modified to prevent a negative **Storage** from being calculated. If the Outflow exceeds the flow rate required to drain the aquifer in a timestep, the **Outflow** is decreased to that flow rate. If calculating **Percolation** and the sum of the **Outflow** and **Percolation** exceeds the flow rate required to drain the aquifer in a timestep, then both **Outflow** and **Percolation** are proportionally decreased so the sum of the two is equal to that flow rate. If however, **Percolation** is input, only **Outflow** is decreased. Detailed documentation of these calculations is available in the Dispatch Methods section of the Simulation Objects Documentation.

Previous Elevation Calc

A new method category, **Previous Elevation Calc**, enables the user to input or calculate the previous timestep's water table elevation based on the previous storage. The **Previous Groundwater Elevation** slot is used in conjunction with the **Water User** to determine the **Maximum Supplement Request**. Detailed documentation of these methods may be found in the Simulation Objects Documentation online.

E. Confluence

Pre-simulation Dispatching

The **Confluence** object may now dispatch before the start of the run. The object checks upstream to obtain the earliest timestep at which an upstream object dispatches. Provided that its dispatch conditions are met, the **Confluence** may then dispatch at the earliest dispatch timestep of any upstream object.

Old models may be adversely affected by this change. If the **Confluence** object contains data before the start of the run, it may now solve and propagate data to other objects. Likewise, if the **Confluence** receives data from an upstream object it may now try to solve in an overdetermined state. In either case, the result is an overdetermination error expressed by one of the following error messages:

"**Object is overdetermined**"

"**Attempting to set slot from multiple sources**"

These errors may or may not be generated from the **Confluence** itself. The problem is fixed by deleting the excess data on the **Confluence** object for all pre-simulation timesteps.

F. Diversion Object

Diversion Request Calculation

A new method category, **Diversion Request Calculation**, is available on the **Diversion Object**. The default method, **Input Diversion Request**, performs no calculations. The **Percent of Available** method computes **Diversion Requested** as a specified percentage of the available water. Detailed documentation of these methods may be found in the Simulation Objects Documentation online.

G. Reservoir Objects

Dispatch Method Change

The **solveMB_givenInflowReleaseRegSpill** dispatch method was changed to **solveMB_-givenInflowRelease**. The **Regulated Spill** slot is no longer a required known for the object to dispatch with this method. Also, the dispatch method is available regardless of the spill method in use. Detailed documentation of these methods may be found in the Simulation Objects Documentation online.

Power Coefficient

The **Best Power Coefficient** and **Max Power Coefficient** tables are now used whenever the BEST or MAX flag is set on **Energy** (regardless of whether or not the **Power Coefficient** is input).

H. Pumped Storage Object

Upstream Inflows

The **Pumped Storage Object** is now able to model inflows from upstream. This enhancement required a change in slot notation. The flow into the reservoir as a result of pumping is accounted/calculated for in the **Pumped Flow** slot. The **Inflow** slot is used to represent inflow into the reservoir from upstream. Currently the object is only allowed to solve downstream (i.e. **Inflow** must be input and cannot be calculated). Old models using this object require three changes: the link between **Inflow** and **Flow TO Pumped Storage** must be removed, a link must be created between **Pumped Flow** and **Flow TO Pumped Storage**, and **Inflow** must be set to zero. Detailed documentation of this object may be found in the Simulation Objects Documentation online.

4. Rulebased Simulation

Documentation is now available for the pre-defined functions used in Rulebased Simulation. The documentation is reached by selecting **Browse Rulebased Simulation Documentation** from the online help menu.

A. Closing a Ruleset

A loaded ruleset is no longer allowed to be closed while remaining loaded. If a loaded ruleset is closed, the ruleset is automatically unloaded. The user will be asked to confirm this action upon closing the ruleset.

B. Print Statements

PRINT statements now always execute when their containing rule executes, regardless of whether or not any other statements within that rule succeed or not. Also, **PRINT** statements failing will not cause the containing rule to fail. E.g., if a **PRINT** statement encounters a NaN, a diagnostic is issued noting this fact, but the rule containing that print statement continues execution (as if nothing had happened).

When a **RuleExpr** is printed out by a **PRINT** statement or by a diagnostic, the RuleExpr's text should be more readable, but could be different from what the user would see if they looked in a model file containing the same expression.

C. Units

All **NumericValues** now have units. If none are specified then units of **NONE** are added. Textual representations of **NumericValues** with units of NONE do not have any unit string.

For the user this means they no longer need to type in units if there aren't any. Units will now default to **NONE**, and units of **NONE** will never show up. This means that users now need to be a bit more careful about units because we aren't as likely to notice when they forget and leave off units.

D. Name Checking

Checking was added to prevent the same name from being used multiple times in the same namespace. This was done to prevent the user from accidentally "hiding" a variable in an outer scope by declaring a variable of the same name in an inner scope.

An example of what is not allowed:

```
WITH (x = 1.0) DO
WITH (x = 2.0) DO
x
ENDWITH
ENDWITH
```

Did the writer really intend to refer to the innermost x? Maybe not. This problem can be corrected by changing either variable name:

```
WITH (x = 1.0) DO
WITH (y = 2.0) DO
x
ENDWITH
ENDWITH
```

This problem will be detected and reported by RiverWare whenever a ruleset is validated (to the CONSISTENT level), i.e., when the user explicitly asks to validate a rule or when the ruleset is executed.

Note that this change actually applies to all named objects, meaning variables as well as functions. If a function is accessible (may be called) from an expression, then its name may not be used as the name of a variable.

E. Division By Zero

There is now a check for division by zero; both normal division and integer division (==- "/" and "DIV"). If the divisor is zero, then an error is issued (at evaluation time) and the rule fails.

F. Rule Language Functions

IsNaN

IsNaN is now a built-in function of the Rule Language and not a predefined function (i.e. it is now represented by a button on the palette). It returns true if a NaN is encountered anywhere in the evaluation of the operand expression, false otherwise. Before it only returned true if the operand was a simple expression involving only an object/slot lookup. If it was more complicated and a NaN was encountered, then the execution failed (reporting that a NaN was encountered).

REMOVE

Returns a list which is identical to the given list except the item at the given position has been removed (positions begin with index 0).

SUB Returns a list which is identical to the given list except the item at the given position has been replaced with the specified expression.

WITH = DO, ENDWITH This defines variable, binds it to the value resulting from the evaluation of the "variable expression", then returns the result of evaluating the "body expression" within the scope of this value.

G. Predefined Functions

Two predefined functions have been added to the Rulebased Simulation Palette. The new functions, as well as all of the existing functions, are described in the Rulebased Simulation Documentation online. Following is a list of new predefined functions:

DATETIME **OffsetDate** (DATETIME, NUMERIC, STRING)

where the string specifies a timestep (as with the predefined function GetDates()), which is added to the DATETIME argument an integral number of times given by the NUMERIC argument (rounded down, units must be "NONE"). The resulting DATETIME is returned.

OBJECT **GetObject** (STRING objectName)

Given the name of an object, finds and returns the object of with that name.

H. Net Subbasin Diversion Requirement

The pre-defined function **NetSubbasinDiversionRequirement** now uses the **MinBypass** slot on the reach (if it exists and is known) as the minimum flow. Detailed documentation of this method may be found in the Rulebased Simulation Documentation online.

I. Diversion Object with Rules

The **NetSubbasinDiversionRequirement** and **NonShortDiversionRequirement** functions now work with the **Diversion Object** as well as **AggDiversionSites**.

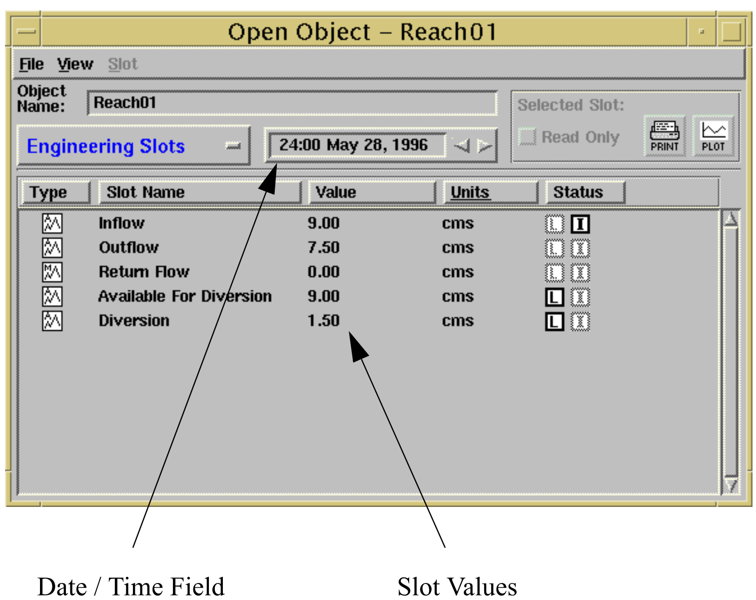
5. GUI (Graphical User Interface)

A. Menu Bar

Import Object(s) and **Export Object(s)** menu items were added to the **Model** menu in the main workspace menubar. A new submenu was added to the **Workspace** menu. **Workspace** ➥ **Objects** contains all options that apply to objects on the workspace.

B. Open Object Dialog

The appearance of the **Open Object** dialog has changed slightly. The most notable difference is the addition of a date/time field. The numbers shown in the **Value** field (to the right of the **Slot Name** field) are the slot values for the timestep expressed in the date/time field above. The left and right arrows in the date/time field can be used to move the date forwards or backwards. The number shown in the **Value** field will change accordingly. The figure on the following page shows the new appearance of the **Open Object** dialog.



6. Closed Bug Reports

The following is a list of the bugs which were fixed for this release. If you wish to view the details for a specific bug, please browse to http://cadswes.colorado.edu/users/gnats-query.html and search our bug database. You will need a RiverWare user login and password.

829	845	901	916	940	1035	1113
1273	1339	1376	1452	1453	1466	1471
1480	1483	1510	1531	1535	1540	1542
1568	1570	1617	1646	1668	1672	1696
1706	1724	1732	1751	1754	1760	1768
1795	1812	1815	1816	1819	1828	1830
1838	1851	1857	1861	1862	1866	1867
1869	1870	1901	1906	1911	1912	1924
1925	1932	1945	1978	1990	1993	2008
2037	2048	2049	2050	2055	2056	2057
2058	2064	2066	2067	2068	2069	2077
2084	2088	2093	2097	2100	2102	2111
2114	2120	2127	2128	2137	2138	2139
2140	2147	2148	2149	2150	2151	2153
2154	2155	2156	2158	2159	2160	2163
2164	2167	2171	2172	2173	2175	2177
2178	2180	2181	2182	2184	2186	2187
2189	2193	2196	2202	2203	2204	2205
2206	2207	2208	2209	2213	2214	2215
2218	2219	2223	2226	2227	2228	2231
2233	2234	2235	2236	2237	2239	2241
2243	2246	2253	2254	2256	2257	2266
2267	2268	2271	2272	2275	2282	2283
2285	2286	2287	2289	2292	2293	2294
2295	2296	2297	2299	2303	2304	2306
2307	2309	2310	2311	2312	2313	2314
2315	2316	2317	2323	2325	2327	2328
2329	2330	2333	2334	2336	2340	2342

2343	2344	2358	2360	2362	2375	2379
2384	2385	2386	2387	2388	2389	2391
2394	2396	2404	2406	2407	2410	2412
2417	2423	2429	2431	2435		

Release Notes Version 3.1

1. Special Attention Notes

- The Accounting calculations in RiverWare^{tm} are still under development. Accounting should only be used by sponsors directly involved with the development process.
- The Optimization solver is now available to non-sponsors. It is a beta version. Please report any problems to CADSWES. Online documents for optimization will be released soon.
- Rulesets saved in the new release CANNOT be used in older executables. There is no message to warn the user about this. Rulesets saved under previous executables CAN be used with the new release however.
- An annual (yearly) timestep has been added to RiverWare^{tm} along with the yearly units to support it. Documentation of the development of an annual timestep model and a comparison of its results to the monthly timestep model from which it was derived is available as a link in the sponsor area of the web site.
- It is important that users do not use the Confluence as a bifurcation object. Specifically, the Inflow slot on a Confluence object should not be linked to the Inflow or Return Flow slot on any other object. A bifurcation object is now available in RiverWare^{tm}.
- The AggDiversionSite object, when using the sequential linking structure, has been modified to divert the diversion requirement as opposed to the Total Diversion Requested. See **“AggDiversionSite” on page -146** under the Simulation Objects section of these release notes for additional information.

2. Required Model File Updates

A. Future Value Calculation

Cumulative storage value calculations were added to the calculateFutureValue method in simulation. Old models that perform future value calculations will have to fill in the Marginal Storage Value Table and select the Cumul Stor Value Table Automation method or fill in the Cumul Stor Value Table by hand.

B. Confluence Used for Bifurcation

Error checking was added to the Confluence to make sure an upstream slot is not linked to another upstream slot (including Return Flow). Models trying to use the Confluence as a bifurcation object will get an error message about this. Old models should use the Bifurcation Object instead.

C. Additional Error Checking in Rulesets

Bug fixes and code enhancements were made to tighten up error checking in rulesets. Some rulesets may contain errors that were previously not caught. These rulesets will now be unable to load successfully. Diagnostics information will alert the user and specify the specific area in the ruleset that is not valid. One specific case where old rulesets will not load in the new executable is when a slot is referred to in the ruleset that does not exist on the workspace. If the function that contains the slot was not being used, then this error was never being caught. Now the ruleset will not load until the user removes or turns of the function.

D. Max Outflow and Max Release

The convergence routine used to solve for the maximum Outflow or Release (Turbine Release) has been re-designed to increase robustness. This routine is used whenever the Max Capacity (M) flag is set on Outflow or Release on a reservoir or when using the GetMaxOutflowGivenInflow or GetMaxReleaseGivenInflow rules functions. The nature of the convergence routine is such that the maximum and minimum possible pool elevations for the reservoir are computed in order to bracket the solution. This could effect old model files by causing a table interpolation error if the maximum or minimum pool elevation falls outside of the range given in table slots. This problem is remedied by adding additional data to the table slots that cause the problem. It is possible that the pool elevation values are not realistic values in respect to the physical system (i. e. a pool elevation that is below the bottom of the reservoir). Since these calculations are only performed to bracket the final solution, they are not recorded and will not affect the model results. The new convergence technique may require more iterations before converging. The value in the Max Iterations slot may have to be increased if the user notices a brown warning message which states, “An internal iterative loop reached the maximum iterations of ‘(value in Max Iterations slot)’ when solving for ‘(Outflow or Release)’”. Increasing the value to 40 should be sufficient.

E. CRSSEvaporationCalc

Two evaporation method changes were made in conjunction with adding the annual timestep. The CRSSEvaporationCalc method in the Evaporation and Precipitation category has been renamed MonthlyEvaporationCalc and a new method, SingleEvaporationCalc, has been added. For both methods, the associated evaporation coefficients are now in units of length/time (velocity). Previously, the Evaporation Coefficients slot used in the CRSSEvaporationCalc method used units of length. Old model files will update automatically for the new units, but rulesets that contain hardwired units for the evaporation coefficients will fail with an illegal unit conversion error and will need to be updated manually.

F. Energy Cannot be Input with Max Capacity Outflow

If the Max Capacity (M) flag is set on the Outflow slot on a reservoir, then the Energy slot cannot be set as input. Previously this was not considered an error. If a model has this combination of inputs the user will get the following error when running the model in the new release: “Cannot compute Maximum Capacity Outflow when Energy is input.”

G. Account Carryover Methods

The account carryover methods were moved from the object level to the account level. This means that a carryover method will have to be selected for each storage account as opposed to each reservoir object. Accounting models that were using carryover will have to be modified by selecting the appropriate carryover method on each account. The default method sets carryover to zero.

3. General RiverWare

A. Enhancements to the SCT (Simulation Control Table)

Several enhancements were made to the SCT dialog.

1. Toggling Row Detail is activated by double-clicking on the row or by pressing Alt-D with the row selected.

2. The user may now page up and down through the SCT using the Page Up and Page Down buttons. Paging left and right through the SCT is accomplished by Control-Shift-Left/Right Arrow.

3. Arrow-key navigation around the SCT cells is possible by Control-arrow keys.

4. The user may now Copy and Paste rectangular regions, rows, and columns by using the Edit menu items or by Control-C (copy) and Control-V (paste). Copy/Paste does not paste summary type or units information.

B. Annual Timestep

An annual (yearly) timestep has been added to RiverWare^tm along with the yearly units to support it. Documentation of the development of an annual timestep model and a comparison of its results to the monthly timestep model from which it was derived is available as a link in the sponsor area of the web site.

C. “--norun” Command Line Option

When invoking RiverWare^tm with the --norun (that’s two “-” symbols), RiverWare^tm will load with the Start and Step buttons in the Run Control dialog disabled. This prevents the user from running the model. This was developed for a situation where the model developers wanted to be able to show the model to stakeholders without allowing them to actually perform a run. To invoke RiverWare^tm with this option type the following at the command line prompt:

> riverware --norun

D. Multiple Run Management

The multiple run management functionality was enhanced to enable Simulation runs to automatically follow Optimization runs. This allows Optimization models to be run in the Consecutive mode. This means that an Optimization run is executed for a given time period followed by a Simulation run for that same time period. The Simulation run uses information from Optimization and also provides the initial conditions for the next Optimization run, which is performed for the following run period (as defined by the user). Also, various bugs were fixed to improve the overall functionality of the **Consecutive** mode of multiple run management.

E. Table Slot Enhancement

Table slots now show the full row labels. Previously, the labels were truncated to 14 characters.

4. Simulation Objects

The following enhancements to the RiverWare^{tm} simulation objects are described briefly. The user is encouraged to consult the **Simulation Objects Documentation** in the online help for more detailed descriptions of the enhancements to the objects and their methods.

A. AggDiversionSite

Sequential Linking Structure Changes

The sequential AggDiversionSite has been modified to divert the diversion requirement as opposed to the Total Diversion Requested. The diversion requirement is the minimum flow rate required to satisfy the Diversion Requested of all Water User elements without resulting in a shortage. This calculation uses the Outgoing Available Water from upstream elements (if it is not linked elsewhere) to determine the amount of water required to meet the request of the downstream element. This differs from the previous calculation which simply diverts the sum of the Diversion Requested for all the elements. This calculation would normally divert more than is required and would result in a larger value for Total Unused Water.

This change could affect model files that use sequential AggDiversionSite objects with multiple Water User elements. Differences in output would occur in the Diversion slot as well as the Total Unused Water slot on the AggDiversionSite. If the diversion point and the return flow point (linked to Total Unused Water) are on different objects, then the amount of water between these two point will also be different than previous results.

B. Reach

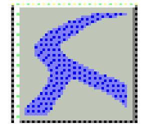
Seepage Calc Methods

Three new methods were added to the Seepage Calc category: Horizontal Gradient Seepage, Vertical Gradient Seepage, and Horizontal and Vertical Gradient Seepage. These three methods are used to model seepage from a reach to the groundwater or an adjacent drainage channel based on the hydraulic gradient and the hydraulic conductivity of the surrounding medium. Darcy's law is used to compute the seepage value. The horizontal seepage methods are designed to model drainage channels that run parallel to the reach. The drains may act as a source or sink to the reach depending on whether the water surface elevation in the drain is higher or lower than that in the reach. The method is flexible enough to allow for multiple drains. The vertical methods are designed to model seepage to groundwater below the reach. Detailed documentation of these methods may be found in the **Simulation Objects Documentation** online.

Pre-simulation Dispatching for Impulse Response Reaches

Modifications were made to the Reach object to allow pre-simulation dispatching when the impulseResponseRouting method is selected in the routing method category.

C. Bifurcation Object



A Bifurcation Object is now available on the object palette. The functionality of this object is similar to that of an upside down Confluence. There are only three slots associated with the Bifurcation Object: Inflow, Outflow1, and Outflow2. When two of the three slots are known the object dispatches to solve for the third. There are no user methods available for this object. Detailed documentation of the Bifurcation Object may be found in the **Simulation Objects Documentation** online.

D. Reservoir Objects

MonthlyEvaporation Calc

The CRSSEvaporationCalc method in the Evaporation and Precipitation category has been changed to MonthlyEvaporationCalc. The 12 Evaporation Coefficients (1 per month) entered by the user were changed to units of Velocity instead of Length. This allows the method to be used for any timestep (except yearly). The change in unit type takes place automatically when old models are loaded into the new release. Rulesets that contain hardwired units for the evaporation coefficients will fail with an illegal unit conversion error and will need to be updated manually

SingleEvaporation Calc

A new method, SingleEvaporationCalc, has been added to the Evaporation and Precipitation category. This method uses a single evaporation coefficient (in units of length/time) to represent the average rate of evaporation. Therefore, it can be used with any timestep. Detailed documentation of this method may be found in the **Simulation Objects Documentation** online.

Monthly Spill Calc

A Bypass slot was added to the monthlySpillCalc method in order to model spike flows. A spike flow must be entered into the Bypass slot to prevent it from being distributed to the turbine release over the month. Detailed documentation of this method may be found in the **Simulation Objects Documentation** online.

Max Flag on Outflow or Release

The convergence routine used to solve for the maximum Outflow or Release (Turbine Release) has been re-designed to increase robustness. This routine is used whenever the Max Capacity (M) flag is set on Outflow or Release (Turbine Release) on a reservoir. The nature of the convergence routine is such that the maximum and minimum possible pool elevations for the reservoir are computed in order to bracket the solution. This could effect old model files by causing a table interpolation error if the maximum or minimum pool elevation falls outside of the range given in table slots. This problem is remedied by adding additional data to the table slots that cause the problem. It is possible that the pool elevation values are not realistic values in respect to the physical system (i. e. a pool elevation that is below the bottom of the reservoir). Since these calculations are only performed to bracket the final solution, they are not recorded and will not affect the model results. The overall result of the new convergence technique is increased robustness so that the method now converges in cases where convergence was not possible previously. However, more iterations may be required before convergence is reached. The value in the Max Iterations slot may have to be increased if the user notices a brown warning message which states, “An internal iterative loop reached the maximum iterations of ‘(value in Max Iterations slot)’ when solving for ‘(Outflow or Release)’”. Increasing the value to 40 should be sufficient.

Future Value Calculations

The Spilled Energy Calculation methods were replaced by the methods in the FutureValueCalcCategory. The methods in this category are used to determine the future value of the energy that would have been generated by the water that was lost through the spillway. The noFutureValueCalc method is the default method for this category. No calculations are performed by this method and no slots are specifically associated with it. The calculateFutureValue method should be selected if the user wishes to perform these calculations. Detailed documentation of this method may be found in the **Simulation Objects Documentation** online.

Cumulative Storage Value Table Automation

This category allows the RiverWare^tm simulation to automate the creation of the Cumulative Storage Value Table (used in the calculateFutureValue method). This category is only visible if calculateFutureValue is selected in the FutureValueCalcCategory. Two methods are contained within this category, None and Marginal Value to Table. The None method is the default and performs no calculations. If the other method is selected, the Marginal Storage Value Table will be used as the source for the generation of the Cumulative Storage Value Table. This is the only calculation associated with this method and there are no slots specifically associated with it. Detailed documentation of this method may be found in the **Simulation Objects Documentation** online.

E. Pumped Storage Reservoir

Pump and Release Accommodation

A new method category, Pump and Release Accommodation, was added to the Pumped Storage Reservoir object. This category contains two methods: Pump or Release Only (the default method), and Pump and Release. These methods perform no calculations and are only used as dependencies for the dispatch methods. A new dispatch method, solveMB_givenPumpedFlowOutflowInflow is available when the Pump and Release method is selected. The method checks the Pumped Flow and Outflow values to determine which one is zero. If Pumped Flow is zero, the solveMB_givenOutflowInflow method is executed. Conversely, if Outflow is zero, the solveMB_givenPumpedFlowInflow method is executed. These new methods will not change the outcome of any pumped storage calculations. They are used to allow both Pumped Flow and Outflow to be input to assist the optimization calculations (specifically, to avoid problems when running a post-optimization simulation run).

F. Thermal Object

Hydro Block Calculation

For both Optimization and Simulation, the Hydro Block calculations are now done based on the same period of time as the model timestep. Previously, in Simulation, the Hydro Block calculations were done on an hourly basis. This is no longer the case and therefore all hourly Hydro Block information has been removed. The "Opt" portion of the name of the remaining Hydro Block slots has been removed because they now apply to both Optimization and Simulation.

Allocated Preferred Customer

A Preferred Customer method was added to this method category on the Thermal Object to allow the user to subcontract energy that goes to a preferred customer before calculating the avoided costs from hydropower. This method is available for both Simulation and Optimization.

5. Rulebased Simulation

A. Model Run Analysis Information

RiverWare^{tm} now has the ability to save and load the Model Run Analysis Data. This option is automatically activated when Save Run Results (Output Values) is selected when saving a model. When the model is subsequently loaded, the user may view this information (located in the Model Run Analysis -- Rulebased Simulation dialog) without running the model first.

B. Yearly Units for Rule Expressions

Annual units are now available for use in rule expressions. RiverWare^{tm} takes into account whether the year is a leap year or not when converting to standard units.

C. Function Type Name Change

Internal Function and External Function

The menu items for adding a function to a ruleset have changed. Previously, a function was added to a policy group by selecting **Ruleset ➥ Add Internal Function** if the user wanted to create a function in the RiverWare^{tm} rule language or **Ruleset ➥ Add External Function** if the user wanted to create a function using the Tool Command Language (Tcl). The menu items have been changed to **Ruleset ➥ Add Function** and **Ruleset ➥ Add Tcl Function**, respectively.

D. Predefined Function Modifications

All predefined functions are described in detail in the **Rulebased Simulation Documentation** online.

GetMaxOutflowGivenInflow and GetMaxReleaseGivenInflow

The convergence routine used to solve for the maximum Outflow or Release (Turbine Release) has been re-designed to increase robustness. This routine is used for the GetMaxOutflowGivenInflow or GetMaxReleaseGivenInflow rules functions. The nature of the convergence routine is such that the maximum and minimum possible pool elevations for the reservoir are computed in order to bracket the solution. This could effect old model files by causing a table interpolation error if the maximum or minimum pool elevation falls outside of the range given in table slots. This problem is remedied by adding additional data to the table slots that cause the problem. It is possible that the pool elevation values are not realistic values in respect to the physical system (i. e. a pool elevation that is below the bottom of the reservoir). Since these calculations are only performed to bracket the final solution, they are not recorded and will not affect the model results. The overall result of the new convergence technique is increased robustness so that the method now converges in cases where convergence was not possible previously. However, more iterations may be required before convergence is reached. The value in the Max Iterations slot may have to be increased if the user notices a brown warning message which states, “An internal iterative loop reached the maximum iterations of ‘(value in Max Iterations slot)’ when solving for ‘(Outflow or Release)’”. Increasing the value to 40 should be sufficient.

NetSubBasinDiversionRequirement

The NetSubBasinDiversionRequirement function has been enhanced. The method now includes Seepage and GainLoss effects (on reach objects) in the diversion requirement calculations. Also, Water User requests are now included in the diversion requirement.

SolveSubBasinDiversions

This is a new predefined function that performs the same calculations as NetSubBasinDiversionRequirement. However, this function also calculates the outflow at the bottom of the subbasin that results from the calculated diversion requirement. The function returns a LIST of two variables where the first is the diversion requirement and the second is the resulting outflow.

E. Predefined Functions

Four predefined functions have been added to the Rulebased Simulation Palette. The new functions, as well as all of the existing functions, are described in the **Rulebased Simulation Documentation** online. Following is a list of new predefined functions:

GetMinSpillGivenInflowRelease (OBJECT, NUMERIC, MUMERIC DATETIME)

This function evaluates to the minimum spill from a StorageReservoir, LevelPowerReservoir, or SlopePowerReservoir with the given inflow and release at the specified timestep. The OBJECT argument is the reservoir on which to perform the calculations, the first STRING is the average inflow into the reservoir over the timestep, the second STRING is the average release from the reservoir over the timestep and the DATETIME is the timestep at which to perform the calculations.

SolveShortage (OBJECT, NUMERIC, DATETIME)

This function is used to solve for the shortage on an AggDiversionSite or a Water User object. It returns a LIST of two NUMERIC values where the first value is the diversion shortage and the second is the depletion shortage. The OBJECT argument is the object on which to perform the calculations, the NUMERIC argument is the water available for diversion, and the DATETIME is the timestep at which to perform the calculations.

SolveSubBasinDiversions (LIST, DATETIME)

This function performs the same calculations as the NetSubBasinDiversionRequirement function. This function differs, however, in the fact that it returns a LIST of two NUMERICS. The first NUMERIC is the diversion requirement and the second is the resulting outflow at the bottom of the subbasin.

SumAccountSlotsByWaterType (OBJECT, STRING, STRING, DATETIME)

This function sums the values of all accounting slots of a given name on accounts of a given water type. The OBJECT represents the object on which the accounts exist, the first STRING is the water type, the second STRING is the name of the slots to sum, and the DATETIME is the timestep at which to perform the summation.

F. Important Bug Fixes

Copy/Paste in ForEach Statements

Several bugs were fixed (2430, 2454, 2455) to enable copying and pasting within a ForEach statement. A complete list of the bugs closed for this release is given under the Closed Bug Reports heading at the bottom of the release notes.

Copy/Paste of Parenthesized Expressions

Several bugs were closed to fix the copying and pasting of expressions in parenthesis (2388, 2389, 2391). A complete list of the bugs closed for this release is given under the Closed Bug Reports heading at the bottom of the release notes.

6. Optimization

A. General Enhancements/Fixes to Optimization

- Checks were added for errors returned from CPLEX function calls. Diagnostics will now be able to notify the user of errors and warnings that occur in CPLEX functions.
- The default value of minimax optimally was changed from 1×10^{-3} to 1×10^{-6}.
- A new function was added to check approximation quality for both 2pt-line and piece wise calculations.
- The behavior of the Pumped Storage Reservoir is now consistent with the other reservoir objects when it is included in the No Opt Subbasin. This means that the Opt In column for Outflow and Pumped Flow is used to estimate flows which will affect optimized objects. These values are NOT used in simulation. The assumption is that the operation will be set using some combination of simulation columns. Alternatively, Outflow and Pumped Flow could just be entered as inputs in the simulation column.
- A function was added to add up individual spill requirements and put them in the Spill Opt In column. These values are used as lower bounds on Spill.
- An additional row was added to the Total Values slot. The row contains the simulation value of the optimization objective, which is the avoided cost plus the cumulative value of storage. This value is also reported to the diagnostics window.
- The marginal cost calculations were changed. If a unit or block exactly covers the load or generation then the marginal cost reported is the next unit or block that would be used.

B. Smooth Energy Calculations

Purpose

The smooth energy calculations were developed to deal with the way optimization handles energy production among reservoirs. The current optimization finds extreme points of an optimal region, where the production of energy is moved from reservoir to reservoir and from timestep to timestep in a disjoint manner. An example of this problem is the following simple matrix:

	Timestep 1	Timestep 2	TOTAL
Reservoir 1	10	0	10
Reservoir 2	0	20	20
TOTAL	10	20	

In most practical cases, the energy demands at every timestep are almost constant, and the energy supply from every reservoir is also almost constant over the run. There are many ways to allocate the energies, but this extreme case is not good. Instead, it is desirable that a smoother energy allocation is found, where each reservoir at each timestep contributes a proportionate amount to satisfying the demand.

Results

Ideally, the energy at each reservoir for each timestep will have a policy constraint at a priority *p* which is directly after the max avoided cost objective. The following constraint can be written to result in "smoothed" energy values:

$$E^{p}_{r,t} \geq \frac{A_r B_t}{D} \quad \textbf{Eq. 1}$$

The constraint defined by equation 1 is written for some t, where E^p is the energy (actual variable) at the subscripted reservoir and timestep,

$$A_r = \sum_t E^{p-1}_{r,t} \quad \textbf{Eq. 2}$$

where E^{p-1} is the resultant energies from the last priority level, and the r subscript is constant,

$$B_t = \sum_r E^{p-1}_{r,t} \quad \textbf{Eq. 3}$$

where E^{p-1} is the resultant energies from the last priority level, and the t subscript is constant and

$$D \equiv \sum_r A_r = \sum_t B_t \quad \textbf{Eq. 4}$$

Equation 1 is a simplified constraint and does not include any flexibility terms. However for the simple example in Table 1, Equation 1 can be applied to get the following results:

	Timestep 1	Timestep 2	TOTAL
Reservoir 1	**10/3**	**20/3**	**10**
Reservoir 2	**20/3**	**40/3**	**20**
TOTAL	**10**	**20**	

example for row 1, column 1:

$$E^{p}_{r,t} \geq \frac{A_r B_t}{D} = \frac{10 \times 10}{30} = \frac{10}{3} \quad \textbf{Eq. 5}$$

The optimization will attempt to get as close to the results in Table 2 as possible. In the case where there may be flexibility terms, the total values are allowed to vary slightly.

Policy Constraints

Because the interface to the user is the constraint editor, the trigger for the creation of the constraints listed above must be simple. This is done through the use of a special subbasin name, Smooth Energy Reservoirs, to which users will add the reservoirs used in the smooth energy calculations. Then, the user will write a single policy constraint: for [t in time by <slot>, ThermalObject.Energy Result[t] = ThermalObject.Smooth Energy[t]]

This constraint will be replaced with a constraint for each of the reservoirs for each timestep. The slots referenced in the user constraint above will be slots that are flagged as linearized variables. The Energy Result slot will be ignored while linearization of the Smooth Energy will trigger the writing of all the physical and policy constraints.

7. Closed Bug Reports

Bug Fixes

The following is a list of the bugs which were fixed for this release. If you wish to view the details for a specific bug, please browse to http://cadswes.colorado.edu/users/gnats-query.html and search our bug database. You will need a RiverWare user login and password.

845	1153	1480	1513	1733	1862	1864
1866	1869	1874	1876	1882	1899	1976
1990	1998	2032	2067	2071	2144	2146
2175	2185	2188	2190	2245	2253	2255
2259	2270	2274	2276	2277	2283	2301
2308	2327	2331	2363	2368	2370	2376
2378	2387	2388	2389	2390	2391	2393
2394	2395	2396	2401	2404	2406	2407
2410	2412	2415	2416	2417	2420	2422
2423	2426	2428	2429	2430	2431	2435
2436	2438	2443	2446	2447	2449	2450
2451	2453					

Release Notes Version 3.2

1. Special Attention Notes

- The Accounting calculations in RiverWare^{tm} are now available to non-sponsors. The User Defined Accounting Methods (discussed in the Accounting section of the release notes) allow users to write methods that move physical water into accounts and apply physical gains/losses to the accounts.
- Rulesets saved in the new release CANNOT be used in older executables. There is no message to warn the user about this. Rulesets saved under previous executables CAN be used with the new release however.
- Adobe Acrobat Reader is no longer included in the RiverWare Core Product file. This means that Acrobat Reader is not installed with RiverWare any longer. This probably won't affect most users because Adobe is most likely installed on your system already. If your system does not have Adobe, you will need to install it. The RiverWare Download Page has a link to the version of Acrobat used by CADSWES. You can also get a more recent version by visiting the Adobe web site. The Download Guide and Installation Guide on the CADSWES web site provide additional information.
- The Tool Command Language (Tcl) that was previously used to write Rules was upgraded to version 8.2.3. The previous version of Tcl we were using was over six years old. It was necessary to upgrade to a recent version that is compatible with Windows NT. Our nightly regression test showed some model differences as a result of this upgrade. We believe these differences to be a result of a difference in the level of precision used in the two versions of Tcl. In one case, however, there was a syntax error in a Tcl function that was not detected by the old Tcl but was detected by version 8.2.3. In this case, the model aborted and a diagnostic message pointed the user to the exact location of the Tcl error. If your model still uses Tcl functions, it is possible that you will encounter minor differences in model run results. These differences should be less than the convergence level (0.01%) and should not affect the policy outcome. It is also possible that your Tcl functions have syntax errors that were not detected by the previous version of Tcl and are now noticed by 8.2.3. If this is the case, your Tcl function will need to be fixed.
- Additional error checking was added to the PeakPowerCalc and PeakBasePowerCalc methods. The new errors enforce a positive peak flow volume (computed as Outflow - Spill - Base Flow, converted to a volume). A negative peak flow volume would result in the computation of negative Power and Energy values. This situation would occur whenever the Outflow is less than the sum of the Spill and Base Flow. According to Dr. Terry Fulp this is an error situation that should result in the run aborting with an error message notifying the user. This may occur if there was an error in the Maximum Controlled Release value or, more likely, if the Base Flow value is too great. One of our CRSS regression tests aborted with this error so it is highly likely that some CRSS models contain this error and will now abort with the new release. In this case the user must decide upon a new Base Flow value (set in the Base Flow Table slot), that will not exceed the Outflow. The error produced in this situation will read, "Negative peak flow volume calculated. Spill + base flow cannot be greater than outflow. Check Max Controlled Release slot and/or base flow values." The left hand side of the diagnostics window will give the object and timestep on which this occurred (this occurred on Lake Havasu in our regression tests). The model must be fixed by reducing the

value in the second column of the Base Flow Table. Contact Terry Fulp if questions arise about the appropriate value for Base Flow.

- A new slot, Power Capacity, was added to the PeakPowerCalc and PeakBasePowerCalc methods. Previously, the power capacity was being computed and set in the Power slot. Now the Power Capacity slot will contain this value and the Power will represent the Power actually produced on a given timestep. This is discussed further in the Simulation Objects section of the release notes.

2. Required Model File Updates

A. Error Checking in PeakPowerCalc and PeakBasePowerCalc

Additional error checking was added to the PeakPowerCalc and PeakBasePowerCalc methods. The new errors enforce a positive peak flow volume (computed as Outflow minus Spill minus Base Flow, converted to a volume). A negative peak flow volume would result in the computation of negative Power and Energy values. This situation would occur whenever the Outflow is less than the sum of the Spill and Base Flow. According to Dr. Terry Fulp this is an error situation that should result in the run aborting with an error message notifying the user. This may occur if there was an error in the Maximum Controlled Release value or, more likely, if the Base Flow value is too great. One of our CRSS regression tests aborted with this error so it is highly likely that some CRSS models contain this error and will now abort with the new release. In this case the user must decide upon a new Base Flow value (set in the Base Flow Table slot), that will not exceed the Outflow. The error produced in this situation will read, “Negative peak flow volume calculated. Spill + base flow cannot be greater than outflow. Check Max Controlled Release slot and/or base flow values.” The left hand side of the diagnostics window will give the object and timestep on which this occurred (this occurred on Lake Havasu in our regression tests). The model must be fixed by reducing the value in the second column of the Base Flow Table. Contact Terry Fulp if questions arise about the appropriate value for Base Flow.

B. Upgrade to Tcl 8.2.3

The Tool Command Language (Tcl) that was previously used to write Rules was upgraded to version 8.2.3. The previous version of Tcl we were using was over six years old. It was necessary to upgrade to a recent version that is compatible with Windows NT. Our nightly regression test showed some model differences as a result of this upgrade. We believe these differences to be a result of a difference in the level of precision used in the two versions of Tcl. In one case, however, there was a syntax error in a Tcl function that was not detected by the old Tcl but was detected by version 8.2.3. In this case the model aborted and a diagnostic message pointed the user to the exact location of the Tcl error. If your model still uses Tcl functions, it is possible that you will encounter minor differences in model run results. These differences should be less than the convergence level (0.01%) and should not affect the policy outcome. It is also possible that your Tcl functions had syntax errors that were not detected by the previous version of Tcl and are now noticed by 8.2.3. If this is the case, your Tcl function will need to be fixed.

C. Minimum Efficiency Slot on the Water User

The Minimum Efficiency slot on the Water User object was changed from a Table Slot to a Series Slot. RiverWare automatically extends the time series range on this slot to match the Run Control Dialog. The single value held in the Table Slot is copied to every timestep in the series. So every model should be updated automatically to use the single table slot value for every timestep in the run. However, if the run dates of the model are changed, values for Minimum Efficiency must be input for the new timesteps. This can be done by hand or preferably through a DMI. If your DMI moves the timestep of your model ahead, then it should be modified to add data to the Minimum Efficiency slot. Another approach would be to extend the timeseries range on the Minimum Efficiency slot to include a very large number of timesteps. Then a value could be input on every timestep using the Fill Values command. This will work as long as the time series is expanded to encompass any possible run period.

D. (Variable) GainLoss Coefficient Restriction

The GainLoss Coefficient (or Variable GainLoss Coefficient) is no longer allowed to be -1.0 when a reach is solving upstream. A GainLoss Coefficient of -1.0 means that 100% of the Inflow to the reach is lost. When solving upstream given an Outflow value, it is impossible to determine a unique Inflow value if the GainLoss Coefficient is -1.0. Basically, an infinite number of Inflows could result in the given Outflow because 100% of it is lost before getting to the Outflow. RiverWare now detects this situation and flags an error when it occurs. Models that contain reaches that solve upstream and have a GainLoss Coefficient of -1.0 will abort when run in the new release. The GainLoss value must be changed to any number that is greater than negative 1.0.

3. General RiverWare

A. Printing an SCT (Simulation Control Table)

Menu options have been provided for printing a selection, the current page, or the entire SCT. Previously, if any cells were selected when the Print Portrait menu item was selected, the pages starting with the selection were printed and, if no cells were selected, the entire SCT was printed (printing the current page was not supported at all).

B. File Chooser Width

A fix was made to the RiverWare 3.1.1 patch release that forced the File Chooser dialog to open at the maximum possible single column width. Prior to this fix, if the user expanded the width of the File Chooser, it would expand to several small columns instead of one wide column. This was a problem when trying to view long file names. The File Chooser dialog was not wide enough to view the entire length of the file name. The fix made to RiverWare 3.1.1 corrected this problem but it introduced another problem that is dependent upon the user’s system. If the maximum File Chooser width is too large, a Galaxy (windows software used in RiverWare) bug would occur that causes RiverWare to crash with a floating point error as soon as the File Chooser is opened. Because this is system dependent, we removed the code that fixed the original problem. Now the File Chooser defaults to the original size and long file names may not be entirely visible. However, an environment variable called RW_FILECHOOSERWIDTH was created so the user can set the maximum file chooser width if it is not large enough to view the entire file name. The bug fix for RiverWare 3.1.1 was using a value of 255. This was large enough to view long file names but it produced the Galaxy core dump on some systems. The user must experiment with the maximum value for RW_FILECHOOSERWIDTH as it applies to his/her system. This number can vary anywhere from about 150 up to 400.

C. Model file vs. DMI Precision

Previously, if TVA ran DMIs, ran the optimization, saved the model, reloaded the model, and reran optimization, the solutions would be different. We have reduced the precision of DMI imports to the precision saved in model file and expect this to eliminate such differences. This is not testable at CADSWES and is essential for TVA to test.

4. Simulation Objects

The following enhancements to the RiverWare^{tm} simulation objects are described briefly. The user is encouraged to consult the **Simulation Objects Documentation** in the online help for more detailed descriptions of the enhancements to the objects and their methods.

A. Water User

Multiple Split Return Flows

A new method, Multi Return Fractional Split, is available in the returnFlowSplitCalculation category. This method allows the user to split the Return Flow and send it to as many destinations as is necessary. In other words, a single Water User can be used to model an areas with similar characteristics that may produce more than one return flow. Each return flow can be linked to a different destination in the model. When this method is selected, the Returned Flows multislot is added. This slot can be linked to the Return Flow (or any other series slot) on several different reaches. When a link is created to this slot, a column representing this link is added to the necessary input table slots. This allows the user to have any number of return flows and data only needs to be given for those return flows that are specified by a link to the Returned Flows slot. Information regarding the use of this method is available in the Simulation Object Documentation online.

Return Flow Routing

A new method category called Return Flow routing is available on all Water User objects. The methods available in this category are dependent upon the method selected in the returnFlowSplitCalculation category. Three methods are available to route the either the return flow, the surface or ground water return flows, or any of the multiple split return flows. The impulse response method is the only routing calculation that is used for return flows. If the user needs to route return flows using a method other than impulse response, a separate Reach object must be used. Information regarding the use of the Return Flow Routing methods is available in the Simulation Object Documentation online.

Split Return Flow Fraction/Efficiency

Since the Multi Return Fractional Split method has been added to the returnFlowSplitCalculation category, the previously existing two categories were renamed so that it is apparent that these methods are used to split between surface and groundwater returns. Therefore, Split Return Flow Fraction and Split Return Flow Efficiency have been renamed SW GW Fractional Split and SW GW Efficiency Split, respectively.

Minimum Efficiency Slot

The Minimum Efficiency slot on the Water User object was changed from a Table Slot to a Series Slot. RiverWare automatically extends the time series range on this slot to match the Run Control Dialog. The single value held in the Table Slot is copied to every timestep in the series. So every model should be updated automatically to use the single table slot value for every timestep in the run. However, if the run dates of the model are changed, values for Minimum Efficiency must be input for the new timesteps. This can be done by hand or preferably through a DMI. If your DMI moves the timestep of your model ahead, then it should be modified to add data to the Minimum Efficiency slot. Another approach would be to extend the timeseries range on the Minimum Efficiency slot to include a very large number of timesteps. Then a value could be input on every timestep using the Fill Values command. This will work as long as the time series is expanded to encompass any possible run period.

Minimum Diversion Request

A new slot, Minimum Diversion Request, has been added to all methods in the Diversion and Depletion Request category. If the user has input a value on this slot, the Diversion and Depletion Request methods will make sure that the calculated Diversion Request is at least the Minimum Diversion Request. If however, the calculated Depletion Request is zero, this slot is not used and the Diversion Request is set to zero. The use of this slot is optional.

B. Reach

Impulse Response Slot Reconfiguration

The Lag Coeff slot was reconfigured to display the lag coefficients in rows rather than columns. This happens automatically and should not affect model results.

Evaporation Category

A new Evaporation Calculation category is available on the Reach object. This category is only available when noRouting is selected in the routing method category. The evaporation category contains a default method, which does nothing, and an Inflow Exponent Pan Evap method. This method computes evaporative loss from the reach based on an empirical equation that uses the Inflow raised to an exponent and a pan evaporation coefficient. Details on the specifics of the equation are available in the Simulation Objects Documentation online.

Reach Bank Storage Calculation

Previously, when computing the Bank Storage Return for the first few timesteps, a Routed Flow of zero was used for those timesteps prior to the Start timestep. This was causing volume conservation problems so the method was modified to assume a constant value for Routed Flow, prior to the Start timestep, that is equal to the first calculated value for Routed Flow. However, if the user has input Routed Flow values prior to the Start date, these will take priority and will not be reset.

(Variable) GainLoss Coefficient

The GainLoss Coefficient (or Variable GainLoss Coefficient) is no longer allowed to be -1.0 when a reach is solving upstream. A GainLoss Coefficient of -1.0 means that 100% of the Inflow to the reach is lost. When solving upstream given an Outflow value, it is impossible to determine a unique Inflow value if the GainLoss Coefficient is -1.0. Basically, an infinite number of Inflows could result in the given Outflow because 100% of it is lost before getting to the Outflow. RiverWare now detects this situation and flags an error when it occurs. Models that contain reaches that solve upstream and have a

GainLoss Coefficient of -1.0 will abort when run in the new release. The GainLoss value must be changed to any number that is greater than negative 1.0.

C. Confluence Object

Confluence Solution Direction

A new method category, Confluence Solution Direction, was added to the Confluence object. The default method in this category is Solve Upstream or Downstream. If this method is selected the Confluence will be able to solve either upstream or downstream depending on the knowns and unknowns. The user may also select the Solve Downstream Only method. If this method is selected the Confluence will always solve in a downstream direction. This is useful in rules models where slot priorities may be causing the object to solve in a direction that is not intended.

D. Power Reservoirs

Power Capacity Slot

A new slot, Power Capacity, was added to the PeakPowerCalc and PeakBasePowerCalc methods. The peak power value will be set in the Power Capacity slot. This represents the power that could be generated at the given operating head if the turbines are fully open. Prior to this release, the peak power value was stored in the Power slot. Now the Power Capacity slot will hold the peak power and the Power slot will contain the actual power produced. This is calculated by dividing the Energy by the timestep length.

Input Energy Adjustment

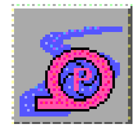
A new method category, Input Energy Adjustment, was added to all power reservoir objects. The default method, No Energy Adjustment, will do nothing. If the user selects Reduce Input Energy, and the input Energy value exceeds the maximum energy for the given timestep, the Energy value will be reduced to the maximum value and will be flagged Max Capacity.

E. Reservoirs

Input Outflow Adjustment

A new method category, Input Outflow Adjustment, was added to all reservoir objects. The default method, No Outflow Adjustment, will do nothing. If the user selects Reduce Input Outflow, and the input Outflow value exceeds the maximum outflow for the given timestep, the Outflow value will be reduced to the maximum value and will be flagged Max Capacity.

F. Inline Power Plant Object



An Inline Power Plant Object is now available on the object palette. This object is used to simulate power production on a reach with no storage capabilities. The object has an Inflow and Outflow that are always equal, and a user method to compute Power and Energy based on the flow rate in the reach. Detailed documentation of the Inline Power Object may be found in the **Simulation Objects Documentation** online.

5. Rulebased Simulation

A. Hypothetical Simulation

A new palette function called HypotheticalSimulation is available on the Rule Palette. This function accepts a lists of user input values and then simulates a portion of the model, defined in a subbasin, without setting slots or having any other effects on the actual model. The function returns a list of NUMERICs, which are the output slots from the hypothetical simulation. The user defines the list of the slot values that are returned from the function. This function is useful in a rule where the user needs to see the downstream affects of a reservoir release, for example, without actually setting the release and waiting for RiverWare to simulate. The hypothetical simulation takes place during the execution of the rule that calls this function, so decisions can be made based on the returned results. If the model has lagged reaches, the user is able to access the downstream affects of a release as well as the future affects of a release. The hypothetical simulation portion of the function exactly replicates the actual simulation that would take place in RiverWare if the input values, specified by the user, were actually set.

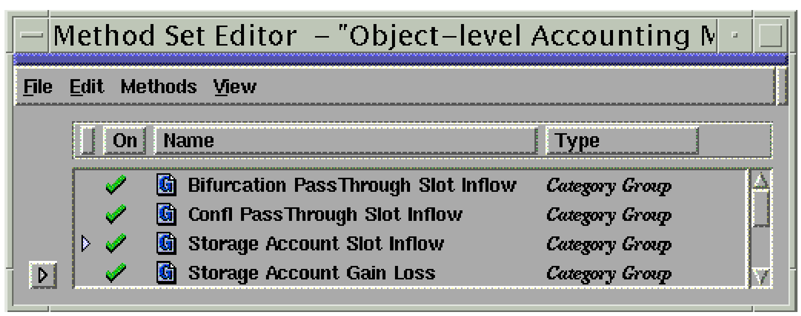
The HypotheticalSimulation function takes three arguments. The first argument is a STRING which specifies the subbasin to simulate. Only those objects that are in the subbasin are hypothetically simulated. The second argument is a LIST of LISTS. Each list includes the slot, value, and timestep that the user want to us as input to the hypothetical simulation. Any values that already exist on the objects will also be used. The third argument is also a LIST of LISTS. Each list includes the slot and the date for all required return values. The function returns a LIST of the values for the specified slots at the specified times. Details on the use of this function and the syntax involved are available in the Rulebased Simulation documentation online.

6. Water Accounting

A. User Defined Accounting Methods

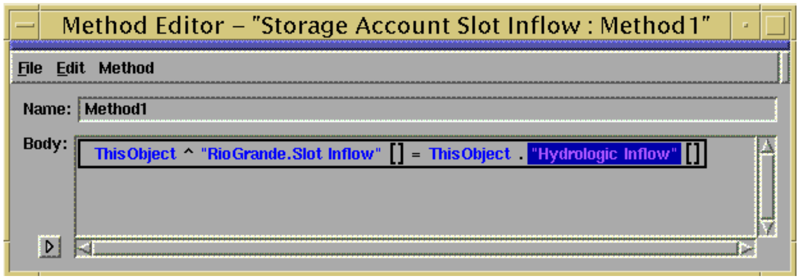
The accounting calculations in RiverWare are now accessible by all RiverWare users. New functionality has been added to allow users to write methods, in the same language used for rules, that move water into and out of the accounting system. In every accounting model there has to be a way to move physical water into the accounts. For example, in a rain event a reservoir will experience hydrologic or local inflows that will increase the storage in the reservoir. Most accounting systems then have some sort of policy that describes how this water is divided among the storage accounts in the reservoir. Another example is when the physical system is experiencing losses, these losses usually have to be applied to the accounts in some specific manner. The User Defined Accounting Methods can be written and selected by the user to accomplish both of these tasks.

The Method Set Editor can be accessed by selecting Accounting->Accounting Methods from the RiverWare Workspace main menu. This will bring up a dialog box that looks similar to the Ruleset Editor.



Each of the categories listed in the Method Set Editor corresponds to a user method category on a particular object or objects. When a method is added to one of these categories, the method then shows up in the list of available user methods in that method category on every object that has that category. The user activates these methods by opening up the object and selecting the method in the appropriate category (the same way user methods are selected for simulation). If a method is selected on an object, that method should only set accounting slots (i.e. Slot Inflow and Gain Loss on particular accounts) on accounts that are on that object. However, the methods are allowed to set slots on data objects. If a method attempts to set a non-accounting slot or a slot on another object and error result.

The user can write generic methods that may be used and selected on several objects. The ThisObject variable can be used when writing methods to access slots of a particular name on whatever object is using the method at a given time. Following is an example of a simple method (this can be printed for increased clarity):



This method sets the Slot Inflow slot on the RioGrande account to the value in the Hydrologic Inflow slot. Since the ThisObject variable is used, this method can be selected on more than one object, and the name of the object that is using the method at a given time replaces the ThisObject variable.

B. Pre-Defined Accounting Methods

Zero Slot Inflows on Reach

The Zero Slot Inflows method in the Reach Pass Through Account Slot Inflow category now sets the Slot Inflow to zero for all accounts on the Reach object.

C. Multiple Supplies Between Accounts

RiverWare accounting now has the ability to model multiple supplies between the same two accounts. This is accomplished by naming an upstream account as a supply, then naming the same account again as another supply. As long as the two supplies have different names this will not be a problem. This is useful when the user needs to differentiate among the various reasons why water is being moved between the two accounts.

7. Optimization

A. Multiple Run Management

Multiple Run Management is now working, but the testing on realistic models has been limited. To truly test MRM TVA should develop DMIs for MRM. If the DMI's are correct, we would expect that MRM will get the same results as manually running consecutively, and calling the single run DMIs between runs.

B. Lambda Cuts

Writing constraints on single variables that are part of a lambda representation now cause RiverWare to automatically add cuts to eliminate lambda variables and reduce linearization error. For example, writing the policy constraint Wheeler.Outflow >= 10 leads to cut constraints that will gradually reduce and eventually eliminate all lambda points with Outflow less than 10 as this constraint is satisfied. In our testing, these constraints have added about 25% to the run time of a model. The cut constraints can be turned off at a reservoir by selecting an appropriate method. We suggest this be tested for excessive run time on current models. In addition, this improvement in the lambda approximations suggests that it now makes sense to selectively increase the number of lambda points used in the lambda approximations. This will require a change in DMIs.

C. Marginal Cost

We have added a Previous Marginal Cost slot. If the generation is between blocks, the Previous Marginal Cost slot will reflect the block cost as generation is reduced while the original Marginal Cost slot will reflect the cost of increasing generation. If the generation is in the middle of a block both costs should be the same. We also added a table slot, Block End Tolerance. If the generation is within this value of the end of a block it will be considered to be at the end in terms of the marginal costs reported. If this value is NaN, it is replaced with zero which will cause the Previous Marginal Cost and Marginal Cost to be identical.

D. Performance Improvement

Performance improvements were made which are particularly noticeable in models with long run times on "No Spill" constraints. However, the gains have been somewhat offset by the increased run times of the Lambda cuts.

E. Smoothed Energy

The original smoothed energy task is completed and functional, but the results indicate that some modifications need to be made before it is useful for river scheduling.

F. Spill Input

Spill (or any type of spill) can be set to input for optimization and the result will be preserved in post-optimization simulation. Also, all of the simulation spill categories now have optimization counterparts.

G. Linearization Zero Terms

When linearization generates a term with a zero coefficient that term is not added. Previously this led to additional unnecessary linearizations and data demands.

H. Diagnostics

CPLEX diagnostics are now directed to the RiverWare diagnostics window. This change led to fixing several bugs that previously had gone undetected.

A number of warnings have been rewritten to be more clear and additional warnings have been added.

I. Bug Fix Highlights

When an expression slot divides by zero, the user now receives an error message to indicate the cause.

The value -0.0 appears to have been eliminated. Two independent sources were fixed.

The model no longer aborts if an entire priority is eliminated implicitly by use of the BY operator and slots with NaN. Additionally, the error message associated with this error has been improved.

Several problems with the optimization parameter dialogs were fixed.

8. Closed Bug Reports

Bug Fixes

The following is a list of the bugs which were fixed for this release. If you wish to view the details for a specific bug, please browse to http://cadswes.colorado.edu/users/gnats-query.html and search our bug database. You will need a RiverWare user login and password.

1327	1353	1395	1400	1816	1827	1879
1921	1963	2039	2123	2125	2179	2191
2214	2216	2280	2217	2232	2260	2261
2269	2341	2405	2419	2496	2527	2537
2542	2546	2585	2605	2611	2614	2618
2632	2637	2645	2646	2647	2648	2650
2655	2660	2669	2679	2682	2684	2689
2690	2693	2694	2695	2698	2700	2729
2734	2737	2738	2739	2740	2748	2751
2756	2767	2770	2771	2772	2776	2778
2779	2782	2786	2788	2794	2795	2797

Release Notes Version 4.0

1. Special Attention Notes

- Prior to this release, a bug was preventing the Maximum Iterations on accounting slots from being checked. This bug is fixed for RiverWare 4.0 so models will now abort if an accounting slot is set more than the maximum number of iterations on a given timestep. It is possible that existing models have been violating this restriction all along. If this is the case, these models will now abort. The user will need to increase the Maximum Iterations on accounting slots for the model to run completely again. This is done by selecting View->Simulation Run Parameters from the Run Control dialog box.
- RiverWare is now available for the Windows 2000 platform. RiverWare will also run on NT, however, it is only supported for Windows 2000. Important information about using the Windows executable is included below in the RiverWare for Windows 2000 section.
- Rulesets saved in the new release CANNOT be used in older executables. There is no message to warn the user about this. Rulesets saved under previous executables CAN be used with the new release however.
- The Stage Table Lookup method on Reach objects was enhanced to compute the Outflow Stage when the reach is solving downstream. Prior to this change, Outflow Stage was only computed when the reach was solving upstream. Because existing models may not have data in the Outflow Stage Table, the table interpolation may fail during the execution of this method. This will prompt a warning message that will not stop the run and will not affect results. However, if the user does not wish to see the warning message, data will need to be input to the Outflow Stage Table.

2. Required Model File Updates

A. Unit Ramping Cost Slot

In optimization models, the Unit Ramping Cost table slot has been removed from the Thermal object (the Ramping Cost series slot is still available). Users still wishing to utilize the Unit Ramping Cost slot can select it from the Ramping Modeling method category on Power Reservoir objects. See the Optimization section of the release notes for more details.

B. Maximum Iterations on Account Slots

Prior to this release, a bug was preventing the Maximum Iterations on accounting slots from being checked. This bug is fixed for RiverWare 4.0 so models will now abort if an accounting slot is set more than the maximum number of iterations on a given timestep. It is possible that existing models have been violating this restriction all along. If this is the case, these models will now abort. The user will need to increase the Maximum Iterations on accounting slots for the model to run completely again. This is done by selecting View->Simulation Run Parameters from the Run Control dialog box.

3. Model Loading

A. Local Inflow Solution Direction

When loading a model, RiverWare gives a warning letting the user know that the Local Inflow Solution Direction category name is replacing the localInflowCalculationCategory category name. The Local Inflow Solution Direction method category allows the user to choose which direction RiverWare solves on a Reach object. After you save your model in RiverWare 4.0, these warnings will not show up the next time you load the model. See the Simulation Objects section of the online help for more details.

B. Some “SeriesSlots” changed to “AggSeriesSlots”

Some SeriesSlots have been converted to AggSeriesSlots. When loading old models, diagnostics messages may be generated as old slot types are automatically converted to new slot types:

Trying to convert former slot type (“SeriesSlot”) to new slot type (“AggSeriesSlot”).

Do not be concerned by these messages. You do not need to make any changes to your model. The use and functionality of these slots has not changed.

4. RiverWare for Windows 2000

RiverWare is now available and supported for Windows 2000 (it will also run on NT but CADSWES is supporting Windows 2000). The user should be aware of the following differences that exist in RiverWare for Windows:

- Middle-mouse features such as QuickLink or rearranging the rows in the run analysis dialog are activated with the combination (pressed in this order): Alt + right mouse button + left mouse button.
- QuickLink can also be activated using the right-mouse button.
- The Locator View window often gets in a bad state when you resize the main workspace.
- It is possible that the objects may get shifted off the workspace if the workspace window is resized in certain ways. In order to make the objects visible again, you must save the model then reload it. Reloading the model will shift the model so that all objects are visible on the workspace.
- Ruleset files can be moved from unix to windows without modification. To move a Ruleset file from Windows to Unix you must run dos2unix on the ruleset file.
- Plotting is not supported on Windows.
- Optimization is not supported on Windows.
- The Windows DMI executable can be a DOS batch file or any other windows executable that can be run directly from a command shell.
- When saving model files that you intend to move between windows and unix systems, always save with the .gz extension. This saves the model in a binary format that is the same on windows and unix.

5. General RiverWare

A. Optional Keyword for AggSeries Slots in DMIs

There is a new optional keyword for use in the DMI User Control File. The “aggregate” keyword is used to specify whether or not the DMI should import/export all time series slot on an AggSeries slot or just the first time series column.

aggregate = <true> or <false>

The term “aggregate” is an optional keyword=value pair (KV pair) for import and export. If present, with the value “true”, and if the slot indicated is an AggSeries slot, the data file is expected to (on import) or will (on export) contain data for all subslots (columns) in the AggSeries slot. If the KV pair is absent, or if its value is “false”, only the data for the first subslot (column) of the AggSeries slot are present.

When AggSeries slot data are imported or exported in toto, the data are in row-major format, one timestep per line. The subslots of the aggregation must be homogeneous in start-date, end-date and step size, and all subslots (columns) must be represented on each line.

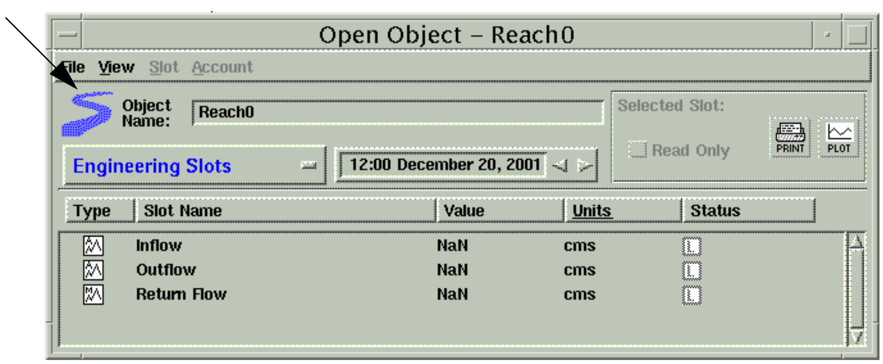
If used with the ‘flags=true’ KV pair, the data will appear in the form:

value flag   value flag value flag ...

If the named slot is in fact the first subslot (column) of an AggSeries slot, the behavior is the same as if the subslot (column) name were absent.

B. Object Icon in Open Object/Slot Dialog

An object icon has been added to every Open Object and Open Slot dialog. This shows the user the type of object that the Open Object or Open Slot dialog originated from.



C. Resume Run

Functionality has been added to allow users to resume a stopped or aborted run. When a run is stopped or aborted, a resume button appears on the Run Control dialog. After clicking the resume button, a warning appears that says “Resuming a stopped or aborted run will likely corrupt the model’s output! Resuming from a stopped or aborted run should be used for model and rule debugging purposes ONLY. Validity of output NOT guaranteed.” The user is then able to select the timestep at which the run should resume. This feature is useful to debug large, long running models. This new resume feature allows the user to fix the problem and continue the run. As the warning suggests, the results are not guaranteed and the model must be rerun to test that changes have not affected previous timesteps. The resume functionality does not support accounting models at this time.

D. Command Line Options

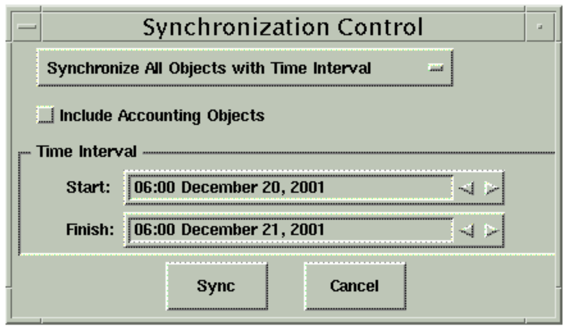
Three new command line options were added. The --ruleset option invokes the ruleset editor for the specified ruleset. The --model option was added to replace the --file option to load a model file. The --file option is still supported but may be eliminated in the future. Finally, a --noprefs option was added to prevent the user interface from loading the user’s preferences. This may be useful if the user’s preferences become corrupted. The user’s preferences consist of window sizing and positioning, and how rules are formatted. All of the command line options are explained by typing riverware --help.

E. Deleting Links with Quick Link Editor

A button was added to the Quick Links dialog (middle mouse button over a link) to allow users to delete links. This was implemented to allow users to easily delete hidden links. Links between slots become hidden when their dependent methods are deselected. Previously, users would have to reselect the correct method to un-hide the link and then delete it.

F. Synchronize Workspace Objects to Specified Time Interval

A new dialog was added to enhance the ability to synchronize workspace objects to a specified time interval. Previously, there were menu options to synchronize all or selected objects to the run control. Now, there is a dialog box (see below) that allows the user to synchronize all or selected objects with the run control or to a specified time interval. A toggle button was also added to the same dialog to allow users to synchronize the timesteps or time interval for accounting slots on all or selected objects. The new time interval must encompass the run control time interval.



G. Plot Directly to File

The output manager was enhanced to allow a plot to be exported to a file instead of directly to the plotter program. This was implemented to overcome memory problems with large models that were not able to fork processes to execute the plotter program. To load a plot into xmgr use the following command in a terminal window:

pxmgr -batch YourPlotFileName

6. Simulation Objects

The following enhancements to the RiverWare^{tm} simulation objects are described briefly. The user is encouraged to consult the **Simulation Objects Documentation** in the online help for more detailed descriptions of the enhancements to the objects and their methods.

A. Reach

Local Inflow Solution Direction Category

The name of the category LocalInflowCalculationCategrory was changed to Local Inflow Solution Direction to more generally describe the types of methods in the category. Methods in the category allow the user to select the type of local inflow calculation and limit the solution direction, i.e., the dispatch methods available. When a model with the old category name is loaded, the category names are changed and a warning is posted, but model results are not affected.

LocalInflowDownstreamOnly method

A new method, LocalInflowDownstreamOnly, was added to the Local Inflow Solution Direction category.   This method, available only with the noRouting method selected, forces the reach to solve downstream only by limiting the available dispatch methods to solveNROutflow. The method is especially useful in Rulebased Simulation models for reaches that always solve downstream or models where rule priorities force the reach to solve in the wrong direction.

Seepage and Riparian CU Loss method

A new method, Seepage and Riparian CU Loss, was added to the Seepage Calc category. It is only available when using the noRouting method in the routing method category and LocalInflowDownstreamOnly in the Local Inflow Solution Direction category. It models seepage and loss from a reach by an empirical equation with inflows and consumptive use as inputs. More information can be found in the Simulation Objects Documentation online.

B. Reservoir

Input Seepage method

A new method, Input Seepage, was added to the Seepage Calculation category to allow users to input the seepage or set the seepage with a rule.

7. Rulebased Simulation

A. Rule Agenda Order

An enhancement has been made to the Ruleset Editor to allow the user to specify whether the rule agenda will execute in ascending or descending priority order. This functionality was added to allow the user to decide which rule execution order is most appropriate. The user must select whether to execute the rules in the descending rule priority, 1, 2, 3, ..., or in ascending rule priority, ..., 3, 2, 1. (Remember rule 1 has a higher priority than rule 3) Rulesets, by default, will execute 1, 2, 3, ... and existing models are not affected. From the main Ruleset Editor dialog, click on the triangle in the lower left corner to expand the window and access this option.

B. Rules Formatting and Printing

Functionality has been added to allow the user to format and print the rules. The user can configure line breaking and indenting in the Ruleset Layout Editor (accessed by selecting Ruleset->Ruleset Layout from the main Ruleset Editor). This is useful to prevent long, single line rules that do not fit on the screen. The user specifies the line breaking and indenting both before and after a rule statement or variable (e.g., IF, DO, +, <expr>). The ruleset, group, or a single rule can be printed to either the printer or a postscript file by selecting File->Print Ruleset from the Ruleset Editor dialog. The user can select the font, orientation, and whether various descriptors are printed. The user preferences, layout and printer settings, can be imported/exported to an ASCII file. This is useful if a user has a desired ruleset layout and would like to configure different rulesets and models to look the same.

C. New Palette Functions

WeightedSum

A new palette function called WeightedSum is available on the Rule Palette. The function calculates the normalized weighted sum of a list of numbers. The function takes two arguments, a list of values to be summed and a list of the weights of the values. It calculates the weighted sum as:

$$\frac{\sum_i \mathrm{weight}_i \cdot \mathrm{value}_i}{\sum_i \mathrm{weight}_i}$$

See the Rulebased Simulation Documentation online for more information.

Hypothetical Target Simulation (HypTargetSim)

A new palette function called HypTargetSim is available on the Rule Palette. This function finds a value which, when set on a given slot, will lead to a desired value on another slot. Given a control slot and a target slot, target date/time, and target value, the HypTargetSim function uses hypothetical simulation (see description of the predefined function HypSim) to find a value x such that if the control slot were set to x at all timesteps in the range [current date, target date], then the target slot's value would equal the target value. The return type of this function is a NUMERIC with the value x. Details on the use of this function and the syntax involved are available in the Rulebased Simulation documentation online.

Hypothetical Target Simulation With Status (HypTargetSimWithStatus)

A new palette function called HypTargetSimWithStatus is available on the Rule Palette. This function finds a value which, when set on a given slot, will lead to a desired value on another slot. If a value satisfying this criterion is not found, then an attempt is made to find a value that comes close to doing so. Given a control slot and a target slot, target date/time, and target value, the HypTargetSimWithStatus function uses hypothetical simulation (see description of the predefined function HypSim) to find a value x such that if the control slot were set to x at all timesteps in the range [current date, target date], then the target slot's value would equal the target value. A two-item list is returned. The first item in the list is a boolean TRUE value if a satisfying control slot value was found, FALSE otherwise. If the first item is TRUE, then the second item is the satisfying control slot value, otherwise this value is as close as the function could get to finding such a value.

Note: this function is very similar to HypTargetSim: this only difference is that HypTargetSim fails if it can not find a satisfying control slot value, whereas this function does not fail, rather it still returns a value, along with the indication that this value does not achieve the target.

Details on the use of this function and the syntax involved are available in the Rulebased Simulation documentation online.

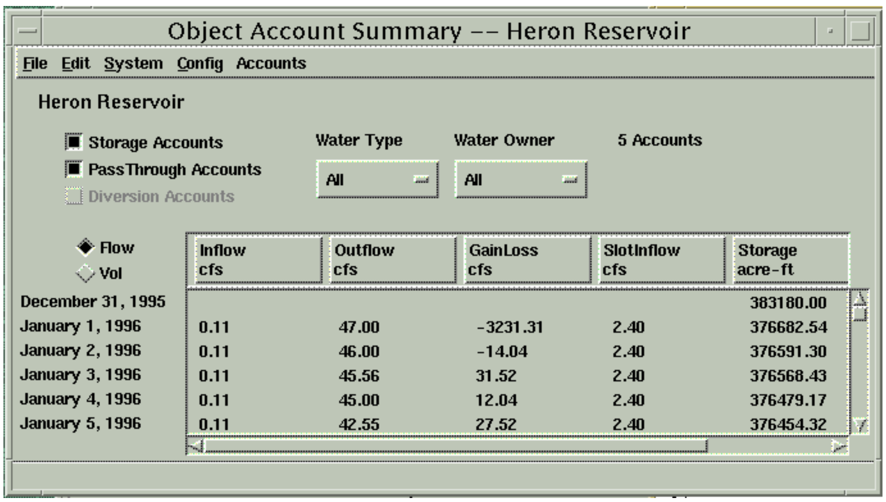
8. Water Accounting

A. Max Iterations Bug Fixed

Prior to this release, a bug was preventing the Maximum Iterations on accounting slots from being checked. This bug is fixed for RiverWare 4.0 so models will now abort if an accounting slot is set more than the maximum number of iterations on a given timestep. It is possible that existing models have been violating this restriction all along. If this is the case, these models will now abort. The user will need to increase the Maximum Iterations on accounting slots for the model to run completely again. This is done by selecting View->Simulation Run Parameters from the Run Control dialog box.

B. Object Account Summary Dialog

An Object Account Summary dialog has been added to display summary information about the accounts on an object. This new feature can be accessed by selecting Account->Summary from the Accounts view of the Open Object dialog. The dialog shows the sum of each series slot (inflow, outflow, etc.) for all accounts on the selected object. In addition, filters are available to view only the information for each water owner and water type. This dialog is a useful tool to determine the total accounting inflows, outflows, and storage for a given object.



C. Diversion Accounts

Functionality has been added to diversion accounts on Water User Objects and Aggregate Diversion Sites. Given a value in the Diversion slot, the diversion account solves for either Return Flow or Depletion depending on which slot is known and which is unknown. If neither Depletion nor Return Flow are known, Depletion is set to Diversion and Return Flow is set to zero. The Diversion slot on the diversion account can only be linked (using supplies) to the newly implemented diversion slot on a pass through account. Return flows from the diversion account can be linked (via supplies) back to the return flow on a pass through account (either the same account being diverted from, or a downstream account). Diversion accounts can be added to Water User objects or to Aggregate Diversion Sites when using the Lumped linking structure.

D. Inflow/Outflow and Diversion/Return Flow Supply Type

All accounting supplies have been assigned either an Inflow/Outflow or Diversion/Return Flow type. This is necessary to prevent selection of incorrect sources for supplies. The user must now specify the type of supply desired before the source accounts become visible. The Inflow/Outflow supply type is used to link an account to an upstream account. In this case, the supply will link the Outflow of the upstream account to the Inflow of the downstream account. The Diversion/Return Flow supply type is used to link pass through accounts to diversion accounts. In this case, the supply will link the Diversion slot on the pass through account to the Diversion slot on the diversion account (if created from the diversion account), or it will link the Return Flow slot on the diversion account to the Return Flow slot on the pass through account (if created from the pass through account).

E. Linking Pass Though Accounts and Diversion Accounts

Diversion and return flow slots have been added to pass through accounts. These slots should be used to link pass through accounts to diversion accounts. On the diversion account, the user should create a supply that names the pass through account, from which water is being diverted, as the source to the diversion account in question. This will create a supply between the Diversion slot on the pass through account and the Diversion slot on the diversion account. The user would then go to the pass through account that is receiving the return flow from the diversion account. Here the user should create a supply that names the diversion account as the source. This will create a supply between the Return Flow slot on the diversion account and the Return Flow slot on the pass through account. When creating these supplies, on both the diversion account and pass through account, the user should be creating supplies that are of the type Diversion/Return Flow.

F. Account Demands

In the account configuration dialog, a tab has been added to show the demands from an account. This information in this dialog is read only, the user still must configure the supplies on downstream accounts. However, this new tab is useful to show the supplies that both connect the account in an upstream and downstream direction.

G. New User Defined Accounting Method Categories

Pass Through Acct Gain Loss

A new accounting level method category, Pass Through Acct Gain Loss, was added to the Reach object. This category only appears when an accounting controller is chosen from the Run Control dialog. This method category allows users to write and select Object Level Accounting Methods that set the

GainLoss slot on Pass Through Accounts on reaches. Prior to the introduction of this category, the GainLoss slot on a Pass Through Account could only be computed in terms of an optional Gain Loss Coefficient (input through the account configuration dialog), which indicated the fractional portion of the flow which was lost. If the user has input a Gain Loss Coefficient and has also created and selected a method in the Pass Through Acct Gain Loss category that sets the GainLoss slot on the same account, the Gain Loss Coefficient will be ignored.

Agg Diversion and Water User Reconciliation

A method category was added to the AggDiversionSite and Water User objects to contain user defined accounting methods for reconciling accounting water with the physical water. The categories are named Agg Diversion Reconciliation and Water User Reconciliation, respectively. These categories contain no methods so it is the responsible for the user to write these methods using the RiverWare Policy Language. Once the methods are created, they will appear, and can be selected, in the new categories.

H. Supply Slots in the SCT

Accounting supply slots can now be selected and used in the Simulation Control Table (SCT).

9. Optimization

- User defined subbasins can now have "types" such as No optimization, preferred customer, etc. Previously, these basins had to have special names. Now they can be named anything, but they need to have the appropriate type associated with them.
- Objectives can now be relaxed for later priorities. For example, objective must be within 5% of optimality, or within $100,000 of optimality. This feature is accessed by selecting Objective Min (or Max) w/ Flexibility instead of Objective Min (or Max). This selection will introduce an additional line in to the constraint editor where the user may create an expression representing the flexibility. The expression must evaluate to a constant. In addition, this line has a button to select if this value should be interpreted as a fraction of the optimal objective or an absolute quantity to relax the objective.
- Kentucky and Barkley have always been assumed to be connected to the adjoining canal using particular ends of the canal: Barkley to the "1" side and Kentucky to the "2" side. This requirement is because the canal flow equation is not symmetric with respect to these reservoirs. This requirement has been noted in the online documentation, but nothing in the code prevented a user from making incorrect links. With this release the connections are enforced and an incorrect connection will result in an error message.
- Previously the optimization formulation treated the canal symmetrically. The formulation now uses the same asymmetric formula as in simulation. (Because of linearization error, the representation remains approximate.)
- Diversion objects can now be included in optimization. The Diversion slot is a CPLEX variable, while the following slots are linearized as specified:
  Available for Diversion: a function of head using the Gravity Head Flow Table,
  Head: Diversion Intake Elevation - Diversion Base Elevation, and
  Diversion Intake Elevation: substitute with linked slot.
  All other slots are expected to be constant.
  The only physical constraint is that Diversion <= Available for Diversion.
- Optimization computes both spill and canal flows based on the average of the current and past elevation. Previously, simulation did this, but optimization used only the current time step's elevation.
- The preferred customers modeling has been revised as previously planned. Users select the preferred customer method and specify a set of reservoirs to be in a preferred customer subbasin. The reservoirs may be a mixture of optimized reservoirs and reservoirs with energy that is allocated each day but the total is fixed rather than optimized. The Preferred Customer Energy is a CPLEX variable on the thermal object with lower bound of zero and upper bound equal to the sum of maximum energy generation for each of the subbasin members. A physical constraint is added that requires the sum of energy produced by the subbasin to be greater than or equal to the Preferred Customer Energy variable. The existing equations referencing system energy generation have been modified to subtract the preferred customer energy variable from the total generation. The modeling is completed when the user adds a policy constraint on the preferred customer energy, e.g. Thermal Object.Preferred Customer Energy >= Data Object.Energy Request
- Many model files contain extra optimization columns on slots that are no longer in use. These columns will be removed automatically.
- The use of the inflow2 slot has been modified. If the inflow2 slot on a reservoir is not linked, the optimization will expect values should be put in the simulation column. If the inflow2 slot is linked then the values will come from the linked slot. This was related to bug 2578.

- Turbine ramping is now modeled for each power reservoir when the trackRamping method is selected. This method creates two CPLEX variables to track increases and decreases in turbine ramping with the following physical constraint:
  Turbine Increase - Turbine Decrease = Turbine Release - Turbine Release(-1).
  In addition, each power reservoir has a table slot to hold the Unit Ramping Cost and a series slot that combines the costs:
  Ramping Cost = Unit Ramping Cost * (Turbine Increase + Turbine Decrease)
  After selecting methods, users can link corresponding MultiSlots on the thermal object to the individual reservoir slots: Turbine Increase, Turbine Decrease, and Ramping Cost. By referencing Thermal Object.Ramping Cost in an objective function users can minimize the total system ramping cost.
- The potential approximation error for piecewise approximations has been reduced by automatically adding a set of cuts. The worst possible error now is along a line connecting the first and last approximation points.
- "Hole cuts" are now added to the model when the appropriate method is selected on power reservoirs. When selected, cuts are added as physical constraints that reduce the incidence of holes in the schedule. The cuts constrain the segments of the piecewise linearization of power:
  segment(i,t) <= segment(i,t-1) + segment(i,t+1) - segment length(i) for all i
- Both optimization and simulation now model fractional timesteps in expressions. These expressions are modelled in a way that is similar to the existing modelling of fractional time lags in reaches.e.g.
  outflow[5.2] translates to: 0.8 outflow[5] + 0.2 outflow[6]
  This had been filed as bug 803.
- Users can now define optimization variables without a change in the RiverWare code. Any Series Slot on a Data Object that starts with a name of "RW" will be treated as a CPLEX variable. The user can then add whatever policy constraints are necessary for the variable to have the desired behavior.
- A new method has been added to initialize turbine release to zero if it is missing (NaN). The method was added in part because of automatic generation of piecewise segments for period zero required by other enhancements.
- Code has been added to the table slot which will automatically eliminate piecewise segments during creation if the curvature is incorrect. A warning is still issued and the table is not changed.
- The automation of power linearization worked only in limited circumstances and has been repaired to work more generally. In addition, we added diagnostics for inconsistent power tables.
- When CPLEX terminates with a status hinting at numerical instability we automatically reset the CPLEX parameters to be exceedingly tolerant of numerical difficulty. We issue a warning and re-optimize.
- Automatic restart for objective functions has been turned off because of evolution of the models. Restarting at any time seems to do more harm than good. If the model is regularly restarting, we recommend increasing the time limit as necessary: under "Goal Parameters", change "Initial Time Limit".
- We increased the maximum number of pieces in a piecewise approximation from 20 to 30 to facilitate using every operating point of the power curve in the "many pieces" model.
- We added functionality to identify rows that are forcing a slot (or even an expression) to a single value. Use this fact to identify additional fixed variables both for reporting in the OptAnalyst as well as improving the speed and numerical stability of the optimization.

- We added a similar check on cuts that were forcing lambda variables to zero.
- Extrapolation of spill tables was improved by basing the extrapolation on storage for Level Power Reservoirs.
- Cut constraints have been improved to make them more useful by
  a. allowing cuts on constraints where the right hand side varies,
  b. generating additional cuts after splitting equations, and
  c. removing automatic generation of initial BWL point when the method to "reduce" cut constraints is activated. The initial point is both less useful and interferes with reducing in this case.
- Patrick Lynn improved the performance of Optimization runs which involve constraint sets with disabled constraints. During these runs, if the user had selected the option to write the CPLEX problem description to log files, then considerable time was spent doing this for disabled constraints. We don’t now bother to write anything out in this situation because no new optimization is done for disabled goals and so the problem contains no new information.
- We made the following enhancements to diagnostics:
  Missing applicability limits for initial inflow.
  Min and max inconsistent with approximation points.
  Constraints that attempt to force slots beyond bounds.
  Moved an infeasibility warning that was misplaced.
  Preferred customer warnings
  Numerical instability: problems that go from feasible to infeasible.
  Improved the context of many diagnostic messages.
  Made curvature checking less finicky for power data.
  Warning if the initial value is greater than a slot’s upper bound.
  No longer issue certain warnings for cut constraints.
  Prevent LHS >= RHS type warnings for constraints with frozen variables.
  Abbreviated some very long names for cuts.
  Updates of objective function values for MiniMax constraints whenever the objective value improves.
- The following bug fixes were made for code related at least partially to optimization. Some bugs were fixed immediately and do not have bug numbers.
  2834: Optimization cannot be rerun.
  2850: When saving a constraint set, model core dumps.
  CPLEX bug: writing files changes pivots.
  Incorrect cplex parameters.
  Incomplete detection of constraints inactive by Nan.
  The value -0.0 being returned by optimization.
  Incomplete detection of out of order piecewise variables.
  Inadvertent deactivation of curvature checks.
  An error message causing core dumps.
  We invalidated rows that contain only a Z variable.
  Changes in optComputeFixedOutflows to accommodate a bug fix for the problem of variable days in the month.
  Incorrect arguments in a call to notifyAddRowToProblem.

10. Closed Bug Reports

Bug Fixes

The following is a list of the bugs which were fixed for this release. If you wish to view the details for a specific bug, please browse to http://cadswes.colorado.edu/users/gnats-query.html and search our bug database. You will need a RiverWare user login and password.

245	248	249	251	252	260	261
277	295	296	299	301	304	317
325	331	369	375	376	386	387
702	711	752	803	834	912	918
934	1097	1114	1270	1338	1377	1378
1450	1458	1487	1502	1527	1544	1557
1591	1613	1628	1661	1673	1680	1681
1702	1718	1722	1740	1749	1752	1774
1781	1786	1789	1804	1844	1845	1855
1868	1871	1878	1880	1881	1896	1900
1905	1919	1922	1928	1933	1935	1937
1939	1941	1944	1946	1952	1958	1968
1969	1977	1979	1987	2001	2002	2005
2031	2047	2062	2070	2075	2094	2095
2099	2109	2115	2143	2145	2165	2192
2195	2210	2211	2220	2238	2273	2324
2397	2414	2444	2490	2522	2543	2576
2578	2594	2604	2622	2633	2634	2640
2641	2643	2649	2652	2654	2657	2665
2671	2687	2691	2696	2697	2702	2726
2731	2732	2746	2757	2768	2769	2773
2774	2775	2781	2784	2789	2790	2796
2798	2801	2801	2802	2803	2804	2807
2808	2810	2811	2812	2813	2815	2817
2818	2823	2824	2825	2829	2830	2834
2838	2841	2842	2843	2847	2848	2850
2853	2854	2855	2856	2858	2859	2861
2864	2865	2866	2867	2868	2869	2870
2872	2873	2875	2876	2877	2878	2881
2882	2883	2884	2885	2886	2887	2888

2889	2893	2895	2896	2897	2904	2905
2906	2907	2908	2909	2910	2911	2912
2913	2915	2916	2918	2920	2921	2922
2923	2924	2925	2926	2927	2928	2930
2931	2932	2934	2935	2936	2937	2938
2939	2940	2942	2944	2947	2948	2951
2952	2956	2957	2960	2961	2962	2964
2966	2970	2976	2978			

Release Notes Version 4.1

1. Special Attention Notes

- RiverWare is now available for the Windows 2000 platform. RiverWare will also run on NT, however, it is only supported for Windows 2000. Important information about using the Windows executable is included below in the RiverWare for Windows 2000 section.
- Plotting is now available for the Windows version of RiverWare. RiverWare uses PrestoPlot for all plotting that takes place on the Windows platform. This is intended as a temporary solution until a better cross-platform plotting solution can be found.
- Optimization is now available for the Windows version of RiverWare. You will need a Windows CPLEX license to run optimization on Windows. Contact CADSWES for this.
- Rulesets now have file versioning so that ruleset files can be matched with model files. This allows RiverWare see which release was last used to save the ruleset. The first time a ruleset is loaded into RiverWare Release 4.1, RiverWare will not recognize the ruleset version (because an existing ruleset will not have one yet) and the user will see the following RiverWare notice.

  Even though the dialog box says that the file cannot be recognized as a RiverWare ruleset, it will recognize it when the Continue button is clicked. Then, once the ruleset is saved in the new release, it will have a version number and you will not see this message again.

- Several new predefined functions have been added to the rules palette. Since these are very general functions, and have very general names, there is a possibility for naming conflicts with existing rulesets. For example, one of the new functions is call “Sum”. If an existing ruleset contains a user defined function or variable called “Sum”, the ruleset will not load in the new release. The user will get an error message when loading the ruleset. The message explains exactly where the conflict is located. In order to load the ruleset in the new release, the user will need to modify the ruleset to alleviate the conflict. This is done by changing the name of the user defined function or variable.

Negative Outflow Warnings Removed

- Prior to this release, if a reach object computed a negative outflow it would print a warning message to the diagnostics window. In Rulebased Simulation models, reaches often solve several times per timestep. While some of these solutions may result in a negative outflow, the final result is usually a positive outflow. This results in several warning messages that are insignificant because the final answer is not negative. Furthermore, these messages clutter the diagnostics window and are generally annoying. In RiverWare 4.1 these warning messages have been removed. Since most users ignored these messages for the reasons given above, this is generally not a problem. However, if some users were relying on these warning messages to catch modelling errors, they need to be aware of this change and find this information some other way.

2. Required Model File Updates

A. solveMB_givenInflowRelease

The iteration technique for the solveMB_givenInflowRelease dispatch method on reservoir objects has changed. As a result of this, the method may converge to slightly different values (within the convergence limit). This can be fixed by decreasing the value in the Convergence slot. Also, it may be necessary to increase the number in the Max Iterations slot. If you are seeing a warning message that says "Internal loop reached the maximum iterations of ..." then you need to do this.

This new iteration technique is a bisection method that is bounded by the maximum and minimum pool elevation values in the Elevation Volume Table. Therefore, this requires the same range of values for pool elevation in the spill, max release, and elevation volume tables. For example, if the elevation volume table ranges from 0-2400 ft, then the spill table needs to go from 0-2400 ft. If these tables are inconsistent in an existing model, the model will not run in this release until the tables are updated.

B. Inline Power

The Inline Power object was enhanced to include the following general slots: Turbine Release, Max Turbine Release, Plant Capacity Fraction, Bypass, Min Bypass, and Hydro Capacity. The addition of the Max Turbine Release slot will cause existing models (that use the Inline Power object) to abort. A Max Turbine Release value must be input in order to fix the model. The user should be aware that the units for all of the new slots will be standard RiverWare units and users must configure them accordingly.

C. Reach GainLoss with Time Lag Routing

Two of the GainLoss Calculation methods on the Reach object, Seasonal GainLoss Flow Table and Interpolated Flow GainLoss, are no longer valid methods when Time Lag Routing is the selected routing method on the reach. The reason for this change is that it is impossible to get the same answers solving upstream and downstream when using Time Lag Routing with one of these loss methods. Therefore, we disabled these two methods when Time Lag Routing is selected. If an existing model has a reach with both Time Lag Routing and one of the two loss methods mentioned above, RiverWare will give the following warning message when loading the model in the 4.1 release: "The <loss method name> method is no longer available when using timeLagRouting. You will need another reach to do the Gain Loss calculations. ..." If this happens, the GainLoss method on the reach in question will be changed to No GainLoss. You will need to create a separate reach object to do the Gain Loss calculations.

D. Name Conflicts in Rulesets

Several new predefined functions have been added to the rules palette. Since these are very general functions, and have very general names, there is a possibility for naming conflicts with existing rulesets.

For example, one of the new functions is call “Sum”. If an existing ruleset contains a user defined function or variable called “Sum”, the ruleset will not load in the new release. The user will get an error message when loading the ruleset. The message explains exactly where the conflict is located. In order to load the ruleset in the new release, the user will need to modify the ruleset to alleviate the conflict. This is done by changing the name of the user defined function or variable.

E. GainLoss Specification on Pass Through Accounts

There are two ways to compute the GainLoss slot on Pass Through Accounts. One way is to specify a GainLoss coefficient on the account. This will compute GainLoss as a percentage of the inflow to the account. The other way is to set GainLoss directly using an object level accounting method. Prior to this release, the user could theoretically give a GainLoss coefficient and set the GainLoss slot with a method. Obviously this is an overdetermination. However, instead of giving an error, RiverWare just ignored the GainLoss coefficient. In the 4.1 release, this will result in an error. If this is happening, the user needs to either turn off the method, or remove the GainLoss coefficient.

3. Model Loading

A. Ruleset Loading

Rulesets now have file versioning so that ruleset files can be matched with model files. This allows RiverWare see which release was last used to save the ruleset. The first time a ruleset is loaded into RiverWare Release 4.1, RiverWare will not recognize the ruleset version (because an existing ruleset will not have one yet) and the user will see the following RiverWare notice.

Even though the dialog box says that the file cannot be recognized as a RiverWare ruleset, it will recognize it when the Continue button is clicked. Then, once the ruleset is saved in the new release, it will have a version number and you will not see this message again.

B. Name Conflicts in Rulesets

Several new predefined functions have been added to the rules palette. Since these are very general functions, and have very general names, there is a possibility for naming conflicts with existing rulesets. For example, one of the new functions is call “Sum”. If an existing ruleset contains a user defined function or variable called “Sum”, the ruleset will not load in the new release. The user will get an error message when loading the ruleset. The message explains exactly where the conflict is located. In order to load the ruleset in the new release, the user will need to modify the ruleset to alleviate the conflict. This is done by changing the name of the user defined function or variable.

C. Unit Changes

Enhancements were made to the way RiverWare handles units. Part of this enhancement includes a more rigorous method of enforcing valid units and unit types. As a result of this change, it was noticed that some older models have slots that have either invalid units or invalid unit types. When RiverWare encounters these slots, it resets the units and prints the following warning message when loading the model:

Invalid <unit type> units “old units” changed to “new units”.

If a slot has invalid units, and it has gone undetected by the user this long, then most likely this is a slot that is not used in modeling (and therefore probably doesn’t contain any values). In that case, the warning message can be ignored. However, it is probably safest to look at the slot mentioned in the warning and verify that the units and unit type are now correct.

D. Reach GainLoss with Time Lag Routing

Two of the GainLoss Calculation methods on the Reach object, Seasonal GainLoss Flow Table and Interpolated Flow GainLoss, are no longer valid methods when Time Lag Routing is the selected routing method on the reach. The reason for this change is that it is impossible to get the same answers solving upstream and downstream when using Time Lag Routing with one of these loss methods. Therefore, we disabled these two methods when Time Lag Routing is selected. If an existing model has a reach with both Time Lag Routing and one of the two loss methods mentioned above, RiverWare will give the following warning message when loading the model in the 4.1 release: “The <loss method name> method is no longer available when using timeLagRouting. You will need another reach to do the Gain Loss calculations. ...” If this happens, the GainLoss method on the reach in question will be changed to No GainLoss. You will need to create a separate reach object to do the Gain Loss calculations.

E. Some “SeriesSlots” changed to “AggSeriesSlots”

Some SeriesSlots have been converted to AggSeriesSlots. When loading old models, diagnostics messages may be generated as old slot types are automatically converted to new slot types:

Trying to convert former slot type (“SeriesSlot”) to new slot type (“AggSeriesSlot”).

Do not be concerned by these messages. You do not need to make any changes to your model. The use and functionality of these slots has not changed.

4. RiverWare for Windows 2000

RiverWare is now available and supported for Windows 2000 (it will also run on NT but CADSWES is supporting Windows 2000). The user should be aware of the following differences that exist in RiverWare for Windows:

Differences in RiverWare for Windows

- Middle-mouse features such as QuickLink or rearranging the rows in the run analysis dialog are activated with the combination (pressed in this order): Alt + right mouse button + left mouse button.
- QuickLink can also be activated using the right-mouse button.
- The Windows DMI executable can be a DOS batch file or any other windows executable that can be run directly from a command shell.

Problems/Bugs in RiverWare for Windows

- The Locator View window often gets in a bad state when you resize the main workspace.
- It is possible that the objects may get shifted off the workspace if the workspace window is resized in certain ways. In order to make the objects visible again, you must save the model then reload it. Reloading the model will shift the model so that all objects are visible on the workspace.

Saving Model Files and Rulesets

- When saving model files or ruleset files that you intend to move between windows and unix systems, always save with the .gz extension. This saves the model/ruleset in a binary format that is the same on windows and unix.

Enhancements to RiverWare for Windows

- Plotting is now available for the Windows version of RiverWare. RiverWare uses PrestoPlot for all plotting that takes place on the Windows platform. This is intended as a temporary solution until a better cross-platform plotting solution can be found.
- Optimization is now supported on Windows. You will need a Windows CPLEX license to run optimization on Windows. Contact CADSWES for this.

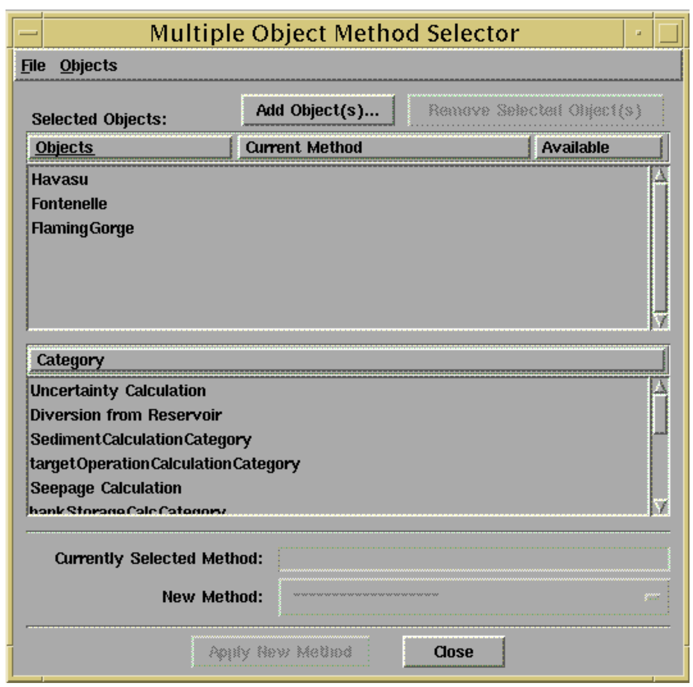
5. General RiverWare

A. Multi-Object Method Selector

Before the Multi-Object Method Selector dialog box was available, a user had to select engineering methods for each object individually, using the Open Object dialog for each separate object. If a new RiverWare release brought a new engineering method to the Slope Power Reservoir simulation object, for example, a user would have to select this new method on each Slope Power Reservoir object in an existing model. For large models, this could be a tedious and time-consuming task. The purpose of the Multi-Object Method Selector is to allow the user to set a current engineering method for a potentially large group of objects from a single dialog.

This task is complicated by the fact that all objects of the same type do not necessarily have the same engineering methods or method categories available. So, for example, it is not always possible for a user to select a given method on all Level Power Reservoirs. The currently selected engineering methods on an object determine the currently available methods and method categories.

To overcome these difficulties, this dialog indicates which objects have a given method category available and therefore which objects will need to be re-configured in order to make the given category available. The dialog similarly indicates which engineering methods are available on each object for a given category. Once an engineering category and method is selected, the dialog only changes the engineering method on objects which have the desired category and method available.



- Open the Multi-Object Method Selector from the main RiverWare menu: “Workspace” -> “Objects” -> “Select Methods on Objects...”

- Add objects to the object list by pressing “Add Objects...” then select objects in the object selector and press “Apply.”
- Select a category from the category list.
- Verify that the category is available on all desired objects by inspecting the “Current Method” column in the object list.
- Select a new method using the “New Method” option menu.
- Verify that the selected method is available on all desired objects by inspecting the “Available” column in the object list.
- Apply the new method to all the objects by pressing the “Apply New Method” button.
- Verify that the objects listed in the confirmation dialog are the objects you intend to affect, and press “OK.”

This is just a general description of how the dialog is used. If you need more detailed user instructions, contact CADASWES.

B. DMI Importing

Importing with New Start Date After Existing End Date

Prior to this release, if a DMI was importing data into a Series Slot, and the new Start Date for the slot was later than the existing End Date on the slot, the import would abort unless both a new Start Date and End Date were specified. In the RiverWare 4.1 release, it is only necessary to specify a new Start Date for the slot. When this happens, RiverWare moves the Start Date ahead to the new date and then resizes the slot based on the amount of data being imported.

Importing to Aggregate Series Slots

The DMI input files for Agg Series slots now allow comments. Anything following a # symbol will be treated a comment and ignored. Also, blank lines are now ignored. However, all other white space is significant. For example, if the Agg Series slot has 10 columns and the input is:

1 2 3 4 5 6 7
8 9 10

this will result in an error because the end of the line after 7 means that you are trying to enter 7 values for one timestep and 3 values for the next timestep. Each row must be complete and represent a single timestep. A blank line is ignored now as if it was not there. Before, a blank line meant that the last row had been entered.

C. Command Line Options

A new command line option was added. The --log option is used to write all console output to a file. This is useful when running RiverWare in batch mode because all diagnostic output is written to the terminal/console window in that case. All of the command line options are explained by typing riverware --help.

6. Simulation Objects

The following enhancements to the RiverWare^{tm} simulation objects are described briefly. The user is encouraged to consult the **Simulation Objects Documentation** in the online help for more detailed descriptions of the enhancements to the objects and their methods.

A. Data Objects Now Have Different Colors

A new enhancement to the Data Object allows the user to set the color of the object. The Data Object's color can be set by selecting Edit->Set Icon Color from the Open Object dialog.

B. Inline Power

The Inline Power object was enhanced to include the following general slots: Turbine Release, Max Turbine Release, Plant Capacity Fraction, Bypass, Min Bypass, and Hydro Capacity. The addition of the Max Turbine Release slot will cause existing models (that use the Inline Power object) to abort. A Max Turbine Release value must be input in order to fix the model. The user should be aware that the units for all of the new slots will be standard RiverWare units and users must configure them accordingly.

The Turbine Release, rather than the Inflow, is now used for the power calculation. The Plant Capacity Fraction is used when the plant is not operating at full capacity. The Bypass slot is set to a user input Min Bypass value plus the spill. A new dispatch method, solveMB_givenOutflow was added to allow the object to solve upstream. A new method category, called Solution Direction, was added to allow either upstream and downstream solving, or solving in the downstream direction only.

Also, methods for calculating spill cost and turbine ramping cost were included for use in optimization models.

C. Reach

Negative Outflow Warnings Removed

Prior to this release, if a reach object computed a negative outflow it would print a warning message to the diagnostics window. In Rulebased Simulation models, reaches often solve several times per timestep. While some of these solutions may result in a negative outflow, the final result is usually a positive outflow. This results in several warning messages that are insignificant because the final answer is not negative. Furthermore, these messages clutter the diagnostics window and are generally annoying. In RiverWare 4.1 these warning messages have been removed. Since most users ignored these messages for the reasons given above, this is generally not a problem. However, if some users were relying on these warning messages to catch modelling errors, they need to be aware of this change and find this information some other way.

GainLoss Methods with Time Lag Routing

Two of the GainLoss Calculation methods on the Reach object, Seasonal GainLoss Flow Table and Interpolated Flow GainLoss, are no longer valid methods when Time Lag Routing is the selected routing method on the reach. The reason for this change is that it is impossible to get the same answers solving upstream and downstream when using Time Lag Routing with one of these loss methods. Therefore, we disabled these two methods when Time Lag Routing is selected. If an existing model has a reach with both Time Lag Routing and one of the two loss methods mentioned above, RiverWare will give the following warning message when loading the model in the 4.1 release: “The <loss method name> method is no longer available when using timeLagRouting. You will need another reach to do the Gain Loss calculations. ...” If this happens, the GainLoss method on the reach in question will be changed to No GainLoss. You will need to create a separate reach object to do the Gain Loss calculations.

D. Reservoir

Plant Power Equation

A new method, Plant Power Equation, has been added to the Power Calculation Category. This method computes power based on the Water Power Equation:

$$Power = \frac{TurbineRelease \times H \times e \times PlantCapFraction}{UnitCompatibiltyFactor}$$

where power is the plant power, turbine release is the flow through the turbines, H is the net head across the turbines, e is the plant efficiency expressed as a decimal percentage, and the Power Plant Capacity Fraction is the fraction of full capacity at which the plant is operating.

Peak Power Equation

A new method, Peak Power Equation, has been added to the Power Calculation Category. This method computes power based on the Water Power Equation:

$$Power = \frac{PeakFlow \times H \times e \times PlantCapFraction}{UnitCompatibiltyFactor}$$

where power is the plant power, peak flow is the peaking flow rate through the turbines, H is the net head across the turbines, e is the plant efficiency expressed as a decimal percentage, and the Power Plant Capacity Fraction is the fraction of full capacity at which the plant is operating. Once the peak flow and the power have been determined, the method computes the peak time. This is the amount of time the turbines were running at peak power.

CurrentSurfaceAreaPanAndIce

A new evaporation method, called CurrentSurfaceAreaPanAndIce, has been added to all reservoir objects. This evaporation method is identical to the PanAndIceEvaporation method except that is uses the current surface area instead of the average surface area.

Input Bank Storage

A new method, Input Bank Storage, was added to the bankStorageCalcCategory on all reservoir objects. This method allows the user to input a time series range of bank storage values.

E. AggDistribution Canal Elements

Input Seepage

A new method, Input Seepage, was added to the Canal Seepage category on Distribution Canal Elements. This method allows the user to input the seepage losses from the canal elements.

7. Rulebased Simulation

A. New Palette Functions

Following is a brief description of the new rules palette functions (Predefined Functions) available for use in the RiverWare Policy Language for writing rules. Details on the use of these function and the syntax involved are available in the Rulebased Simulation documentation online.

HypLimitSim

This function is used to find the greatest control slot value which doesn't cause another specified slot to exceed a given value during a given time range. For example, this function could be used to find the constant outflow value, over some time period, that will keep the pool elevation from exceeding a given value. This function is similar to the HypTargetSim function except that instead of finding a control slot value that leads to the target slot value at a particular timestep, it finds a control slot value which leads to the limit slot value not exceeding a limiting value over a range of dates.

HypLimitSimWithStatus

This function is used to find the greatest control slot value which doesn't cause another specified slot to exceed a given value during a given time range. For example, this function could be used to find the constant outflow value, over some time period, that will keep the pool elevation from exceeding a given value. This function is similar to the HypTargetSim function except that instead of finding a control slot value that leads to the target slot value at a particular timestep, it finds a control slot value which leads to the limit slot value not exceeding a limiting value over a range of dates. This function returns a LIST. If a solution cannot be found with the given min and max values, it will return the closest answer it can find and a FALSE boolean value to let the user know that it failed. If the function succeeds it will return true.

Note: this function is very similar to HypLimitSim: the only difference is that HypLimitSim fails if it can not find a satisfying control slot value, whereas this function does not fail, rather it still returns a value, along with the indication that this value does not achieve the limit.

TargetHWGivenInflow and TargetSlopeHWGivenInflow

These functions are used to perform a lumped mass balance across several timesteps. Given a target range and the total inflows over the target range, it will compute the outflow required to meet the given target pool elevation at the target date. This is analagous to the target operation in Simulation. The TargetSlopeHWGivenInflow function needs to be used when performing a target operation on a Slope Power Reservoir.

Floor

This function takes a NUMERIC "value" and a NUMERIC "factor" as arguments. The "value" is converted into the units of "factor". Then the function returns the largest integer multiple of "factor" which is not greater than the converted "value".

Ceiling

This function takes a NUMERIC “value” and a NUMERIC “factor” as arguments. The “value” is converted into the units of “factor”. Then the function returns the smallest integer multiple of “factor” which is not less than the converted “value”.

Fraction

This function takes a NUMERIC “value” and a NUMERIC “factor” as arguments. The “value” is converted into the units of “factor”. Then the function returns the fractional portion of this converted “value” after is has been divided by “factor”.

GetSlot

Returns a slot given a STRING that represents a slot name.

GetElementName

Given an OBJECT which is an element in an aggregate object, this function returns the name of that element as a STRING and without the name of the aggregate object at the beginning.

IntDivision

This new predefined function replaces the DIV button on the rules palette. It returns the integer portion of the division of two numbers.

Modulus

This new predefined function replaces the MOD button on the rules palette. It returns the remainder of the integer division of two numbers.

NextDate

This function takes a partially specified date/time and a fully specified reference date. The function resolves the partially specified date/time into one that is fully specified. The specified fields of the partial date/time are copied into the return date, and the missing fields are filled in so that the resulting date is the closest date possible to the reference date. If the partial date cannot be resolved to the reference date, it is resolved into the next date in the future which works. For example, if the partially specified value is “May 10”, and the reference date is the current timestep, the function will return the fully specified date that corresponds to the next May 10th that occurs after the current timestep.

PreviousDate

This function takes a partially specified date/time and a fully specified reference date. The function resolves the partially specified date/time into one that is fully specified. The specified fields of the partial date/time are copied into the return date, and the missing fields are filled in so that the resulting date is the closest date possible to the reference date. If the partial date cannot be resolved to the reference date, it is resolved into the previous date in the past which works. For example, if the partially specified value is “May 10”, and the reference date is the current timestep, the function will return the fully specified date that corresponds to the previous May 10 that occurred before the current timestep.

AnnualEventStats, AnnualEventCount, and AnnualEventLastOccurance

Three functions were added which analyze a slot’s value over some number of years, noting the occurrence of certain "events". The functions all have the following set of arguments:
o SLOT slot
o DATETIME analysis period start date
o DATETIME analysis period end date
o DATETIME event period start date (year, if specified, is ignored)
o DATETIME event period end date (year, if specified, is ignored)
o NUMERIC value threshold
o BOOLEAN value threshold is upper bound (else lower bound)
o NUMERIC subevent count threshold
o BOOLEAN subevent count threshold is upper bound (else lower bound)

The analysis period start and end dates define the period during which the analysis will be performed. Within the analysis period, only the timesteps which occur on or between the day and month of the event period start and end dates are considered. Each of these periods within the analysis period is called an event period. At each event period, an event can either occur or not. An event is defined by the value threshold and comparison type and the subevent count threshold and comparison type. At each timestep within an event analysis period, the slot’s value is compared to the threshold value. If the value threshold is an upper bound and the slot’s value is greater than the value threshold, then a subevent is said to have occurred at that timestep; similarly, if the value comparison is a lower bound and the slot’s value is less than the value threshold, then a subevent is said to have occurred. After the subevents within an event analysis period have been noted, then they are counted up and compared to the subevent count threshold. If the subevent count threshold is an upper bound and the number of subevents which occurred in an event analysis period is greater than the subevent count threshold, then an event is said to have occurred, and similarly, if the subevent count comparison is a lower bound and the number of subevents which occurred in an event analysis period is less than the subevent count threshold, then an event is said to have occurred. For example, a user might define an event as outflows from a particular reservoir of greater than 10,000 cfs on five days between March 1 and July 31 of each year in the analysis period.

The three new functions are:

- LIST AnnualEventStats(...)
  The return list contains the following items (listed in order, with index):
  (0) the total number of event periods.
  (1) the number of events which occurred.
  (2) the number of event periods which occurred after the last event.
  If no events occurred, then this is the number of event periods.
- NUMERIC AnnualEventCount(...)
  The return value is the number of events which occurred.
- NUMERIC AnnualEventLastOccurrence(...)
  The return value is the number of event periods which occurred after the last event. If no events occurred, then this is the number of event periods.

TableInterpolation3D

A three column table interpolation function has been added to the list of pre-defined rules functions. If the user has a three column table that relates three different variables (for example, time of the year vs. flow rate vs. loss coefficient), the function will take values for two of the columns and will perform a three-dimensional, linear interpolation to find the corresponding value in the third column.

Sum

This function returns the sum of a LIST of NUMERIC values.

SumByIndex

Given a LIST of lists and an index, this function will sum the values at the given index in each list.

MaxItem and MinItem

These functions return the maximum/minimum number in a LIST of NUMERIC values.

DateMax and DateMin

These functions are passed in two DATETIME arguments. They return the greater/lesser date of the two.

LeapYear

This function returns true if the given date is a leap year.

GetDatesCentered

This function returns a LIST of dates, separated by a given interval, and centered at a given date. If desired, dates not within the run duration are filtered out.

IsEven

Returns true if the value is an even number

IsOdd

Returns true if the value is an odd number

GetNumbers

This function returns a sequence of values in a given range with a given offset.

GetTableRowValsSkipNaN and GetTableColumnValsSkipNaN

These functions are just like GetTableRowVals and GetTableColumnVals except that if a NaN is encountered, it is skipped and left out of the return list instead of causing the rule to terminate early.

B. New Palette Functions For Use With Accounting

WaterTypes

This function returns a list of the names of all user-defined Water Types defined in the model.

WaterOwners

This function returns a list of the names of all user-defined Water Owners defined in the model.

ReleaseTypes

This function returns a list of the names of all user-defined Release Types defined in the model.

Destinations

This function returns a list of the names of all user-defined Destination Types defined in the model.

ReleaseTypesFromObject

This function returns a list of unique names of ReleaseTypes of all Supplies which represent outflows from an Object.

DestinationsFromObjectReleaseType

This function returns a list of unique names of Destinations of all Supplies which are of the indicated Release Type (possibly “all” or “none”) and which represent outflows from the indicated Object.

AccountNamesByWaterType

This function returns a list of names of Accounts on the specified Object that are of the specified Water Type. The Water Owner Argument can be “none”.

AccountNamesByWaterOwner

This function returns a list of names of Accounts on the specified Object that are of the specified Water Owner. The Water Owner Argument can be “none”.

AccountNamesFromObjReleaseDestination

This function returns a list of names of Accounts on the specified Object that have Supplies which are of the indicated Release Type (possibly “all” or “none”) and Destination (possibly “all” or “none”) and which represent outflows from the indicated Object. Supplies which represent “internal flows” between two Accounts on the Object are not considered.

C. Functions Returning Supply Names

The first Argument of the following eight functions -- “SourceList” or “TargetList” -- is a list (ListValue) of {OBJECT, ACCOUNT NAME} pairs, each represented by a two-element ListValue. (The Account Name item is a StringValue). That is, the first Argument is a ListValue of constrained ListValues.

Values passed in for the second and third Arguments -- ReleaseTypeString and DestinationString -- can be “all” or “none.” (“None” corresponds to Supplies which have the default ReleaseType or default Destination).

There are two sets of functions in this section:

SupplyNamesFrom	SupplyNamesFrom1to1
SupplyNamesFromIntra	SupplyNamesFromIntra1to1
SupplyNamesTo	SupplyNamesTo1to1
SupplyNamesToIntra	SupplyNamesToIntra1to1

Each function in the first group returns a ListValue of SupplyNames (StringValues) corresponding to the {OBJECT, ACCOUNT NAME} pairs in the SourceList or TargetList argument.

The functions in the second group (whose names end in “1to1”) return an ordered ListValue of SupplyNames (StringValues) where exactly ONE SupplyName value corresponds to each of the {OBJECT, ACCOUNT NAME} pairs in the SourceList or TargetList argument. If there is no Supply that meets the criteria, an empty string (““) is returned to correspond to the Source/Target item. If there is MORE THAN ONE Supply that meets the criteria, a run-time error is reported.

SupplyNamesFrom

This function returns a ListValue of names of Supplies which represent outflows from the Objects, from the indicated Accounts. THIS function does NOT impose the restriction that zero or one Supplies matches the criteria for every item in the Source List.

(See general section comments, above).

SupplyNamesFromIntra

This function returns a ListValue of names of Supplies which represent internal flows on the Objects, from the indicated Accounts (to other Accounts on the same Object.) THIS function does NOT impose the restriction that zero or one Supplies matches the criteria for every item in the Source List.

(See general section comments, above.)

SupplyNamesTo

This function returns a ListValue of names of Supplies which represent inflows to the Objects, to the indicated Accounts. THIS function does NOT impose the restriction that zero or one Supplies matches the criteria for every item in the Target List.

(See general section comments, above.)

SupplyNamesToIntra

This function returns a ListValue of names of Supplies which represent internal flows on the Objects, to the indicated Accounts (from other Accounts on the same Object.) THIS function does NOT impose the restriction that zero or one Supplies matches the criteria for every item in the Target List.

(See general section comments, above.)

SupplyNamesFrom1to1

This function returns an ordered ListValue of names of Supplies which represent outflows from the Objects, from the indicated Accounts. EXACTLY one Supply Name (or "") is returned for each Account in the Source List.

(See general section comments, above).

SupplyNamesFromIntra1to1

This function returns an ordered ListValue of names of Supplies which represent internal flows on the Objects, from the indicated Accounts (to other Accounts on the same Object.) EXACTLY one Supply Name (or "") is returned for each Account in the Source List.

(See general section comments, above.)

SupplyNamesTo1to1

This function returns an ordered ListValue of names of Supplies which represent inflows to the Objects, to the indicated Accounts. EXACTLY one Supply Name (or "") is returned for each Account in the Target List.

(See general section comments, above.)

SupplyNamesToIntra1to1

This function returns an ordered ListValue of names of Supplies which represent internal flows on the Objects, to the indicated Accounts (from other Accounts on the same Object.) EXACTLY one Supply Name (or "") is returned for each Account in the Target List.

(See general section comments, above.)

D. New Palette Buttons

FIND

This is used to find the index of a given item in a list. If the item is not contained in the list, a “-1” is returned.

STOP_RUN

This new RPL operator takes any type of argument. When it is evaluated, it aborts the run with an error message which contains the argument as part of the message. For example:

```
WITH (index = FIND 100.0 WITHIN getOutflows()) DO
IF (index < 0)
STOP_RUN “Expected an Outflow of 100”
ELSE
index
ENDIF
ENDWITH
```

IF ... ELSE ...

An IF-THEN-ELSE button has been added to the rules palette. This simplifies the creation of IF-THEN-ELSE expressions. Prior to this release, users had to separately use the IF button and the ELSE button.

E. Changes to Existing Palette Functions

Log and Ln

The previous use of these to functions was error prone. Two calls to one these functions which are equivalent but in different units will give different results. Therefore it is necessary to include the unit type that should be used to perform this operation. The Log function now takes two arguments, both NUMERIC. The Log function takes the first argument, converts it into the units of the second argument, and then returns the base 10 logarithm of the converted value. The Ln function converts the first NUMERIC into the units of the second and then returns the natural logarithm of the converted value.

If these functions are used in existing rulesets, they will continue to be used in the old way and will be renamed OldLog and OldLn. We encourage users to updated their rulesets to use the new functions.

F. Single Object SubBasins for HypSim Functions

There are several rules predefined functions which simulate the behavior of a SubBasin of objects into the future without changing those objects (HypSim, HypTargetSim, HypTargetSimWithStatus, HypLimitSim, and HypLimitSimWithStatus). The first argument to all of these functions is a string, which has been interpreted as the name of the SubBasin on which to perform the hypothetical simulation. We have generalized these methods to also accept the name of an object as the first argument. If the first argument is not the name of a SubBasin but is the name of an object, then the hypothetical simulation is performed on just that object. This eliminates the need to make several single object subbasins.

G. Searching Within Rulesets and Policy Groups

RiverWare 4.1 has the ability to search for strings in the name, descriptions and definitions of groups, functions and rules. Users can access the search functionality through the "Find..." menu items in the Group and Ruleset editors.

H. Rearranging Rules Within the Group Editor

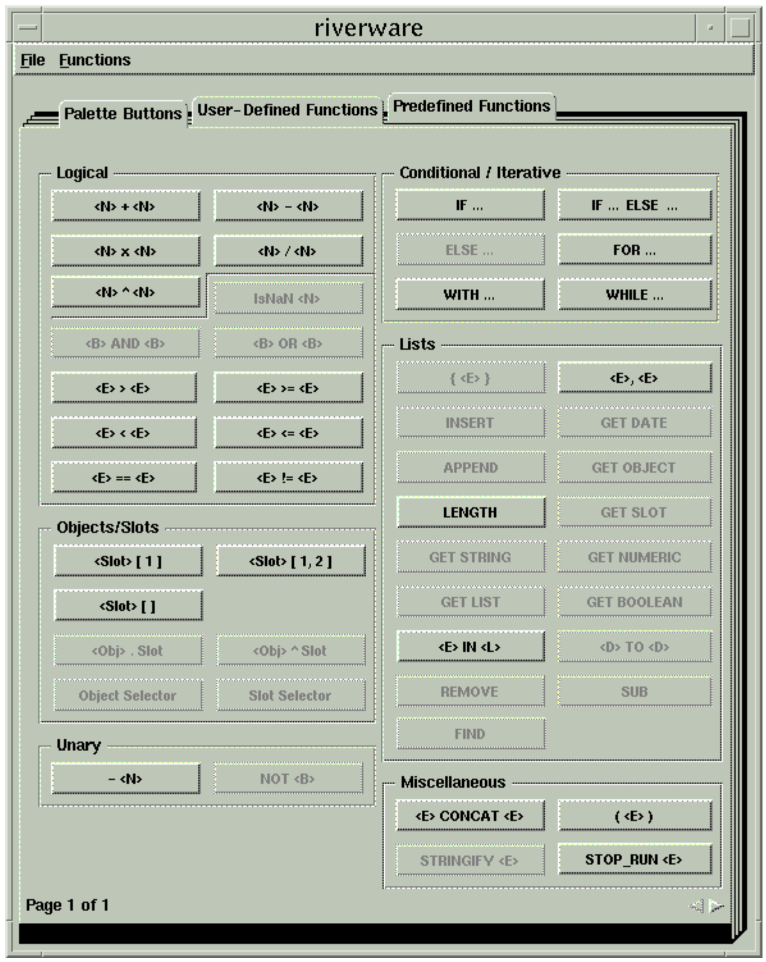
Rules can now be rearranged within the Policy Group Editor dialog. Previously, rules could only be rearranged through the main Ruleset Editor.

I. Compressing Rulesets

Rulesets are now able to be compressed and saved with the .gz file extension. If moving rulesets between UNIX and Windows, the ruleset files must be compressed.

J. Rules Palette Redesign

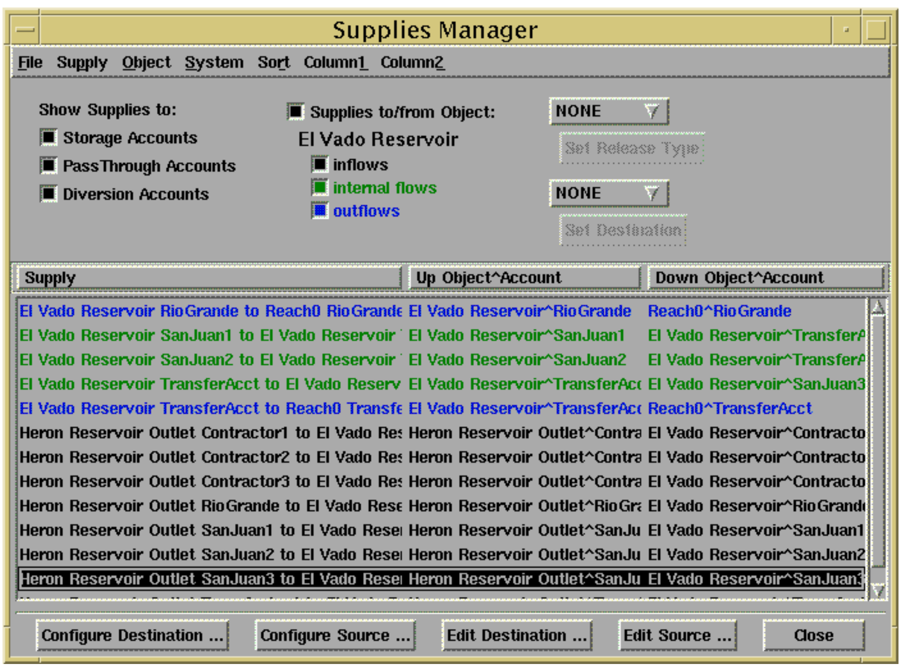
The rules palette has been re-designed for ease of use. Below is a screen shot of the new palette. The palette buttons are still located on the main palette view. However, now there are separate tabs for the rules functions. The first tab is the main palette view, the second tab is for User-Defined Functions (added to the ruleset by the user), and the third tab is for pre-defined functions in RiverWare. These are now grouped by type instead of listed in alphabetical order. The user can switch between the group view and the function view using the Functions menu. Also in the Functions menu is a search mechanism which will search for a string in a function's name, description, and/or definition.


riverware
File Functions
Palette Buttons
User-Defined Functions
Predefined Functions
Logical
<N> + <N>
<N> - <N>
<N> x <N>
<N> / <N>
<N> ^ <N>
IsNaN <N>
<B> AND <B>
<B> OR <B>
<E> > <E>
<E> >= <E>
<E> < <E>
<E> <= <E>
<E> == <E>
<E> != <E>
Objects/Slots
<Slot> [1]
<Slot> [1, 2]
<Slot> [ ]
<Obj> . Slot
<Obj> ^ Slot
Object Selector
Slot Selector
Unary
- <N>
NOT <B>
Conditional / Iterative
IF ...
IF ... ELSE ...
ELSE ...
FOR ...
WITH ...
WHILE ...
Lists
{ <E> }
<E>, <E>
INSERT
GET DATE
APPEND
GET OBJECT
LENGTH
GET SLOT
GET STRING
GET NUMERIC
GET LIST
GET BOOLEAN
<E> IN <L>
<D> TO <D>
REMOVE
SUB
FIND
Miscellaneous
<E> CONCAT <E>
(<E>)
STRINGIFY <E>
STOP_RUN <E>
Page 1 of 1

8. Water Accounting

A. Supplies Manager

The new Supplies Manager dialog box provides an overview of the accounting Supplies in a RiverWare model. This dialog box can be accessed by selecting Accounting->Supplies Manager from the main RiverWare menu. The user can limit the set of supplies displayed to those to particular types of accounts (storage, pass through, diversion), and to those that are related to a particular engineering object - that is, supplies that are inflows to the object, outflows from the object, and/or flows between different accounts on the object. Color annotation of supply data is used to indicate a certain supply configuration, error condition, and the relationship of supplies to a particular object. The information displayed about each supply, and the order of the supplies presented in this dialog box are configurable by the user. From the Supplies Manager, the user can delete supplies and open various dialog boxes about the two accounts connected by a supply or those accounts' respective engineering objects. For more information, or details on how to use this dialog, call CADSWES for help.

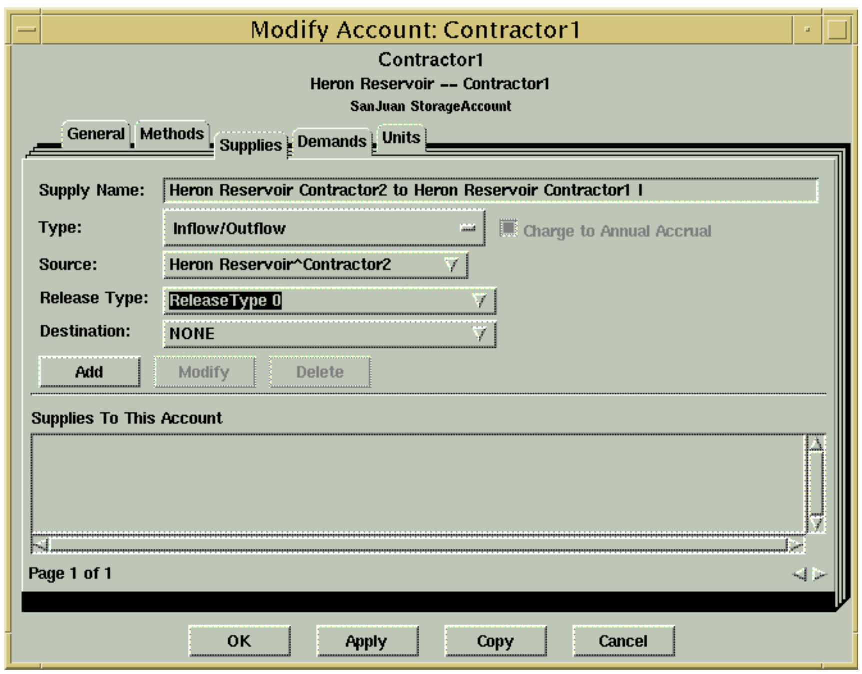


B. Transfer In and Transfer Out Slots

Two new slots, Transfer In and Transfer Out, were added to the Storage Account. These slots should be used for transfers that take place between accounts on the same reservoir. This allows the user to distinguish between outflows from accounts that are going downstream, and transfers that are staying in the reservoir but going to a different account.

C. New Supply Attributes: Release Type and Destination Type

Supplies can now be assigned a release type and a destination type. Basically, this is a way to group supplies together so they can be accessed easily by rules or viewed through the Supplies Manager. This is similar to labelling an account to have a specific water type and water owner (except this applies to supplies instead of accounts). In general, a release type represents the purpose for the release and the destination type represents the ultimate destination for the release from the account. By default, all supplies have a default of NONE for both the release type and the destination types. Release types and destination types are created, deleted, and added through the Water Accounting System Configuration Dialog. This dialog is accessed by selecting Accounting->Account System Configuration from the main RiverWare menu. Once supply types have been created, supplies can be assigned a type either through the Supplies Manager or the Supplies page of the Account Configuration Dialog (see below). If using the Supplies Manager to set supply types, the types must be displayed in Column1 and Column 2 of the dialog.



D. Accounts on Distribution Canals

The Distribution Canal object has been enhanced to allow Pass Through Accounts. The accounts function in the same manner as Pass Through Accounts on a Reach object.

E. GainLoss Specification on Pass Through Accounts

There are two ways to compute the GainLoss slot on Pass Through Accounts. One way is to specify a GainLoss coefficient on the account. This will compute GainLoss as a percentage of the inflow to the account. The other way is to set GainLoss directly using an object level accounting method. Prior to this release, the user could theoretically give a GainLoss coefficient and set the GainLoss slot with a method. Obviously this is an overdetermination. However, instead of giving an error, RiverWare just ignored the GainLoss coefficient. In the 4.1 release, this will result in an error. If this is happening, the user needs to either turn off the method, or remove the GainLoss coefficient.

F. Supply Slots in the SCT

Accounting supply slots can now be selected and used in the Simulation Control Table (SCT).

9. Optimization

- The Inline Power object has been enhanced. The enhancements have been motivated by the desire to model Ocoee2 at TVA as an Inline Power object. The main enhancements are to add a bypass slot and to allow optimization.
- The Constraint Editor has been enhanced to allow the user to close a goal or group by double-clicking on a constraint row under a goal or a group. In goal view, the user can double-click on the empty left-most column (open/close) or the fourth (goal-type) column to close the goal. In group view, the user must double-click on the left-most column (open/close) to close the group.
- The calculation of cumulative value of storage has been enhanced in two ways. First, flows in reaches that have not yet reached a reservoir by a given timestep are added to the reservoir storage to create a new slot, Anticipated Storage. The linearization of cumulative value is now done as a function of anticipated storage instead of storage. The second enhancement is to calculate the initial anticipated storage and the cumulative value of that anticipated storage. The suggested use of this initial value is to subtract it from the objective, e.g. " - Thermal Object.Total Cumulative Storage Value [0]". Thus, the new objective becomes Maximize avoided operating cost + NET increase in cumulative storage value. An attempt was made to include anticipated storage in the simulation calculations as well. This proved very difficult because of the interactions with object dispatching. This effort was abandoned, but the differences between optimization and simulation are very small. Still, the inclusion of these terms in optimization had a noticeable effect on flows during testing. In particular, flows at the end of the run were comparable to flows during the rest of the run, as desired.
- The automatic generation of a BWL point representing the initial conditions has been deactivated when the method generating "reducing" constraints is turned on; this point was interfering with the reducing constraints. The optimization now recognizes when lambda variables are implicitly fixed at zero, freezes appropriate variables and constraints, and passes the information to the OptAnalyst.
- The approximation error in spill constraints for level power reservoirs has been reduced by extrapolating spill tables in terms of storage rather than pool elevation.
- This release contains a large improvement in numerical stability. One fairly reliable measure of numerical stability is the condition number of the optimal basis. During a goal program there are a series of optimal bases and the condition numbers generally, if not monotonically, increase as optimization progresses. Prior to this work the condition number were roughly 1e+10 for one of the recent models with a long run time on "No Spill" constraints. After this work, the condition numbers are approximately 1e+6. While ILOG, the makers of CPLEX, suggests that ideally the condition numbers should be less than 10e+5, this improvement is still considerable.

  The improvement is due to several factors. The initial effort focused on revising the units used in formulating the problem for CPLEX, the so-called OPT_UNITS. In the literature this kind of work falls under the more general category of scaling matrices. While the importance of scaling is widely accepted and easily demonstrated with small matrices, optimal scaling of matrices remains more of an art form than a science. With that in mind, we followed the general guidance that numbers close to one are preferable, and choosing "natural" units is advisable. The last piece of advice had been previously confirmed when SI units proved numerically on small problems where TVA's user units worked fine. After trying several sets of units we converged on one set that we were unable to improve upon. Here is a sample of some of those units:
  Length: 10 m
  Area: 1e+7 m2
  Volume: 1e+8 m3

Flow: 1000 cms
Power: 1000 MW
Energy: 1000 MWH
Value: 1e+5 $

This task took somewhat longer than expected because, the optimization code had hidden assumptions about units in it. Those assumptions caused bugs, and they have been removed.

- Examining the optimization units led to several other enhancements that contributed to the reduction in the condition numbers. First, the precision of floating point numbers given to CPLEX has been made consistent. Second, an existing tolerance on minimum matrix coefficients has been used throughout optimization. Third, the Z variables introduced by RiverWare are now scaled based on the constraints of each priority. This last change required reworking the reporting of the satisfaction levels, and as part of that effort the satisfaction levels are now reported in terms of percentages, e.g. 100 means the constraints are fully satisfied.

The final optimization solution is checked for numerical instability based on 33 measurements. These measurements are compared against anticipated values and large differences are reported. The anticipated values will probably be refined as more models are run. The new tests added about 20 seconds to the runtime on a Sparc Ultra 5.

10. Closed Bug Reports

Bug Fixes

The following is a list of the bugs which were fixed for this release. If you wish to view the details for a specific bug, please browse to http://cadswes.colorado.edu/users/gnats-query.html and search our bug database. You will need a RiverWare user login and password.

14	22	172	173	182	183	189
214	220	231	235	239	240	241
242	298	306	322	383	499	514
592	691	738	797	807	833	896
942	1334	1521	1538	1839	1853	1966
2090	2101	2103	2104	2118	2132	2166
2183	2200	2228	2242	2304	2326	2364
2392	2427	2434	2469	2487	2528	2532
2535	2545	2589	2597	2626	2638	2656
2668	2728	2750	2777	2781	2806	2807
2828	2831	2833	2836	2837	2839	2840
2857	2871	2880	2890	2899	2900	2901
2902	2914	2917	2919	2949	2950	2955
2958	2959	2963	2965	2967	2969	2972
2974	2975	2976	2977	2978	2979	2980
2981	2982	2983	2984	2985	2986	2987
2988	2989	2990	2992	2993	2996	2997
2998	2999	3000	3001	3002	3003	3004
3006	3007	3008	3009	3010	3011	3012
3013	3014	3016	3017	3018	3019	3020
3021	3022	3023	3024	3025	3026	3027
3028	3029	3030	3031	3033	3034	3035
3036	3037	3038	3039	3040	3042	3043
3044	3045	3047	3048	3049	3051	3052
3053	3054	3055	3056	3058	3059	3060
3063	3065	3069	3070	3071		

Release Notes Version 4.2

1. Special Attention Notes

- If the text or graphics in this file are not clear, you may need to print this document. Resolution should improve on the printed page.
- RiverWare now uses new plotting for both the Windows and Solaris platforms. The plotting tool was developed at CADSWES using the new Qt GUI package. Detailed documentation of the new plot tool is included in the online help (not in this file). CADSWES is open to any suggestions or questions that you may have concerning the new plotting tool.

2. RiverWare for Windows 2000 and Windows XP

RiverWare is now available and supported for Windows 2000 and Windows XP (it will also run on NT but CADSWES is supporting Windows 2000 and XP). The user should be aware of the following differences that exist in RiverWare for Windows:

Differences in RiverWare for Windows

- Middle-mouse features such as QuickLink or rearranging the rows in the run analysis dialog are activated with the combination (pressed in this order): Alt + right mouse button + left mouse button. In Windows, the mouse configuration can also be changed so that middle mouse button actions are executed with the right mouse button (this would avoid the awkward sequence mentioned above).
- QuickLink can also be activated using the right-mouse button.
- The Windows DMI executable can be a DOS batch file or any other windows executable that can be run directly from a command shell.

Problems/Bugs in RiverWare for Windows

- The Locator View window often gets in a bad state when you resize the main workspace.
- It is possible that the objects may get shifted off the workspace if the workspace window is resized in certain ways. In order to make the objects visible again, you must save the model then reload it. Reloading the model will shift the model so that all objects are visible on the workspace.

Saving Model Files and Rulesets

- When saving model files or ruleset files that you intend to move between windows and unix systems, always save with the .gz extension. This saves the model/ruleset in a binary format that is the same on windows and unix.

New Plotting

- RiverWare now uses new plotting for both the Windows and Solaris platforms. The plotting tool was developed at CADSWES using the new Qt GUI package. Detailed documentation of the new plot tool is included in the online help (not in this file). CADSWES is open to any suggestions or questions that you may have concerning the new plotting tool.

3. General RiverWare

A. SCT

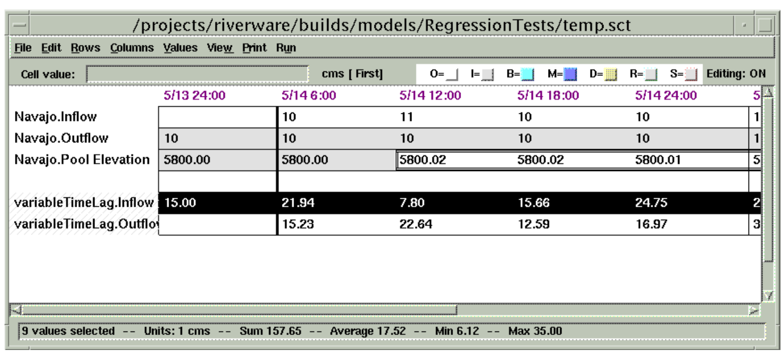
Enabling and Disabling Dispatching

Object dispatching can now be enabled or disabled directly from the SCT dialog. Previously, this could only be done through the Model Run Analysis dialog. To enable or disable dispatching, select a slot and select Rows ➥ Enable Dispatching or Rows ➥ Disable Dispatching. This will enable/disable dispatching for the object to which the selected slot belongs. When dispatching is disabled, the selected slot and all other slots on the object will have red cross-hatching over the name.

Slot Statistics

The SCT dialog now shows simple statistical calculations for a group of selected values. If the user highlights/selects a group of cells, the window at the bottom of the SCT will show the number of values selected, the units, sum, average, min and max (see dialog below for an example).

Note: to view the details of this screen shot, you may need to print this page

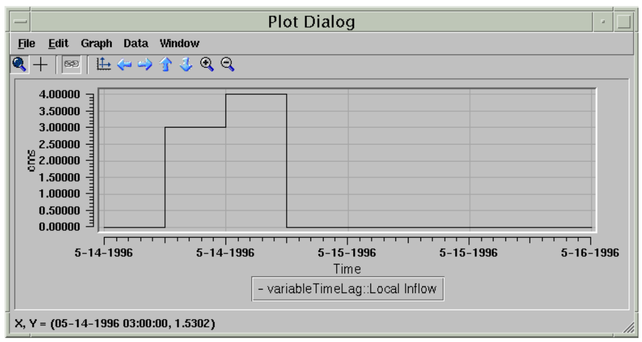


B. Qt Integration for Graphical User Interface

RiverWare is in the process of moving from Galaxy as the graphical user interface (GUI) to Qt. Qt is a more current and supported GUI that will allow RiverWare to move forward with user interface enhancements. In addition, it is a more stable, usable and better supported product (Galaxy really isn't supported at all anymore). Hopefully this transition will be relatively transparent to the user. However, new dialogs developed in Qt will have a slightly different look than the existing Galaxy dialogs. Two examples of this are the new Periodic Slot and Scalar Slot (discussed below). The overall plan is to develop new dialogs in Qt and move existing dialogs from Galaxy to Qt as the opportunities arise. The transition is expected to span a few years.

C. New Plot Dialog

RiverWare now uses new plotting for both the Windows and Solaris platforms. The plotting tool was developed at CADSWES using the new Qt GUI package. Detailed documentation of the new plot tool is included in the online help (not in this file). CADSWES is open to any suggestions or questions that you may have concerning the new plotting tool. Below is an example of the plotting dialog.



D. Periodic Slot

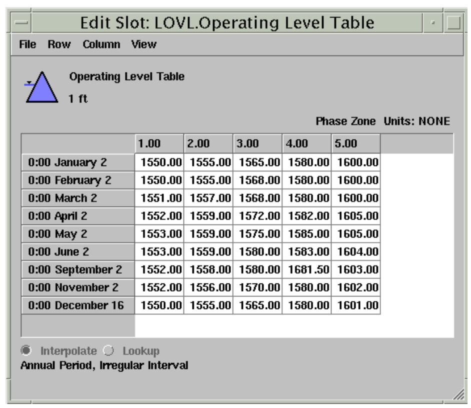
A new type of RiverWare slot has been added (to simulation objects as well as data objects) to represent periodic data. By periodic data, we mean a sequence of data which repeats at regular time intervals. An example might be a set of evaporation coefficients for a reservoir. The rate of evaporation varies with such factors as temperature and wind speed, factors which vary seasonally. It is natural to assume that this variation is the same for each year, leading to a data set such as the following:

	Evaporation Coefficient
January	1
February	3
March	6
April	15
May	28
June	26
July	20
August	11
September	5
October	9
November	11
December	6

Each value represents the evaporation coefficient which applies at any time in the given month. Thus if a computation of evaporation requires the evaporation coefficient for 10 a.m. May 16, 2002, its value would be 28.

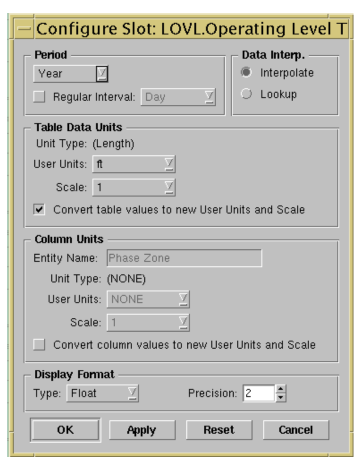
Prior to this release, RiverWare did not support natural entry of, or access to, this sort of data. If a method required a certain input value at each timestep, then these values must be put in a time series whose range is that of the run. Thus for the case of periodically repeating data, such as these evaporation coefficients, the user would have to repeatedly enter the same data, once for each year of the run. For a ten year run, the user must enter 120 values instead of 12. If the evaporation coefficient estimate changed for one month, the user would have to change 10 values instead of 1. Even worse, if the timestep were daily, the user would have to enter 3,660 values instead of 12.

However, with the introduction of the new Periodic Slot this process becomes much simpler. Below is an example of a new Periodic Slot called Operating Level Table.



	1.00	2.00	3.00	4.00	5.00
0:00 January 2	1550.00	1555.00	1565.00	1580.00	1600.00
0:00 February 2	1550.00	1555.00	1568.00	1580.00	1600.00
0:00 March 2	1551.00	1557.00	1568.00	1580.00	1600.00
0:00 April 2	1552.00	1559.00	1572.00	1582.00	1605.00
0:00 May 2	1553.00	1559.00	1575.00	1585.00	1605.00
0:00 June 2	1553.00	1559.00	1580.00	1583.00	1604.00
0:00 September 2	1552.00	1558.00	1580.00	1681.50	1603.00
0:00 November 2	1552.00	1556.00	1570.00	1580.00	1602.00
0:00 December 16	1550.00	1555.00	1565.00	1580.00	1601.00

In this example, the period identified by this slot is one year. This means that the data contained within this slot is repeated every year. Periodic slots are allowed to have periods of either one year, one month, one day, 12 hours, or 6 hours. The period is configurable by the user through the View ➥ Configure dialog:



In addition to identifying a period, the user can identify an interval for the data. The interval defines the data increment for the period. In the evaporation coefficient example above, the period is one year and the interval is one month. This means there is a data point for every month which is repeated every year. The valid intervals depend on the period selected. In general, they can vary from one hour to one month.

If the data interval is not a fixed interval, the Periodic Slot is said to have an irregular interval. This means that the period is not broken up into even intervals. This is controlled by de-selecting the Regular Interval checkbox in the configuration dialog. It the period does not have a regular interval, it is up to the user to create the intervals for the Periodic Slot. This is done by adding rows and then specifying dates for each row. The screen shot of the Operating Level Table above is an example of an irregular period.

Periodic Slots can have a single or multiple columns. The column headers can have units that represent some physical feature of the data. For example, in the evaporation coefficient table above, the evaporation coefficients may also depend on the pool elevation of the reservoir. If this were the case, the slot would be two-dimensional with dates for the rows and pool elevations for the columns, the table data (the evaporation coefficients) would exist in the body of the table. The user can configure the number of columns, the name of the columns, the values associated with each column, and the units associated with the column values.

Another configurable feature of the Periodic Slot is the method of data interpretation. When a Periodic Slot is accessed for a date that falls within a given interval (as opposed to exactly on the date which defines the interval) the slot can either perform a lookup or an interpolation. For the evaporation coefficient example above, if a computation of evaporation requires the evaporation coefficient for 10 a.m. May 16, 2002, its value would be 28 if the Periodic Slot were set for lookup mode. If however, the Period Slot were configured for interpolation, the evaporation value for 10 a.m. May 16, 2002 would be around 27 (approximately half way between the value of 28 given for May and 26 given for June).

Periodic slots may exist on simulation objects or the user may create them on data objects. If created on a data object, the Periodic Slot is fully configurable by the user. If however, the Periodic Slot exists on a specific object for a specific method, it may be pre-configured to for either regular/irregular interval or interpolate/lookup data interpretation. If pre-configured, these options may not be configurable by the user.

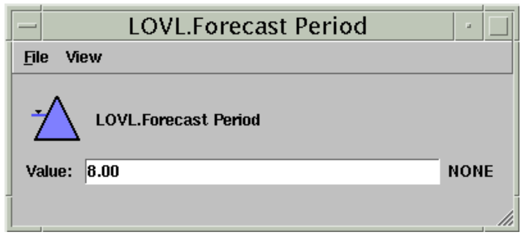
There are three ways of accessing the Periodic slot from the RiverWare Policy Language:

- `<object.slot> []`
  Accesses the given periodic slot at the current timestep, returns a numeric value.
- `<object.slot> [ <date/time expression> ]`
  Accesses the given periodic slot at the given timestep, returns a numeric value.
- `<object.slot> [ <date/time expression>, <numeric expression> ]`
  Accesses the given periodic slot at the given date and secondary dimension value, returns a numeric value.

Also, there are predefined functions that are design to perform certain operations on periodic slots (see the Rulebased Simulation online help).

E. Scalar Slot

A new type of RiverWare slot, the Scalar Slot, has been added to represent a single piece of numeric data. This is analagous to a 1-row, 1-column table. A screen shot of the new Scalar Slot is shown below.



4. Simulation Objects

The following enhancements to the RiverWare^{tm} simulation objects are described briefly. The user is encouraged to consult the **Simulation Objects Documentation** in the online help for more detailed descriptions of the enhancements to the objects and their methods.

A. Groundwater Storage Object

Current Storage Linear Flow

The Current Storage Linear Flow method calculates Outflow as a linear function of the Average Storage at the current timestep. This is similar to the previously existing Linear Flow method, except that outflow is based on the average storage over the current timestep as opposed to the instantaneous, beginning of timestep storage. Therefore, this method avoids the artificial one timestep lag caused by the Linear Flow method.

Lagged Linear Flow

The Lagged Linear Flow method calculates Outflow as a linear function of a previous (specified by a lag time), instantaneous storage value. This method is identical to the Linear Flow method except that the user controls which previous storage is used to calculate the current outflow. A user input lag time that represents an integer number of timesteps is used to specify the lag between storage and outflow.

Impulse Response Outflow

The Impulse Response method computes Outflow using a set of impulse response coefficients. The current outflow is a result of several previous inflows multiplied by their corresponding coefficients (where the number of previous inflows used is equal to the number of coefficients specified). This is analagous to the impulse response methods on the Reach and Water User objects.

Impulse Response Components

A new method category, Impulse Response Components, is available whenever the Impulse Response Outflow method is selected in the GW Outflow Calc category. The Multiple Response Components method in this category allows the user to track multiple responses to the inflow impulse. If using this method, and linking the response components, then the Outflow slot should not be linked to any object. This would be “creating” water because the response components are a subset of the total outflow. Likewise, it the Outflow slot is linked, then the response components should not be linked to any object that is not a data object.

Inflow from Groundwater Slot

A new slot called Inflow from Groundwater was added to the groundwater object. This slot is used to account for inflows to the groundwater object that may come from other linked groundwater objects. Water coming in through the Inflow from Groundwater slot will be included in the mass balance, but will not be considered when determining the Outflow using either the Impulse Response Outflow method or the Current Storage Linear Flow method.

B. Water User

Input Diversion Requests

Input Diversion Requests is a new method in the Diversion and Depletion Requests category. When Diversion Requested is input, Depletion Requested is calculated as the Diversion Requested multiplied by the Minimum Efficiency.

Input Depletion Requests

When this method is selected, and Depletion Requested is input by the user, Diversion Requested is computed as the Depletion Requested divided by the Minimum Efficiency. If the computed value is larger than the Max Flow Capacity, then Diversion Requested is reset to the Max Flow Capacity.

Pump Back Return Flows

Pump Back Return Flows is a method in the Return Flow Calc category on Water Users. This method is only available if the Impulse Response method is selected in the Return Flow Routing category. Return Flow is calculated as a function of diversion, consumptive use requirement, irrigated area, and incidental depletions. If there are pumped back flows, this water is added into the return flow and removed from the routed return flow. This is meant to model a physical system where return flows are pumped from a routed location, reapplied to an irrigated area, and then allowed to return again (after a specified depletion).

C. Reach Object

Time Lag Downstream Only Dispatch Method

A new dispatch method was added to the Reach object that forces the reach to always solve in a downstream direction when using time lag routing. This method is active only when the Local Inflow Downstream Only method is selected in the Local Inflow Solution Direction category. Previously, when time lag routing was selected, the reach would solve in either direction depending on whether or not it had an inflow or outflow value. This often resulted in unnecessary resolving. If users have models that use the time lag routing method, and the reaches are always solving in the downstream direction, it is recommended that they take advantage of this new dispatch method.

Leakage Slot Added

A new slot, Leakage, was added to the Seepage and Riparian CU Loss method. This method exists in the Seepage Calc category and is available only when No Routing is the routing method and Local Inflow Downstream Only is selected in the Local Inflow Solution Direction category. If Leakage is input or set by a rule, it is used in the seepage calculations. Otherwise, Leakage is calculated by the method as it was prior to this release.

D. Reservoir Objects

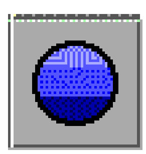
Surcharge Release Calculation Category

A new method category, called Surcharge Release Calculation, was added to the Storage Reservoir and Level Power Reservoir. The methods in this category are used to model the Kansas City and Southwest Division Army Corps of Engineers' algorithms for mandatory (surcharge) releases. If the reservoir's pool elevation exceeds the top of the flood pool, then the reservoir is in surcharge operations and must make releases to bring the reservoir back down to the flood pool. The computed surcharge releases are stored in the Surcharge Release slot and are included in the reservoir's outflow. These methods are still in the testing phase and should not be used by anyone except the Army Corps of Engineers. However, these methods were designed to be generic so in the future they can be used by anyone who needs to model surcharge releases.

Surcharge Release Flag

A Surcharge Release flag was added to the list of special flags that can bet set on a series slot. This flag can only be set on the Surcharge Release slot. When set, it will act as a known value (even though it will not really have a value before dispatching - this is similar to the Maximum Capacity flag) allowing the reservoir to dispatch with the solveMB_givenInflowSurchargeRelease dispatch method. The flag can either be set through the open slot dialog or by a rule (see the Rulebased Simulation section below for more information about setting flags with rules).

E. Control Point Object



A new object was added to the RiverWare Object Palette called the Control Point object. This object is used for the Flood Control methods that will be added to the new Computational Subbasin. These flood control methods have yet to be added to RiverWare. For now, the Control Point computes Outflow as the sum of Inflow and Local Inflow whenever Inflow is known.

F. Forecast Hydrology Methods

Several new methods were added to the Reach, Reservoir, and Control Point objects to compute inflow forecasts. These methods assume a period of perfect knowledge where the hydrologic/local inflows are equal to a known inflow value. After the period of perfect knowledge, the inflow values for the remaining timesteps in the forecast period are computed (based on the method selected). All of these method execute at the beginning of each controller timestep. That way, for each timestep there is an inflow forecast that extends out into the future. As the controller timesteps move forward, the forecast is always being updated.

Forecast Hydrology on Reservoir Objects

In order to enable the forecasting methods on reservoir objects, the Forecast Hydrologic Inflow method must be selected in the hydrologicInflowCalculationCategory. This causes the instantiation of a new method category called Generate Forecast Hydrology. There are four methods available in this category: No Forecast (this is the default method which does nothing), Geometric Recession, Exponential Recession, and Coefficient and Exponent Forecast Inflow. All of these methods are based on a period of perfect knowledge followed by a period of forecasting. The Geometric Recession method computes the forecasted flow as a fraction of the previous forecasted flow value. The Exponential Recession method computes the forecasted flow based on the first order, exponential decay equation. The Coefficient and Exponent Forecast Inflow method assumes a one timestep period of perfect knowledge. The remaining timesteps in the forecast period are computed using the current and previous known inflow values using the following formula (starting at i = 1):

$$LI_i = LI_{i-1} + LI_{i-1}\frac{(KI_i - KI_{i-1})}{KI_{i-1}}((C^i)^E)$$

where KI_i is the Known Inflow at timestep i, LI_i is the Local Inflow at timestep i, C is a coefficient and E is an exponent. The counter i represents the timestep beyond the current timestep. So, i = 1 is the current timestep + 1, i = 2 is the current timestep + 2, etc. The coefficient, C, and exponent, E, are the values in the Forecast Inflow Parameters slot.

Forecast Hydrology on Reach

On Reach objects, users can select the forecast hydrology methods through the Generate Local Inflows category. This category is only available when either Input Local Inflow or Local Inflow Downstream Only is selected in the Local Inflow Solution Direction category. There are four methods available in the Generated Local Inflows category: No Forecast Local Inflow (this is the default method which does nothing), Geometric Recession, Exponential Recession, and Coefficient and Exponent Forecast Inflow. These methods are analagous to the forecasting methods on the Reservoir object (see the above section for descriptions).

Forecast Hydrology on Control Point

On Control Point objects, the forecasting methods are accessed by selecting Forecast Local Inflows in the Local Inflow Calculation category. This adds the Generate Forecast Inflows category. There are three methods available in the Generated Forecast Inflows category: No Forecast Local Inflow (this is the default method which does nothing), Geometric Recession, and Exponential Recession. These methods are analagous to the forecasting methods on the Reservoir object (see the above section for descriptions).

5. Rulebased Simulation

A. New Palette Functions

Following is a brief description of the new rules palette functions (Predefined Functions) available for use in the RiverWare Policy Language for writing rules. Details on the use of these function and the syntax involved are available in the Rulebased Simulation documentation online.

SolveSlopeStorageGivenInflowHW

The SolveSlopeStorageGivenInflowHW function solves a Slope Power Reservoir when inflow and pool elevation are known. The function returns a LIST with two values: the resulting outflow and the resulting storage. This function works the same as the analagous dispatch method on the Slope Power Reservoir. Therefore, this function will return the same results for outflow and storage as if the object simulated/dispatched with the same inflow and pool elevation values.

SolveSlopeStorageGivenInflowOutflow

The SolveSlopeStorageGivenInflowOutflow function solves a Slope Power Reservoir when inflow and outflow are known. The function returns a LIST with two values: the resulting pool elevation and the resulting storage. This function works the same as the analagous dispatch method on the Slope Power Reservoir. Therefore, this function will return the same results for pool elevation and storage as if the object simulated/dispatched with the same inflow and outflow values.

GetColMapVal

This function is given a Periodic Slot, a date, and a value with the units of the Periodic Slot's data. It performs an inverse lookup to return the column map (secondary value) which corresponds to the given table value.

GetLinkedObj

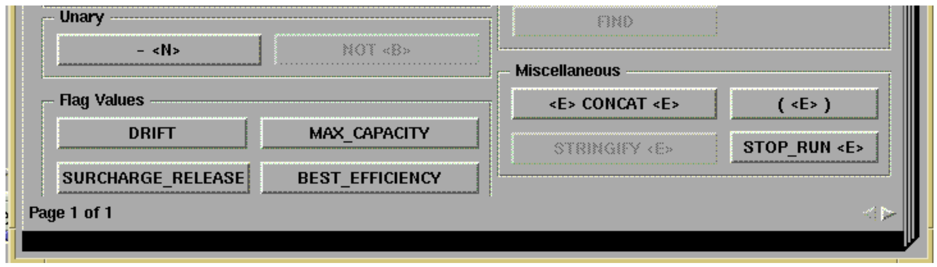
When given a SLOT, this function returns a LIST of the objects which contain the slots to which the given slot is linked. An empty LIST is returned if the slot is not linked to any other slots.

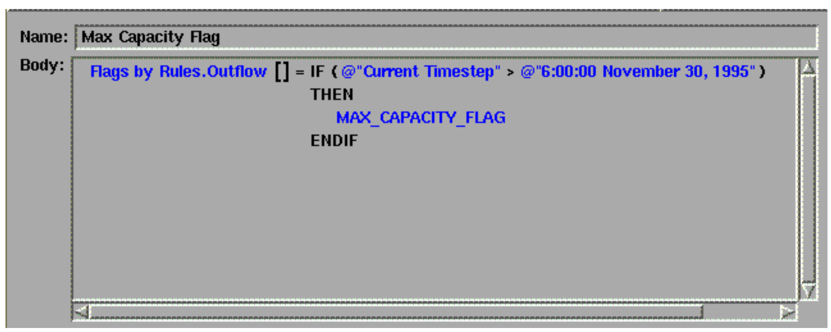
AccountNamesByAccountType

When given an OBJECT and a STRING representing an account type (one of “Storage”, “PassThrough”, “Diversion” or “ALL”), this function returns a LIST of the accounts of the indicated type on the given object.

B. Setting Flags with Rules

The RiverWare Policy Language has been enhanced to allow rules to set special flags on series slots. The only flags which may be set are those which have the semantics “considered known (when the object is selecting a dispatch method) but are actually computed by the object at dispatch time”. These include the Surcharge Release, Max Capacity (for both Outflow and Energy), Best Efficiency and Drift. Each flag now has its own palette button for rule building. Below is a screen shot of the flag value buttons at the lower left corner of the palette. Also an example of a rule that sets a flags is given.





C. Performance Improvement to Hypothetical Simulation Functions

We Improved the performance of RPL hypothetical simulation functions by limiting the amount of information which is copied from objects on the workspace to the clones of them which are used for hypothetical simulation. In the past, the hypothetical simulation functions made no assumptions about which data would be needed from the objects in the subbasin under consideration, so it was all copied over when these objects were cloned. This approach does not scale well as the number of timesteps in the run is increased. We now make an educated guess about which data will be used by the hypothetical simulation and only clone the relevant portion.

This enhancement should be a big improvement to models that use the hypothetical simulation functions and have a large number of timesteps. Since we are making an educated guess about how much information to copy to the clones, existing models could be affected if our guess is incorrect. Let CADSWES know as soon as possible if it seems like the hypothetical simulation functions were working correctly for previous releases but not for this release.

6. Accounting

A. Nambe Falls Loss Calculation

A new method, called Nambe Falls Loss Calculation, was added to the Storage Account Gain Loss category. This method is intended to replace the Nambe Falls portion of the Daily Program formerly used to model the upper Rio Grande system. This method is very specific and should only be used in the Rio Grande model.

B. Exporting Data from Object Account Summary Dialog

Export All Slots (Display Precision) and Export All Slots (Model Precision) operations are now available from the Object Account Summary dialog box "File" menu. The displayed slot sums (across the selected set of Accounts on a specific SimObj) are output to a text file: one column per Slot, one row per timestep. Also, comments appear at the beginning of the file indicating the Object Name, the number of Accounts represented in the sums, and information about the various Slots (one Slot per comment row) - including the Slot Name, Unit Type, and Units of the data used for that Slot. (The Unit Type and Units will depend on the user’s current setting for the Flow / Volume toggle in the Object Account Summary dialog box).

7. Optimization

- The optimization controller has been upgraded from using CPLEX version 6.6 to version 8.0. The new version of CPLEX requires that a different license manager be installed by optimization users. Some of the new functions in CPLEX replace code developed in the past by CADSWES. Now that the new version is in place, additional incremental improvements in the use of new CPLEX functions and a new C++ interface can be explored.

8. Bugs Fixed

The following is a list of the bugs which were fixed for this release. If you wish to view the details for a specific bug, please browse to http://cadswes.colorado.edu/users/gnats-query.html and search our bug database. You will need a RiverWare user login and password.

1480	1840	1877	1892	1903	1929	1983
2009	2036	2044	2059	2117	2126	2129
2152	2162	2169	2252	2264	2278	2339
2377	2398	2399	2411	2432	2433	2448
2468	2493	2558	2587	2613	2616	2623
2624	2644	2651	2658	2681	2688	2692
2701	2845	2891	2973	3057	3061	3073
3076	3079	3080	3081	3082	3084	3085
3086	3087	3088	3092	3093	3095	3098
3103	3104	3107	3109	3112	3113	3117
3118	3120	3121	3124	3126	3128	3129
3130	3131	3132	3134	3135	3136	3139
3140	3141	3143	3145	3146	3148	3149
3150	3151	3152	3154	3155	3158	3159
3160	3162	3163	3165	3166	3168	3169
3170	3171	3172	3173	3174	3175	3176
3177	3179	3180	3181	3182	3183	3184
3185	3186	3187	3188	3190	3192	3193
3194	3197	3198	3199	3200	3205	3207
3208	3209	3212	3213	3214	3220	3221
3223	3224					

Release Notes Version 4.3

1. Special Attention Notes

- If the text or graphics in this file are not clear, you may need to print this document. Resolution should improve on the printed page.

2. RiverWare for Windows 2000 and Windows XP

RiverWare is now available and supported for Windows 2000 and Windows XP (it will also run on NT but CADSWES is supporting Windows 2000 and XP). The user should be aware of the following differences that exist in RiverWare for Windows:

Differences in RiverWare for Windows

- Middle-mouse features such as QuickLink or rearranging the rows in the run analysis dialog are activated with the combination (pressed in this order): Alt + right mouse button + left mouse button. In Windows, the mouse configuration can also be changed so that middle mouse button actions are executed with the right mouse button (this would avoid the awkward sequence mentioned above).
- QuickLink can also be activated using the right-mouse button.
- The Windows DMI executable can be a DOS batch file or any other windows executable that can be run directly from a command shell.

Problems/Bugs in RiverWare for Windows

- The Locator View window often gets in a bad state when you resize the main workspace.
- It is possible that the objects may get shifted off the workspace if the workspace window is resized in certain ways. In order to make the objects visible again, you must save the model then reload it. Reloading the model will shift the model so that all objects are visible on the workspace.

Saving Model Files and Rulesets

- When saving model files or ruleset files that you intend to move between windows and unix systems, always save with the .gz extension. This saves the model/ruleset in a binary format that is the same on windows and unix.

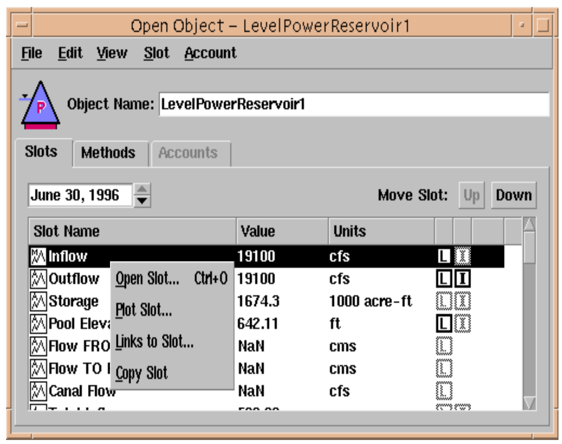
New Plotting

- RiverWare now uses the same integrated plotting tool for both the Windows and Solaris platforms. The plotting tool was developed at CADSWES using the new Qt GUI package. Detailed documentation of the new plot tool is included in the online help (not in this file). CADSWES is open to any suggestions or questions that you may have concerning the new plotting tool.

3. General RiverWare

A. New Open Object Dialog

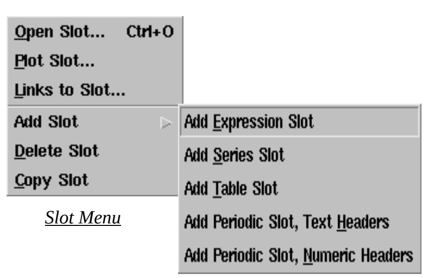
The Open Object dialog has been completely re-written using the Qt graphical user interface toolkit. The new dialog has a slightly different layout, but all previous functionality remains in nearly the same place as in the old dialog.



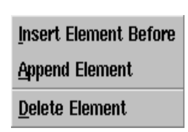
Note: The old Open Object dialog can still be accessed for this release by setting the environment variable RW_USEOLDOPENOBJECT. This should only be used as a temporary workaround as the old Open Object dialog will be permanently removed in an upcoming release.

In addition to numerous bug fixes from the old Open Object dialog, some of the new enhancements in the dialog include:

- Extensive use of right-mouse-button context menus. Many functions are now available both from the dialog menubar and from context menus. Most items in the lists - slots, accounts, and aggregate elements - have their own context menus that are activated by right-clicking on an item in the list.



Slot Menu

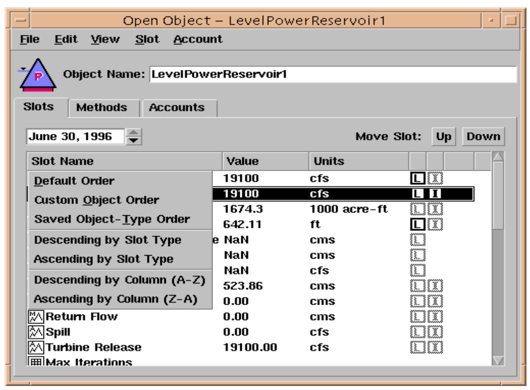


AggElement Menu

Account Menu

- Open and plot slots directly from the Engineering Methods view.

- Display slots for different controllers directly from the Open Object dialog without changing the controller in the Run Control Dialog. From the main dialog menubar select “View” ➥ “Show Slots for.”
- Reorder the slots in the “Engineering Slots” view. Slots can be ordered by selecting a slot and pressing the “Up” and “Down” buttons at the top of the slot list or, for non-aggregate objects, by clicking and dragging a slot within the list. The new custom slot order is automatically saved for the object. The slot order can also be saved to be applied to other objects of the same type by selecting “View” ➥ “Save Object-Type Slot Order.” All slot orders are saved in the model file.
- Sort the items in any of the lists - engineering slots, engineering methods, or accounts - by pressing a column in the header at the top of the listview. All lists can be sorted alphabetically ascending or descending by any column in the list. The engineering slots list can also be sorted by slot type, by the custom slot order for the specific object, or by the slot order saved for all objects of the given type.



- Aggregate objects now use the same Open Object dialog as non-aggregate objects.

B. Exporting a Slot Now Includes Comments

The text files generated when exporting a slot now include automatically generated comment lines (starting with "#"). These comment lines include the slot name and the scale and units of the data. Exported files for Table Slots and Agg Series Slots include one comment line for each slot column.

Note: The comment lines are intended for user convenience only. They are human readable only -- not "machine" readable. The exact format of these comment lines is not guaranteed, and could be changed in future releases.

C. Qt/Galaxy Integration (Solaris Only)

The background and foreground colors are controlled differently for Galaxy-based dialogs and Qt-based dialogs in RiverWare. Galaxy-based colors are controlled through the X-Windows manager. While Qt-based dialogs are controlled through the ’qtconfig’ application. A new environment variable, RW_SYNC_XRESOURCES, has been added to RiverWare. By setting this environment variable, Qt will query Galaxy and attempt to mimic the colors used by Galaxy. Galaxy dialogs often use a dithering algorithm, so colors may not match exactly.

4. Simulation Objects

The following enhancements to the RiverWare^{tm} simulation objects are described briefly. The user is encouraged to consult the **Simulation Objects Documentation** in the online help for more detailed descriptions of the enhancements to the objects and their methods.

A. Reach Object

Impulse Response Routing for Seepage

A new method that allows seepage to be routed using the Impulse Response method was added to the Reach object. The option to route seepage using this method becomes available when a seepage calculation method is chosen. Upon choosing to route seepage, the calculated seepage values (un-routed) are stored in the PreRouted Seepage slot. The routed values are stored in the Routed Seepage slot.

Known Inflow Slot Changed to Deterministic Local Inflow

The Known Inflow slot name on the Reach was changed to Deterministic Local Inflow to better reflect the true content of the slot. Existing models that use the Known Inflow slot will be automatically updated to the Deterministic Local Inflow slot the first time the model is saved.

B. Distribution Canal

Impulse Response Routing for Seepage

A new method that allows seepage to be routed using the Impulse Response method was added to the Distribution Canal. The option to route seepage using this method becomes available when a seepage calculation method is chosen. Upon choosing to route seepage, the calculated seepage values (un-routed) are stored in the PreRouted Seepage slot. The routed values are stored in the Routed Seepage slot.

C. Reservoir Objects

New Reservoir Convergence Algorithm

A new convergence algorithm based on the bisection method is now used on Reservoir objects. Previously, in the event that the getMaxOutflow, getMaxRelease, getMinSpillGivenInflowRelease and mass balance functions did not converge, the functions would enter a second convergence algorithm that would determine the intersection of the two curves under the assumption that the curves were straight lines. This approach proved to be problematic in instances when the two curves are, in fact, not straight lines. For example, when the pool elevation drops below the spillway crest during a timestep, the spill is simulated using a decay function which does not exhibit linear behavior. To aide this problem and others, the line intersection algorithm was replaced with a search algorithm based on the bisection method. The bisection method is an incremental search algorithm in which the interval is always divided in half. Using this method, the assumption that the curves are linear is eliminated. For a more detailed description of the bisection convergence algorithm, refer to the **Simulation Objects Documentation** in the online help.

Changes to the Use of Minimum Power Elevation

Previously, if the pool elevation dropped below the minimum power elevation during an iterative routine such as getMaxOutflowGivenInflow, the turbine release was set to zero. If the pool elevation rose above the minimum power elevation during the iteration, the turbine release was set according to the maximum release table. In the event that the pool elevation was near the minimum power elevation at the start of the function, this logic proved to be problematic because it introduced a discontinuity in the max release curve. For example, if the pool elevation was a tiny bit below the minimum power elevation, the release was zero. Yet, if the pool elevation in the next iteration was slightly above the minimum power elevation, the release could be set to some large value obtained from the maximum release table. In this situation convergence could not be obtained. To fix this convergence problem, it is now assumed that the turbine release is zero throughout the iterative function if the pool elevation at the previous timestep is less than the minimum power elevation. Similarly, it is assumed that a release is possible if the previous pool elevation is greater than the minimum power elevation even if the pool elevation during the function drops below the minimum power elevation.

NOTE: This change could significantly affect models that have reservoirs which operate close to the minimum power elevation. Neither the old nor the new approach represents physical reality, however, so a “real” fix to this problem is still needed.

Convergence of Mass Balance Solve Storage Near Zero

The mass balance of the Reservoir was not converging in specific cases when the storage value was very near zero. In RiverWare the massBalanceSolveStorage convergence routine looks for the intersection of the reservoir mass balance equation and some other equation such as max outflow. A problem was occurring when the intersection of the lines was very close to the storage = zero limit and the iteration loop required storage to go negative before converging. The mass balance routine now converges via one of two possible approaches.

The first approach uses the negative range in the search for storage. In this approach users must append an additional row to the Elevation Volume Table and define a negative storage value. This approach is quite effective for convergence purposes and also gives valuable information if the solution ends up being in the negative range. If the storage solution is negative, RiverWare notifies users that the outflow is too great to be physically possible. For diagnostics purposes, this method also provides users with a measure of exactly how short the storage is.

If users do not want to specify negative storage values and do not want to allow negative storage values in the solution, a second approach to convergence is employed. When users do not append the Elevation Volume Table with a negative storage value RiverWare does not allow the search algorithm to go into the negative range. Instead, the algorithm uses storage = 0 whenever it is in the negative storage range. If the outflow is really too great to be physically possible, then the algorithm will keep iterating until it reaches maximum iterations. If this happens, then RiverWare does a final mass balance check at the storage = 0 point and informs the user that the outflow is too great and the run stops.

Minimum Pool Elevation Warning

A warning was created on the Slope Power Reservoir to warn the user if the Pool Elevation slot was set to a value that is below the minimum pool elevation. If the dispatch method determines a pool elevation that is less than the minimum, the slot is first set to this value and then the warning is issued.

Max Release Warning

Within the Storage Reservoir, if an input Release value is greater than Max Release, a warning message is generated. The warning, “Input Release is greater than Max Release,” does not abort the run, however, users should check that input values are correct.

Known Inflow Slot Changed to Hydrologic Inflow

The Known Inflow slot name was changed to Hydrologic Inflow to better reflect the true content of the slot. Existing models that use the Known Inflow slot will be automatically updated to the Hydrologic Inflow slot the first time the model is saved.

D. Control Point Object

Regulation Discharge Category

A new method category called Regulation Discharge was added to the Control Point object. The methods in this category model the Southwest Division Army Corps of Engineers’ algorithms for calculating the maximum amount of flow that is allowed in the channel and the empty space available at the control point based on the state of the system. These methods are executed prior to flood control methods that can utilize the empty channel space. At the selection of any regulation discharge method, a method category for both Sag Operation and Regulation Recession appear. Selecting methods in these categories model additional algorithms that can alter the regulation discharge results. The regulation discharge methods are still in the testing phase and should not be used by anyone except the Army Corps of Engineers. However, they are designed to be generic so in the future they can be used by anyone who needs to model regulation discharge.

Known Inflow Slot Changed to Deterministic Local Inflow

The Known Inflow slot name was changed to Deterministic Local Inflow to better reflect the true content of the slot. Existing models that use the Known Inflow slot will be automatically updated to the Deterministic Local Inflow slot the first time the model is saved.

5. Rulebased Simulation

A. Performance Improvements

The performance of models using RPL sets (rule based simulations and some accounting simulations) has been improved. Briefly, the changes responsible for the improvements were:

- RiverWare now caches a reference to the function accessed by each function call, saving the time required to look up the function by name.
- Some function argument error checking in done only once at the beginning of a run instead of every time the function call is evaluated.
- When diagnostics are disabled, we more thoroughly avoid spending time processing certain rule diagnostics.
- Symbols (references to variables and functions) are managed more efficiently during validation and execution.

On several large benchmark models these changes improved the overall runtime by an average of greater than 30%.

B. New Palette Expression

Following is a brief description of a new rules palette expression available for use in the RiverWare Policy Language for writing rules.

MAP LIST

The `MAP LIST` expression. This expression can replace the `FOR` expression in some situations and is typically much more efficient. In particular, the following pattern involving a `FOR` expression:

```
FOR ( <type/name pair> IN <list expression> )
WITH LIST result = { } DO
       APPEND <expression not involving result> ONTO result
ENDFOR
```

may be replaced with the following pattern involving a `MAP LIST` expression:

```
MAPLIST ( <type/name pair> IN <list expression> ) DO
       <expression not involving result>

ENDMAPLIST
```

Example:

```
MAPLIST ( NUMERIC x IN {1, 2} ) DO
       x + 10

ENDMAPLIST
```

Evaluates to the list:

```
{ 11, 12 }
```

C. New Palette Functions

Following is a brief description of the new rules palette functions (Predefined Functions) available for use in the RiverWare Policy Language for writing rules. Details on the use of these functions and the syntax involved are available in the Rulebased Simulation documentation in the online help.

RowLabel, ColumnLabel

The RowLabel and ColumnLabel functions get the label associated with the row or column of a table slot.

AccountNamesFromObjReleaseDestinationIntra

The AccountNamesFromObjReleaseDestinationIntra function is the same as AccountNamesFromObjReleaseDestination function except that it only looks at transfer supplies, as opposed to outflow supplies.

DatesInPeriod

Given a periodic slot and a date, the DatesInPeriod function returns an ordered list of dates representing the beginning time of each interval which begins in the specific period containing the input (reference) date.

Every periodic slot has a period associated with it, and this period is divided into intervals. Intervals are either regular (e.g., Days) or irregular (e.g., 8:00 July 3). One can map a period (divided into intervals) onto a timeline, leading to several specific periods (divided into specific intervals). For example, the period "Year" maps onto specific periods corresponding to each year, such as the specific period which is the year 2003.

Providing a reference date serves to indicate a specific period, and this function returns the dates corresponding to the beginning of each time interval which begins in that specific period.

Split

The Split function takes two strings as argument, a primary and separator string, and returns a list of strings formed by representing the substrings of the primary string which are separated by the separator string. This function is case sensitive.

Exp

The Exp function takes two numeric arguments, an operand and an exponent, and returns the result of exponentiating the operand to the power given by the exponent. The return value is dimensionless (has no units).

The exponent is not restricted to being an integer (as with the "^" operator), but it is an error for the operand to have units.

SumSlotSkipNaN, SumFlowsToVolumeSkipNaN

The SumSlotSkipNaN and SumFlowsToVolumeSkipNaN are variations of the SumSlot and SumFlowsToVolume which treat NaN's as zeroes.

FlattenList

The FlattenList function takes a list and replaces any lists contained within that list with the individual items in those lists.

ToCelsius, ToFahrenheit, ToKelvin

The ToCelsius, ToFahrenheit, and ToKelvin functions convert a value in one temperature scale to another scale.

D. Changes to Temperature Units

The RplUnit temperature dimension has been expanded to three dimensions, corresponding to the following three temperature scales: Kelvin, Celsius, and Fahrenheit. Up until now we had a single temperature dimension, but this was not adequate for representing units such as "m/F". However, more work remains to be done to fully support operations involving temperature. In particular, we need to provide a more convenient mechanism for allowing users to guarantee that values read from the workspace have units with a particular scale.

E. New Rulebased Simulation Diagnostics Settings Categories

Hypothetical Simulation

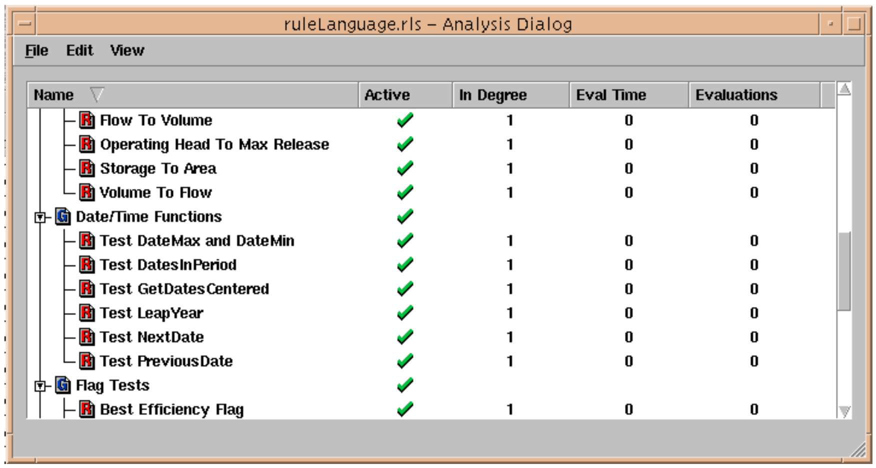
A new diagnostics category “Hypothetical Simulation” has been created to issue informative diagnostics during the execution of a RPL hypothetical simulation function. The category can be toggled on within the Rulebased Simulation Diagnostics Settings dialog box. Diagnostic messages are posted during the execution of any one of the five hypothetical simulation function methods. Among other messages, the diagnostics indicate the range over which a hypothetical simulation is occurring. All Hypothetical Simulation diagnostics messages are prepended with the string “HypSim”.

Function Execution

A new function diagnostics category, Function Execution, has been added to the Rulebased Simulation Diagnostic Settings. This diagnostic category allows function diagnostics to be toggled on and off independent of rule execution diagnostics.

F. Rules Analysis List Dialog

A Rules Analysis dialog was added to RiverWare. The analysis dialog provides a list of Rpl objects (Rules, Functions, Groups) of ruleset and provides a mechanism to view various characteristics of those Rpl Objects. For example, the analysis dialog can be used to examine static features like the orphaned functions of a ruleset. The analysis dialog can also be used examine dynamic features like the evaluation time of the each Rpl object.



Rules Performance Analysis

The ability to instrument the evaluation time of functions and rules has been added to Rulebased Simulation. By selecting the "Enable Rules Performance Analysis" toggle in the Simulation Run Parameters dialog, which accessed through the Run Control dialog, the rule-based evaluation instrumentation is enabled. This instrumentation will track the CPU time spent during evaluation/ execution and number of evaluations of each function and rule. This instrumentation itself does consume CPU time, so it should only be used for debugging purposes. The results of instrumentation can be viewed in the new Rules Analysis List dialog.

G. Function Diagnostics Menu Items

New menu options have been added to the Ruleset Editor and the Group Editor to enable/disable pre/ post diagnostics in all functions in the ruleset/group.

6. Accounting

A. Plotting Account Slots

Users can now plot accounting slots from the Edit Account dialog box by selecting a slot display column (by clicking the column header or any cell value) and selecting the "File >> Plot Slot..." menu operation. This brings up a plot dialog box. The user can plot many individual slots from a single account.

B. Plotting from Object Account Summary

Users can now plot series data from the Object Account Summary dialog box. The data shown in that dialog box represents the sum of analogous slots across a set of Accounts on a single Engineering Object, with one slot type per display column. A plot for one Slot type is generated by selecting its display column (by clicking the column header or any cell value) and selecting the "File >> Plot Slot ..." menu operation. This brings up a Plot dialog box.

Only a single static plot can be generated for each Object Account Summary Dialog Box (i.e. one such plot for each Engineering Object). The plot is not updated when any of the Account Slot data which contributed to the sum changes. Performing a subsequent plot operation from the Object Account Summary dialog box replaces the previously generated plot.

7. Optimization

A. New Warning

A new warning has been added to insure that the first approximation point of a spill upper bound approximation is less than the initial value of elevation or storage (depending on which is used in the linearization). Previously, cases that would generate this warning would lead to an infeasible linear program.

B. Conditional Constraints

Each constraint can now have conditions added to it by selecting a button in the constraint editor. The default is that no conditions are placed. The button options are no conditions, a condition expression, a time condition, or both. Both of these conditions appear as separate lines below the constraint.

The time condition specifies a range of valid model start times for the constraint in question to be valid. The range is specified as a pair of month/day entries. For example, a constraint used in the winter might have a time condition like "Nov 5 <= run start time <= Feb 15". These dates are editable.

The condition expression is built up from the expression editor. It should evaluate to true or false based on conditions known at the beginning of the run. The expressions use any of the following operators: <=, >=, =, <, or >. The left and/or right side of these expressions are linear expressions that would typically reference slots. Multiple conditions can be created by using the newly created “AND” and "OR" operators. As with other expressions, the expression editor will allow nonsensical expressions to be entered and the user has the responsibility of entering a reasonable expression. The new operators can in theory be used in formulating constraints and objectives as well, but there doesn’t seem to be any immediate practical benefit of doing so.

An example of a condition expression is:

“(((Boone.Pool Elevation[0] > 1600 "ft") OR (South Holston.Pool Elevation[-1] >

1700 "ft")) AND (AVG i FROM -4 TO -1, Watauga.Outflow[i] <= 100 "cfs"))”

C. Performance Improvement and Numerical Stability

Several technical changes were made to improve performance. The details are as follows.

- Variables with redundant bounds were changed to infinite bounds to reduce unnecessary pivoting.
- The upper bounds on variables were changed to use optimization units instead of internal units to prevent "infinite" bounds (by CPLEX’s definition) from being translated to finite bounds.
- The setting of the algorithm was moved so that either a primal or dual algorithm can be used to solve a linear program. The algorithm selected is based on the type of goal.

- A new capability was added to detect slow progress in the LP and trigger both a fresh "presolve" and a restart with a fresh basis.
- A new and more efficient CPLEX function, CPXtightenbds, was used to instead of CPXchgbds where ever possible.
- Several CPLEX parameters were adjusted to improve performance based on conversion to CPLEX 8.0 and changes in TVA's problems.
- Frequently, when RiverWare is generating internal variable names for CPLEX non-slot variables, the name is similar to the previous variable; code was added to retain the last name generated and to reuse it when possible.

Numerical stability was dramatically improved by keeping floating point numbers stored as doubles throughout optimization. Previously, some numbers were converted to text during formulation of the optimization problem.

Instead of adding constraints with a single variable, the bounds on that variable are adjusted, thus reducing the size of the linear program.

Diagnostic capability was enhanced by adding dumpSAV, dumpBAS, and dumpPRE functions. These functions generate respectively a binary CPLEX problem and basis file, a text basis file, and a presolve file.

8. Bugs Fixed

The following is a list of the bugs which were fixed for this release. If you wish to view the details for a specific bug, please browse to http://cadswes.colorado.edu/users/gnats-query.html and search our bug database. You will need a RiverWare user login and password.

2402	2494	2607	3094	3096	3097	3099
3101	3102	3110	3119	3122	3123	3137
3138	3142	3147	3153	3178	3211	3215
3217	3219	3226	3230	3234	3235	3236
3237	3238	3239	3240	3241	3242	3243
3244	3246	3249	3250	3251	3253	3254
3255	3256	3257	3258	3259	3260	3262
3263	3264	3265	3267	3268	3269	3271
3272	3273	3276	3278	3279	3280	3282
3283	3284	3285	3286	3288	3290	3292
3293	3294					

Release Notes Version 4.4

1. Special Attention Notes

- If the text or graphics in this file are not clear, you may need to print this document. Resolution should improve on the printed page.
- New basin-scale flood control algorithms have been implemented in RiverWare. These algorithms are described in the **Flood Control** section of these release notes as well as in the online help.
- RiverWare's DMI has been significantly enhanced-- both in its functionality and in its ease of use. A brief description of these enhancements is provided later in these release notes. Users are encouraged to read the **DMI Documentation** in the online help for a more detailed description of the new DMI.
- The SCT has been re-implemented and enhanced. A brief overview of the new features and functionality are provided in these release notes. Users are encouraged to read the **SCT Documentation** in the online help for full detail.
- On the Water User, the Application Efficiency slot for the Pump Back Return Flow methods was changed from a series slot to a scalar slot. Any data previously in the Application Efficiency slot will be lost when users open and save their models in RiverWare 4.4. Users will need to re-enter a single efficiency value into the Application Efficiency slot.
- There has been a change to the lookup date on periodic slots with irregular intervals. If a lookup is done on the Periodic Slot for a date which falls exactly on an irregular interval boundary, RiverWare now always returns the lookup for the prior interval. This change could break existing rulesets. References to periodic slots at "date -1" might need to be replaced with the more natural "date".
- Many RiverWare Solaris users have reported problems using the numeric keypad (on the right side of the keyboard). The problem on Solaris is that the key mapping used for Solaris/X11 keyboards confuses Riverware's GUI toolkits (and those in other applications). The solution is to change the mapping of the numeric keypad keys to conform to a setup that Riverware can understand. Instructions and a script file are available on our web site, under the RiverWare user pages:

  http://cadswes.colorado.edu/sponsors/

  Log in to the RiverWare Sponsor and User pages. Scroll down to the RiverWare User Information section and click on "RiverWare Application Notes". Click on "Numeric Keypad Fix for Solaris" and follow the instructions.

  NOTE: This is NOT a problem on Windows. Windows users should ignore this fix.
- A new power method, Plant Efficiency Curve method, has been added to Power Reservoirs. This method is similar to the Plant Power Calc method, except that it uses one table, Plant Power Table, instead of the four tables used by the Plant Power Calc method (Best Turbine Q, Max Turbine Q, Best Power Coefficients, and Max Power Coefficients). This allows the user to put in several efficiency points instead of just two (the best and max). The Plant Power Table is a 3-D table that

relates operating head, turbine release, and power. The Plant Power Table is used to automatically generate the max and best turbine Q tables (called auto best and auto max turbine Q for this method). The Plant Power Table replaces the Power Linearization Table used in Optimization. All existing models using the Power Linearization Table will be updated automatically to change the name of the Power Linearization Table to Plant Power Table. Users should be aware that data must be entered into the table in increasing, concave blocks of the same operating head for the 3-dimensional table interpolation to work correctly. It is possible that the new concavity check may catch mistakes in the data (that the old Power Linearization Table ignored), thus causing the run to abort. Data may need to be updated to fix any non-concavity issues. See the documentation in the online help for more information on this method and the formulation of the table.

- A new predefined rules function, FloodControl, has been added to RPL. Some users' rulesets may already have a user defined function with this same name. Though the ruleset may open, it will not load or validate. An error will be posted to notify users that the name FloodControl is not unique. Users will have to edit their ruleset to change the name of their user defined FloodControl function to some other name.
- When validating a ruleset, RiverWare now issues diagnostics about all the errors encountered all at one time. This change was necessary to check whether two functions with the same name (e.g., FloodControl) were included in the ruleset. Users may see more errors at one time than they are used to seeing.
- Users of the ResetRanDev predefined function should be aware of recent performance enhancements that do not execute RPL print statements and send them to the diagnostic output unless Diagnostics are turned on. Some users' rulesets execute the ResetRanDev function through a print statement. ResetRanDev should now always be called from a function with arguments, not from a print statement. E.g.,

```
object.slot[]=IF(NOT ResetRanDev (...))
                STOP_RUN "ResetRanDev Failed"
                ENDIF
```

  This will never assign any values, but will always evaluate the function call.
  Refer to the ResetRanDev function in the **Rulebased Simulation Documentation** in the online help for more information.

2. RiverWare for Windows 2000 and Windows XP

RiverWare is available and supported for Windows 2000 and Windows XP (it will also run on NT but CADSWES is supporting Windows 2000 and XP). The user should be aware of the following differences that exist in RiverWare for Windows:

Differences in RiverWare for Windows

- Middle-mouse features such as QuickLink or rearranging the rows in the run analysis dialog are activated with the combination (pressed in this order): Alt + right mouse button + left mouse button. In Windows, the mouse configuration can also be changed so that middle mouse button actions are executed with the right mouse button (this would avoid the awkward sequence mentioned above).
- QuickLink can also be activated using the right-mouse button.
- The Windows DMI executable can be a DOS batch file or any other windows executable that can be run directly from a command shell.

Problems/Bugs in RiverWare for Windows

- The Locator View window often gets in a bad state when you resize the main workspace.
- It is possible that the objects may get shifted off the workspace if the workspace window is resized in certain ways. In order to make the objects visible again, you must save the model then reload it. Reloading the model will shift the model so that all objects are visible on the workspace.

Saving Model Files and Rulesets

- When saving model files or ruleset files that you intend to move between windows and unix systems, always save with the .gz extension. This saves the model/ruleset in a binary format that is the same on windows and unix.

3. General RiverWare

A. DMI

Significant enhancements have been made to RiverWare's Data Management Interface (DMI). New functionality includes the ability to import data in the middle of a timeseries and the ability to put multiple data files in the control file. Also, users can now invoke a group of DMIs all at once with the new DMI Group feature. With the enhanced DMI, users still create their individual executables and control files, however, this process has been made easier through a new graphical user interface. The graphical user interface makes the creation of user key words much more intuitive.

The user is encouraged to consult the **DMI Documentation** in the online help for a more detailed description of the functionality and use of the DMI.

B. SCT

The System Control Table (SCT) has been enhanced and re-implemented in the Qt graphical user interface (GUI). The new SCT Configuration dialog box adds ease to and extends the capabilities of configuring the SCT. For example, users can now reverse the axis orientation of the SCT so that run timesteps are viewed either vertically (in rows) or horizontally (in columns), depending on user preference. It is also now much easier to configure the time aggregation of slots. The user is encouraged to consult the **SCT Documentation** in the online help for a more detailed description of the SCT and other new functionality.

When loading an existing SCT, users are now prompted to either migrate and work with the SCT in the new QT GUI format (... 2.0) or continue with the old-style format (... 1.0). Users should note that the SCT is not backwards compatible-- once a SCT is saved in the 2.0 version, it cannot be opened again in the 1.0 version. Future RiverWare releases may not support the old SCT.

C. Computational Subbasin

A new subbasin type, the Computational Subbasin, has been added to RiverWare. The Computational Subbasin supports computations that involve more than one object, so-called "global" solutions, though they need not encompass the entire network. A Computational Subbasin is created through the same dialogs as other typed subbasins, but it, like simulation objects, contains slots and other attributes that you can inspect and change, by "opening" the subbasin. It contains no general slots; all slots are dependent on user-selectable methods. The Computational Subbasin is instrumental to the new flood control algorithms recently implemented in RiverWare. See the **Flood Control** section below for more details.

D. Optional Elimination of Comment Lines in Exported Slots

It is now possible for users to eliminate the comment lines that are automatically generated when exporting a slot. These comment lines start with a '#' and include the slot name and the scale and units of the data. This caused problems for some users' post-processing tools. To disable comment generation in Solaris, use the 'setenv' command to define the following environment variable:

setenv OLD_4P2_EXPORT_COMMENT_STYLE 1

E. Open Object Dialog

Slot Reordering

Whenever users re-order slots in the Open Object Dialog, this ordering is automatically saved when the model is saved. Now every time a model is loaded the Open Object Dialog will display the most recent slot ordering. Users can still toggle between the object's "Custom" slot ordering, the "Saved Object-Type" slot ordering, and the "Default" RiverWare slot ordering by pressing a column header at the top of the list view.

F. Plotting

Plotting Keyboard Accelerator

A keyboard accelerator has been added to plot slots from the Open Object Dialog. Highlight the desired slot and then press:

Ctrl+P

Plotting Contour Curves

RiverWare now has the capability to plot three-dimensional table slots using contours. The default behavior plots column 1 of the table slot on the x-axis, column 2 on the y-axis, and the values in column 0 as the contours. Each of these contours is plotted as a distinct curve. In the Plot TableSlot dialog box, users can toggle the "Generate Contour Curves" button and select which column to plot on each axis.

Plotting TableSeries and AggSeries Slots

Users plotting TableSeries and AggSeries slots can now select which column to plot. (Previously, RiverWare always plotted the first column.)

Scaling

RiverWare now honors the user-set slot scaling value (e.g., 1000 cfs) when plotting. The scaling value is reflected on the plot axis labels.

DateAxis Toolbar

A new DateAxis toolbar is available under the Window menu of the plot dialog. This toolbar contains a date-time spinner which will automatically re-center the plot to the specified date. The toolbar also contains a "Synch the dates on all plots" button (a calendar, clock and down arrow) which will synch all the plots to the timestep of the currently selected plot. Synch dates can also be invoked with the keyboard accelerator Ctrl+D.

Hovering Over a Plot Point Displays Information

Hovering over a plot point will now generate a tool tip with information about that point: the slot name, time, and point value.

Accounting

Several fixes have been made for plotting accounting slots. Users can now select to plot Supplies directly from the plot dialog by selecting Data >> Add Series Curve, just as they would with any other type of slot. Supplies are now plotted in user units and slot names are correctly represented in the legend. It is also now possible to plot slots from the Account Detail dialog with “File >> Plot Slot”.

G. AggSeries Slots on the Data Object

Users can now add AggSeries Slots to Data Objects. Under the “Slot” heading in the Open Object dialog, select “Add AggSeries Slot”. The name of each column can also be edited.

H. Numeric Keypad

Many RiverWare Solaris users have reported problems using the numeric keypad (on the right side of the keyboard). The problem on Solaris is that the key mapping used for Solaris/X11 keyboards confuses RiverWare’s GUI toolkits (and those in other applications). The solution is to change the mapping of the numeric keypad keys to conform to a setup that RiverWare can understand. Instructions and a script file are available on our web site, under the RiverWare user pages:

http://cadswes.colorado.edu/sponsors/RiverWare/AppNotes/
Log on as user: rwuser
and password: Zanskar

NOTE: This is NOT a problem on Windows. Windows users should ignore this.

I. Synchronizing With Run Control

Exclude Slots with Different Timestep from Run

When synchronizing objects with the Run Control, users now have the option to exclude slots that have a different timestep than that of the Run Control. This option may be useful, in particular, to retain data stored in Data Objects.

J. End of Run Diagnostic

RiverWare now displays a green diagnostic at the end of a run. The diagnostic will state whether the run finished, aborted, or was stopped. The diagnostic will also display the number of seconds elapsed since the run was started.

K. Periodic Slot

Change to Lookup Date on Periodic Slots with Irregular Intervals

If a lookup is done on the Periodic Slot for a date which falls exactly on an interval boundary, RiverWare returns the lookup for the prior interval. This was always true for Periodic Slots with regular intervals, the behavior has been added to consistently work for Periodic Slots with irregular intervals.

NOTE: This change could break existing rulesets. References to periodic slots at “date -1” might need to be replaced with the more natural “date”.

Horizontal Scrollbar

The Periodic Slot now has an “automatic” horizontal scroll bar that appears when the window isn’t wide enough to display all the columns. The minimum height of the slot is set to approximately three lines.

Inverse Interpolation

The inverse interpolation on periodic slots (given a date and a table value, return the appropriate column map value) has been re-implemented. The new behavior orders the interpolations consistently, thus fixing any inconsistencies in forward and backward interpolation.

NOTE: This change could potentially cause numeric differences in models with methods which use inverse interpolation on a periodic slot or in models with rulesets that call this function directly by calling getColumnValue.

4. Simulation Objects

The following enhancements to the RiverWare simulation objects are described briefly. The user is encouraged to consult the **Simulation Objects Documentation** in the online help for more detailed descriptions of the enhancements to the objects and their methods.

A. Canal Object

Canal Flow Table Method

A new method, Canal Flow Table, has been added to the Canal Flow Calculation category of the Canal object. This method is general and solves for any canal flow that can be described using the Canal Flow Table. This method takes the average pool elevation of the lower Reservoir and the difference in average elevation between the two Reservoirs and uses linear interpolation to determine Canal Flow from the Canal Flow Table.

B. Control Point Object

Include Locals in Outflow Category

A new method category called Include Locals in Outflow was added to the Control Point object. The two methods in this category, Locals Included in Outflow and Locals Not Included in Outflow, allow flexibility in the use of specific local flow data. In most cases, the default method, Locals Included in Outflow, is the appropriate method. However, for basins in which local flow data is reported cumulatively (e. g., in the Army Corps of Engineers Southwest Division), users can choose the Locals Not Included in Outflow method which allows the local inflow to be excluded from the system until a reservoir object is reached, thus providing an accurate calculation of the total inflow to the reservoir.

Regulation Discharge Methods

The Regulation Discharge methods are part of the new flood control algorithms now available in RiverWare. These methods determine the regulation discharge, meaning the maximum flow that is allowed in the channel at the control point, for each timestep in the specified forecast period. See the **Flood Control** section below for details of the Regulation Discharge methods.

Key Control Point Balancing Methods

The Key Control Point Balancing methods are part of the new flood control algorithms now available in RiverWare. Selection of a method in this category makes a control point a key control point and allows for the balancing of storage in the associated reservoirs with respect to the empty space available in the channel at the control point (available space is determined by the Regulation Discharge methods). Calculations for these methods are actually initiated from a flood control method selected on a computational subbasin that includes the control point. For details on these methods as well as other flood control related methods, see the **Flood Control** section below.

Change to the Forecasting Methods

In the Generate Forecast Inflows methods (Geometric Recession and Exponential Recession), it is now no longer necessary to include data in the Deterministic Inflow slot past the end of the run. Previously, because the period of perfect knowledge could extend past the end of the run, users were required to enter deterministic inflow data for the number of timesteps in the period of perfect knowledge past the end of the run. Now, if this data is not entered, the Local Inflow values past the end of the run are assumed to be zero. If the data is entered, the method will work in the same way it always has (i. e., use the Deterministic Inflow data to determine the Local Inflow values past the end of the run).

C. Pipeline Object

A new object, the Pipeline object, was added to RiverWare. This object solves for outflow given inflow or inflow given outflow.

Pipeline Solution Direction Category

The pipeline solution direction category contains two methods (Solve Upstream or Downstream and Solve Downstream Only) to allow users to specify the direction the Pipeline solves. The default method, Solve Upstream or Downstream, should remain selected for basic Simulation. In Rulebased Simulation, however, the user may need to limit the Pipeline to downstream solution only. In this situation users can select the Solve Downstream Only method.

D. Reach Object

Step Response Routing Method

A new routing method, Step Response, has been added to the Reach object. This method uses inflow values and lag coefficients to calculate the outflow for the current timestep, as well as future timesteps. The total number of outflows computed will equal the number of lag coefficients. The general outflow calculation for this method is the same as that for the Impulse Response Routing method. The difference is that with the Step Response Routing method the outflow is calculated for the current timestep and future timesteps. The Impulse Response Routing Method calculates outflow for the current timestep only.

Change to the Forecasting Methods

In the Generate Forecast Inflows methods (Geometric Recession and Exponential Recession), it is now no longer necessary to include data in the Deterministic Inflow slot past the end of the run. Previously, because the period of perfect knowledge could extend past the end of the run, users were required to enter deterministic inflow data for the number of timesteps in the period of perfect knowledge past the end of the run. Now, if this data is not entered, the Local Inflow values past the end of the run are assumed to be zero. If the data is entered, the method will work in the same way it always has (i. e., use the Deterministic Inflow data to determine the Local Inflow values past the end of the run).

E. Reservoir Objects

Surcharge Release Category and Methods

A new method category, Surcharge Release, has been added to all Reservoir objects. The Surcharge Releases methods, together with the new Regulation Discharge methods, Key Control Point Balancing methods and Flood Control Release methods, are based on US Army Corps of Engineers flood control algorithms. All these methods are, however, designed to be generic and could potentially be used for flood control in any river basin. The Surcharge Release methods determine mandatory releases made when the reservoir is in the surcharge pool. These methods are executed only when the Reservoir's Outflow slot is set with the Surcharge Release (S) flag. This flag can only be set by a rule. The Surcharge Release method category contains four new methods: Flat Top Surcharge, Induced Surcharge Curve, Pass Inflows, and Specified Surcharge. Brief descriptions of these methods follow:

The Flat Top Surcharge method is based on US Army Corps of Engineers Southwest District algorithms. The method determines the surcharge releases for the forecast period to prevent overtopping of a reservoir. The name of this method comes from the process of computing releases during the forecast period to flatten the flood wave peak as it comes through the reservoir by making some anticipatory releases. This approach aims to prevent excessively large inflows from creating equally large releases by extending the time period over which these inflows are released.

The Induced Surcharge Curve method follows the procedure used by the US Army Corps of Engineers Kansas City office to determine surcharge releases during a forecast period for reservoirs with tainter gates. This method determines a surcharge release (and gate opening) for each timestep in the forecast period.

The Pass Inflows method is designed to pass the inflows to the reservoir whenever the pool elevation enters the surcharge pool. If the inflows cannot be passed (due to the physical limitations of the outlet works) the surcharge release is set equal to the max outflow. Then the gates remain open until the surcharge pool is evacuated.

The **Specified Surcharge method** is used to compute the surcharge release based on a user specified value. As always, the surcharge release is limited to the physical maximum outflow from the reservoir.

Flood Control Release Calculation Category and Methods

The new Flood Control Release Calculation method category holds two flood control release methods, Operating Level Balancing and Phase Balancing. These methods work together with the methods selected on a computational subbasin and the predefined FloodControl rule function. Selecting a Flood Control Release Calculation method on a reservoir actually sets up dependent slots to be available for use by the predefined FloodControl rule function. The same method must also be selected on the computational subbasin of which this reservoir is a member. The Operating Level Balancing and Phase Balancing methods are described in the **Flood Control** section below.

Changes to the Forecasting Methods

The Geometric Recession and Exponential Recession forecast methods now set the Hydrologic Inflow Forecast slot instead of the Hydrologic Inflow slot. This change was necessary to enforce proper dispatching. The Coefficient and Exponent Hydrology method on the Reservoir object and analagous methods on the Reach and Control Point objects remain unchanged.

In all the Generate Forecast Inflows methods (Geometric Recession, Exponential Recession, and Coefficient and Exponent Hydrology), it is now no longer necessary to include data in the Deterministic Hydrologic Inflow slot past the end of the run. Previously, because the period of perfect knowledge could extend past the end of the run, users were required to enter deterministic hydrologic inflow data for the number of timesteps in the period of perfect knowledge past the end of the run. Now, if this data is not entered, the Hydrologic Inflow Forecast values past the end of the run are assumed to be zero. If the data is entered, the method will work as it used to: use the Deterministic Hydrologic Inflow data to determine the Hydrologic Inflow Forecast values past the end of the run.

Plant Efficiency Curve Power Method

A new power method, Plant Efficiency Curve method, has been added to Power Reservoirs. This method is similar to the Plant Power Calc method, except that it uses one table, Plant Power Table, instead of the four tables used by the Plant Power Calc method (Best Turbine Q, Max Turbine Q, Best Power Coefficients, and Max Power Coefficients). This allows the user to put in several efficiency points instead of just two (the best and max). The Plant Power Table is a 3-D table that relates Operating Head, Turbine Release, and Power. The Plant Power Table is used to automatically generate the max and best turbine Q tables (called auto best/max turbine Q for this method).

NOTE: The Plant Power Table replaces the Power Linearization Table used in Optimization. All existing models using the Power Linearization Table will be updated automatically to change the name of the Power Linearization Table to Plant Power Table. Users should be aware that data must be entered into the table in increasing, concave blocks of the same Operating Head for the 3-dimensional table interpolation to work correctly. It is possible that the new concavity check may catch mistakes in the data (that the old Power Linearization Table ignored) thus causing the run to abort. Data may need to be updated to fix any non-concavity issues. See the documentation in the online help for more information on this method and the formulation of the table.

F. Water User Object

Additions/ Changes to Pump Back Return Flow Method

Two new slots, Non Applied Water and Project Efficiency, have been added to the Water User object when the Pump Back Return Flow method is selected. The method computes Non Applied Water as a function of Diversion, Incidental Depletions, Irrigated Area, Application Efficiency, and Project Efficiency. Return Flow and Depletion are now functions of Non Applied Water. The Non Applied Water slot can be either user input or set by Rules. The basic structure of the Pump Back Return Flow method remains unchanged.

Also, the Application Efficiency slot was changed from a series slot to a scalar slot. NOTE: Users will need to re-enter a single efficiency value into the Application Efficiency slot.

5. Flood Control

A. Overview of Flood Control Algorithms

RiverWare has a new capability to execute basin-scale flood control algorithms on a computational subbasin. A flood control method is selected on the computational subbasin in the Flood Control method category. It is invoked by the new predefined rule function FloodControl(). Reservoirs and Control Points in the subbasin each have corresponding methods for flood control that should be selected consistently with the Computational Subbasin method.

Two Flood Control methods are available in this release. Both are basin-scale methods that calculate flood control releases from all reservoirs in the subbasin that are in the flood pool with the objectives of:

- maintaining a balance among the reservoir storages as prescribed by the specific method;
- avoiding flooding at downstream control points;
- calculating releases that empty the flood pools as soon as possible within a user-specified forecast period while maintaining constraints on increasing and decreasing releases.

Both the new Flood Control methods are based on US Army Corps of Engineers flood control algorithms. The Operating Balancing method is based on the Southwest Division SUPER program's flood control algorithm. The Phase Balancing method is based on the flood control policy used by the Kansas City District. Both methods have been implemented in RiverWare as general methods that could potentially be used for flood control in any river basin. These Flood Control methods are still under development. Users who may interested in the new Flood Control methods should contact CADSWES before implementing them in their models.

A summary of how to use the new Flood Control methods is described in the next paragraphs. Refer to the **Simulation Objects Documentation** and the **Rulebased Simulation Documentation** in the online help for details.

B. Model Configuration for Flood Control

In order to use the Flood Control methods, an existing RiverWare model should be configured as follows:

1. Add Control Point Objects to the points in the network where channel capacity limits the flood control releases.
2. Create a Computational Subbasin through the Edit SubBasins dialog on the Workspace menu. Include in the subbasin all objects that are part of the reservoir and river network, including the Control Points. All objects on the network must be linked and no loops may exist.
3. Select a Flood Control Method on the Subbasin. Select methods for all dependent method categories that appear when the Flood Control method is selected. Provide all input data required on the slots on the Computational Subbasin associated with the Flood Control method selected. Refer to the Computational Subbasin Documentation for details about the methods and their input requirements.
4. Provide forecasted inflows (forecast the flood event). The inflows over the forecast period can be provided as Local Inflows to Reaches and Control Points and as Hydrologic Inflows to Reservoirs. You can forecast at some or all of these points. On each of these objects, select Forecast Local

Inflows method under the Local Inflow Calculation or Hydrologic Inflow Calculation Category, then select the forecasting method you would like to use under the Generate Forecast Inflows Category. Provide data as needed to forecast the inflows at the control point. Refer to the each object's documentation for details.

5. At control points, select the Regulation Discharge Method according to your policy. Select the Key Control Point Balancing method consistent with the Flood Control method you selected on the Subbasin and according to the regulation implemented at that control point. Flooding Exception and Sag Operation can also be selected. Provide input data as required for each method selection. Refer to the Control Point documentation for details.
6. On Reservoirs, select the same method in the Flood Control Release Calculation category that you chose on the Computational Subbasin. Some data like forecast period can be propagated automatically to all reservoirs. Refer to Computational Subbasin documentation for details. Provide data as needed by the method selected. See specific Reservoir object documentation for details.

   NOTE: Sloped Storage Reservoirs cannot be included in a subbasin using the current selection of Flood Control methods because both methods require a unique relationship between Storage and Pool Elevation.
7. On Reservoirs, select a method for Surcharge Release. This method releases water in the Surcharge Pool that is not subject to downstream channel constraints. Provide data as needed by the method selected. Refer to the Reservoir object documentation for details.

C. Execution of Flood Control Algorithm in Simulation

The new flood control algorithms are designed to be executed by rules. Following is a description of how the many parts of the flood control algorithm are executed in order at each timestep. Refer to the documentation for each object for further details.

- During execution of the Beginning of Timestep routines on the Reservoir, Control Point and Reach objects, the selected Inflow Forecasting methods are executed, setting the Hydrologic Inflow Forecast slot for all timesteps in the Forecast Period, beginning with the current simulation timestep. The objects do not dispatch as a result of the setting of the Hydrologic Inflow slot.
- Lower priority rules execute and simulation propagates the results until the flood rules are next on the agenda.
- The first set of flood rules to execute sets the Surcharge Release Flag (S) on the Outflow slot of each Reservoir in the computational subbasin. A separate rule sets the Surcharge Release Flag on each Reservoir starting with the upstream reservoirs and continuing downstream. The simulation after each rule execution dispatches the Reservoir. The Surcharge Release Flag is interpreted as an input, so the reservoir executes the solveMB_givenInflowOutflow. As the dispatch method is being executed, the Surcharge Release Flag is detected and the object executes the selected surcharge release method. The surcharge releases are computed for the entire forecast period. These surcharge releases are set in the surcharge release slot. Also, the outflow slot is set equal to the surcharge release slot. After surcharge calculations are completed, the Surcharge Release Flag is removed from the current controller timestep so that surcharge releases will not be recomputed on subsequent dispatches. When the reservoir solves, it routes its surcharge releases down to the next reservoir before it (the downstream reservoir) computes surcharge releases.
- The next rule sets the Regulation Discharge (G) flag on the Reg Discharge Calculation slot on each Control Point in the Computational Subbasin for the current timestep. Setting this flag results in execution of the dispatch method which in turn executes the selected Regulation Discharge method

and any dependent methods (such as Balance Level) on the Control Point. After execution, the regulation discharge flag is removed so that regulation discharge will not redispatch unless this flag is reset by a rule. After executing the selected Regulation Discharge method, the dispatch method checks to see if outflow has changed from its previous value. If it has not, the outflow slot is not reset using the regulation discharge rule priority. This prevents the regulation discharge rule priority from propagating downstream and triggering unnecessary and, in some cases, undesirable resolving.

- Lastly, a single rule invokes the predefined FloodControl() function on the subbasin. The function executes the selected Flood Control method on the Computational Subbasin. The function returns values for Outflow and Flood Control Release for each reservoir in the computational subbasin at the current controller timestep. The rule then sets the Flood Control Release and Outflow slots on each reservoir (outflow is the sum of flood control release and surcharge release). The setting of outflow triggers each reservoir to dispatch with the solveMB_givenInflowOutflow dispatch method. Nothing out of the ordinary happens in the dispatch method as a result (it doesn’t matter that we’re dispatching as a result of flood control, the object dispatches as it normally would when getting a new outflow).

6. Rulebased Simulation

A. Hypothetical Simulation

New Argument

A new argument has been added to each of the hypothetical simulation functions. This argument indicates the number of timesteps before and after the current timestep which might be involved in the simulation. Hypothetical simulation involves making copies of all the objects in the subbasin and this new argument is used to determine how much data should be copied from each object. Users should set this argument equal to the number of timesteps before and after the current timestep which they would like to be considered in the hypothetical simulation. If no value is assigned to this argument, RiverWare will use a heuristic scheme to automatically assign a reasonable value to this argument the first time a ruleset is loaded in RiverWare version 4.4. For further detail on how this argument is used in hypothetical simulation, see the hypothetical simulation predefined functions in the **Rulebased Simulation Documentation** in the online help.

B. Rules Palette Predefined Functions

Following is a brief description of changes to the rules palette predefined functions available for use in the RiverWare Policy Language for writing rules. Details on the use of these functions and the syntax involved are available in the **Rulebased Simulation Documentation** in the online help.

FloodControl

The new FloodControl predefined function invokes the selected Flood Control method on a computational subbasin. For each reservoir in the subbasin, two pairs are returned: one for the Outflow slot and one for the Flood Control Release slot on the reservoir.

Change to SumSlotsInARange

The “Sum Slots in a Range” predefined function now uses the timestep of the slot instead of the timestep of the model (i.e., controller timestep) when converting values. This change was made because the slot could be on a data object and have a different timestep than that of the model.

ResetRanDev

The execution of the ResetRanDev predefined function in some users’ rulesets could be affected by recent performance enhancements. These performance enhancements do not execute RPL print statements and send them to the diagnostic output unless Diagnostics are turned on. Some users’ rulesets currently execute the ResetRanDev function through a print statement. ResetRanDev should now always be called from a function with arguments, not from a print statement. E.g.,

```
object.slot[]=IF(NOT ResetRanDev (...))
        STOP_RUN “ResetRanDev Failed”
        ENDIF
```

This will never assign any values, but will always evaluate the function call.
The ResetRanDev function is used to initialize internal data structures which permit the RanDev function to return a pseudo-random sequence of numbers. Refer to the ResetRanDev function in the **Rulebased Simulation Documentation** in the online help for more information.

C. Rules Palette Buttons

New Regulation Discharge Flag Button

A button has been added to the Rules Palette to set the new Regulation Discharge flag (G). Regulation Discharge and its dependent methods are executed when the Regulation Discharge flag is set for a timestep on the Reg Discharge Calculation slot on a control point. The Regulation Discharge method calculates the maximum flow allowed in the channel at the control point as calculated by the flood control releases. This calculation dictates the total water that could be released from all the reservoirs upstream as a result of flood control operations.

New Surcharge Release Flag Button

A button has been added to the Rules Palette to set the new Surcharge Release flag (S) for flood control. Setting the surcharge release flag on a Reservoir’s Outflow slot allows the surcharge release methods to be executed. The selected Surcharge Release method calculates the releases out of the surcharge pool that are not subject to downstream channel constraints.

D. RPL Units

Several units have been added to the list of RPL units to make the list consistent with those units available in Simulation. The units of million gallons per day (mgd), mega liters (ML), giga liters (GL) and liters (liters) have been added to the list of RPL units.

E. Rules Analysis Dialog

Close Window Keyboard Accelerator

A keyboard accelerator has been added to close the Rules Analysis Window:

CTRL+W

F. Setting Specific Columns on the AggSeries Slot with a Rule

It is now possible to set specific columns of an AggSeries Slot with a rule. Previously it was only possible to set the first column of an AggSeries Slot with a rule. This new functionality may be particularly useful now that the Data Object supports AggSeries Slots. Users can specify the column by adding column number information to the rule (e.g., object.slot[<date>, <column number>]). If the column number is not specified, the first column will be set.

7. Accounting

A. New Accounting Method on the Reservoir Object

A new method, Elephant Butte Loss with RG Compact, was added to the Storage Account Gain Loss method category on the Reservoir object. This method is specific to accounting in the Rio Grande model. This new method is similar to the Elephant Butte Loss Calculation method. The difference is that when the old method is selected, the Rio Grande GainLoss is distributed only to accounts with a positive storage. If the new method is selected, the Gain Loss is distributed to all accounts, regardless of whether or not the storage is negative.

B. Change to Existing Storage Account Gain Loss Methods on the Reservoir

The Elephant Butte Loss Calculation and El Vado Loss Calculation methods in the Storage Account Gain Loss category on the Reservoir object have been updated to consider multiple Rio Grande accounts. These methods are specific to accounting in the Rio Grande model. The gain loss calculation is done in the same manner as before except that now it distributes the Gain Loss value proportionally (based on storage) among all Rio Grande accounts rather than assigning the Gain Loss to only one Rio Grande account. Also, these Loss Calculation methods now take into account any transfers between two Rio Grande accounts.

8. Closed Bug Reports

The following is a list of the bugs which were fixed for this release. If you wish to view the details for a specific bug, please browse to http://cadswes.colorado.edu/users/gnats-query.html and search our bug database. You will need a RiverWare user login and password.

2819	3091	3303	3305	3312	3313	3314
3317	3318	3321	3322	3326	3327	3328
3329	3330	3339	3340	3341	3342	3342
3343	3343	3344	3346	3347	3351	3353
3354	3355	3356	3357	3358	3364	3365
3366	3367	3368	3369	3370	3371	3372
3375	3376	3382	3384	3386	3387	3295
3310	3332	3335	3336	3350	3373	3375
3379	3380	3384	3389	3392	3393	3395
3397	3399	3400	3405	3409		

Current Release Notes Version 4.5

1. Special Attention Notes

- If the text or graphics in this file are not clear, you may need to print this document. Resolution should improve on the printed page.
- The new environment variable **RIVERWARE_SITE** has been added to specify the location of version-independent Riverware runtime files such as *riverwareDB*. Previously, the user had to copy their *riverwareDB* file to each new installation directory (specified by **RIVERWARE_HOME**). By setting the **RIVERWARE_SITE** environment variable to point to a new version-independent directory containing the user's *riverwareDB* file, all future Riverware installations can automatically access these site-specific, version-independent runtime files.

2. RiverWare for Windows 2000 and Windows XP

RiverWare is available and supported for Windows 2000 and Windows XP (it will also run on NT but CADSWES is supporting Windows 2000 and XP). The user should be aware of the following differences that exist in RiverWare for Windows:

Differences in RiverWare for Windows

- Middle-mouse features such as QuickLink or rearranging the rows in the run analysis dialog are activated with the combination (pressed in this order): Alt + right mouse button + left mouse button. In Windows, the mouse configuration can also be changed so that middle mouse button actions are executed with the right mouse button (this would avoid the awkward sequence mentioned above).
- QuickLink can also be activated using the right-mouse button.
- The Windows DMI executable can be a DOS batch file or any other windows executable that can be run directly from a command shell.

Problems/Bugs in RiverWare for Windows

- The Locator View window often gets in a bad state when you resize the main workspace.
- It is possible that the objects may get shifted off the workspace if the workspace window is resized in certain ways. In order to make the objects visible again, you must save the model then reload it. Reloading the model will shift the model so that all objects are visible on the workspace.

Saving Model Files and Rulesets

- When saving model files or ruleset files that you intend to move between windows and unix systems, always save with the .gz extension. This saves the model/ruleset in a binary format that is the same on windows and unix.

3. General RiverWare

A. DMI

DMI File Chooser Path Is More Intuitive

The DMI file chooser path has been modified to open to the same path as the model file. After a selection has been made in the DMI file chooser, the file chooser will open to the last selected path.

DMI File Chooser "All Files"

In the DMI file chooser dialog, the "All Files" file chooser pattern was changed from "*.*" to "*" to include files without extensions. Now all files, with and without extensions, will be recognized by selecting "All Files".

B. SCT

The SCT 2.0 has been significantly enhanced. The enhancements to the SCT include new display features, new editing features, and new features related to open slot dialogs and printing. Other changes to the SCT include bug fixes. The general nature of these enhancements is described in the release notes below. More information on these enhancements can be found in **Appendix 1: RiverWare 4.5 Release SCT Enhancements**. The user is encouraged to consult the SCT 2.0 documentation in the **User Interface** section of the online help for a detailed description the general functionality of the SCT (not including these recent enhancements).

New Display Features

The SCT now supports optional day and year dividers (in addition to the month and weekend dividers that were already available). Slot dividers in the horizontal timestep orientation can now be made relatively thin- they used to always be tall enough to support a single line of text. Users can now select the font displayed in the SCT. The text color and background color of the Selection Info Area are also now user configurable. The horizontal timestep axis orientation now indicates when object dispatching has been disabled with red cross-hatching (this has always been the functionality in vertical timestep axis orientation).

User Settable Fonts

The user can now choose the SCT's font. Only one font can be displayed at any given time and that font is used for both screen display and printing. Under the Font tab of the SCT Configuration dialog, the user can select one of three fonts, Default Font, Font A, and Font B. Under each of these items is a sample text field showing the font specification using the corresponding font. Under the Font A and Font B items are two buttons, Configure and Reset. The Configure button brings up the Qt Font Selector to allow the user to select a new font. The Reset button assigns the default font to the corresponding font item.

Editing Target Operations

It is now possible to edit/set target operations in the SCT even if the final timestep value of the target is NaN. If users set a target operation with NaN as the final value and then run the model, the run will abort as expected. For ease of editing, the SCT will no longer check this. Also, when setting values in a target operation with the SCT, values entered will automatically be entered in the final day of the target operation. When copying and pasting target operations, if the Target Begin timestep is not part of the copied region, the first timestep in the paste region will automatically be assigned the Target Begin flag.

Opening Multiple Slots Directly From the SCT

Users can now open multiple slots directly from the SCT by highlighting the desired slots and selecting the new "Slot->Open Slots" menu item. The toolbar button of a open folder is a shortcut to this operation.

Preservation of Height and Width

When an SCT is saved and reloaded, its width and height are now preserved.

Printer Properties

Individual use printer property choices for printing the SCT are now better preserved, particularly in situations where several users are operating RiverWare under the same login account.

Integrated Sum in Selection Info Area

The Selection Info Area at the bottom of the SCT has been enhanced to better support the summary of rate values (e.g., flow).   When rate values are selected, the Integrated Sum of the values is displayed with an indication of the integrated unit type and unit (e.g., for "flow" values, the integrated unit type is "volume"). This is important primarily for irregular timesteps (e.g., monthly) for which the sum of various per-month rate quantities in differently-sized months is not well defined. Conventional summary information (e.g., Average, Min, Max, ...) of rates of irregular timesteps are based on the earliest timestep of the selection. The size of the irregular interval used in the calculation is indicated with the following nomenclature: /month28, /month29, /month30, /month31, /year, or /yearL (for leap-year).

Selecting Slots in New SCT

When starting a new empty SCT, a message box is displayed describing how to add Slots to the SCT and allowing the user to immediately open up either of the two Slot Selectors for that purpose.

Optional Date/Time Spinner

An optional Date/Time Spinner was added to the SCT for quick navigation to a particular timestep. The Date/Time Spinner can be optionally hidden or shown by the user with a new setting in the SCT Configuration dialog on the "Toolbar" tab.

General SCT Performance Enhancements

In the 4.4.0 release, having the SCT 2.0 open significantly slowed down Simulation and Optimization runs. This undesirable behavior has been fixed.

Previously, loading an SCT with multiple occurrences of the same slot, then loading a different SCT and then running a model was causing Riverware to become unstable. This problem has been fixed.

C. New Model Info Dialog

A new Model Info dialog has been added for storing users' comments and a save history with the model file. This information is accessed by selecting "Model-> Model Info" from the main workspace menu. The File Info dialog box contains a "File Save History" field and a "File Comment" field. The File Save History field saves the user name, date, time, and version of RiverWare with which the model was saved. If a model is viewed and saved with RiverWare Viewer, the File Save History will indicate the model save information from the full version of RiverWare as well as model information from each save with RiverWare Viewer. Saving with the full (non Viewer) version of RiverWare will clear out the File Save History and only provide information about the most recent full version save. Saving with RiverWare Viewer will always append the File Save History field with the new save information. Note that the Model Info Dialog registers the save information only the first time you do a save during a RiverWare session. If you wish register the save in subsequent saves, you must choose the "Save As" option. (This functionality of the File Save History may be changed in future releases.) The File Comment field is an editable text field in which users can type any information or comments about the model. This information is stored with the model file. Users who plan to send copies of their models to RiverWare Viewer users will want to load and save their models with the most current release, and perhaps enter a brief description of the model in the File Comment field. This will provide RiverWare Viewer users with the appropriate model information.

D. Expression Slots

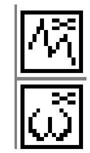
Expression slots have been significantly enhanced to offer more flexibility in editing and evaluation of expressions. The new expression slots, like the old expression slots, use a computational expression to specify how the values of a slot are computed. Existing expression slots will continue to work in RiverWare 4.5 however they will not be editable. If the user wishes to create a new expression slot or change an old expression slot, he/she will need to user the new expression slot editor. This editor uses RPL (RiverWare Policy Language) which is the same syntax used for writing rules. New functionality of the expression slots is outlined below:

Adding a New Expression Slot

The new expression slots are available on Data Objects by selecting Slot -> Add Series Slot with Expression or Slot -> Add Scalar Slot with Expression. Existing Expression Slots will continue to be supported, but users are encouraged to use the new scalar and series slot expressions to utilize the new functionality

Scalar and Series Expression Slots

Both scalar and series slots now may have their values computed by expression. Expression slots are identified by a 'x' in the upper right hand corner of the traditional scalar and series slot icons as shown:



Use of RPL

The computation of expression slots is now specified using RPL, the RiverWare Policy Language. RPL is computationally expressive and has an associated structured editor.

There is a special RPL set associated with RPL expression slots to which the user may add utility groups and functions. These functions may be called from any RPL expression slot.

Timing of Expression Slot Evaluation

The timing of expression evaluation is more flexible. The following options are available:

- interactively only
- beginning of the run
- end of the run
- beginning of the timestep
- end of the timestep

Users with large models might choose to evaluate expression slots interactively only, or at the end of run, to save on computation time. Evaluating expression slots interactively allows the user to select which expression slots to evaluate and these slots are evaluated only when the user chooses to do so. Users stepping through a model might choose to evaluate expression slots at the end of the timestep. Those interested in the final model result might choose to evaluate expression slots at the end of the run.

+ There is a special RPL set associated with RPL expression slots to which the user may add utility groups and functions. These functions may be called from any RPL expression slot.

E. Periodic Slots

Plotting

RiverWare 4.5 has the ability to add periodic slot curves to the plot dialog. The use of this feature should be fairly straightforward.

Multiple Year Periods

Multiple year periods are now supported on the Periodic Slot. The user can specify the number of years over which the data repeats. This is represented as year 1, year 2, year 3, ..., etc. with a user specified base year which represents the year at which the data cycle begins.

F. Data Objects

New Slots

Data objects have been enhanced to allow the additions of several new slots. The following slots can now be added to a data object: Series Slot, Series Slot with Expression, Aggregate Series Slot, Table Slot, Periodic Slot, Scalar Slot, and Scalar Slot with Expression. The new expression slots are a major enhancement and are described in more detail under the **Expression Slots** heading above.

Data Objects in Subbasins

Data objects are now allowed in user-defined subbasins.

G. Simulation Run Parameters

A few new features have been added to the Simulation Run Parameters dialog. This dialog is accessed by selecting View->Simulation Run Parameters from the main Run Control dialog. The first new addition is the Series Extension Increment field. This field has a default value of 1 but the user can increase this as necessary. This value tells RiverWare how much to extend a series slot if a value is written to a series slot at a date past the end of run date. For example, if the user changes the value from 1 to 10, then if a value is set past the end of run date on a series slot, that slot will be extended by 10 timesteps. This feature is useful only for performance improvement. If your model has very large series slots (many timesteps) and is often setting values past the end of run date on these slots (large lag times) then this value should be increased from 1 to the number of timesteps that represents the largest lag time.

The second new feature is a checkbox to model run analysis information. By default this is always enabled. If the user was not interested in seeing model run analysis information, he/she could disable this feature and may see a small performance improvement.

The third feature is a checkbox to enable the collection of RPL set performance information. This feature is disabled by default for performance reasons. If the user wanted to analyze the performance of any RPL sets (rulesets, expression slots, and user defined accounting methods), he/she could enable this feature and then analyze the data in the new RPL Analysis Dialog.

H. Extended Model File Precision

When saving a model file using the File->Save As menu option, the user now has the option to save the model data with extended precision. Normally all data is saved with 12 digits of precision. While this is enough precision for most applications, values that are saved to 12 digits of precision are not guaranteed to export and re-import as the same number (there may be differences in the last decimal place). Saving model data with extended precision will store values with 17 digits of precision. While this will increase the size of the model file, it will guarantee that all values are preserved when exporting and re-importing. The extended precision option is activated in the Confirm Save Model As dialog (the same dialog where you specify whether or not to save the model output). Once the extended precision option is activated, subsequent saves of that model will always save with extended precision.

I. Units

Units of “gal” (gallon) and “BG” (billion gallons)

The unit "gal" for "US liquid gallon" has been added to the RPLUnits (RiverWare Policy Language units) file. The unit "gal" will now be recognized in rulesets. The unit "gal" was already available for display in slots. The volume unit of "BG" (billion gallons) is now available in both Simulation and RiverWare Policy Language. For simulation, the slot configuration can be changed to display units of BG. For rules, the rule controller will now recognize and process rules with units of BG.

J. RiverWare Command Language (RCL)

A new command has been added to the RiverWare Command Language (RCL) used for running RiverWare in batch mode. An optional !SaveOutput flag has been added to the SaveWorkspace command if the user wants to save a model including the output data. If the model is configured to save the output already, then this flag is not necessary. However, the user may have the model configured to not save the output but may want to save the output when running the model in batch mode. The !SaveOutput flag would be necessary to accomplish that task.

K. RIVERWARE_SITE Environment Variable

The new environment variable **RIVERWARE_SITE** has been added to specify the location of version-independent Riverware runtime files such as *riverwareDB*. Previously, the user had to copy their *riverwareDB* file to each new installation directory (specified by **RIVERWARE_HOME**). By setting the **RIVERWARE_SITE** environment variable to point to a new version-independent directory containing the user’s *riverwareDB* file, all future Riverware installations can automatically access these site-specific, version-independent runtime files.

4. RiverWare Viewer

RiverWare Viewer is a new "read-only" version of RiverWare. This version of RiverWare is available at no cost to those who would like to view the output of model runs, but do not need to build, modify or run models themselves.

Current license holders do not need a new license to run RiverWare Viewer. Full RiverWare license holders can download the RiverWare 4.5 Release and run and examine RiverWare Viewer through the command line by typing:

riverware --viewer

Stakeholders and other parties interested in using only the RiverWare Viewer can download it for free from the CADSWES web pages. Information and instructions are provided on the RiverWare Viewer web page:

http://cadswes.colorado.edu/riverware/viewer/

RiverWare Viewer users must contact CADSWES directly for the free license file. In future releases, this process will be automated through the CADSWES web pages.

5. Simulation Objects

The following enhancements to the RiverWare simulation objects are described briefly. The user is encouraged to consult the **Simulation Objects Documentation** in the online help for more detailed descriptions of the enhancements to the objects and their methods.

A. Control Point Object

Flood Control Methods

The control point methods related to flood control were reorganized by adding a highest level category called Flood Control. This category serves to split the phase balancing (COE-KC) and operating level balancing (COE-SW) procedures. If users have existing models using flood control and control points, they will need to make the appropriate selection in the flood control category (from the default of None to one of the two flood control methods) to get back the related flood control categories. If the control point is a key control point, then the appropriate method in the key control point balancing category will need to be re-selected. Also the appropriate method in the regulation recession category will need to be re-selected if it was active prior to this release.

Additonal Peaking Flow Slot

A new slot, Additional Peaking Flow, was added to the Regualtion Discharge methods. Input to the new slot is optional and existing models do not require any changes. Additonal Peaking Flow is the difference between the estimated peak flow through the control point (average over the timestep) and the instantaneous peak during the timestep. Additional Peaking Flow is used in the empty space calculation. Empty space is calculated as the regulation discharge minus the inflow, minus the local inflow, minus the additional peaking flow (if a value is input). Typically, the Additional Peaking Flow slot will contain zeros for most timesteps and peak values on certain timesteps with peaks.

B. Reservoir Objects

Changes to Plant Efficiency Curve Power Method

The Plant Efficiency Curve Power Method on the Power Reservoirs has been changed. The method now generates the Auto Best Turbine Q Table using the second to last point in the Plant Power Table for a given operating head (previously, the second point was used). If there are only two points in the table for a given operating head, the second point is both the best efficiency and max capacity point.

The Plant Efficiency Curve Power method was new in the 4.4 release and allows the user to input several efficiency points instead of just the two (the best and max) available with the Plant Power Calc method. The Plant Power Table (a 3-D table that relates Operating Head, Turbine Release, and Power) is used to automatically generate the max and best turbine Q tables (called Auto Best Turbine Q and Auto Max Turbine Q) for this method.

Changes to Peak Power Calc and Peak Base Power Calc

In the PeakPowerCalc and PeakBasePowerCalc methods, if the Plant Power Cap Fraction was set to zero the Turbine Release was not automatically set to zero. Instead water was allowed to pass through the turbines instead of the spillways. Now, in both methods, if the Plant Power Cap Fraction is zero the Turbine Release is set to zero and any outflow is being correctly sent through the spillways.

Changes to Physical Constraint Methods (affects HypSim)

The physical constraint functionality was enhanced to eliminate problems associated with the hypothetical simulation functions. While this problem fixes some rare hypothetical simulation bugs, it could produce differences in the values returned by hypothetical simulation (especially when the outflow is at max capacity). The new code should improve the accuracy of hypothetical simulation but the user should be aware of possible model differences because of this.

C. Slope Power Reservoir

A new method category called Slope Partition was added to the Slope Power reservoir object. The new category contains the Partition BW Elevation method. This method allows the user to divide the reservoir into longitudinal partitions and calculate the steady flow through each partition (intermFlowParams). The flow parameter at each partition is then used in a 3-D table interpolation to find the backwater (BW) elevation at each of the partitions. This method does not affect the mass balance calculations and does not sum for the total storage over all partitions.

D. Stream Gage

Fractional Flow Method

The Stream Gage has a new method category, Conditional Flow Calc, that contains the Fractional Flow user method. The default method in this category is None, so existing models do not require changes. The new user method, Fractional Flow, calculates and sets Gage Inflow based on a comparison between two conditions. If Condition One is less than Condition Two, then the Gage Inflow is set to Condition One multiplied by a user input seasonal Loss Factor plus a user specified Constant. If Condition One is not less than Condition Two, then Gage Inflow is set to a user specified Normal Flow. The following pseudo-code displays the logic of how the Gage Inflow slot is calculated:

IF (Condition One (e.g., Diversion) < Condition Two (e.g., Diversion Requested))

$$Gage\text{Inflow} = (Cons\tan t + (ConditionOne \times Fraction))$$

ELSE

$$Gage\text{Inflow} = \text{Normal Flow}$$

The Condition One, Condition Two, and Normal Flow slots can be user input, linked, or set by rules.

A new dispatch method solveGageInflowGivenConds sets Gage Inflow if the two dispatch slots Condition One and Condition Two are known. The gage object will dispatch using solveGageInflowGivenConds only if the user method Fractional Flow has been selected and neither

Gage Inflow nor Gage Outflow are known. If the None method is selected, the Stream Gage does not dispatch. In that case, Gage Inflow and Gage Outflow are internally linked so values propagate immediately. This internal linking was the existing behavior on the Stream Gage.

6. Flood Control

A. Overview of Flood Control Algorithms

RiverWare has a new capability to execute basin-scale flood control algorithms on a computational subbasin. A flood control method is selected on the computational subbasin in the Flood Control method category. It is invoked by the new predefined rule function FloodControl(). Reservoirs and Control Points in the subbasin each have corresponding methods for flood control that should be selected consistently with the Computational Subbasin method.

Two Flood Control methods are available in this release. Both are basin-scale methods that calculate flood control releases from all reservoirs in the subbasin that are in the flood pool with the objectives of:

- maintaining a balance among the reservoir storages as prescribed by the specific method;
- avoiding flooding at downstream control points;
- calculating releases that empty the flood pools as soon as possible within a user-specified forecast period while maintaining constraints on increasing and decreasing releases.

Both the new Flood Control methods are based on US Army Corps of Engineers flood control algorithms. The Operating Balancing method is based on the Southwest Division SUPER program's flood control algorithm. The Phase Balancing method is based on the flood control policy used by the Kansas City District. Both methods have been implemented in RiverWare as general methods that could potentially be used for flood control in any river basin. These Flood Control methods are still under development. Users who may interested in the new Flood Control methods should contact CADSWES before implementing them in their models.

A summary of how to use the new Flood Control methods is described in the next paragraphs. Refer to the **Simulation Objects Documentation** and the **Rulebased Simulation Documentation** in the online help for details.

B. Model Configuration for Flood Control

In order to use the Flood Control methods, an existing RiverWare model should be configured as follows:

1. Add Control Point Objects to the points in the network where channel capacity limits the flood control releases.
2. Create a Computational Subbasin through the Edit SubBasins dialog on the Workspace menu. Include in the subbasin all objects that are part of the reservoir and river network, including the Control Points. All objects on the network must be linked and no loops may exist.
3. Select a Flood Control Method on the Subbasin. Select methods for all dependent method categories that appear when the Flood Control method is selected. Provide all input data required on the slots on the Computational Subbasin associated with the Flood Control method selected. Refer to the Computational Subbasin Documentation for details about the methods and their input requirements.
4. Provide forecasted inflows (forecast the flood event). The inflows over the forecast period can be provided as Local Inflows to Reaches and Control Points and as Hydrologic Inflows to Reservoirs.

You can forecast at some or all of these points. On each of these objects, select Forecast Local Inflows method under the Local Inflow Calculation or Hydrologic Inflow Calculation Category, then select the forecasting method you would like to use under the Generate Forecast Inflows Category. Provide data as needed to forecast the inflows at the control point. Refer to the each object's documentation for details.

5. At control points, select the Regulation Discharge Method according to your policy. Select the Key Control Point Balancing method consistent with the Flood Control method you selected on the Subbasin and according to the regulation implemented at that control point. Flooding Exception and Sag Operation can also be selected. Provide input data as required for each method selection. Refer to the Control Point documentation for details.
6. On Reservoirs, select the same method in the Flood Control Release Calculation category that you chose on the Computational Subbasin. Some data like forecast period can be propagated automatically to all reservoirs. Refer to Computational Subbasin documentation for details. Provide data as needed by the method selected. See specific Reservoir object documentation for details.

   NOTE: Sloped Storage Reservoirs cannot be included in a subbasin using the current selection of Flood Control methods because both methods require a unique relationship between Storage and Pool Elevation.
7. On Reservoirs, select a method for Surcharge Release. This method releases water in the Surcharge Pool that is not subject to downstream channel constraints. Provide data as needed by the method selected. Refer to the Reservoir object documentation for details.

C. Execution of Flood Control Algorithm in Simulation

The new flood control algorithms are designed to be executed by rules. Following is a description of how the many parts of the flood control algorithm are executed in order at each timestep. Refer to the documentation for each object for further details.

- During execution of the Beginning of Timestep routines on the Reservoir, Control Point and Reach objects, the selected Inflow Forecasting methods are executed, setting the Hydrologic Inflow Forecast slot for all timesteps in the Forecast Period, beginning with the current simulation timestep. The objects do not dispatch as a result of the setting of the Hydrologic Inflow slot.
- Lower priority rules execute and simulation propagates the results until the flood rules are next on the agenda.
- The first set of flood rules to execute sets the Surcharge Release Flag (S) on the Outflow slot of each Reservoir in the computational subbasin. A separate rule sets the Surcharge Release Flag on each Reservoir starting with the upstream reservoirs and continuing downstream. The simulation after each rule execution dispatches the Reservoir. The Surcharge Release Flag is interpreted as an input, so the reservoir executes the solveMB_givenInflowOutflow. As the dispatch method is being executed, the Surcharge Release Flag is detected and the object executes the selected surcharge release method. The surcharge releases are computed for the entire forecast period. These surcharge releases are set in the surcharge release slot. Also, the outflow slot is set equal to the surcharge release slot. After surcharge calculations are completed, the Surcharge Release Flag is removed from the current controller timestep so that surcharge releases will not be recomputed on subsequent dispatches. When the reservoir solves, it routes its surcharge releases down to the next reservoir before it (the downstream reservoir) computes surcharge releases.

- The next rule sets the Regulation Discharge (G) flag on the Reg Discharge Calculation slot on each Control Point in the Computational Subbasin for the current timestep. Setting this flag results in execution of the dispatch method which in turn executes the selected Regulation Discharge method and any dependent methods (such as Balance Level) on the Control Point. After execution, the regulation discharge flag is removed so that regulation discharge will not redispatch unless this flag is reset by a rule. After executing the selected Regulation Discharge method, the dispatch method checks to see if outflow has changed from its previous value. If it has not, the outflow slot is not reset using the regulation discharge rule priority. This prevents the regulation discharge rule priority from propagating downstream and triggering unnecessary and, in some cases, undesirable resolving.
- Lastly, a single rule invokes the predefined FloodControl() function on the subbasin. The function executes the selected Flood Control method on the Computational Subbasin. The function returns values for Outflow and Flood Control Release for each reservoir in the computational subbasin at the current controller timestep. The rule then sets the Flood Control Release and Outflow slots on each reservoir (outflow is the sum of flood control release and surcharge release). The setting of outflow triggers each reservoir to dispatch with the solveMB_givenInflowOutflow dispatch method. Nothing out of the ordinary happens in the dispatch method as a result (it doesn't matter that we're dispatching as a result of flood control, the object dispatches as it normally would when getting a new outflow).

7. Rulebased Simulation

A. RPL Analysis Dialog (“Rule Calling Tree”)

The new RPL Analysis Dialog is a tool for analyzing and documenting a RPL set. This highly customizable dialog displays detailed information about all objects in a RPL Set (including descriptions and performance information) and the relationships between these objects. Below is a brief description of the RPL Analysis Dialog.

This new dialog is available from any RPL editor dialog by selecting
Ruleset->Ruleset Analysis....

Detailed documentation on the use of the RPL Analysis Dialog can be found in the online help under **Rulebased Simulation Documentation**. Some key features of the new RPL Analysis Dialog are described below:

+ Three synchronized treeviews onto the entire ruleset:

1) the classic groups view

2) descending the static call graph (displays which functions are called by an object)

3) ascending the static call graph (displays which functions call an object)

+ Selecting an object in one view automatically selects and scrolls to the same object in the other views)

+ Displays information and relationships between any user-selectable object types, including: statements, predefined functions, rules, etc.

+ User-customizable column types, including object descriptions and performance information.

+ Opens any RPL editor dialog, including "Replace existing editor" mode where opening a new dialog closes the previously opened dialog to avoid screen clutter.

+ Allows printing and exporting (tab-delimited text files) of any portion of the views.

+ Navigation shortcuts for each treeview.

B. New Palette Buttons for Set Operations (where lists are sets)

Union

The set union expression takes two lists and returns a single list that contains the items that are in either list or both lists. Duplicate items are removed.

Intersection

The set intersection expression takes two lists and returns a single list that contains the items that are in both lists.

<L> - <L> Set Difference

The set difference expression takes two lists and returns a single list that contains the items that are in the left hand list but not in the right hand list.

<L> ^ <L> Set Symmetric Difference

The set symmetric difference expression takes two lists and returns a single list that contains the items that are not in both lists. This is equivalent to the expression:

(list1 U list2) - (list1 intersect list2)

This is also equivalent to the expression:

(list1 - list2) U (list2 - list1)

C. Rules Palette Predefined Functions

Following is a brief description of new predefined functions and changes to existing predefined functions available for use in the RiverWare Policy Language. Details on the use of these functions and the syntax involved are available in the **Rulebased Simulation Documentation** in the online help.

Modified Predefined Functions

The following predefined functions have been modified to return the account names in ascending priority date order:

AccountNamesByAccountType

AccountNamesByWaterType

AccountNamesByWaterOwner

AccountNamesFromObjReleaseDestination

AccountNamesFromObjReleaseDestinationIntra

(Previously these predefined functions returned the account names in alphabetical order, though this behavior was not a documented feature.)

Slot Sum Functions Now Accept Periodic Slots

RiverWare 4.5 supports periodic slots as arguments to RPL predefined functions which, in prior releases, only supported series slots. Where appropriate, RiverWare uses lookups on the periodic slot at dates in synch with the run series. The following predefined functions were enhanced to work for periodic slots: SumFlowsToVolume, SumFlowsToVolumeSkipNaN, SumSlot, SumSlotSkipNaN, GetSlotVals, GetDisplayVal.

Since Periodic Slots often have multiple columns, new predefined functions were added to sum slots or get slot values by column: SumFlowsToVolumeByCol, SumFlowsToVolumeByColSkipNaN, SumSlotByCol, SumSlotByColSkipNaN, GetSlotValsByCol, GetDisplayValByCol. These functions can also be used to sum columns on Aggregate Series slots.

AccountPriorityDate (STRING AccountName)

This function accepts one STRING argument, an account name, and returns a DATETIME, the account's priority date. The function fails if the account doesn't exist or if it doesn't have a priority date. (PassThroughAccounts do not have a priority date; StorageAccounts and DiversionAccounts have a priority date if the user specified one in the user interface.)

AccountNameFromPriorityDate (DATETIME PriorityDate)

This function accepts one DATETIME argument, a priority date, and returns a STRING, the name of the account with the priority date. The function fails if no account has the priority date.

Note that the two new predefined functions described above can be used with the existing Maplist predefined function to map a list of account names to a list of priority dates, or a list of priority dates to a list of account names.

SortPairsAscending (LIST pairs) SortPairsDescending (LIST pairs)

The input LIST, pairs, must be a list of lists and each member list must contain at least two elements. The pairs are sorted into ascending/descending order by the second element's value and a list containing the first elements of this sorted list of pairs is returned. Duplicates are not removed.

Sort (LIST)

This functions sorts a list into increasing order.

Reverse (LIST)

This function reverses the order of items in a list.

GetDate (STRING dateText)

This function returns the date which corresponds to the input text. Legal text is the same as is legal for symbolic date/times. In other words, it takes a STRING and turns it into the corresponding DATETIME. For example, the expression

GetDate("January 1, Current Year")

is exactly equivalent to the expression

@"January 1, Current Year"

SolveOutflowGivenEnergyInflow

This function returns the outflow of the specified reservoir given a value for energy and inflow.

D. Inline Comments in Rules

Rulesets (and all other RPL sets) have been enhanced to allow inline comments. Two new buttons have been added to the RPL Palette: Add Comment and Delete Comment. These features are used to add or remove a text comment from the body of the rule or function.

E. Printing Rulesets

The dialogs used to print RPL sets have been re-implemented in Qt. As part of this work new printing options and features have been made available. Information is available in the online help under **Rulebased Simulation Documentation** if more detail is required on printing and formatting RPL sets.

8. Accounting

A. Automated Pass Through Account Creation Function

It is now possible to automatically generate pass-through accounts. This function allows the user to identify two existing accounts on different simulation objects and create linked pass-through accounts on all intermediate simulation objects in one single operation. This new functionality is a convenient alternative to creating pass through account via the Open Object dialog individually for each intermediate object. The Pass Through Account Creation dialog can be accessed from either the Open Object dialog box or the Water Accounts Manager dialog box. From either of these dialogs select Account -> Create -> Pass Through Accounts. Next, select the desired upstream account and desired downstream account. Select or enter the desired Account Name, Account Water Type, Account Water Owner, Supply Release Type, and Supply Destination. Click OK and all intermediate pass through accounts will be automatically generated. Further details on the Automated Pass Through Account Creation Function are available in the **User Interface** section of the online help.

B. Account Manager Dialog

Several new capabilities have been added to the Account manager Dialog. During this enhancement process, the Accounting Manager dialog box was ported from Galaxy (GUI toolkit) to Qt.

A new property, Account Priority Date, can be now be set via the Account Manager Dialog box. The Account Priority Date represents the date a water right was acquired and can be set on Storage and Diversion Accounts. Priority date is specified by Year, Month, Day, and hour (1 to 24). No two accounts may have the same Account Priority Date.

It is also now possible to set the Water Type and Water Owner of multiple Accounts via the Account Manger Dialog. Note that properties can not be set on accounts having an open Account Configuration dialog -- a warning message pop-up dialog informs the user of that condition, and allows the user to raise the Account Configuration dialog box.

More information is available in the **User Interface** section of the online help.

C. Supply Manager Dialog

The RiverWare Supplies Manager can now show and sort Supply Types. The Supplies Manager dialog box shows a single Supply per row. There are two configurable data columns which can each show one of several properties of the Supply or of the Supply’s Upstream or Downstream Account. ("Supply Type" was just added to the available selections). The Supply Types are indicated with these names: ST_DivRet, ST_InOut, and ST_Transfers.

More information is available in the **User Interface** section of the online help.

D. Priority Date Fields

Accounts now have an optional attribute called Priority Date. An account can be configured to have a priority date through either the account configuration dialog (to modify a single account) or through the Water Accounts Manager dialog. The priority date is used to specify the priority of an account. An earlier priority date implies a higher priority. This information can be used to sort accounts by priority date in the Water Accounts Manager dialog, or it can be used in conjunction with the new RPL predefined functions that make use of this information. These functions are discussed in the Rulebased Simulation section above.

E. Plotting Account Multislot Data

RiverWare now supports plotting of account data at both the account level and the multislot level. If the user has an account open, a slot can be plotted by selecting a column and selecting the plot menu item (under the File menu title). In addition, if the user double clicks on a multislot (i.e. Outflow or Inflow) to open the multislot detail dialog, the user can plot the data from individual supplies by selecting a column and using the plot menu item.

9. Optimization

A. Diagnostics

New Diagnostic reports in millions of dollars

A new optimization diagnostic reports the final objective function value in millions of dollars.

Warning Messages Removed

The warning messages informing users that they have created additional optimization variables have been removed. User-created optimization variables are now available for AggSeries slots and are the recommended option for user-created variables. These slots function approximately the way Outflow slots on reservoirs do. They automatically add columns for a total of 3 columns. The optimization output column is copied over to the simulation column and is marked as input. When the next optimization run starts all, the values in both the simulation and optimization output columns are cleared.

B. Power Regulation

Hydropower can be an economic source of ancillary power services. One ancillary service, power “regulation”, uses hydropower to “follow” fluctuations in real-time power demand. With this release, RiverWare has methods which allocate turbine capacity for power regulation. After modeling is complete, the allocated capacity becomes available to dispatchers for real-time load following.

This functionality is intended to be used primarily with optimization and post-optimization simulation in RiverWare. Consequently, most non-optimization users will not want to model power regulation and the default settings for the methods related to power regulation reflect this. On power reservoirs, the new method category is “Regulation Category”, and the default setting is “None”.On thermal objects, the new method category is “Regulation”, and the default setting is “No Regulation”.

Detailed documentation on how optimization users can add regulation to their models is in the document, *Power Regulation in RiverWare,* available from CADSWES.

C. Objective Function

Thermal Object Avoided Operating Cost

When optimization reports an objective function value that includes "Thermal Object.Avoided Operating Cost" the units will now be reported in the units selected by the user for the "Thermal Object.Total Values" slot.

Thermal Objective Reported in Simulation

Simulation has a new method category, "Thermal Objective Reported", that controls which objective is reported for simulation. At this time there are four methods that use the existing slots:

1. none
2. Avoided Cost
3. Avoided Cost Plus Cumulative Value of Storage (includes the value of final storage)
4. Avoided Cost Plus Net Cumulative Value of Storage (includes final value - initial value)

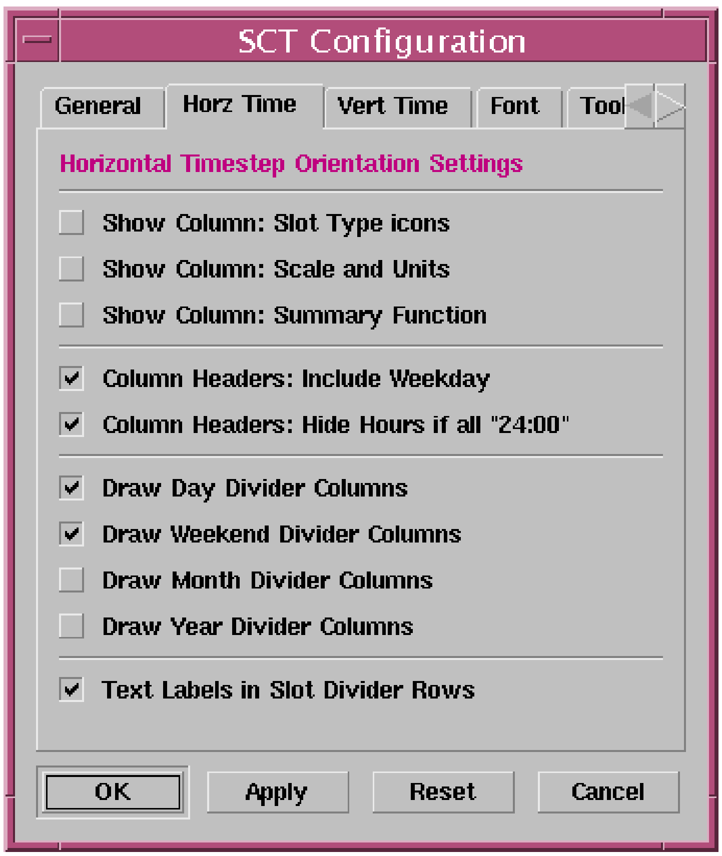
The units for the Total Value slot will also be used for reporting this value.

10. SCT

A. New Display Features

Optional Day and Year Dividers

The original release of SCT 2.0 supported optional automatic divider rows and columns for months and for weekends (between Friday & Saturday, and between Sunday & Monday). The new release also supports optional automatic divider rows and columns for **days** and **years.** Each of these four types of time dividers can be independently enabled or disabled, and can be shown with independently configurable colors.



To configure these options, select “View >> SCT Configuration ...” menu item, and operate these controls of the indicated tabbed panes:

“Horz Time” tab *(see image -->)*
[ ] Draw Day Divider Columns
[ ] Draw Weekend Divider Columns
[ ] Draw Month Divider Columns
[ ] Draw Year Divider Columns

“Vert Time” tab
[ ] Draw Day Divider Rows
[ ] Draw Weekend Divider Rows
[ ] Draw Month Divider Rows
[ ] Draw Year Divider Rows

“Color” tab
(press the buttons to pick a different color)
[ ] Day Divider
[ ] Weekend Divider
[ ] Month Divider
[ ] Year Divider

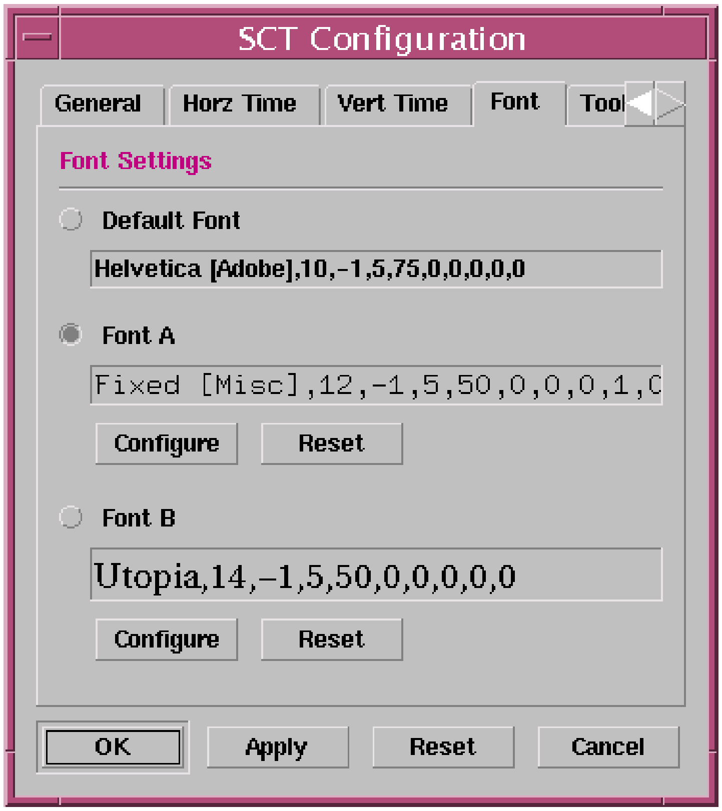
Textless, Thick-Line Slot Divider Option in Horizontal Timestep Axis Orientation

The user can insert “slot dividers” in between slot rows or slot columns. In horizontal timestep axis orientation (where slots correspond to rows), slot dividers were originally made tall enough for a single line of text. Now, there is an option to draw slot divider rows as only a thick colored line.

This option is selected for the whole SCT. That is, all slot divider rows (in horizontal timestep axis orientation) can be either tall enough for text labels, or can be drawn as only a thick horizontal line. This selection is made by the user in the “Horz Time” tab of the SCT Configuration dialog box with the following new toggle button:

[ ] Text Labels in Slot Divider Rows

User Settable Fonts



The user can choose the SCT's font. Only one font can be displayed at any given time, and that font is used for both screen display and printing.

Two custom font specifications can be saved with each SCT, and with the default SCT configuration. The user can choose to use either of those two custom font specification, or the default font.

To choose between those three options (Default Font, Font A and Font B), and to configure the font specification for the latter two options, open up the SCT Configuration dialog box by selecting the "View >> SCT Configuration ..." menu item, and click on the "Font" tab. *(See image to the right).*

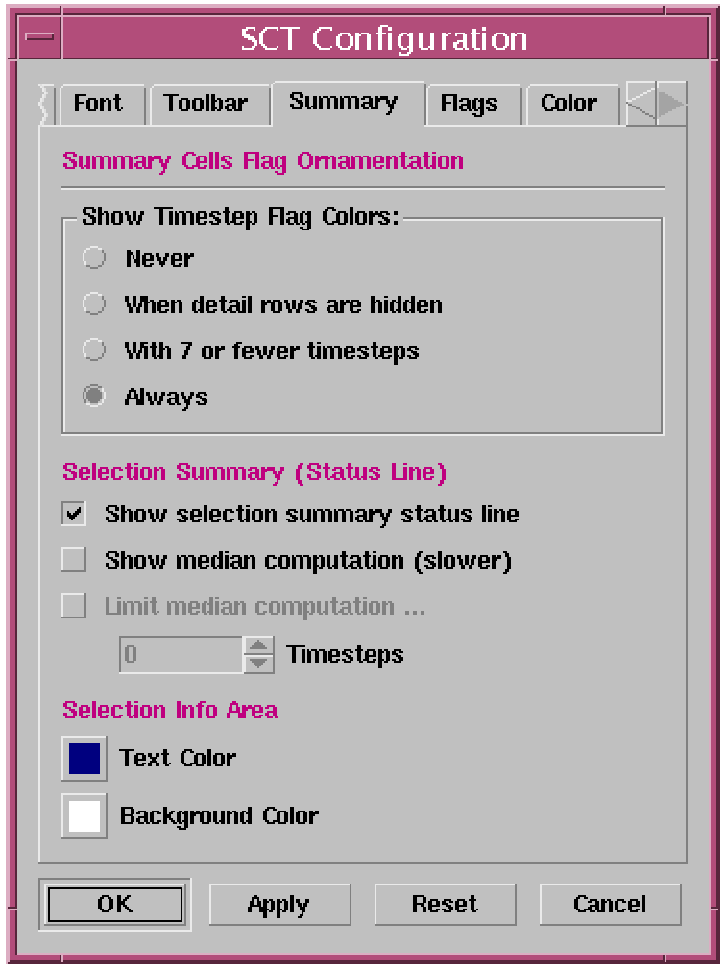
Click one of the three radio buttons to indicate the font specification to be used by the SCT.

Click either of the "Configure" pushbuttons to change the corresponding custom font specification. This brings up a font selector which allows the user to select a different font face (font family), font size, font weight (e.g. normal or bold), and other font properties.

Click either of the "Reset" buttons associated with either the Font A or Font B item to restore that font specification to the default font.

Applying a font specification to the SCT (with either the "OK" or "Apply" button) may take a moment to complete since the SCT's geometry needs to be readjusted.

Selection Info Area: User Settable Background and Text Colors



The user can now configure the colors for the Background and the Text displayed in the Selection Info Area at the bottom of the SCT. These colors are chosen from the “Summary” panel of SCT Configuration Dialog Box. Pressing either of these buttons brings up a Color Chooser:

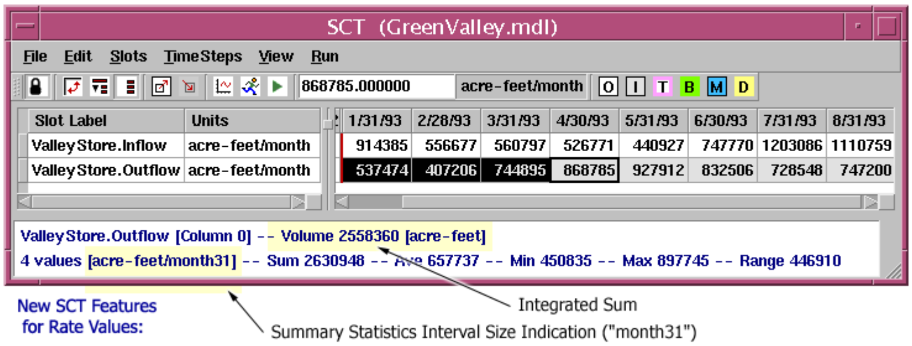
Selection Info Area
[ ] Text Color
[ ] Background Color

See image to the right and in the next section.

Selection Info Area: Integrated Sums for “per-time” values (e.g. Flow)

When values of only one particular RATE ("per-time") unit type are selected, the "Integrated Sum" of those selected values is displayed, with an indication of the integrated unit type and unit (e.g. for "flow" values, the integrated unit type is "volume" -- and for “power” values, the integrated unit type is “energy”). *See the image below.*

This is important primarily for irregular timesteps (e.g. monthly) where the sum of various per-month rate quantities in differently-sized months isn't well defined. The integrated value is also useful where the rate values' display-unit time component differs from the timestep (e.g. cms values in a daily timestep model).



Selection Info Area: Interval size indication for irregular time units (e.g. monthly)

Apart from the Integrated Sum described in the previous section, the display of conventional summary statistics (e.g. average, minumum, maximum) of a selected set of irregular rate values is enhanced. All summary computations are done in well defined rate units (e.g. *something* per-second). But the user can choose to have rate values displayed in “per-month” or “per-year” values -- which are not generally well defined over multiple months or years. To address this ambiguity, the KIND of month or year which is used to convert the computed summary statistics is indicated in the Selection Info Area using the following nomenclature, *(see also the image above):*

... /month28
... /month29
... /month30
... /month31
... /year
... /yearL

The particular interval used for that conversion is based on the size of the earliest timestep in the selection.

Object Dispatching Ornamentation in Vertical Timestep Axis Orientation

To indicate that a slot's object's dispatching is disabled, the original release of SCT 2.0 supported a crosshatch ornamentation drawn on **slot labels** only in horizontal timestep axis orientation (where rows correspond to slots). There was no such ornamentation implemented for vertical timestep axis orientation (where columns correspond to slots). Now, in that orientation, the crosshatch for such slots (whose object's dispatching is disabled) is drawn over the data cells, using the same user defined color for the object dispatching crosshatch. [The omission of this feature in the original SCT 2.0 release was documented as bug 3431].

B. New Editing Features

Changes to Target Operation Editing

1. Target Operation: No restriction on final timestep value for Setting a new Target Operation

The “Edit >> Target Operation” menu item and the Target Operation toolbar button used to be unavailable to the user (disabled) if the final timestep of the current cell selection didn’t have a defined numeric value. Now, the availability of that operation (to create a new Target Operation) is not dependent on the final timestep numeric value. Any Target Operation having an undefined (“NaN”) value in the final timestep will cause a model run failure, but the user is no longer prevented from creating it. The user must enter a value in that final timestep for the Target Operation to become valid. Note that selecting the final timestep cell of a defined Target Operation and entering a value will preserve the Target flag on that timestep.

2. Target Operation: Setting a Target Operation results in giving Keyboard Input Focus to the final selected timestep.

The typical way of defining a new Target Operation is to first select the range of timesteps within a Reservoir Storage or Pool Elevation Slot, and either select the “Edit >> Target Operation” menu item or press the Target Operation toolbar button. Before this feature was revised, the selection of that whole timestep range remained -- so any subsequent entry of digits caused every timestep within the new Target Operation to be assigned the entered value. This behavior was revised. Now, as a result of defining a new Target Operation, keyboard focus is forced to the final timestep in the selected range. Subsequent entry of digits causes the assignment of the entered number to only the final “target” timestep.

3. Target Operation: Copying of incompletely selected Target Operations

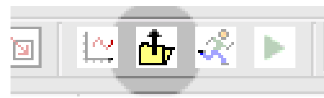
The original release of SCT 2.0 didn’t paste a Target Operation to the destination timesteps if the originally selected source (copied) timesteps didn’t include *both* the Target Begin and Target (End) timesteps. (But this limitation applies only to Target Operations that include a Target Begin timestep, and not those defined with only a Target [end] Flagged timestep).

With the revised SCT, if the copied region contains a Target (end) Flag, but not a corresponding Target Begin Flagged timesteps (and if this is a Target Operation which actually does have an explicit Target Begin Flag), then a Target Operation is defined in the destination (paste) timestep region, with the Target Begin Flag assigned to the *earliest timestep in that destination timestep region.*

Note that if a single timestep is selected as the destination region (for the paste operation), then that timestep is effectively the first timestep of an implied multiple-timestep destination region which is the same size as the original source (copied) timestep region. So, in the scenario described above, that single selected destination region would receive the Target Begin flag.

C. Other New Features

Open Slot Dialogs shown from the SCT



Open Slot dialog boxes for simulation slots (and not for accounting slots) can now be opened from the SCT. When one or more slots are selected, selecting the new “Slot >> Open Slots ...” menu item or the new Open Slots toolbar button *(see image to the right)* the Open Slot dialog boxes for the selected slots are shown. If Open Object dialog boxes for those slots are already open (e.g. previously opened from the Open Object dialog box), then those existing Open Slot dialog boxes are raised.

As with most of the other toolbar buttons, the Open Slot toolbar button is optionally shown. To show or hide this new toolbar button, select the “View >> SCT Configuration ...” menu item and click on the “Toolbar” tab. Select or deselect this toggle button:

[ ] Button: Open Slots

Window Size Persistence

When an SCT is saved and reloaded, its width and height are preserved. This is automatic -- no user operations or settings are required.

When the user saves the current SCT as the **default SCT configuration** (with “View >> Defaults >> Save Current Settings as Default”), the current size of the SCT becomes the default SCT size.

The default SCT configuration is used in these three situations:

when a new SCT is created;

when the user migrates an old SCT (1.0) to the new SCT;

when the user applies the default configuration to an SCT using “View >> Defaults >> Apply Default Settings”.

Printer Settings

The original release of the SCT 2.0 read and saved the printer selection and printer property choices with every print operation. These values are saved in the “user preferences” of the currently logged-in user account. This causes a problem for RiverWare users who are sharing a single Unix (Solaris) user account. Now, those values are read from the user account preferences only at RiverWare program startup, and are saved at RiverWare program exit (but only if the print operation was used during the session). This insures that a particular person’s print selections remain stable during a RiverWare session even if other users are operating RiverWare logged in under the same user account.

Optional Date/Time Spinner for Timestep Navigation

An optional Date/Time spinner was added to the SCT 2.0 Toolbar for navigating (automatically scrolling) to specified timesteps. This will be useful especially in models with many timesteps.

The Date/Time spinner can be shown or hidden by the user, depending on a setting in the SCT Configuration which is stored in SCT files. The low-level default is to SHOW the DateTime Spinner. (That default can be changed by hiding the DateTime Spinner in an SCT, and then saving that SCT configuration as the default configuration with "View >> Defaults >> Save Current Settings as Default").

To Show or Hide the DateTime spinner:

Select from the SCT menubar: "View >> SCT Configuration ..."

Select the "Toolbar" tab

Turn on or off the following toggle button: [X] Date Time Spinner

Click the [OK] or [Apply] buttons.

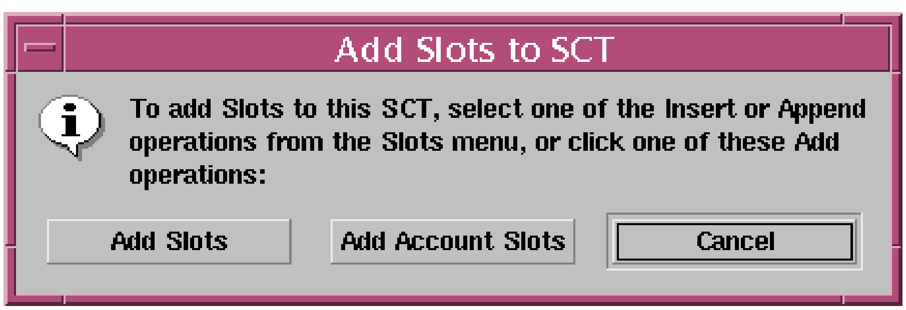
Entering a date in the Spinner, or operating the up and down buttons of the Date/Time spinner causes the SCT to be scrolled horizontally or vertically (depending on the timestep axis orientation) so that the indicated timestep is shown in the leftmost column or topmost row. An exception to this is when the indicated timestep is within the last "screen" of the time range, in which case the SCT is just scrolled to that last screen.

The Date/Time spinner's up and down buttons change the indicated date/time by one timestep, even when the SCT is showing timestep aggregations. Since all the timesteps within an SCT timestep aggregation are shown within the same column (and row -- when details are hidden), the SCT will not always be scrolled as a result of clicking the spinner's up and down buttons.

The "step" of the Date/Time spinner matches the Run Control timestep interval. The Date/Time spinner's time range matches the SCT's time range, which is the time range of Run Control PLUS the number of visible PRE-simulation and POST-simulation timesteps configured in the SCT.

Opening a new SCT, prompt to Add Slots

When creating a new SCT, the message box illustrated below is presented to the user for easy initiation of Slot Selection to add Slots to the SCT. This occurs only if the Workspace is not empty (i.e. only if at least one Object exists).



D. SCT Bug Fixes

Selection Info Area: "Obscured Timesteps" Description on Summary Cells

The time range of certain Series Slots may extend beyond the time range of the SCT. When this occurs, a corner triangle ornament is shown in the upper left or lower right of the slots's first or last timestep cell. Actually, this is shown on both summary cells and detail cells. When one of those cells is selected, a message is displayed in the SCT selection info area (at the bottom of the SCT) indicating the number of timesteps of the Slot which are not visible (i.e. the number of "obscured" timesteps).

There was a bug which sometimes prevented the display of that information in the selection info area when a summary cell was selected. This is now fixed.

Target Operation setting operation: Expand slot's time series

Setting a Target Operation failed (had no effect) if the selected timestep cells extended before or after the time range of the slot. That time range is now expanded as needed.

SCT Configuration Dialog Box fixes

(A) The SCT Configuration dialog box has both an "OK" button and an "Apply" button which apply the user's settings to the SCT. The "OK" button performs the "Apply" operation *and* dismisses the dialog box. There was a bug which sometimes prevented the "OK" button to apply changes if the "Apply" button had previously been operated. This is now fixed.

(B) Applying changes made in the SCT Configuration dialog box interfered with other changes to the SCT (e.g. swapping axis or changes to the timestep aggregation configuration) made when the SCT Configuration dialog box was already open. This is now fixed.

Selection Information Area: Read Only

The Selection Information Area at the bottom of the SCT had been editable by the user. That is now disabled, but the user can still copy text from that area by (1) selecting the desired text, (2) pressing the right mouse button over the selected text, and (3) clicking "Copy" from the context popup menu.

Saved "Lock" status not staying locked on loading an SCT from the Workspace.

The SCT supports a "Lock" toggle which allows certain aspects of the SCT configuration -- generally the set of slots represented in the SCT and the labels used for those slots -- to be unchangeable. With the original release of the SCT 2.0, an SCT opened from the RiverWare workspace always came up UN-locked, regardless of the lock status of the saved SCT. This is now fixed.

Retaining window scroll position after adding slots and other reconfigurations.

With the original release of the SCT 2.0, the action of adding or inserting slots, or performing many other reconfigurations caused the SCT to redisplay from the top-left corner.

Now for slot / slot divider insertion operations and most configuration change operations, the SCT scroll position is retained (measured in pixels from the top-left). An exception to this is the slot **append**

operation, which causes the SCT to redisplay at the end of the slot list (either the last row or the last column, depending on the timestep axis orientation).

Target Operation: Invalid state possible when pasting a new target operation over an existing one.

Bug 3446. Under certain conditions, as a result of pasting a copied timesteps containing a target operation, it was possible for the Begin Target flag of an existing Target Operation to not be cleared when it should have been. This is now fixed.

Model name change not reflected in SCT window title.

Bug 3435. The SCT window title shows both the name of the SCT and the name of the currently loaded model. The latter was not being updated when the name of the loaded model (i.e. the name of the RiverWare workspace) was changed, e.g. after performing a "Model >> Save As ..." operation from the workspace window. This is now fixed.

Clicking OK in the Multiple Slot Selector does not always add the highlighted slots to the SCT.

Bug 3432. There were actually several bugs in the Multiple Slot Selector, including a related one which showed up in the Diagnostic Manager (See bug 3526 and 3533 in the bug reporting system -- not described in this document).

Disable Dispatching cross-hatching is not updated in the SCT when selected from the Model Run Analysis dialog.

Bug 3433. Before the SCT 2.0, the Model Run Analysis dialog was the only place from which the Object Dispatching Disabled state for an Object could be changed, so no system-wide notification was needed, and none was implemented. This has been added. So any change of this property on an Object made in any SCT or in the Model Run Analysis dialog now causes an update in the others displaying the respective Object.

Bad Timeslice copying: Paste as Input into TableSeriesSlots

Bug 3498. When copying a whole timestep range across all Slot Items in an SCT which includes Table Series Slots, the Paste As Input operation skipped every other target timestep. For example, for a Table Series Slot:

Selected Values: `111 222 333 444`
Target Values: `111 (no change) 222 (no change)`

Can't see data in high precision in SCT

Bug 3512. The contents of the Toolbar Value Entry Field and the initial value displayed during an in-cell edit operation had been displayed always with six fractional decimal digits, regardless of the configured "precision" of the Slot containing the value. Now, the Slot's precision is respected, but a *minimum* of six fractional decimal digits are displayed.

Slot name changes not handled properly.

The association between an SCT's reference to a Slot and the actual Slot wasn't being maintained when the Slot's name changed. A Slot's name can change in the following three ways:

The Slot's containing Object is renamed by the user.

The Slot's containing Account is renamed by the user.

For Slots on a Data Object, the Slot is renamed by the user.

The change of a Slot's name doesn't effect the displayed Slot item label, since the Slot label is only *initialized* from the Slot name. But the Slot List saved in SCT files, and the display of the actual Slot name in other parts of the SCT (e.g. in the Selection Info area) do need to use the actual current Slot name.

11. Bug Fixes

The following is a list of the bugs which were fixed for this release. If you wish to view the details for a specific bug, please browse to http://cadswes.colorado.edu/users/gnats-query.html and search our bug database. You will need a RiverWare user login and password.

351	431	447	494	593	599	663
739	781	967	1184	1607	1824	2553
2573	2590	2639	2670	2851	3068	3115
3116	3261	3349	3352	3381	3396	3396
3400	3401	3402	3403	3404	3405	3407
3408	3409	3410	3411	3415	3416	3418
3420	3421	3422	3423	3424	3426	3427
3428	3429	3431	3432	3433	3434	3435
3436	3437	3438	3439	3440	3442	3444
3445	3446	3447	3448	3449	3450	3451
3452	3453	3454	3455	3457	3458	3459
3461	3462	3463	3465	3466	3467	3468
3469	3470	3471	3472	3473	3474	3475
3476	3477	3479	3480	3482	3483	3483
3484	3485	3486	3487	3488	3489	3493
3494	3497	3498	3499	3500	3503	3506
3508	3512	3513	3515	3516	3517	3518
3521	3522	3524	3525	3526	3528	3529
3530	3533	3539	3540	3541	3543	3546

Current Release Notes Version 4.6

1. Special Attention Notes

If the text or graphics in this file are not clear, you may need to print this document. Resolution should improve on the printed page.

Full conversion to new SCT (2.0)

In completing the migration to the new SCT, it is now no longer possible to create an old style (1.0) SCT. Now when users select **SCT -> New SCT**... the new version (2.0) of the SCT is automatically created. When 1.0 version SCTs are loaded and saved they are automatically converted to the 2.0 version SCT.

Flags set by rules

Whenever a rule sets the Drift, Max Capacity, or Best Efficiency flag on a slot, RiverWare now requires that object to dispatch immediately. This is the usual behavior, but if it does not occur, RiverWare will post an error message and abort. Users should be able to resolve this error by reordering rules or restructuring the rule logic.

Partition BW Elevation method changed to Weighting Coefficients method

The Slope Partition category and the Partition BW Elevation method on the Slope Power Reservoir have been removed and replaced by the Slope Storage Coefficients category and the Weighting Coefficients method. Users with models in which the Partition BW Elevation method was selected will have to select the Weighting Coefficients method the first time the model is loaded. Also, any user input slot data related to the Partition BW Elevation method will have to be re-imported into the Weighting Coefficients method's slots. All slot names have remained the same.

Hydro Capacity slot on Inline Power object

The Hydro Capacity slot on the Inline Power object is now only available and computed if a power method is selected.

Check Iterations

Check Iterations is now always enabled during rulebased simulation. Check Iterations checks the number of times a slot is set during one timestep and is used to detect infinite loops. Previously, having 'check iterations' turned on slowed down model performance. Now there is no decrease in performance when Check Iterations is turned on.

RPL Expression Slots

Values in RPL expression slots which are evaluated “Never” or “Only Interactively” are now no longer cleared at the beginning of a new run. Previously these values were always cleared and would remain cleared until the user interactively evaluated the slot. Users should be aware that values in an expression slot evaluated “Never” or “Only Interactively” could be the result of a previous run, i.e., the run after which the slot was evaluated.

2. General RiverWare

A. DMI

Calling DMIs from rules

It is now possible to execute DMI groups from rules. The user can associate one or two DMI groups with a rule. Whenever the rule is executed, the DMI groups are executed, one as the first step of rule execution, one as the last. Values imported by the pre-execution DMI group are available for use by the rule's statements. To add the execution of a DMI group, select **rule --> add pre-/post-execution DMI group**.

An example application of this new feature is executing an external water quality model at each timestep. In this example, the water quality model might take as input RiverWare values which reflect the current state of the system and return a recommended reservoir release value. At each timestep the rule would first execute an output DMI to export current values from relevant RiverWare slot(s), e.g., inflow on a reach. An input DMI then runs the external water quality model (which reads the data from the output DMI) and then imports the resulting recommended reservoir release values.

Modification of the data_date keyword

The behavior of the data_date DMI keyword has been modified as follows: If the data_date is earlier than the slot's start date (after the start_date keyword has been processed), the slot's start date is set to the data_date. Similarly, if the data_date is later than the slot's end date (after the end_date keyword has been processed), the slot's end date is set to data_date. In either case a diagnostic message is posted.

DMI allows spaces in paths

The DMI now allows spaces in file paths if the user selects the "allow spaces in file paths" option in the DMI editor dialog. Previously the DMI would replace spaces in paths with '_'. Note that if users have written their DMI executable to recognize white space as the end of a path, and they begin using spaces in path names, then the executable should be modified.

Diagnostics

When all slots are successfully processed by a DMI, an informational diagnostic is generated. Previously this was a warning message. If not all the slots were successfully processed, a warning is still posted.

B. Batch Mode

Output during batch mode

A new command, Output <outputName>, has been added to the RiverWare Command Language (RCL). The command allows output files to be generated directly from batch mode, so long as the output configuration has already been specified in the Output Manager of the model. Note that Plot Pages cannot be generated. If an Xmgr Data Format File is to be generated, the option to **Save to File** (rather than Send to Plot Program) must be selected.

Setting user parameters

RCL has been modified to allow the batch script to set user parameters with the following command:

InvokeDMI (dmi name) -UuserParam1=value -UuserParam2=value ...

Multiple user parameters can be set. The parameters and their values must be valid, otherwise the batch script fails. If the model is saved, the parameters and their values are not saved with the model file.

C. Workspace

New implementation

The workspace has been reimplemented in Qt with many new features. A brief overview of the new features is provided below. Please see the workspace documentation in the RiverWare help for more details.

- New zooming capabilities magnify objects or zoom out to examine a model in less detail. The zoom features can be accessed by clicking on the zoom buttons on the toolbar or by right clicking with the mouse on the workspace.
- Context sensitive pop-ups provide information about objects and links when the mouse is “hovered” above the object or link.
- A dockable listview window displays a list of all objects on the workspace. Objects can be listed alphabetically, by object type, etc. The dockable window can be moved to new positions on the workspace or completely detached from the workspace by clicking on the raised grey lines (the handle) of the window and dragging it to a new position.
- The canvas properties: width, height, background color, text color, font, and icon size can be modified in the new Canvas Configuration Dialog by selecting **Workspace ➥ Canvas Properties** or by right clicking with the mouse on the workspace.
- Right-clicking on a link, an object, the workspace, etc. provides pop-up context menus for options such as adding/deleting links, opening/adding/ deleting objects, zooming etc.
- The entire workspace image can be printed by selecting **File ➥ Print.**

D. Run Control Dialog

New implementation

The Run Control dialog has been reimplemented in the Qt GUI interface. After changing the run start/ end date, users must click a green check mark to accept or red x mark to cancel the changes before the run can be started.

E. Multiple Run Management

The Multiple Run Management (MRM) dialog has been reimplemented in Qt and has many new features. These new features are described briefly below. For more detail, see the MRM documentation in the RiverWare help.

Multiple configurations

The MRM now supports multiple configurations contained in one model file. The Multiple Run Control dialog opens with a list of the configurations saved with the model file. Users must select the desired configuration to edit or run it. This flexibility could be useful for models in which users may want to run an MRM run with two or three different rulesets.

Output to multiple files

It is now possible to send the output from a MRM run to multiple files, potentially one file for each slot. To do this, users can modify the output control file using the standard DMI syntax: object.slot file=fileName. Previously, the output from a MRM file was always in the form of a RiverWare Data Format (RDF) file which could be used with ExcelWriter.

Output DMI after each run

It is now possible to run an output DMI after each MRM run. This works like a normal DMI, e.g., outputting one file per slot rather than a combined RDF file.

Providing trace number to input/output DMIs

When running multiple traces in MRM, it is now no longer necessary to write an input (or output) DMI for each trace when the only difference in the DMIs is the trace number. To make use of this new feature, the DMI executable can reference the last command line parameter passed from RiverWare: -STrace=traceNumber.

Portable MRM configurations

It is now possible to use environment variables when specifying a policy set, thus allowing portability across machines. To use an environment variable, users can directly type in the path to the policy set rather than using the file chooser.

Classic configuration or Lite configuration

In the default MRM configuration (now called Classic), MRM runs execute once for each combination of each DMI with each index sequential or concurrent run. With the Lite configuration, MRM runs execute once for each DMI-index sequential/concurrent run pair. The Lite configuration is needed to run the CRSS Lite model.

DMIs can be a DMI group

MRM can now call DMI groups. If a DMI group is called during MRM, all the DMIs in the group must be input DMIs or all must be output DMIs.

F. Diagnostics

Improved table interpolation diagnostics

The diagnostics for table interpolations have been improved. When an interpolation fails, RiverWare now posts a diagnostics which describes the slot name, date (when applicable), and value that was used for the failed interpolation.

CLEAR_STATE and RESET_STATE diagnostics removed

The CLEAR_STATE and RESET_STATE diagnostics have been removed from Simulation. These messages were deemed excessive and not useful.

G. Table Slots

Configuring Units

It is now possible to configure the user units for all columns of a table slot at the same time. (This functionality already exists on AggSeriesSlots and other columnar slots.)

H. Expression Slots

Display of RPL expression

The RPL expression in an expresison slot is now only displayed if the expression is currently invalid. Selecting **View->Show Expression** (Alt+Shift+S) will display / hide the RPL expression.

Values in slots evaluated "Never" or "Only Interactively" not cleared

Values in RPL expression slots which are evaluated "Never" or "Only Interactively" are now no longer cleared at the beginning of a new run. Previously these values were always cleared and would remain cleared until the user interactively evaluated the slot. Users should be aware that values in an expression slot evaluated "Never" or "Only Interactively" could be the result of a previous run, i.e., the run after which the slot was evaluated.

I. SCT

Export Copy

The Export Copy function of the SCT now supports optional inclusion of displayed (non-hidden) row header fields associated with the cells selected for Export Copy. This option is available by first selecting several cells, then selecting Export Copy from the Edit menu, then in the resulting Export to Clipboard dialog toggling the 'Include Row Headers' box.

Go To Feature

The SCT now has a new 'Go To' feature which allows the user to find a slot in the SCT and "jump" to that position in the SCT. By selecting **Go To ➥ Find Slot...**, the user can search for a slot in two ways: by searching for a slot beginning with a specified string, or by searching for a slot that matches a given wildcard pattern (i.e. *Inflow*). If dividers have been added to the SCT, the user can jump to the slot following each of the specified dividers.

Full conversion to new SCT (2.0)

In completing the migration to the new SCT, it is now no longer possible to create an old style (1.0) SCT. Now when users select **SCT -> New SCT...** the new version (2.0) of the SCT is automatically created. When 1.0 version SCTs are loaded and saved they are automatically converted to the 2.0 version SCT.

No display of hours in timesteps of days or longer

The SCT no longer displays the hours for models with a timestep of days or longer. This is valid because for daily and larger timesteps the hours are always aligned at midnight (24:00).

J. Model File Information

Model File Timestamp

RiverWare model file timestamps are now updated each time the model file is saved, rather than the first time after the model file is loaded.

K. Model Save Backups

Backups of previous RiverWare versions automatically created

Previously RiverWare always used the ".bak" suffix; now it uses the old version number when a model file is saved with a new version for the first time. For example, when model.gz-, last saved with version 4.5- is saved with version 4.6, the backup name will be model.4.5.gz (rather than model.bak.gz). This ensures there will be a model file compatible with version 4.5 until the user explicitly removes it.

L. RiverWare Policy Language (RPL) Editor

RPL editor dialogs reimplemented in Qt

The RPL editor dialogs have been reimplemented in Qt with several new enhancements. These changes are described briefly below. Additional detail is available in the Ruleset Editor Dialog documentation in the RiverWare help.

- Context sensitive menus (menus specific to the area in which you clicked) pop up with a right mouse click.
- **View -> Disable Mouse Edits** disables the ability to turn rules on and off by clicking on the rule and also disables the ability to edit the name of a rule directly in the RPL Set Editor.
- Execution constraints other than “Execute only when TRUE” will be shown by default. Otherwise this section of the rule editor will be hidden and can be accessed by selecting **View -> Execution Constraints**.
- Rule descriptions are by default hidden. View the rule descriptions by selecting **View -> Show Description** from the rule editor, or by selecting **View -> Show Selected Description** for the main RPL set dialog to toggle through descriptions of every rule or function in the RPL set.
- **View -> Close Other Editors** closes all other RPL boxes besides the main RPL editor and the current dialog.
- **View -> Expand/Collapse All Groups** expands/collapses groups to show/hide all rules and functions

M. Multiple Object/ Slot/ Account Selector

Multiple Object/Slot/ Account Selector updated in Qt

RiverWare 4.6 includes the initial implementation of the new Qt "Grand Unified Selector" for the selection of Simulation Objects, Physical Slots, and Accounts. All former uses of the old Galaxy-implemented Multiple Object and Multiple Slot selectors are replaced by this new selector, including within the SCT, Diagnostics Settings dialogs, Output Configuration Manager, Snapshot Manager, Multiple Object Method Selector, Edit (user-defined) SubBasins manager, Supplies Manager, Scenario Manager, MRM Slot Store, and the Reservoir Selector (e.g. for ListSlots on the Control Point object).

New features include:

- For Slot selection, the ability to select individual columns of AggSeries, TableSeries, and Table Slots (if appropriate for the particular selection)
- Filtering of presented items, with either inclusion or exclusion of the matching items, by:
  - Name wildcard-match (SimObj, Slot, or Account).
  - SimObj "has Account" (any, or a single selected Account)
  - SimObj inclusion in a user-defined SubBasin (any, or a single selected SubBasin)
  - Slot Unit Type (e.g. "Flow", "Area", etc.)
  - Slot Type (e.g. "Series", "AggSeries", "Expression", ...)
  - Slot Attributes ("Dispatch" or "RBS Governing").
  - Account Type

- Account Water Type
- Account Water Owner

N. Sedmtr file

sedmtr file updated

The sedmtr file that is packaged with RiverWare releases for use with CRSS has been extended by copying the first 15 simulations to the end of the file. This extension allows MRM to now perform 100 simulations for CRSS.

3. RiverWare Viewer

RiverWare Viewer is a "read-only" version of RiverWare. This version of RiverWare is available at no cost to those who would like to view the output of model runs, but do not need to build, modify or run models themselves.

Current license holders do not need a new license to run RiverWare Viewer. Full RiverWare license holders can download the RiverWare 4.5 Release and run and examine RiverWare Viewer through the command line by typing:

riverware --viewer

Stakeholders and other parties interested in using only the RiverWare Viewer can download it for free from the CADSWES web pages. Information and instructions are provided on the RiverWare Viewer web page:

http://cadswes.colorado.edu/riverware/viewer/

RiverWare Viewer users must contact CADSWES directly for the free license file. In future releases, this process will be automated through the CADSWES web pages.

4. Scenario Manager

The Scenario Manager is a new tool that allows for editing only a small portion of a RiverWare model to test various scenarios without affecting the integrity of a baseline model. A brief overview of the Scenario Manger is provided in this document. The user is encouraged to consult the **Scenario Manager** documentation in the RiverWare help for a more details.

The Scenario Manager provides the capability to create a baseline model that cannot be altered by other users. The creator of the baseline model can specify a set of slots for which values may be changed by a different user to test various scenarios. Models can be viewed and run using these various scenario values without corrupting the values in the baseline model. The Scenario Manager provides a convenient interface to load, edit, and save values for these slots, run the model using these different slot values, and compare the baseline values with the scenario values. The key components of the Scenario Manger are desecribed below:

Creation of a baseline model

A baseline model must be generated before any scenarios can be created. The baseline model is generated by saving an existing model, with or without a ruleset, as a baseline model. Once a model has been saved as a baseline model, model topology, methods, rulesets, and non-scenario slots become uneditable.

Creation of a scenario slot list

The creator of the baseline model specifically sets which slots can be manipulated by other users to generate new scenarios. This list cannot be edited other than changing input values by scenario users. New scenarios to test permutations of the model can only use the slots specified in the scenario slot list, and all input values must fall within the minimum or maximum constraints (if any) set on the slot.

Creating, editing, and running scenarios

Once the baseline model with scenario slot list has been created, other users can create, edit, and run scenarios of the baseline model. The scenario users first create a scenario by providing alternative data for slots in the scenario slot list and saving the scenario. The scenario can then be run using the new data.

Comparing scenario runs

The Scenario Manager allows for comparisons between slots in the baseline scenario run and various scenario runs or between slots in the various scenario runs. Comparisons are managed through the Snapshot Manager and the Output Manager.

5. Simulation Objects

The following enhancements to the RiverWare simulation objects are described briefly. The user is encouraged to consult the **Simulation Objects Documentation** in the RiverWare help for more detailed descriptions of the enhancements to the objects and their methods.

A. Computational Subbasin

Mead Flood Control Method

The Mead Flood Control method has been added to the Computational Subbasin. This method was developed for the CRSS-Lite annual timestep model and cannot be used with other models. The method is used for annual flood control calculations on Lake Mead. A series of CRSS-Lite slots and objects, identified by name and type, must exist on the workspace and be members of the computational subbasin for the subbasin analysis to succeed.

B. Reservoir Objects

Monthly Evap Calc Annual Timestep Method

A new evaporation method, MonthlyEvapCalcAnnualTimestep, has been added to all reservoir objects. This method calculates evaporation on an annual timestep using monthly coefficients and was developed for use with the CRSS-Lite model. This method is general enough to be used with any annual timestep model that has monthly evaporation coefficients.

C. Storage Reservoir

Tailwater Calculation Category

The Tailwater Calculation category has been added to the Storage Reservoir. A single method, Input Tailwater Elevation, was added to the category. This method is used if the tailwater elevation is linked to the downstream reservoir pool elevation or directly input by the user. There are no tailwater elevation calculations associated with this method. In other words, the outflow does not affect the tailwater elevation other than by changing the downstream pool elevation. When the tailwater elevation is above the tailwater reference elevation, the effective head is used to compute the max release via the 'Head Vs Max Release' table. Otherwise, the max release is calculated using the average Pool Elevation and the Max Release table. The following slots are associated with this method: Tailwater Elevation, Tailwater Reference Elevation, Effective Head, and Head Vs. Max Release.

D. Slope Power Reservoir

Slope Storage Coefficients Category

A new method category, the Slope Storage Coefficients category, has been added to the Slope Power Reservoir. The category contains two methods: Impulse Response Coefficients and Weighting Coefficients. The Impulse Response Coefficients method is the default and calculates segment and reservoir storage in the previously existing manner. The Weighting Coefficients method uses weighting coefficients to calculate the segment and reservoir storage. When the Weighting Coefficients method is selected, the reservoir can be divided into longitudinal partitions and the steady flow through each partition (intermFlowParams) is calculated. The flow parameter at each partition is then used in a 3-D table interpolation to find the backwater elevation at each of the partitions. This method replaces the Slope Partition Category and Partition BW Elevation method. Existing models that used the Partition BW Elevation method must be updated by selecting the Weighting Coefficients method and reimporting data into the method dependent table slots. The Weighting Coefficients method works with both simulation and optimization.

E. Inline Power Reservoir

Computation of Hydro Capacity

The Hydro Capacity slot that is used in optimization was previously being computed/linearized as Maximum Turbine Release times the Power Plant Capacity Fraction. This flow value is now converted to power using the Flow Power Table. This is done for both simulation and optimization. Also, because optimization now calculates the Hydro Capacity at the beginning of the run, this removes the need to linearize Hydro Capacity and it is now a SeriesSlot instead of a AggSeriesSlot. Note that Hydro Capacity is now only available and computed if a power method is selected.

F. Bifurcation Object

Fractionally Split Outflows method

A new method category, Outflow Calculation, has been added to the bifurcation object. This category contains two methods: Two Outflows and Fractionally Split Outflows. The Two Outflows method is the default and solves exactly as the bifurcation did previously. The Fractionally Split Outflows method allows users to split the outflow into multiple outflow destinations (e.g., more than two). The Split Outflows slot is a nocompute multislot in which each subslot represents one outflow from the bifurcation object. The Outflow Fractions Table is used to calculate what fraction of the total outflow is proportioned to each Split Outflows subslot. When the Fractionally Split Outflows method is selected, the inflow must be known for the Bifurcation object to solve. The Fractionally Split Outflows method is not available for use with optimization.

Solve Downstream Only method

A new method, Solve Downstream Only, allows users to specify that the bifurcation object always solves in the downstream direction (i.e., solve for outflow given inflow). This method can be useful in rulebased simulation models where rule priorities can cause the object to dispatch in different directions, potentially causing problems. This method is available from the Bifurcation Solution Direction category. The default method in this category, Solve Upstream or Downstream, allows the object to solve in the previous manner.

6. Rulebased Simulation

A. Calling DMIs from rules

It is now possible to execute DMI groups from rules. The user can associate one or two DMI groups with a rule. Whenever the rule is executed, the DMI groups are executed, one as the first step of rule execution, one as the last. Values imported by the pre-execution DMI group are available for use by the rule's statements. To add the execution of a DMI group, select **rule --> add pre-/post-execution DMI group**. (See the General RiverWare section above for an example application of this new feature.)

B. Flags set by rules

Whenever a rule sets the Drift, Max Capacity or Best Efficiency flag on a slot, RiverWare now requires that object to dispatch immediately. If it does not, RiverWare will post an error message and abort. Users should be able to resolve this error by reordering rules or restructuring the rule logic.

C. Check Iterations

'Check Iterations' is now always enabled during rulebased simulation. 'Check Iterations' checks the number of times a slot is set during one timestep and is used to detect infinite loops. Previously, having check iterations turned on slowed down model performance. Now there is no decrease in performance when Check Iterations is turned on.

D. Rules Palette Predefined Functions

Following is a brief description of new predefined functions and changes to existing predefined functions available for use in the RiverWare Policy Language. Details on the use of these functions and the syntax involved are available in the **Rulebased Simulation Documentation** in the RiverWare help.

RunStartDate()
RunEndDate()

These functions return the start or end date of the currently active controller.

NumColumns (SLOT tableSlot/periodicSlot)
NumRows (SLOT tableSlot/periodicSlot)

These functions return the number of columns or rows in a table slot or periodic slot. If the slot is not a table slot or periodic slot, the run is aborted with an error message.

TableLookup (SLOT tableSlot, NUMERIC lookupColumn, NUMERIC returnColumn, NUMERIC lookupValue,

DATETIME referenceDate, BOOLEAN roundDown)

This function looks up a value in a specified column of a TableSlot, finding the row whose value is closest to the lookup value and smaller/larger as specified by an argument, and returns the value in that row of the specified column.

SovleMonthlyStorageAnnualTimestep(OBJECT reservoir, SLOT res inflow, SLOT res outflow, SLOT res previous storage, DATETIME month at which to do the calculation)

This function solves for a monthly storage value in an annual timestep model. The function was developed for use with the CRSS-Lite model but is general enough for use in any annual timestep model.

SolveMonthlyOutflowAnnualTimestep(OBJECT reservoir, SLOT res inflow, SLOT res storage, SLOT res previous storage, DATETIME month at which to do the calculation)

This function solves for a monthly outflow value in an annual timestep model. The function was developed for use with the CRSS-Lite model but is general enough for use in any annual timestep mode.

MeadFloodFontrol(STRING name of subbasin, DATETIME current timestep, SLOT previous Powell storage, SLOT current Powell storage, SLOT previous Mead storage, NUMERIC flood control release month index)

This function invokes the Mead Flood Control user method on the computational subbasin and returns the current storage in Mead. The function can only be used with the CRSS-Lite model because it requires that certain objects and slots, identified by name, be part of the model and computational subbasin.

SupplySlotsFrom (LIST object account pairs, STRING release type, STRING destination)
SupplySlotsFrom1to1(LIST object account pairs, STRING release type, STRING destination)

These functions return a list of Supply slots of Supplies which represent outflows from given Accounts and which have the indicated ReleaseType and Destination. The 1 to 1 version is used to return exactly one supply slot for each account. If there is more than or less than one supply for each account, the function will produce an error message and abort.

SupplySlotsFromIntra (LIST object account pairs, STRING release type, STRING destination)
SupplySlotsFromIntra1to1(LIST object account pairs, STRING release type, STRING destination)

These functions return a list of Supply slots of Supplies which represent internal flows from given Accounts and which have the indicated ReleaseType and Destination.The 1 to 1 version is used to return exactly one supply slot for each account. If there is more than or less than one supply for each account the function will produce an error message and abort.

SupplySlotsTo (LIST object account pairs, STRING release type, STRING destination)
SupplySlotsTo1to1(LIST object account pairs, STRING release type, STRING destination)

These functions return a list of Supply slots of Supplies which represent inflows to given Accounts and which have the indicated ReleaseType and Destination.The ‘1 to 1’ version is used to return exactly one supply slot for each account. If there is more than or less than one supply for each account the function will produce an error message and abort.

SupplySlotsToIntra(LIST object account pairs, STRING release type, STRING destination)
SupplySlotsToIntra11o1(LIST object account pairs, STRING release type, STRING destination)

These functions return a list of Supply slots of Supplies which represent internal flows to given Accounts and which have the indicated ReleaseType and Destination.The ‘1 to 1’ version is used to return exactly one supply slot for each account. If there is more than or less than one supply for each account, the function will produce an error message and abort.

E. Hypothetical Simulation

Diagnostic message changes

The diagnostic message format for HypSim has changed slightly. Previously the messages for a hypothetical simulation object were preceded by “object_HpySim:”. Now the messages are preceded by “HypSim:subbasin:object”.

Performance improvements

There have been significant performance improvements to the execution of hypothetical simulation. This is achieved by saving clones of subbasins and the recycling memory allocated to the subbasins’ series slots.

7. Accounting

A. Supply Manager Dialog

Supply Role

The Supply Role has been added as an optional column and sort criteria to the Supply Manager dialog. The existing supply roles are “StandAlone”, “ExchInput”, “Borrow”, “ExchDest” and “Payback”.

B. Pass Through Accounts on Reservoirs

Solution with Diversion and Return Flow

‘Pass through accounts’ on reservoirs now account for diversion and return flow when solving for storage and outflow. Previously there was no solution method to account for diversions on pass through accounts on reservoirs.

C. Transfers

Transfers accept negative values

Transfers-in and -out now accept negative values. They used to issue an error and refuse a negative value.

8. Optimization

A. Power Regulation

Computation of Hydro Capacity

The Hydro Capacity slot was previous being computed/linearized as Maximum Turbine Release times the Power Plant Capacity Fraction. This flow value is now converted to power using the Flow Power Table. This is done for both simulation and optimization. Also, optimization now calculates the Hydro Capacity at the beginning of the run. This removes the need to linearize Hydro Capacity and it is now a SeriesSlot instead of a AggSeriesSlot. Note that Hydro Capacity is now only available and computed if a power method is selected.

B. Behavior Prior to Beginning of Run

Referencing variables prior to Beginning of Run

Prior to this release, a small number of optimization variables could not reference values before beginning of run. This has been corrected.

9. Closed Bug Reports

The following is a list of the bugs which were fixed for this release. If you wish to view the details for a specific bug, please browse to http://cadswes.colorado.edu/users/gnats-query.html and search our bug database. You will need a RiverWare user login and password.

2678	3089	3555	3556	3561	3572	3574
3576	3577	3578	3579	3581	3582	3584
3585	3586	3587	3591	3593	3598	3600
3601	3602	238	243	244	247	253
256	257	263	269	270	272	274
276	281	287	290	291	292	293
313	343	400	402	403	404	405
406	417	426	434	436	437	438
439	440	448	449	458	461	464
466	475	478	493	497	515	519
520	521	522	524	525	536	544
552	561	566	568	570	586	597
598	600	601	606	607	608	618
620	625	627	631	632	647	656
657	662	664	670	682	703	737
743	792	795	854	866	899	909
920	929	930	931	936	946	948
949	950	951	952	953	981	982
987	988	989				

Current Release Notes Version 4.7

1. Special Attention Notes

If the text or graphics in this file are not clear, you may need to print this document. Resolution should improve on the printed page.

Optimization Slots

In the process of implementing the new optimization controller, a number of slots were added or modified. The new slots are visible when using the existing controller but should not affect model behavior. In addition, the number of columns of some LP Parameter slots were modified to make them consistent. This could affect DMI's. Finally, the Hydro Generation slot on the Thermal Object was previously being set to zero at the end of the run if not valid. This no longer occurs in this release.

2. General RiverWare

A. Database DMI's: HEC-DSS connection

There is now the ability to develop a direct connection between RiverWare and the Hydrologic Engineering Center's Data Storage System (HEC-DSS). This connection is established by creating a new Database DMI from the DMI menu of the DMI Manager. Parameters, Name Maps and Data Sets are then created in the Utilities menu. More information on this feature can be found in the **Data Management Interface Documentation** in the RiverWare Help. This is the alpha release of this feature; the functionality and user interface are still under development.

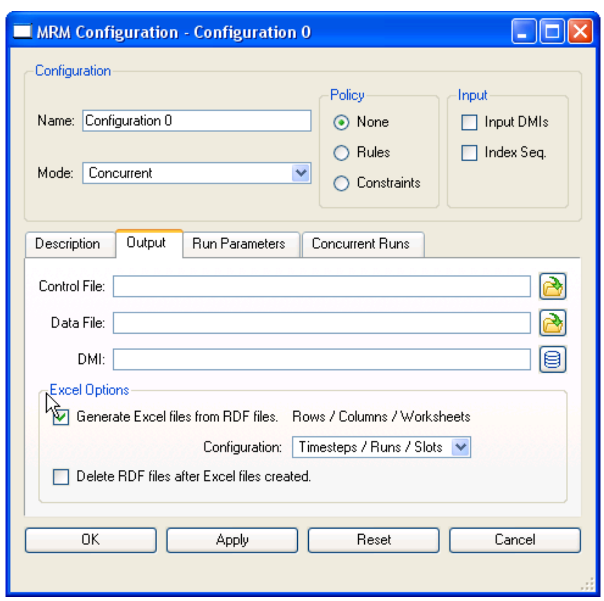
B. DMI

It is now possible to use scalar, list, and periodic slots in DMI import and/or export processes. The syntax necessary to use these slots is described in the **Data Management Interface Documentation** in the RiverWare Help.

C. Multiple Run Management

Generate Excel Files from RiverWare

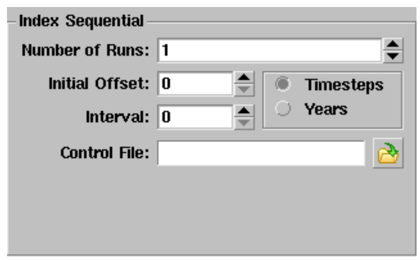
In MRM, it is possible to generate Excel files directly from RiverWare (Windows only), bypassing the ExcelWriter step. A screen shot of this feature is shown in the figure.



In the Output tab of the MRM configuration, the user must select the toggle: "Generate Excel files from RDF files" and then specify the configuration. MRM then creates the Excel files specified data files. The user can also specify that they wish to delete the RDF files after the Excel files are created.

Index Sequential Rotate By Years

An option has been added to the input tab of the MRM Configuration dialog to allow the initial offset and interval of rotation of input data for index sequential runs to be specified in years as well as in timesteps. The addition of years allows for daily data to automatically rotate 365 or 366 timesteps for each year depending on whether or not it is a leap year. This prevents an accumulating offset of the input data over many runs due to the leap year days if only 365 timesteps can be specified as the rotation.



Output Data File

In MRM, the output data file is now editable again in the user interface. Previously it was read only for models which migrated from the old MRM implementation to the new.

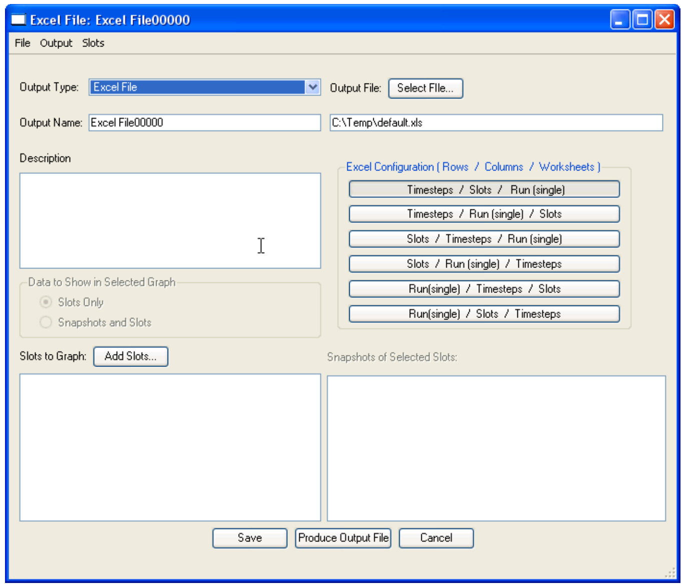
D. Output Manager

Output Manager Ported to Qt

The Output Manager was ported to Qt to improve its maintainability and appearance.

Generate Excel Files from RiverWare

Enhancements were made to allow the user to directly generate Excel files from Riverware (Windows platform only). This is accessed from the Output Manager as a new Output Type. The user must enter an Output Name and select or enter the name of the output Excel file. The user then selects the slots and the desired Excel configuration, i.e. slots as rows, timesteps as columns, runs as worksheets. A screen shot of this feature is shown in the figure. The user no longer needs to create RDF files and use ExcelWriter.



Plotting Accounting Slots

Accounting slots can now be plotted directly from the Plot Dialog. Previously, accounting slots could only be plotted from the Output Manager or from the SCT.

Environment Variables in the Output Manager

It is now possible to use environment variables in the output file paths for output devices.

E. Scenario Manager

Scaling Scenario Slots

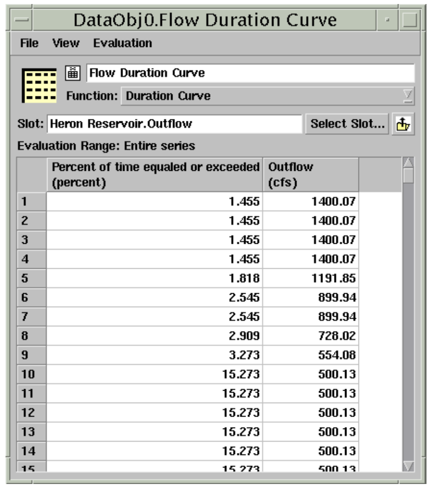
In the Scenario Manager, it is now possible to scale all of the values in a scenario slot using the Scale Slot menu option. It is also possible to revert those scaled slots back to baseline values using the Fill with Baseline Values menu option.

F. Statistical Table Slots

Flow Duration and Annual Max Frequency Curves

The Statistical Table slot was added to the Data Object. The user selects the desired series slot as input and selects either a Duration Curve or a Max Annual Frequency Curve. The Duration Curve ranks the data in order and calculates the percentage of time each value is equaled or exceeded. The Max Annual

Frequency Curve determines the maximum value for each year, then ranks the values and determines the percent exceedence. The user can then plot the resulting statistical data.



G. Run Control

Extended Time Series Range

The date/time range was extended from 500 years to 2,000 years. The valid date/times now range from 24:00 December 31, 1799 to 24:00 December 31, 3799.

H. Batch Mode and RiverWare Command Language (RCL)

New command line arguments

New command line arguments were added for running RiverWare from a command line prompt. The --objlist <file> prints a sorted list of all the simulation objects in the model, once loaded, to the specified <file>. The --slotlist <file> argument prints a list of the slots in the model, once loaded. Included with this is descriptive information about the slot including input or output data. By default, the initial timestep is used to characterize the data. The --slotdate <date> option changes the timestep at which it characterizes data. The <date> is specified as a string, e.g. “12:00 March 13, 2006.” Finally, the --acctdata <file> option prints a list of the accounts and descriptive information to the specified <file>. A full list of command line arguments can be found by typing “riverware --help” in the command window.

StartController Enhancement for MRM

In the RiverWare Command Language, the StartController command was extended to include the MRM configuration name:

```
StartController!MRM {configuration name}
```

If the configuration name isn't specified, or if it doesn't exist, batch mode prints an error message and exits.

I. Working with Models on Windows and Solaris

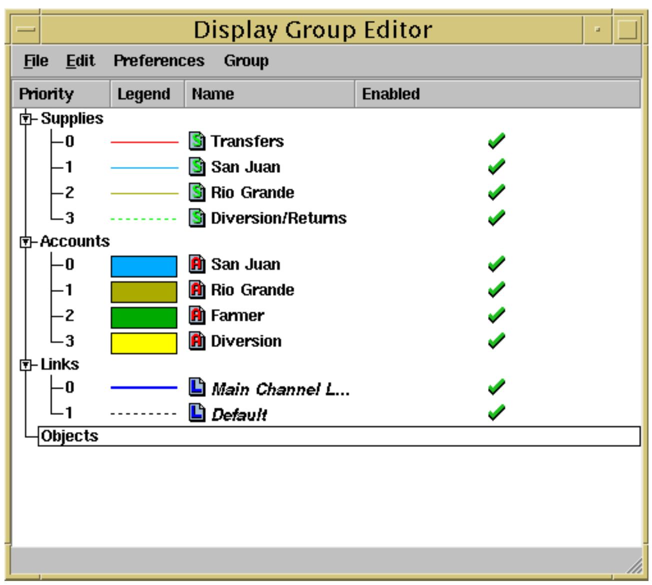
It is no longer necessary to save a model using the .gz extension if you wish to use it on both Windows and Solaris platforms. Now, models saved in an uncompressed format should be compatible on both platforms.

3. User Interface Enhancements

A. RiverWare Workspace

Object and Link Display Groups

There is a new feature called the Display Group Editor that allows the user to change the appearance of the Objects, Links, Accounts, and Supplies on the workspace. A screen shot of the editor is shown below. These groups contain members that are chosen using the new selector dialog. The selector dialog, described below, can be used to filter by attributes. The user is then able to change the display for the entire group. For example, all main channel links can be colored while diversion and return flow links can be dotted grey. The groups are prioritized such that a higher priority (lower number) will override a lower priority if there are conflicts amongst group members. The groups can be disabled or enabled using the check mark on the right of the editor.



Time Scroll Option on Abort

On an aborted run, it is now possible to scroll all time-scrollable windows to the context time. If the run aborts, there is now a “Time Scroll” button on the RiverWare notice window. For example, if your model aborts on Jan. 1, 1985, the user can select to scroll all time windows, like the Open Slot dialog, SCT’s and the Plot window to this date. This saves the user time when debugging the model.

Show Workspace Option

A new option was added to the File menu of the Open Slot and Open Object dialog that allows the user to show the workspace. This is accessed from the File -> Show Workspace menu.

Close All Objects and Open Selected Objects

On the Workspace menu, there is now an option to close all Open Object and Open Slot dialogs. This is accessed from the Workspace->Objects and Workspace->Slots menus, respectively. The submenu for Slots in the Workspace menu is also new; it contains the following operations: Open Slot and Close All Slots.

New Sub menus in the Policy Menu

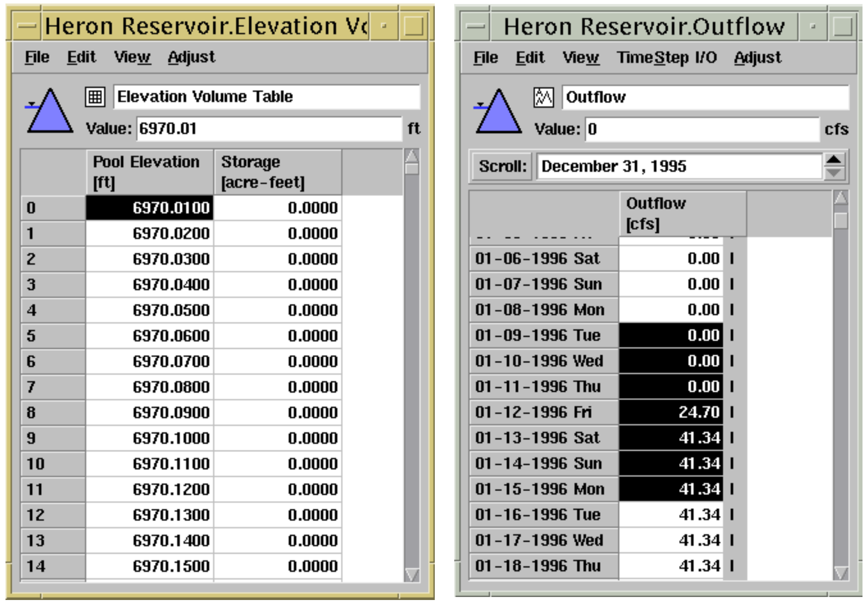
Two new submenus were added to the Policy menu on the workspace: “Open Expression Slot RPL Set” and “Accounting Methods.” This allows users to access each of the different RPL sets from one menu.

B. Open Object Dialog

It is now possible to copy a slot and paste it to a data object. This action is performed from the Slot menu on the open Object dialog.

C. New Open Slot Dialog

The Open Slot dialog has been re-implemented in Qt and has been enhanced to address many usability issues; following is a description of the changes. First, on series slots, a “scroll to” feature has been added. The user enters a date and either hits return or clicks Scroll to move to that date. Also, a date/time spinner has been added. Previously, the old galaxy dialogs were difficult to scroll using the scroll bars. This has been fixed in the new implementation. There are now dividers to separate dates. For example, in a daily model, a divider is shown between each month. The column width is adjustable using the Adjust menu. There is now the ability to do multi-cell operations, such as set to Output, set to Input, or enter a value for all selected cells. The user highlights the desired cells and then uses standard options available from the Edit, TimeStep I/O, right-click menus or is type in a desired value. The copy and paste features also work for multi-cell selections. When pasting, the user must select the complete paste range, not just the first paste cell. The user can either Paste (input flags are maintained, output values are not pasted) or Paste as Inputs (all values are pasted and flags are converted to input). The figure below shows a screen shot of the new dialogs.

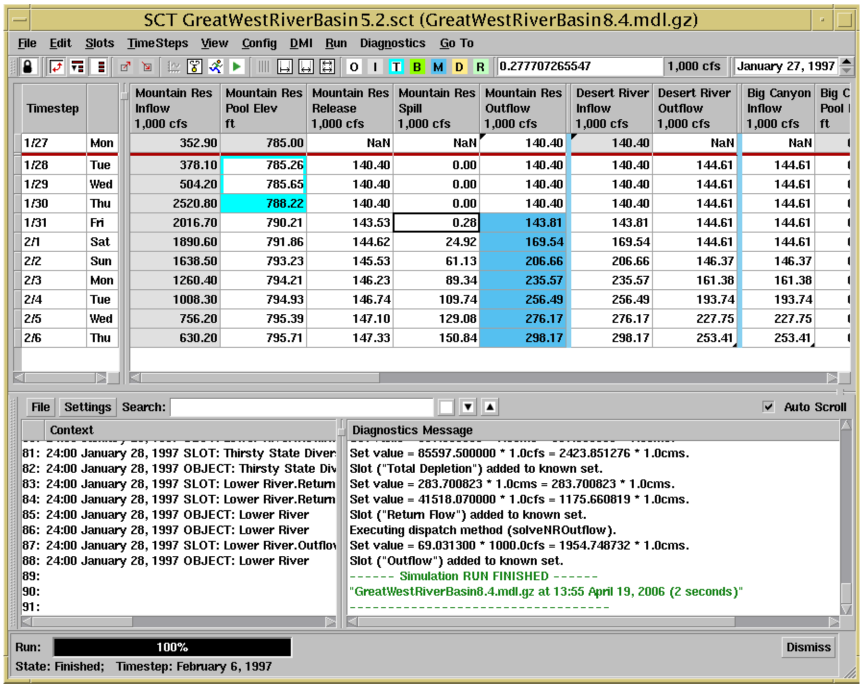


D. System Control Table (SCT)

The System Control Table (SCT) has been enhanced for better usability. Now the user can use the SCT for nearly all aspects of running a RiverWare model.

Diagnostics Window and Run Status Window Imbedded in SCT

The Diagnostics Window and Run Status window have been imbedded in the SCT status window. A screen shot of the SCT with these two windows is shown in the figure below. The Diagnostics Window can be configured through the Diagnostics menu of the SCT.



DMI Menu Now Appears in SCT Menu Bar

The DMI menu from the workspace now appears in the SCT menu bar. Enhancements include the display of DMI program/group icons to visually distinguish the three types of DMI items, and the option to show all DMI items within the DMI menu instead of within cascading submenus.

Slot Navigation with the Go To Menu

A new menu has been added to the SCT called the Go To menu. This menu allows the user to find a slot using the Find Slot option. In addition, if there are dividers in the SCT, a cascading menu is available that allows you to go to the divider. The first time the Go To menu is chosen, there is an Instructions menu which provides detailed directions on using this menu.

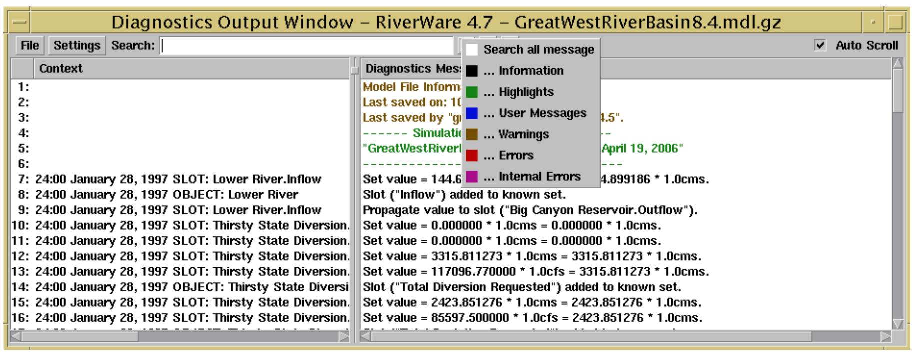
SCT File Menu

There is now the ability to load or create new SCT's directly from an existing SCT. In addition, when opening an SCT, the previously opened named SCT's are listed for quick loading under the Reopen menu. Finally, there is now the option to open models directly from the SCT.

E. Diagnostics Output Window

Diagnostics Window Ported to Qt

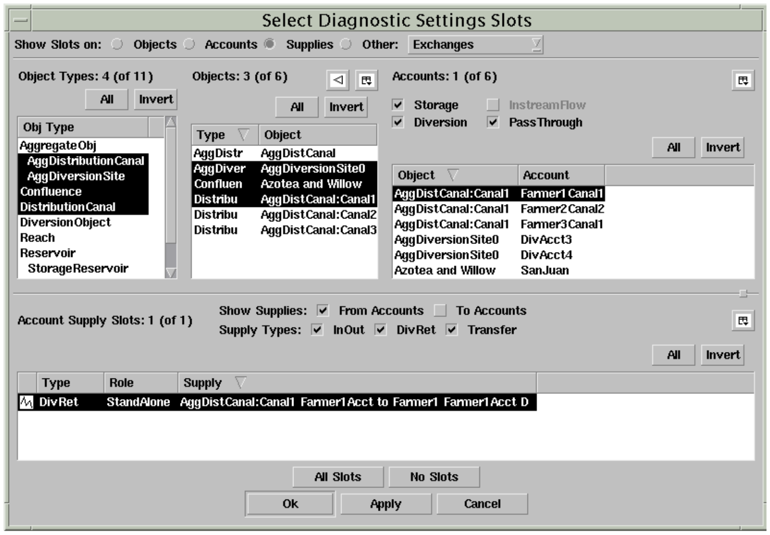
The Diagnostics Output Window was ported to Qt and enhanced. There is a search toolbar where the user can enter key terms and search either up or down. The user can also specify the type of diagnostics to search including Information, Highlights, User Messages, Warnings, Errors, Internal Errors, and all messages. This is accessed by clicking on the colored square (it is white to start) just to the right of the search box. The screen shot below shows the dialog and the diagnostics type search filter. In addition, the window scrolling has been improved and line numbers have been added. Finally, the following options have been added to the Edit menu: Copy Message Line, Copy Visible Message, Copy All Message Lines. These menus allow the user to copy diagnostic messages and paste them into an external program.



F. Selector Dialog

The selector has been completely re-designed and implemented in Qt. Previously, there were multiple selectors depending on the context, i.e. whether the user was selecting a slot, an object, or an account. Now it is the same selector for all cases, with the appropriate choices.

Depending on what is being selecting, different panels will be visible. For example, in the screen shot below, an accounting supply is being selected so there are panels for Object Type, Object, Accounts, and Supplies. The selection can be filtered using the toggle buttons above the panel or the “filter by” option from the icon above the panel to the right. More information on this feature is available in the **User Interface** section of the RiverWare Help.



4. Simulation Objects

The following enhancements to the RiverWare simulation objects are described briefly. The user is encouraged to consult the **Simulation Objects Documentation** in the RiverWare Help for more detailed descriptions of the enhancements to the objects and their methods.

A. Slope Power Reservoir

Weighting Coefficients Method

In the Weighting Coefficients method, the Segment BW Table has been renamed Partition BW Table and a unique three column block of data now represents the partitions headwater, backwater, and flow relationship. In addition, the method was modified to set the Backwater Elevation equal to the value of the most upstream partition's backwater elevation. This allows the user to link the Backwater Elevation to an upstream reservoir's Tailwater Base Value slot.

B. Power Reservoir Objects

Peak Power Equation with Off Peak Spill

A new power method called Peak Power Equation with Off Peak Spill was added to the Power Calculation Category on the power reservoir objects. This new method uses the standard power equation to calculate power and energy produced for a peaking portion of the timestep using the water power equation. Included also is a calculation of the off peak spill that occurs when the turbines are not operating.

Additional Hydropower Release

A new category called Additional Hydropower Release Calculation was added to the power reservoir objects. It is used to calculate the additional release necessary to meet a hydropower demand. Two methods were added to this category: the default, no-action No Additional Release method and the Meet Hydropower Load method. Both methods are dependent on having the Phase Balancing or Operating Level Balancing flood control method selected. In addition, this category is dependent on having the Peak Power Equation with Off Peak Spill power calculation method selected. The Meet Hydropower Load method is used by the U.S. Army Corp of Engineers - Southwestern Division to calculate the additional hydropower release necessary to meet a hydropower load. The methods in this category are executed from the HydropowerRelease() predefined rule function.

Load Calculation

A new category called Load Calculation was added to the power reservoir objects. The category is dependent on having the Meet Hydropower Load method selected (see above). In this new category there are seven new methods: No Method, Input Load, Annual Load, Monthly Load, Periodic Load, Seasonal Load and Seasonal Load Time. The selected method in this category is executed at the beginning of each timestep to calculate the desired energy (load) to be generated for the timestep.

C. Distribution Canal

Storage Calculation

A new method category, Storage Calculation, has been added to the Aggregate Distribution Canal object. If selected, the Input Change in Storage method allows the user to specify when, and at what rate, the canal fills and drains. Between fill and drain dates, the distribution canal will mass balance to track the storage. It is assumed that storage will remain constant and the flows in the canal should be such that storage is maintained. Evaporation and other losses are removed from the canal outflow.

Evaporation from Storage

A new method, Evaporation from Storage, has been added to the Aggregate Distribution Canal object. There is only one user method available, Input Evaporation. The Input Evaporation method allows the user to specify evaporation in a periodic slot. In order to maintain storage (and it is assumed that storage is kept constant except when filling/draining) flows through the canal must be large enough to account for evaporation. Any evaporation is removed from the canal outflow when in the mass balance calculation.

D. Pipeline Object

Pipeline Hydraulics

The Pipeline object has been enhanced to track the head and head loss associated with pressurized pipe flow. Head loss is computed based on the Hazen-Williams formula.

E. Thermal Object

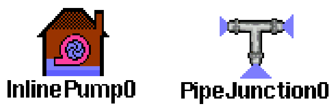
Regulation Calculation

The simulation modeling of an ancillary service, voltage regulation, has been improved in two ways. First, regulation is checked for consistency with power generation and hydro capacity (MW): power + regulation <= hydro capacity. If necessary, regulation is reduced to satisfy this constraint. Second, several warning messages have been added. In the course of this work, several relatively small bugs in the simulation calculation of values on the thermal object were detected and corrected.

F. New Objects: Pipe Junction and Inline Pump

Two new objects have been added to the RiverWare Object Palette, the Inline Pump and Pipe Junction. These objects are intended to be used with the Pipeline object to model a pipeline distribution network.

The Inline Pump object is intended to model a booster pump station which adds head and computes the energy consumed. The Pipe Junction object simulates the split or junction of pressurized pipe flow.



G. Table Interpolation Error and Warning Messages

The table interpolation warning and error messages have been enhanced to increase clarity and to supply more information about the variables involved. Information is now given about the table, the timestep, and the value used in the interpolation. All information is given in user units.

H. Water Quality / Salinity Enhancements

The well-mixed salinity calculations were enhanced on the following objects: Reaches, Aggregate Reaches, Aggregate Diversion Sites, Confluences, Reservoirs, Bifurcations and Stream Gages.

The Reach and Aggregate Reach objects were enhanced to solve in an upstream direction (when Outflow Salt Concentration is known), and for Local Inflow Salt Concentration (when both Inflow and Outflow Salt Concentration are known). Prior to this release, the Reach and Agg Reach could only solve in the downstream direction.

The Reservoir object has been enhanced to solve in both the upstream and downstream direction. Also, a new user-selectable solution method was added. In addition to the existing default method that solves given a weighting factor, a new method has been added to use the Huen or predictor-corrector solution approach.

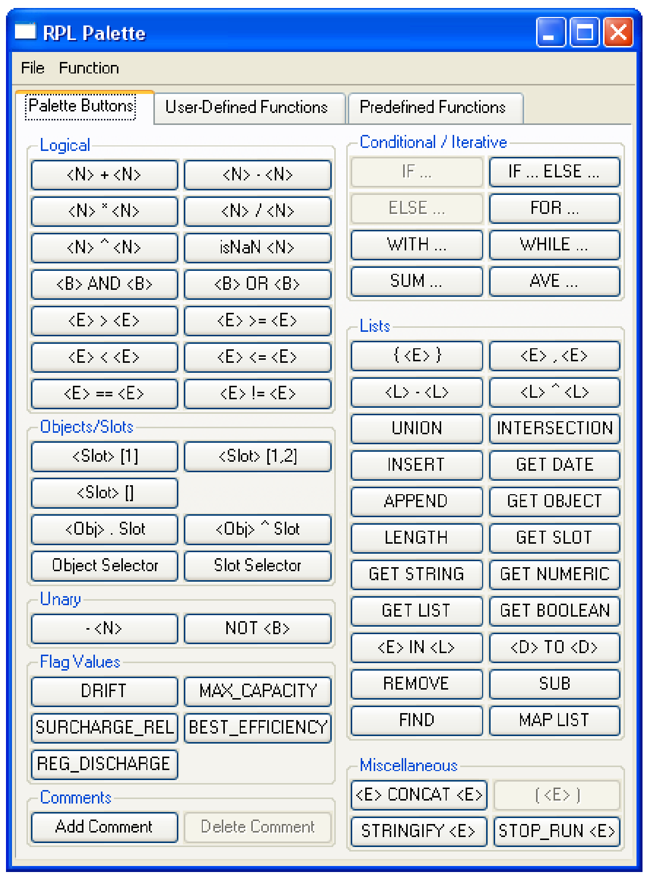
On each of the objects mentioned above, slots were added to hold the salt mass data as well as salt concentration data. Essentially, each salt concentration slot (i.e. Inflow Salt Concentration, Diversion Salt Concentration, etc.) now has a corresponding salt mass slot.

5. Rulebased Simulation and RiverWare Policy Language (RPL)

A. RPL User Interface

RPL Palette Dialog Ported to Qt and enhanced

The RPL Palette was re-implemented in Qt. As a result, the dialog is much more compact and easier to use, especially on Windows. The palette has the same general layout with three tabs: Palette Buttons, User-Defined Functions, and Predefined Functions. On the two function tabs, the user is now able to sort the functions alphabetically by Return Type, Name, or Arguments. In addition, the columns can be rearranged more easily. For the functions, the user must now double click a function on the palette to add it to the selected expression. For user-defined functions, a single click selects the function and shows the description in the Description window, if enabled. Finally, a search feature has been added to the bottom of the Palette so the user can more easily search the functions' Names, Descriptions, and/or Definitions.



New RPL Palette Buttons

Two new buttons were added to the Conditional/Iterative section of the RPL palette, SUM and AVG. These two operators provide a preconfigured FOR loop to sum or average the values over the specified index.

Enable/Disable RPL Statements

It is now possible to enable/disable individual statements in RPL. For example, a user may disable one assignment statement in a rule. This is accomplished by right clicking on the selected statement and toggling off Enable. This can also be performed through the Edit menu. The disabled statement changes color according to the user preferences in the Layout->Display dialog.

Enable/Disable Items in a RPL LIST

It is now possible to enable/disable individual items in a RPL List. For example, a user may have a list of reservoirs but wishes to disable the first reservoir. This is accomplished by right clicking on the selected item in the list and toggling off Enable. This can also be performed through the Edit menu. The disabled item changes color according to the user preferences in the Layout->Display dialog.

Default Agenda Order

The default agenda order has been changed from “1, 2, 3...” to “... 3, 2, 1”. This only affects new policy sets and can be changed from the View ->Show Advanced Properties menu on the Ruleset Editor.

B. RPL Predefined Functions

Following is a brief description of a new predefined function available for use in the RiverWare Policy Language. Details on the use of these functions and the syntax involved are available in the **Rulebased Simulation Documentation** in the RiverWare Help.

HydropowerRelease

This function calculates the additional outflow necessary to meet an unmet load (energy requirement) while preventing additional downstream flooding. This function is dependent on having the predefined function FloodControl() and its associated methods execute first which sets up the network topology and checks for necessary data. The HydropowerRelease rule was developed specifically for the U.S. Army Corp of Engineers to implement their hydropower release operations.

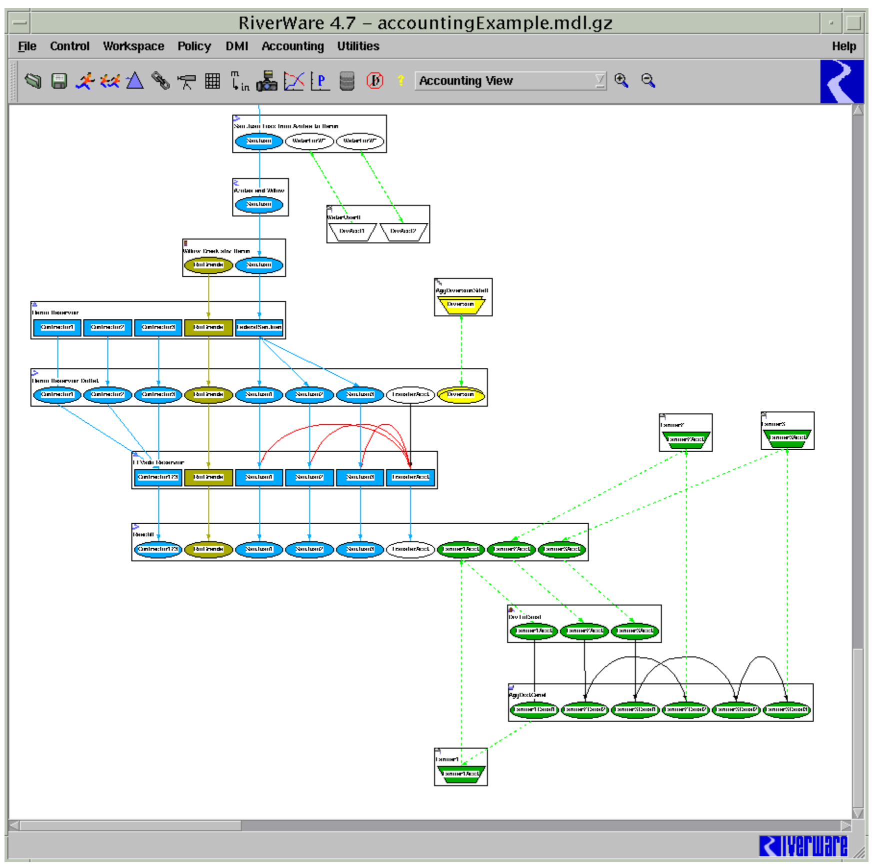
Random, RandomNormal

Random(NUMERIC seed, NUMERIC index, NUMERIC units) returns a number from a random sequence of numbers uniformly distributed between 0.0 and 1.0. RandomNormal(NUMERIC seed, NUMERIC index, NUMERIC units) returns a number from a random sequence of numbers whose distribution is normal with a mean of 0 and a standard deviation of 1.

6. Accounting

A. New Accounting Workspace

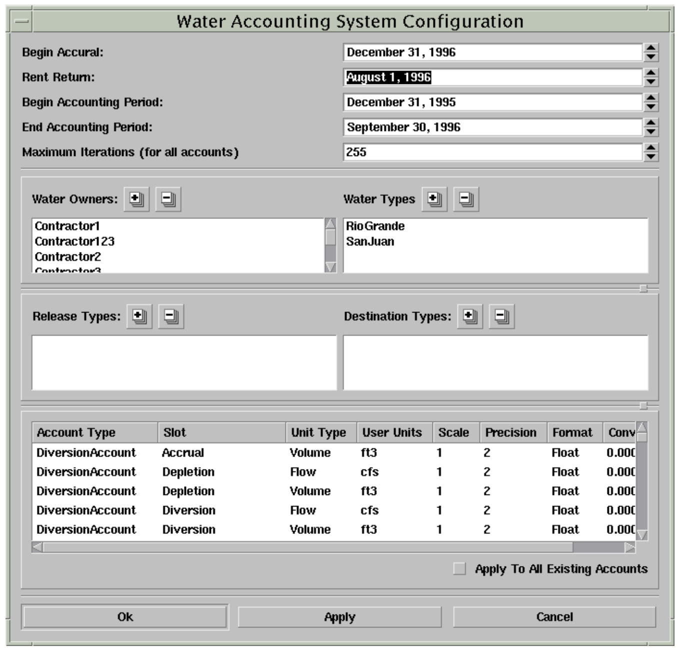
A new feature has been added to RiverWare that allows the user to visualize and build an accounting network. Once Accounting is enabled, a pull-down menu appears on the toolbar that allows the user to switch from the Simulation View to the Accounting View. The first time this action is performed, RiverWare locates the objects according to the simulation view layout. The objects and accounts can be rearranged by dragging them to their new location, which is saved with the model file. Large rectangles represent objects; the icon and name are shown in the upper left. The small rectangles inside the object represent storage accounts, ovals represent pass-through accounts, and trapezoids represent diversion accounts. The arrows represent the supplies. Colors and other display attributes of the objects, accounts, supplies are controlled using the Display Group Editor found on the Workspace menu. Simulation links can be shown from the Display Group Editor -> Preferences menu. A configured display is shown in the screen shot below.



The Accounting View can also be used to view and build models. Double-clicking on the object rectangle or the account brings up the appropriate dialog. New objects can be added using the right click->Add Objects menu. Supplies can also be added by right clicking on the downstream account, selecting Add Supply, then right clicking on the upstream account. More information on this feature is available from the **User Interface** section of the RiverWare Help.

B. Accounting System Configuration Dialog

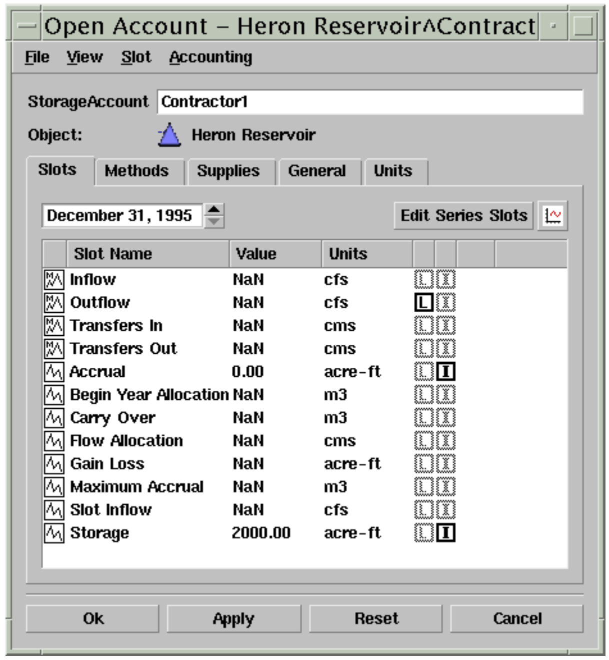
The Accounting System Configuration Dialog was reimplemented in Qt as shown in the following screen shot.



This dialog is accessed through the Accounting -> Account System Configuration menu. In the new dialog, there are no longer tabs. Instead, everything is shown in one view. Water Owners, Water Types, Release Types and Destination Types can be added by clicking on the “+” icon or deleted using the “-” icon. User Units, Scale, Precision, Format, and Convergence can be changed by right clicking on the desired variable.

C. Account Configuration Dialog - Open Account Dialog

The Open Account dialog has been reimplemented in Qt and enhanced for usability as shown in the following screen shot.



In the new dialog, there is now a Slots tab in addition to the Methods, Supplies, General, and Units tabs. The Slots tab shows the accounting slots in a format similar to the Open Object dialog. Double clicking on a slot brings up the standard Open Slot dialog. The Supplies tab now incorporates information on both supplies and demands; the Demands tab was removed. The Units tab looks similar to the old dialog; right clicking on a cell changes the value.

7. Optimization

A. Stochastic Optimization

The first implementation of a network stochastic programming algorithm is available in RiverWare. Stochastic optimization allows the user to maximize avoided cost and future value based on alternative hydrologic scenarios. This work is still in the research stage; please contact riverware-support@colorado.edu for more information.

B. Power Efficiency Curve Method

A scalar slot, Power Curvature Tolerance was added to the Power Reservoir for use in optimization models. This slot is instantiated either by the Plant Efficiency Curve method in simulation or a power linearization method in optimization. This slot is used as a parameter in the method Check Z Curves and reflects how much violation of the desired curvature is within tolerance, and overrides the default value.

8. Bugs

A. Closed Bug Reports

The following is a list of the bugs which were fixed for this release. If you wish to view the details for a specific bug, please browse to http://cadswes.colorado.edu/users/gnats-query.html and search our bug database. You will need a RiverWare user login and password.

1010	1574	1585	1980	2500	2501	2506
2805	3032	3077	3157	3161	3203	3299
3331	3567	3590	3668	3717	3719	3721
3722	3724	3725	3729	3730	3731	3732
3733	3735	3736	3738	3740	3741	3746
3747	3748	3749	3750	3751	3753	3754
3758	3764	3765	3766	3768	3770	3772
3773	3776	3777	3778	3780	3781	3782
3783	3784	3785	3786	3787	3788	3790
3791	3792	3794	3799	3800	3801	3805
3807	3808	3816	3817	3818	3824	3825
3828	3830	3832	3833	3834	3835	3838
3839	3839	3843	3844	3845	3846	3849
3852	3854	3861	3862	3863	3865	3866
3867	3868	3869	3870	3873	3876	3877
3878	3879	3880	3881	3882	3883	3883
3884	3885	3887	3888	3890	3891	3892
3893	3894	3897	3898	3901	3902	3906
3907	3908	3909	3910	3911	3913	3915
3916	3918	3919	3920	3921	3922	3924
3926	3927	3928	3929	3930	3931	3932
3933	3934	3936	3939	3941	3942	3943
3950	3952	3957	3961	3964		

Current Release Notes Version 4.8

1. Special Attention Notes

If the text or graphics in this file are not clear, you may need to print this document. Resolution should improve on the printed page.

Hydrologic Inflow Forecast

The slot Hydrologic Inflow Forecast was added as a dispatch slot to the reservoir objects. In certain models, the Hydrologic Inflow Forecast was calculated throughout the forecast period but did not cause the reservoir to dispatch given the new information. This could change results in models that use the Geometric Recession or Exponential Recession in the Generate Forecast Hydrology category.

Changes to the Accounting system

To decrease the size of accounting models, a number of changes were made that could affect existing models. In general, restrictions were tightened on the allowed slots on passthrough accounts. Slots that are no longer supported are removed from the model file. Although this change will not affect the solution of the accounting system, it is possible that this change could affect existing rulebased models that use functions to look up accounting information on the objects.

For more information, see “Changes to Passthrough Accounts” on page 365. If you have any difficulty updating your model, please contact riverware-support@colorado.edu.

2. General RiverWare

A. Multiple Run Management

Iterative MRM

A new mode of Multiple Run Management (MRM) was added called Iterative MRM. Iterative runs are multiple runs where MRM rules at the end of each run examine the state of the system and, if appropriate, set inputs for the subsequent simulation run. If no values are set and/or modified or the maximum number of iterations occurs, then the simulation ends. MRM rules are written in the RiverWare Policy Language. For more information on iterative MRM, consult the **Multiple Run Management Documentation** in the RiverWare Help.

B. Statistical Table Slots

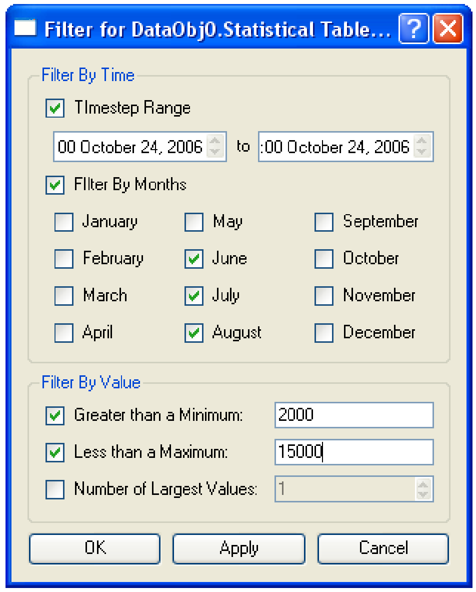
The Statistical Table Slot was enhanced with new functionality as described below. For more information on the Statistical Table Slot, see the **Statistical Table Slot Documentation** in the RiverWare Help.

New Statistical Functions

Two new statistical functions were added as options to the slot. Annual Min Frequency Curve determines the frequency of exceedence for the minimum annual value. The Annual Average Frequency Curve determines the frequency of exceedence of the average annual value.

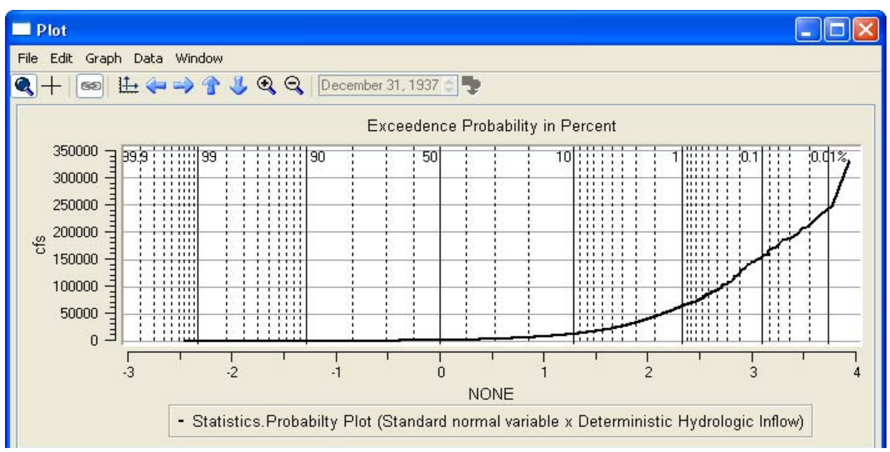
Filtering Input Data

It is now possible to filter the input slot data for the statistical slot by date range, month, minimum value, maximum value, and number of largest values as shown in the following screenshot



Additional Statistics and Display

Statistical table slots now display the standard normal values for the exceedence probabilities, the rank of the value, and the year (where appropriate, such as the annual statistical table slots) as additional column in the statistical slot. With this new data, it is now possible to plot the statistical slot using axes and grids that are similar to normal probability paper as shown in the following screenshot. In this type of plot, the vertical markers are added automatically but can be modified by the user.



C. Batch Mode and RiverWare Command Language

Removed --noacctmin option

The "--noacctmin" option was removed as an argument when invoking riverware from the command prompt. With the removal of this option, the user can no longer turn on full-future account solving. Filtering out future solving has occurred for many years now and is now permanent.

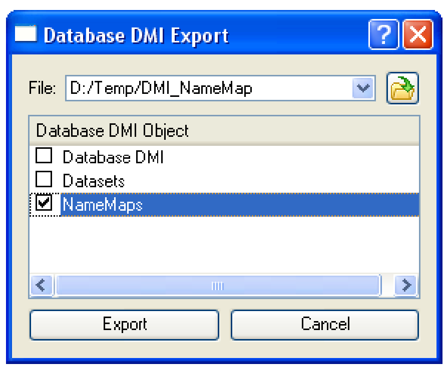
Modified --acctdata option

The "--acctdata" option was modified to include the account priority date in the output file. This option is available when riverware is executed from the command prompt.

D. Data Management Interface

Import and Export of Database DMI Objects

It is now possible to import and export Database DMI objects including Database DMI's, Name Maps, and Datasets. This action is performed from the File menu in the DMI Manager. The following screenshot shows the dialog used to select the objects to export. More information can be found in the **Data Management Interface Documentation.**



E. riverwareDB file

The riverwareDB file can now be used to define the default units of the column headings in periodic slots instantiated from the simulation object.

F. License Expiration Warning

A message was added to the diagnostics that warns the user when their license is about to expire. The message appears each time RiverWare is opened starting 5 days before the license expires. We encourage you to contact installsupport@cadswes.colorado.edu if you get this message and wish to renew your license.

3. General User Interface Enhancements

A. Diagnostics Output Window

Minor user interface changes were made to the diagnostics output window including moving the Clear Messages option from the File Menu to the Edit Menu. In addition, a new menu item “Add 'Search' text as User Message” was added to the Diagnostics Output Window under the Edit menu. This menu option allows the user to add the text in the 'Search' box to the diagnostics output. The User Message acts as a bookmark that can be queried.

B. Expression Slots

The Series Slot with Expression dialog to configure the timeseries was ported to Qt. In addition, the user can now select to Always Sync Range with Run Control but still have a timestep that is different than the run’s. There is the possiblity that the range in this slot will extend beyond the run control and the expression will not evaluate successfully. For example, if you have a daily model that runs from Jan 1 to March 15th and the expression slot is configured to evaluate monthly, the expression slot will try to evaluate on March 30th but may not have enough data to solve. This updated dialog is shown in the following screenshot:

C. Workspace

If the user drags icons off the canvas, all of the selected objects will be returned to their original position and a warning dialog is posted. This was done to prevent the user from inadvertantly moving objects or accounts off the canvas and not being able to move them back.

4. Simulation Objects

The following enhancements to the RiverWare simulation objects are described briefly. The user is encouraged to consult the **Simulation Objects Documentation** in the RiverWare Help for more detailed descriptions of the enhancements to the objects and their methods.

A. Reservoir Objects

Low Flow Releases Category

A new category was added to the reservoir objects named Low Flow Releases. Within this category there is the default no-action method and the Enable Low Flow Releases method. The Enable Low Flow Releases method is used with the MeetLowFlowRequirement predefined RPL function used to meet low flow requirements at a downstream control point by releasing from one or more reservoirs.

Operating Levels Category

A new category called Operating Levels was added to the reservoir objects. In this method, the user can select the Conservation and Flood Pools method if the user wishes to define flood and conservation pools on the reservoir. If not, the default no-action None method can be used.

Diversion Capacity Slot

A new slot, Diversion Capacity, was added as a general slot to the reservoir objects.

Hydrologic Inflow Forecast

The slot Hydrologic Inflow Forecast was added as a dispatch slot. In certain models, the Hydrologic Inflow Forecast was calculated throughout the forecast period but did not force the reservoir to dispatch given the new information. This could change results in models that use the Geometric Recession or Exponential Recession in the Generate Forecast Hydrology category.

A. Bifurcation Object

Solution Direction

Two new methods were added to the Bifurcation Solution Direction category: Solve Outflow1 Only and Solve Outflow2 Only. These two methods limit the available dispatch methods so the bifurcation will only solve in one direction.

Negative Outflow Warnings

Negative outflow warnings were removed from the bifurcation object.

B. Control Point

Low Flow Requirement Category

On the control point, a new category called Low Flow Requirement was added to allow the user to determine the required low flow. The user can select the Reservoir Level Lookup method to relate the low flow requirement to the level of a reservoir. Or, in the Low Flow Periodic Lookup method, the user can input a periodic table of low flow requirements.

C. Distribution Canal

Head Based Seepage

A new seepage method, Head Based Seepage, was added to the Canal Seepage category. This new method determines the seepage from the canal as the function of water surface elevation, water table elevation, canal bed elevation, and conductance from the canal.

D. Diversion Object

Periodic Diversion Requests

A new method was added to the Diversion Request Calculation called Periodic Diversion Requests. This method allows the user to input a periodic slot containing the diversion requests.

Reservoir Level Lookup

A new method was added to the Diversion Request Calculation called Reservoir Level Lookup. This method allows the user to input a periodic slot that relates the Diversion Request to the level of a specified reservoir.

Diversion Object Solution Direction

A new category was added to the Diversion Object called Diversion Object Solution Direction. In this category, there is the default method Solve For Outflows and the new Solve Given Outflows. Solve For Outflows provides the previous functionality. If the user selects, Solve Given Outflow, the available dispatch method become SolveDiversionGivenOutflow.

New SolveDiversionGivenOutflow Dispatch Method

This new dispatch method is only available when the Solve Given Outflow is selected in the Diversion Object Solution Direction category. This dispatch method requires that the total Multi Outflow is known and the Diversion and Diversion Request are unknown.

Diversion Shortage as a general slot

Diversion Shortage was added as a general slot to the Diversion Object. Calculated in the dispatch method, the Diversion shortage is the difference between the Diversion and Diversion Request.

E. Groundwater Storage Object

Evapotranspiration Category

A new method category, Evapotranspiration, was created to simulate evapotranspiration directly from the groundwater. It contains the following methods which specify how the user wishes to parameterize the evaporation calculation: None, Input ET Rate, Input ET Volume, and Elevation ET Table. This method is available for either the Single Groundwater or Connected Groundwater objects.

Groundwater Solution Type Category

A new method category, Groundwater Solution Type, was added to the groundwater object. The default method is called Single Groundwater Object and represent the previous functionality. A new method, Connected Groundwater Objects, was added to allow the user to model groundwater objects that are connected to other groundwater objects.

Specify Connected Groundwater Objects Category

This method allows the user to specify the number and location of the connected groundwater objects with respect to the current object. This new method category contains 14 user methods representing all combinations of Upstream, Downstream, Left and Right. For example a groundwater object may be connected to only one other groundwater object which is upstream. Or it may be connected to four other groundwater objects which are upstream, downstream and to the left and right. A method called No Connected Groundwater Objects method category is also available to specify that there is no connection to other groundwater objects.

Head Based Percolation Method

A new method, Head Based Percolation, was added to the GW Deep Percolation category to allow the user to determine percolation as a function of groundwater elevation. This method is only available if the Connected Groundwater Objects method is selected.

Input Pumped Flow Method

A new method was added to the Pumping Calc category called Input Pumped Flow. It models groundwater pumping by removing a given amount of water from storage. This method is dependent on the selection of the Connected Groundwater Objects in the GW Solution Type category

New Dispatch Method SolveGWMB_GivenPreviousElevations

This dispatch method is used exclusively when the Connected Groundwater Objects method is selected. The solveGWMB_givenPreviousElevations dispatch method will compute the current Storage and Elevation values based on the previous elevations and any other selected mass balance variables.

F. Reach

Stage Table Lookup Method

The Stage Table Lookup user method was modified on the Reach object. Previously, the Stage slot in this method was set equal to whichever value was known, Inflow Stage or Outflow Stage (as calculated using inflow and outflow stage tables). If both values were known, it is set as the average of the two.

In the revision, the stage slot is set equal to an average value whenever possible. If inflow and outflow stage values are known for the current time step, the stage is set as the average of these two values. If one of the values is not known for the current time step, a value is sought at the previous time step. The stage is then set as the average of a current time step stage value (either inflow or outflow) and the previous time step stage value (either inflow or outflow, corresponding to whichever is not available at the current time step). If a value from the previous time step is still not available, at the first time step of a model run, for example, no averaging is done. The stage slot value is set equal to whichever value is known at the current time step.

Head Based Seepage Method

A new seepage method, Head Based Seepage, was added to the Seepage Calc category. This new method, only available if the Stage Table Look Up method is selected, determines the seepage from the reach as a function of stage, water table elevation, streambed elevation, and conductance from the reach.

Periodic Minimum Bypass Method

A new method called Periodic Minimum Bypass was added to the Minimum Diversion Bypass category. It allows the user to input a periodic slot that contains the Minimum Bypass.

Diversion Capacity Slot

A new slot, Diversion Capacity was added to the Reach. It is dependent on having either the Available for Diversion or Head Based Diversion method selected.

G. Water User

Irrigation Acreage and Evapotranspiration Rates Category

A new category called Irrigation Acreage and Evapotranspiration Rates Category was added to the Water User. This category, available only when the Irrigation Requests method is selected in the Diversion and Depletion Request user category, allows the user to specify how they wish to parameterize the Irrigated Area and Evapotranspiration Rate slots. The Input Acreage and Rates method, the default, mirrors the previous functionality in the Irrigation Requests method where the user inputs a time series of Irrigated Area and Evapotranspiration Rates. The Aggregate Acreage and Rates method allows the user to input Crop-specific Irrigated Area and Crop-specific Evapotranspiration Rates. The method then sums the Crop-specific Irrigated Area to get the total Irrigated Area and averages (weighted by area) the Crop-specific Evapotranspiration Rate to get the Evapotranspiration Rate.

Irrigated Area GW Return Rate method

The Irrigated Area GW Return Rate method was added to the returnFlowSplitCalculation category on the water user. This method allows the user to split return flows between the surface water and groundwater as a function of diversion, diversion request, groundwater return rate, and irrigated area. The method is dependent on having the Irrigation Requests method selected in the Diversion and Depletion Request category.

Multiple Supply Sources Category

A new method category was added to the water user called Multiple Supply Sources. Aside from the default “None” method, it has a single selectable method called Multiple Supply Reservoirs. This method instantiates the Supply From Reservoirs slot and Maximum Delivery Rates slots.The Supply From Reservoirs slot should be linked to the Multi Outflow slot of each supplying diversion object. It will be used to specify the diversion objects that act as supplies, and it will hold the data returned by the ComputeReservoirDiversions RPL function that computes the diversions from each reservoir to meet a demand requirement.

New Diversion Request Calculations

Two new methods were added to the Diversion and Depletion Request Calculation category, Periodic Diversion Request and Reservoir Level Lookup. The Periodic Diversion Request calculates Diversion Requested using a periodic slot. The Reservoir Level Lookup method calculates the Diversion Requested as a function a specified reservoir’s Operating Level.

Limit Diversion Category

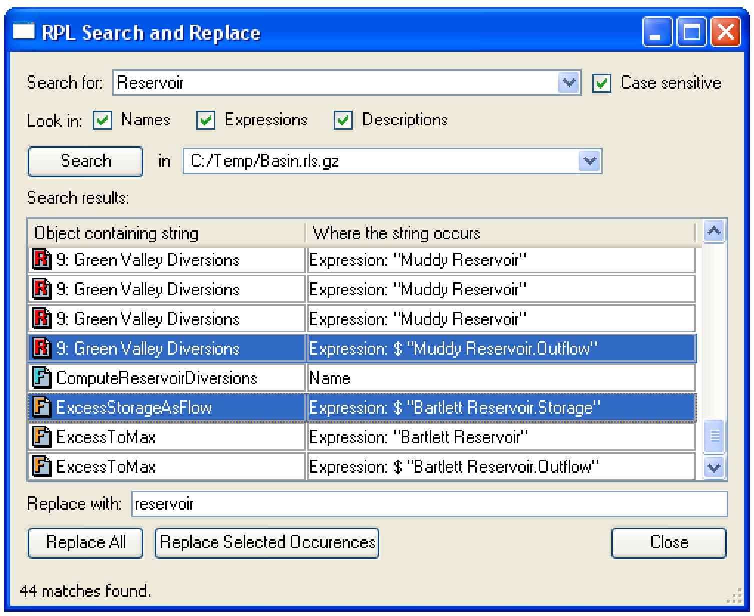
A new method category called Limit Diversion was added to the water user. Aside from the default “None” method, the category has a user selectable method called Limit By Reservoir Level. This method performs no calculations directly but will add the Demand Reservoir slot. If this method is selected, the RPL function, ComputeReservoirDiversions which computes the Supply From Reservoirs slot, will not compute a diversion if the Demand Reservoir is in the flood pool or if its level is higher than the supply reservoir.

5. Rulebased Simulation and RiverWare Policy Language (RPL)

A. RPL User Interface

Search and Replace

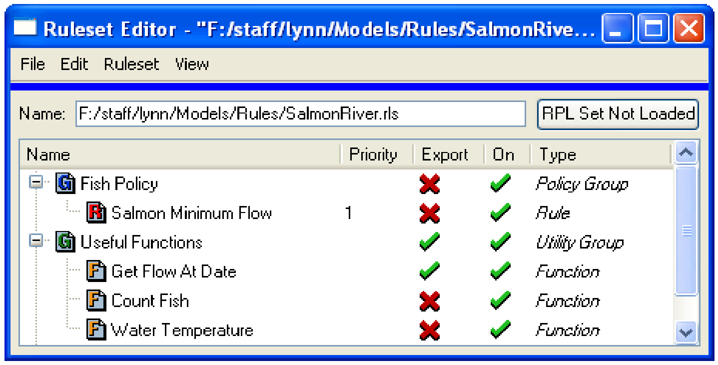
In the RiverWare Policy Language set editors, it is now possible to Search and Replace. The RPL search and replace dialog supports flexible replacement of strings within a RPL set. Within this dialog the user can search for all occurrences of a string and replace all or some of those occurances with another string. The screenshot below shows this dialog.



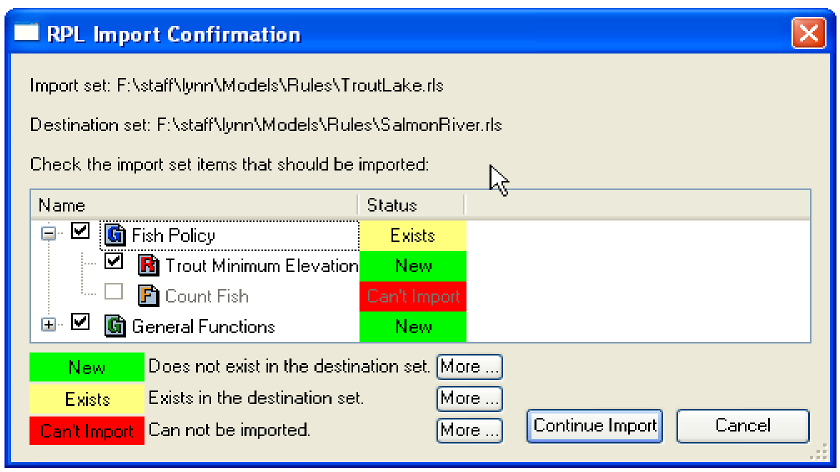
For more information see the **RPL Search and Replace** section of the Riverware's Rulebased Simulation online help.

Import and Export of RPL blocks

Functionality has been added to allow the import and export of RPL blocks between rulesets, object level accounting methods, MRM rules, expression slot RPL sets and optimization ruleset. Now the user can export a rule, group, or the entire set. To export, the user shows the Export column using the View menu. The user then selects the rules and/or groups to be exported and then uses the File menu to initiate an export. The following screenshot shows the export column.



To import, the user selects import from the File menu on the set editor and selects a file to import. RiverWare opens the following dialog which allows the user to confirm the import and resolve any conflicts. More information is available in the **RPL Editor Dialogs** section of the RiverWare Rulebased Simulation help

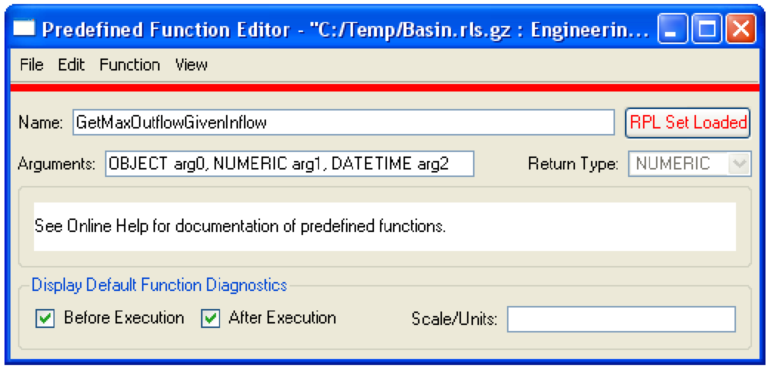


Deleting RPL Blocks

A confirmation dialog is now presented when the user attempts to delete a group, rule, or function in the RPL Set Editors. This was added to prevent inadvertent deletion of RPL objects.

B. Predefined Function Diagnostics and Display

The user can now enable predefined function diagnostics before and after execution of the function. To enable this functionality, the display of predefined functions was also added to the RPL set editor. The user can now display predefined function groups using the View menu. Although not editable, opening a predefined function displays the name of the function, the arguments, and text saying that the function cannot be edited. Similar to user defined functions, the user can then specify to print Before Execution or After Execution diagnostics for each predefined function. Functionality was added to turn on and off all predefined function diagnostics from the main RPL set editor under the Ruleset -> Function Diagnostics menu. Below is a screenshot of a predefined function with function diagnostics enabled.



C. RPL Predefined Functions

Following is a brief description of new predefined functions available for use in the RiverWare Policy Language. Details on the use of these functions and the syntax involved are available in the **Rulebased Simulation Documentation** in the RiverWare Help.

HasRuleFiredSuccessfully

This function returns a boolean of whether the specified rule has fired successfully on the current timestep.

ComputeReservoirDiversions

This function is used to meet multiple water user demands using multiple reservoir diversions. It was developed for the U.S. Army Corp of Engineers to allocate diversions that come directly from one or more reservoirs.

MeetLowFlowRequirement

This function computes the necessary Low Flow Releases from contributing reservoirs to meet the low flow requirement at a specified control point. It was developed for the U.S. Army Corp of Engineers.

6. Accounting

A. Changes to Passthrough Accounts

To improve the size and functionality of the accounting system, a number of changes were made to passthrough accounts as follows.

Legal Lag

RiverWare was modified to allow legal lags only on passthrough accounts on Reach and Distribution Canal Objects. If you have a lag on a passthrough account on a reservoir, your model will need to be updated.

Gain/Loss

Gain/Loss slots will be allowed only on passthrough accounts that are on reaches, distribution canals or reservoirs. The Gain/loss Coefficient slot is only available on passthrough accounts on reaches.

Diversions and Return Flows

Diversions and return flows will be allowed only on reaches, distribution canals, diversion objects, reservoirs, and water users. Diversions and return flows are left on passthrough accounts on reservoirs for backward compatibility reasons only.

Transfers

Transfers in and transfers out will be available on passthrough accounts on Control Points, Stream Gages and reservoirs. If you have transfers in or transfers out on other objects, you will need to move these to a Stream Gage, Control Point or reservoir.

Storage

Previously, all passthrough accounts had a Storage slot, even if it was not enabled. Now, Storage is allowed only on passthrough accounts on reservoirs when it is enabled using the “Storage Allowed” checkbox. Furthermore, the Storage slot is instantiated only if the Storage Allowed is checked. This could affect rulesets that look for Storage on all passthrough accounts. The user will need to modified the ruleset to only look at the correct accounts.

Inline Power Plants

It is now possible to create passthrough accounts on Inline Power Plant objects.

Linkage to offstream reservoirs

Because of changes to the accounting system, the physical linkage used to connect a reach to an offstream reservoir should now look like the following:

Reach.Diversion <----->DiversionObject.Diversion

DiversionObject.Outflow <----> Reservoir.Inflow

On the accounting network supplies should be connected as follows:

Reach^Passthrough.Diversion<---->DiversionObject^Passthrough.Inflow

DiversionObject^Passthrough.Outflow<---->Reservoir^Storage.Inflow

Previously, the Reach^Passthrouh.Diversion was connected to the DiversionObject^Passthrough.Diversion.

B. Changes to Storage Accounts

A Diversion multislot and a Return Flow multislot were added to the storage account. In the account solution, Diversion and Return Flow were added to the storage mass balance but not to the accrual calculation.

C. Changes to Diversion Accounts

Lag unit type

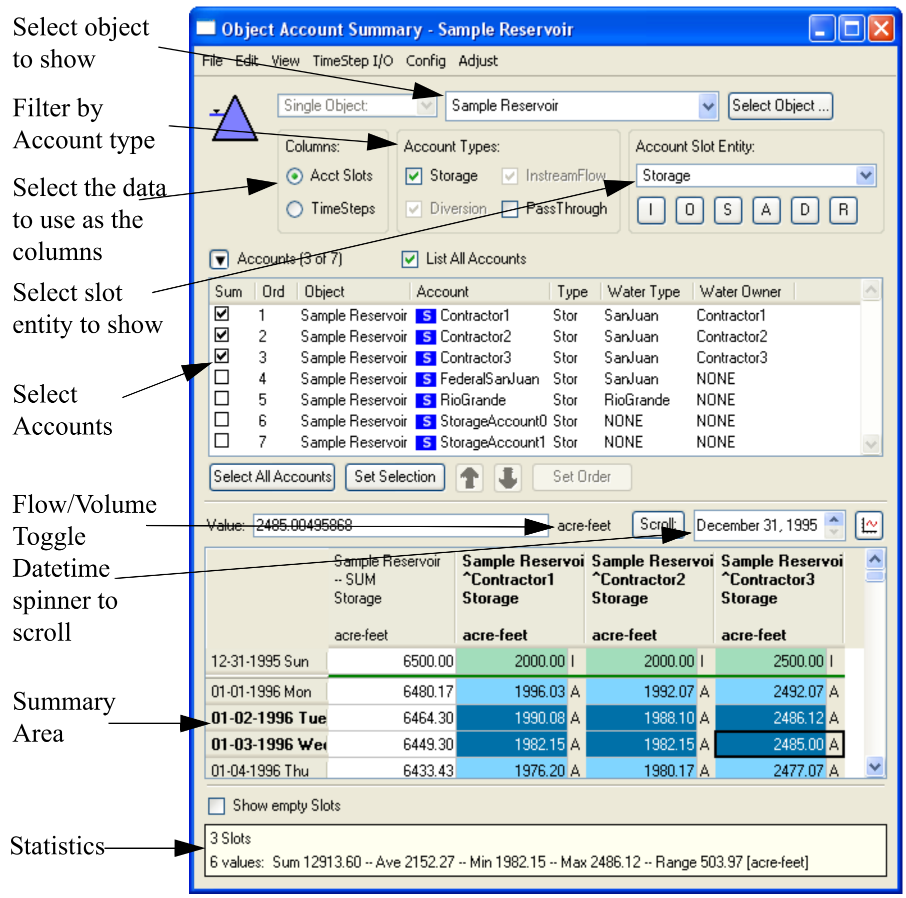
On Diversion Accounts, the return flow lag now has units of time, like that for passthrough account.

D. Open Slot Dialog Menus for Accounting Slots

On the Open Slot dialog for accounting slots, the TimeStep I/O menu and the context menus (i.e. right click) were changed to the following: Set to Input, Set All to Input, Clear Non-Inputs, Clear Values, Clear All Values. These selections are different from simulation slots because accounting slots are solved for differently.

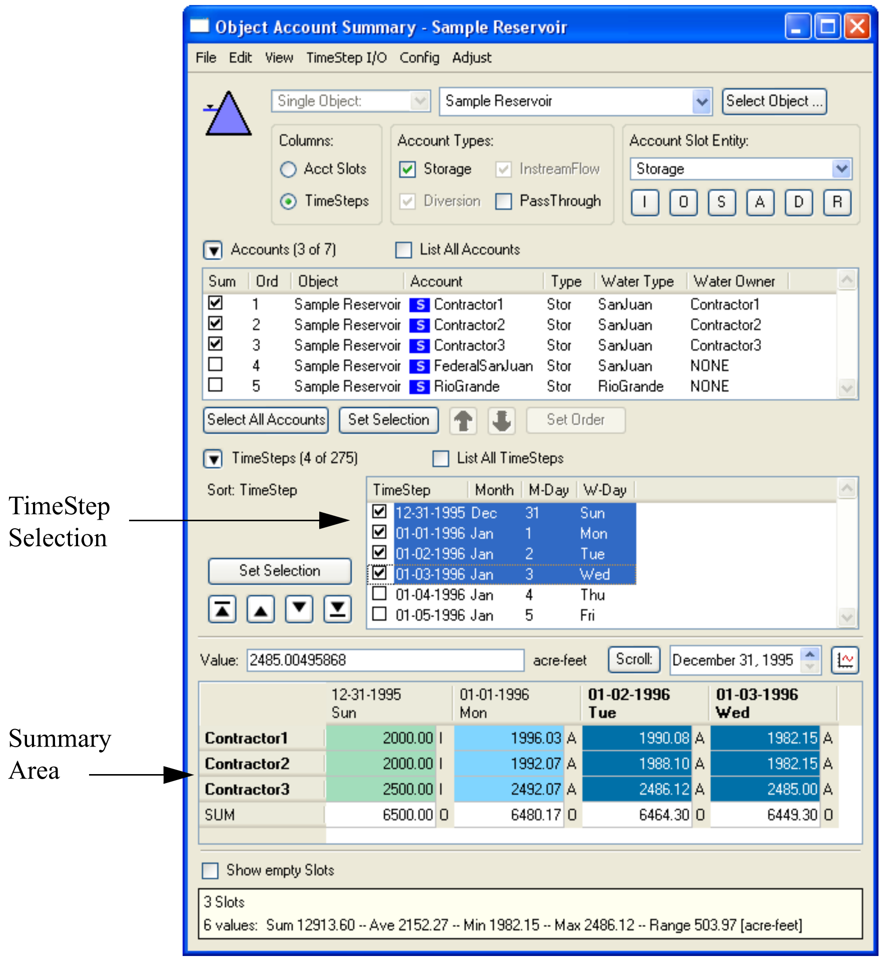
E. Object Account Summary Dialogs

The Object Account Summary Dialog was re-implemented and enhanced. The Object Account Summary Dialog shows summary data about selected accounts on a specified object. For example, the user could select to see the total accounting storage for a given water type. The main difference from the old dialog is that now both the summation and the components of that sum are now shown. In addition, there is enhanced filtering and display functionality. Following is a screenshot showing the new Object Account Summary Dialog and a description of the components of the dialog.



Select Objects: The user can select the object using either a pull-down menu or through the slot selector dialog. Currently, the user can only select one object to show; in the future, multiple objects will be supported.

Columns: The user can show timesteps as either the column or the rows. If Acct Slots is selected, the accounts are shown across the columns and timesteps go down the rows as shown in the above screenshot. If Timesteps is selected, the timesteps are displayed across the columns and the accounts displayed down the rows in the table as shown in the following screenshot. If Timesteps is selected, the user can select the timesteps to display using the Set Selection button and the check boxes.



Account Types: Accounts can be filtered by type, i.e. Storage, PassThrough, Diversion, or Instream Flow, using the check boxes.

Account Slot Entity: The slot entity (Outflow, Inflow, Storage, etc...) shown in the summary area is selected using the pull-down menu. The most common slot types can be selected using buttons.

Account Selection: The accounts can be ordered and selected for display in the summary area. If the List All Accounts toggle is selected, then all accounts will be shown. Otherwise, only the selected accounts are shown. Each column can be sorted by clicking on the column heading. To select multiple accounts, highlight the row and click Set Selection. All accounts can be selected using the Select All Accounts button.

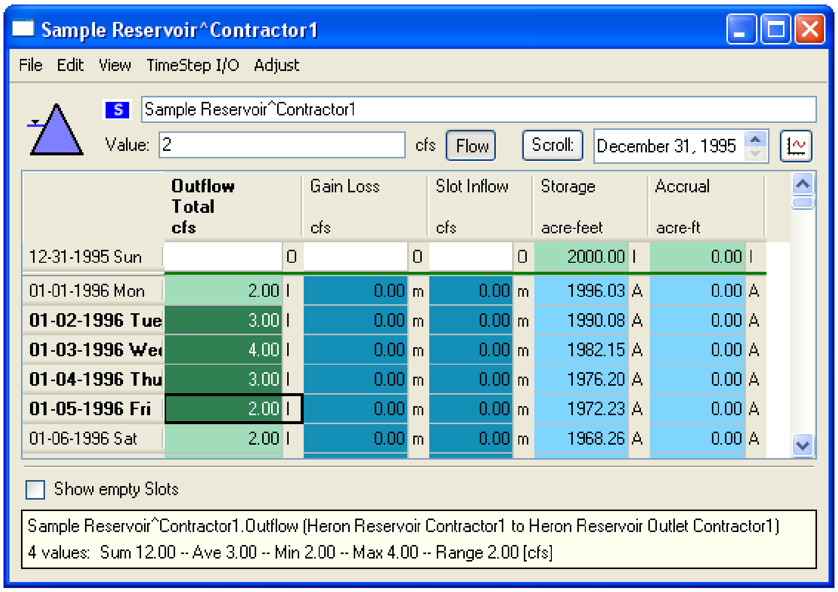
Summary Area: The summary area shows each of the selected slots and the total sum in the left most column. If appropriate, values in the summary area can be switched from Flow to Volume using the toggle button. Using the Show Empty Slots toggle, the user can select to show or hide slots that don't contain any data.

Statistics Information: The following summary statistics are displayed for the highlighted selection: Sum, Average, Minimum, Maximum, and Range.

Miscellaneous: Additional features have been added to the dialog. The selection can now be exported to the clipboard using the Export Copy feature. In addition, the configuration can be saved using the Config ->Save As menu.

F. Edit Account Dialogs

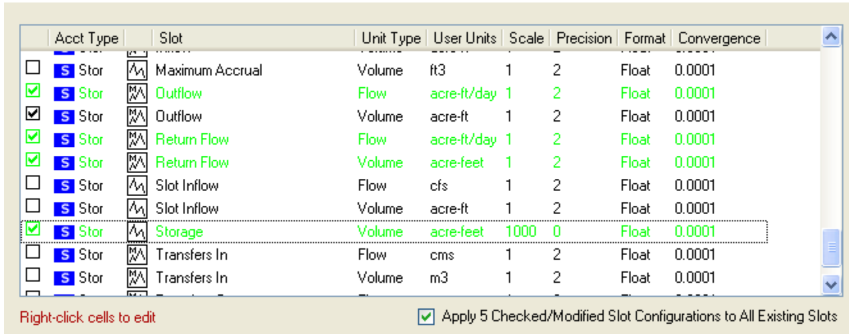
The Edit Account Dialog was re-implemented in Qt and enhanced for usability as shown in the following screenshot:



Although similar to the old dialog, the updated version has increased usability. The user can choose to show or hide slots that do not contain any data and the order of the columns can be changed. In addition, a datetime spinner was added to allow the user to jump to a specified date. Summary data was added to the bottom of the dialog to show the sum, average, minimum, maximum, and range of the selection. In addition, Export Copy functionality was added to allow the user to export data to the clipboard and then paste it in Excel. As in the old dialog, there is the Flow to Volume toggle and the ability to open the component supplies directly. This is now done by right clicking and selecting Open Slot.

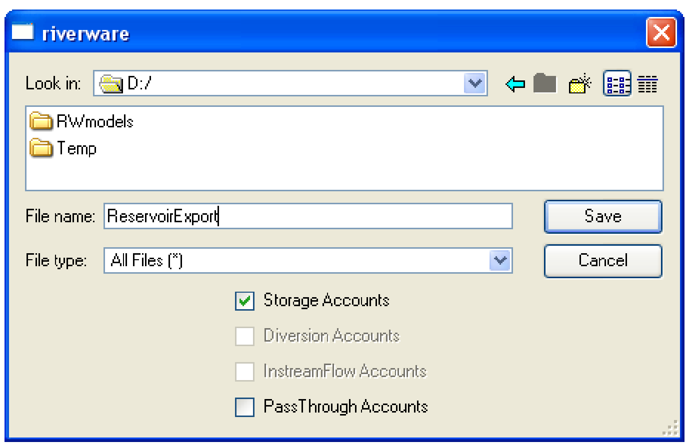
G. Water Accounting System Configuration Dialog

The Water Accounting System Configuration dialog was enhanced to allow the user to better configure many accounting slots at one time. Shown in the following screenshot, the user is now able to use check boxes to select the slots they wish to change. If the “Apply Checked/Modified Slot Configurations to All Existing Slots” toggle is checked, then the configuration edits will apply to all of the checked slots and will change existing slots. If it is not checked, any edits will only apply to slots on accounts added in the future. This feature gives the user much more control over the configuration of accounting slots.



H. Import and Export of Objects and Accounts

It is now possible to import and export objects with their accounts. When exporting, the user is presented with the option to select the type of accounts to export as shown in the following screenshot. Note, when exporting, supplies connecting accounts are not maintained. On import, if an account has the same priority date as an existing account in the model, 1 second is added to the priority date of the imported account and a warning message is posted.



I. Future solution of Accounts

The user can no longer turn on full-future account solving. Disabling future solving has been occurring for many years now, and is now permanent. Previously, the user could enable full-future account solving using the “--noacctmin” option when invoking riverware.

7. Closed Bug Reports

The following is a list of the bugs which were fixed for this release. If you wish to view the details for a specific bug, please browse to http://cadswes.colorado.edu/users/gnats-query.html and search our bug database. You will need a RiverWare user login and password.

38	3839	3905	3948	3958	3968	3969
3971	3973	3974	3978	3979	3980	3981
3982	3983	3984	3985	3986	3988	3990
3991	3992	3993	3994	3995	3997	4001
4004	4007	4008	4009	4010	4013	4014
4016	4017	4018	4019	4020	4023	4024
4025	4027	4028	4029	4030	4033	4034
4035	4037	4043	4045	4046	4048	4050
4051	4052	4053	4055	4056	4057	4058
4060	4061	4063	4064	4065	4068	4069
4071	4072	4075	4076	4077	4078	4079
4082						

Release Notes Version 4.9

1. Special Attention Notes

1.1 Subslots default convergence

Subslots on multi-slots are now given a convergence type of "None" when they are created. Previously, subslots were given the default convergence of 0.01% and there was no way to modify or change this value. Convergence issues will be caught by the multi-slot or the other end of the link, so checking convergence on subslots is unnecessary. Although test models have shown insignificant numerical differences in results, this modified approach could change the results of some models.

Please contact riverware-support@colorado.edu if multi-slot values have changed significantly.

1.2 Slot name change

1.2.1 Deterministic Local Inflow and Deterministic Hydrologic Inflow

As part of the new cumulative to incremental disaggregation methods described **HERE (Section 4.1.3)**, the name of the control point slot "Deterministic Local Inflow" was changed to "Cumulative Local Inflow." On reservoir objects, the name of the slot "Deterministic Hydrologic Inflow" was changed to "Cumulative Hydrologic Inflow." The forecast methods in the Generate Forecast Inflows/Hydrology category that previously used the "Deterministic Local/Hydrologic Inflow" slots now use the new "Deterministic Incremental Local/Hydrologic Inflow."

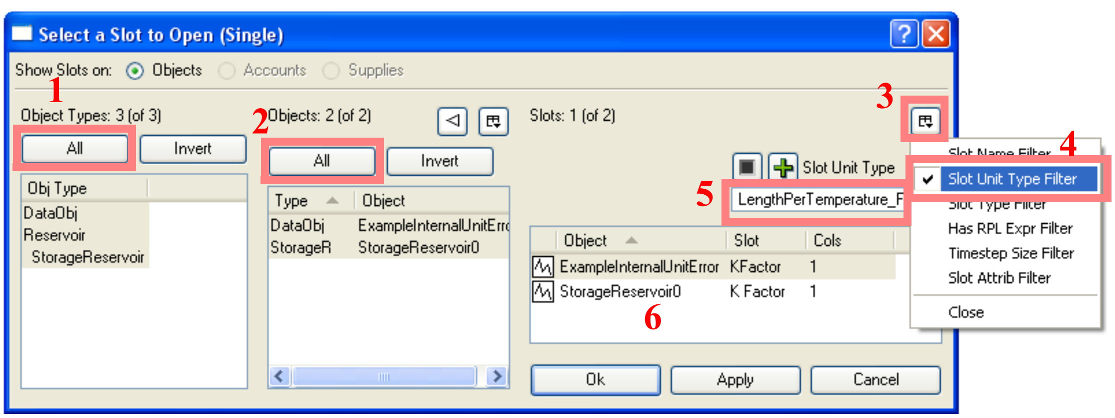
If you use one of the Generate Forecast Inflows/Hydrology methods that access this slot, there are two options:

- If you wish to continue using data in the old "Deterministic Local/Hydrologic Inflow" slot in its previous form (either cumulative or incremental), it is recommended that you re-input the data into the new "Deterministic Incremental Local/Hydrologic Inflow" slot. If you do not re-input the data, RiverWare automatically copies the existing data from the new Cumulative Local/Hydrologic Inflow into the Deterministic Incremental Local/Hydrologic Inflow at the beginning of a run. The data will not have input flags. To see or modify the input data, you would need to select the Compute Forecast Period Incremental Local/Hydrologic Inflow method in the Calculate Incremental Local/Hydrologic Inflows on Subbasin method temporarily. To avoid having to select this method, it is recommended that you re-input the data into the Deterministic Incremental Local/Hydrologic Inflow slot.
- If you have cumulative flows in the old Deterministic Local/Hydrologic Inflow slot and you plan to disaggregate the flows using one of the new methods, the data should remain in the new Cumulative Local/Hydrologic Inflow slot. You must then select a new disaggregation method in the Calculate Incremental Local/Hydrologic Inflows on Subbasin on the Control Point/Reservoir and create a subbasin to perform the disaggregation.

In addition, if any of these slots are referenced by DMI's, output manager devices, rules, or expression slots the models will need to be modified. For more information on these methods, please click **HERE (Section 5.1.5)** (reservoirs) or **HERE (Section 5.2.6)** (control points).

1.3 LengthPerTemperature unit type changed to LengthPerTemperature_F

The unit type LengthPerTemperature was changed to LengthPerTemperature_F. The internal, standard units for this type are “m/F” and user units include “ft/F” and “inches/F.” In the old LengthPerTemperature unit type, there were units of “m/C” and “ft/C,” these have been removed. When users open an existing model in RiverWare 4.9 for the first time, the following warning message is posted regardless of whether this unit type is used: “`The unit type LengthPerTemperature was changed to LengthPerTemperature_F. Existing data in slots with this unit type must be updated. See the RiverWare 4.9 release notes in the online help for more information.`” In RiverWare’s engineering methods, this unit type is only used in the K Factor slot on the “PanAndIceEvaporation” and “CurrentSurfaceAreaPanAndIce” evaporation methods. Users who have either of these two methods selected or are using this unit type on data objects will need to re-input the correct data into these slots. To identify if your model has slots with unit type, use the slot selector from the main workspace. Select **Workspace ➥ Slots ➥ Open Slot** to bring up the slot selector. The following screenshot shows the slot selector configured to select slots with this unit type. In the Slot Selector, click the **All** button in the Object Types column (1) and the **All** button in the Objects column(2). Then click on the slot filter button (3) and select **Slot Unit Type Filter** (4). In the pull down menu, select **LengthPerTemperature_F** (5). Any slots that appear in the slot area (6) have this unit type and must be addressed. Highlight a slot and click **Apply** or **OK** to open this slot. If you have slots with this unit type, you will need to re-import or re-enter the data and also make sure any DMI’s and/or rules are updated to correctly reference these slots.



2. General RiverWare

2.1 Documentation

The RiverWare help files have been reorganized to be more general and sorted by topic. Additional documentation has been provided on how simulation and rulebased simulation works. Also, accounting documentation is now available.

We recommend using Acrobat Reader 8.1 on Windows or Acrobat Reader 7.0 on Solaris (or later versions) for compatibility with our menus and links. In Reader 8.1, a minor configuration change is necessary to add the “previous” and “next” buttons to the toolbar. Click on Tools->Customize Toolbars. A window titled “More Tools” will open. Scroll down to the “Page Navigation Toolbar” section and toggle on the “Previous View” and “Next View” buttons. Click on “OK”. These two buttons are useful when following links in the help files. When following a link, the “Previous View” button will return you to the previous document and the “Next View” button can then take you back to the link page.

Searching the online help can be done using the Acrobat Reader Search Utilities.

2.2 Batch Mode/RCL

2.2.1 *ListSlotDMI command*

A new keyword pair was added to the RiverWare Command Language (RCL): SlotListDMI <DMI name> <output file>

This pair writes information about the slots to / from which the DMI imports / exports data; the information is written as comma-separated values to the output file. The information includes:

- The slot’s name.
- The slot’s priority (determined by its dataset association).
- The slot’s begin date “mm-dd-yyyy”.
- The slot’s begin time “hh:mm:ss”.
- The slot’s end date “mm-dd-yyyy”.
- The slot’s end time “hh:mm:ss”.
- The dataset associated with the slot.
- The dataset’s type, currently DSS or HDB.

If the dataset is DSS, then additional type specific information is written : the DSS path “/A/B/C/D/E/F/”.

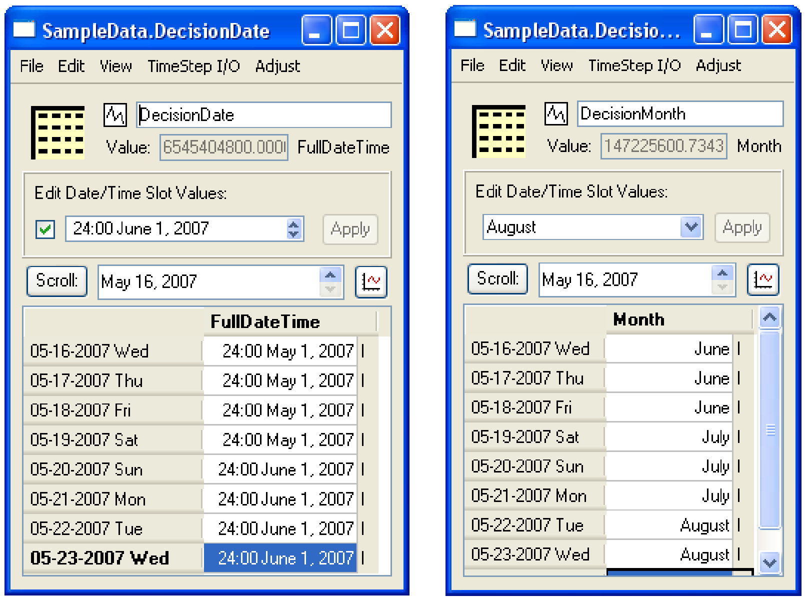
More information on this and other RCL keywords can be found **HERE (BatchMode.pdf, Section 4)**.

2.3 DateTime values in slots

It is now possible to store DateTime values in series, aggregate series, table, and scalar slots on data objects. To store datetimes, a new unit type, DateTime was added. Within this unit type, the user can specify the following either fully or partially specified datetimes (as user units):

- Full DateTime
- Month
- Month and Day
- Time of Year
- Day of Month
- Time of Month
- Time of Day
- Year

To input dates into the slot, the user can either type a DateTime into the slot or use the provided selector and then click apply. The structure of the selector depends on the type of user unit that is specified. The following screenshots show both a slot with a fully specified DateTime and one with a partially specified DateTime showing only the month:



For more information including directions on storing DateTime values in slots, **HERE (Slots.pdf, Section 5)**.

2.4 Data Management Interface

2.4.1 Database DMI's: HDB connection

There is now the ability to establish a direct data connection between RiverWare and the Hydrologic DataBase (HDB). This connection requires Oracle Client or a full database installation to be available from the user's machine. Data is transferred by creating and configuring HDB datasets in the Dataset Manager and running DMIs containing these datasets. More information on this feature can be found **HERE (DMI.pdf, Section 5.3.2)**. This is the alpha release of this feature; the functionality and user interface are still under development.

2.4.2 DMI Import of Periodic Slots

A bug related to units and configuration of a multiple-column periodic slot during importation has been fixed. When importing (and resizing) data via a DMI to a periodic slot, columns other than the first did not have the correct units or configuration. After the table is resized to match the number of underlying table columns on the periodic slot column map, all the columns are set to have the same configuration (including units) as the first.

2.5 Multiple Run Management (MRM)

In the MRM consecutive mode, a change was made to allow the user to enter up to 99,999 timesteps instead of the default 99 timesteps.

2.6 Units

2.6.1 m^3/d

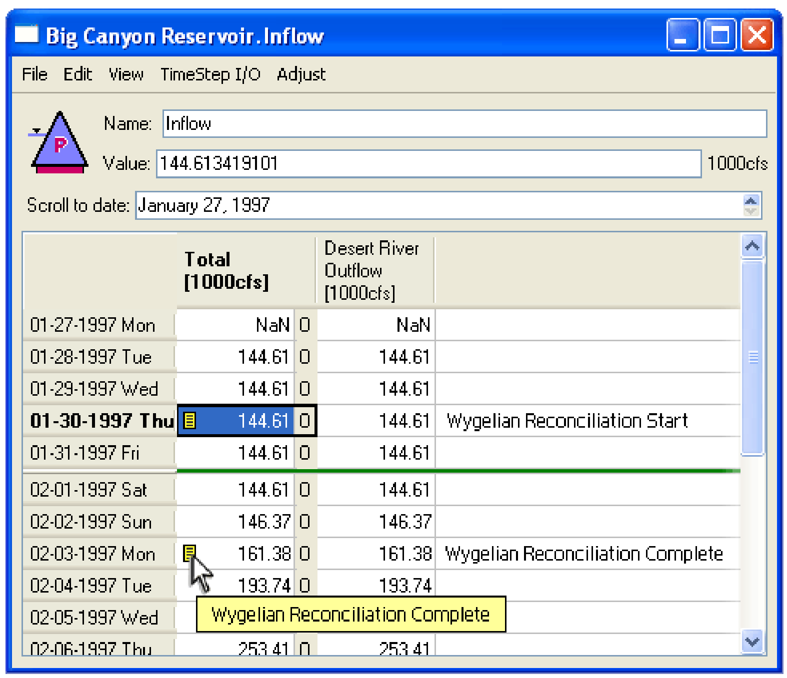
A new flow unit was added to the **units** file: m^3/day. RiverWare displays it as m3/day.

3. General User Interface Enhancements

3.1 Slots

3.1.1 Notes on Series Slots

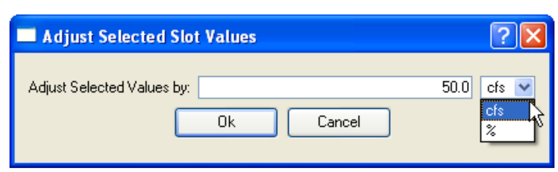
It is now possible to add notes to values in series slots. These can be used to denote when certain operations start, change, or end. The user can see the notes through a tool tip or by configuring to show a column of notes as shown in the following screenshot.



Further information is given **HERE (Slots.pdf, Section 6.1)**.

3.1.2 Slot Adjust Values

One or more values selected in a slot can be adjusted using the “Adjust Values...” item available from the Edit menu of slot dialogs. When the user selects “Adjust Values...” RiverWare opens an Adjust Selected Slot Values dialog which allows the user to provide the amount by which the selected slot values should be adjusted. Values may be adjusted by a percentage, or if all of the values have the same units, by a fixed increment in user units. The user first



selects (highlights) the slot values to be adjusted then chooses the "Adjust Values..." option from the Edit menu. In the Adjust Selected Slot Values dialog that appears, the user enters the adjustment value. The user then applies that adjustment value to the selected slot values by selecting the "Ok" button or cancels the adjustment using the "Cancel" button. The dialog automatically closes.

The slot value(s) assure) adjusted by adding a certain amount to the existing slot value(s) or by multiplying the slot value(s) by a percentage. The user may specify a positive or negative quantity. The percentage option adjusts the existing amount by adding a specified percentage of that amount.

For example if the values 10.0 and 100.0 acre-ft/month are selected and the user enters 10 acre-ft/month into the Adjust Slot Values Dialog and selects "Ok", then the values will be changed to 20.0 and 110.0. If the user enters 10%, the values will be changed to 11.0 and 110.0.

Note that it is easy to select all cells in a column by clicking on the header for that column.

3.1.3 Open Series in SCT

The Open SeriesSlot and Open TableSeriesSlot dialog boxes now support functions to show the series data in a new SCT or add the series data to the single open SCT (enabled only if one SCT is shown).

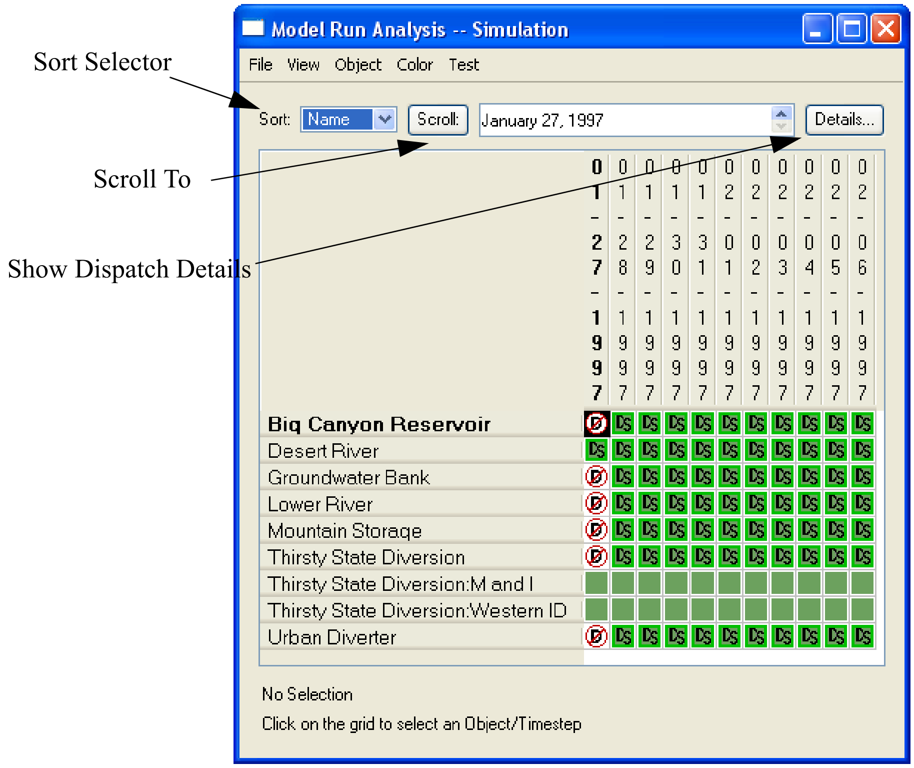
These functions are accessible from series-data applications of the Open Slot dialog: **File ➥ SCT ➥ Show in New SCT** and **Add to Open SCT**.

3.2 Global Time Scroll

A context menu option was added that allows the user to globally scroll the all opened dialogs to a given timestep. On an open slot dialog, the user can right click on a timestep in a slot and select Global Time Scroll. Then all open (or previously opened) dialogs that have a timestep will scroll to this timestep. For example, the Model Run Analysis, opened plotting devices, and Open Object dialogs will scroll to that timestep. This operation can be performed from numerous locations in RiverWare including the Open Slot dialog and Model Run Analysis.

3.3 Model Run Analysis port to Qt

The Model Run Analysis and its related dialogs were ported to Qt. The dialogs, although similar to the previous version, now have a new look as shown in the following screenshot:

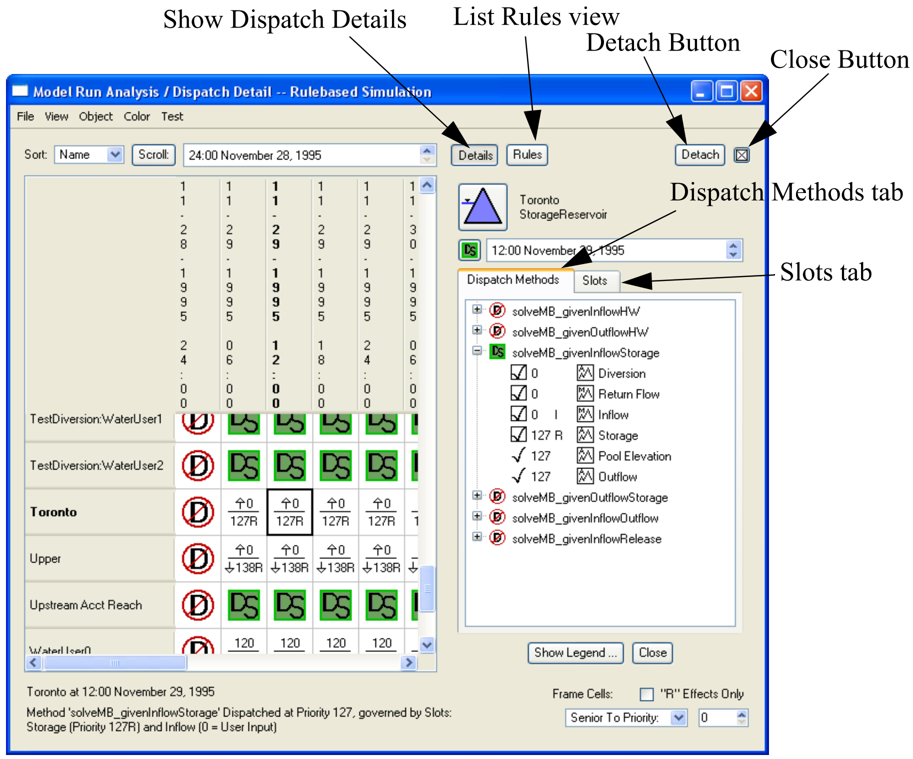


Also noted on the screenshot are some additional features including:

- The objects can be sorted by Name, Type, Position, or Internal order.
- Scroll to Date functionality
- A button to show the Dispatch Details. (This button will open the Dispatch Details in a docked window.)

In addition, the Dispatch Details and List Rules dialogs are now in Qt. These two dialogs can either be shown as stand alone dialogs or docked in the Model Run Analysis as shown in the following rulebased run dialog.

When docked, the dialogs can be separated using the Detach button. When in stand alone mode, the dialogs can be docked from the Dispatch Detail’s **File ➥ Dock in Model Run Analysis** menu. A button is also provided to switch between the Dispatch Dialog and List Rules. Finally, on the Dispatch Detail's dialog, the Dispatch Methods and Slots view are now on separate tabs.



In the new dialogs:

- "Time on Top" is the only currently implemented configuration
- The font can be changed
- The rules colors can be changed from the color menu
- Pre-simulation and post-simulation timesteps are now shown

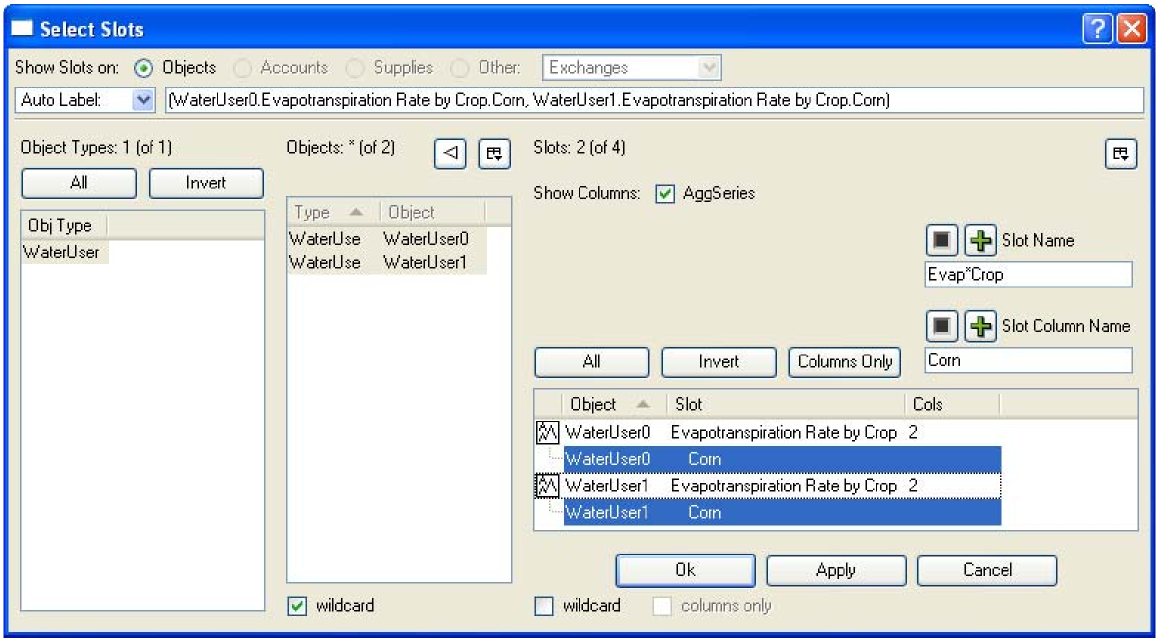
On the Model Run Analysis dialog, right-click context menus were added to Show Dispatch Detail, Open the Object, Copy the Time, Global Scroll, and Disable Dispatching.

In the Dispatch Detail dialog, clicking on the Object icon brings up the Open Object dialog. Similarly, Clicking on the icon brings up the Model Run Analysis and docks the Dispatch Detail.

3.4 Slot Selector Enhancements

A new filter was added to the slot selector dialogs to filter slots by timestep size. Using this filter, the user can specify to show only slots of a given timestep size.

In addition, the selector was enhanced to show and select by the column name in Series Slots, Table Slots and Table Series Slots. This is appropriate and available, for example, in Database DMI Name Maps where the user can select to import column 2 of an Agg Series Slot. To facilitate functionality, a Column Name filter was added to the selector. In addition, a push button was added to highlight "Columns Only" on the selection. The wildcard toggle also works for this type of selection. A "columns only" toggle was added next to the wildcard toggle to specify that in the wildcard selection, only the columns should be selected and not the overall slot. Following is an example of how this could be used: A user configures 5 agg series slots to contain crop water requirements for 10 different crops. (5 slots * 10 columns = 50 timeseries) When creating a name map for use in importing via the database DMI, the user sets the filter to select each of the columns that are labeled “Crop 1” across the multiple slots. The user can then specify that “Crop 1” maps to “corn” in the database Name Map. This enables the user to set up only 10 Name Maps, one for each crop, instead of the 50 that were previously required. Following is a screenshot of the selector showing these new filters.



3.5 Timestep size on SCT

An option was added to allow the user to configure the SCT to display slots at a different timestep from the Run Control. For example, an SCT can be configured to show monthly slots within a daily model. Only one timestep size is allowed per SCT, but multiple SCT’s can be configured with different timestep sizes for a given model.

This feature is configured using a new “SCT Timestep Size Override property” found on the General tab of the SCT configuration dialog.

4. Engineering Methods

This section describes engineering object methods that involve more than one object. The methods for each object are also described in the “Simulation Objects” section below.

4.1 Spatial, Temporal, and Incremental Flow Disaggregation

New methods were added to the reservoirs, Control Point, and Computational Subbasins to allow the user to disaggregate flows spatially, temporally, and incrementally as follows.

4.1.1 *Spatial disaggregation methods*

Two approaches were added to allow flows to be spatially disaggregated throughout a subbasin. The **WAM Precipitation Curve Number** method uses the Water Availability Model (WAM) method to disaggregate known flows spatially throughout a computational subbasin. It uses the NRCS curve number, mean precipitation, and drainage area along with the known flow at a "gage" control point to calculate the unknown local inflows (Distributed Flow) at all other control points in the subbasin. For more information click **HERE (Objects.pdf, Section 7.1.20.2)**. The **Drainage Area** method disaggregates known flows spatially throughout a computational subbasin based on drainage area. For more information click **HERE (Objects.pdf, Section 7.1.20.3)**.

4.1.2 Specified Factors temporal disaggregation method

The **Specified Factors** temporal disaggregation method takes the Distributed Flow (typically a monthly value in a daily timestep model--though this is user configurable) and temporally disaggregates it to be the same timestep size as the run control. The method multiplies the Distributed Flow by a Temporal Disaggregation Factor to obtain the Temporally Disaggregated Flow. For more information click **HERE (Objects.pdf, Section 7.1.21.2)**.

4.1.3 Calculate Incremental Local Inflows category

In certain basins, local inflow data is input into the model as cumulative values, that is, the local inflows for a given control point or reservoir includes all of the upstream local inflows including water entering upstream objects. Because RiverWare must have distributed data, methods were added to compute incremental local inflows from cumulative local inflow data. Computation of incremental local inflows has two variations to it: with and without forecasting. In the simple case, forecasting is not necessary and the incremental local inflows can be calculated at the beginning of run for all timesteps in that run. In the more complex case, cumulative inflows are forecasted throughout the forecast period, then the forecasted incremental flows are calculated. This forecasting occurs at the beginning of each timestep. To facilitate these two variations, categories and methods were added to the Computational Subbasin, Control Points, Reservoirs, and Confluences.

Users will first need to set up one computational subbasin for each group of control points and reservoirs that contain cumulative local inflow data. The computational subbasin(s) must include all control points and reservoirs containing the cumulative local inflow data as well as all the intervening reaches and confluences. Each control point and reach should only be included in one computational subbasin.

For each computational subbasin, select a method from the **Compute Incremental Local Inflows** category. This enables the **Reservoir Boundary for Incrementals** category. If cumulative local inflow data is only cumulative until a reservoir is reached, select the **Stop at Reservoirs** method. Otherwise, select the **Continue Through Reservoirs** method if cumulative data continues through reservoirs, or **Ignore Reservoirs** if there is no cumulative data on reservoirs.

For each control point and reservoir in the computational subbasin several new methods must be selected. In RiverWare, local inflows are called "Local Inflows" on Control Points and "Hydrologic Inflows" on Reservoirs. In this discussion, we will use the terminology Local Inflows exclusively; please substitute Hydrologic Inflows anywhere a reservoir is referenced. First, Select either the **Input Local Inflows** or **Forecast Local Inflows** from the **Local Inflow Calculation** category. Next, select a method from the **Calculate Incremental Local Inflows on Subbasin** category. Depending on the **Local Inflow Calculation**, you can either select to calculate incrementals for the Full Run or calculate incrementals and forecast throughout the Forecast Period. For more information click **HERE (Objects.pdf, Section 7.1.22)**.

5. Simulation Objects

5.1 Reservoir Objects

5.1.1 Flashboard and Superboard Spill methods

In the reservoir flashboards and superboards unregulated spill methods, a check was added to see if the availability slot is input or set by a rule. Previously, the availability was just checked for inputs, not rules. Now, users can set the availability with a rule.

5.1.2 Surcharge Error Check

An error check was added to the Flattop Surcharge method to ensure that the non-zero portion of the Rating Curves is increasing.

5.1.3 Peak Power Equation with Off Peak Spill - Warning message removed

In the Peak Power Equation with Off Peak Spill method on the power reservoirs, the following warning message was removed: “Pool Elevation too low to generate power.” This warning message was posted any time the reservoir was below the Minimum Power Elevation. The method behaves the same as previously: power and energy are still calculated to be zero; only the message has been removed.

5.1.4 Compute Incremental Hydrologic Inflows on Subbasin category

Two new methods were added to reservoir objects in the new **Calculate Incremental Hydrologic Inflows on Subbasin** category: **Compute Full Run Incremental Hydrologic Inflows** and **Compute Forecast Period Incremental Hydrologic Inflows** methods. These methods are used to disaggregate cumulative hydrologic inflows. The first method disaggregates cumulative inflows to Incremental Hydrologic Inflows for the entire run. The second method forecasts and disaggregates cumulative inflows to incremental hydrologic inflows on each timestep throughout the forecast period.

5.1.5 Slot name change: Deterministic Hydrologic Inflow

On reservoir objects, the name of the slot “Deterministic Hydrologic Inflow” was changed to “Cumulative Hydrologic Inflow.” In addition, the forecast methods in the Generate Forecast Hydrology category that previously used the “Deterministic Hydrologic Inflow” slots now use the new “Deterministic Incremental Hydrologic Inflow.”

If you use one of the Generate Forecast Hydrology methods that use these slots, there are two options:

- If you wish to continue using data in the old “Deterministic Hydrologic Inflow” slot in its previous form (either cumulative or incremental), it is recommended that you re-input the data into the new “Deterministic Incremental Hydrologic Inflow” slot. If you do not re-input the data, RiverWare will automatically copy the existing data from the new Cumulative Hydrologic Inflow into the Deterministic Incremental Local/Hydrologic Inflow at the beginning of a run. The data will not have input flags. To see or modify the input data, you would need to select the Compute Forecast Period Incremental Hydrologic Inflow method in the Calculate Incremental Hydrologic Inflows on Subbasin method temporarily. Because of this, it is recommended that you re-input the data into the Deterministic Incremental Hydrologic Inflow slot.
- If you have cumulative flows in the old Deterministic Hydrologic Inflow slot and you plan to disaggregate the flows using one of the new methods, the data should remain in the new Cumulative Hydrologic Inflow slot. You then must select a new disaggregation method in the Calculate Incremental Hydrologic Inflows on Subbasin category on the reservoir and create a subbasin to perform the disaggregation.

In addition, if any of these slots are referenced by DMI's, output manager devices, rules, or expression slots the models will need to be modified. Click **HERE (Objects.pdf, Section 24.1.10)** to go to the documentation on the Generate Forecast Hydrology category for the storage reservoir.

5.2 Control Point

5.2.1 Variable Routing Coefficients category

A new category, **Variable Routing Coefficients** was added to the Control Point. Within this category, a new method, **Compute Aggregate Coefficients** allows the user to specify that this Control Point has an alternative set of routing coefficients that are to be used in the Flood Control calculation. Click **HERE (Section 5.3.1)** for more information.

5.2.2 Local Inflow Spatial Disaggregation on Subbasin category

This category has two methods that are used to hold the slots necessary for the calculation of Distributed Flow at an ungaged control point using the known flow at the Gage Control Point on the computational subbasin. In the **WAM Precipitation Curve Number** method, there are six slots: Distributed Flow, Drainage Area, Curve Number, Mean Precipitation, Upstream Gages, and Downstream Gage. These slots will be accessed by the computational subbasin when executing the computational subbasin's WAM Precipitation Curve Number method. In the **Drainage Area** method, there are four slots: Distributed Flow, Drainage Area, Upstream Gages, and Downstream Gage. In both of these methods, the computational subbasin will use the user input Distributed Flow values in the Gage Control Point to calculate and set the Distributed Flow values at all other control points in the subbasin. The **WAM Precipitation Curve Number** method takes into account the drainage area, mean precipitation and NRCS Curve Number while the **Drainage Area** method uses only the drainage area in the calculation. For more information click **HERE (Objects.pdf, Section 9.1.3)**.

5.2.3 Gage Control Point category

A new category, Gage Control Point, was added to the Control Point when the WAM Precipitation and Curve Number method is selected. Methods in this category are used to indicate which Control Points are the "gage" control points. There are two methods in this category: the default, no action None method and the Gage Control Point method. When selected, the Gage Control Point method indicates that the control point is considered a "gage" control point. When this method is selected, the Control Point changes from a blue color to an orange color. For more information click **HERE (Objects.pdf, Section 9.1.4)**.

5.2.4 Local Inflow Temporal Disaggregation on Subbasin category

A new method category, **Local Inflow Temporal Disaggregation on Subbasin,** was added to the control point. The **Local Inflow Temporal Disaggregation on Subbasin** method category contains two new methods: **None**, and **Specified Factors**. The **Specified Factors** method contains one new slot: **Temporally Disaggregated Flow**. This slot holds the result of the temporal disaggregation as calculated from the computational subbasin. For more information click **HERE (Objects.pdf, Section 9.1.5)**.

5.2.5 Compute Incremental Local Inflows on Subbasin category

Two new methods were added to control point objects in the new **Calculate Incremental Local Inflows on Subbasin** category: **Compute Full Run Incremental Local Inflows** and **Compute Forecast Period Incremental Local Inflows** methods. These methods are used to disaggregate cumulative local inflows. The first method computes incremental local inflows for the entire run. The second method computes forecasted incremental local inflows on each timestep for the forecast period. For more information click **HERE (Objects.pdf, Section 9.1.6)**.

5.2.6 Slot name change: Deterministic Local Inflow

On Control Points, the name of the slot “Deterministic Local Inflow” was changed to “Cumulative Local Inflow.” In addition, the forecast methods in the Generate Forecast Inflows category that previously used the “Deterministic Local Inflow” slots now use the new “Deterministic Incremental Local Inflow.”

If you use one of the Generate Forecast Inflows methods that use these slots, there are two options:

- If you wish to continue using data in the old “Deterministic Local Inflow” slot in its previous form (either cumulative or incremental), it is recommended that you re-input the data into the new “Deterministic Incremental Local Inflow” slot. If you do not re-input the data, RiverWare will automatically copy the existing data from the Cumulative Local Inflow into the Deterministic Incremental Local Inflow at the beginning of a run. The data will not have input flags. To see or modify the input data, you would need to select the Compute Forecast Period Incremental Local Inflow method in the Calculate Incremental Local Inflows on Subbasin method temporarily. Because of this, it is recommended that you re-input the data into the Deterministic Incremental Local Inflow slot.
- If you have cumulative flows in the old Deterministic Local Inflow slot and you plan to disaggregate the flows using one of the new methods, the data should remain in the new Cumulative Local Inflow slot. You then must select a new disaggregation method in the Calculate Incremental Local Inflows on Subbasin category on the Control Point/reservoir and create a subbasin to perform the disaggregation.

In addition, if any of these slots are referenced by DMI’s, output manager devices, rules, or expression slots the models will need to be modified. Click **HERE (Objects.pdf, Section 9.1.2)** to go to the documentation on the Generate Forecast Inflows category for the Control Point.

5.3 Computational Subbasin

5.3.1 Control Point Variable Routing Coefficients category

Functionality was added to allow the subbasin to use alternative routing coefficients in the Flood Control calculation. A new category called **Control Point Variable Routing Coefficients** was added to the computational subbasin. In this category are two methods, a default do-nothing **No Method,** and the new method **Compute Aggregate Coefficients**. This new Compute Aggregate Coefficients method is used to determine the set of routing coefficients to use for each Control Point in the subbasin. For each Control Point, the method aggregates routing coefficients using the intervening reach routing methods. This allows the Flood Control calculation to make use of variable routing coefficients during high flow events. This calculation is only performed during the Flood Control calculation and does not affect the routing in the simulation objects. For more information click **HERE (Objects.pdf, Section 7.1.24)**.

5.3.2 Multiple downstream-most objects in flood basin

It is now possible to have more than one downstream-most object in a subbasin used by the Flood Control predefined function.

5.3.3 Local Inflow Spatial Disaggregation

A new method category, **Local Inflow Spatial Disaggregation**, was added to the computational subbasin. The category contains three methods: the default no-action method **None**, the **WAM Precipitation Curve Number**, and the **Drainage Area** method. The **WAM Precipitation Curve Number** method calculates the Distributed Flow at an ungaged control point using the known flow at the Gage Control Point as well as the NRCS curve number, mean precipitation, and drainage area of both the gaged and ungaged control points. The **Drainage Area** method calculates the Distributed Flow at an ungaged control point using known flow at the Gage Control Point using drainage area ratios only. For more information click **HERE (Objects.pdf, Section 7.1.20)**.

5.3.4 Local Inflow Temporal Disaggregation

A new method category, **Local Inflow Temporal Disaggregation**, was added to the computational subbasin. The category contains two methods: the default no-action method **None**, and the **Specified Factors** method. The **Temp Disagg Factors** slot is required input for the **Specified Factors** method and holds a daily timeseries of the factors by which the monthly **Distributed Flow** values are multiplied to temporally disaggregate to daily. In practice, the data for the **Temp Disagg Factors** slot can be developed from historical daily data that is converted to a daily factor (percent per day of the monthly value). This slot is located on the computational subbasin (and not the control point) because the disaggregation factors apply to all control points in the subbasin. For more information click **HERE (Objects.pdf, Section 7.1.21)**.

5.3.5 Compute Incremental Local Inflows

A new method category, **Calculate Incremental Local Inflows**, was added to the computational subbasin. The category contains three methods: the default no-action method **None**, the **Compute Full Run Incremental Local Inflows** method, and the **Compute Forecast Period Incremental Local Inflows** method. The latter two methods calculate the incremental local inflows to all control points and reservoirs in the subbasin given the cumulative local inflows at each object without forecasting and with forecasting, respectively. The computational subbasin(s) must be set up by the user and must include all control points and reservoirs which contain the cumulative local inflow data as well as all the intervening reaches and confluences. Cumulative local inflow data can be either cumulative until a reservoir is reached in the river system or continue through one or more reservoirs. For more information click **HERE (Objects.pdf, Section 7.1.22)**.

5.3.6 Reservoir Boundary for Incrementals Category

A new category **Reservoir Boundary for Incrementals** is available if one of the **Calculate Incremental Local Inflows** is selected**.** The category contains three methods, the default **Stop at Reservoirs**, **Continue Through Reservoirs,** and **Ignore Reservoirs**. These methods are used to specify how cumulative local inflows are configured in the basin. For more information click **HERE (Objects.pdf, Section 7.1.23)**.

5.4 Diversion Object

5.4.1 Change to SolveMB_GivenOutflow dispatch method

On the Diversion object's **solveMB_givenOutflow** dispatch method, “Available for Diversion” was removed as a required known in the dispatch conditions. This dispatch method solves for the Diversion and Diversion Request given the Multi Outflow. Typically, the Multi Outflow is calculated by a rule using the ComputeReservoirDiversions predefined function. This function determines the reservoir diversion and limits diversions to be less than the available water in the reservoir. As a result, Available for Diversion is not a required known for this dispatch method. For more information click **HERE (Objects.pdf, Section 12.2.5)**.

5.5 Reach

5.5.1 Base Plus Fractional Loss Method in the GainLoss Calculation Category

A new method **Base Plus Fractional Loss** was added to the **GainLoss Calculation** category on the reach. This method models loss in a reach as a base loss plus a loss fraction of the flow above that base. In addition, total loss is limited to a maximum value. For more information click **HERE (Objects.pdf, Section 22.1.10.6)**.

5.5.2 Variable Step Response routing method

A new routing method, **Variable Step Response**, was added to the Reach. In this routing method, the user specifies a set of flow thresholds and a set of corresponding step response routing coefficients. When the reach dispatches, the routing method selects the appropriate routing coefficients based on the inflow to the reach. This method was added to support systems where large overbank floods lead to increased travel times. For more information click **HERE (Objects.pdf, Section 22.1.1.6)**.

5.6 Water User

5.6.1 Fraction Return Flow Input category

A new category called **Fraction Return Flow Input** was added to the **Water User** object. This category, dependent on the selection of the **Fraction Return Flow** method in the **returnFlowCalculation** category, specifies how the Fractional Return Flow slot is to be input. Within this category are three new methods: **Input Fraction**, **Zero Fraction**, and **Periodic Fraction**. The default method is the **Input Fraction** which duplicates the existing functionality. The **Zero Fraction** method sets a zero for Fraction Return Flow each timestep. The **Periodic Fraction** allows the user to input a periodic slot that is used to calculate the Fractional Return Flow. For more information click **HERE (Objects.pdf, Section 27.1.5)**.

6. RiverWare Policy Language

6.1 RPL User Interface

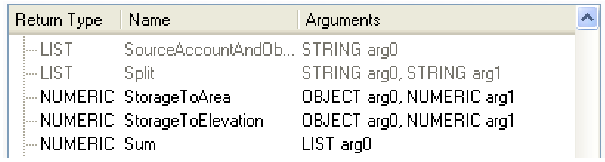
6.1.1 RPL Statements

In RPL set editors, the Rule/Method menu option was improved to only show the types of statements relevant to the given set. In a Ruleset or Object-level Accounting Method set, the following statements can be added: Print, Assignment, ForEach, If, If Else, and Stop Run. The last three statements are new, click **HERE (Section 6.2)** for more information. In a RPL based Optimization set, the following statements can be added: Soft Constraint, Constraint, Objective, Freeze, If, and If Else.

6.1.2 RPL Palette

Re-use of expressions in sub-expression: When the user selects a non-empty RPL expression, and then clicks a palette button, RiverWare now does a better job, where applicable, of re-using the existing expression in the first sub-expression. In general, the existing expression becomes the first part in the new expression. So if you have an expression 10 [“cfs”] and you click on the <N>+<N> button, the expression becomes 10 [“cfs”] + <N>. In the WITH and GET operators, the selected expression becomes the body of the expression.

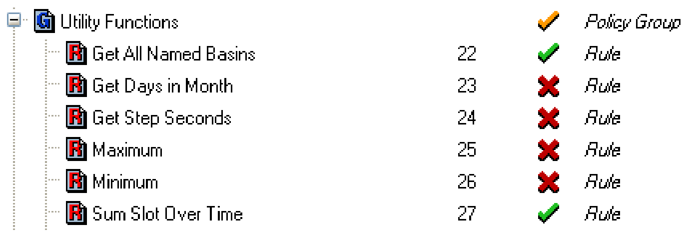
Available Palette Buttons: The palette was improved to better show which buttons are available for a selected expression. In particular, all buttons are disabled when a type/name pair is selected. For example, in a ForEach statement, if the “NUMERIC result” is selected, all palette buttons become disabled. Also, when a binary expression is selected, the correct palette buttons are now enabled.



Functions: On the palette, the functions are now either shown as available or unavailable to replace the selected expression based on expression type and the function's return type. Available functions (either predefined or user defined) are shown in dark text, while unavailable functions are shown in a light grey text. The screenshot above shows that the functions that return a NUMERIC are available and the functions that return a LIST are not available. The user can still single click on a function to select it and show the description (user-defined functions only). Double clicking an unavailable function will give a Paste Error and ask if you would like to continue using this function.

6.1.3 Operations in RPL set editor dialogs

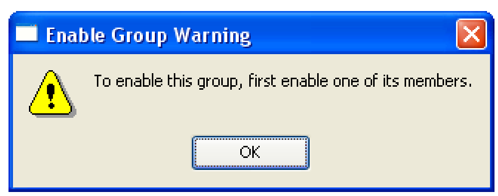
Orange Check Mark: In the RPL dialogs, an orange check mark was added to policy and utility groups to specify that one or more items in that group is "off" as shown in the following figure. As before, the user can



click on the orange check to turn "off" the entire group, resulting in a red X. To turn it on again, restoring the previous state and showing an orange check, simply click the red X.

Clicking Red X: Also, clicking on an item's X in a group that is turned "off" now turns the entire group "on" without making any changes. This prevents the user from inadvertently changing the status of an item in a group that is off only to find that it is now different when the entire group in turned back "on".

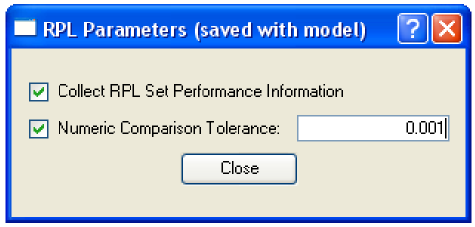
If all individual items in a group are turned off (red X), then the entire group is considered off and the group will also have a red X. If the user clicks on the group's red X, a warning message will appear to indicate that at least one item in the group should be turned on.



Deselecting a Row: In the RPL set editor, left-clicking on a row in the listview that was previously selected by left-clicking causes the row to become de-selected. Previously, clicking on a selected row had no special significance. Also, there was no reliable and easy way to de-select a row.

6.1.4 RPL Parameters Dialog

A new “**RPL Parameters**” dialog was added to the Policy menu on the workspace. This dialog allows the users to provide settings and values which affect all applications of RPL. These parameter settings are saved with the model file.



Currently, there are two parameters:

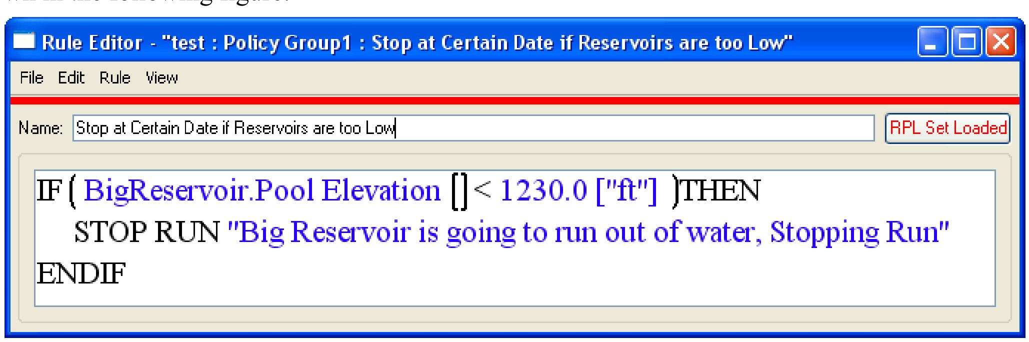
- **Collect RPL Set Performance Information:** This switch is not new. It has been moved from the Simulation and Rulebased Simulation run parameters dialogs. (Previously, this was accessed from the **Run Control ➥ View ➥ Simulation Run Parameters** or **Rulebased Simulation Run Parameters**.)
- **Numeric Comparison Tolerance:** This parameter specifies whether or not to use a tolerance value for numeric comparisons in RPL and allows the user to specify the tolerance value.

6.2 IF and IF ELSE Statements

It is now possible to add an IF or IF ELSE statement as the uppermost statement in a rule. This is similar to adding an assignment statement. Care should be exercised when using these statements as the left-hand side of the expression can quickly be hidden under multiple layers of logic.

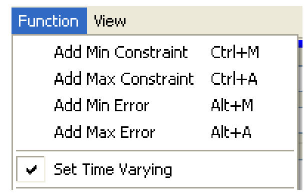
6.3 Stop Run Statement

A new Stop Run statement was added to RPL for use as the uppermost statement in a rule. This STOP RUN <expr> statement is accessible from the **Rule ➥ Add Stop Run** menu. When executed, this statement will abort the run and post an error message contained in the specified <expr>. The new Stop Run statement provides functionality allowing a rule to stop a run at the uppermost level. Using the Stop Run statement with the new IF and IF ELSE statement allows a rule to evaluate an expression and stop the run if necessary as shown in the following figure:



The existing STOP_RUN button is still available on the palette. This button should be used within a rule when it is desirable to stop the run inside another statement. The difficulty with this approach is that the expression has to be within an assignment or Print statement. If using a Print statement, then diagnostics have to be turned on to evaluate the Print. This is not the intended use of either the assignment or print statement. The new Stop Run statement avoids having to place the STOP_RUN expression within a Print statement that only evaluates if the user has diagnostics enabled.

6.4 Time Invariant Functions



It is now possible to designate a user defined function as being "time invariant". To indicate that a function does not vary with time, the function editor's Function menu provides a toggle control labelled "Set Time Varying". A check mark (on, by default) indicates the function does vary with time. No check mark (off) indicates the function does NOT vary with time. Toggling the check mark off communicates to RiverWare that the function is guaranteed to evaluate to the same value each time it is evaluated, i.e., it is time invariant. Note that functions with arguments will almost certainly not be time invariant; if a function has an argument, then presumably there are some argument values for which the function will evaluate to different values. If a function with no arguments is time invariant, then the first time the function is called within a run the body will be evaluated and the result saved internally. For all subsequent calls of that function within the run, the cached value will be returned without further computation, reducing computation time.

Note that incorrect application of caching to a time varying function will lead to incorrect results, so it is recommend that the time varying property be toggled off for a function only when it is definitely time invariant, run time is critical, and RPL set analysis has indicated that a significant portion of the run is spent evaluating the function. When the function does not vary with time a warning message Warning: this function is time invariant. is added to the bottom of the function editor.

Note that during rule evaluation the workspace remains unchanged (because RPL expressions evaluate without side effects), so it is safe to cache values for functions without arguments within a single rule. RPL does this automatically for all functions without arguments. Multiple evaluations of such a function within the same rule execution will cause the function to evaluate only once.

6.5 RPL Diagnostics

6.5.1 FOREACH diagnostics

A diagnostic was added to the "Rule Execution" category. This message is posted when a FOREACH statement is called. The diagnostic prints the list of values over which the FOREACH statement is iterating.

6.6 Modified Predefined Functions

6.6.1 HydropowerRelease

In the HydropowerRelease predefined function, a call is made to determine the maximum proposed power release. This call was modified such that RiverWare does not abort with an error if the Elevation Volume table is exceeded during the mass balance iteration. Instead, the limits of the table are used in the iteration scheme.

6.6.2 SolveOutflowGivenEnergyInflow

The predefined function SolveOutflowGivenEnergyInflow was modified such that RiverWare does not abort with an error if the Elevation Volume table is exceeded during the mass balance iteration. Instead, the limits of the table are used in the iteration scheme.

6.6.3 MeetLowFlowRequirement

The MeetLowFlowRequirement predefined function was incorrectly accessing the current slot values before returning the result to the calling rule. The function was fixed to now add the calculated flow to the current values in the Low Flow Release and Outflow slots.

6.7 New General Predefined Functions

6.7.1 DateToNumber and NumberToDate

Two new predefined functions were added that convert between RPL date/times and numeric values which are used to encode those dates in a way appropriate for slots that have the new DateTime unit type.

6.8 New Accounting Predefined Functions

6.8.1 AccountAttributes

AccountAttributes(STRING -- "object^account") returns a list containing the account's attributes, i.e., the account's water type, water owner, and account type of the form {STRING, STRING, STRING}.

6.8.2 ObjAcctSupplyByWaterTypeRelTypeDestType

ObjAcctSupplyByWaterTypeRelTypeDestType(STRING -- subbasin, STRING -- water type, STRING -- release type, STRING -- destination) returns a list of lists each containing an {Object, Account, and Supply}. The function is provided a subbasin (argument 1), a water type (argument 2), a release type (arguments 3) and a destination type (argument 4). The function searches the specified subbasin and finds all of the {Object, Account, Supply} triplets which match the following conditions: the object is in the given subbasin, the returned object^account is served by the supply, and the supplying account (upstream end of the supply) has the given water type, release type, and destination.

6.8.3 ObjectsFromAccountName

ObjectsFromAccountName(STRING -- account name, STRING -- account type) returns a list of the objects that contain an account with the given name and type.

6.8.4 ObjectsFromWaterType

ObjectsFromWaterType(STRING -- water type, STRING -- account type) returns a list of the objects that have an account with the indicated water type and account type.

6.8.5 SourceAccountAndObject

SourceAccountAndObject(STRING -- supply name) returns a list containing the indicated supplies' source (upstream) account and object of the form {STRING, OBJECT}.

6.8.6 SupplyAttributes

SupplyAttributes(STRING -- supply) returns a list containing the supply's attributes, i.e., the supply's release type and destination of the form {STRING, STRING}.

7. Accounting

7.1 Documentation

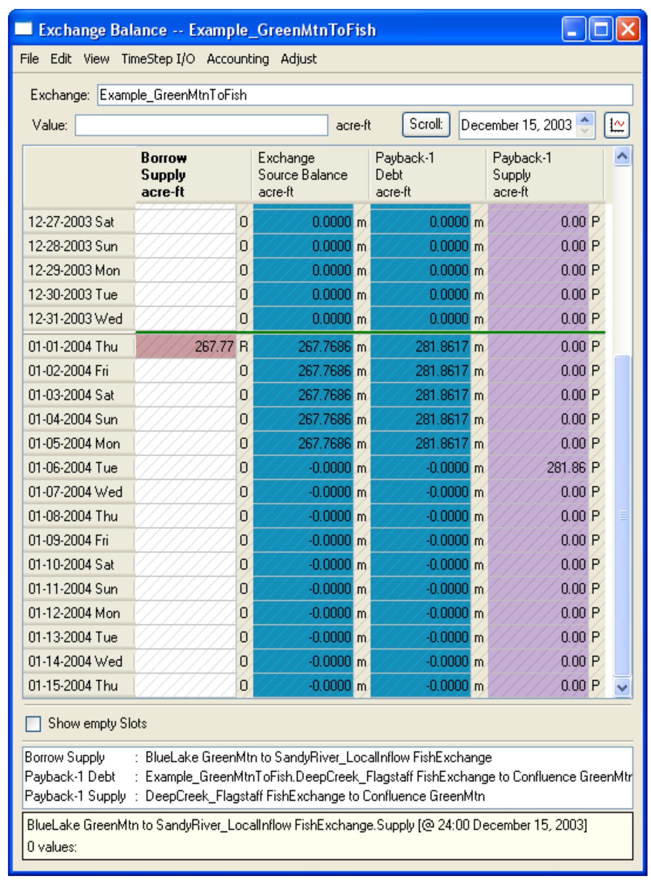
Documentation of the Accounting system was added to the RiverWare Help files. See “Accounting Overview” for the help file.

7.2 Water Rights Appropriation Solver

A Water Rights Appropriation solver was added to RiverWare. This solver determines how to appropriate natural flows based on the accounts’ priority dates. Further documentation on the methods and predefined functions that constitute this solver can be found in the Accounting section of the RiverWare help files **HERE (, Section 5)**.

7.3 Exchange Balance Dialog Ported to Qt

The Accounting system's Exchange Balance dialog was ported to Qt, providing the general capabilities of the new Open Series Slot dialog for Accounting Slots. A screenshot of the new dialog is shown below. Now the Payback Supply series are also shown as a column on the dialog. The column labels have been generalized and a key has been added to the bottom of the dialog. As a result, there are no long supply names in the column labels. Otherwise, the dialog has the same functionality plus the added functionality that exists in the new implementation of the Qt slots, including better column width management and an information area on the bottom of the dialog.



7.4 Synchronizing the Accounting System when Enabling

When enabling Accounting, if there are not yet any accounts defined, the Accounting System's time range (i.e. the accounting period) and timestep size are now synchronized with the time range and timestep defined on the Run Control.

7.5 Opening an Account from the Accounting View

In the Accounting view, when the user double clicks an Account icon only the account dialog opens. Previously, the Open Object dialog would also appear.

7.6 Keyboard Accelerators

The keyboard accelerators, Alt+O and Ctrl+Alt+O are now defined as follows for accounting: Alt+O -- Clear Selected Values, Ctrl+Alt+O -- Clear All Values in the selected Slots.

7.7 Clear All Operation on Orphaned Accounts

Generally, an Account MultiSlot can be edited directly only when it has exactly one Supply. This limitation applies to the "Clear Values" menu operation on the Account MultiSlot as well. A new exception to that limitation enables the "Clear Values" menu operation when there are no Supplies on a MultiSlot. This feature is needed only in anomalous circumstances, e.g. as a result of some internal error, when all links (Supplies) are removed, providing a way to completely clear the MultiSlot.

7.8 Diversion Account

7.8.1 Return Flow Lag Units Type Change

The units of a diversion account Return Flow Lag slot have changed from TIME to NONE/NOUNITS. The value is interpreted as a number of timesteps in which to lag the Return Flow. Fractional lags are not permitted.

RiverWare will automatically update the unit type on existing models and issue a warning. If the slot has a valid, non-zero value, RiverWare issues another warning to the effect that the user has to convert the value from time to number of timesteps. There is NO automatic conversion from time to number of timesteps. This change applies ONLY to the diversion account Return Flow Lag. Passthrough account lag is unchanged.

7.8.2 Diversion Account Solution Equation

The diversion account solution equations were modified to conserve mass when there is a Return Flow Lag and timestep length is non-constant (e.g. monthly). Now, the equation uses the Diversion, Depletion, and Return Flow as a volume (using the length of the appropriate timestep). The full equations for the Diversion account can be found **HERE (, Section)**

8. Optimization

8.1 Upgrade to CPLEX 10.1

RiverWare's optimization now uses CPLEX 10.1 and Concert 2.3.

8.2 Change in "Convolved" Table Calculation

Nonlinear functions with two variables have the form y = f(x,z). These functions are linearized during optimization in RiverWare where the value of f is held in a table. For example, a Stage Flow Tailwater Table holds tailwater elevation, y, as a function of stage, x, and outflow, z. The table has the structure where the z values (outflow) is repeated while varying the x values (stage). The optimization first estimates a linear function for y as a function of x given an estimated z value. Some linearization methods use a second step to add a linear factor of z to this approximation. Others implicitly assume a constant z variable.

In some cases, such as the Stage Flow Tailwater Table, reversing the roles of the x and z variables in the linearization makes sense. Riverware creates a new "convolved" table to hold the resulting table in these cases. In our example, the resulting table is the Convolved Stage Flow Tailwater Table.

Previously, the convolved table was just a re-ordering of the original table. However, if the x values in the original table do not repeat, the resulting convolved table can be badly structured resulting in poor linearizations and runtime errors.

Now, the calculation of the convolved values first calculates a "full" table where every x value exists for every z. Visually, if the x and z values were viewed in a graph, the full table would appear to be a complete grid of points. The full table of y values is then created by interpolating and extrapolating values in the original table. The table can then be convolved correctly.

9. Closed Bug Reports

The following is a list of the bugs which were fixed for this release. If you wish to view the details for a specific bug, please browse to http://cadswes.colorado.edu/users/gnats-query.html and search our bug database. You will need a RiverWare user login and password.

3406	3588	3769	3803	3889	3935	3938
3940	3951	3956	3965	3966	4026	4047
4054	4062	4086	4089	4091	4092	4093
4108	4109	4110	4115	4120	4123	4125
4128	4129	4130	4131	4132	4134	4135
4137	4138	4139	4140	4141	4142	4143
4144	4147	4148	4149	4150	4151	4155
4156	4157	4158	4159	4161	4162	4163
4165	4166	4167	4168	4169	4170	4171
4171	4171	4174	4175	4176	4177	4179
4180	4182	4183	4185	4186	4187	4188
4189	4190	4191	4194	4196	4197	4199
4200	4201	4202	4204	4205	4207	4211
4217	4218	4220	4222	4223	4224	4225
4227	4228	4229	4230	4231	4234	4235
4236	4237	4238	4239	4240	4241	4243

4244	4246	4249	4250	4251	4254	4256
4257	4258	4262	4263	4264	4265	4269
4270	4276	4282	4285	4287	4290	4291
4293	4295	4296	4297	4303	4305	4306
4307						

Release Notes Version 5.0

1. Special Attention Notes

Following are special attention notes, indicating that

- functionality has changed that requires the user to update models, or
- results may differ

If you have any questions, please contact riverware-support@colorado.edu

1.1 Convergence

1.1.1 Checking Iterations when Convergence is None

Previously, if a slot had “None” specified as the convergence criteria, the iteration count was being skipped. This bug has been fixed and a convergence type of None will now result in the slot skipping the convergence check but max iterations will be checked. A possible implication of this fix is that some models which were not previously reaching their maximum iteration will now do so.

1.1.2 Convergence Type and Min/Max on Accounting Slots

On accounting slots (Account.Inflow, Account.Outflow), the convergence type will be set to **Percent Change** and only changes to the value will be permitted. In models created using previous versions of RiverWare, the convergence type will be changed on model load if they are not already **Percent Change**. Accounting supplies between two multislots (e.g. transfers in & out) will be changed to have a convergence of **None** and those between a series slot and a multislot will have the convergence of the series slot typically **Percent Change**. Also, there is no min/max checking done on account slots so this configuration option has been disabled.

With this change, many supplies now will have **None** as the convergence criteria. Even though the account solving will converge based on the convergence of the slots to which the supplies are propagated, rules that set supplies may fire more often as they will always reset the value, even if it is exactly the same. If this situation is occurring, users may need to modify some rule logic and should judiciously set the rules comparison tolerance **HERE (RPLTypesPalette.pdf, Section 2.2.1)** if they have not already done so.

1.2 Convergence Slot Name Change

On Reservoir objects the **Convergence** slot has been renamed **Convergence Percentage**. The new name was chosen as it is more descriptive of the slots purpose. The user will see a warning message when the model is first loaded. If this slot is used in RPL sets or DMI’s, the user will need to update the RPL set or DMI with the new name.

1.3 Muskingum Cunge routing method

A bug was fixed in the Muskingum Cunge method where the Distributed Outflows were being written at the previous timestep. The Outflow to the reach was correct. This bug was fixed so that now the Distributed Outflows are written at the correct timestep. Users of this method will notice different results in the Distributed Outflows slot but the Outflow from the reach will be the same.

1.4 Old-style Optimization is no longer supported

In RiverWare 5.0, the original (Tcl-based) optimization is no longer supported. Now, only RPL-based optimization runs can be made.

1.5 Removed support of TCL functions in RPL

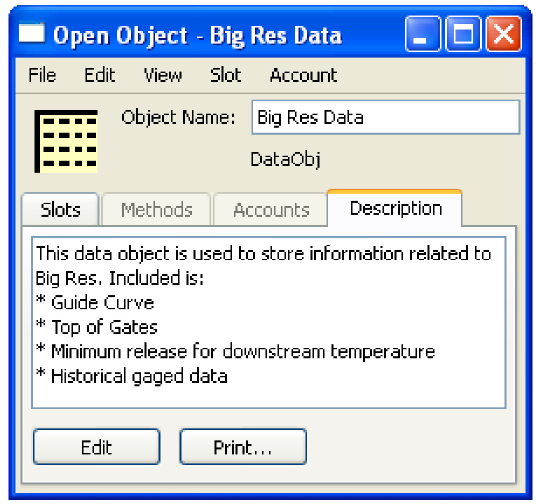
The RiverWare Policy Language (RPL) no longer supports Tool Command Language (TCL) user-defined functions. When the RPL set is loaded (the set can still be opened) and an enabled Tcl function is found, an error is issued: “RPL no longer supports Tcl functions. Please remove or disable the function.” Please convert any TCL functions into RPL functions.

2. General RiverWare

2.1 Data Object and Slot Descriptions

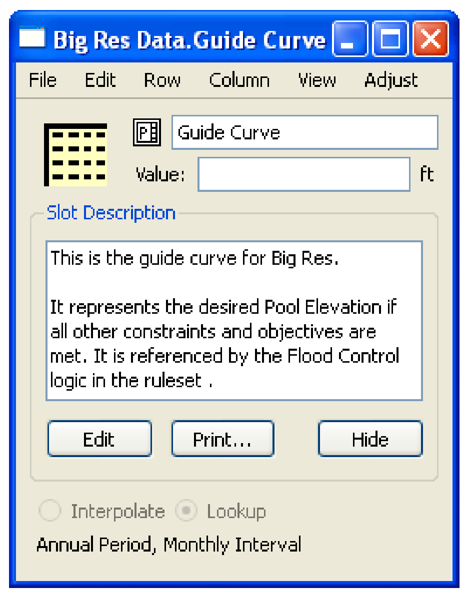
2.1.1 Description Tab Added

A tab was added to the Data Object to allow the user to provide a description of the object. See screenshot. Descriptions can be copied/pasted to/from the system clipboard or printed directly to a printer or file.When printed, all of the descriptions for the slots on the object are also printed. Click **HERE (ObjectDialogs.pdf, Section 2.8)** for more information.



2.1.2 Description of Slots on Data Object

Any slot on a data object can now have a description as shown in the screenshot. This description is accessed from the **View ➥ Add Description** or **View ➥ Show Description** (if it already exists). Descriptions can be copied/pasted to/from the system clipboard or printed directly to a printer or file. Click **HERE (Slots.pdf, Section 2.2)** for more information.



2.2 Diagnostics Manager Ported to Qt

The **Diagnostics Manager** and **Diagnostics Configuration** dialogs were re-implemented. The look and feel is the same as the previous windows but there are minor differences. Click **HERE (Diagnostics.pdf, Section 1)** for documentation on the diagnostics interface.

2.3 File Loading

2.3.1 Dialogs modified

The following Load/Save file choosers were improved for better functionality:

- Load Model File
- Save Model File As
- Open RBS Ruleset / Open and Load
- Open Optimization Ruleset / Open and Load

In particular, the dialogs are now re-sizable and on Windows there is a toolbar on the left side with buttons to common locations like **Desktop**, **My Recent Documents**, and **My Computer**.

Tip: The **My Recent Documents** links is especially useful as it provides a history of models and directories that have been used. Once you click on **My Recent Documents**, you may need to sort the column by clicking on **Date Modified** to see the more recently edited docs.

A default file extension filtering was added. The user can filter model files by:

- *mdl, *.mdl.gz *.rw and *.rw.gz (default)
- gzip Files (*.gz)
- All *

For RPL sets, the filters include

- RuleSet files (*.rls, *.rls.gz)
- gzip files (*.gz)
- All (*)

In addition, the user can use asterisks (*) as wildcards in the File name to further filter by file types.

Tip: With this default filtering, it becomes even more convenient to use one of these extensions when naming models and rulesets

Click **HERE (ModelFiles.pdf, Section 2)** for more information.

2.3.2 Re-open Model or Ruleset from File menu

Menu options were added to allow the user to “Reopen” files. These options allow the user to re-open commonly used files saving the user a step locating the file. Click **HERE**

(ModelFiles.pdf, Section 2.1) for more information. This option was added to the following:

- Model Files: On the **File** menus on the RiverWare workspace, a menu was added to allow the user to **Reopen Model**.
- Rulesets: From the **Policy** ➥ **Ruleset**, and **Policy** ➥ **Optimization Ruleset** menus on the RiverWare workspace, menus were added to allow the user to **Reopen** or **Reopen and Load** a ruleset.
- SCTs: From the main Workspace **Utilities** ➥**SCT** menu, options were added to allow the user to **Reopen** an SCT. This menu also exists on the SCT's **File** menu.

2.4 Import/Export

2.4.1 Export/Import of Links, Accounts and Supplies

When exporting objects, the user is now able to specify that links, accounts and/or supplies are to be included in the action.

2.4.2 Import Object Location

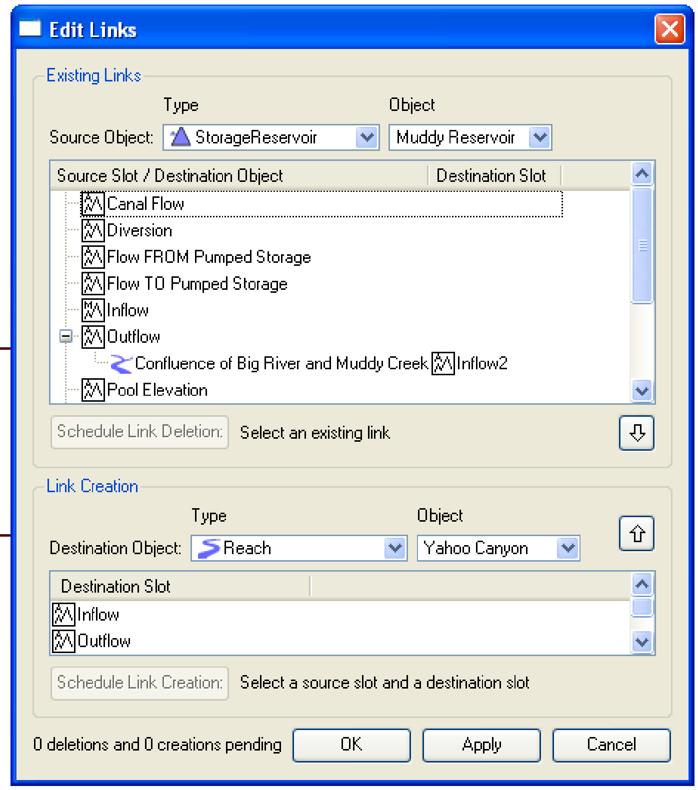
The object import behavior now places objects at their original locations (coordinates) on the workspace. When objects are imported they become the new workspace selection and at least one of the objects is scrolled into view. The user can then move all the objects or use the Subbasin Manager dialog to easily define a new subbasin containing all of the selected objects. This allows the user to more permanently associate imported objects with each other. Also, when importing objects, RiverWare now includes the accounting system coordinates. Previously these were only included when saving a model file.

2.4.3 Import Paste Slot Data

Import Paste was implemented in the standard Slot dialogs, supporting copying from an external tabular data application (e.g. Microsoft Excel) into RiverWare slots. This is supported for all Series Slots and Table Slots, including Periodic Slots. Click **HERE (Slots.pdf)** for more information.

2.5 Link Editor

The link editor was re-implemented for better usability and functionality. It now shows existing links in a tree-view layout. Links can be created or deleted directly from this dialog. Click **HERE (ModelBuilding.pdf, Section 6.2.3)** for more information.



Tip: Quick links, using the right mouse click on the workspace, is still the quickest way to create or delete links.

2.6 Performance

2.6.1 File loading of compressed files

A better model file loading mechanism was implemented to speed up the loading of gzip compressed files on Windows. File load time should be increased by approximately 20%.

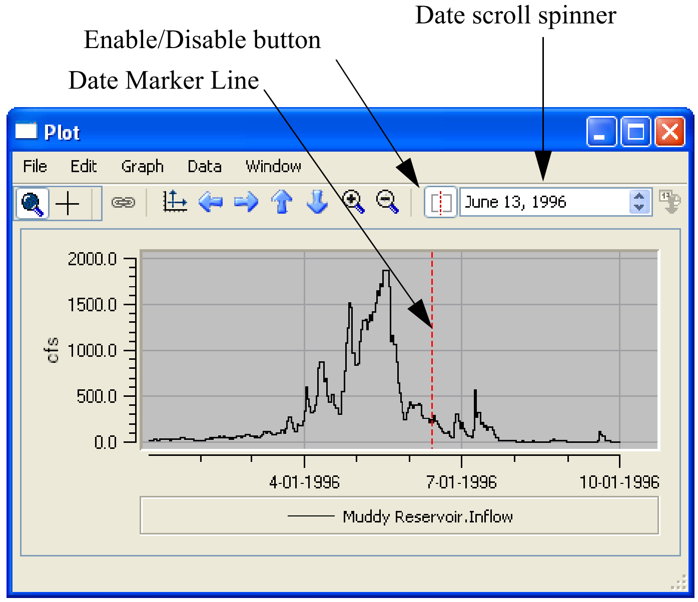
2.6.2 Run Length Encoding

The model file format has been modified to use run-length encoding where possible for flags and data. To maximize the ability to use this encoding for flags, the flags series is written out separately from the data series. Small model files might get slightly larger, but most large model files will get smaller especially if they are large in the number of timesteps.

2.7 Plotting

2.7.1 Date Display Marker

When enabled, an automatic red vertical marker line is shown at the date displayed in the date time spinner in the toolbar. The user enables/disables this marker using a button next to the date scroll spinner. Note, the marker line can be used when a Global Time Scroll operation occurs. Global Time Scroll operations synch all dialogs to the selected date. It can be selected from the right-click context menu on slots and plots.



2.7.2 Multi-layout Plots

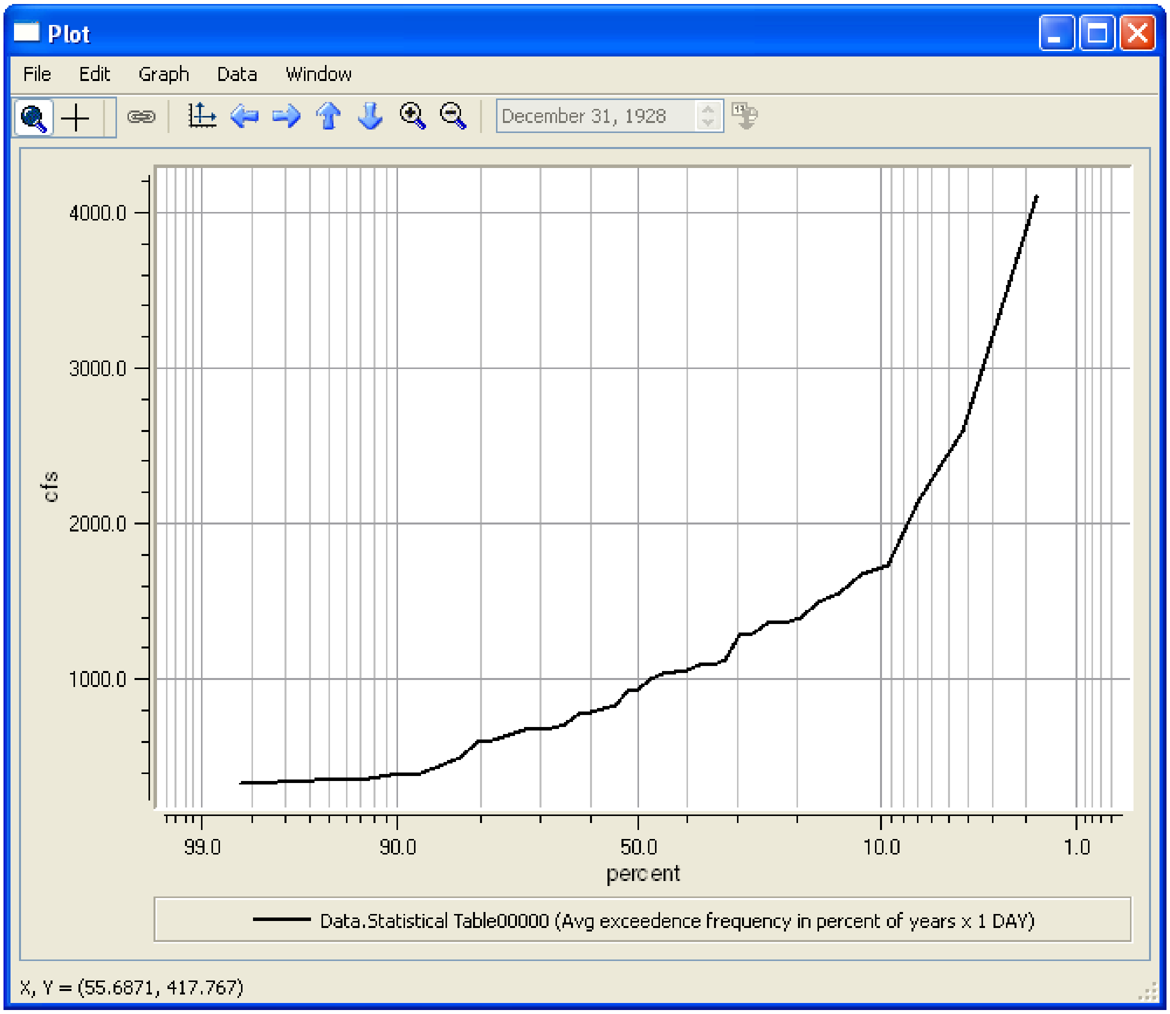
Multi-layout plots (2x2, 3x2, 3X3, etc) now plot better and fit on the screen.

2.7.3 Periodic Slot Plotting

Plotting of periodic slots was enhanced so that values at the begin time and end time of the specified plot time range are plotted, as well as any points defined in the periodic slot that fall into the plot time range. This ensures that the periodic slot line is plotted even if no defined points in the periodic slot fall into the plot time range, and also ensures that in the case where defined periodic slot points fall into the time range, that the periodic slot line is plotted from the full left side to the right side of the graph instead of being cut off at defined periodic slot points.

2.7.4 Probability Scale

A true probability scale was added to plotting in RiverWare. When exceedence percent values from a statistical slot are graphed from the open slot or open object dialogs, they will automatically be plotted with the true probability scale. This scale has 50% as the center line, and the scale gradations go symmetrically and irregularly (using probability scale) outward to values approaching 0 and 100 as seen on normal probability paper. This replaces the “faux” scale that was previously implemented to plot standard normal variables. Click **HERE (Slots.pdf, Section 4.11.5)** for more information.



2.7.5 Time Labeling

Better time labeling was added to plots that displaying time. Ticks are now generated that are more appropriate to the range of time being shown. Instead of the random date labeling in previous releases, the new labeling chooses beginning of years, months, days or hours, as appropriate, for ticks and labeling. Also, the plot labeling was changed so that ticks on the time scale are marked and labeled at the beginning of day (hour 00:00) instead of in the middle of the day (hour 12:00). Time labeling is now automatic; the user is not able to select the number of tick marks or select that it is logarithmic. The user can still configure the time axis limits.

2.8 Run Analysis

Buttons were added to the Run Analysis dialog to allow the user to move objects up or down in the list. This allows the user to re-order objects by **Custom**, **Name**, **Position**, or **Type**.

2.9 Selector

2.9.1 Account Priority data

A filter was added to the selector to allow the user to select accounts by priority date. Two options were added: **Junior To** date and **Senior To** date.

2.9.2 Slot Type Filter

The Slot Type filter can be set to show only Scalar Slots and 1x1 Table Slots. This is useful in the new Slot Lists on the new SCT Tabs (**HERE (Section 8.1)**) -- both Scalar Slots and 1x1 Tables are shown within the same list.

2.9.3 Scalar Values

The selector dialogs were improved to now show Scalar Slot values in the column when the Slot Type Filter is set to “Scalar and 1X1 Table”. This allows the user to see the value of the slot when making selections.

2.10 Slots

2.10.1 Column widths

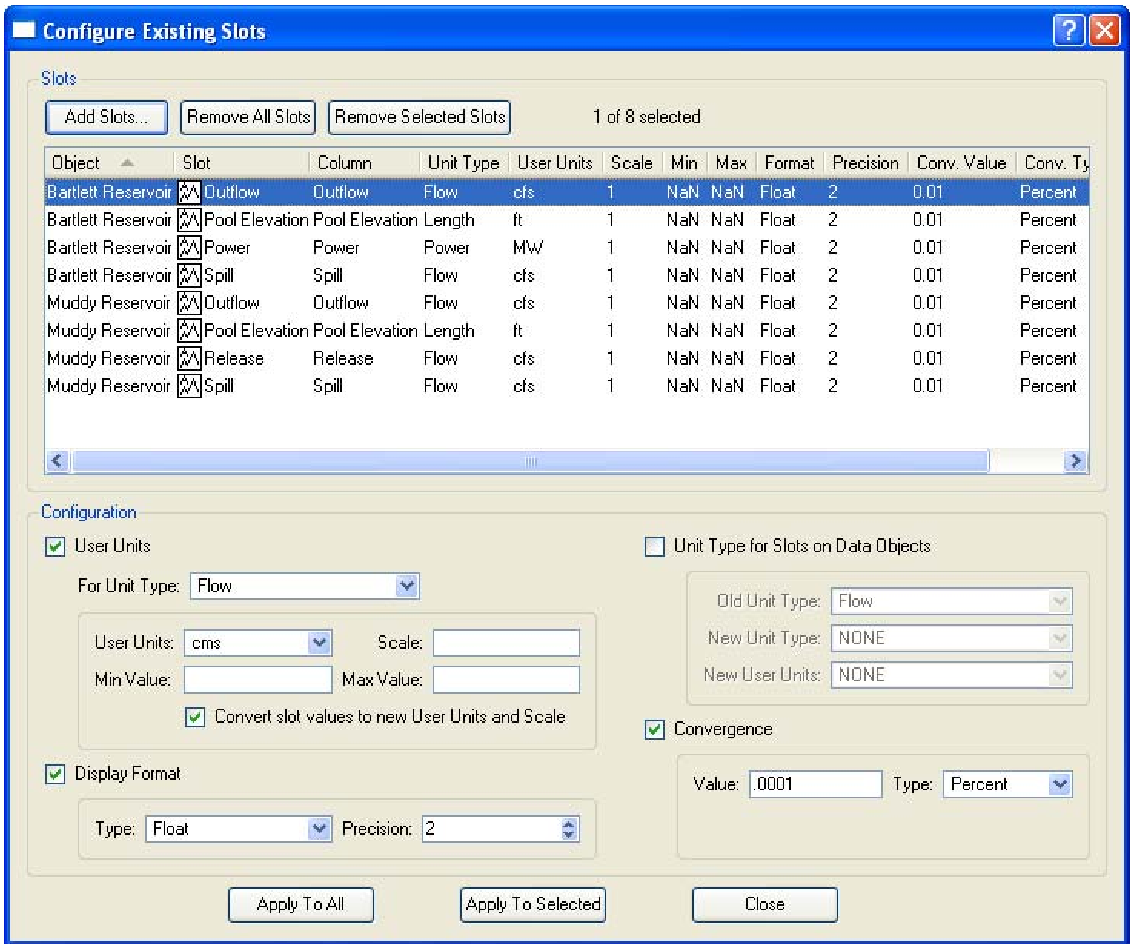
On the open slot dialog, the “Fit/Grow” column-width adjustment operations were improved to take into account the increased width of “bolded” header text, used to indicate selected columns.

2.10.2 Convergence

On the **Configure Slot** dialog, the display of convergence types **Absolute**, **Unit Percent**, and **Percent** were re-labeled to better show their meaning. In particular, if the **Absolute** or **Unit Percent** is chosen, the unit that is to be used is now shown in the dialog. Documentation of the convergence criteria was added **HERE (Slots.pdf, Section 4.1.4)**.

2.10.3 Global Slot Configuration Dialog

A global slot configuration dialog called **Configure Existing Slots** was added. This dialog is accessed from the **Workspace ➥ Slots ➥ Configure Slots** and allows the user to select one or more slots (using the selector) and configure all or selected slots. Configuration options include: **User Units**, **Display Format**, **Convergence,** and **Unit Type for Slots on Data Ob**jects. Click **HERE (Slots.pdf, Section 3)** for more information.



2.10.4 Integer Indexed Series Slots

Users can now add Integer Indexed Series and Agg Series slots to Data Objects. These slots behave like timeseries but are indexed by integer (1, 2, 3, ...) instead of date. These slots were implemented to work with the Iterative Mode of Multiple Run Management (i.e. each value in the slot represents a run) but can be useful for other purposes. More information on integer indexed series can be found here **HERE (Slots.pdf, Section 4.4)**. More information on iterative mode of MRM can be found **HERE (Section 5.2)**.

2.10.5 Periodic Slot re-implementation

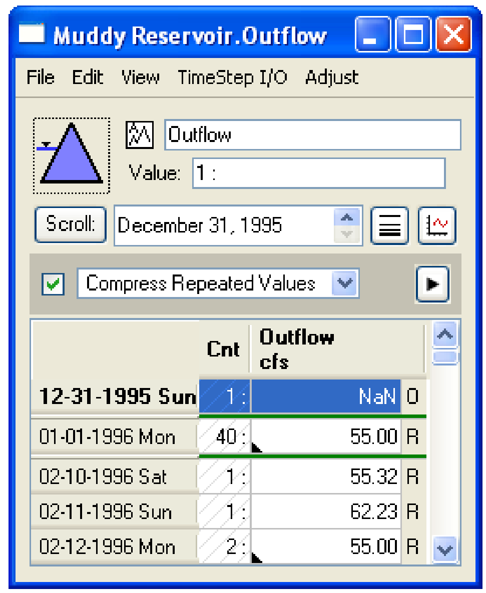
The periodic slot dialog was re-implemented to be more similar to other slots. The user can now do the same actions that are available on other slots like:

- Multiple-Cell editing
- Multiple cell Copy and Paste operations, including Export Copy
- Import Paste (to and from the system clipboard)
- Fill Values Below (with value of the selected cell)
- Replace NaNs Below (with value of the selected cell)

- Interpolate vertically between the values of two selected cells, or a range of selected cells
- Adjust Values (of an arbitrary selection of cells)
- Column Sum Row (optionally shown as the bottom row)
- User Supplied Text Descriptions (on Periodic Slots on Data Objects)
- Column width Adjust Operations (five different operations)

2.10.6 Series Display Compression

The compression of series slots feature has been added. Click **HERE (Slots.pdf, Section 4.1.5)** for more information. This display feature allows the user to filter the data that is shown. The filtering options include:



- Compress Repeated Values (shown to the right)
- Hide NaN Values
- Hide Value: 0 (or other user defined value)
- Hide NaNs and Value: 0 (or other user defined value)
- Show Values: 0 (or other user defined value)
- Show NaNs and Values: 0 (or other user defined value)
- Show Values <= 0 (or other user defined value)
- Show Values >= 0 (or other user defined value)

When deciding if a value should be shown or not. The utility uses the selected Precision Type. Precision Types may be set to one of the following options:

- Display
- Convergence
- Exact

2.10.7 Slot Configuration

On the **Configure Slot** and slot **Configure Timeseries** dialog, the Object, Slot, and Account (where applicable) is now more clearly indicated. Also, on the **Configure Timeseries**, there is now a button to allow the user to show the Run Period (and the Accounting Period for accounting slots).

2.10.8 Slot Order

On open objects, the user can now initialize the custom order from any of the automatic sort orders: **Object Name**, **Object type**, or **Object Icon Position** (vertical, on Simulation canvas). The Up and Down icon buttons can then be used to further customize the slot order. Click **HERE (ObjectDialogs.pdf, Section 2.2.2)**

2.10.9 Statistical Slots

The statistical slots were modified to :

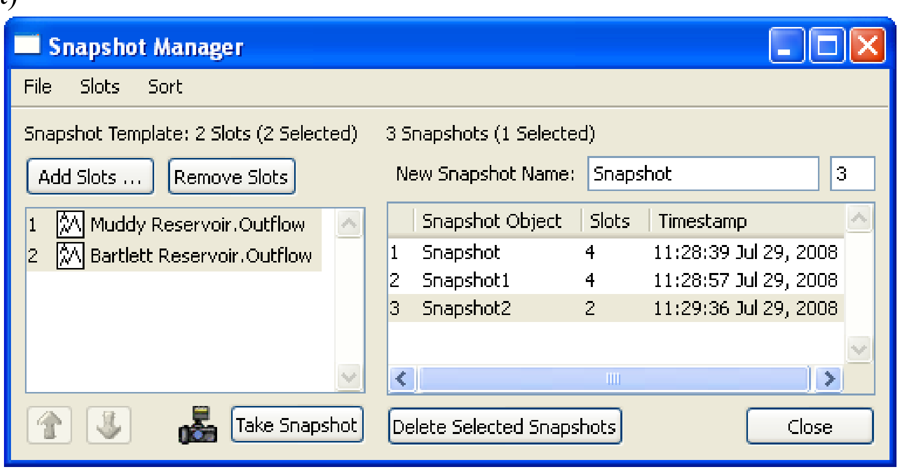
- display partial duration frequency functions (min and max)
- display value duration frequency functions (min, max, and avg)
- display fully specified date column where applicable
- allow a different frequency calculation method
- add an option to plot all data columns of value duration results.

Click **HERE (Slots.pdf, Section 4.11)** for more information

2.11 Snapshot Manager

The Snapshot Manager dialog was re-implemented and enhanced. Click **HERE (Output.pdf, Section 7)** for more information. Highlights include:

- New columns have been added to display the number of slots contained within the snapshot and a timestamp indicated the date and time when the snapshot was created.
- A variety of slot order options have been added to the Snapshot Manager dialog including up and down arrow buttons and a **Sort** pull down menu. The typical cut, copy, paste, remove, select all, invert selection, and add slots menu items are available within the **Slots** pull down menu.
- Removing a Slot from the Snapshot slot list will not remove it from previously created Snapshot Objects. Nor will deleting the original Slot (e.g. an original Slot on a Data Object)



2.12 Software Technology Changes

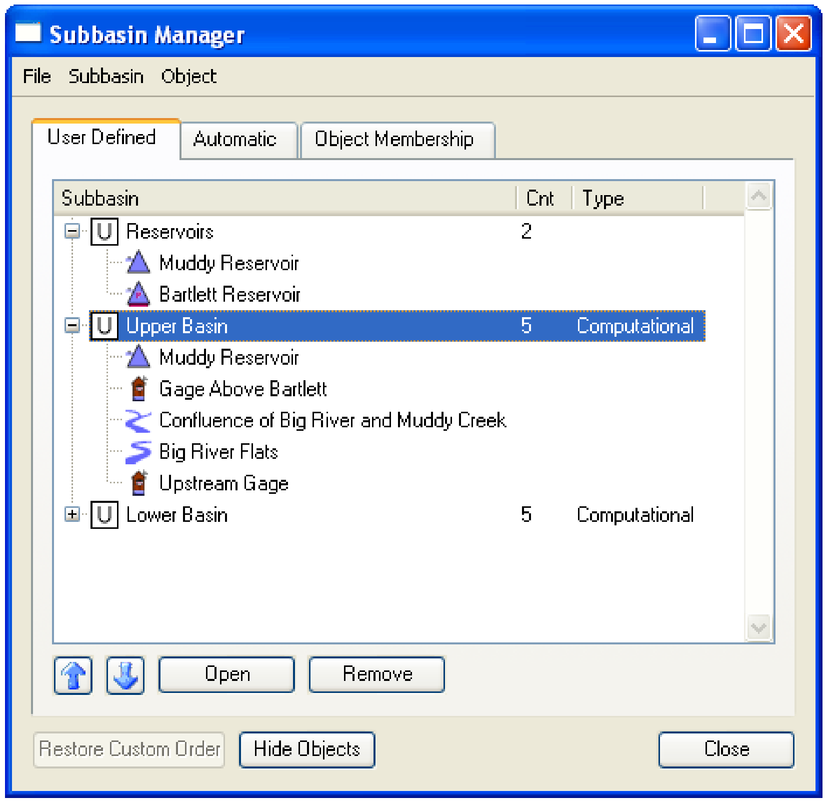
The 5.0 release is a major milestone in RiverWare development. After many years of removing dialogs that use the "Galaxy" graphical user interface support library, all Galaxy dialogs have been replaced and Galaxy is no longer used by RiverWare.

Following is complete list of major software technology changes that have been implemented in RiverWare 5.0:

- Completed removal of the "Galaxy" GUI support library. This has been replaced by Qt.
- Began the port from (Trolltech) Qt3 to Qt4 using the Qt3-Compatibility support library.
- Completed port of Qwt (plotting package) from version 0 to version 5.
- Upgraded the Tool Command Language (TCL) used for model saving and loading from version 8.3 to version 8.5.

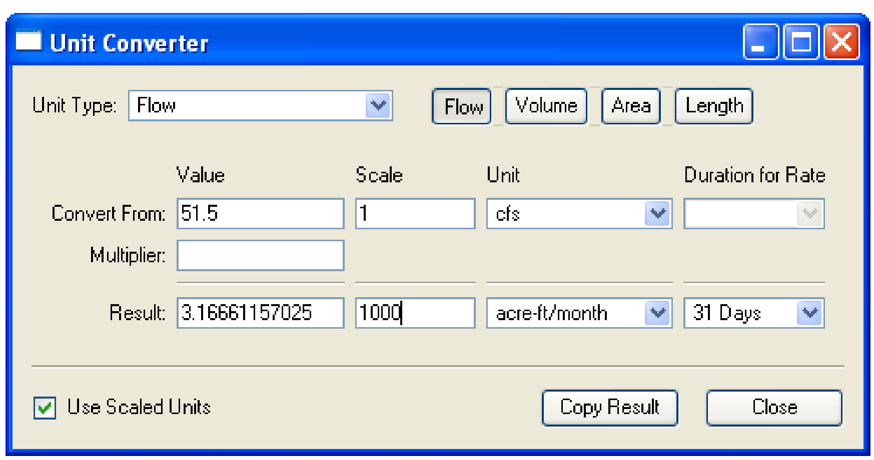
2.13 Subbasin Manager

The **Subbasin Manager** dialog has been re-implemented. It is now divided into three tabs which represent the **User Defined** subbasins, **Automatic** subbasins, and **Object Membership** of subbasins. On the **Object Membership** tab the user selects an object and subbasins containing this object are then shown in the list below along with the number of objects within the subbasins and the type of the subbasins. The subbasin list may be expanded in tree view to show all the objects contained within each subbasin on the list. This dialog now provides better support for re-organizing the list of subbasins and opening subbasins directly from the manager. For more information, click **HERE (Subbasins.pdf, Section 1)**.



2.14 Units

2.14.1 Unit Converter



The **Unit Converter** was re-implemented. Click **HERE (Units.pdf, Section 3)** for more information. Now there is better support for varying timesteps (i.e. months and year). The user can select the length of the month or year to use (where applicable). Also, there are quick buttons for the common unit types Flow, Volume, Area, and Length. Also, calculations are automatic; hitting enter is not necessary.

2.14.2 New Units

The following units were added to the units file. Additional units can be defined by the user in the “units” file in the RiverWare installation directory.

- m^3/month: RiverWare displays it as m3/month.
- m^3/year: RiverWare displays it as m3/year.

2.15 Workspace - *Canvas Selection*

The selected Workspace Canvas (Simulation or Accounting) is now saved in the RiverWare model file and the model is automatically opened to that view. Now, if you close a model with the accounting view shown, it will re-open to the accounting canvas.

3. Accounting

3.1 Exchange Manager and Exchange Configuration dialogs ported to Qt

The **Exchange Manager** dialog and **Exchange Configuration** dialogs were re-implemented. The **Exchange Configuration** dialog no longer has tabs, all of the data can be seen at once. Click **HERE (, Section)** for more information.

3.2 Import/Export of Accounting Supplies

Import and export of objects now allows supplies to be imported/exported as well. When objects are exported, accounts and supplies are optionally exported based on user selection. Note that supplies cannot be exported unless Accounts and Links are also exported. If only a subset of a model is selected, links and supplies may be broken.

When importing objects which already exist on the workspace, the imported objects are renamed. RiverWare now does the same for supplies located on these objects. If the supply name is a duplicate, the import mechanism will assign the string DUPL to the end of the new name. In addition, if the imported supply has a Release Type or Destination that does not already exist, RiverWare will add the supply’s release or destination type to the accounting system configuration. Similarly with imported Accounts, if the Water Type or Water Owner does not exist in the importing model, it will be created.

3.3 Slots

3.3.1 Instream Flow Account

The “Available Natural Flow” slot on the Instream Flow Account was changed to “Available Allocatable Flow.” This slot is available when you have a priority date or water rights method selected.

3.3.2 Convergence Type and Min/Max on Accounting Slots

On Accounting slots (Account.Inflow, Account.Outflow), the convergence type will be set to **Percent Change** and only changes to the value will be permitted. In models created using previous versions of RiverWare, the convergence type will be changed on model load if they are not already **Percent Change**. Accounting supplies between two multislots (e.g. transfers in & out) will be changed to have a convergence of **None** and those between a series slot and a multislot will have the convergence of the series slot typically **Percent Change**. Also, there is no min/max checking done on account slots so this configuration option has been disabled.

With this change, many supplies now will have **None** as the convergence criteria. Even though the account solving will converge based on the convergence of the slots to which the supplies are propagated, rules that set supplies may fire more often as they will always reset the value, even if it is exactly the same. If this situation is occurring, users may need to modify some rule logic and should judiciously set the rules comparison tolerance **HERE (RPLTypesPalette.pdf, Section 2.2.1)** if they have not already done so.

3.3.3 Slot Configuration

On the **Configure Slot** and slot **Configure Timeseries** dialog, the Object, Slot, and Account is now more clearly indicated. Also, on the **Configure Timeseries** dialog for accounting slots, there is now a button to allow the user to **Synch with Accounting Period** and a button to **Show** the Run Period and the Accounting Period.

3.4 Water Rights Allocation

3.4.1 Account Subordination

The predefined function **SolveWaterRights** (and the new **SolveWaterRightsWithLags**) now includes the ability to model subordination of water rights. The user defines this subordination through method selections on the dominant account. Click **HERE (, Section)** for more information.

3.4.2 Account Subordination Viewer

A dialog was added to the accounting system to display accounts that are Subordinate or Dominate to one another. This is used in a water rights model using the SolveWaterRight predefined function to allocate water based on priority dates with subordination. Click **HERE (, Section)** for more information.

3.4.3 Disaggregation of Initial requests from Annual Values

In the previous version of RiverWare, the method category **Account Initial Request Calculation** on **Computational Subbasins** (**HERE (Objects.pdf, Section 7.1.19)**) had the following methods and dependencies:

- **Daily Timestep** instantiated the following periodic slots:
  - Daily Demand Coefficients
  - Daily Leap year Demand Coefficients

- **Monthly Timestep** instantiated the following periodic slots:
  - Daily Demand Coefficients
  - Daily Leap year Demand Coefficients.

These methods and dependent slots have been replaced with following:

- **Periodic Coefficients** now instantiates:
  - Daily Demand Coefficients
  - Daily Leap year Demand Coefficients
  - Monthly Demand Coefficients
  - Monthly Leap year Demand Coefficients
- **Series Coefficients** now instantiates:
  - Daily Demand Coefficient Series
  - Monthly Demand Coefficient Series

The Series Coefficients methods will use series slots to find the multipliers for determining per-timestep demands on the accounts rather than using periodic slots. Having two different methods and associated series slots allows each of the slots to be input once and saved in the model file, and they will remain across timestep-size changes to the model. Note that it is not be possible to set up a model to use the periodic slot for the monthly run and the series slot for the daily run without user intervention (changing this method selection) when switching run timestep sizes.

3.4.4 Fill Conservation Pool and Meet Diversions from Storage Accounts

The new method, **Fill Conservation Pool with Diversions**, was added to the Storage Account method category **Calculation of Initial Request**. This method will compute the amount required to fill the conservation pool (as with the **Fill Conservation Pool** method) and to that amount it will add the total demands of the prioritized water accounts that divert from the storage account directly. Click HERE (, Section) for more information.

3.4.5 Percentage of Total Requirement to Meet Demand on Storage Accounts

A new category and methods have been added to determine whether a fill factor will be used, and if so, the form that it will take. This new category is to be used with **Fill Conservation Pool** and **Fill Conservation Pool with Diversions** methods. The new Storage Account method category **Cons Pool Fill Factor** contains the following methods: **None**, **Fill Factor is Series**, and **Fill Factor is Scalar**. The last two methods have the dependent Fill Factor slots associated with them. Click HERE (, Section) here for more information.

3.4.6 Priority Slot on acct is recalculated when date is changed

If the **Priority Date** is changed on an account, the **Priority** scalar slot for all accounts are re-calculated based on the new date. This allows the user to immediately see the effect of changing a **Priority Date**.

3.4.7 Results of Turning Off a Water Right

When a Water Right is turned off (has no priority date), it does not automatically deselect "dependent" methods. There is no such thing as dependent methods on accounts, so all methods and their data are maintained.

3.4.8 SolveWaterRightsWithLags

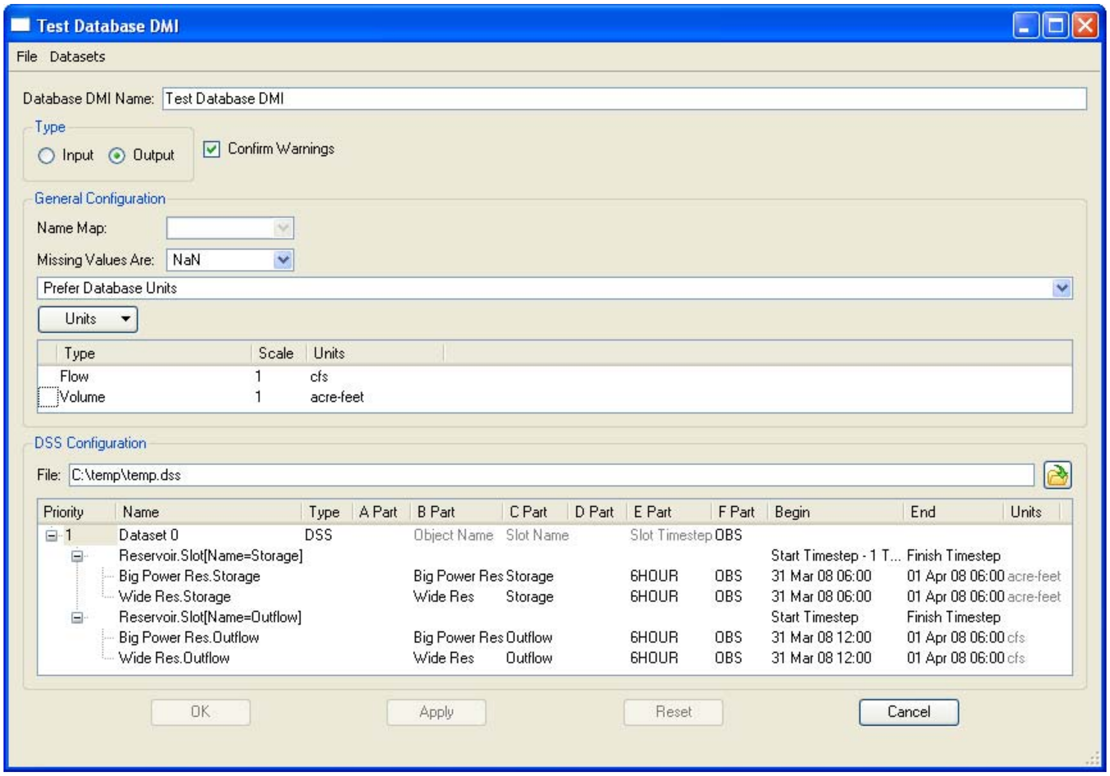
A new predefined function **SolveWaterRightsWithLags** was added to allow the water rights allocation functionality to compute allocations when there are lags involved in the solution. Click **HERE (, Section)** for more information.

4. Database DMI

4.1 Database DMI editor

A new Database DMI editor dialog was created that provides one-dialog for configuration of fully functional DSS Database DMIs. It allows the user to specify all required configuration information and as much optional configuration information as is feasible. The real power of this dialog is that the user can see the fully specified information that will be sent to the DSS database.

This dialog is like an editable "view" into the Dataset Manager and Database DMI dialogs. Thus, the user can see what has already been configured in those dialogs but also make edits that will be applied to those pieces. It is important to note that if the user edits a dataset or Database DMI in the editor window, the user cannot also edit the individual components at the same time. Click **HERE (DMI.pdf, Section 5.2)** for more information.



4.2 HDB Datasets - User specified timeout value

For HDB datasets, a user specifiable dataset read/write timeout value was added. This value will override the client/server default value of 60 seconds. Only HDB datasets expose the value in the user interface.

4.3 Name Map Order

The user can now re-order name maps in the **Name Map** dialog. Previously, the maps were always listed by priority order. The user can switch between custom and priority order using the **Display** menu. In custom mode, the user can re-arrange name maps using the up and down arrows. For more information click **HERE (DMI.pdf, Section 5.4.2)**.

4.4 No Units

The database DMI now allows slots whose unit type is NONE to be read or written, regardless of the availability of dataset or database units. If the slot unit type is NONE then no unit conversion is possible. This means users don't have to create datasets which specify the NONE unit for the purpose of reading or writing data for which no unit conversion is possible.

4.5 Table Series slots

The Database DMI functionality is now able to support Table Series Slot and Agg Series Slot columns. The slot selector was also improved to support the selection of these slots for this purpose. Click **HERE (Selector.pdf, Section 3)** for more information on selecting table series slot columns.

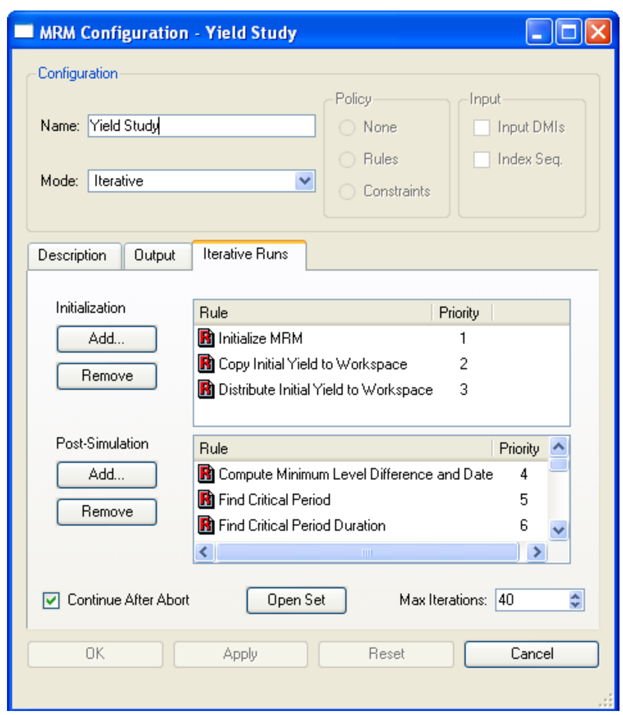
5. Multiple Run Management

5.1 Accounting Slots using DMI's

When using output DMIs with MRM, the account name is now written into the output file for accounting slots.

5.2 Iterative Mode Configuration

The **Iterative Runs** tab of the MRM configuration dialog was re-implemented to provide a more usable interface. In addition, a better rule selector was added. Click **HERE (MRM.pdf, Section 4.3.3)** for more information.



5.3 MRM Output to RDF files

The same data can now be sent to multiple RDFs during an MRM run using the following syntax:

```
Object.Slot: file=filename1 file=filename2
```

Additionally, MRM can now output data that is not at the same timestep as the run. Within the MRM configuration dialog, the user can select the following options:

- Must match - the slots' timesteps must match; the first slot's timestep determines the file's timestep, subsequent slots' whose timesteps don't match are skipped.
- Use smallest - use the smallest timestep; for example, if monthly and yearly slots are configured for the file use a monthly timestep (and yearly slots will output 11 NaN followed by a value).
- Use largest - use the largest timestep; for example, if monthly and yearly slots are configured for the file use a yearly timestep (and monthly slots will output their December values).

For more information, click **HERE (MRM.pdf, Section 4.8)**

5.4 Spaces in Control File paths

For some time now, in DMI's there is the option to allow spaces in paths in the control file. This ability has been extended to Output control files that are specified in the MRM configuration output tab.

6. Optimization

6.1 RPL Based Optimization

The RPL-based optimization controller is now the only optimization controller supported in RiverWare. The original (Tcl-based) optimization is no longer supported.

RPL-based optimization is a global solution that solves for the optimal solution across all timesteps. To contrast, Simulation and Rulebased simulation solve each timestep, marching forward in time. In RPL-based optimization, the user creates an optimization policy set, using the RiverWare Policy Language (RPL), that contains constraints and objectives. RiverWare uses this set along with mass balance and other physical constraints and approximations to create an optimization problem. The optimization problem is then solved by the CPLEX solver and the results are sent back to RiverWare. Note, a separate CPLEX license is still required.

A typical optimization model uses the following three steps:

1. Simulation run to determine the consequences of any inputs
2. RPL-based optimization run to solve the optimization problem
3. Rulebased simulation run that incorporates some of the optimal results and removes linearization errors. For example, one option is for the rules to return the optimal reservoir outflows to the workspace.

If you would like additional information on using this controller, please contact riverware-support@colorado.edu.

6.2 Documentation

Preliminary documents were added for optimization **HERE (Optimization.pdf, Section 1)** but the documents are still under development. In addition, documentation of the thermal object was added **HERE (Objects.pdf, Section 26.1)**.

6.3 Optimization Run Parameters

The **Set CPLEX and Goal Parameters** was re-implemented and renamed the **Set Optimization Solver Parameters**. This dialog now provides a more user friendly tree-view of the parameters used in optimization.

RiverWare is shipped with two files, cplex.par and goals.par, which provide overrides for optimization parameter defaults. There was not an effective way for the user to make changes to these values that would take effect for future runs.

Now, when an optimization controller is selected RiverWare first looks for the files cplex.init.par and goals.init.par in the optimization directory (the value of the environment variable RIVERWARE_OPT_DIR or /tmp/opt-<user name> if that variable is not set). If a parameter override file is found there, it is used, otherwise it looks for the installed version of that file.

When the user changes parameter settings in the Optimization Parameters dialog, there is a toggle indicating whether or not they would like to save the changes to a file; if this is selected when changes are accepted by the user, the non-default parameter settings are written to the cplex.init.par and goals.init.par files in the optimization directory. Unless these files are removed or the optimization directory is moved, all subsequent optimization controllers will begin by reading these parameter settings

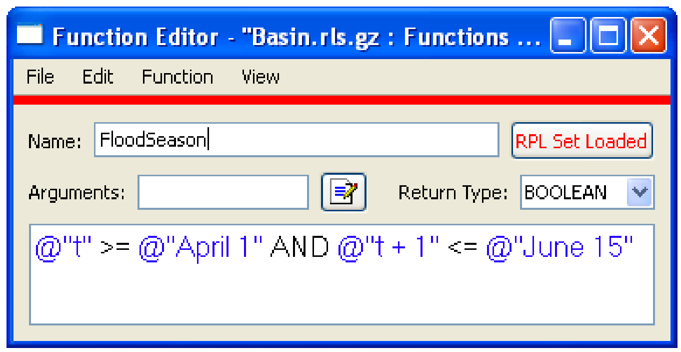
7. RiverWare Policy Language

7.1 RPL User Interface

7.1.1 Comments on Statements

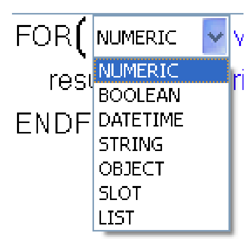
Previously, comments could be added to RPL expression, but not RPL statements themselves (Assignment, Print, ForEach, etc...). Now the user can add comments to RPL statements using the **Add Comment** or **Delete Comment** buttons on the palette.

7.1.2 DateTime Support Changes



The RPL DateTime syntax was modified for a more compact notation for referencing the current timestep. The symbolic DateTime grammar was extended to support “t” for “current timestep”, “t-1” for “Previous Timestep”, and “t+1” for “Next Timestep”. In addition, numerics within the date/time string no longer require the unit of “Timestep”. For example, the DateTime notation “Start Timestep + 2 Timesteps” is now represented as “Start Timestep +2”. All DateTime are shown in this new format, the user can still type in the old format and they will be automatically converted.

7.1.3 Editing types in RPL Looping variables



Menu based entering of RPL types of looping variables (For, With, While) in RPL expressions has been provided. Users can now individually select and edit the type and name of a variable name declaration. To edit a type, the user double clicks on the type, is presented with a pull-down menu listing all the RPL types, and the user selects one of these types. The user edits a name as they would a literal value. The inline editor prevents the user from entering invalid names. Click **HERE (RPLUserInterface.pdf, Section 2.4.5)** for more information.

Note: Previously it was possible to copy/paste a type/name pair together, now the type and name must be selected/copied/pasted individually.

7.1.4 Editing Values

Users no longer have to hit enter when editing literal values in RPL editors. Clicking the mouse outside of the edit field is considered completion of the edit.

7.1.5 *Modified display of looping expressions*

The display of the RPL FOR expression was modified from:

```
FOR( NUMERIC index IN <list expr> )WITH NUMERIC result = <numeric expr> DO
   <numeric expr>
ENDFOR
```

to:

```
FOR( NUMERIC val IN <list expr> )WITH NUMERIC result = <numeric expr> DO
   result = <numeric expr>
ENDFOR
```

This provides an explicit visual cue to what is done with the result of evaluating the body.

Also, the display of the WHILE expression was modified to:

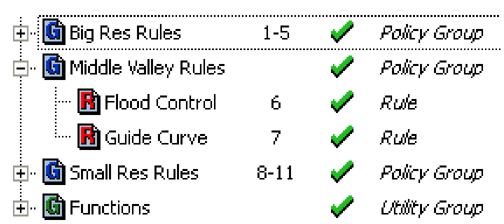
```
WHILE( <boolean expr> )WITH NUMERIC result = <numeric expr> DO
   result = <numeric expr>
ENDWHILE
```

7.1.6 *Open and Load*

When using the Open and Load command from the Policy menu RiverWare will now open the ruleset whether it is valid or not. Previously, if the selected ruleset was not valid RiverWare would post a message in the Diagnostic Output and not open the set. Now, RiverWare still posts the message but also open the set without loading it.

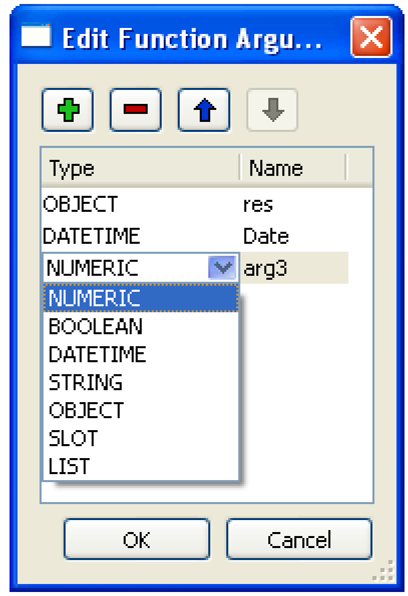
7.1.7 *Policy Group Priority Range*

The RPL list view in the RPL dialog has been modified to show the priority range for Policy Groups whose members are not currently visible. For example, in the screenshot, the group Big Res Rules contains rules 1-5 and the group Small Res Rules contains rules 8-11.

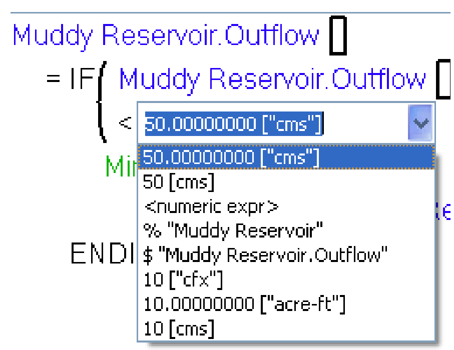


7.1.8 RPL Function Argument Editor

This dialog provides a structured interface to specifying the type and names of a RPL function's arguments. For example, in the screenshot, there are two existing arguments (OBJECT res, and DATETIME Date) and the user is configuring a third argument. The old way of specifying function arguments by entering them directly into the function editor is still supported.



7.1.9 RPL Value Inline Editor Changes



The RPL value inline editor now uses a pull-down menu which provides a history of previous edits within the dialog. This effects the editing of literal values within RPL expressions. As before, the user initiates the edit by double clicking on the terminal expression they wish to edit (a value or an empty expression). This creates an inline editor which allows the user to edit the value in place. If an existing value is being edited, the editor is initialized with the text corresponding to that value, otherwise it is empty. This editor differs from the previous one in the following ways. At the right-hand side of the editor is a button which provides access to a menu containing the previous values entered in the dialog. There is also a popup menu (accessible by right-clicking within the editor) which provides basic editing operations such as copy and paste. Click **HERE (RPLUserInterface.pdf, Section 2.4.2)** for more information.

This means there are three ways to edit the contents of the inline editor.

- Type in a value,
- Select one of the values in the pull-down menu, or
- Use the editing operations (copy/paste) in the popup menu.

The user signals completion of editing by hitting Enter or by clicking somewhere outside of the inline editor. This closes the editor and replaces the originally selected expression with the entered value. As before, if the entered text is not valid the user is provided with a notification window and the expression reverts to its original value. The entered text is added to the list of values which will be accessible in the inline editors menu the next time a value is edited in the dialog whether it is valid or not. C

Tip: This feature is useful when the user enters invalid text in a RPL expression. Previously the user would have to retype the entire input, with the new features, the user can simply select what was previously typed and correct any mistakes within the text entry.

7.1.10 TCL user-defined functions are no longer supporter

The RiverWare Policy Language (RPL) no longer supports Tool Command Language (TCL) user-defined functions. When the RPL set is loaded (the set can still be opened) and an enabled Tcl function is found, an error is issued: “RPL no longer supports Tcl functions. Please remove or disable the function.” Please convert any TCL functions into RPL functions.

7.2 RPL Palette

7.2.1 NanToZero Operator

A **NanToZero** operator was added to the RPL Palette. This operator has a single numeric sub-expression; that sub-expression is a lookup of an invalid value (NaN), then **NaNToZero** evaluates to 0.0 in the units of the lookup slot. Otherwise it simply returns the value in the lookup slot, unchanged. This operator provides a simple and efficient way to treat a missing slot value as zero, a common requirement of water accounting policy. This is only useful when the sub-expression is an object/slot lookup expression. Click HERE (RPLTypesPalette.pdf, Section 2.8) for more information.

7.2.2 Tool Tips

Mouse-over tool tips were added for all palette buttons. These will help the user find the appropriate button without having to look in the help.

7.3 Predefined Functions

The following predefined functions were added or modified. If the user previously had a user-defined function of the same name, the user-defined function name will have to be changed or the set will not load

7.3.1 FloodControl

The FloodControl function executes the selected flood control method on the computational subbasin and returns slots and values to set on those slots. Now, the function also returns the Target Balance Level is and its value. The Target Balance Level stores what was previously shown on the Temp Balance Level slot. Click HERE (RPLPredefinedFunctions.pdf, Section 40) for more information.

7.3.2 GetAccountFromSlot

GetAccountFromSlot(SLOT slot) predefined function has been added to the RiverWare Policy Language. Given a Slot, the function return its parent account name as a String. It is an error if the slot is not on an account. Click **HERE (RPLPredefinedFunctions.pdf, Section 46)** for more information.

7.3.3 GetObjectFromSlot Function

GetObjectFromSlot(SLOT slot) predefined function has been added to the RiverWare Policy Language. Given a Slot, the function return its parent Object. The slot must either be on a Simulation Object or an account, otherwise it is an error. Click **HERE (RPLPredefinedFunctions.pdf, Section 75)** for more information.

7.3.4 GetRowIndexByDate Function

GetRowIndexByDate(SLOT slot, DATETIME date) predefined function has been added to the RiverWare Policy Language. Given a slot with rows indexed by date, this function returns the 0-based numeric index corresponding to a given date. The value -1 is returned if the given date is not within the date range of the slot. This function is applicable to the following types of slots: Series Slot, Table Series Slot, and Periodic Slot. It is considered an error if the slot is not indexed by date. Click **HERE (RPLPredefinedFunctions.pdf, Section 78)** for more information.

7.3.5 GetSlotName Function

GetSlotName (SLOT slot) predefined function has been added to the RiverWare Policy Language. Given a SLOT, return the slot name portion of the full name as a String. Click **HERE (RPLPredefinedFunctions.pdf, Section 84)** for more information.

7.3.6 HasRuleFiredSuccessfully Function

The RPL predefined function **HasRuleFiredSuccessfully** now accepts the string “`Current Rule`” as a reference to the currently executing rule (block). This prevents the user from having to type in the full name of the rule and edit the name each time the rule name changes. Click **HERE (RPLPredefinedFunctions.pdf, Section 95)** for more information.

7.3.7 HydropowerRelease

The **HydropowerRelease** function determines the releases to meet an energy demand or load. If the Seasonal Load Time method is selected on a reservoir, the HydropowerRelease now also returns the Load slot and value to set on that slot. Click **HERE (RPLPredefinedFunctions.pdf, Section 96)** for more information.

7.3.8 Run Time Function

RunTime predefined function has been added to the RiverWare Policy Language. This function returns the number of seconds which have elapsed since the current run began, or if called from outside a run, the total number of seconds within the last run. This function is useful for analyzing performance. Click **HERE (RPLPredefinedFunctions.pdf, Section 162)** for more information.

7.3.9 Slot Functions now work on Table Series Slots

The following functions take a slot and time range as input and either gets or sums values within a range on the slot. These were extended to work on Table Series Slots:

- **GetSlotVals**
- **GetSlotValsByCol**
- **SumSlot**
- **SumSlotByColumn**
- **SumSlotSkipNaN**
- **SumSlotByColSkipNaN**
- **SumFlowsToVolumne**
- **SumFlowsToVolumeSkipNaN**
- **SumFlowsToVolumeByCol**
- **SumFlowsToVolumeBySkipNaN**

7.4 RPL Set Analysis - Find Next Button

In the Search field, the “Find Next” button has been replaced with two simple arrow icon buttons, up-triangle and down-triangle to search forward or backward, respectively. In addition, pressing Return in the search box now searches forward.

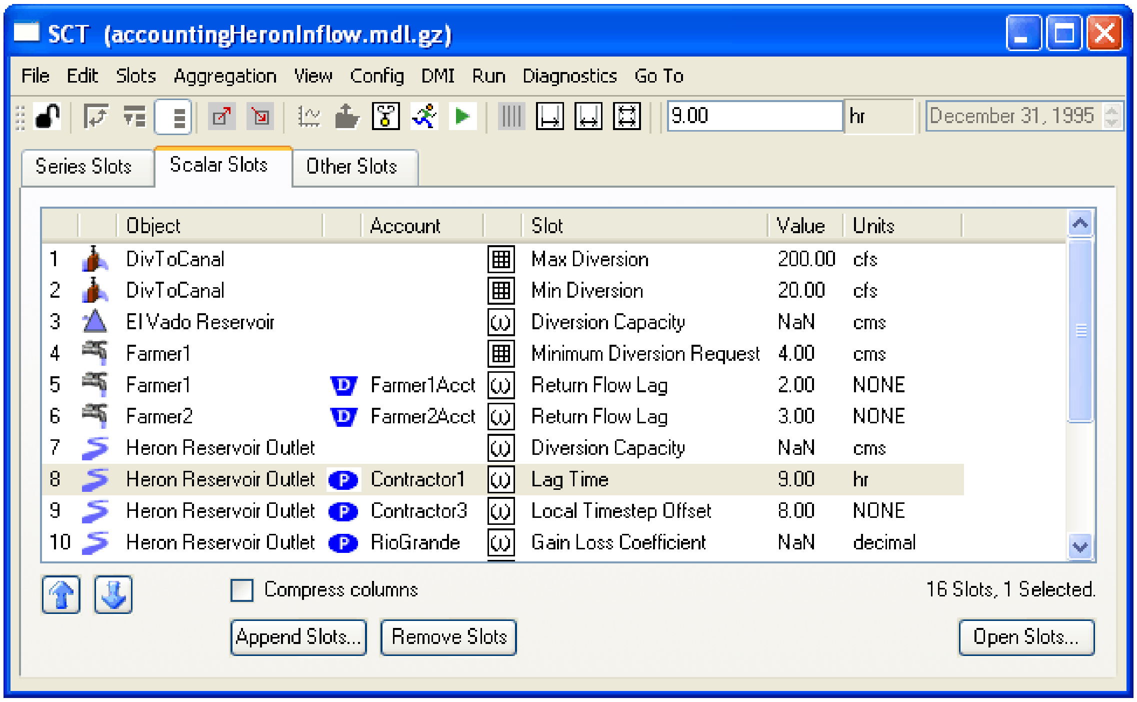
7.5 Executing DMI’s from Rules

When executing a DMI from a rule (using pre and post execution DMI’s) it is no longer necessary to execute a DMI group. Now a rule can execute a single DMI directly.

8. SCT

8.1 Scalar and Other Slots tabs

A tabbed approach was added to the main SCT display area. The tabs are “**Series Slots**”, “**Scalar Slots**”, and “**Other Slots**”. The **Series Slots** tab, which is the conventional SCT data table, can contains all series slots and table series slots. The **Scalar Slots** tab can contain both scalar slots and 1x1 table slots. The user can change a single scalar value by editing the cell directly. Also, multiple scalar values can be edited directly from the SCT by selecting the slots and typing a new value in the toolbar. The **Other Slots** tab can contain all slot types which are not supported by the other tabs. Click **HERE (SCT.pdf, Section 6)** for more information.



8.2 SCT Column Width Adjustment

Column Width Adjustment toolbar buttons have been added to the SCT dialog. The available adjustment options include:

- Resize Columns: Set All to Selected Column Width
- Grow Columns: Fit Data
- Resize Columns: Fit Data
- Resize Columns: Fit All

Also, the “Fit/Grow” column-width adjustment operations were improved to take into account the increased width of “bolded” header text, used to indicate selected columns.

8.3 SCT configuration defaults

When a new SCT is created, it no longer aggregates timesteps by default. Also, if there is no default SCT defined, the warning message is not displayed anymore. The user can define the default SCT to aggregate if desired. For more information on the default SCT configurations click **HERE (SCT.pdf, Section 8.17)**.

8.4 Supporting different timesteps

In the RiverWare 4.9, the user could create and use SCTs that have a different timestep than the current run step. Now the users now have two options for determining the range of the SCT (begin and end dates, timestep size):

- **Relative to Run** (the old way): the range and timestep default to that of the run when the SCT is created. The user can specify the number of pre- or post-run timesteps to view in addition to those within the run. They can also override the timestep of the run and specify a different timestep.
- **Based on Slot ranges**: the timestep is determined from the first slot added to the SCT, the range is maintained to be the minimal range which includes all the ranges of the member slots.

A new toggle was added to the **General** tab: **Always Synchronize to Slots** which engages the **Based on Slot** range mode described above.

9. Simulation Objects

9.1 Computational Subbasin

9.1.1 Changes to Flood Control algorithm

The **Operating Levels Balancing** Flood Control algorithm has been modified to better deal with tandem reservoirs and when they can store. This was done to prevent situations where the upstream reservoir is making releases to be stored in a downstream reservoir which is surcharging and there is downstream flooding. The downstream reservoir can now only store either in the conservation pool or through tandem balancing when the downstream reservoir is not surcharging at the current controller timestep. This check does not affect flood releases that are being passed through because there is space downstream. That will still happen even if the downstream reservoir is surcharging. More information can be found **HERE (Objects.pdf, Section 7.1.3.3)**.

9.1.2 Initialize Flow Slots for Routing

A new category was added to the computational subbasin called **Initialize Flow Slots for Routing**. This category contains methods that are used to initialize slots that are required to be known for routing to solve at the start timestep. It searches throughout the subbasin to determine the earliest pre-simulation timestep at which data must be known for each object to solve at the start timestep. It sets values in these slots at pre-simulation timesteps according to the selected method. There are three methods: the default, no-action **No Method**, **Backcast Zeros** and **Backcast Initial Value**. More information can be found **HERE (Objects.pdf, Section 7.1.25)**.

9.1.3 RiverWare - MODFLOW Link

A dynamic link between RiverWare and MODFLOW 2000 was added. This link allows the user to model the interaction between surface water in RiverWare and shallow groundwater in MODFLOW. In RiverWare, the user specifies the RiverWare objects and MODFLOW cells or segments involved in data exchange using the Computational Subbasin object. The Computational Subbasin displays cell by cell values for exchanged data. Then, the Reach, Water User, Aggregate Diversion Site, and GroundWater Storage objects each contain methods that, when selected, allow an object's data to be exchanged with MODFLOW. During a run, the two models run in parallel, exchanging data (seepage, heads, stages, return flows, etc) at each RiverWare timestep / MODFLOW stress period. Note, the RiverWare timestep must match the MODFLOW stress period.

More information on this connection can be found **HERE (Objects.pdf, Section 7.2.1)** along with links to each of the relevant RiverWare objects involved in the data exchange.

9.1.4 Reservoirs Only Method

The **Reservoirs Only** method was added to the **Reservoir Boundary for Incremental** category on the subbasin. This method allows users to set up a subbasin of only headwater reservoirs. They then can input cumulative locals and the method will copy these to the forecast slot. This allows consistent data input across all reservoirs that disaggregate local inflows. More information can be found **HERE (Objects.pdf, Section 7.1.23.4)**.

9.2 Control Point

9.2.1 Hydropower Flooding Exception Category

The **Hydropower Flooding Exception** category was added to the control points with two methods: **No Method** (default) and **Flooding Does Not Constrain Hydropower Releases**. The **No Method** method is the previous behavior. Any proposed hydropower releases (calculated by the **HydropowerReleases** predefined function) would be cut back by any additional flooding at each downstream control point. The method, **Flooding Does Not Constrain Hydropower Releases**, excepts the given control point so that flooding is allowed at that control point due to hydropower releases only. More information can be found **HERE (Objects.pdf, Section 9.1.15)**.

9.2.2 Regulation Discharge Methods

The slots, **Level Regulation Parameter** and **Percent Full Regulation Parameter** were added to the control point dependent on selection of a regulation discharge method. These output slots provide the user with the parameter or level that was used in the regulation discharge calculation. The appropriate slot is set from the regulation discharge method which is executed from the dispatch method. More information can be found **HERE (Objects.pdf, Section 9.1.9)**.

9.3 Reach

9.3.1 *Local Inflow Adjust*

It is no longer require that Local Inflow Adjust be input on the reach if dispatching before the start of the run with the **solveNRLocalInflow** method. Local Inflow Adjust now defaults to 0.0 in this condition. This is consistent with the rest of the methods as this slot is filled with zeros at the beginning of the run (for the run range only).

9.3.2 *Muskingum Cunge Improved Method*

The **Muskingum Cunge Improved** method is a new routing method on the Reach object. The new method is a modification to the **MuskingumCungeRouting** method but is designed to better conserve mass. More information can be found **HERE (Objects.pdf, Section 22.1.1.12)**.

9.3.3 *Muskingum Cunge routing method*

A bug was fixed in the Muskingum Cunge method where the Distributed Outflows were being written at the previous timestep. The Outflow to the reach was correct. This bug was fixed so that now the Distributed Outflows are written at the correct timestep. Users of this method will notice different results in the Distributed Outflows slot but the Outflow from the reach will be the same.

9.3.4 *Periodic GainLoss Method*

A new **Periodic GainLoss** method was added to the Reach object. This method is used to model gain and/or loss in a reach. The gain and loss values are entered as periodic data for a given time range. Gains are entered as positive values and losses are entered as negative values. This method will be available for all routing methods except **Time Lag Routing**. More information can be found **HERE (Objects.pdf, Section 22.1.10.7)**.

9.4 Reservoirs

9.4.1 *Operating Level Balancing Flood Control*

The Target Balance Level slot was added and the Temp Balance Level slot was removed from the reservoir's **Operating Level Balancing** flood control method. Now, the Target Balance Level is returned from the **FloodControl** function and set from the rule. The Target Balance Level stores what was previously shown on the Temp Balance Level slot

9.4.2 *Peak Power Eqn With Off Peak Spill*

The slots Dump Energy, Operation Factor, and Thermal Purchase were added to the **Load Calculation** methods on the Reservoir. These slots are output values describing how much power was produced compared to the desired Load. Dump Energy, Operation Factor, and Thermal Purchase are calculated at the end of the **Peak Power Eqn with Off Peak Spill** method unless the **Seasonal Load Time** method is selected. In that case, Dump Energy and Thermal Purchase are calculated at the end of timestep as the Load is not yet known. But, Operation Factor is always calculated at the end of that power method.

9.4.3 Seasonal Load Time method

In the **Seasonal Load Time** method, the Load slot was added. Now, when the **HydropowerRelease** function is called, the Load is also returned to the calling rule.

9.5 Water User and Agg Diversion Site Objects

9.5.1 Dispatch method required knowns

The dispatch method names were changed from

- solveStandAlone_givenDivReqDepReq to solveStandAlone_GivenDivReq - **HERE (Objects.pdf, Section 27.2.1.1)**
- solveSequential_givenDivReqDepReq to solveSequential_givenDivReq - **HERE (Objects.pdf, Section 27.2.2.1)**

Depletion Requested is no longer a required known for these methods. If Depletion Requested is not specified, the local variable will be set equal to Diversion Requested but the Depletion Requested slot will not be set. Also, Depletion Shortage will not be calculated.

Tip: With this change, in rulebased simulation, the user no longer has to set Depletion Requested with a rule in order for the Water User to dispatch.

9.5.2 Sequential Structure Modifications

On the water user element on an AggDiversionSite (when set to be sequential), the Outgoing Available Water now does not include the groundwater return flow. Groundwater return flow goes into the ground and is either lost or linked to another object. Therefore the new approach sets the Outgoing Available Water equal to surface water return flow only.

On the AggDiversionSite, sequential set up, the slot Total Surface Return Flow is currently set up to sum the element's Surface Return Flow. This is incorrect or not-meaningful as downstream elements can use leftover Surface Return Flow. It has been changed to set the Total Surface return Flow equal to the last element's Surface Return Flow. This may not be the same as the Total Unused Water. Total Unused Water can include water that was not diverted by the last element. The last element's Surface Return Flow is only the portion of water that was diverted that it returned via the surface. Click **HERE (Objects.pdf, Section 27.2.2)** for more information on the Sequential structure dispatch algorithm

10. Water Quality

10.1 Documentation

Documentation of the water quality system was added to the RiverWare help: **HERE (WaterQuality.pdf, Section 1)**.

10.2 Predictor Corrector Salt Model

The Predictor Corrector (given Inflow Salt Concentration) salt calculations on reservoirs now better handle situations where the reservoir runs out of water. When this occurs, the reservoir is treated like a reach and the salt concentration is set to a weighted salt average of the inflows to the reservoir. For more information, click **HERE (WaterQuality.pdf, Section 16.3.3.9)**.

In addition, the Simple Well-Mixed salinity dispatch methods no longer set diversion salt concentration equal to zero if diversion is zero. This was leading to unusual dispatching patterns. Now, if Diversion is zero, the concentration is non-zero but the Diversion Salt Mass will still be zero.

11. Closed Bug Reports

The following is a list of the bugs which were fixed for this release. If you wish to view the details for a specific bug, please browse to http://cadswes.colorado.edu/users/gnats-query.html and search our bug database. You will need a RiverWare user login and password.

517	674	676	697	852	1674	2096
2359	2659	2686	2874	3072	3083	3090
3377	3568	3583	3592	3684	3688	3763
3829	3953	3963	4215	4219	4232	4245
4253	4272	4275	4286	4289	4298	4300
4301	4304	4308	4310	4314	4316	4317
4319	4322	4324	4325	4326	4327	4329
4330	4331	4333	4334	4337	4339	4340
4341	4342	4343	4344	4345	4346	4347
4348	4350	4352	4353	4354	4357	4359
4360	4362	4363	4364	4365	4366	4368
4369	4370	4371	4372	4373	4374	4375

4376	4377	4378	4379	4380	4381	4385
4386	4388	4390	4392	4393	4394	4396
4397	4398	4399	4400	4401	4402	4403
4406	4407	4408	4410	4411	4416	4417
4419	4422	4423	4424	4426	4427	4428
4429	4430	4435	4436	4437	4438	4439
4440	4447	4448	4449	4450	4451	4452
4453	4454	4459	4460	4467	4468	4469
4472	4476	4477	4478	4479	4480	4482
4483	4485	4486	4487	4489	4490	4491
4492	4493	4494	4495	4496	4497	4499
4500	4501	4502	4503	4504	4505	4506
4507	4508	4509	4510	4512	4514	4515
4516	4517	4519	4521	4522	4523	4524
4525	4530	4531	4532	4534	4535	4536
4537	4538	4539	4540	4541	4542	4545
4546	4548	4550	4553	4554	4556	4559
4560	4561	4564	4565	4566	4567	4568
4569	4570	4571	4572	4574	4575	

Release Notes Version 5.1

1. Special Attention Notes

Following are special attention notes, indicating that

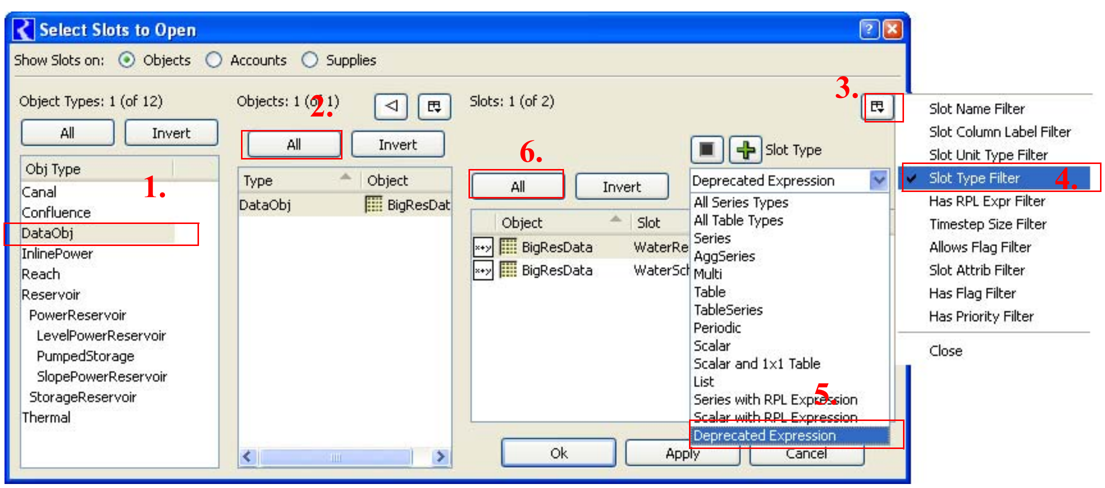
- functionality has changed that requires the user to update models, or
- results may differ

If you have any questions, please contact riverware-support@colorado.edu

1.1 Deprecated Expression Slots

Old-style expression slots will no longer be supported in the **next** major release of RiverWare (5.2). In preparation, if your model has any of these Deprecated Expression Slots, a warning will be produced on model load. Please update these to RPL based Expression slots. In this release (5.1), they will continue to work as before.

To help you find these slots, use the workspace **Slots ➥Open Slots**... menu. Then in the selector (see image below) choose, **DataObj** (1), and select all of your data objects (2). Then use the **Slot Type Filter** (3 and 4) and set the pull-down to “Deprecated Expression”. This will provide a list of all the Deprecated Expression Slots. Select All (6) and click OK to open all of the slots.



Then, re-implement each slot using RPL-based Expressions Slots. These are added to the Data Object using the **Slot ➥ Add Series Slot with Expression** menu. Because the syntax is completely different, each expression must be manually re-created. Click **HERE (Slots.pdf, Section 4.6)** for a description of the RPL-based expression slots.

1.2 Changes to the thermal object

The Thermal object's methods and categories were re-configured. New method selection will need to be made to duplicate previous configurations. Click **HERE (Section 11.5)** for more information.

2. Accounting

2.1 Exchange Configuration

The Exchange Configuration dialog was made **modal** meaning that edits can not be made to other dialogs when this dialog is open.

2.2 Sharing of accounting linked slots

In accounting, a "supply" is used to link two accounts. Previously, this resulted in three instances of the series, one on each account and on the supply itself. Now, accounting links share the data resulting in only one instance of the series. This makes models load faster, smaller in memory, and run faster. Note, you will not notice any difference within the RiverWare interface, it is all be done behind the scenes.

2.3 Supply Manager

In the Supply Manager Dialog, "Exchange" was added as an option for the two configurable columns and sort order.

2.4 Timing of certain Object Level Accounting Methods

In preparation for future work, the timing of object level accounting methods was modified so that in the future these methods can execute at different times, i.e. beginning of run, beginning of timestep, etc.

The only method that now executes at a different time is the "Zero Slot Inflows" method that exists on most of the objects. This method now executes at the **beginning of the run** to set all Slot Inflows to 0.0.

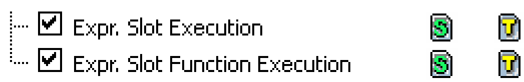
All other Object Level Accounting Methods execute at the same time as before, that is, at the end of the timestep.

3. Diagnostics

3.1 Expression Slots

Diagnostics for Expression Slot evaluation were added. The following categories were added to the Simulation, Rulebased Simulation and Workspace diagnostics settings dialog.

- Expr. Slot Execution
- Expr. Slot Function Execution



The **Simulation** and **Rulebased Simulation** setting control diagnostics issued **during a run** of the appropriate expression slot evaluation times (i.e. before or after timestep, before or after run). The **Workspace** categories apply to expression slots evaluated **outside of a run**, that is, when you evaluate a slot expression manually via the open slot dialog or from the workspace.

4. DMI

4.1 Dataset Selector

In the Database DMI editors (both the original and new versions), the cascading menu accessed from the **Datasets ➥ Add** menu has been replaced with a modal dialog. This dialog allows the user to better select a Dataset especially when the datasets have long names.

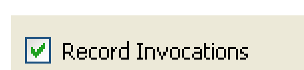
4.2 Executing DMI’s from RPL

The changes made to executing DMI’s from RPL blocks is described **HERE (Section 7.1)**.

4.3 Invocations and Clearing Values

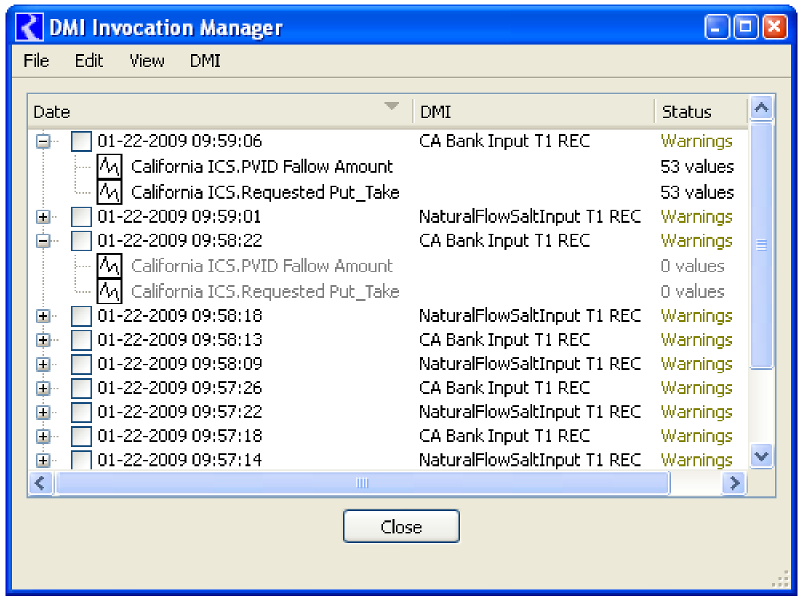
Functionality was added to allow you to track the invocation of Input DMI’s. With this feature enabled, you can then clear any value set by that input DMI.

You specifies that a DMI should record invocations within the DMI Editor using a toggle.



When this toggle is checked, any values imported via the DMI are given the DMI Input flag, “Z”, to specify that it was set by a DMI. This flag behaves identically to the Input “I” flag.

Then you can use the new DMI Invocation Manager which displays a view of all DMI invocations which have been recorded. For each invocation, the dialog shows the DMI, date, status, user, and slots the invocation set. The dialog then allows you to:



- Clear invocations (clearing the values set by that DMI)
- Delete the record of the invocation.

Click **HERE (DMI.pdf, Section 2.4)** for more information.

5. Optimization

5.1 Mixed Integer Programming

A Mixed Integer Program (MIP) solver was incorporated into RiverWare. MIPs are optimization problems that contain both continuous and integer variables. This work was motivated to better model power at the unit level. As a result, The MIP solver works in concert with the Unit Power methods described **HERE (Section 11.3)**.

5.2 Changes to the Thermal Object

The thermal object slots and methods were modified as described **HERE (Section 11.5)**. Additional information on the behavior of these methods in optimization can be found **HERE (Optimization.pdf, Section 5.10)**. Additional information on converting a thermal object to this new approach can be found **HERE (Optimization.pdf, Section 5.10.3)**.

5.3 CPLEX licensing

RiverWare was upgraded to use CPLEX 11.0 and Concert 2.5. Optimization requires a license for CPLEX version 11.0 or a later version.

In addition, an error message was added if an Optimization run is started and there is no valid CPLEX license. Previously a warning was issued but the run would continue until the optimization solution was attempted.

5.4 Automatic Ruleset Generation

An optimization run consists of a simulation, optimization and rulebased simulation run. After the optimization run, the user switches to rulebased simulation and has the option to automatically generate a ruleset that will set Reservoir.Outflow to the optimal value. The order in which rules appear was modified. Now, each rule, associated with a reservoir, are ordered topologically. Specifically, the low to high priority order of rules now corresponds to a upstream to downstream ordering of the associated reservoirs. That is, low priority rules are for upstream reservoirs, high priority rules are for downstream reservoirs. When using the default agenda order (...3,2,1), this causes the reservoirs to solve upstream to downstream. Note that if two objects are on different tributaries or in unconnected basins, then there is no constraint on the relative order of their associated rules.

6. Plotting and Output

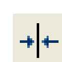
6.1 Curve Configuration allows slot to be changed

The **Curve Configuration** dialog for existing curves has been modified so that you can now change the slot associated with the curve (formerly the slot could only be selected when the curve was created and could not be changed thereafter).

On the plot, click the **Edit ➥ Curve Configuration**, then click the **Select Slot...** button. It brings up a Slot Selector for you to choose the new slot. The formatting of the curve remains, only the slot referenced changes.

6.2 Date Centering

In the plot dialog, an icon button was added to allow you to center the plot on the date in the scroll bar. Clicking that button with the Shift key pressed also causes a “global scroll” to that date.



6.3 Date Marker

In the plot dialog, an icon button was added to allow you to mark the given date in the date scroll bar with a dotted-red vertical line.

6.4 Export/Import of Output Device Configuration

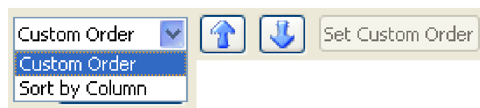
Output Devices (that is, the configuration, not the output itself) can be exported to or imported from a file. This allows better sharing of these devices amongst models. This action is performed from the Output Manager or the plot page.

If devices are created in one model, they can all be exported to a file and imported into the other model. If the same objects and slots are present in the second model, the devices will be fully specified with valid slot pointers in all the devices

If plots are exported from one mode and imported into another one that does not have the same objects and slots, the curves will not have valid slots. You must generated the plots and then the curves will appear in the legend of the plot, but without any data for the curves. You can then configure and select new slots as described **HERE (Section 6.1)**.

For more information on this utility, click **HERE (Output.pdf, Section 1.2)**.

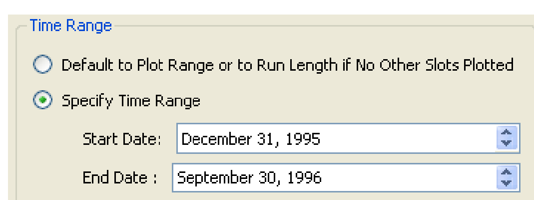
6.5 Ordering of Plots



Output devices, including Plot Pages, can now be custom sorted in the Output Manager. This ordering persists to the Plot Page Selection List. The sorting tools, in the lower left corner of the Output Manager dialog, allow you to either **Sort by Column** or sort by **Custom Order**. When Custom Order is selected, you can highlight one or more devices and move them up or down in the list using the arrow keys. When the Sort by Column is selected, clicking on a column heading sorts the devices in order. Clicking the **Set Custom Order** uses the displayed order to replace the Custom Order.

6.6 Periodic Slot Plotting

Previously, you had to specify a fixed date range for a periodic slot plot when creating the plot. Now, you have the following options when creating the plot and in the configuration dialog:



1. Default the plot range to either the run length (if there are no other slots plotted) or the existing plot range (based on other slots on the plot). This behavior is dynamic so that as slots are added or removed or as the time range for slots change, the plot range of the periodic slot will adjust.
2. Specify the time range. This range can be changed in the configuration dialog.

6.7 Plotting statistical slots

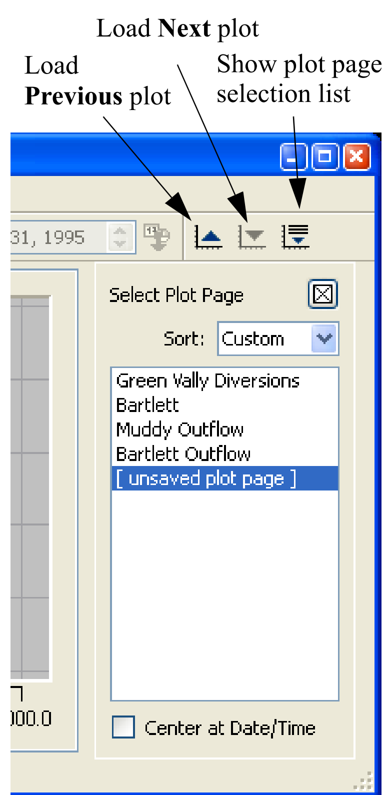
Plotting a duration curve statistical slot now plots with a linear scale for the exceedence percentage axis by default. Previously, it defaulted to a probability scale.You can still change the axis configuration using the **Edit ➥ Axis Configuration** menu.

6.8 Plot Page Selection List

A list of the available plotting devices was added to the plot page. You can click on a name, use arrow keys, or the new icon buttons and the new plot will generate.

This list of items is now used with the **File ➥ Open** menu. If the plot Page Selection List is already shown, the **File ➥ Open** option is disabled.

The order of plotting devices is controlled by the Sort pull-down menu and can be sorted by Name or Custom. To define the Custom sort, use the Define... option which takes you to the Output Manager where you can arrange the devices as described **HERE (Section 6.5)**



6.9 Plotting invalid slots

The plot utility now allows curves without valid slots in the current model to be loaded into plots as “placeholder” curves, which can then be given slots from the current model in the curve configuration dialog as described **HERE (Section 6.1)**.

7. RiverWare Policy Language

7.1 Executing DMI's from RPL

The following two changes were made to the utility that executes DMI's from RPL blocks:

7.1.1 Individual DMI's vs Groups

Individual DMI's can now be executed from RPL blocks. Previously only DMI groups could be executed.

7.1.2 Database DMI's

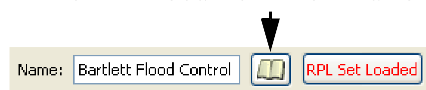
Database DMI's can now be fully executed from RPL blocks. Previously, there were issues executing Database DMI's, particularly that executing a HDB dataset would not ask for a login and would post a meaningless message.

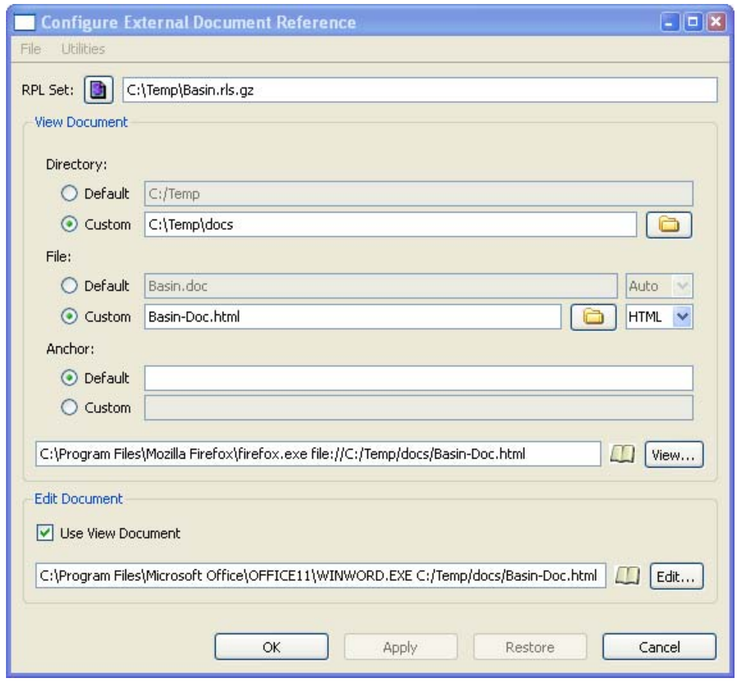
7.2 Link to External Documentation

Functionality was added to allow you to link a RPL set to documentation that resides in a separate file viewable by commonly used programs. The following is an overview of the capabilities, additional information can be found **HERE (RPLUserInterface.pdf, Section 7)**:

- From a RPL dialog, you are able to easily access external documentation for the RPL item associated with that dialog. This button only appears once the documentation is configured.
- The four supported types of documents are:
  - HTML,
  - MS Word,
  - PDF, and
  - plain Text

External Documentation Button





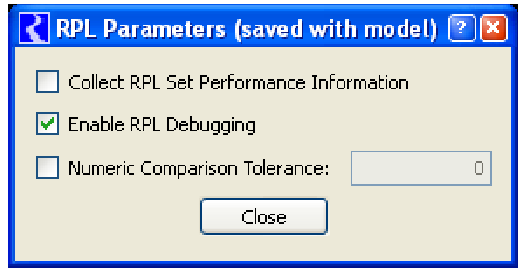
- You are able to specify the applications for both viewing and editing each type of document.
- Two modes of access are provided:
  - Edit - you can view, create, and change the contents of the document.
  - View - you can view but not change the contents of the document.
- The granularity of the documentation is flexible. You can associate a separate document with each RPL object within a RPL set or you can document an entire RPL set with a single document.
- When using HTML, the application can open to the most relevant portion of the document.
- The user can create an HTML template of the RPL set that contains the description field for each object. The user can then expand the documentation using an HTML editor.

7.3 New Predefined Functions- GetSeriesSlots

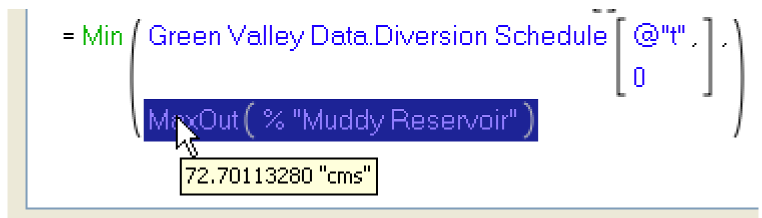
The GetSeriesSlots RPL predefined function was added. This function takes an Object as an argument and returns a list of visible series slots on that object. Click **HERE (RPLPredefinedFunctions.pdf, Section 80)** for more information

7.4 RPL Debugging

As a first step towards future debugging of RPL execution, RPL expressions now optionally save the value to which they last evaluated and you can easily view these values.



To enable this feature, in the RPL Parameter dialog (**Policy ➥ RPL Parameters**), click the the toggle which enables RiverWare to collects RPL debugging information, i.e., whether or not values are cached during RPL expression evaluation. This is a workspace-level toggle and applies to the execution of all RPL expressions associated with the current model. Note that collecting this information (and, more generally, supporting interactive debugging) has a significant impact on both computation time and memory usage.



When RPL debugging has been enabled, the user can interact with the RPL editor windows to view execution data. At any time between runs or when a run in paused (through the Run Control dialog) when the user selects a RPL expression, if that expression has been evaluated at some point, then the last value to which it evaluated is displayed in a tooltip.

The value shown is the last value of that expression at either the end of the run or the end of the timestep (when stepping). Multiple evaluations of an expression may lead to different results. Also, if that expression has not evaluated, no value will be shown.

Additional information can be found **HERE (RPLUserInterface.pdf, Section 6)**.

7.5 RPL File Menus

On most RPL Editor menus, the File menu was improved to better indicate the type of RPL set that you would like to open or save. Depending on the application, this includes a RBS Ruleset, Global Function Set, or Optimization Policy Set. Also, the cascading **Reopen** menus were added to the File menu.

7.6 RPL Global Function Sets

Global functions were added to allow you to define a function in one location and then use it in any of the RPL applications including:

- Rulebased Simulation Rulesets,
- Optimization Policy Sets,
- Object Level Accounting Method Set,
- MRM Rules, and
- RPL Expressions Slots.

Global RPL Functions exist within **Global Functions Sets**. Multiple Global Function Sets can be opened within a RiverWare session and apply to all RPL applications in that model. All functions must have a unique name and cannot conflict across global function sets. All relevant global function sets should be opened before trying to load a ruleset.

For more information on global functions, click **HERE (RPLUserInterface.pdf, Section 5)**.

7.7 RPL User Interface

7.7.1 Undo/Redo

Undo/Redo has been added for editing RPL expressions and is available from the Edit menu, right-click context, or keyboard shortcuts (ctrl-z undo; ctrl-shift-z redo)

Undo and redo are on a per-dialog basis; the dialog must be selected before the undo/redo operation is performed. Also, the history of changes is preserved if a RPL dialog is closed and re-opened, but is not preserved if the set is closed.

The number of undos/redos is only limited to take you back to the original expression; there is no artificial limit imposed

7.7.2 Cut/Delete Operations

The cut and delete operations for RPL editing were modified to exhibit more standard behavior:

- delete - deletes the selected item (expression or statement)
- cut - copies the selected item to the copy buffer then deletes it

There is one minor exception: if an empty expression which is an item in a list is selected, that list item is removed from the list. Thus to remove a non-empty expression from a list, one can cut/delete it twice -- the first cut will clear the expression, the second will remove it.

In addition, the Clear operation was removed (Cut and Delete now subsume Clear).

7.7.3 Numeric Syntax

RPL numeric value and units are now specified with double quotes instead of square brackets and double quotes. For example, previously, you would type:

`1000 ["acre-ft/day"]`. Now you can type `1000 "acre-ft/day"`

On input the double quotes can be omitted when the unit name is a single word with no punctuation (i.e., does not contain '-', '/', '*', or a multiplicative factor).

Examples of valid syntax:

- 1.0
- 1.0 cfs
- 1.0 “cfs”
- 1.0 “cfs-day”
- 1.0 “1000 cfs-day”

The old syntax is still supported for input, but it will be display and written to files using the new syntax.

7.7.4 Display of Brackets, Braces and Parenthesis

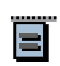
On RPL expressions, the display of parentheses, brackets and braces were improved.

Old: FOR(NUMERIC val IN <list expr>)WITH LIST result = {} DO

New: FOR (NUMERIC val IN <list expr>) WITH LIST result = {} DO

7.7.5 RPL Icons

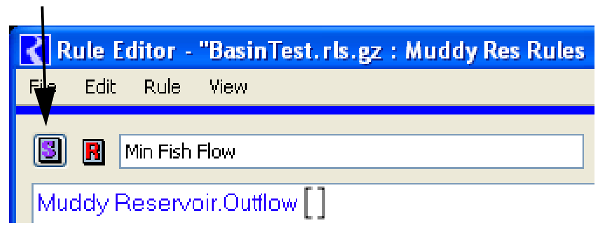
Changed the RPL icons further to improve the interface. Each type of RPL item now has a unique letter, icon, and/or color:

Letter	Icon	Item	Letter	Icon	Item
G		Goal	S		Set
M		Method	=		Statement
P		Policy Group	F		User-defined Function
F		Predefined Functions	U		Utility Group
R		Rule	U		Utility Group of predefined functions

7.7.6 RPL Dialog Set buttons

The above icons were added to RPL dialogs to show you the type of the current dialog. Also the “Set” icon button was added to allow you to show the containing set for the given RPL dialog. Click on the button to follow back to the upper level dialog and the tree view will be expanded and the appropriate item will be selected.

Button to take you to the Set



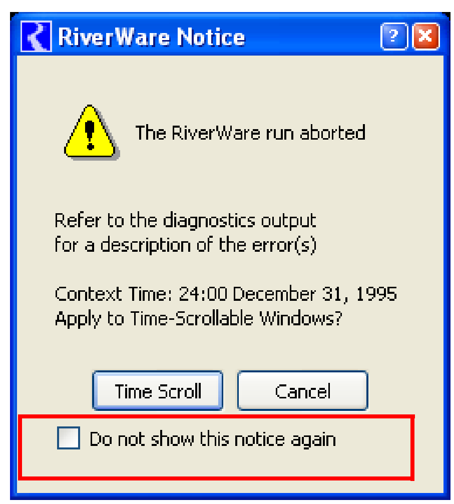
7.7.7 Sizing of Windows

RPL dialogs were modified to better allocate space when re-sizing the window. When an execution constraint is shown, the statement display portion of the RPL block (rule) editor dialog (i.e. the upper half) will now take as much vertical space as is available. For example, if you resize the dialog, the statements frame will grow and the description and execution constraints frames will retain their vertical heights, to a certain degree. There is still area for improvement in this operation.

8. Run Control

8.1 Abort Confirmation

Added to the run abort dialog is a checkbox which allows you to not show the dialog again. If you select this box, then subsequent aborts will use the same selection (Time Scroll or Cancel) and the dialog will not be shown. This applies only to the current RiverWare session.



8.2 Step and Initialization

At the beginning of a run, the **Step** button now performs only initialization on the first click. The second step executes the first timestep. Previously, the first click of the **Step** button performed initialization AND executed the first timestep.

9. SCT

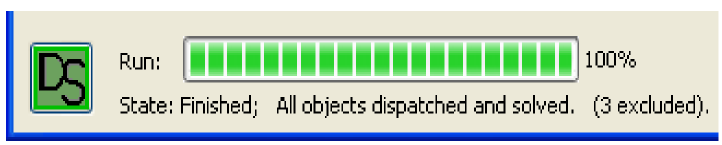
9.1 Diagnostic Output

The diagnostic output window was modified so that when docked in an SCT it does not take up excessive space as follows:

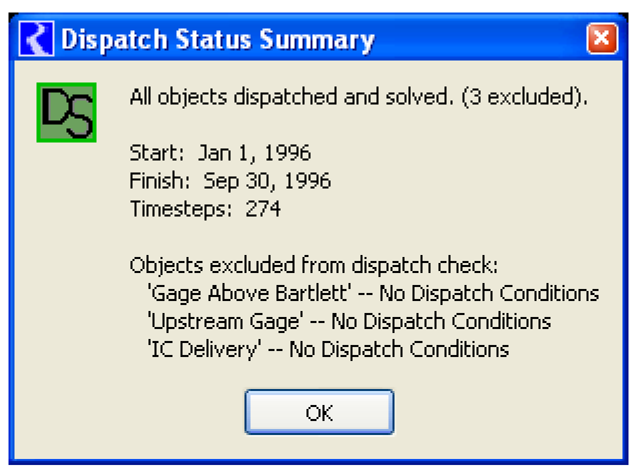
- Removed the title bar
- Added ability to hide the column headers (**Settings ➥ Show/Hide Column Headers**)
- Added ability to hide the diagnostic menu toolbar (From the SCT: **Diagnostics ➥ Show/Hide Integrated Toolbar**)

9.2 SCT Run Status Panel

In the Run Status area of the SCT, information on the dispatching of objects within the run was added. An icon is shown that displays the most limiting dispatching of objects within the run. Also displayed are the number of objects that meet the most limiting condition.



Clicking on the icon takes you to the Model Run Analysis tool with the first relevant object at the earliest timestep highlighted. When you shift-click on the icon, a dialog is



shown with a summary of the run analysis.

10. Selector Filters

10.1 Expression Slot filters

Two new Slot Type Filter values were added to select expression slots:

- Series with RPL Expression
- Scalar with RPL Expression

This is slightly redundant with the separate Slot Filter: “Has RPL Expr” but clarifies the slot type. Finally, the filter “Expression” was replaced with “Deprecated Expression.”

10.2 Has Flag

A new filter, “Has Flag”, was added to the selector dialog that allows you to filter series slots by any flag. For example, you can filter to see only slots that have the R (Rules) flag set on one or more timesteps.

10.3 Has Priority

A new filter “Has Priority” was added for Series Slots and Supplies. Slots having a timestep with the specified priority number are then shown.

11. Simulation Objects

11.1 Reach

11.1.1 Inflow Stage Table Look Up Method

The “Inflow Stage Table Look Up” method was added to the Reach object. This method uses inflow to determine the stage. It was added to avoid some of the issues that occur when a reach re-dispatches and uses the existing “Stage Table Look Up” method. A full description of both methods is **HERE (Objects.pdf, Section 22.1.6)**.

Also, for both of these methods, negative values in the stage tables are no longer necessary. If the flow is less than the value on the stage table, the smallest value is used.

11.1.2 Reach Seepage Routing method

A new method, “One Timestep Seepage Lag” was added to the reach “Seepage Routing” category. This method lags the computed Seepage by one timestep. This method was added for use with the “Stage Table Lookup” stage calculation and “Head Based Seepage” calculation to provide an explicit solution on the reach. For more information, please see **HERE (Objects.pdf, Section 22.1.13.3)**.

Also, Seepage can now be input or set by a rule for any of the seepage methods.

11.1.3 Variable Time Lag Routing

Outflow was removed as a required unknown for dispatch conditions. This makes it more consistent with other dispatch methods.

11.2 Reservoirs

11.2.1 Spill Capacity Fractions:

New functionality was added to the reservoir objects to allow better modeling of Spill. For each type of spill—Regulated, Unregulated, and Bypass—Capacity fraction slots were added to represent the fraction of the spillway that is available. For example, the Bypass Capacity Fraction is used to specify the percentage of the Bypass works that is available. See the spill methods **HERE (Objects.pdf, Section 17.1.8)** (for the level power reservoir).

11.2.2 Regulated Spill Overflow

A new category, "Regulated Spill Overflow", and method "Closed Gate Overflow" were added to represent uncontrolled flow that spills over a regulated spill structure that is closed for maintenance or other reasons. Click **HERE (Objects.pdf, Section 17.1.10)** for more information (on the level power reservoir).

11.2.3 Spill slots linked to Expression Slots

A change was made to the spill methods to check if Bypass or Regulated Spill are linked to an expression slot. If they are linked and they have a valid value, they are treated as known values and are not re-computed. Note, the expression slots should be configured to evaluate at the beginning of the current timestep to make this linking approach work correctly.

11.2.4 Slope Power Reservoir: Editing of Column labels on select slots

Changes were made to allow user editing of Slot Column labels for the following two slots on the Slope Power Reservoir:

- Partition Flow Parameters
- Partition BW Elevation

11.3 Power Reservoirs - Unit Power Methods

A new power method, Unit Power, was added to better model power production at the individual unit level. This method uses a three dimensional table that contains the columns Operating Head, Turbine Release, and Power for each unit in the plant. For more information click **HERE (Objects.pdf, Section 17.1.1.12)**.

Also, as part of the Unit Power Method, the following categories and methods were added. They are all dependent on having the Unit Power Method Selected:

- **Startup** category and **Unit Lumped Cost** method: Used to compute the cost of starting or stopping one or more units. For more information click **HERE (Objects.pdf, Section 17.1.38.2)**.
- **Head Loss** category and **Shared Penstock Head Loss** method: Used to compute additional head loss that occurs when individual units share a penstock. **HERE (Objects.pdf, Section 17.1.39.2)**
- **Cavitation** category and **Unit Head and Tailwater Based Regions** method: Used to check if a unit is operating in a cavitation region. **HERE (Objects.pdf, Section 17.1.40.2)**
- **Avoidance Zones** category and **Unit Head Based Avoidance Zones** method: Used to check if a unit is operating in an avoidance region. **HERE (Objects.pdf, Section 17.1.41.2)**
- **Frequency Regulation** category and **Unit Frequency Regulation** method: Used to model frequency regulation (Note , not implemented fully). **HERE (Objects.pdf, Section 17.1.42.2)**

11.4 U Flag

The U flag has been added for use with the new Unit Power method. The flag is set on Energy or Turbine Release and causes the slot to be considered an Input, but no value is required. The flag indicates that the unit level values (Unit Turbine Release or Unit Energy) will be specified. It can be set on the Slot dialog, through the SCT, or using a Rule.

11.5 Thermal Object

11.5.1 Economic Valuation Categories

The ThermalReplacementValueCategory has been removed and replaced by the following categories:

- Linear Economic Value - **HERE (Objects.pdf, Section 26.1.5)** - This is a new approach to valuation. It is a simplified version of the existing Block evaluation where only a single block is used.
- Block Economic Value - **HERE (Objects.pdf, Section 26.1.6)**
- Thermal Unit Replacement Value - **HERE (Objects.pdf, Section 26.1.7)**

Each category contains a default, no-action method and a method that does that type of evaluation. Thus, both optimization and simulation may have up to three independent evaluations: Linear, Block, or Thermal Unit Replacement. Accordingly, each type of evaluation has its own slots which are typically the existing slots with either Linear, Block, or Thermal added to the beginning of the name.

For each method, the inclusion and ordering of power sources are now in a table. The tables may differ for different evaluations. Previously the ordering was specified by selection of specifically named methods.

The following slots have been removed, but their functionality has been replaced with new slots specific to the economic evaluation methods:

- Avoided Operating Cost
- Net Avoided Operating Cost
- Conventional Replacement Value
- Pump Replacement Value
- Allocated Replacement Value
- Marginal Operating Costs
- Previous Marginal Operating Costs
- Total Values

Also, the Thermal Cost slot is no longer used. It used to be needed to facilitate the optimization formulation. The Block Hydro Capacity Slot has been eliminated because it is not used in the new optimization controller.

Additional information on converting a thermal object to this new approach can be found **HERE (Optimization.pdf, Section 5.10.3)**.

11.5.2 Regulation Category

On the Thermal object **Regulation** category, the name of the method **Regulation** was changed to **Two Sided Regulation**. For more information on this method, click **HERE (Objects.pdf, Section 26.1.4)**.

11.5.3 System Startup Cost

On the Thermal object, a slot System Startup Cost was added as a general slot.

11.6 USACE - SWD Functionality

A number of performance related changes were made to speed up U.S. Army Corp of Engineers - Southwest Division (USACE-SWD) models. These include:

- No dispatching beyond forecast period
- No setting of values beyond forecast period in the Reach step response routing
- Caching of routing vectors in the Computational Subbasin, and
- Implementing a custom top/down dispatching order in situations where slots are being set on a number of objects across the network.

These changes were made explicitly for USACE models and should not adversely affect other models. The described behavior only occurs when there is a Computational Subbasin with Operating Level Balancing method selected in the Flood Control category and there is a Forecast Period slot.

In addition, a specific document was developed that describes all of the functionality used in USACE-SWD models. It can be found **HERE (USACE_SWD.pdf, Section 1)**.

12. Slots

12.1 Expression Slots - RPL

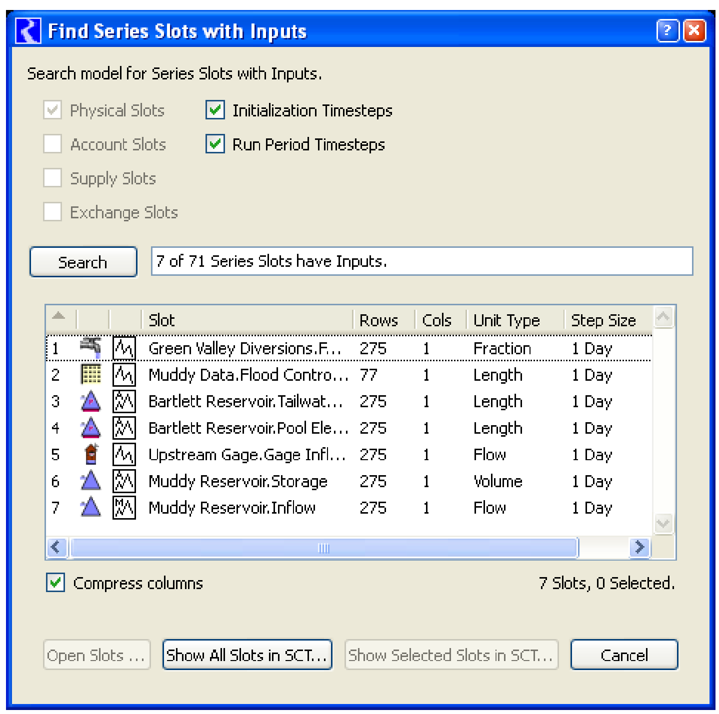
A number of changes were made to expression slots:

- Expression Slots no longer allow Input Flags
- Expression slots now have better diagnostics as described **HERE (Section 3)**
- Expression slots can now have an If without and Else.

12.2 Expression Slot - Old Style

Old style expression slots will not be supported for future releases. Please convert them to RPL Expression slots. A warning message is issued on model load if any old-style expressions are found. Click **HERE (Section 1.1)** for more information.

12.3 Find Series Slots with Inputs



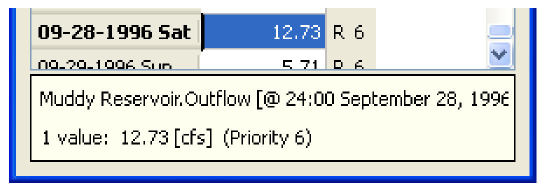
A new feature, "Find Series Slots with Inputs", can be used to find values that are input in the model. It is accessed from the RiverWare Workspace using the: **Workspace ➥ Slots ➥ Find Inputs** menu. You have options to filter on the types of series slots on which to look for input values including Physical, Account, Supply, and Exchange Slots. The search may be limited to either Initialization Timesteps (before the Run Start timestep) or Run Period Timesteps (on or after the Run Start timestep). Finally, you have the option to open slots, containing objects, or to add slots to an SCT for further viewing. For more information, click **HERE (Slots.pdf, Section 4.1.7)**.

12.4 MultiSlot Dialogs:

On the Open Slot dialog for Multi-slots, a check box was added below the slot data to allow you to “Show Subslots”. The check box text indicates the number of subslots in the MultiSlot. The check box is shown only if the MultiSlot has at least one subslot. It is initialized to OFF if the MultiSlot has exactly one subslot; otherwise, it is initialized to On.

12.5 Selection Statistics Area

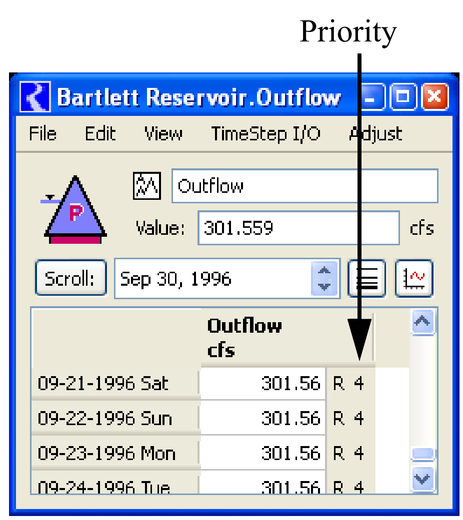
The Selection Statistics Area (a.k.a. summary area) is now supported for all series slots (previously it was available only in accounting dialogs). The Selection Statistics Bar is optionally shown using the toggle under the **View ➥ Show Selection Statistics** menu.



12.6 Showing priority in series data

Priorities are showable in all series slot applications. They are shown by default in the slot dialog for both physical and accounting slots when a rulebased simulation controller is selected, but are off by default in the other accounting applications (e.g. edit account).

When you change to a non-rulebased simulation controller, priority display is turned off in all instances. When priorities are showable, priority display can be toggled on or off with the Ctrl + Shift + P accelerator:



12.7 Statistical Slot Functions

Four new functions were added to statistical slots that will generate

- Monthly Maximums by Year
- Monthly Minimums by Year
- Monthly Average by Year
- Monthly Totals by Year

Click **HERE (Slots.pdf, Section 4.11.6)** for more information.

12.8 Unit Defaults on Data Objects Slots

When slots on Data Objects are configured, the user unit and scale are read from the riverwareDB file and used as defaults when a new unit type is chosen. For example, you have a riverwareDB file that says that flow slots should use 1000 cfs as the scaled units. If you create a new slot on a data object and specify that it has Flow unit type, the configuration dialog will default the user units to cfs and the scale to 1000. This make model building easier and more consistent.

13. User Interface - Miscellaneous

13.1 Closing Workspace or RPL sets

When you close, exit, or clear the workspace or closes a RPL set, RiverWare asks you if you really want to go through with the action because doing so will lose any changes made since the last time you saved. Now a more informative dialog is presented listing all of the items that will be closed. Better canceling of the close is now supported.

13.2 File Loading

Directories were added to the **Reopen** menus. Previously, the reopen menus had shown only specific files (model files, Rulesets, SCTs, etc.). With this change, those menus also present a list of recently accessed directories shown with a yellow folder icon. Selecting a directory item opens a file chooser initialized to the specified directory.

You can now define a single “default” directory (for the specific type of file) using an environment variable. When selected, the **File ➥ Open...** menu will open a file chooser initialized to that directory the first time within a RiverWare session. In the reopen menu, this default directory is shown as a green folder. Supported Environment Variables:

Type of file	Environment Variable
Model Files	RIVERWARE_DFLT_MODEL_DIR
Rulesets	RIVERWARE_DFLT_RULESET_DIR
Optimization Rulesets	RIVERWARE_DFLT_OPTSET_DIR
Global Function Set	RIVERWARE_DFLT_GBLSET_DIR
Object Import/Export	RIVERWARE_DFLT_OBJ_DIR
SCT Files	RIVERWARE_DFLT_SCT_DIR

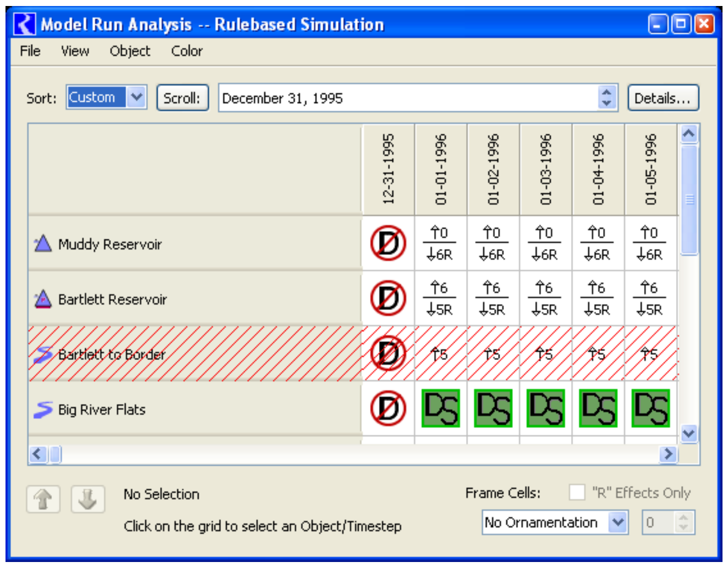
Also for file loading, your selection of the file filter (i.e. “Files of type:” pull-down menu) is now preserved. Thus, you can specify to use the “All (*)” file filter and it will persist across RiverWare sessions until changed. Filter selections are saved independently for the five different file types: Models, Rulesets, Optimization Rulesets, Sim Object (Import/ Export), and SCTs.

13.3 Icons on windows

On windows, an icon is now shown for all RiverWare dialogs in both the upper left corner and on the Task Bar.

13.4 Model Run Analysis

The Model Run Analysis tool was re-implemented. The following improvements were made:



- Rotated text in the column headers
- Swappable axis (Time on Top or Side), as was previously supported.
- Context menus supported on row and column headers (as well as in table cells).
- “Dispatching Disabled” red crosshatch now shows on both table cells and headers.
- Small object icons optionally displayed in row headers.

13.5 MRM Run Control

In the MRM Run Control dialog, if there is only one configuration, it is selected. Also, new configurations are automatically selected.

13.6 Open Object Dialog - Show slots in SCT

The Open Object dialog now supports showing all of the object's slots in a new SCT or adding them to a single open SCT. These operations are under the **Slot ➥ SCT** submenu. Slots are placed within the SCT in the order they are displayed in the Open Object dialog.

14. Workspace

The Simulation workspace was re-implemented. The following additional features were added:

14.1 About RiverWare dialog

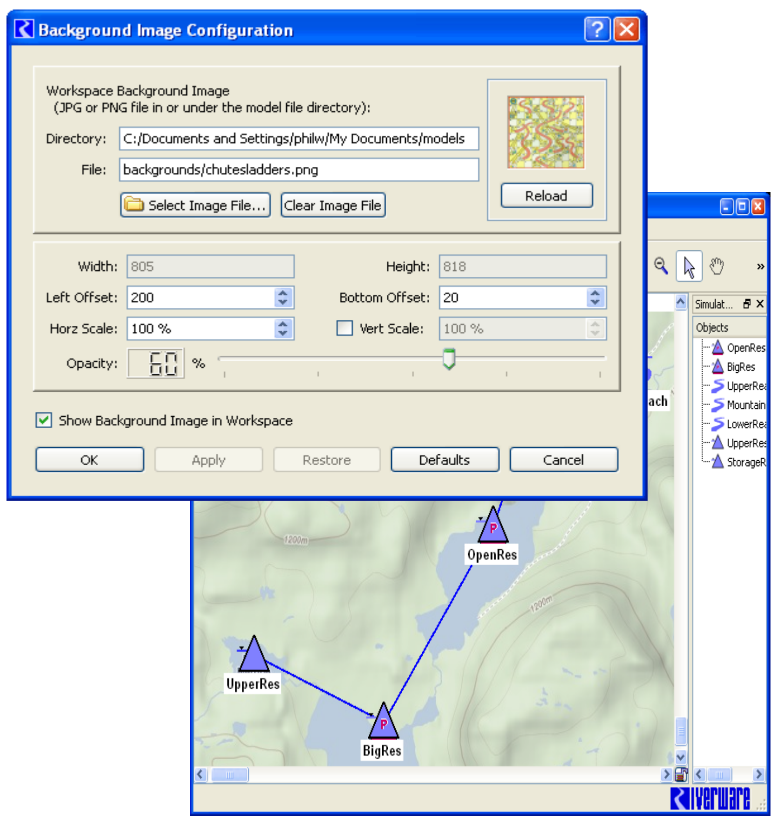
The **About RiverWare** dialog was modified to better show the system information and provide a link to the CADSWES website. This dialog is accessed from the **Help ➥ About RiverWare** menu. The menu **Help ➥ System Info...** menu was moved to a button on the **About RiverWare** dialog.

14.2 Background Image

The ability to add a background image to the Simulation Workspace was added. Note, the accounting workspace is not yet supported.

Now you can show any jpg or png behind the objects.

For more information on this utility, click **HERE (Workspace.pdf, Section 4.1.2)**.



14.3 Close All Dialog

A utility was added to close multiple RiverWare dialogs. Clicking the Lightning Bolt icon (on the workspace and on RPL dialogs),  opens the following dialog. Then, you can choose which of the dialogs you wish to close. This utility does not closed the **Workspace**, **RPL Set editors** or unsaved **SCTs**.

Alternatively, Shift-Clicking on the Lightning Bolt icon closes all dialogs except the workspace and the top level RPL Set editors.

This is available on both the Simulation and Accounting Workspace.

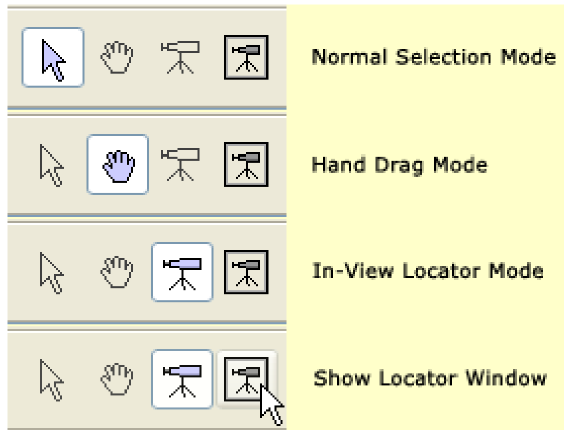
14.4 Lock and Unlock the workspace

Better utilities were added to lock and unlock the workspace.

14.5 Open Slots menu

From the workspace, the menu **Workspace ➥ Slots ➥ Open Slot...** was changed to **Open Slots...** so that now multiple slots can be opened at one time. If you choose more that four slots, a warning dialog is posted asking if you want to continue.

14.6 Toolbar buttons for navigating



The following tool bar buttons were added to the Simulation Workspace only:

- **Selection Mode** is used for selecting and repositioning Simulation Object icons on the workspace.
- **Hand Drag Mode** allows you to move the workspace canvas within the visible workspace area. This is analogous to operating the Workspace's scrollbars.
- **In-View Locator View Mode** is an alternative to the separate Locator Window.
- **Locator View** is the original separate dialog. It was also improved. Click **HERE (Workspace.pdf, Section 3.2)** for more information.

15. Closed Bug Reports

The following is a list of the bugs which were fixed for this release. If you wish to view the details for a specific bug, please browse to http://cadswes.colorado.edu/users/gnatsquery.html and search our bug database. You will need a RiverWare user login and password.

2600	2785	3064	4015	4036	4172	4173
4213	4214	4261	4320	4338	4428	4461
4463	4466	4473	4520	4529	4533	4543
4547	4552	4555	4563	4573	4577	4578
4580	4581	4582	4583	4585	4586	4587
4588	4589	4590	4592	4593	4594	4595
4596	4597	4598	4599	4601	4602	4603
4604	4605	4606	4608	4609	4610	4611
4612	4613	4614	4615	4617	4618	4619
4620	4622	4624	4626	4627	4629	4631
4632	4633	4635	4636	4637	4638	4639
4641	4642	4643	4644	4646	4647	4648

4649	4650	4651	4652	4654	4655	4656
4657	4658	4660	4661	4662	4663	4664
4665	4666	4668	4670	4672	4673	4674
4675	4677	4678	4679	4680	4682	4683
4684	4685	4686	4687	4689	4690	4691
4692	4693	4695	4696	4698	4700	4701
4702	4703	4704	4707	4708	4709	4710
4711	4713	4715	4716	4717	4718	4720
4721	4722	4723	4725	4726	4727	4731
4733	4734	4735	4736	4738	4739	4740
4741						

Release Notes Version 5.2

1. Special Attention Notes

Following are special attention notes, indicating that

- functionality has changed that requires you to update models, or
- results may differ

If you have any questions, please contact riverware-support@colorado.edu

1.1 Deprecated Expression Slots removed

Old-style expression slots are no longer supported in RiverWare 5.2. When loading a model and these slots are found, a message is posted and the slots are ignored (i.e. they are not loaded into the model).

Please see Special Attention Notes in the Prior Release Notes for information on finding and converting these slots using RiverWare 5.1.

1.2 Integer indexed slot display and synchronizing

Integer indexed slots are indexed by an integer instead of a timestep. Internally, these are stored as having an hourly timestep starting at Dec 31,1799. A bug (4797) was fixed where if a data object containing these slots was synchronized, the integer indexed series slots would also be synchronized to that new timestep and start/end date. Now, integer indexed slots will not be synchronized and any existing slots will be fixed on model load. If you had policy that referred to the timestep of these slots, it must be modified. Also, the display of these slots has been improved on the SCT cell values and summary statistics.

1.3 Series Slots converted to Periodic Slots

On the reservoirs, the following slots were converted from Series Slots to Periodic Slots:

- Irrigated Area Loss Rate
- K Factor
- Meadow Area Loss Rate
- Pan Ice Switch

When you first load your model, if you are using these slots, a series of warning message will be posted to diagnostics, for example:

```
"SLOT: Reservoir.K Factor: Trying to convert former slot type ("SeriesSlot") to
   new slot type ("PeriodicSlot")."
```

You must re-entered the data into these slots where applicable. This is especially true for the Pan Ice Switch; previously, the value would default to 0 if not input, now the value MUST be input. A single 0.0 in the periodic slot is sufficient if only 0 is required.

Click **HERE** to go to the Storage Reservoir section.

2. Accounting

2.1 Data Object Exchange Utility

A specialized utility was added to the Accounting system to allow users to create an alternative mechanism to track water exchanged between accounts. In this approach, the user tracks the exchange with rules that reference specifically named slots on data objects. This utility, called the Data Object Exchange Builder, helps to create this type of exchange by adding slots to a data object and creating supplies on the workspace. The rules must be defined by the user and no support is provided as to what the rules do or how they are written.

More information on this utility can be found in the Data Object Exchange Overview section.

2.2 Diversion Account Enhancements

2.2.1 Return Flow Calculation - Variable Efficiency Return Flow

A new method was added to the Diversion Account's **Return Flow Calculation** category. The **Variable Efficiency Return Flow** method computes the **returnFlow** by multiplying the Diversion by the minimum of the Max Efficiency or the ratio of Depletion Requested to Diversion. For more information on this method, click **HERE (Section)**.

2.2.2 Return Flow Route or Split

A new category, **Return Flow Route or Split**, was added to the Diversion Account. This category has two methods: **Simple Lag** and **Split and Route**. The default **Simple Lag** method (**HERE (Section)**) uses the existing approach where the return flow can be lagged by an integer number of timesteps and no splitting of return flows is allowed. The **Split and Route** method (**HERE (Section)**) allows you to split the return flows to multiple supplies and then route those return flows using linear routing coefficients. Note, the **Split and Route** method cannot be used by a diversion account in a computational subbasin that performs a water rights allocation using the prior appropriation method and water rights solver.

3. Batch Mode and RCL

3.1 RCL specification of Machine\share paths

In RCL scripts, the file syntax did not allow the windows \\MachineName\shareName specification of paths. Now, an example of the correct syntax is:

```
OpenWorkspace \\\\MachineName\\shareName\\test.mdl.gz
```

4. Diagnostics

4.1 New Information on start up

An informational diagnostic is shown at start up which indicates which RiverWare Resource Database file (riverwareDB) is being used. If there is no riverwareDB file, a message is also posted.

4.2 Diagnostic window on Solaris

On Solaris, when a run aborts, the Diagnostics Output Window is no longer automatically set to be the active window but is still raised to the top.

5. DMI

5.1 Excel Database DMI Datasets

In the database DMI utility, an Excel Dataset was added to better allow you to interface with Excel. A database DMI can use an Excel dataset to import or export data directly from/to Excel. There are two main ways to specify how the data will be represented in Excel:

- **Using Ranges and Name Maps**: The user specifies Names Maps to correlate either Excel Named Ranges or Cell References to slots in RiverWare.
- **Using Headers and Sheet Names**: The user specifies that a standard Header naming convention will be used to correlate slots in RiverWare to data in Excel.

Within each of these two approaches, there are many user configurable options and features. Click **HERE (DMI.pdf, Section 5.3.3)** for more information.

5.2 Line enders

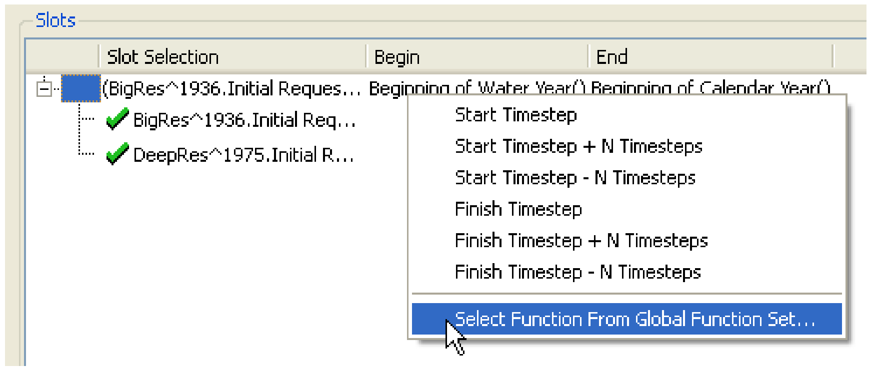
A new feature was added to the Control File-Executable type DMIs. This feature allows you to specify the line ending sequence that DMI's write. As specified in the DMI Editor, the choices are:

- Native (default for the current platform)
- Windows or
- Unix

Click **HERE (DMI.pdf, Section 3.5.7)** for more information.

5.3 RPL functions to specify Begin/End dates

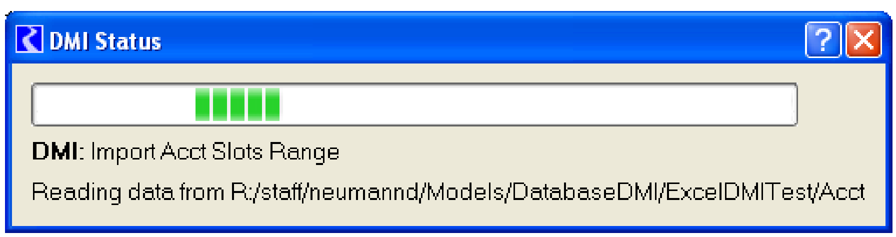
For Database DMI's, you can now specify the slot selection's **Begin** or **End** date with a RPL function defined in an opened Global Function Set. The function must not have any arguments and must return a fully specified datetime variable.



Click **HERE (DMI.pdf, Section 5.2.2.2)** for more information.

5.4 Status Dialog

A more informative status bar is now available during DMI execution. This dialog shows information on the DMI that is executing, the slots that it is processing and the location of the data. Because this dialog has minor impact on performance, especially when processing a large number of slots, it is optional and by default is not shown. This status dialog can be shown by toggling on the menu **DMI ➥ Show Status Bar** from the **DMI Manager**.



6. General RiverWare

6.1 RIVERWARE_HOME environment variables

On windows, the environment variable RIVERWARE_HOME_XX is optional for RiverWare to run. If it is not set, RiverWare will use the executable's directory, i.e. it assumes RIVERWARE_HOME_XX is the location of riverware.exe. The directory used can be seen in the **Help ➥ About RiverWare ➥ Show System Info...** menu.

7. Multiple Run Management

7.1 Iterative Mode Output Control File

Iterative MRM no longer requires an output control file (although one can still be provided). Previously, even if no file was needed, a blank file was required.

8. Optimization

8.1 Constraints for Input Values

Previously, optimization was failing to use input values for some slots if the policy set didn't need the value either directly or indirectly. One noticeable example was pool elevation inputs for level power reservoirs.

Now, an input value leads to an expression, slot[t] = input value. This expression is forced into the model through the "linearization" process. The results depend on what happens to this expression during linearization. In the case of pool elevation, for example, the expression is replaced initially with an equivalent expression for storage and eventually reflected by setting the bounds on the storage variable equal to the appropriate value. A similar process is used for any slot replaced by substitution.

If instead, the slot is not replaced by this kind of substitution, then the original expression is introduced as a hard constraint. If the slot is linearized by a method other than substitution, the slot in the constraint will be replaced by a linear expression of other slots.

If the slot is not linearized, its defining constraints will be introduced, and the value will be used in those constraints.

If a slot is linked to another slot with an input value, this process is followed for both slots.

Slot minimum/maximum values are optional for decision slot variables that have a value. In the past, such variables would never be introduced, but now that they are linearizing expressions which contain variables with values, these variables exist.

8.2 Modified definitions

The Tailwater Base Value was added to the list of slots defined by certain optimization definitions.

8.3 Modified the substitution approximation code

When translating a constraint on one slot to a constraint on another slot, the original constraint value may lie outside of the table describing the slot relationship. The table may imply that the constraint cannot be satisfied. In this case, RiverWare now issues an error. Alternatively, the table may imply that the constraint is always satisfied. In this case, RiverWare now issues a warning that alerts the user that the table may be missing values.

8.4 Forward lags

When the code encounters the variable s[t] where s is the reach Inflow or Local Inflow slot, in theory, it should write an equation like:

(1) Reach.Outflow[t+Lag] = Reach.Inflow[t] + Reach.Local Inflow[t]

Prior to now, it would write the equation:

(2) Reach.Outflow[t] = Reach.Inflow[t-Lag] + Reach.Local Inflow[t-Lag]

which is incorrect, though until the changes above, this did not cause any noticeable problems.

In practice, this problem currently doesn't arise. If the Inflow or Local Inflow are going to influence the solution, a constraint on outflow will pull their values into the formulation. We may have to revisit this situation in the future if a new lagged physical constraint is added to the model. For now, this would have been a costly fix without any practical benefit.

Instead, Inflow and Local Inflow have been removed from the list of slots whose variables are defined by the reach mass balance definition. Because this leaves Inflow and Local Inflow potentially undefined, the check that all slots referenced in a problem must have at least one definition has been relaxed.

8.5 Unconstrained slots

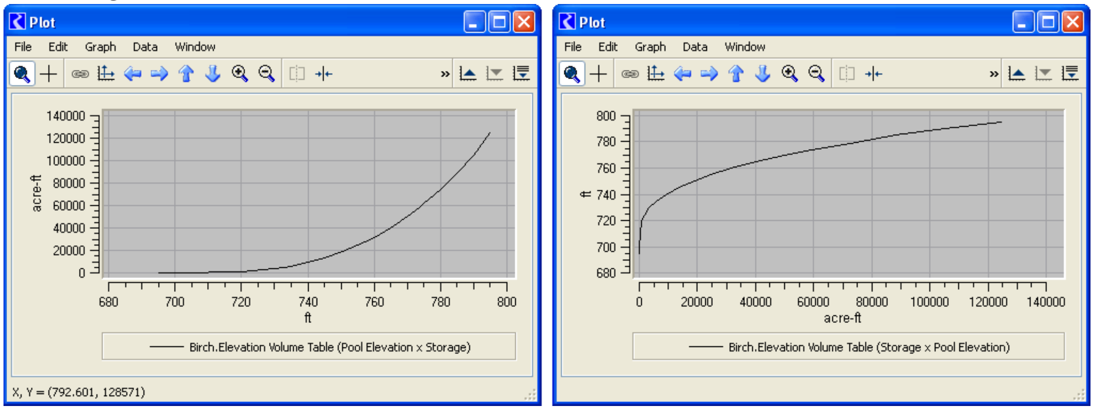
A warning is issued if certain slots are unconstrained during optimization (i.e., they are not linked and NaN). Currently, these slots are Reservoir.Inflow, Reach.Inflow, Reach.Local Inflow, Confluence.Inflow1, and Confluence.Inflow2. Additional slots may be added to this list in the future.

Optimization

9. Plotting and Output

9.1 Table Slots - Reverse axes

Typically, when you plot a table slot with two columns, the plot shows the first column on the X axis and the second column on the Y axis. For some slots, like the Elevation Volume table, this is not ideal; the Elevation would more naturally be on the Y axis. A user preference has been added to allow you to override this default and instead reverse axes for slots that have this type of configuration. An example of this axis switch is shown in the two plots below. The left plot is the standard plot, the right plot is switched using the new setting.

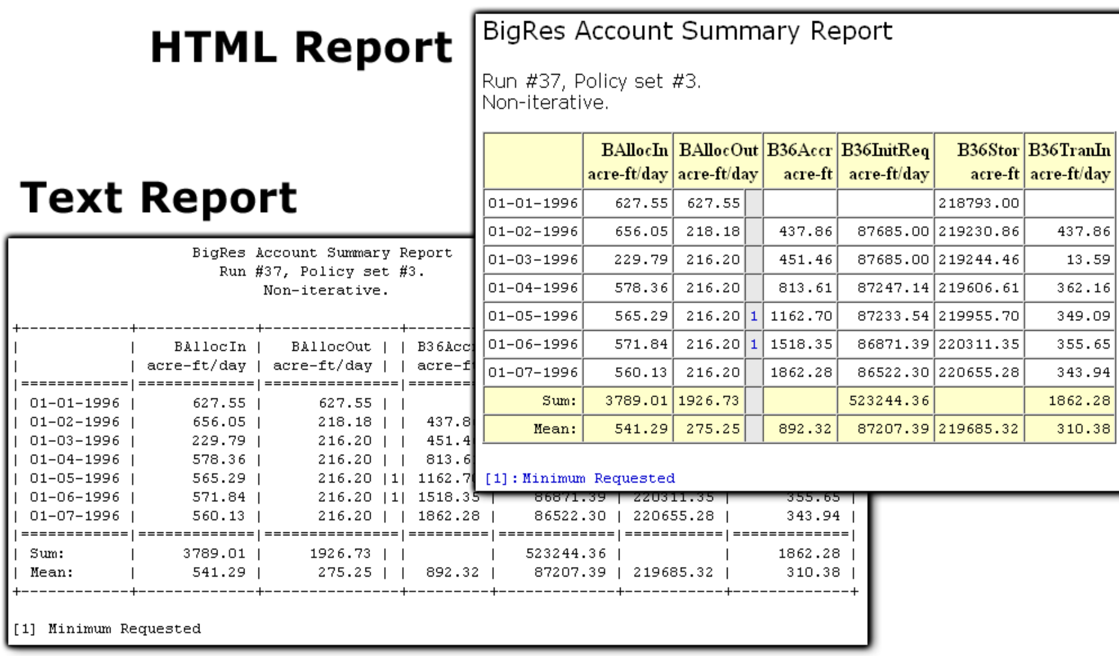


For more information click **HERE (Output.pdf, Section 2.3.4.3)**

9.2 Tabular Series Slot Report device

A new output device was added to the Output Manager. The Tabular Series Slot Report generates a plain text or HTML document showing, in a table or multiple tables, values for a set of series slots. The data for each series slot is displayed in one column of the table. A sample is shown below.

For more information, click **HERE (Output.pdf, Section 3)**.



BigRes Account Summary Report

Run #37, Policy set #3.
Non-iterative.

	BAllocIn acre-ft/day	BAllocOut acre-ft/day		B36Accr acre-ft	B36InitReq acre-ft/day	B36Stor acre-ft	B36TranIn acre-ft/day
01-01-1996	627.55	627.55				218793.00	
01-02-1996	656.05	218.18		437.86	87685.00	219230.86	437.86
01-03-1996	229.79	216.20		451.46	87685.00	219244.46	13.59
01-04-1996	578.36	216.20		813.61	87247.14	219606.61	362.16
01-05-1996	565.29	216.20	1	1162.70	87233.54	219955.70	349.09
01-06-1996	571.84	216.20	1	1518.35	86871.39	220311.35	355.65
01-07-1996	560.13	216.20		1862.28	86522.30	220655.28	343.94
Sum:	3789.01	1926.73			523244.36		1862.28
Mean:	541.29	275.25		892.32	87207.39	219685.32	310.38

[1]: Minimum Requested

10. RiverWare Policy Language

10.1 Agenda order is not always shown

The agenda order (3,2,1... or 1,2,3...) is only applicable for RBS rulesets, iterative MRM, and optimization goal sets. Thus, a change was made so that the other sets (expression slot sets, accounting method sets, and global function sets) do not even show this setting using the **View ➥ Show Advanced Properties**. Also, for optimization goal sets, the agenda order is shown but must always execute in the 1,2,3... order; it cannot be changed.

10.2 Enabled/Disabled Expressions

The display of disabled expressions within RPL dialogs was changed to be cross hatched instead of using a solid color. You can change the color of the cross hatching (and all other display colors) in the RPL Layout dialog, **HERE (RPLUserInterface.pdf, Section 6.2.2)**. Also, the semantics of enabling or disabling an expression was modified. Now the toggle menu says “Enabled”; it has a check mark when enabled and no check mark when disabled.

10.3 IsInput Predefined Function

The RPL predefined function IsInput(slot, datetime) now will return false if the slot[datetime] is NaN.

10.4 Performance

An improvement was made to the caching of RPL expression values during initialization of a run. This improves evaluation time especially for expression slots evaluating at the beginning of the run that call the group of RPL functions that includes SumObjectsAggregatedOverTime, MaxObjectsAggregatedOverTime, etc.

10.5 Re-implementation of the List of Rules, Methods, Goals

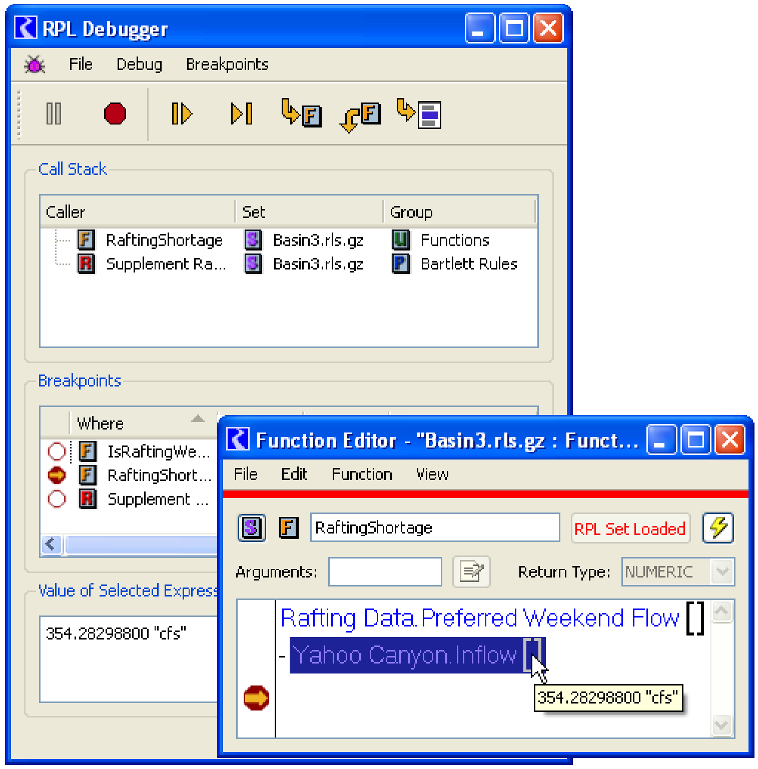
In RPL sets, the list of blocks (rules, methods, goals) was re-implemented. The following functionality was added:

- Optionally show statements in the tree-view
- Copy/paste uses the system clipboard
- Drag and Drop is more intuitive:
  - Drag/Drop between two sets is a copy/paste operation, Drag/Drop within a set is a cut/paste operation
  - Dropping an item will append it after that location where it is dropped.

For more information click **HERE (RPLUserInterface.pdf, Section 1.6.1)**.

10.6 RPL Debugging

A fully functional RPL debugger was added. Now you can pause RPL execution, look at the values of RPL expressions as they are evaluated, and step through RPL execution. A screenshot of this utility is shown while the run was paused in the RPL function to the right. For more information, click **HERE (RPLDebugging.pdf, Section 2)**.



10.7 RPL Diagnostics units

For diagnostics that print RPL values and for the RPL debugger, it is now possible to show numeric values in the units specified in the Resource Database (riverwareDB) file. A toggle “User Resource Database Units for Diagnostics” was added to the RPL Parameters. Click **HERE (RPLDebugging.pdf, Section 3.1)** for more information.

10.8 Save loaded RBS set with model

It is now possible to save the loaded RBS Ruleset and/or the Optimization Goal Set with the model file instead of in a separate file. This behavior is controlled through a setting in the Run Control, **View ➥ Optimization/Rulebased Simulation Run Parameters** dialog.

The toggle **Save Loaded RPL Set with Model** controls where the set is saved. By default, this toggle is **OFF** meaning the set is saved in a file external to the model. Checking it **ON** will save the **Loaded** set with the model file. When a model file has this toggle ON and it is opened, the RPL set is loaded and then minimized (iconified).

For more information click **HERE (RPLUserInterface.pdf, Section 1.3)**.

11. Run Control

11.1 Order of controllers

In the run control dialog, the list of controllers was re-ordered as follows:

- Simulation
- Optimization
- Rulebased Simulation
- Post-Simulation Accounting
- Inline Simulation and Accounting
- Inline Rulebased Simulation and Accounting

11.2 Pause before Timestep

In the Run Control dialog, a toggle and datetime spinner were added to allow you to run, but pause before the specified timestep. This was added for debugging purposes. For more information, click **HERE** **(RunControl.pdf, Section 5)**

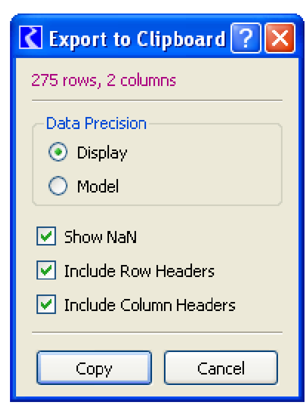
12. SCT

12.1 Copy Slot lists from SCT to Output Device config

From the SCT, you can now copy one or more selected slots to RiverWare's slot clipboard. From the slot clipboard you can paste the list of slots to various places such as the Output Device slot lists and the Snapshot Manager slot list.

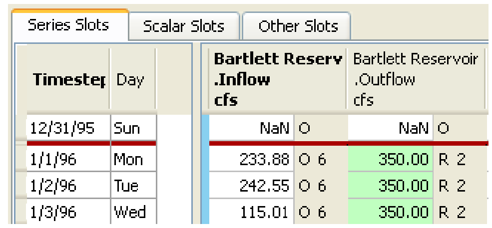
12.2 Export Copy optionally includes Column Headers

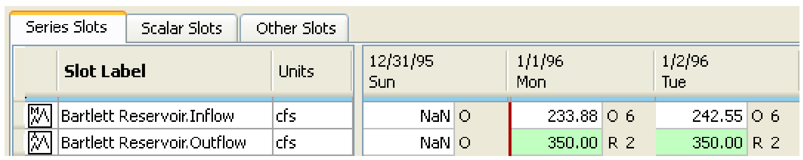
When you perform an **Export Copy** (**Edit ➥ Export Copy...**) from the SCT, you now have the option to include **Column Headers** along with **Row Headers**. In the SCT vertical timestep mode, the column headers include the slot/label and units. In horizontal timestep mode, the column headers include the timestep and weekday. For more information click **HERE** **(SCT.pdf, Section 9.11)**



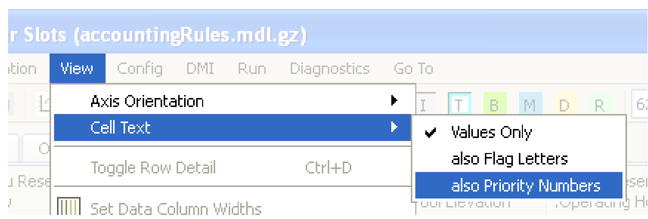
12.3 Flag letters and Rule Priority numbers

Previously on the SCT, series slot flag states were indicated only by background cell colors. Now, the user has the option of showing a flag letter and RPL priority numbers in addition to background color. Screenshots show this for both orientations of the SCT.





This option is contorlled through the **View ➥ Cell Text** menu. For more information, click **HERE (SCT.pdf, Section 2.5)**

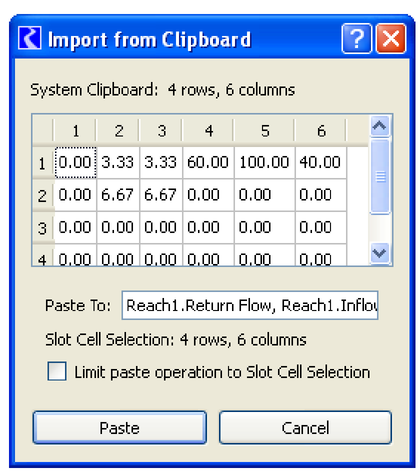


12.4 Four Hour Dividers

It is now possible to add four hour dividers (after 24:00, 4:00, 8:00, 12:00, 16:00, and 20:00) to an SCT in both axis configurations. This is configured in the **SCT Configuration Horz Time** or **Vert Time** tab (depending on axis configuration). Then the color of the divider can be set in the **Color** tab

12.5 Import Paste

Two dimensional import paste is now supported to the SCT. You can copy a table of data from Excel or another application and then **Import Paste (Edit ➥ Import Paste...**) the values. A dialog (shown to the right) displays the data that will be imported and provides options on how the import should perform.



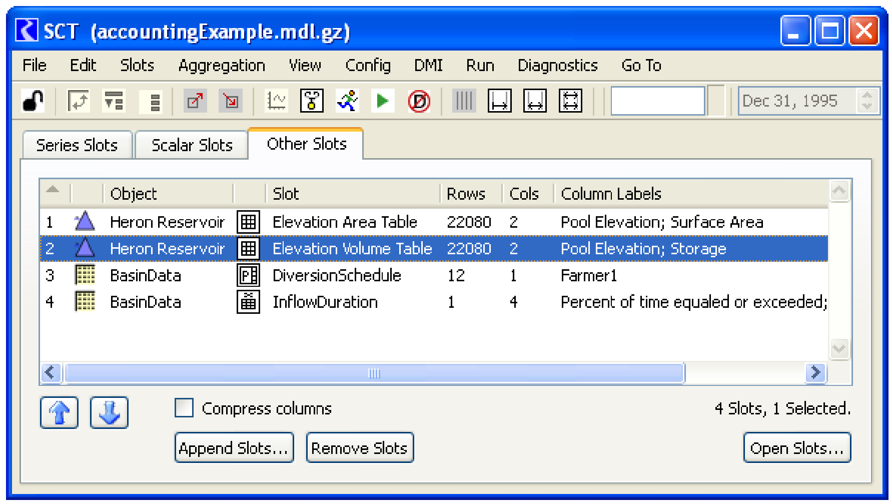
12.6 SCT on abort

When a run aborts, the SCT no longer automatically scrolls to the abort operation's "context" timestep. The option to "Time Scroll" is still available to mimic the previous behavior.

12.7 Table Slots Column Labels

On the SCT, the **Other Slots** tab now lists, for Table Slots, the

- number of rows
- number of columns and
- the Column Labels.



13. Selector

13.1 Integer Indexed Slot Filter

In the slot Selector, there is a new filter option for finding integer indexed slots. This option, **Integer Indexed Slots,** is available in the **Slot Type** filter.

14. Simulation Objects

14.1 Power Reservoirs

14.1.1 Unit Power allows negative unit energy

On the power reservoirs, the Unit Power method was modified to allow the user to set (via input or rules) negative Unit Energy values to represent times when the unit is consuming energy. In this case, the Unit Turbine Release is set to zero.

14.2 Reservoirs

14.2.1 Conversion of series slots to Periodic

On the reservoirs, the following slots were converted from Series Slots to Periodic Slots:

- Irrigated Area Loss Rate

- K Factor
- Meadow Area Loss Rate
- Pan Ice Switch

When you first load your model, if you are using these slots, a series of warning message will be posted to diagnostics, for example:

```
"SLOT: Reservoir.K Factor: Trying to convert former slot type ("SeriesSlot") to
   new slot type ("PeriodicSlot")."
```

You must re-entered the data into these slots where applicable. This is especially true for the Pan Ice Switch; previously, the value would default to 0 if not input, now the value MUST be input. A single 0.0 in the periodic slot is sufficient if only 0 is required.

14.2.2 Periodic Net Evaporation Method

A new evaporation method, Periodic Net Evaporation was added to the reservoirs' Evaporation and Precipitation category. Periodic Net Evaporation computes the gross evaporation from the reservoir and then subtracts out components of evaporation that would have occurred if the reservoir had not been built. This is the net evaporation and is set in the **Evaporation** slot. Each area of the submerged reservoir is separate including: river, streamside, terrace, and any remaining areas.

14.2.3 Single Value Seepage method

A new seepage method, Single Value Seepage, was added to the reservoirs' Seepage Calc category. The Single Seepage Value method sets the seepage through the face of the dam equal to a scalar value.

For more information, click **HERE (Objects.pdf, Section 24.1.24.4)**.

14.3 Reach

14.3.1 Pan Evaporation method

A new method, Pan Evaporation, was added to the reach's Evaporation Calculation category. This method models evaporation based on the pan evaporation rate, the surface area of the reach and a pan evaporation coefficient.

For more information, click **HERE (Objects.pdf, Section 22.1.19.3)**.

14.3.2 Reach Seepage

In the Head Based Seepage and One Timestep Seepage Lag methods, positive seepage is limited to be less than or equal to the inflow to the reach. A bug occurred when the reach re-dispatched with a larger inflow. The seepage was not reverting to its original value, but was using the constrained value. A slot "Seepage from Previous Timestep Conditions" was added to hold the lagged seepage. Then, the seepage is reset to this value when necessary.

14.4 Groundwater Storage - Evaporation category and methods

A new category, Evaporation, was added to the groundwater storage object.

This category contains two methods: No Evaporation and Wetted Sand Evaporation. No Evaporation is the default method and performs no calculations. The Wetted Sand Evaporation method computes the evaporation that occurs from the wetted sand of the shallow groundwater.

For more information, click **HERE (Objects.pdf, Section 14.1.11)**.

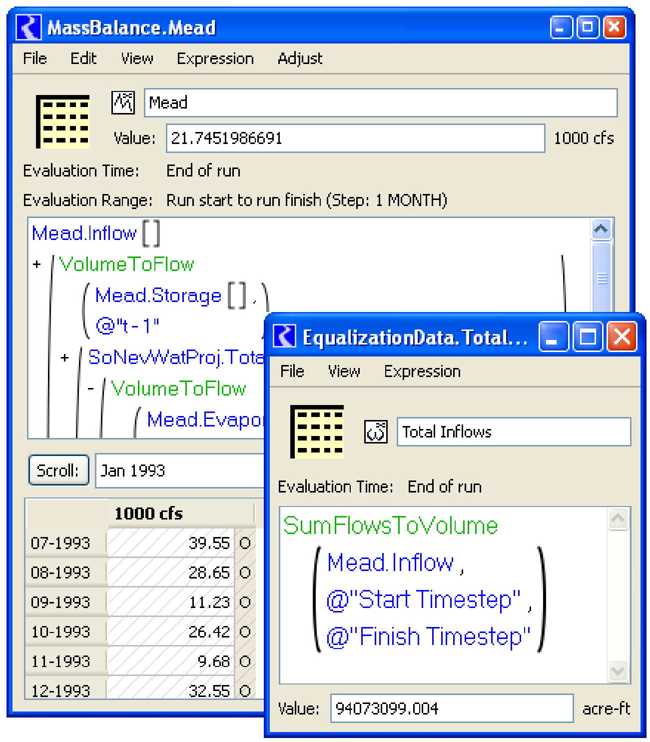
15. Slots

15.1 Expression Slot Re-implementation

Both Series and Scalar Expression slots were re-implemented to support more functionality including:

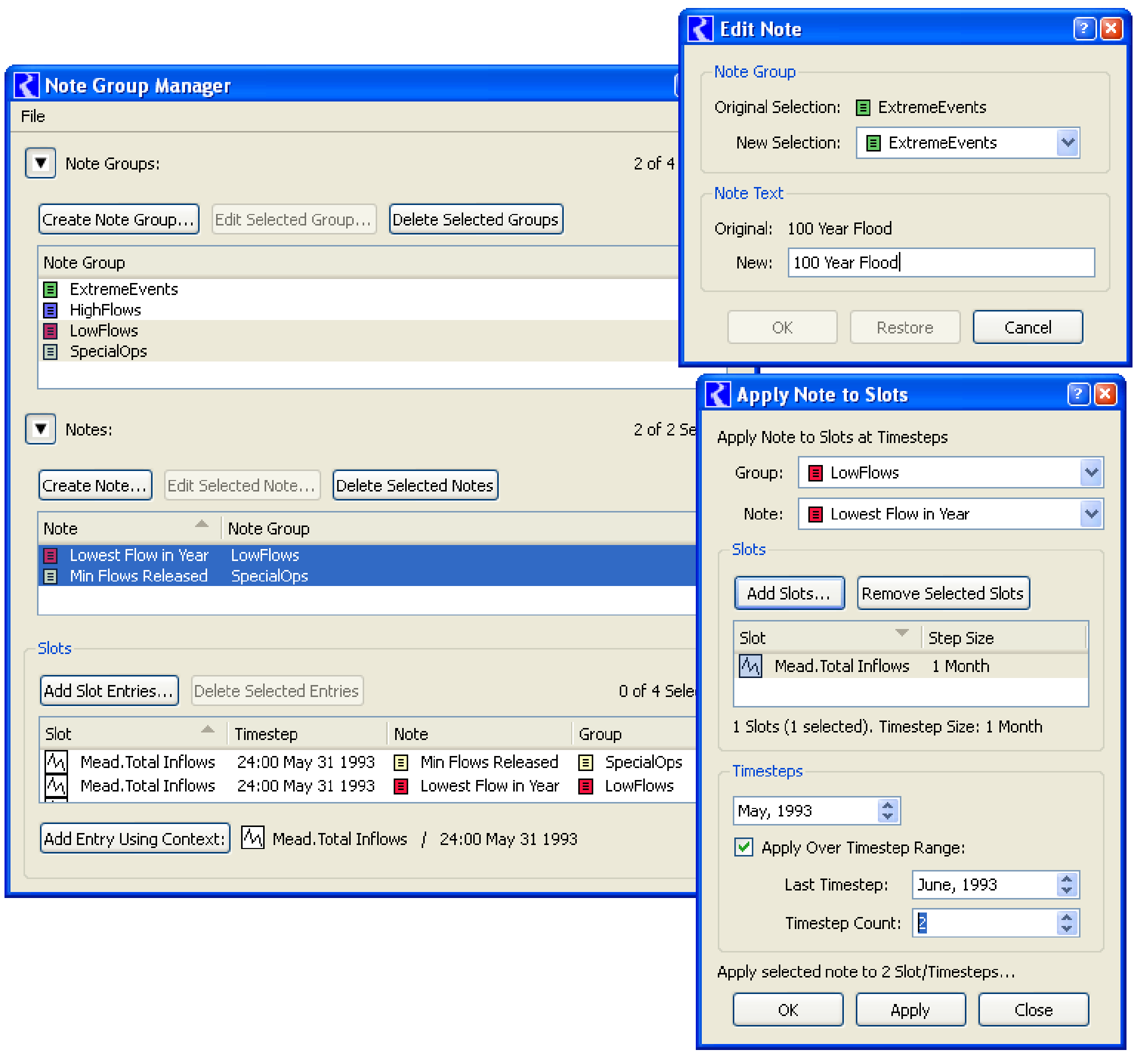
- Copying values
- Scrolling to a date
- Compressing values
- Showing Notes
- RPL debugging

In addition, the dialog layout and a few menus were re-arranged. Also, by default, the RPL expression is now shown.



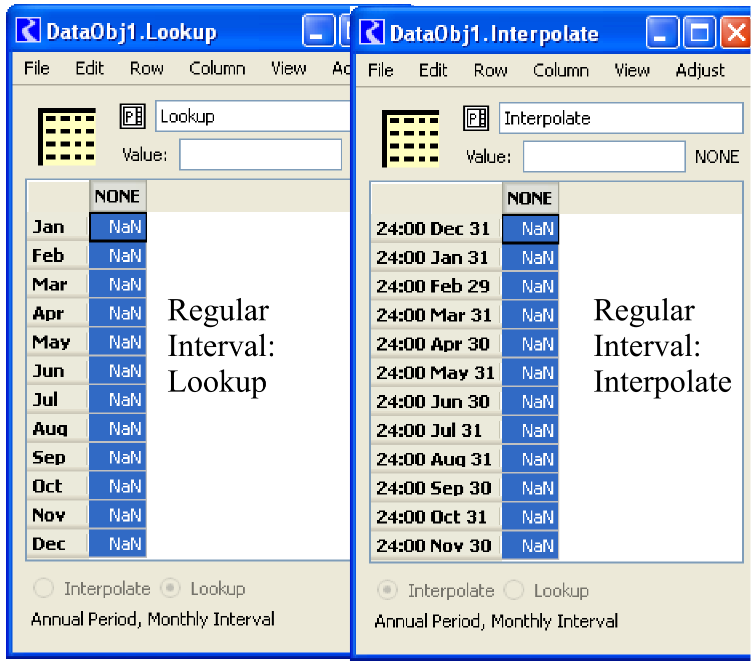
15.2 Notes on Series Slots re-implementation

Notes on series slots were re-implemented. Notes, still organized within Note Groups, are now directly applied to individual series slot timesteps rather than by associating their containing Note Groups with whole series slots. Additionally, multiple notes can be associated with a timestep on an individual series slot. The note manager dialogs were re-designed; some samples of the dialogs are shown in the screenshot. Click **HERE (Slots.pdf, Section 6)** for more information on this utility.



15.3 Periodic Slot - Regular interval row headers

The display of row headings on periodic slots configured with a **regular interval** have been changed. For example, when added to a data object, the default **Lookup** and **Interpolate** slots are:

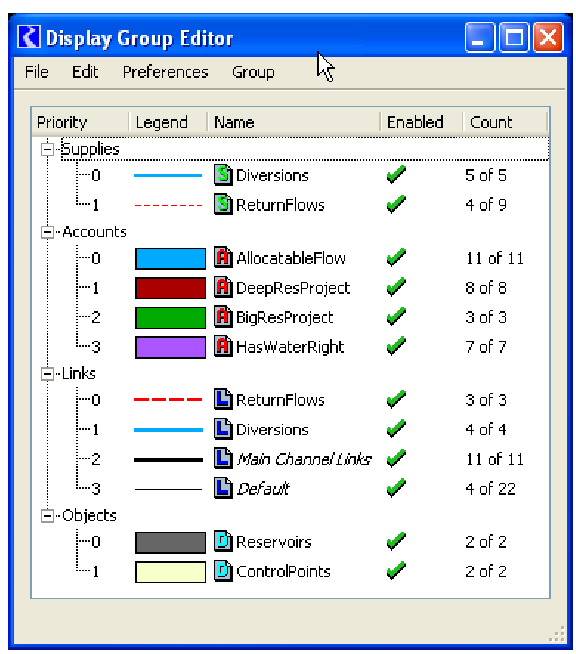


Note, this only applies to Regular Interval periodic slots; irregular interval slots have not been changed. For more information on periodic slots, click **HERE (Slots.pdf, Section 4.12.1.1)**.

16. Workspace

16.1 Display Group Editor dialog

The Display Group Editor was improved with changes to the display of the Legend lines and colors. Also, a column was added that shows a count of the active items in each group.



16.2 Font and Text Size

The ability to globally set the dialog font and text size was added. Use the **Utilities ➥ Windows ➥ Set Font** menu to access the font chooser dialog. This font will apply to all dialog menus, lists, buttons, and other text. There are few limitations with this feature:

- The font setting is only changed during a single RiverWare session. It does not persist between sessions.
- The font setting does not affect the workspace font size, existing SCTs, or RPL expressions.
- Different fonts seem to work well in RiverWare if they are reasonably sized but some dialogs don't display extreme-sized fonts.

16.3 Loaded RBS ruleset and Opt Goal set buttons added to workspace

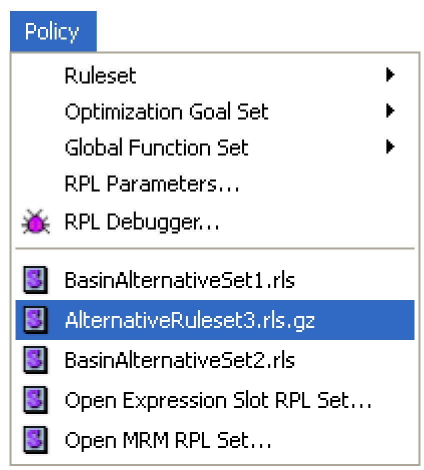
The workspace now has buttons on the bottom of the dialog to show the loaded RBS ruleset 

or optimization goal set 

. The bar is red when there is a loaded set, grey when there isn't. Clicking the button (when red) brings that loaded set to the front.

16.4 Policy menu reorganized

On the workspace, the **Policy** menu was re-organized as shown in the screenshot to the right. Now, the name of any opened set (and any set saved with the model) is added to the bottom of the menu as shown. Only the short name is shown in the menu, but the full path is shown in the workspace status bar.



16.5 Links in status bar

When you mouse over a link in either the Simulation or Accounting View, a tool tip shows the name of the link(s). Now, the name is also shown in the workspace status bar (lower left corner). If there are multiple links, only the first one is shown.

17. Closed Bug Reports

The following bugs have been closed for this release. For more information on any bug, see the CADSWES website. The bugs are listed in order by bug number:

700	957	981	1146	1151	1176	1199	123
1	1258	1265	1267	1269	1477	1520	167
5	1765	1942	1992	2157	2161	2284	234
5	2418	2497	2518	2554	2555	2680	284
6	2929	3100	3225	3248	3270	3374	339
0	3391	3414	3425	3481	3501	3510	351
4	3523	3536	3550	3603	3604	3650	366
1	3666	3673	3687	3696	3702	3708	370
9	3737	3739	3752	3755	3756	3759	376
0	3761	3779	3802	3806	3810	3837	384
0	3847	3875	3903	3925	3944	3945	398
9	4146	4152	4153	4210	4279	4288	432
0	4355	4358	4395	4412	4446	4457	446
1	4463	4471	4518	4528	4544	4549	461
6	4623	4625	4654	4659	4667	4669	469
7	4699	4712	4729	4732	4736	4738	474
1	4743	4745	4747	4748	4749	4750	475
1	4752	4753	4754	4755	4756	4757	475
8	4761	4762	4763	4764	4766	4767	476
8	4769	4770	4771	4772	4774	4775	477
6	4778	4784	4785	4787	4788	4789	479
0	4791	4793	4794	4795	4796	4797	479
9	4800	4801	4802	4803	4804	4806	480
7	4808	4809	4810	4811	4812	4813	481
6	4817	4818	4819	4820	4821	4822	482
3	4825	4826	4827	4828	4831	4832	483
5							

Release Notes Version 6.0

1. Special Attention Notes

Following are special attention notes, indicating that:

- Functionality has changed that requires you to update models, or
- Results may differ

If you have any questions, please contact riverware-support@colorado.edu

1.1 Accounting - Water Rights Solver Does Not default Slot Inflows to Zero

The computational subbasin Prior Appropriation method (in the Water Rights Allocation category) was changed to no longer set Slot Inflows to zero at the beginning of run. The introduction of user specified execution times for Object Level Accounting Methods (OLAMs) makes this automatic setting unnecessary and undesired.

Click **HERE (Section 2.3.2)** for more information on the model changes necessary.

1.2 Accounting - Instream Flow Reference Level Removed from OLAMs

The category Instream Flow Reference Level on the control point was incorrectly implemented as an Object Level Accounting Method. It has been converted to a normal method category. If you had user-defined methods in this category, they will be deleted when loading the model in 6.0. Please move them to another category or re-implement them as necessary in RiverWare 5.2.10 before moving to 6.0

2. Accounting

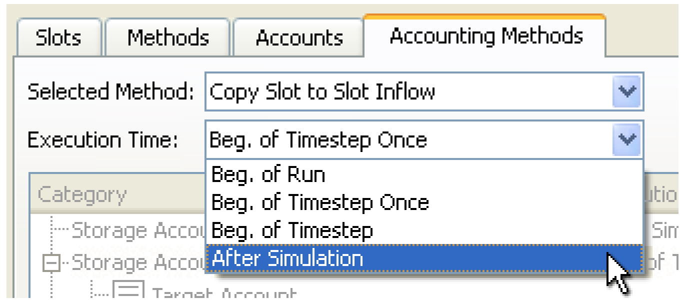
2.1 Object Level Accounting Methods

2.1.1 Execution Times Are User Selectable

You are now able to specify when Object Level Accounting Methods (OLAMs) execute. The choices are:

- **Beg. of Run:** Execute once at the beginning of the run.
- **Beg. of Timestep Once:** Execute once at the beginning of the timestep.
- **Beg. of Timestep:** Execute at the beginning of the timestep and as dependencies change.
- **After Simulation:** Execute after each timestep's simulation is complete and as dependencies change.

To facilitate the selection of the execution time, the Accounting Methods are now displayed in a separate “Accounting Methods” tab on the Open Object dialog.



2.1.2 Copy Slot to Slot Inflow Method Added

A new compiled OLAM has been added to Reaches, Control Points, and Reservoirs. The **Copy Slot to Slot Inflows** method copies the object’s local inflow to the target account’s **Slot Inflow** and sets the other accounts’ **Slot Inflow** to zero. The target account is specified in a list slot called **Target Account**. Click **HERE (, Section)** for more information.

2.1.3 Multi Object Method Selector Enhanced

The multi-object method selector was enhanced to allow you to better select OLAMs. Now the OLAM categories are shaded grey. From the multi-object method selector, you can also set the OLAM execution time and for the **Copy Slot to Slot Inflow** method, you can set the Target Account for many objects at once. Click **HERE (ObjectDialogs.pdf, Section 4.11)** for more information.

2.1.4 Category Name Changes

The default category/policy group names for the object level accounting methods were changed as shown in the following table. If you customized the name of any of these, they will be changed back to the default.

Old Category Name	New Category Name
Bifurcation PassThrough Slot Inflow	Bifurcation Account Slot Inflow
Agg Diversion Reconciliation	Agg Diversion Account Reconciliation
Confl PassThrough Slot Inflow	Confluence Account Slot Inflow
Pipe Junction Pass Through Slot Inflow	Pipe Junction Account Slot Inflow
Pipe PassThrough Slot Inflow	Pipeline Account Slot Inflow
Inline Pump Pass Through Slot Inflow	Inline Pump Account Slot Inflow
DistributionCanal PassThrough Slot Inflow	Distribution Canal Account Slot Inflow
Storage Account Slot Inflow	Reservoir Account Slot Inflow
Storage Account Gain Loss	Reservoir Account Gain Loss
Reservoir Reconciliation	Reservoir Account Reconciliation
Control Point Pass Through Slot Inflow	Control Point Account Slot Inflow
Water User Reconciliation	Water User Account Reconciliation
Gage PassThrough Slot Inflow	Stream Gage Account Slot Inflow

Old Category Name	New Category Name
Reach PassThrough Slot Inflow	Reach Account Slot Inflow
Pass Through Acct Gain Loss	Reach Account Gain Loss

2.1.5 Diversion Object Account Slot Inflow

A new category on the diversion object and OLAM policy group was added: "Diversion Object Account Slot Inflow". Two compiled methods are available from the Diversion Object's Accounting Methods tab: **No Method** and **Zero Slot Inflows**. Click HERE (, Section) for more information

2.1.6 Instream Flow Reference Level Removed

The category Instream Flow Reference Level on the control point was incorrectly implemented as an Object Level Accounting Method. It has been converted to a normal method category. If you had user-defined methods in this category, they will be deleted when loading the model in 6.0. Please move them to another category or re-implement them as necessary in RiverWare 5.2.10 before moving to 6.0

2.2 Supplies

2.2.1 Supplies Manager - Double Click on Supply Opens Supply Editor

In the **Supplies Manager**, double clicking a supply opens the **Edit Supply** dialog where you can rename and configure that supply. Previously, this operation opened the **Edit Account** dialog for the destination account.

2.2.2 Supplies Manager - Copy List to Clipboard

In the Supplies Manager, the menu operation **File ➥ Copy List to Clipboard** copies a "tabular" string representation of the currently displayed supply list to the System Clipboard. Fields are delimited with tab characters and lines are delimited with new line characters -- suitable for importing into a spreadsheet, such as Microsoft Excel.

2.2.3 Supply Name Format

You can now specify the format for supply names in the **Supply Name Format** dialog. Once configured, the supply name format is used for all new supply names. Also, you can apply that format to one or more existing supply names in the **Supplies Manager**. Click HERE (, Section) for more information.

2.3 Water Rights Accounting

2.3.1 Performance improvement

In the accounting system, the SolveWaterRights and SolveWaterRightsWithLags RPL predefined functions were copying more values than necessary. Now, the function copies values in the range: [current timestep, current timestep + maximum subbasin lag] This change can have a large impact on performance. For example, it led to a 30% decrease in total run time for the 5 year daily model used to test this change.

2.3.2 Prior Appropriation No Longer Sets Zeros For Unknown Slot Inflows

The computational subbasin Prior Appropriation method (in the Water Rights Allocation category) was changed to no longer set Slot Inflows to zero at the beginning of run. The introduction of user specified execution times for Object Level Accounting Methods (OLAMs) makes this automatic setting unnecessary and undesired.

To **reproduce** previous results you need to select the Zero Slot Inflows method on each object in the subbasin and ensure that it is set to execute at Beginning of Run (default for this method). You can use the Multi-Object Method Selector to perform this selection on many objects of the same type.

You may also wish to consider using the new **Copy Slot to Slot Inflow** method (Reservoirs, Reaches, Control Points) which can be used to automatically copy local inflows into the allocatable flow's slot inflow at the beginning of run or beginning of timestep. This prevents having to input or set via rules these values on the Slot Inflows.

One note, currently, most OLAMs, (including Zero Slot Inflows and Copy Slot to Slot Inflows) will fail (and stop the run) if it attempts to overwrite an INPUT slot inflow. In this case, you will need to either remove the input and let the method set it or use a different method to set Slot Inflows.

2.4 Miscellaneous

2.4.1 Accounting Period Must Encompass Run

Accounting period can be changed so that it doesn't cover the run period for a single run, causing inconsistencies when the model is run more than once. A check was added and will issue an error if the accounting period does not encompass the run period.

2.4.2 Accounts Manager - Copy List to Clipboard

In the **Accounts Manager**, the menu operation **File ➥ Copy List to Clipboard** copies a "tabular" string representation of the currently displayed account list to the System Clipboard. Fields are delimited with tab characters and lines are delimited with new line characters -- suitable for importing into a spreadsheet, such as Microsoft Excel.

2.4.3 Categories Require an Accounting Controller to be Selected

The following categories are only applicable to accounting. Now, their visibility is dependent on having one of the accounting controllers selected in the Run Control dialog:

Object	Category
Computational Subbasin	Water Rights Allocation
Computational Subbasin	Account Initial Request Calculation
Control Point	Instream Flow Reference Level

No model changes are necessary.

2.4.4 Creating Multiple Supplies on the Workspace

It is now possible to create two or more supplies between the same two accounts directly from the workspace. Previously, you could only do this from the downstream account. Now, when you create a supply using the accounting view's right-click menus, if there is already a supply between the two accounts you are now presented with a confirmation dialog asking whether you wish to continue. A unique name will be generated for the new supply.

2.4.5 Lagged Return Flows At Beginning Of Run

At the beginning of the run, non-input values are cleared from accounts over the accounting period. Previously, if return flows are lagged from a Diversion Account, the timesteps prior to the accounting period are not then solved to populate the lagged return flow values that are at the beginning of the accounting period, effectively leaving a hole in the accounting data for return flows. Now, after the outputs have been cleared, the account resolves and fills in the missing lagged data at the start of the run.

3. Batch Mode and RCL

3.1 GetSlot and SetSlot Commands

The RiverWare Command Language (RCL) GetSlot and SetSlot commands were enhanced to support Scalar Slots. The commands have the following syntax:

- GetSlot {Object.Slot} [<date time>]
- SetSlot {Object.Slot} [<date time>] value

The <date time> is only required for Series Slots. Also, GetValue now returns the value in user units (it previously returned it in internal units). SetValue expects the value in user units (as before). For more information click **HERE (BatchMode.pdf, Section 4.4.7)**.

3.2 Setting Environment Variables in Batch Mode

RCL scripts can now set environment variables for use within the script and within the RiverWare run. See the Batch Mode section **HERE (BatchMode.pdf, Section 4.2)** for more details.

4. Data Management Interface

4.1 Excel DMIs Allow Environment Variable In Paths

In Excel Database DMI datasets, environment variables are now allowed in paths.

4.2 Excel Worksheet Label Length and Excel DMIs

Because Excel limits worksheet tab lengths to 31 characters, the interface for Excel Database DMI datasets was modified so that Excel worksheet tab names are limited to 31 characters. In addition, the Excel dataset execution was modified so that if slot names are in an orientation to be written to a tab, the name length is checked and if it exceeds 31 characters, the slot is not written and the user is given a message and advised to use a Name Map to map to a shorter name for writing the slot to Excel.

4.3 DMI's Executed from RPL

All input DMIs called from RPL can import values only to unlinked series slots on data objects.

Database DMIs set values and the output flag when executed from RPL. Note, input control file-executable DMIs executed from RPL still set the input flag on the imported values.

5. General RiverWare

5.1 64 bit version

A separate installation package is available for 64 bit operating systems. With this version of the executable, you are able to take advantage of the increased memory of the 64 bit system. For more information on performance and why you would need 64 bit, click **HERE (Performance.pdf, Section 4.4.1)**.

5.2 About Dialog

Additional information was added to the **Help ➥ About ➥ Show System Info** dialog regarding your license including, Type, Node-locked or Floating, and days until expiration.

5.3 Licensing

New RiverWare licenses will be created by the Reprise licensing system. Old licenses (FlexLM) will continue to work but will be replaced by CADSWES when they expire.

5.4 Model File Icon

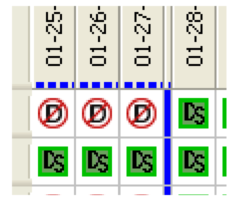
A new icon was added to describe model files. This icon is displayed where model files are listed such as the **File ➥ Reopen** menu. Further, files that end in the ".mdl" suffix will display this icon in windows explorer. Double clicking the icon will open the latest installed version of RiverWare and load that model. Because of the general nature of the ".gz" extension, this file association has not been made. In windows, you can manually associate ".gz" files with RiverWare so that RiverWare will automatically open when you double click a ".gz" file. Alternatively, you can right click on the ".gz" file and use window's "Open With" command and choose RiverWare.

5.5 RiverWare Home Environment Variable

On windows, the RiverWare installation setup file no longer sets the RIVERWARE_HOME_XXX environment variable. The relevant information is now automatically determined at run time. Other applications that explicitly access this variable should be modified.

6. Model Run Analysis

6.1 Pre-simulation Timestep Separator



On the Model Run Analysis grid, a separator was added to distinguish pre-simulation timesteps from simulation timesteps. A solid blue divider line separates the initial and start timestep. Also, timesteps before the start time are denoted with a blue dotted line in their timestep label cell. See the screenshot to the right for a sample.

6.2 Miscellaneous Changes

Following are miscellaneous changes to this dialog:

- A view menu was added to the Dispatch Detail dialog when detached. This was done in order to provide two new menu actions with accelerators: **Show Methods Tab** (Ctrl+M) and **Show Slots Tab** (Ctrl+S).
- **Enable / Disable Dispatching** is now supported on selections of multiple objects.
- Performance is improved for certain operations including re-ordering when rows or columns are selected.
- An hourglass cursor is shown during slow operations like ordering columns with a large number of objects or timesteps.

7. Multiple Run Management

7.1 Iterative MRM configuration

For iterative MRM runs, the rules executed before the first run were renamed “Pre-MRM Run Rules” while the rules executed after each run have were renamed “Post-Run Rules”. This was done to avoid confusion between these rules and the new Initialization Rules **HERE (Section 11.3)**.

7.2 MRM Controller - Removed Two Tier Editing

Editing of MRM configurations was modified to no longer have two tiered user confirmation. The apply (green check) and cancel (red x) buttons have been removed from the multiple run control dialog. When you click **OK** or **Apply** in the MRM configuration dialog, the edits are immediately applied.

8. Optimization

8.1 CPLEX version

RiverWare was upgraded to use CPLEX 12.2.

8.2 Optimization Diagnostics

The Diagnostics Manager dialog was modified to give you control over optimization diagnostics. The previously disabled **Optimization** button was removed while an **Enable All Optimization Diagnostics** toggle was added. When checked, this gives you all optimization diagnostics.

8.3 Optimization Parameters

8.3.1 Location of Non-default Parameters

All non-default settings of optimization parameters are now saved in the model file. As a result, the "Save non-default settings to parameter file" checkbox was removed from the "Set Optimization Solver Parameters" dialog. Further, RiverWare no longer makes use of the following files:

- cplex.par
- goals.par
- cplex.init.par
- goals.init.par

If you had been using one of the override files, cplex.init.par or goals.init.par in the optimization working directory, and want to continue to use these non-default values with a given model (we don't expect this to be the case), then you will need to load the model, interactively set parameters to non-default values as necessary, then save the model.

8.3.2 New Optimization Parameters

The following new Optimization “goal” parameters were added:

- SATISFACTION VAR OBJECTIVE COEFF: This value is used as the coefficient in objectives expressions for derived objectives (single minimax, repeated minimax, and summation). For minimax objectives, the objective expression is:

  a * x

  where a is the satisfaction variable coefficient and x is the satisfaction variable. For summation objectives, the objective expression is:

  (a * x_1) + (a * x_2) + ... + (a * x_n)

  where a is the satisfaction variable coefficient and x_i is the satisfaction variable associated with the i'th soft constraint.
- FRESH BASIS_FREQUENCY: This integer parameter controls how often the solver starts with a fresh basis when solving an optimization

problem. If the number of variables frozen since the last fresh basis is greater than this parameter's value, then the solver discards the basis before solving the problem again. The default value is 100.

8.4 Miscellaneous

Following are miscellaneous changes to the optimization solution:

- For SUMMATION objectives, the solution's objective value is now reported in the diagnostics as average percent satisfied, e.g.:

  "SUMMATION constraints are on average 99.9% satisfied."
- Similarly, the Run Status dialog display of the Objective Value is now the average percent satisfied, whereas previously it was the raw objective value.
- Raised the maximum value to which integer values may be set from 16777215 to 2147483647 and lowered the minimum from -16777215 to -2147483647.
- To improve numerical stability and performance, additional freezing is done when a minimax objective is fully satisfied.

9. Performance

Performance improvements to RPL are described **HERE (Section 11.5)**. Performance improvements to water right accounting are described **HERE (Section 2.3.1)**. Following are general performance improvements:

9.1 Run Time Reduced with Dialogs Open

When you have many slot or account dialogs open, the run can slow down as these update. Now, the dialogs are only updated every 0.8 seconds while running and 0.1 seconds while not-running. This improves the performance of runs with slot dialogs open, especially accounting models. In one accounting model, having one **Edit Account** dialog open would run in 30 seconds while it ran in only 11 seconds when the dialog was closed. Now the run takes 12 seconds if you have the dialog open.

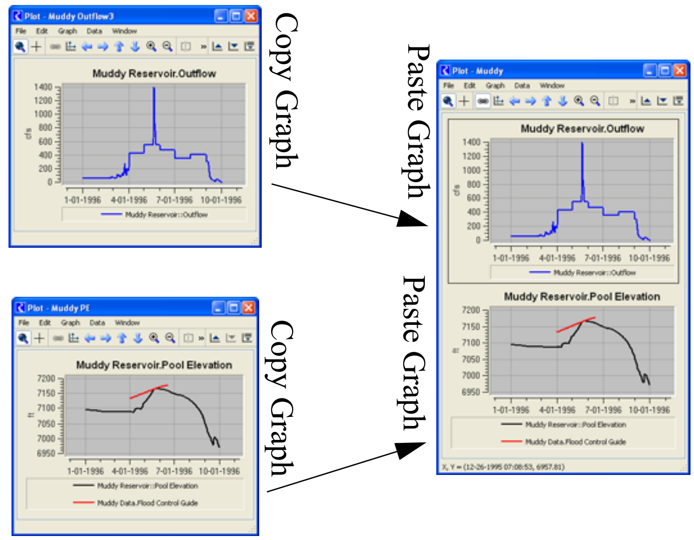
9.2 String Re-implementation Improvements

The representation of strings within RiverWare was re-implemented. In the course of this work, performance improvements were made. In one large test model that had a lot of list processing and lists of strings, there was a 24% decrease in run time. Another model showed about 10% reduction in run time.

10. Plotting and Output

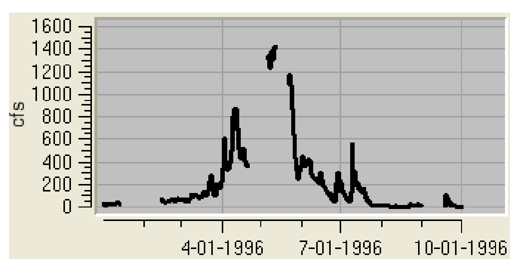
10.1 Copy / Paste of Graphs

A **Copy Graph** and **Paste Graph** feature was added to allow you to move graphs (i.e. individual plots) amongst layouts. The **Graph ➥ Copy Graph** menu allows you to copy the selected graph to the plotting clipboard and then **Graph ➥ Paste Graph** menu allows you to paste that graph to a new location. These two menus allow you to quickly combine or separate multi-layout graphs. For example, you may have two great 1X1 plots configured as desired. Now you wish to combine those into a 2X1 graph so that you can see them on a linked x axis. Select a 1X1 graph and copy it. Then create a new 2X1 graph and paste the first graph onto one of the empty graphs. Repeat the copy for the second graph and then paste it into the empty graph in the 2X1 layout.



10.2 NaNs in Plots

NaNs within a data series were plotted misleadingly. NaNs are now represented as a gap in the plot curve.

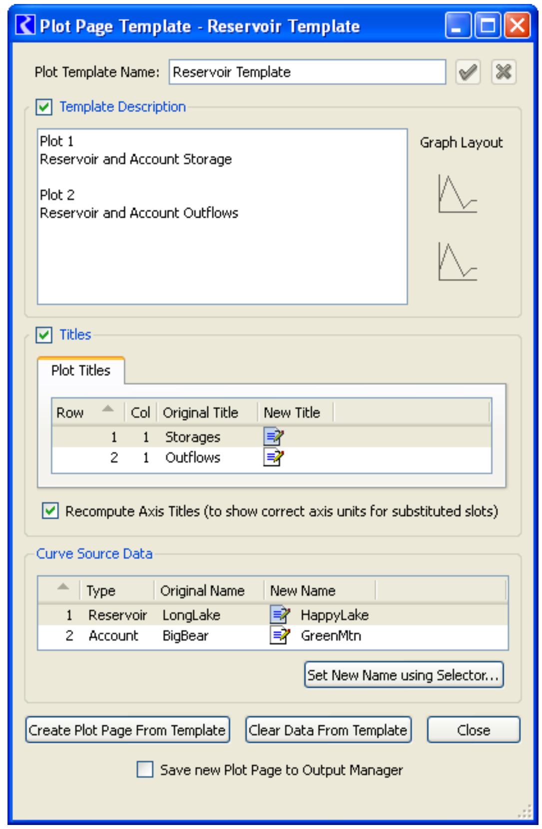


10.3 Open Slot from a Plot

You can now open a slot directly from a plot. Click on the curve legend and choose **Open Slot(s)...**

10.4 Plot Templates

A new "Plot Template" device was added to the output manager. This utility allows you to:



- Create and configure a plot
- Save as a template where you specify the pieces of data you wish to be editable in that template
- Apply the template by substituting new data to generate the plot

The plot template utility is described **HERE (Output.pdf, Section 2.6)**.

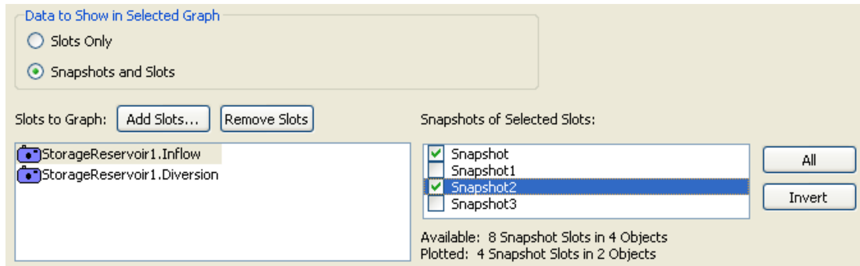
10.5 Plot Page now Allows Any Type of Slot

Any type of plot-able slot can now be added to the Slot List in the Plot Page accessible from the Output Manager. Previously, only series slots were listed. Further you can now open a slot directly from this slot list by double clicking on the slot name.

10.6 RDF Single Run Output

For the output manager's single run RDF and CDF output, the timesteps field name in the header was changed from "timesteps" to "time_steps" to match the name in MRM output as well as the documentation.

10.7 Snapshot Plots



In the plot page dialog, you can specify whether to include snapshot data in plots. Previously, this was an all or nothing operations, you either showed plots of all snapshots or none. Now, snapshot slots be shown in plots on a per-snapshot selection. This is controlled through checkable items in the snapshot selection area.

11. RiverWare Policy Language

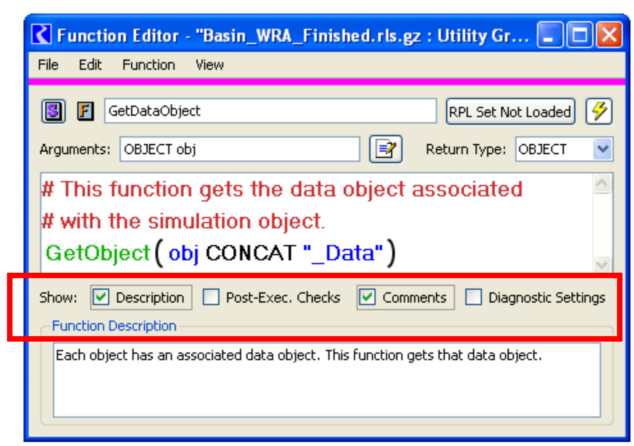
11.1 Comments within Expression

Support for inline comments within expressions was extended in several ways:

- Comments can now be shown or hidden within all dialogs displaying RPL expressions using the **View ➥ Show Comments** menu or the new checkbox described **HERE (Section 11.2)**.
- Deletion of the selected comment is now supported from the Edit menu and using the **Del** key.

11.2 Display of Optional Items

RPL editors have panels which are optionally displayed. The display of these optional dialog items are controlled via checkboxes in the **View** or **Expression** menu. For example, the Rule Editor dialog allows the user to optionally show or hide the text description associated with that rule.

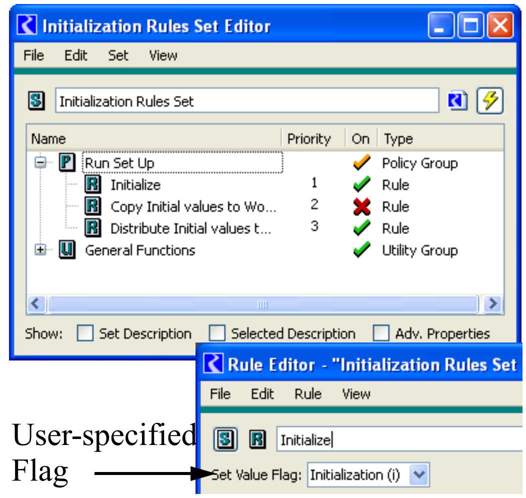


An additional row of checkboxes was added to these dialogs to provide more convenient control over the display of the most commonly viewed optional items. In addition, frames around each of these checkboxes provides a visual indication of whether or not the hidden item contains non-default content.

Click **HERE (RPLUserInterface.pdf, Section 2.2)** for additional information.

11.3 Initialization Rules

Initialization rules were added to RiverWare to allow you to execute logic to “set up” a run, set default values, or set initial conditions. Initialization rules are saved in the model file in a separate set that can be accessed from the workspace **Policy ➥ Initialization Rules**. These rules have the following properties:



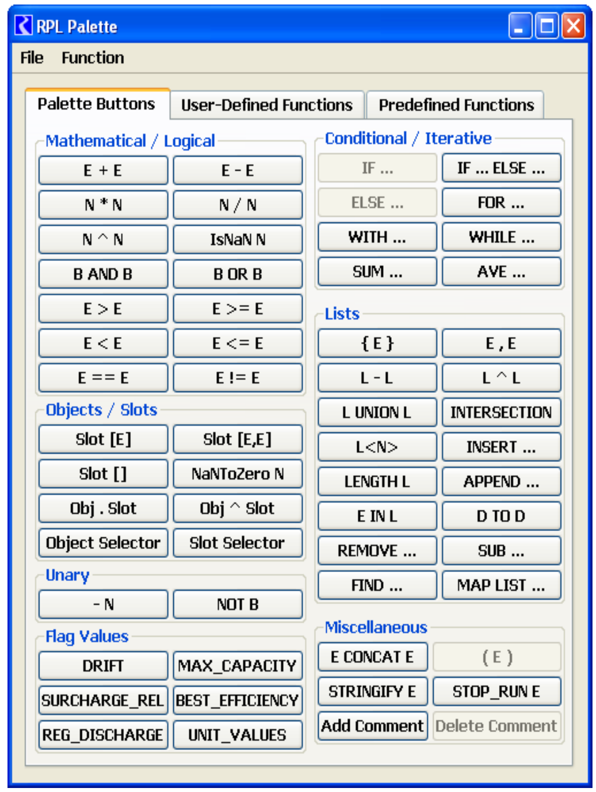
- For simulation and rulebased simulation runs, they are executed once at the beginning of the run after inputs are registered but before beginning of run data checking.
- Values set by initialization rules are given either the initialization flag “i” or the DMI input flag “Z”, based on user specification for each rule.
- There is one set per model and the set is saved in the model file.

For more information, click **HERE (Simulation.pdf, Section 5.1.2)**.

11.4 Palette

11.4.1 Button Labels and Reorganization

The palette button labels were simplified and made more consistent. The palette is shown to the right. Full documentation of the palette is provided **HERE (RPLTypesPalette.pdf, Section 2)**.



11.4.2 Equality Operators Support All Data Types

In the RiverWare Policy Language, the equality and inequality operators (== and !=) were extended to all data types including BOOLEAN, SLOT, OBJECT, and LIST. Previously, only DATETIME, NUMERIC, and STRING were supported. Expressions can now be written more efficiently. For example, the following expression checks if the looping variable res (of type OBJECT) is the object named BigRes. Previously, you would have written:

IF ((STRINGIFY res) == "BigRes")...

Now, it should be re-written:

If (res == %"BigRes") ...

This change improves the performance and readability of the expression.

11.4.3 List Access

The RPL language provides seven operators for accessing list items, one for each type which might be returned, i.e GET NUMERIC @ INDEX <num> FROM <list>, GET BOOLEAN @ INDEX <num> FROM <list>, etc... These operators were replaced with a single operator for which the type of the item being accessed remains unspecified. The new operator has the following syntax:

LIST < NUMERIC >

An example is shown to the right. In this screenshot, **triplet** is a LIST containing three items: {slot, datetime, numeric}.

This new operator has the following advantages:

- Improved readability of policy: the display of expressions involving list item access is simpler and more compact. It now more closely resembles the syntax commonly used by other programming languages for accessing sequential data.
- Improved RPL palette: the RPL palette is smaller and simpler because the seven GET buttons have been replaced by a single button. See the next section for a screenshot.

11.5 Performance

The runtime performance of the RPL Debugger was improved; in the sample model the time decreased by an order of magnitude. Although enabling the RPL Debugger will slow down most models, this improvement makes the RPL debugger much easier to use for many real applications.

General RPL performance was improved by modifying the processing of numeric values, list values and units.

11.6 Predefined functions

11.6.1 ElevationToAreaAtDate, StorageToAreaAtDate, and StorageToElevationAtDate

New predefined functions called ElevationToAreaAtDate, StorageToAreaAtDate, and StorageToElevationAtDate were added for use with the changing Elevation Volume and Elevation Area methods described **HERE (Section 13.2.1)**. These functions behave identically to the non “AtDate” versions but allow you to specify at which date the conversions should be performed. This datetime is required only when the Changing Elevation Volume / Area methods are selected.

11.6.2 Certain Date Functions no Longer Require Fully Specified Datetimes

The following predefined functions no longer require a fully specified datetime:

- GetMonth
- GetMonthAsString
- GetDayOfMonth
- GetYear

They evaluate correctly as long as they have the required information. For example, GetMonth will work if the month is specified. Thus, you can now successfully call GetMonth(@“Current Month”).

11.6.3 Iterative Hypothetical Simulation

Additional checking and warning messages were added to the hypothetical simulation predefined functions which iterate over individual hypothetical simulations to achieve a desired result. These warnings make it easier to identify when algorithmic assumptions have been violated which might affect the integrity of the results. Documentation for the group of hypothetical simulation functions was also improved.

Click **HERE (RPLPredefinedFunctions.pdf)** for additional information.

11.6.4 PercentRank and Percentile functions added

Functions to compute the "PercentRank", **HERE (RPLPredefinedFunctions.pdf, Section 151)**, and "Percentile", **HERE (RPLPredefinedFunctions.pdf, Section 150)**, were added to the RiverWare Policy Language (RPL) predefined functions.

11.6.5 Predefined Function Automatic Dependent Slots

Previous Storage is no longer registered as a dependency by getMaxOutflowGivenHW, getMaxOutflowGivenInflow, getMaxOutflowGivenStorage, getMaxReleaseGivenInflow, and getMinSpillGivenInflowRelease.

11.7 Rule Execution

When a rule encounters an invalid value during rule execution, rule execution is halted, the rule finishes ineffectively, and the rule will execute again only after one of its dependencies changes. As an alternative, a property was added to rules which allows the user to change this behavior for rules that are not expected to encounter an invalid value. When the **Stop On NaN** property has been set for a rule (using the **Rule ➥ Stop on NaN** menu), invalid values cause the simulation to halt with an error message, allowing the user to investigate the cause of the unexpected invalid value.

Click **HERE (RPLUserInterface.pdf, Section 2.2.6)** for additional information.

11.8 Sets

11.8.1 Close Dialog Versus Close Set

For RPL Set Editor dialogs, RiverWare now makes a distinction between closing the window (dialog) versus closing the set. For previous versions of RiverWare, closing a RPL set editor window also closed the set. Following is a description of the two behaviors:

Close Window: Closing a RPL Set Editor window closes the editor for the RPL set, but does not close the set itself. Closing a set window is easily reversible: selecting the appropriate item in the Workspace Policy menu will reopen the editor.

From within RiverWare, this action is initiated from the main menu of a RPL set editor by selecting **File ➥ Close Window** (Ctrl+W). This closes that window without affecting any other window.

In addition, the set editor can be closed using whatever mechanisms are provided by the operating system's window manager for closing windows. For example, Windows operating systems support closing a window when the user clicks on the red X button in the window's upper right corner.

Close Set: Closing a set removes that set from RiverWare's internal memory, and so is not easily reversible. This action is initiated from the set editor's menu by selecting File ➥ Close (and Unload) Set. The user is then presented with a confirmation dialog pointing out that unsaved changes to the set will be lost and giving them the option to cancel the operation. This behavior has not changed, though the "Ctrl+W" shortcut for this action has been removed.

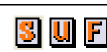
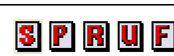
Sets that are saved within the model file can not be closed directly; to remove these sets from memory the user must clear the workspace or load a new model. Thus the only types of RPL sets which may be deleted via the RPL Set Editor's File menu are:

- RBS Rulesets (not loaded or loaded but not saved in the model)
- Optimization Goal Sets (not loaded or loaded but not saved in the model)
- Global Function Sets

Note that clearing the workspace or loading a model implicitly closes any existing sets, and in this case the user is presented with a confirmation dialog analogous to the one described above.

11.8.2 Modified Colors Of RPL Sets and Icons

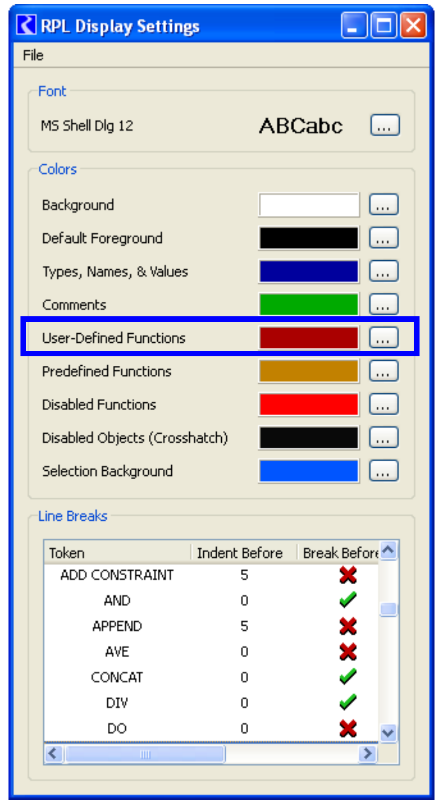
Each application of RPL now has a unique color associated with it. For those sets always saved with the model file, the icons and color bar is always the same. For RBS, Optimization and Global RPL sets, the editors associated with a single set will have the same color, but that color is different for each set. The line color for loaded RBS sets remains red (to match the icons). For the loaded optimization set's editors, the line is purple, to match the goal set icons.

RPL Set	Color	Icons
Expression Slot Set	Orange	
Global Function Set	Brown	
Initialization Rules	Teal	
Iterative MRM Ruleset	Navy Blue	
Object Level Accounting Method Set	Green	
Optimization Goal Set	Purple	
Rulebased Simulation (RBS) Ruleset	Red	

11.8.3 RPL Display Settings and Display Of User-defined Function Calls

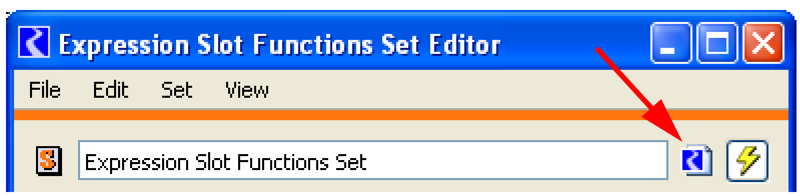
The **RPL Layout Editor** was renamed the **RPL Display Settings** dialog and was re-implemented to more intuitive and easier to use. The dialog can be accessed from the **Set ➥ Display Settings** menu on any RPL dialog. Click **HERE (RPLUserInterface.pdf, Section 6.2)** for more information.

Further, within expressions, calls to user-defined RPL functions can now be shown in a user-settable color. The color is configured in the display settings dialog shown to the right.



11.8.4 Sets Saved with Model Now Have Indicator Icon

RPL sets that are saved in the model file now have a model file icon displayed next to the title bar.



11.9 Units

When a RPL expression accesses a value on a slot, there are now several options for how the slot value is represented internally:

Type	Description	--rplslotvalunits argument
mixed	The slot's user scale and standard units. This was the original representation, the only possibility until now, and is the current **default**.	mixed
standard	A scale of 1.0 and the slot's standard units	std
user	The slot's user scale and user units, unless the units are time-varying (e.g., acre-feet/month), in which case a scale of 1.0 and standard unit is used.	user

The RPL slot value representation scheme has two primary impacts:

- Numerical accuracy of the computation - the representation scheme affects the magnitude of the RPL values and so impacts numerical accuracy. Generally speaking the greatest accuracy is expected when using values of moderate magnitude. For many models, this consideration favors the "user" representation.
- Diagnostics - Sometimes diagnostics present values in a form related to their internal representation. In most cases, this consideration favors the "user" representation.

A command line argument was added to control the RPL slot unit representation. the argument is "--rplslotvalunits" and it requires an argument as listed in the above table

Using the default “mixed” units will reproduce results in your model but you may consider using the “user” option for diagnostic and/or accuracy purposes.

The RPL unit grammar was also extended to allow parsing of the caret character to indicate "raised to the power of". This brings the input and display syntax into agreement. For example, in the past a value was displayed as"m^2" but that was not legal input; now it is.

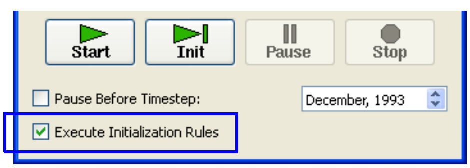
12. Run Control

12.1 Button labels

On the run control dialog, the button label was changed from **Step** to **Init**. When you click the **Init** button, the run proceeds through the initialization phase and pauses before the first timestep. Once paused, the button the says **Step** again.

12.2 Execute Initialization Rules

When there are initialization rules defined and you have either the simulation or rulebased simulation controller selected, the Run Control dialog now allows you to specify whether you wish to execute Initialization Rules. Check the box to execute the rules, uncheck the box to skip execution. SCT



13. Simulation Objects

13.1 Groundwater Storage object - Wetted Sand Evaporation

On the Groundwater Storage object, Wetted Sand Evaporation method, three slots were added to model Soil Limited Evaporation. These slots are optional inputs; without inputs, the previous functionality is used.

If the user inputs the "Soil Limited Evaporation Elevation", an alternative equation may be used if the wetted area excluded is zero (reach above flow is zero) and the previous elevation is less than the Soil Limited Evap Elevation. Then evaporation is the

Soil Limited Evap Rate * Soil Limited Evap Factor * Wetted Area.

Otherwise, the existing equation is used.

13.2 Reservoirs

13.2.1 Changing Elevation Volume and Elevation Area Methods

Functionality was added to allow the elevation vs volume and elevation vs area relationships on the storage and level power reservoir to have data that changes at various times within a run. When trying to match historical results, these methods can be used to simulate a re-survey of the reservoir bathymetry that occurs periodically. A new method, **Time Varying Elevation Volume** was added to the **Sedimentation Calculation** category. Also, a new category and method called **Surface Area Modification** and **Time Varying Elevation Area** method were added. In both of these methods, the user provides the survey date as a column header on a table. The column then represents the new data to use until the next column in the table becomes valid. For more information on using these methods, click **HERE (Objects.pdf, Section 24.1.28.3)** and **HERE (Objects.pdf, Section 24.1.29.2)**.

13.2.2 Convergence Percentage Slot

The slot Convergence Percentage is now used correctly as a percentage. This tightens up convergence in many spill computations. Some models may now abort with an error when before they did not.

13.2.3 Method and Category Name Changes

The following method and category names on the reservoir objects were changed to be more consistent:

Category	Method	New Name
SedimentCalculationCategory	N/A	Sediment Calculation
Sediment Calculation	NoSediment	None
	CRSSSedimentCalc	CRSS Sediment Calc

Category	Method	New Name
Evaporation and Precipitation	NoEvaporation	None
	MonthlyEvaporationCalc	Monthly Evaporation
	MonthlyEvaporationCalcInAnnualTimestep	Monthly Evaporation In Annual Timestep
	SingleEvaporationCalc	Single Evaporation
	DailyEvaporationCalc	Daily Evaporation
	PanAndIceEvaporation	Pan and Ice Evaporation
	CurrentSurfaceAreaPanAndIce	Pan and Ice Evaporation, Current Surface Area
	heatBudgetEvaporation	Heat Budget Evaporation
	InputEvaporation	Input Evaporation

13.2.4 Peak Base Power Calc

In the **PeakBasePowerCalc**, if the outflow was less than the first value on the Base Flow Table, it would use a very small value. Now it issues an error if the lookup value is not on the table. This change could lead to a new error condition. If you want to match old results, you can insert 0 outflow and 0 baseflow as the first row of the table.

13.2.5 Unregulated spill near the crest

For certain inputs, the unregulated spill near the spillway crest was not correct. Note, this change can lead to slightly different numerical results. Click **HERE (Objects.pdf, Section 24.1.3.3)** for more information on the change.

13.3 Thermal Object - Load Evaluation

A new category, **Modified Load Evaluation**, was added to the Thermal object. Within this category, the **Calculate Modified Load** method subtracts the net hydropower generation from the System Load. Also, within optimization, it allows you to write constraints to level the load to the extent possible.

14. Slots

14.1 Clear Values

For scalar slots, table slots, table series slots and periodic slots, a **Clear Values** operation was added to the **Edit** menu.

14.2 Editing of Values In Slot Dialogs

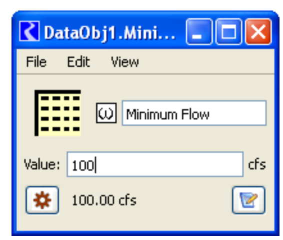
Enhancements and bug fixes were made to editing of values in the Open Slot, SCT, and Edit Account dialogs. Following is a list of changes that may impact you:

- **Double clicking a cell no longer converts it to input:** Previously, if you double clicked on any slot (including account slot) or SCT cell, it would convert the value to an input flag. Now, if no additional keys are pressed after a double-click, the value and flag remain.
- **Tab key doesn't select cells**: Previously, if you used the tab key to move to the next cell, it would select the first cell. Any edits you made to the second cell would be applied to the first cell. This no longer happens. The **Tab** key just moves to the next cell.
- **Editing a value takes you to left side of number**: Previously, if you edited a very precise number, it would start the edit operation on the right side. This hid the larger magnitude digits. Now, the edit begins on the left side showing you the larger magnitude digits.

14.3 Initialization Flag

Previously, the "i" flag was called the **Computed Input** flag. Because it is used by Iterative MRM and the new Initialization rules, HERE (Section 11.3), which both perform model setup functionality, the flag is now referred to as the **Initialization** flag.

14.4 Scalar and List Slot modifications



The List Slot, Scalar Slot, and Scalar Expression Slot were re-designed to remove the **Ok**/**Apply**/**Cancel** editing paradigm. Now, the values are applied immediately. In addition, on the two scalar slots, new buttons were added to configure the slot and edit the description (on data objects). Also, on newly created scalar slots on data objects, the default is now NaN instead of 0.0.

Import/Export now works correctly for scalar slots.

15. Subbasins

15.1 Subbasins Containing Aggregate Objects

Previously, it was impossible to remove element objects from the subbasin and save/load the model. Now, when an element object is removed from a subbasin, it is no longer automatically added back when the model is saved and loaded. Also, when the object selector is used to add objects to a subbasin, aggregate elements are only added to the subbasin if they are explicitly selected.

16. System Control Table

16.1 Adding Dividers

It is now easier to add dividers to an SCT. Two menus were added to the **Slots** menu to allow you to **Insert Slot Divider** or **Append Slots Divider**. As before, the selector can also be used to add dividers. The slots menu wording was modified because of this change.

16.2 Interpolation in multiple-slot selections

Previously, interpolation on the SCT was only possible for one slot at a time. Now, Interpolate Selection is possible for a rectangular selection of slots. The interpolation is still performed across timesteps and is separate for each slot. Click **HERE (SCT.pdf, Section 9.2)** for more information.

16.3 Adjust Values

An **Edit ➥ Adjust Slot Values** operation was added to the SCT. This operation allows you to change multiple selected slot values by a percentage or an absolute value (if they all have the same units).

16.4 Keyboard accelerators

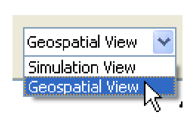
On the SCT, the keyboard accelerators were modified as follows:

Keyboard Accelerator	Menu Operation
Ctrl+S	File ➥ Save Model
Ctrl+Shift+S	File ➥ Save Model As ...
Ctrl+F	View ➥ Fit Row Header Columns
Ctrl+G	View ➥ Grow Columns to Data

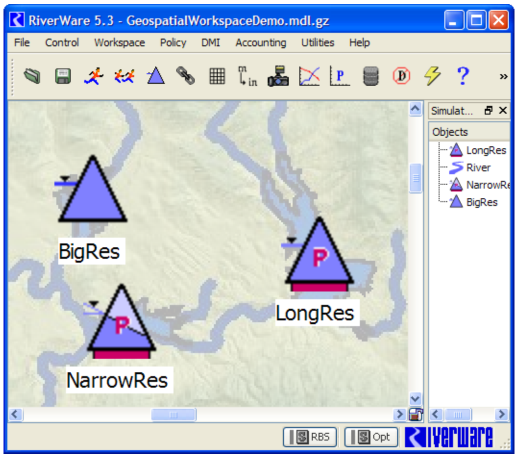
17. Workspace

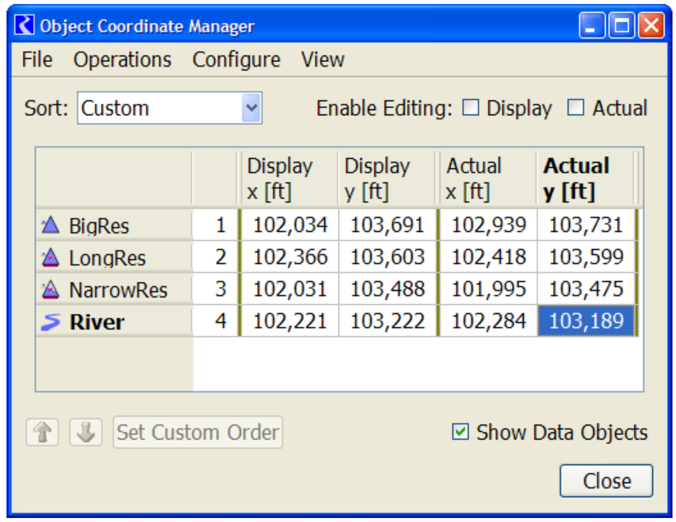
17.1 Geospatial Canvas

A new **Geospatial View** canvas was added to the RiverWare workspace. This canvas allows you to add and configure a georeferenced image file and then specify georeferenced coordinates for each object. This canvas also has enhanced display settings for the size of objects and label location, font and color.



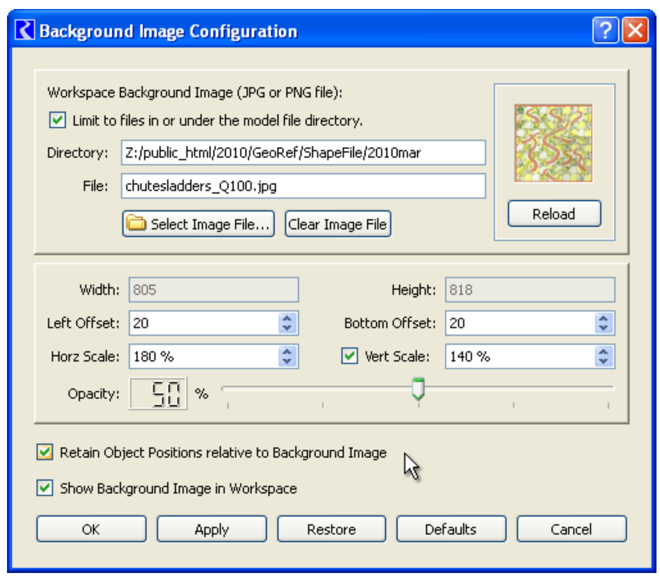
For more information, click **HERE (Workspace.pdf, Section 4.3)**.





17.2 Images on the Simulation View

Two enhancements were made to the background image support for the **Simulation View** only. These enhancements are not relevant for the new Geospatial View, which implements distinct support for a background image.



- Background images are no longer limited to image files in or under the loaded model file directory. That limitation can still be imposed through the use of a new checkbox. With this enhancement, it is no longer necessary to load (or save) the workspace before configuring the Simulation View's background image.
- When re-scaling the image or changing the pixel offsets from the left or bottom edges of the workspace, the user has the option to "Retain

Object Positions" (in the Simulation View) relative to the background image.

For more information, click **HERE (Workspace.pdf, Section 4.1.2)**.

Note that the Geospatial View will not support independent re-scaling of the image's horizontal and vertical dimensions, nor independent horizontal and vertical scales for real-world coordinates. Also the Geospatial View will not support map images rotated with respect to compass direction. Considering those limitations, some users may prefer to continue to use the Simulation View with a background map image.

18. Closed Bug Reports

The following bugs have been closed for this release. For more information on any bug, see the CADSWES website. The bugs are listed in order by bug number:

915	917	1348	1384	1451	1852	1860
1907	1982	2015	2141	2249	2250	2262
2403	2408	2445	2479	2570	2954	3114
3206	3319	3324	3325	3334	3345	3383
3387	3394	3417	3496	3538	3557	3599
3638	3711	3726	3728	3762	3767	3793
3798	3804	3872	3883	3914	3923	3937
3946	3954	3959	4002	4006	4012	4031
4070	4073	4080	4081	4096	4101	4133
4136	4145	4164	4193	4195	4212	4216
4255	4271	4274	4277	4281	4283	4294
4299	4302	4315	4323	4328	4335	4336
4387	4405	4414	4415	4428	4445	4455
4458	4470	4484	4488	4498	4551	4562
4630	4645	4681	4688	4714	4728	4737
4744	4746	4759	4760	4773	4779	4780
4782	4783	4786	4798	4805	4814	4815
4821	4824	4829	4830	4833	4834	4836
4837	4838	4839	4840	4841	4842	4843
4844	4845	4846	4847	4848	4849	4850
4851	4852	4853	4854	4857	4858	4859
4860	4861	4862	4863	4864	4865	4866

4867	4868	4869	4870	4872	4873	4876
4877	4878	4879	4880	4881	4882	4883
4884	4885	4886	4887	4890	4891	4892
4893	4894	4896	4897	4898	4899	4900
4901	4902	4903	4904	4905	4906	4907
4908	4909	4910	4911	4912	4913	4914
4916	4917	4918	4919	4920	4921	4922
4923	4924	4926	4927	4928	4929	4930
4931	4932	4933	4934	4935	4936	4937
4938	4939	4940	4941	4942	4943	4944
4945	4946	4947	4948	4949	4950	4951
4952	4952	4953	4954	4957	4958	4959
4960	4961	4962	4963	4965	4966	4967
4968	4969	4971	4972	4973	4974	4975
4978	4979	4980	4981	4982	4983	4984
4985	4986	4987	4988			

Release Notes Version 6.1

1. Special Attention Notes

Following are special attention notes, indicating that:

- Functionality has changed that requires you to update models, or
- Results may differ

If you have any questions, please contact riverware-support@colorado.edu

1.1 Excel Database DMIs and Object Name Maps

If your existing Excel dataset references a name map that has an object mapping, the results of the DMI could be different or not work. Click HERE (Section 3.2) for more information.

1.2 Peak Base Power Calc

In the “PeakBasePowerCalc” and “LCRPowerCalc”, certain operating head computations were using the previous Pool Elevation when it should have used the current value. In certain situations, this may result in numerical differences. In most of our test models, the difference is less than 1% on all timesteps; for example, on one model, the largest difference was 0.8% in spill on a few timesteps. But on one test model that had certain flow conditions, the largest difference was ~5% in spill slot values while energy, and turbine release slots were only 0.3% different.

1.3 Power Plant Cap Fraction

The Power Plant Cap Fraction was incorrectly applied in the getPlantPowerEqnRelease. When energy/power is known, the Power Plant Cap Fraction is now applied to the maximum that can be produced, not the Turbine Release calculation. The equation is now:

Turbine Release = (Power * Unit Compatibility Factor)/(Net Head * Plant Efficiency)

1.4 Reservoir Hydrologic Inflow Calc

When the level power or storage reservoir is dispatching and solving for Hydrologic Inflow (using the solveMB_givenInflowOutflowHW or solveMB_givenInflowOutflowStorage dispatch method), the precipitation is now included in the mass balance equation.

Also, on the storage reservoir, the pumped storage flow (+Flow TO Pumped Storage - Flow FROM Pumped Storage) is added to the equation to compute hydrologic inflow. This matches how it is done on the level power reservoir.

1.5 Uncertainty Methods, Slots, and Units

Uncertainty methods, slots and unit types were removed. For more information click: **HERE (Section 6.4.9)** for reservoir methods, **HERE (Section 6.3.3)** for reach methods, and **HERE (Section 14.2)** for unit types.

1.6 Unregulated Spill Slots

A more generalized nomenclature for the **Flashboard** and **Flashboard and Superboard** methods was implemented. Now the methods and slots are referred to as: **Two Unregulated Flows** and **Three Unregulated Flows**.

When an old model is opened, method, slot, and columns names are automatically updated. Please modify any rules that referenced the flashboard or superboard slots.

1.7 USACE-SWD Hydropower Function

The HydropowerRelease predefined RPL function determines the additional release to meet hydropower load without causing additional downstream flooding as determined by the FloodControl predefined RPL function. This function was modified and in some cases, results may be different than in previous versions. For more information, click **HERE (Section 15.2)**.

2. Accounting

2.1 Gain Loss Coefficients on Passthrough Accounts

A category called **Gain Loss Coefficient** and methods were added to the passthrough account to model gain loss coefficients that vary over time. The methods are:

- **Constant Gain Loss Coefficient**: specify the gain loss coefficient on a scalar slot. This was the previous approach.
- **Variable Gain Loss Coefficient**: specify a series slot of gain loss coefficients.
- **Periodic Gain Loss Coefficient**: specify a periodic slot of gain loss coefficients.

For more information, click **HERE (, Section)**.

2.2 Object Level Accounting Method Diagnostics

Diagnostics for Object Level Accounting Methods (OLAMs) were improved to now allow you to show diagnostics for:

- RPL Method Execution
- RPL Function Execution
- RPL Print Statements

These diagnostics are available in the accounting diagnostic configuration in the **Account Method** group.

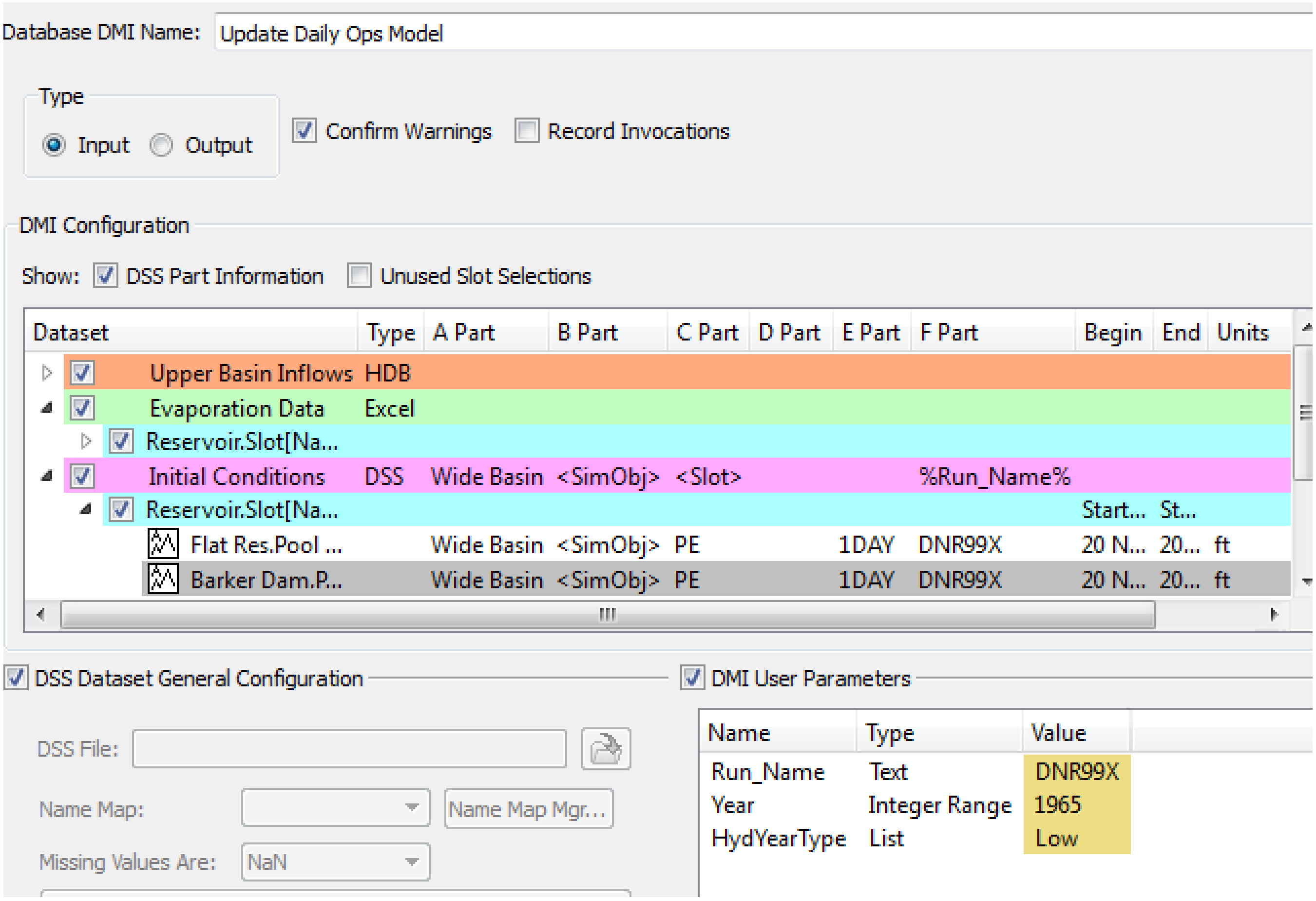
3. Data Management Interface

3.1 Database DMI Editor

The **Database DMI Editor** was re-implemented and enhanced as follows:

- Modified layout to be more general.
- HDB and Excel datasets are supported.
- DSS Datasets now support user parameters.
- DSS Datasets allow workspace entities, essentially wildcards on objects, slots, and/or accounts, in part information.
- DSS Datasets display the fully resolved part information.
- Datasets and slot selections can be disabled for debugging purposes.
- Unused slot selection are explicitly shown.
- DSS data types can now be specified in this dialog.
- The “Original” and “New” **Database DMI Editor**s were removed

For more information and a user guide for this dialog, click **HERE (DMI.pdf, Section 5.2)**.



3.2 Excel Database DMIs and Name Maps

Name maps for slots have been available in Excel Database DMIs to map slots to Excel ranges (range approach) or to map to new slot names (header approach). Previously, name maps for objects have been ignored. Now, object name maps can be used (in the header approach only) to indicate an alternate name for the object used in Excel. The following criteria is used for Excel datasets, for each slot:

- If there is no name map, the RiverWare object and slot name is used in Excel.
- If there is a slot mapping only, the specified mapped name is used in Excel.
- If there is an object mapping only, the mapped object is used for the object name followed by a period and the RiverWare slot name. This combined string is used in Excel.

- If there is a slot **and** object mapping, the mapped object name is used followed by a period and then the mapped slot name. This combined string is used in Excel.

If your existing Excel dataset references a name map that has an object mapping, the results of the DMI could be different or not work.

Note, object name maps are not applicable to the range approach and are ignored. In this approach, the Excel range must be specified for each slot using a slot name map.

For documentation of the Excel dataset use of name maps, click **HERE (DMI.pdf)**.

3.3 Excel Database DMI Performance

To improve performance, an Excel workbook is saved only when a workbook is closed or when the DMI is completed. In a test of writing approximately 160 slots, the performance improved from 23 seconds to 3 seconds.

3.4 HDB - Oracle Client Version

The HDB database connection was upgraded to use the Oracle 11g Client. You will now need Oracle 11g client to connect to HDB from RiverWare. The Oracle client is 32-bit or 64-bit depending on the version of RiverWare being used.

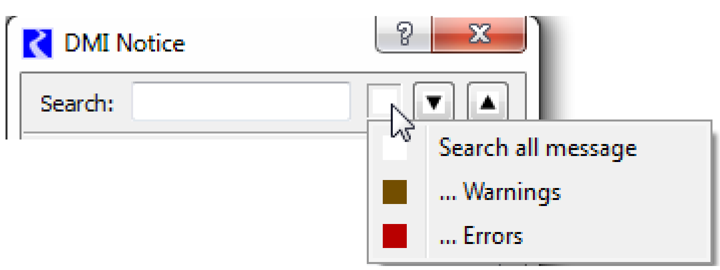
3.5 Parameters

The **DMI Parameter** dialog was re-implemented and modified as follows:

- Spaces are now allowed in text and list values. For control file-executable DMIs, the values are enclosed in double-quotes on the command line
- Parameters are now allowed in DSS Database DMIs as described **HERE (DMI.pdf, Section 5.2.3.2)**.

3.6 Notice Windows

The DMI notice window was enhanced to allow better search and display functionality. The DMI messages are now color coded and you can search for text including wildcards and by message type. For more information, click **HERE (DMI.pdf, Section 2.5.1)**.



3.7 Unique Temporary Directories

In the Control File-Executable DMI approach, The control file syntax was enhanced to introduce the variable `%tempdir` which is replaced by a guaranteed unique temporary directory generated by RiverWare. For more information, click **HERE (DMI.pdf, Section 3.2.2)**.

4. Diagnostics

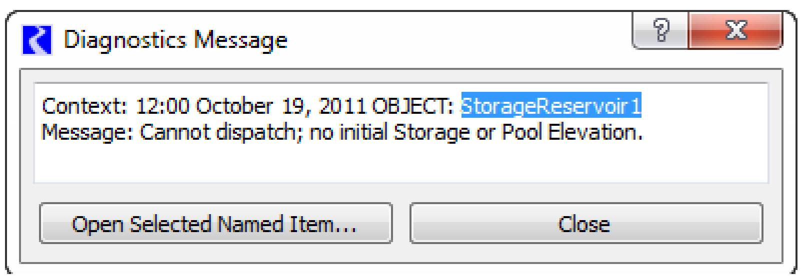
4.1 Environment Variables in File Specification

The diagnostic output file specification can now use environment variables. Environment variables are specified by the "$" and the delimiters, () or {}. For example:
`$(MODEL_DIR)/temp/model.diag` or `${MODEL_DIR}/temp/model.diag`

4.2 Show in Popup Window

The diagnostics output window often contains very long lines of text. If you wish to see a message text in a more concise word-wrapped window, use the right-click **Show Message in Popup Window.** A dialog will open which shows the message, including the context information, wrapped to multiple lines.

Also, when you select text that is the name of an object, account or slot, the button **Open Selected Named Item...** button becomes enabled. Click the button to open the appropriate dialog for that object, account or slot.



For more information, click **HERE (Diagnostics.pdf, Section 1.4)**.

5. Multiple Run Management

5.1 Configuration Dialog Layout

The MRM configuration dialog was modified as follows:

- The **Policy** buttons were replaced by a toggle.
- The **Index Sequential** toggle was replaced by a button.
- The **Output** tab Excel options were re-arranged.
- **Slot Name** options were added as described **HERE (Section 5.6)**.
- On the **Policy** tab, a button was added to allow you to **Append Ruleset**.

- On the **Input** tab, a button was added to allow you to **Append DMI**.
- On the **Input** tab, you can now specify an Initialization DMI as described **HERE (Section 5.2)**.
- Added a **Traces** option as described **HERE (Section 5.3)**.

For more information on this dialog, click **HERE (MRM.pdf, Section 4)**.

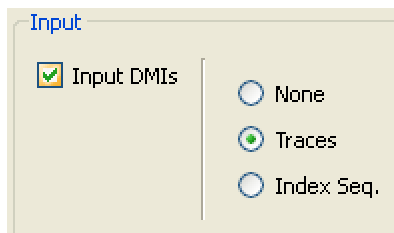
5.2 Initialization DMI

The input tab of the MRM configuration dialog now has an initialization DMI. You can optionally specify a DMI or group that is invoked at the beginning of the multiple run. Click **HERE (MRM.pdf, Section 4.5.1)** for more information.

5.3 Input DMIs and Traces

When Input DMIs is selected, now there is the option to use Traces instead of Index Sequential. This allows you to run only a portion of the runs specified by the Input DMIs. You can specify

- None - No traces
- the **First Trace**
- the **Number of Traces.**



For more information, click **HERE (MRM.pdf, Section 4.5.2)**.

5.4 Iterative Pre-Run Rules

In Iterative MRM, it is now possible to execute Pre-Run rules before each single run. Click the **Before Each Run** toggle. The default is the previous behavior, that is, they only execute **Before First Run**. Click **HERE (MRM.pdf, Section 4.3.3)** for more information.

5.5 Iterative MRM flag

The “i” flag is now specific to iterative MRM. The name of the “i” flag was changed to “Iterative MRM” (originally it was “Computed Input”, then it was “Initialization”, now it is “Iterative MRM”).

5.6 Output Slot Name options

The MRM output to Excel file includes three slot name options:

- Long: the full slot name (limited to 31 characters for worksheet names, Excel’s limit)

- Short: the name shortened using a heuristic (removed spaces and vowels)
- Index: the name slotN is used: E.g. slot0, slot1,...

For more information, click **HERE (MRM.pdf, Section 4.8)**.

5.7 Output to Excel

The Excel Output from MRM (and from output devices) now uses the same code as the new RdfToExcel library to create Excel files from RDF files. This includes the ability to specify Output slot names described above.

6. Objects

6.1 Agg Diversion Site

Agg Diversion Site objects with the **Lumped** structure now compute and set the Total Depletion Shortage and then allocate the shortage proportionally to each member elements' Depletion Shortage slot. Note, this only applies to **lumped** agg diversions. Click **HERE (Objects.pdf, Section 3.1.1.3)** for more information.

6.2 MODFLOW connection

RiverWare's connection with MODFLOW is currently not functional. The associated methods on the Computational Subbasin, Aggregate Diversion Site, Groundwater Storage, Reach, and Water User objects have been disabled and cannot be selected. An error will be posted during model load if the methods were previously selected.

This functionality is described **HERE (Objects.pdf, Section 7.2.1)**. If you wish to use this functionality or have any questions, please contact CADSWES at riverware-support@colorado.edu.

6.3 Reach

6.3.1 Autoregressive Outflow

To be more general, the category **Negative Outflow Adjustment** category was changed to **Outflow Adjustment**. A new method was then added to this category called **Autoregressive Outflow** method. This method computes the outflow to be a function of the inflow and outflows at previous timesteps. For more information, click **HERE (Objects.pdf, Section 22.1.16.3)**.

6.3.2 Stage Adjustment Category

A category, **Stage Adjustment**, and method, **Stage Coefficient Weighting** were added to the reach. This method adjusts the current stage to be a weighted sum of the previously computed current stage and previous timesteps' stage values. For more information, click **HERE (Objects.pdf, Section 22.1.7)**.

6.3.3 Uncertainty Methods, Slots, and Units removed

The **Reach Uncertainty Calculation** category and all methods were removed. All uncertainty unit types were also removed.

6.4 Reservoir

6.4.1 Conditional Operating Levels

A category, **Conditional Operating Levels** category and method **Inflow Sum over Range** were added to the level and storage reservoirs. This category and methods allow the operating level relationship to change to an alternative table at specific times in the run. In particular, this method switches the operating level table based on a hydrologic condition. At the beginning of the timestep on the trigger date, if the sum of the **Inflow Sum** slot over the criteria range is greater than the **Trigger Volume**, the **Operating Level 2 Table** is used. It continues using this table until the reset date at which it goes back to the original table. Any time the table switches, the **Operating Level Storage Table** is re-computed.

For more information, click **HERE (Objects.pdf, Section 24.1.26)**.

6.4.2 Elevation Maximum Duration Constraints

A category **Elevation Maximum Duration Constraints**, and method **Constant Additional Surcharge Release** was added. This category is only available when the **Flat Top Surcharge** method is selected. This method modifies the surcharge release to constrain a reservoir's Pool Elevation to not be above a certain level for longer than a certain period of time. A single reservoir can have multiple constraints of this type, each applying to a different elevation. For example, Res A might have two constraints:

- Pool Elevation should not be greater than 1000 m for more than 2 consecutive days.
- Pool Elevation should not be greater than 800 m for more than 5 days.

For more information, click **HERE (Objects.pdf, Section 24.1.17)**.

6.4.3 Hydrologic Inflow Calculation

When the level power or storage reservoir is dispatching and solving for Hydrologic Inflow (using the solveMB_givenInflowOutflowHW or solveMB_givenInflowOutflowStorage dispatch method), the precipitation is now included in the mass balance equation.

Also, on the storage reservoir, the pumped storage flow (+Flow TO Pumped Storage - Flow FROM Pumped Storage) is added to the equation to compute hydrologic inflow. This matches how it is done on the level power reservoir.

6.4.4 Inflow Sum Slot

A general slot, **Inflow Sum**, was added to all reservoir objects. The slot sums water coming into the reservoir. It is like **Total Inflows** but does not remove Diversions and Flow TO Pumped Storage as **Total Inflows** does. **Inflow Sum** is set at the end of each dispatch method.

For more information, click **HERE (Objects.pdf)**.

6.4.5 Max Flag on Outflow when linked to Canal

Previously, a reservoir linked to a canal could not have the max flag specified on outflow. The solution equations were enhanced to now allow one or both reservoirs to have the max flag on outflow. For more information on the canal solution, click **HERE (Objects.pdf, Section 6.2.1)**.

6.4.6 Operating Level Storage Table

The slot **Temporary Operating Level Table** was renamed **Operating Level Storage Table** (and made non-temporary). This slot is computed at run time and is derived (for more information click **HERE (Section 13.2)**) from the **Operating Level Table**.

6.4.7 Power Plant Failure methods

A category, **Power Plant Failure**, and method **Max Pool, Outflow, Tailwater** were added to the power reservoirs.

The **Max Pool, Outflow, Tailwater** method models the shutoff and failure of the plant when one of the above slots exceeds its criteria. If it only exceeds its shutoff limit, it cannot produce power on that timestep. If it exceeds its failure limit, it cannot produce power on that timestep and any future timesteps. The **Power Plant Cap Fraction** is used to track failure where 1=On and 0=failed.

To implement the method, the power methods were re-organized so that each one can call this method and then check for failure or shutoff. In some cases, the tailwater and operating head computation are done earlier in the methods so they are computed even if the constraints are exceeded. This may change results, now there will be values, when previously there were not.

For more information, click **HERE (Objects.pdf, Section 17.1.5)**.

6.4.8 Sloped Reservoir - Weighting Coefficients method

On the sloped reservoir, the **Profile K Coeffs Table** was added to the **Weighting Coeff**s method. A lookup is done on this table when the **Flow Parameter** is computed for each partition. Existing models with this method will require you to enter values for this table.

For more information, click **HERE (Objects.pdf, Section 23.1.19.2)**.

6.4.9 Uncertainty Methods, Slots, and Units removed

The reservoir uncertainty calculation categories and methods were removed. On the storage and level power reservoir, the following were removed:

- **Uncertainty Calculation** category and all methods
- **Hydrologic Inflow Uncertainty** category and all methods
- **Evaporation Uncertainty** category and all methods
- **Bank Storage Uncertainty** category and all methods

6.4.10 Unregulated Spill Nomenclature

A more generalized nomenclature for the **Flashboard** and **Flashboard and Superboard** methods was implemented. Now the methods and slots are referred to as: **Two Unregulated Flows** and **Three Unregulated Flows**.

When an old model is opened, method, slot, and columns names are automatically updated. Please modify any rules that referenced the flashboard or superboard slots.

For more information, click **HERE (Objects.pdf, Section 24.1.4)**.

6.5 Water User

6.5.1 Water User Groups

A slot, **Water User Groups**, was added to each water user object. It contains the subbasins to which the water user belongs. This gives an indication on the object of its subbasin membership. For more information, click **HERE (Objects.pdf)**.

7. Optimization

7.1 Improved Data Checking

Quality checks were added to piecewise approximations to be similar to the quality checks that exist for tangent and secant approximations. Examples of curvature checking include checks that the pieces have expected relative slopes and checks that the data before and after the pieces lie above/below the lines extrapolated from the end pieces as expected.

For approximation data tables which are expected to be a monotonically increasing function, this assumption is now checked and a warning is issued for each table where it does not hold. Note that 3-dimensional tables describe a family of curves and each of them is checked.

7.2 Infeasible Problem Handling

When the optimization controller encounters an infeasible problem, it now discards the basis and makes another attempt to solve the problem. If the problem is still found to be infeasible, the run is aborted as before.

7.3 Unregulated Spill in Optimization

Although unregulated spill failure is implemented as described **HERE (Section 6.4.10)**, optimization now uses the appropriate unregulated spill table given method selection and failure conditions at the beginning of run. Failure during the run isn't modeled in optimization.

7.4 User Defined Optimization Variables

You can now write optimization policies which refer to user defined variables. Each user defined optimization variable must be a series slot or a column on a agg series slot on a data object.

To configure that a series slot on a data object is a user defined optimization variable, on the series slot configuration dialog, check the **Is User Defined Variable** check box. Then, this slot can participate in the optimization problem. You must still add policy that defines the equation for this variable to pull it into the problem.

Also, the automatically generated post-opt RBS ruleset now includes rules to set the user defined variable slots to their optimal values.

8. Plotting and Output

8.1 Create Similar Plot Pages

A utility, **Create Similar Plot Pages**, was added to allow you to create one or more similar plot pages for different Objects, Slots, Accounts, or Supplies. This utility is similar to plot templates but is more direct and allows you to generate many plot pages at one time. It substitutes the new choices into plot titles and the device name of the plot pages when creating similar new plots.

For more information, click **HERE (Output.pdf, Section 2.7)**.

8.2 Output to Excel

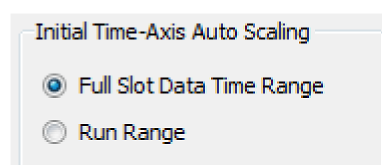
The Excel Output Device now uses the same code as the new RdfToExcel library to create Excel files. This includes the ability to specify Output slot names described **HERE (Section 5.6)**.

8.3 Time Axis Control

To help users with models that have data that is longer than the run range (perhaps due to pre or post-run dispatching as described **HERE (Section 10.1)**), enhancements were made to the plot utility to only plot the run or other range. Two new toolbar icon buttons were added to the plot page dialog (and the **Graph** menu). The options are:

-  **Scale to run range**: Scale the time axis to the run range.
-  **Scale to specified time range**: This opens a dialog to set the time range.

Also, you can configure the default time range to use when plotting. From the plot page, use the **Edit ➥ Preferences ➥ Default Axis Settings** menu. Then specify the desired setting in the **Initial Time-Axis Auto Scaling** region. This setting is persistent in model files.



9. RiverWare Policy Language

9.1 Expression Font Colors

For better readability, the font color of the selected expression's foreground text is now either white or black (dynamically computed) to contrast with the configured background color. Previously, it always used the configured foreground color which could be hard to read.

9.2 Initialization Rules

In RiverWare 6.0, Initialization Rules could either set values with the “Z” or “i” flags. It was decided to replace the “i” flag option with the “R” flag option. Thus, initialization rules can set either the “R” or “Z” flag. In rulebased simulation, values set with the “Z” flag are given the highest priority, that is, zero (0) priority. Values set by initialization rules with the “R” flag are given a low priority equal to the number of rulebased simulation rules plus one (number of RBS rules + 1).

Existing Initialization Rules sets which contain rules which previously set the “i” flag will be adjusted to set the “R” flag instead; a one-time warning will be issued.

Because the “i” flag is now specific to iterative MRM, the name of the “i” flag was changed to “Iterative MRM” (originally it was “Computed Input”, then it was “Initialization”, now it is “Iterative MRM”).

9.3 New Predefined Functions

The following predefined functions were added to RPL:

9.3.1 CompletePartialDate

The datetime function CompletePartialDate(DATETIME partialDate, DATETIME sourceDate) fills in the missing components of the partialDate value to make it fully specified. The missing component are taken from the second argument, sourceDate, a datetime. If not fully specified, sourceData should have at least the components which are missing from the date which is being completed.

For more information, click **HERE (RPLPredefinedFunctions.pdf, Section 19)**.

9.3.2 DispatchEndDate

The datetime function DispatchEndDate returns the last dispatch date. For more information, click **HERE (Section 10.1)** for a description of post-run dispatching or **HERE (RPLPredefinedFunctions.pdf, Section 27)** for the function documentation.

9.3.3 GetRunCycleIndex

The numeric function GetRunCycleIndex() returns the run cycle. For more information, see the section on Run Cycles **HERE (Section 11.1)** or the function documentation **HERE (RPLPredefinedFunctions.pdf, Section 79)**.

9.3.4 GetYearAsString

The string function GetYearAsString(DATETIME date) returns the year of the given datetime as a string. E.g., Given the datetime January 1, 2000, this function will return the string “2000”. For more information, click **HERE (RPLPredefinedFunctions.pdf, Section 93)**.

9.3.5 HasFlag

The boolean function HasFlag(SLOT slot, DATETIME date, STRING flag) checks if the specified slot at the specified datetime has the specified flag. For a description and list of possible flags, click **HERE (RPLPredefinedFunctions.pdf, Section 94)**

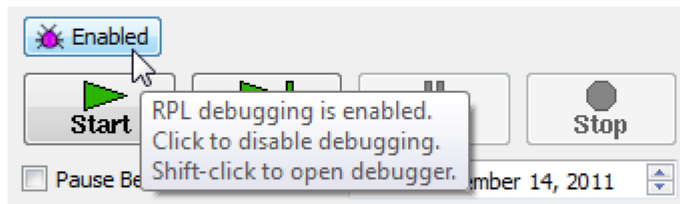
9.4 Palette Functions Tab

On the RPL Palette functions tab, a toggle was added that allows you to show or hide only functions which have the return type of the selected RPL expression.

On the **Predefined Functions** tab, when the checkbox is off, all predefined functions are shown even if no expression is selected.

9.5 RPL Debugging Indicator

A button was added to the Run Control dialog to indicate the state of the RPL Debugger. Click the button to toggle the state. Shift-Click the button to open the RPL Debugger.



This button is shown when RPL Debugging is first enabled, but remains in place for that RiverWare session. To hide the button, use the **View ➥ Show RPL Debugging Button**. For more information on RPL Debugging, click **HERE (RPLDebugging.pdf, Section 2)**

9.6 RPL Set Navigation

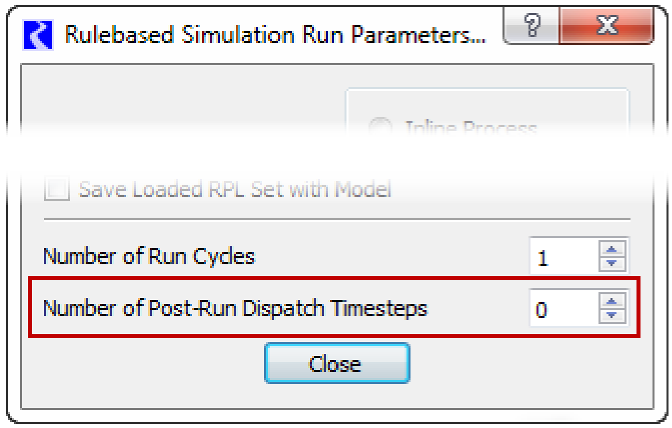
To better aid in navigating RPL sets, color coded icons are now displayed on the bottom of the workspace for any

- Ruleset, goal set, or global function set opened from a file
- Embedded sets (OLAM, expression slots, Init rules, Iterative MRM) that contain at least one group

Mouse over any icon for a tool tip indicating the location or click to open that set. Also, the sets are still available through the **Policy** menu.

10. Run Range

10.1 Post run dispatching



You can now specify the number of timesteps past the finish timestep for which dispatching is possible. From the **Run Control**, use the **View ➥ (Rulebased) Simulation Run Parameters** menu. Then specify the integer number of timesteps in the **Number of Post-Run Dispatch Timesteps** spinner.

This feature is useful when values are forecasted or lagged in the model. The post run dispatching allows the objects to solve past the end of the run so that rules or other logic can correctly look at values past the end of the run.

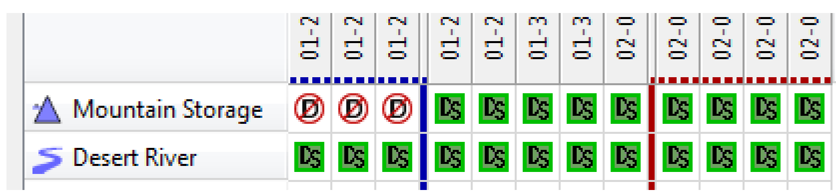
Click **HERE (RunControl.pdf)** for more information.

To further support this a RPL predefined function **GetDispatchEndDate** was added. Also, see the next section for display changes related to the these time ranges.

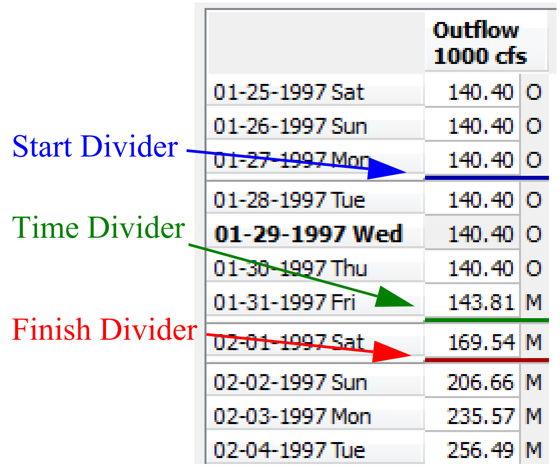
10.2 Run Range Display

The following user interface changes were made to support pre and post run dispatching:

- The model run analysis tool now shows a dotted line for pre (blue) and post run (red) timestep.



- Slot, Edit Account, SCT, and Run Analysis dialogs now show a blue divider before the start timestep, and a red divider after the finish timestep.
- The model run analysis now opens by default to the start timestep.
- Date time spinners are no longer limited to the run range.



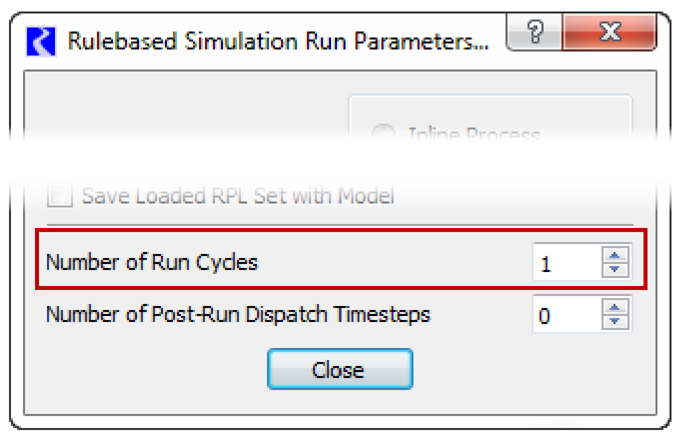
- Plots were enhanced to give better control of the time range displayed. Click **HERE (Section 8.3)** for a description.
- Statistical slots were enhanced to allow control over the analysis range. Click **HERE (Section 13.6)** for more information.

11. Rulebased Simulation

11.1 Run Cycles

Rulebased simulations can now cycle through the run timesteps multiple times. each pass through the run timesteps is referred to as a **Run Cycle**.

Traditionally and by default, RBS simulations cycle through the timesteps in the run a single time, i.e., the default number of Run Cycles is 1. You may adjust this value upwards in the **Rulebased Simulation Run Parameters** dialog.



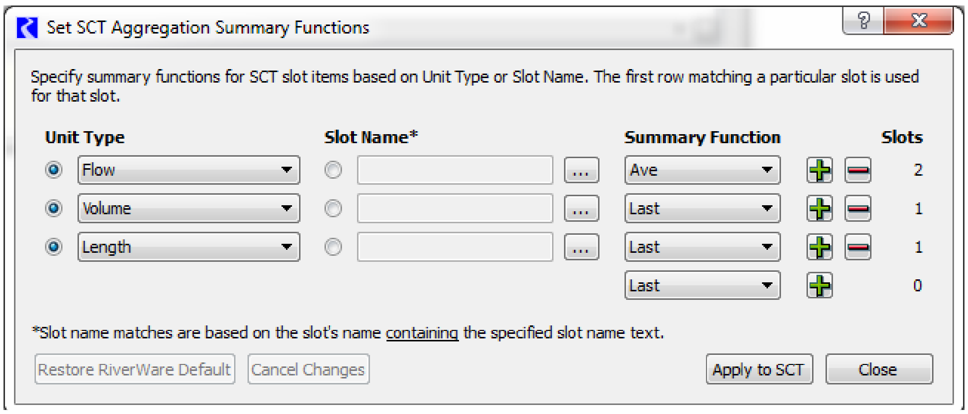
Also, a RPL predefined function GetRunCycleIndex() was added to support this feature.

For more information, click **HERE (Section 9.3.3)**.

12. SCT

12.1 Aggregation Functions

The SCT was improved to allow you to quickly specify the summary function for aggregating timesteps for one or more slots on the SCT.



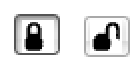
Click **HERE (SCT.pdf, Section 8.6)** for more information.

12.2 Interpolate Shortcut

“Ctrl-L” was added as an accelerator (shortcut) to the Interpolate operation in SCT dialogs.

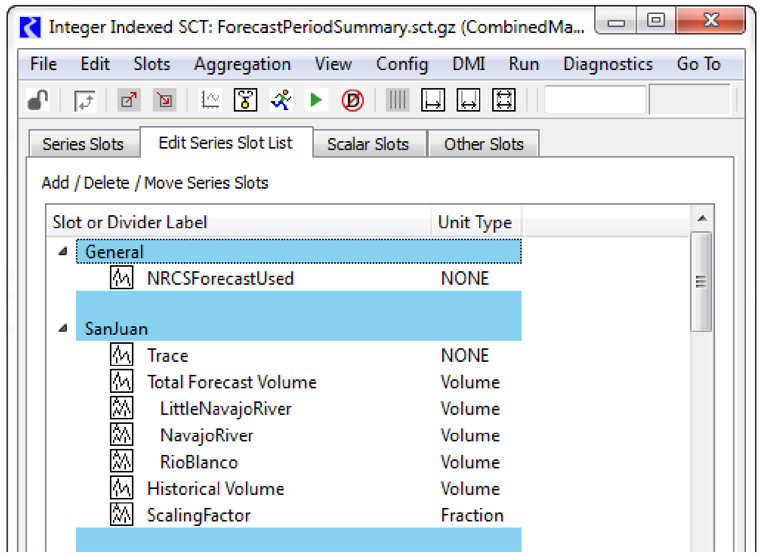
12.3 Lock is Preserved

The SCT’s lock status is now preserved when an SCT is saved and re-opened. Previously, it was always locked when the SCT was opened.



12.4 Series List tab

A new tab was added to the SCT, **Edit Series Slot List**. This tab provides a list of all the series slots in the SCT and allows you to easily rearrange and reorganize them. It has the following features:



- It is the default tab when a new SCT is created.
- You can add, delete, or move slots up or down in the list. You can move a single selected slot or move a group of selected slots.
- You can re-label slots.
- You can group slots together and give them a label in the divider.
- You can **Create Similar Groups** of slots. For example if you have five slots for a given reservoir, you can quickly add those same five slots for each reservoir in your system.

For more information on this feature, click **HERE (SCT.pdf, Section 5)**.

13. Slots

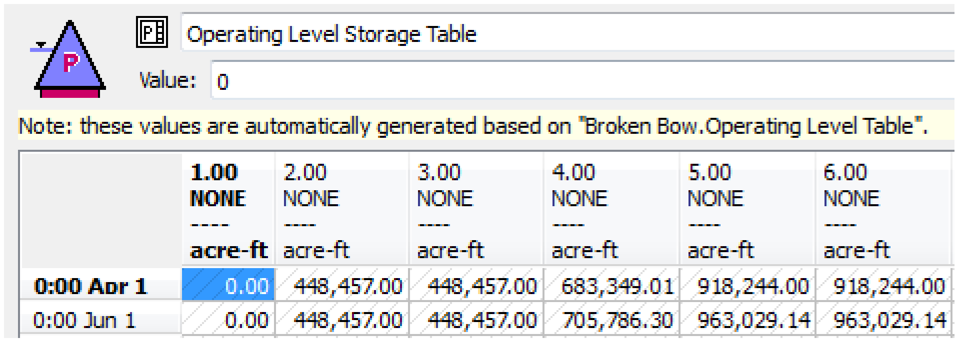
13.1 Collected Notes for Slots with Expression

The ability to collect notes on series slots with expressions was added. If requested, notes from all series slots referenced in the expression of the expression slot will be copied to the expression slot as “collected” notes when the expression slot is evaluated. For more information, click **HERE (Slots.pdf, Section 6.6)**.

These collected notes are also displayed on any **Tabular Series Slot Reports** (**HERE (Output.pdf, Section 3)**) where notes are configured to be shown.

13.2 Derived Slots

Certain table and periodic slots are computed at run time using values from another slot. That is, these slots are "derived" from a different slot.



Now these derived slots are displayed as read-only values (cross-hatched) and they indicate their source slot. When there is an issue accessing derived slots, now the diagnostics correctly indicate the source slot where the data issue should be fixed.

13.3 Interpolate Shortcut

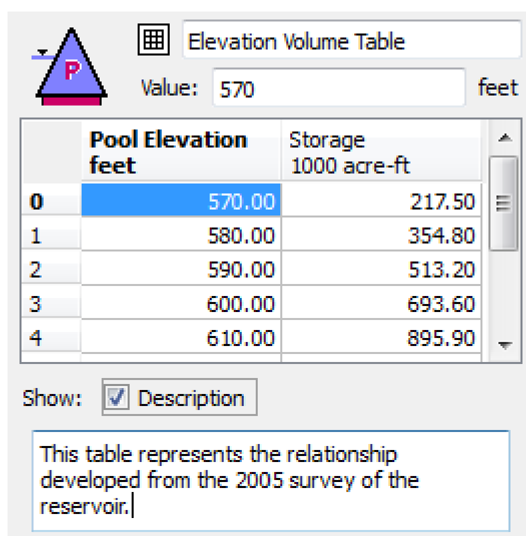
"Ctrl-L" was added as an accelerator (shortcut) for the **Interpolate** operation in slot dialogs.

13.4 Read Only Indication

Previously, on the **Open Object** dialog, slots on snapshot data objects displayed an **RO** indicating they were "read only". This **RO** indication has been removed. The slots still show a cross-hatch over the data indicating it cannot be edited.

13.5 Slot Description

Text descriptions can now be added to any type of slot on any type of objects. Previously, they could only be added to data object slots. The Description can be shown from the **View ➥ Show/Add Description** or from the toggles at the bottom of the dialog.



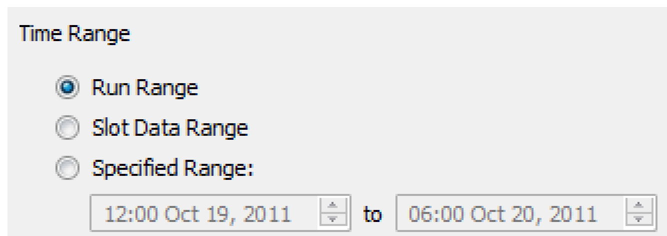
Previously, you could search for slots that had Input values. Now you can also search for slots that have descriptions including those that contain a specific text string. Access the utility from the **Workspace ➥ Slots ➥ Find Descriptions** menu. Then specify the slots you wish to search and whether to look for all descriptions or those descriptions that contain a specific string. Click **Search** to execute. The resulting slots are shown in a list that includes the first 150 characters of the description.

For more information, click **HERE (Slots.pdf, Section 2.2)**.

13.6 Statistical Slot analysis Range

To help users with models that have data that is longer than the run range (perhaps due to pre or post-run dispatching as described **HERE (Section 10.1)**), enhancements were made to the statistical slot to only use the run range for analysis. This allows the run range to be the official analysis period; all computations are performed on that range only.

The statistical table slot now supports options to more easily filter the input slot data to the various time ranges. Previously, you could filter by a specified range. Now the configuration has options to filter by **Run Range**, **Slot Data Range**, or a **Specified Range** as shown in the figure. Newly created statistical slots default to the run range filter.



For more information click **HERE (Slots.pdf, Section 4.11.2)**.

14. Units and Display of Numbers

14.1 Display of Commas in Numbers

You can now show commas as a thousands separator in most numeric displays in RiverWare. By default, this feature is enabled. If you wish to disable it, you can do so from the **Workspace ➥ Show Commas in Numbers** menu.

14.2 Uncertainty Unit Types removed

Because uncertainty methods were removed, all uncertainty unit types were also removed:

- PercentUncertainty
- VolumeUncertainty
- FlowUncertainty
- LengthUncertainty
- TimeUncertainty

14.3 User Unit Additions

The following user units were added to the available user units (i.e. the “units” file):

- **Volume:** cfs-hr, kcfs-hr, KAF, MAF

- **Flow:** kcfs, KAF/day, MAF/day, KAF/month, MAF/month, KAF/year, MAF/year
- **Power per Flow:** MW/kcfs

15. USACE-SWD Methods

15.1 USACE Special Results

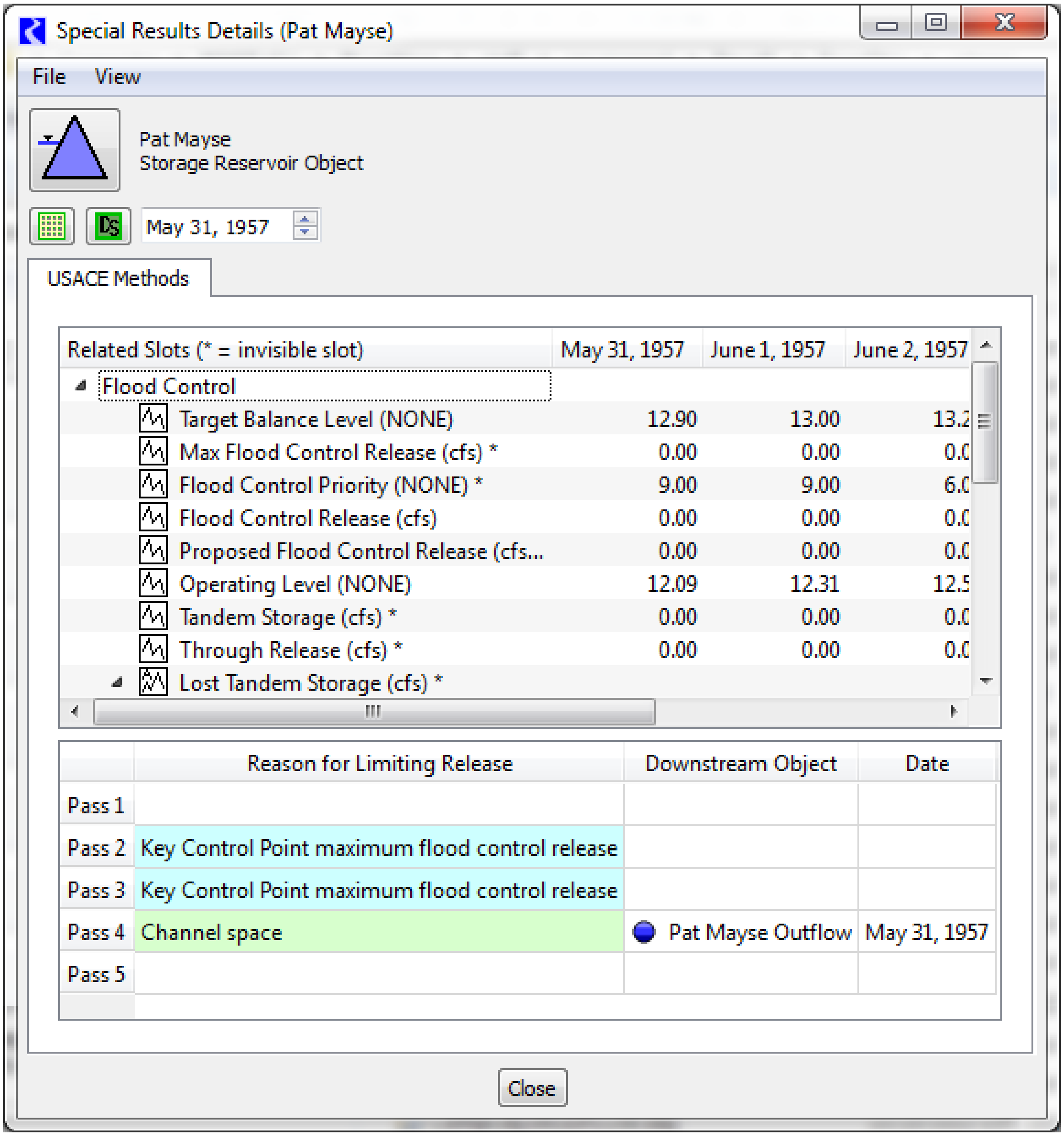
The run analysis dialog was enhanced to display information helpful to understanding and analyzing certain algorithms including Flood Control and other USACE-SWD methods.

The information is displayed in the **Details** panel of the **Run Analysis** dialog. Previously, there were two views: **Dispatch Behavior** and **Rule Effects**. Now there is a third view called **USACE Methods**

This view shows the values for various slots involved in the algorithm. Because the forecast period is so critical, the dialog shows values from the specified timestep and throughout the forecast period. Information includes final and intermediate values and diagnostic information describing the reason that releases were limited.

Because debugging data is shown on this dialog, many previously temporary slots were made non-temporary but are not shown on the Open Object dialog (i.e. they are invisible). Also, many slot's names have been changed.

For more information on this utility, click **HERE (USACE_SWD.pdf, Section 5.5)**..



15.2 Hydropower Modifications

The HydropowerRelease predefined RPL function determines the additional release to meet hydropower load without causing additional downstream flooding as determined by the FloodControl predefined RPL function. This function was modified and in some cases, results may be different than in previous versions.

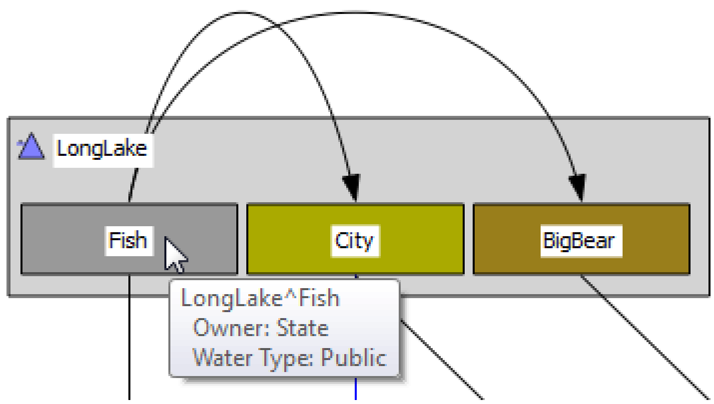
The function uses the empty space computed from the last pass of flood control. In certain situations, on Key Control Points only, this is not the total empty space that should be used for the hydropower additional downstream flooding computation. As a result, the hydropower release was being incorrectly constrained. The was fixed for version 6.0.5 but then modified again for 6.1. If this function is used in your model, the results may be slightly different due to these changes.

16. Workspace

16.1 Accounting canvas re-implemented

The accounting canvas was re-implemented (in Qt4) and improved. Now the standard pan, zoom, and locator views are available. Also, the following improvements were made:

- Object labels are to the right of the icon
- Better display of arrow heads and curved lines



- Selected objects and accounts are now shown with a dotted outline
- Background images can be displayed
- Tool tips and the status bar now show the object, account name, owner, water type, release type and/or destination depending on the item.

For more information, click **HERE (, Section)**.

16.2 Add Item to Workspace Group

A link, account, or object can be added to an existing workspace group using the context menus. Right click the item and choose Add to Link/Object/Account Group and select the destination group.

16.3 Workspace Navigation changes

The following changes were made to the workspace and the locator views:

- When loading a model, if no object is visible within the view, the view is scrolled to the most central object.
- A zoom factor of 140% was added.
- Auto-scaling of both the **Locator View** and **In-View Locator** was improved.

- Only the **Locator View** dialog or the **In-View Locator** mode is active at any one time.

16.4 World File Image Registration

On the geospatial canvas, you can register a background image using an ESRI world file. Supported operations include:

- Determine if there is a world file associated with an image.
- Read a world file.
- Translate between pixel coordinates and map coordinates.
- Calculate world file parameters based on an image and image location.
- Write a world file.

For more information, click **HERE (Workspace.pdf, Section 4.3.2)**

17. Closed Bug Reports

The following bugs have been closed for this release. For more information on any bug, see the CADSWES website. The bugs are listed in order by bug number:

4160	4312	4456	4871	4955	4964	4970
4989	4993	4994	4995	4997	4998	4999
5000	5001	5002	5003	5004	5006	5007
5008	5009	5010	5011	5012	5013	5015
5017	5018	5019	5020	5021	5025	5026
5027	5028	5029	5030	5031	5036	5038
5039	5040	5041	5042	5043	5044	5045
5046	5047	5048	5050	5052	5055	5056
5057	5058	5059	5060	5061	5062	5063
5064	5065	5066	5068	5070	5072	5074
5075	5076	5077	5078	5079	5080	5081
5082	5083	5084	5085	5088	5089	5090
5091	5092	5093	5094	5095	5096	5097
5098	5099	5101	5102	5103	5104	5105
5108	5110	5111	5112	5113	5114	5116
5117	5118	5121	5124	5125	5126	5127
5130	5131	5133	5134	5136		

Release Notes Version 6.2

1. Special Attention Notes

Following are special attention notes, indicating that:

- Functionality has changed that requires you to update models, or
- Results may differ

If you have any questions, please contact riverware-support@colorado.edu

1.1 Energy in Storage category name changes

The names of the energy in storage category and methods were changed:

- The category **energyInStorageCalcCategory** was renamed **Energy in Storage**.
- The method **noEIS** was renamed the **None** method.
- The method **tableLookup** was renamed **EIS Table Lookup**.

Old models will automatically update on load and you will be notified with a warning diagnostic. Click **HERE (Section 7.3.1)** for more information.

1.2 Reservoir Single Value Seepage

The timing of the Single Value Seepage method on the reservoirs was changed. Now the method is executed at the beginning of run and fills the Seepage values for the run range. This could lead to different results as the Seepage information is available earlier in the run. For more information, click **HERE (Section 7.3.5)**.

1.3 Unit Conversions for Area per Time

The previous conversion factor for ft2/day was fixed as it was incorrect by 0.01%. This does not change underlying data, but does change the value that is displayed to the user. Click **HERE (Section 12.1)** for more information.

1.4 Solaris is no longer a supported platform

Solaris is no longer a supported platform. That is, RiverWare is now only available on Windows. Both 32 bit and 64 bit Windows versions are available on the CADSWES website.

2. Accounting

2.1 Diversion Account Max Legal Request

On the Diversion Account, the **Maximum Legal Request** category was added with a method, **Max Request Series** where you specify a series of values that represent the max request. This legal constraint is applied to reduce the **Initial Request** to the **Max Request** and is shown on the **Appropriation Request** slot.

For more information, click **HERE (, Section)**.

2.2 Passthrough Account Outflow Limitation

On the passthrough account, the **Outflow Limitation** category was added with a method **Scalar Max Outflow**. The outflow is computed as the minimum of the proposed outflow and the Max Outflow scalar slot. Any remaining water goes to exactly one diversion supply. Lag, Gain Loss, return flow, and multiple diversion supplies are not allowed under this method.

For more information, click **HERE (, Section)**.

3. Batch Mode

3.1 RCL Commands

The following batch mode Riverware Command Language (RCL) command was added:

```
ConfigureExcelDataset {dmi name} {workbook=...} {sheet=...}
```

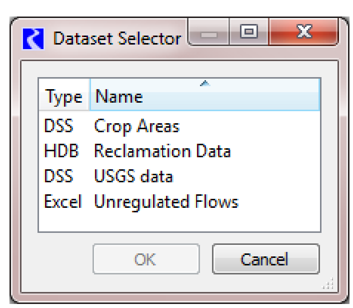
This command invokes the specified Excel DMI and passes the workbook and sheet as parameters (overwriting what is saved in the model file). The command iterates over the Excel datasets in the DMI and replaces the workbook and sheet in the dataset. Note, if the model is saved (via SaveWorkspace) the modified Excel datasets will be saved.

4. Data Management Interface

4.1 Database DMIs

4.1.1 Dataset Selector

In the dataset selector dialog (used to add existing datasets to a database DMI), the dataset type is now shown as a column. See screenshot to the right.



4.1.2 HDB Datasets

For HDB DMI import and export, functionality was added to handle conversions between LENGTH and VELOCITY (length/time) similar to the special handling to convert between VOLUME and FLOW. When values are converted, the time in the particular timestep is used for the calculations. This allows users to import precipitation (in length units) from HDB into a reservoir's Precipitation Rate slot (in velocity units).

4.1.3 Missing value Diagnostic

A diagnostic message was added to notify when a database DMI replaces a missing value with a user specified value. The message is enabled from the Workspace diagnostic settings **Data Management ➥ DMI Dataset** category. An example of the message is:

```
DATASET: Obs Values: Slot "Data.Input Series" timestep "24:00 May 5,
2010" missing value replaced with 999.000000 * 1.0cfs = 28.288530 *
1.0cms
```

4.1.4 User Parameters in DSS File Names

User parameters are now allowed in DSS file names using the syntax %parameter%. For more information, click **HERE (DMI.pdf, Section 5.3.1)**.

5. Diagnostics

5.1 Output window

The diagnostic output window was re-implemented. The following enhancements were made:

- The context / message splitter is now automatically adjusted to fit the context list width when messages are added or the window is resized.
- Performance: In general, the time it takes to add a message does not increase with the number of previously generated messages. This was a problem with the prior Qt3-based implementation.

6. Multiple Run Management

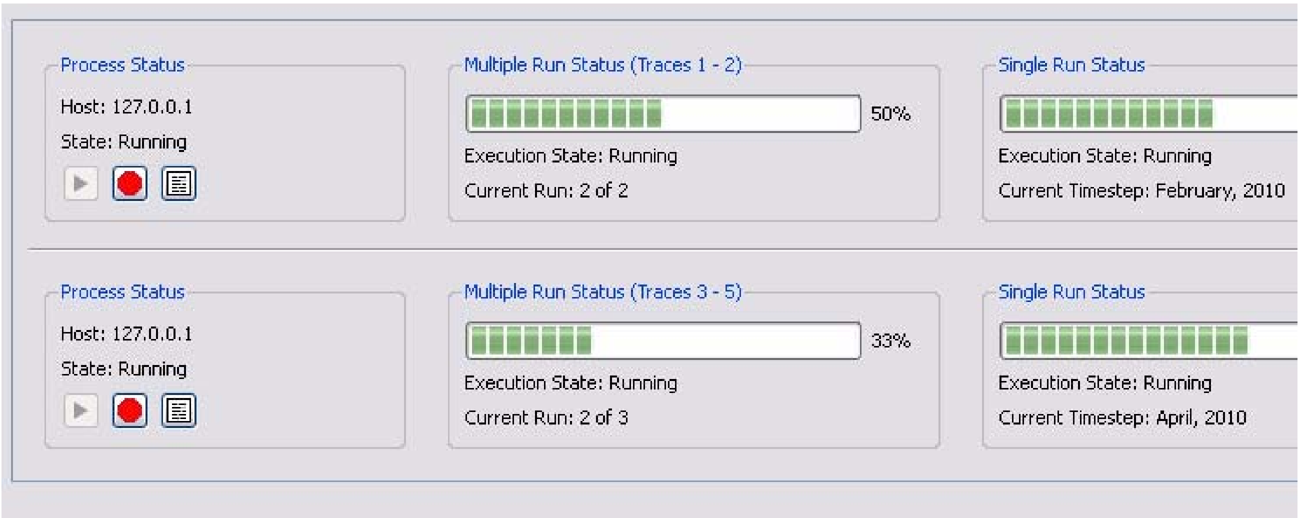
6.1 Excel DMIs

An option was added to allow Excel DMIs to use the MRM trace number as labels in Excel spreadsheets. The configuration options in the Excel Dataset now allow you to specify the Run name as:

- Single Run Name
- Multiple Run Name using Run0, Run1,...
- Multiple Run Names using Trace1, Trace2,...

6.2 Distributed MRM

Concurrent multiple runs can now be distributed across many processors on the same machine. This allows for better end to end run time as multiple simulations are occurring at the same time. Following is a screenshot for the run status for a multiple run distributed to two processors. For more information on this utility, click **HERE (MRM.pdf, Section 6)**.



7. Objects

7.1 Control Point Regulation Discharge

In the **Regulation Discharge**, **Reservoir Current** (or **Future**) **Level Regulation** method, a new slot, **Level Regulation Parameter Minimum**, was added. This slot provides a lower bound on the **Level Regulation Parameter**. Previously, the Level Regulation Parameter was limited to always be greater than or equal to the reservoir's top of conservation pool. If values are not specified in the new slot, then the reservoir's top of conservation pool is used. Existing models do not need to be modified to match previous results.

7.2 Conductance Computations

On the Distribution Canal, Groundwater Storage and Reach objects, methods were added to compute the compute the Conductance for head based flow. Following is a description of the new categories and methods on these three objects.

7.2.1 Distribution Canal

The **Canal Conductance Specification** category was added with two methods:

- **Specify Conductance** (default) - conductance is required scalar value.
- **Compute Conductance** - conductance is computed from hydraulic conductivity, canal seepage thickness, and seepage area. This method is executed from at beginning of run.

7.2.2 Groundwater Storage

The **Groundwater Conductance Specification** category was added with two methods:

- **Specify Conductance** (default) - conductance is required scalar value

- **Compute Conductance** - conductance is computed from hydraulic conductivity, length, width, thickness, and anisotropy ratio of the given and the linked objects. Essentially, the object computes the harmonic mean of the conductivity using geometry of the two adjacent objects. This method is executed from beginning of run.

7.2.3 Reach

The **Reach Conductance Specification** category was added with two methods:

- **Specify Conductance** (default) - conductance is required scalar value
- **Compute Conductance** - conductance is computed from hydraulic conductivity, riverbed thickness, and seepage area. This method is executed from beginning of run.

7.3 Reservoirs

7.3.1 Energy in Storage Methods

The following changes were made to the EIS category and methods:

- The category **energyInStorageCalcCategory** was renamed **Energy in Storage**.
- The method **noEIS** was renamed the **None** method.
- The method **tableLookup** was renamed **EIS Table Lookup**.

Old models will automatically update on load and you will be notified with a warning diagnostic.

In addition, a new method was added to the Energy in Storage category, **EIS Table Lookup with Cons Pool**. This method uses a table lookup of pool elevation to interpolate the energy in storage. Then it uses the pool elevation corresponding to the top of conservation pool to get the EIS at the top of the conservation pool.

7.3.2 Evaporation Rates

The **Evap and Precip Rate Specification** category was added to the reservoir objects to allow alternative methods for specifying evaporation and precipitation rates. This category is only available when the **Input Evaporation** method is selected in the **Evaporation and Precipitation** category.

There are three methods in this new category.

- **None**: Rates must be input or they default to zero.
- **Monthly Rates**: Rates are specified as monthly series.
- **Periodic Rates**: Rates are specified on periodic slots.

Please see section 16.1.17 of the Objects chapter of the RiverWare help for more information.

7.3.3 Flood Control Minimum Release

In the **Operating Level Balancing** method in the **Flood Control Release Calculation** category, a slot **Flood Control Minimum Release** was added. This slot can be set by rule logic (along with Outflow) to make a minimum release before the **Operating Level**

Balancing flood control algorithm is executed. The flood control algorithm will then respect this minimum and include it in outflow. For more information click **HERE (USACE_SWD.pdf, Section 3.4)**.

7.3.4 Operating Level slots

The following slots were added to the reservoir and are associated with method in the **Operating Levels** category:

Conservation Pool method:

- **Conservation Pool Storage**
- **Conservation Pool Full Storage**
- **Conservation Pool Storage Fraction**

Conservation and Flood Pools method:

- **Conservation Pool Storage**
- **Conservation Pool Full Storage**
- **Conservation Pool Storage Fraction**
- **Flood Pool Storage**
- **Flood Pool Full Storage**
- **Flood Pool Storage Fraction**

Conditional Operating Levels category, **Sum Inflows over Interval** method:

- **Operating Level Storage 2 Table**
- **Conservation Pool Storage Fraction 2**
- **Flood Pool Storage Fraction 2**

The “Storage” slots provide the actual storage in that pool. The “Full Storage” provides the total or possible storage in that pool. The periodic “Fraction” slots represent the percentage of that pool's storage at each level (column) in the Operating Level Table

7.3.5 Single Value Seepage

Previously, the **Single Value Seepage** method set non-input **Seepage** to the scalar value in the dispatch method. In some cases this led to excessive dispatching. To fix this, the **Single Seepage Value** method now fills the **Seepage** slot with the scalar value at the beginning of run.

Note, you can still input **Seepage** or set it with a rule.

7.4 Slope Power Reservoir

7.4.1 3D Tables Allow NaNs

The following three dimensional tables now allow NaNs at the bottom of a block:

- **Partition BW Table**
- **Profile Storage Table**
- **Profile Backwater Table**

7.4.2 Max Outflow Computation

Previously, in certain circumstances, setting max outflow on slope power reservoirs failed to solve correctly due to a diverging solution. The max outflow computation was improved to identify this diverging solution and use the bisection method.

Further, diagnostics were added in the **Dispatch Management ➥ SimObj** category to show the pool elevation and outflow (in user units) for each iteration in the max outflow computation on slope power reservoirs.

7.4.3 Segment Storage

In the **SlopeStorageCalc** method, two new slots were added:

- **Segment Storage** - Agg Series slot to report the storage in each segment
- **Segment Storage Adjustment** - 3D table slot to adjust the segment storage based on backwater elevation and change in backwater elevation from previous timesteps.

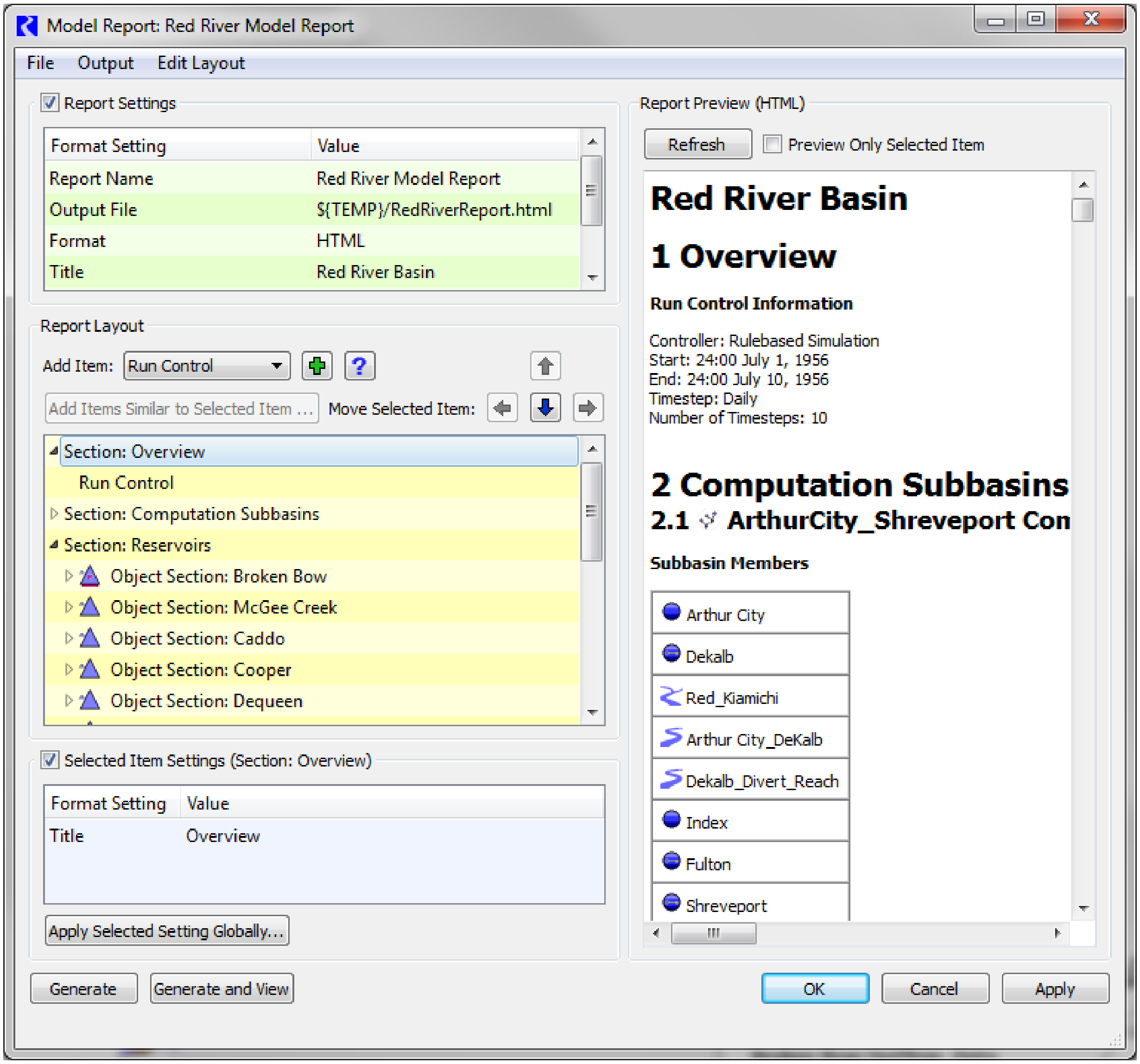
These slots are added to the **SlopeStorageCalc** but are used/calculated in the **Impulse Response** and **Weighting Coeffs** method which do the slope storage calculations.

8. Plotting and Output

8.1 Model Report

A new output device, the **Model Report**, was added to the Output Manager. The **Model Report** is an output device that generates an HTML document describing the current model. The **Model Report** is flexible with respect to both the contents and appearance of the report, allowing the user to configure both the information contained in the report as well as how that information is formatted.

The following screenshot shows an example configuration and a preview of a model report. Click **HERE (Output.pdf, Section 4)** for more information.



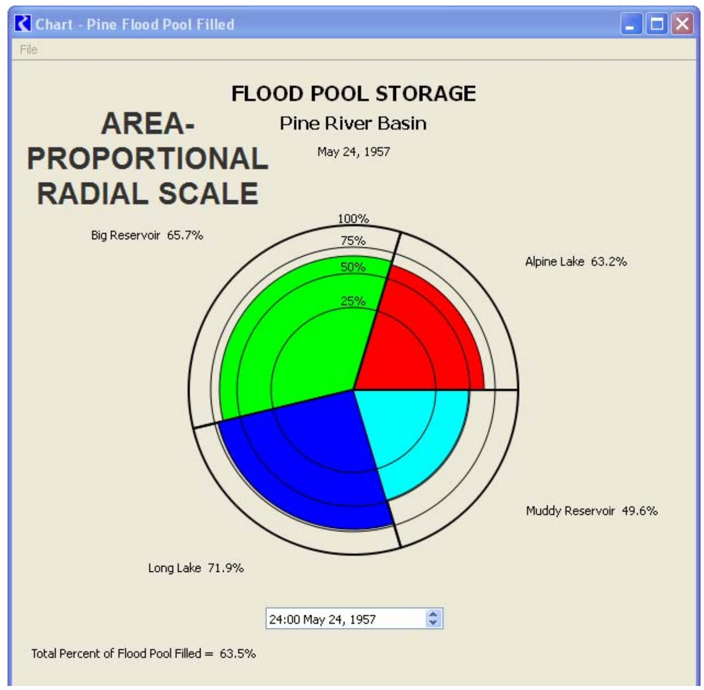
8.2 Pie Charts

A new output device, the **Chart**, was added to the Output Manager. Currently, the chart supports three types of pie chart for data stored in series, periodic, and scalar slots.

- **Standard:** The slices are drawn and colored in proportion to each slot's part of the total.
- **Linear Radial Scale:** The chart shows a radial dimension of data in addition to the data creating the pie slices. For example, the pie slices could show each reservoir's portion of the total flood pool storage that exists in the basin if all flood pools were filled. The radial dimension

could show how much of each reservoir's flood pool is actually filled at a certain timestep. Only the actual storage part of the pie slice is colored. The radial dimension has a linear scale.

- **Area-proportional Radial Scale**: The final option is similar to the linear scale but displays the radial dimension as an area-proportional scale. An example of this chart is shown in the screenshot.

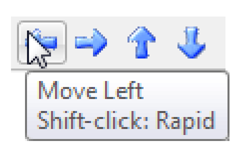


For more information on pie charts, click **HERE (Output.pdf, Section 5)**.

8.3 Plot Dialog - Move Arrows

In the plotting tool, the **Move** buttons  were improved as follows to allow you to more easily navigate through a plot page:

- Holding down the button (or Left/Right/Up/Down arrow key) repeats the move allowing you to scroll.
- Use the Shift Click or (Shift arrow keys) to rapidly move through the plot. Tool tips were added to remind you of these actions.



For more information, click **HERE (Output.pdf)**.

8.4 Temporary Directory

Previously, temporary output files were always written to the folder defined by the TMP or TEMP environment variable. In Windows 7, this is not always available. Now, RiverWare will use the TMP or TEMP environment variables if defined, but will otherwise get the default directory from the operating system. This temporary file path is used by:

- The default paths for the output files from the following output devices: Comma-delimited, RDF, and Excel. The user would typically change the path for these in the user interface to where they want them to be written.
- Default path for optimization log and data files if RIVERWARE_OPT_DIR is not defined.
- Default path for Control File-Executable type DMI files if RIVERWARE_DMI_DIR is not defined.

The RiverWare System information dialog shows the path for the temporary directory used. This can be found in the **Help ➥ About RiverWare** menu, then click on the **Show System Info...** button.

8.5 XMGR Output Devices Removed

The Solaris output device type **XMGR Data File** is no longer supported, so it was removed. A warning message is posted at model load if your model has XMGR devices.

9. RiverWare Policy Language

9.1 Initialization Rules

In accounting models, values set by initialization rules were not correctly used. To fix this, the timing of initialization rule execution was moved to the very end of the initialization phase. In addition, diagnostics for initialization rules can now be found only in the Simulation and Rulebased Simulation Settings. For more information on initialization rules, see section 5.1.2 of the Simulation portion of the RiverWare help.

9.2 RPL Editor Displays

9.2.1 FOR EACH changed to FOR

To be consistent, the **FOR EACH** statement was changed to be the **FOR** statement

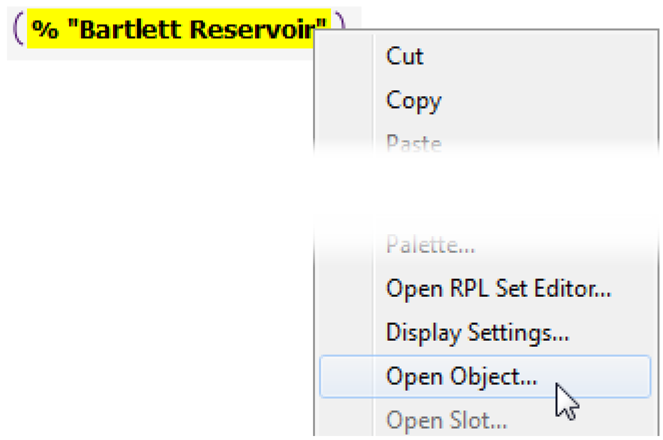
9.2.2 New Display Colors

Two new display colors were added to the RPL Display Settings dialog:

- **Expressions** - the color for key words in expressions (like IF, THEN, AND, OR, etc) The default color is dark purple.
- **Expressions background** - the color used for the background of the bounding rectangle for expressions. The default color is pale gray. Note, this color was added to better show bounding rectangles for each expression in a block. If you do not wish to see it, you can change the Expression Background color to match the Background color. This duplicates previous behavior.

9.2.3 Open Slots and Objects from RPL dialogs

Within RPL expressions, the following items were added to the right click context menu when an expression is selected:



- **Open Object...**
- **Open Slot...**
- When the selected item is a valid object or slot, then the appropriate menu item is enabled, and when activated will open the appropriate dialog. Note that this only works for expressions for which the object can be determined without evaluation.

9.3 RPL WITH Statement

A new RPL statement, **WITH**, was added:

WITH (<type> variable = <expr>) DO
<statements>
END WITH

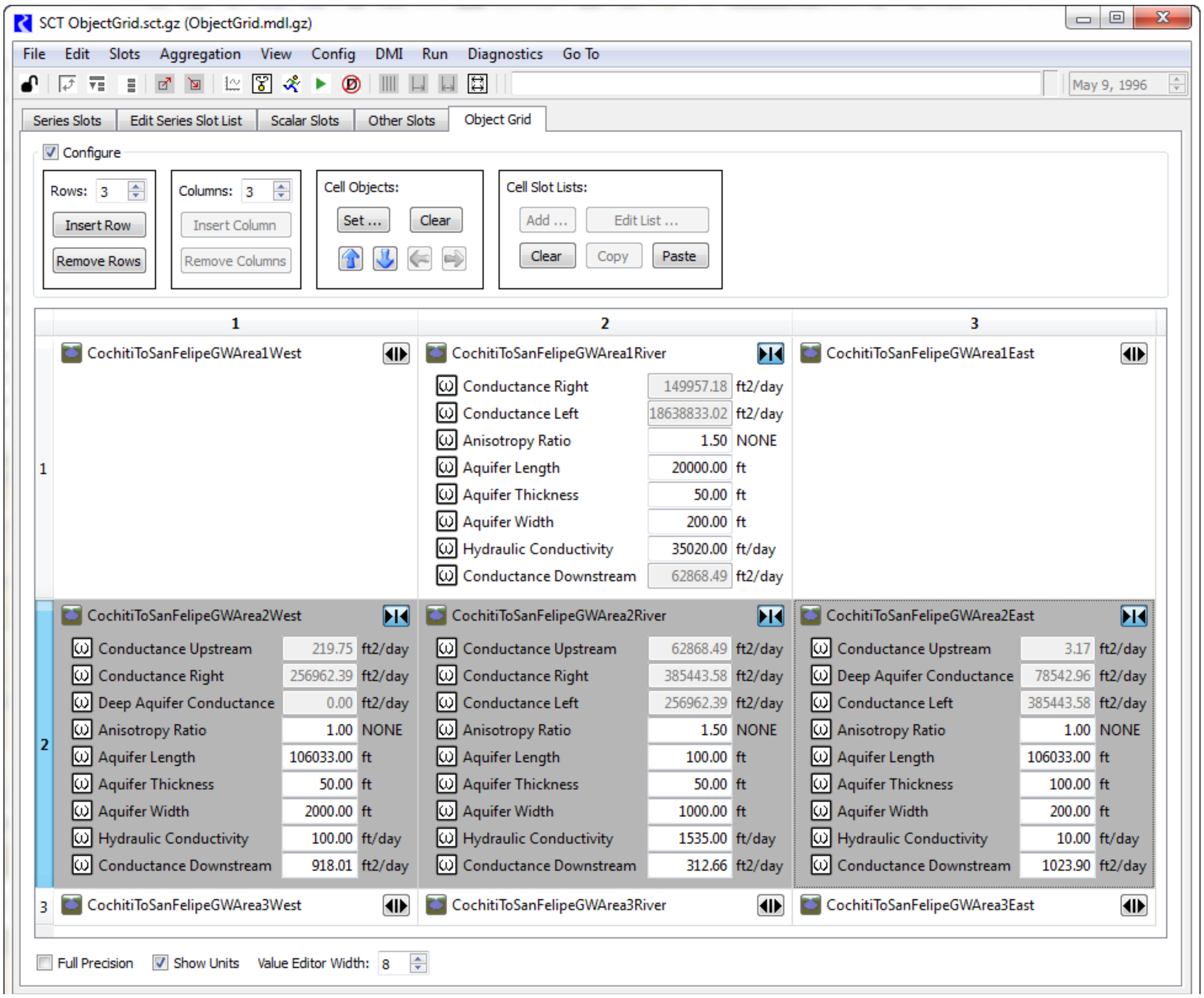
This evaluates the expression, assigns the result to a local variable with the given name and type, then evaluates the contained statements, which may reference the variable. This statement is analogous to the With expression, but can be used across statements.

10. SCT

10.1 Object Grid

A new tab was added to the SCT. The **Object Grid Tab** presents a user-configured grid of simulation objects. Each **Cell** represents one object. Scalar slots and single-cell table slots are displayed (and are directly editable) as a list of slots within the cell. For more information, click **HERE (SCT.pdf, Section 7)**.

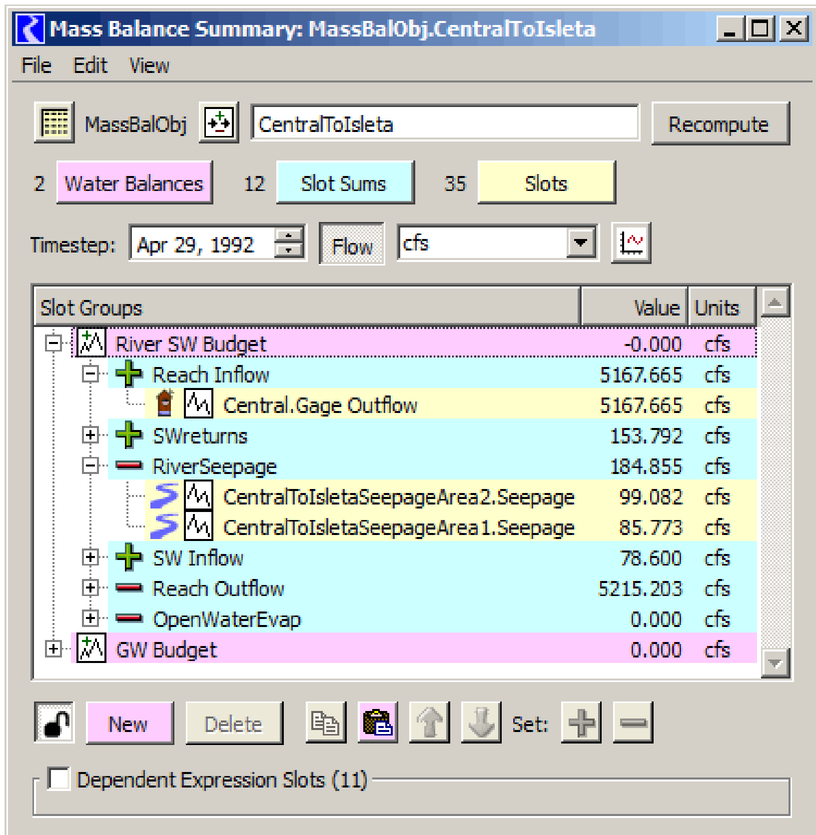
This setup allows you to spatially arrange your objects and then edit the slot data based on that spatial arrangement. An initial use of this tool was for groundwater objects that interact with each other. The network of object was created in the Object Grid and then was used to configure each object’s data as necessary. The following screenshot shows the SCT Object Grid for several groundwater objects:



11. Slots

11.1 Mass Balance Summary

The **Mass Balance Summary** slot is a user-defined hierarchy of series slot collections used to check (i.e. sum) mass balance across many objects. The collections have an associated series slots representing the sum of the contained slots.



There are two levels of within a Mass Balance Summary slot:

- **Water Balance** -- the sum of one or more **Slot Sums**. For example, a water balance might represent all water flowing in/out of the main channel or all flows in the groundwater.
- **Slot Sum** -- the sum of one or more series slots. Slot sums are useful to summarize or classify different slots. For example, a **Slot Sum** might represent all the seepage, evaporation, diversions or return flow slots. The sum is represented as either the positive or negative sense. **Negative** Slot Sums are subtracted from their containing Water Balance. **Positive** Slot Sums are added in the containing Water Balance. Only flow or volume (unit type) series slots having the model run timestep size can be used. References to RPL expression slots are supported for entities not represented by slots on simulation objects.

The screenshot above shows a Mass Balance Summary with one Water Balance and multiple Slot Sums. For more information click **HERE (Slots.pdf, Section 4.16)**.

12. Units

12.1 Conversion factors for Area per Time

The previous conversion factor for ft^2/day was fixed as it was incorrect by 0.01%.

Previous: 1 m^2/s = 9.31E+5 ft^2/day

New 1 m^2/s = 9.30001860003718E+05 ft^2/day

This does not change underlying data, but does change the value that is displayed to the user.

13. Closed Bug Reports

The following bugs have been closed for this release. For more information on any bug, see the CADSWES website. The bugs are listed in order by bug number:

5115	5129	5137	5138	5139	5140	5141
5143	5144	5145	5146	5147	5148	5151
5152	5153	5155	5156	5158	5162	5164
5165	5167	5168	5171	5172	5173	5174
5175	5176	5177	5178	5180	5181	5182
5183	5184	5185	5186	5188	5189	5190
5192	5193	5194	5197	5198	5199	

Release Notes Version 6.3

1. Special Attention Notes

Following are special attention notes, indicating that:

- Functionality has changed that requires you to update models, or
- Results may differ

If you have any questions, please contact riverware-support@colorado.edu

1.1 Unit Schemes

It is now much simpler for you to configure how numeric values are displayed in RiverWare. Now **Unit Schemes** control the display of Units, Scale, Precision and Format. This is a major change in how these attributes are configured.

When you first load your model, a transitional scheme is created to replicate your previous unit configuration. **You should look through this transitional scheme and delete any unnecessary exceptions. This will improve performance of you model.**

Click **HERE (Section 18.1)** for a description of the unit schemes. Or click **HERE** for video presentations on Unit Schemes.

1.2 Slot Name changes

Groundwater slots were re-named to be more consistent and have shorter names as shown in the following table. Existing model files are automatically updated with the new names, including links. Any RPL expressions or DMI's that reference these slots will need to be updated.

Existing Slot Name	New Slot Name	Existing Slot Name	New Slot Name
Previous Adjacent Elevation Upstream	Elevation Upstream Previous	Groundwater Flow Upstream	Flow Upstream
Previous Adjacent Elevation Downstream	Elevation Downstream Previous	Groundwater Flow Downstream	Flow Downstream
Previous Adjacent Elevation Left	Elevation Left Previous	Groundwater Flow Left	Flow Left
Previous Adjacent Elevation Right	Elevation Right Previous	Groundwater Flow Right	Flow Right
Previous Water Table Elevation	Elevation Previous		

1.3 Water Quality

For Layered/Discretized salinity modeling, the Salt Concentration should be linked instead of Salt Mass. You should re-link any existing models.

For all salinity models, linking of salt on stream gages has been simplified. Now there is only a **Salt Concentration** slot when previously there were inflow and outflow salt concentrations. You will need to re-link any stream gage salt concentration slots. Click **HERE** for more information.

1.4 Accounting Clearing Values

On an account, output values on unlinked inflow slots (Inflow, Return Flow, Transfer In) were not cleared during run initialization. A change was made to correctly clear all of these output value. This fixed behavior could lead to different model results.

1.5 Optimization Licensing

The optimization solver IBM ILOG CPLEX is now bundled with RiverWare. To access the solver, your RiverWare license must specifically allow you access to the solver library. **If you use RiverWare's optimization solver, you will need a new RiverWare license file.** Please contact riverware-support@colorado.edu for more information.

2. Accounting

2.1 Water Rights Shared Priority

As part of the priority water rights solver, an enhancement was made to optionally allow a model to have duplicate or shared water right priority dates. When multiple accounts share a priority date, they proportionally share the available water while not shorting higher priority rights. The details of this solution algorithm and more information can be found **HERE (, Section)**.

To use this:

- Enable the **Allow Equal Priority Dates for Accounts** toggle in the **Account System Configuration**
- Select the **Share Proportionally With Limits** method in the **Account Equal Priority Allocation** method category on the water rights computational subbasin
- Configure multiple accounts to have the same priority date on each account or through the **Account Manager**

The relevant account dialogs were also enhanced to show you when you have accounts that share a priority date.

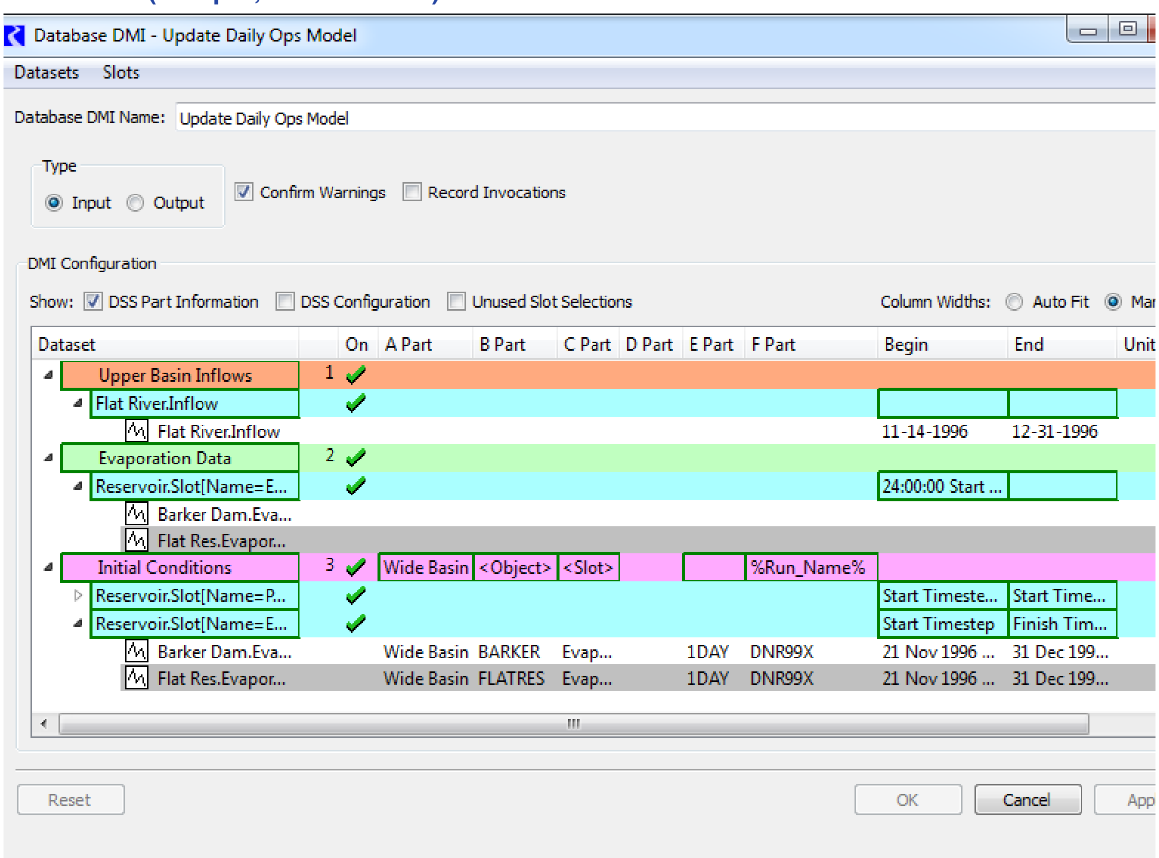
3. Data Management Interface

3.1 Database DMI Interface improvements

The Database DMI dialog was improved for usability as follows:

- Column resize modes, **Manual** and **Auto Fit** were added.
- Check boxes were improved to use the On/Off check marks.
- The Type column was removed. A tool tip on the Dataset gives its type (DSS, Excel, HDB)
- A Priority column was added.
- Green boxes were added to show which cells are editable.
- Tool tips were improved to show content and instructions.
- **DSS Dataset General Configuration** and **DMI User Parameters** areas were combined into one panel.

The screenshot below shows these changes. For more information click **HERE (DMI.pdf, Section 5.2.2)**.



4. Diagnostics

4.1 Diagnostic Output Filtering

The Diagnostic Output dialog was improved to support filtering of results. There are now two approaches to find the desired message:

- **Search** to look for a specific text string within all rows.
- **Filter** to show only rows that match the text string.

For more information click **HERE (Diagnostics.pdf, Section 1.4.1)**.

4.2 Diagnostic Manager Usability

The Diagnostic Manager has been improved to always send output to either the Diagnostics Output or to a file. Previously, you had been able to send it to a dos window.

5. Help and Documentation

5.1 PDF Reader Location

RiverWare Help is composed of PDF files and is now viewed with the program associated with the ".pdf" file extension on your Windows system. This replaces all uses of the ACROREAD_PATH environment variable.

5.2 Video Demonstrations

A number of video demonstrations have been developed for new and existing functionality. Click **HERE** for more information.

6. Linking

6.1 Smart Linker

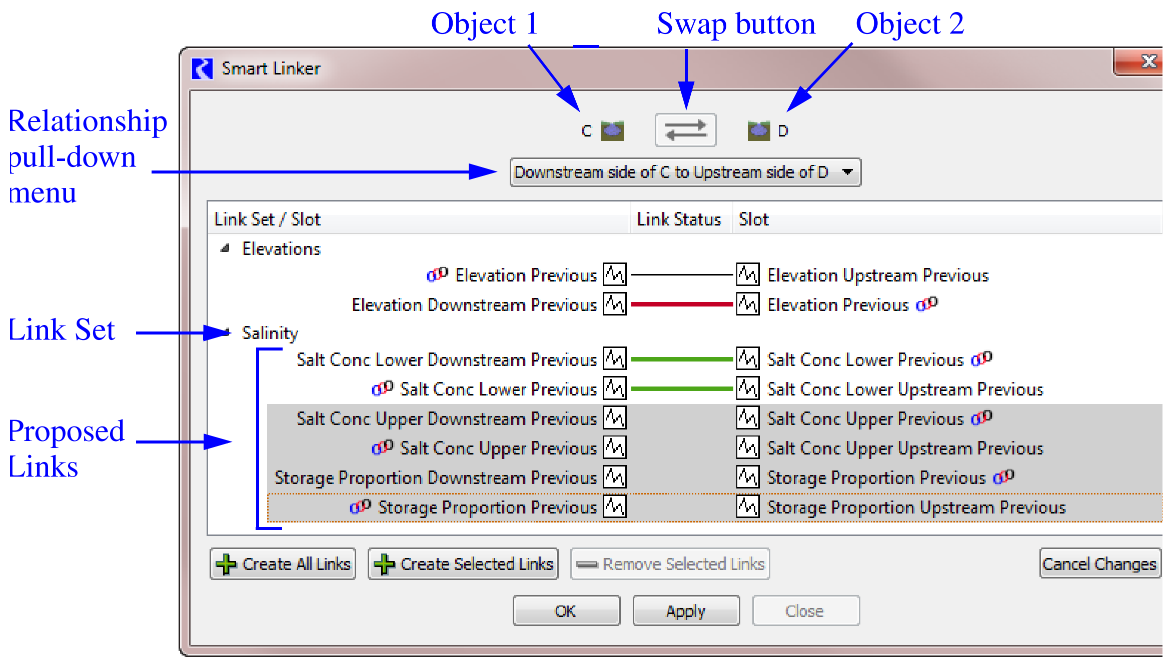
A new utility called the **Smart Linker** simplifies the process of linking slots by recommending a set of links between two selected objects based on the type of object, their method selections, and the relationship between the two objects.

For example, if you select a reach and a groundwater object, and you have the Head Based Seepage method selected on the reach and the Head Based Groundwater Grid method selected on the groundwater object, the Smart Linker proposes the links:

- **Reach.Previous Water Table Elevation** to **Groundwater.Elevation Previous** and
- **Reach.Seepage** to **Groundwater.Inflow from Surface Area**.

For more information, click **HERE (ModelBuilding.pdf, Section 6.2.2)**.and **HERE** for a video demo.

Following is a screenshot of the utility:

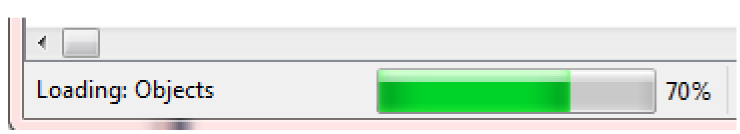


Linking recommendations were implemented for: Reach, AggReach, AggDistributionCanal, Stream Gage, Reservoir, Diversion Object and Confluence, Thermal, and Groundwater. The recommended links are in no way comprehensive; additional recommendations will be added in the future. Please contact riverware-support@colorado.edu if you have specific link recommendations that you would like implemented. All previously existing functionality for linking slots still remains.

7. Model Files

7.1 Save and Load Progress

Progress bars were added to the bottom of the workspace to better show the status of saving and loading the model file.



8. Multiple Run Management

8.1 Distributed Runs

During a distributed multiple run, the DMIs now use guaranteed unique names for the working directory name. This prevents conflicts when multiple runs are executing per trace DMIs. The working directory is removed to prevent a proliferation of directories.

9. Objects

9.1 Groundwater Storage Object

The following category and method names were modified on the groundwater object:

Existing Category Name	New Category Name	Existing Method Name	New Method Name
GW Solution Type	Solution Type	Single Groundwater Object	Single Computed Outflow
		Connected Groundwater Objects	Head Based Groundwater Grid
Specify Connected Groundwater Objects	Lateral Link Direction	No Connected Groundwater Objects	No Linked Objects
GWOutflowCalc	Groundwater Outflow Calculation	existingName	Existing Name
GW Deep Percolation	Deep Percolation		

9.2 Pipe Junction

9.2.1 Pipe Junction Solution Direction methods

On the Pipe Junction, two new methods were added to the Pipe Junction Solution Direction category:

- **Solve Flow 1 Only**
- **Solve Flow 2 Only**

These methods (along with the existing **Solve Flow 3 Only** method) limit the available dispatch methods and allow you to better control the Pipe Junction in Rulebased Simulation.

9.3 Reach

9.3.1 Step Response Seepage Routing

A new method was added to the **Seepage Routing** category on the Reach: **Step Response Seepage**. This method routes the computed seepage forward and sets the **Routed Seepage** slot.

9.4 Water User

9.4.1 Return Flow Routing method enhancements

The **Step Response** and **Multi Split Step Response** return flow routing method were added to the **Return Flow Routing** category. These methods are similar to the respective impulse response methods, but set values forward into the future from the current timestep.

In addition, the following methods were (re)implemented for improved performance, particularly when there are a large number of coefficients:

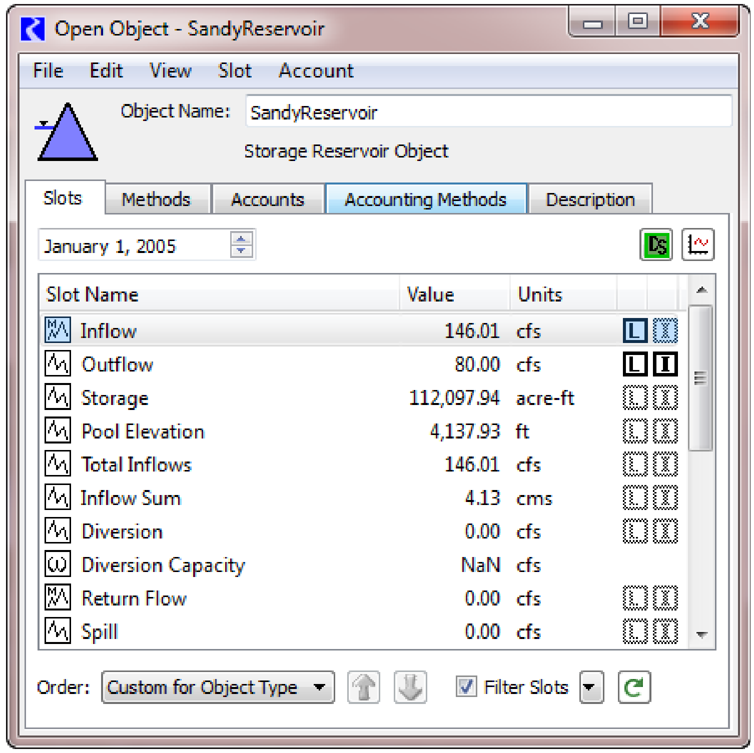
- **Impulse Response**
- **Multi Split Impulse Response**
- **Step Response**
- **Multi Split Step Response**

10. Open Object Dialog

10.1 Description Tab

There is now a user editable **Description** tab on all object dialogs. Use these to provide a text description to document the object. These descriptions can be included in a Model Report as described **HERE (Section 12.1)**.

10.2 Sorting and Filtering Slots



The Open Object dialog was reimplemented and improved for usability:

- Sorting Slots: On the slots tab, there are now more options for sorting slots and applying the settings to many objects. Click **HERE (ObjectDialogs.pdf, Section 2.2.2)** for more information.
- Filtering/Hiding Slots: On the slots tab, slots can be hidden so they do not clutter up your object. Click **HERE (ObjectDialogs.pdf, Section 2.2.3)** for more information. Click **HERE** to link to demonstrations of this functionality.
- On the slots tab, you can now select multiple slots and open, plot, or copy them using a right click menu.

11. Optimization

11.1 CPLEX LIcensing

As described in the special attention notes, The optimization solver IBM ILOG CPLEX is now bundled with RiverWare. To access the solver, your RiverWare license must specifically allow you access to the solver library. **If you use RiverWare's optimization solver, you will need a new RiverWare license file.** Please contact riverware-support@colorado.edu for more information.

11.2 CPLEX File Type

Optimization problems are now written in CPLEX's SAV binary format.

11.3 Diagnostics

Many improvements were made to optimization diagnostics. Previously, diagnostics were either on or off for optimization, with no filtering. Now there are meaningful categories and better messages, particularly for variable replacement and approximation. Print statements within Optimization goals are now supported. Click **HERE (Diagnostics.pdf, Section 4)** for more information.

11.4 Run Sequence Checks

When you initiate a run from either the **Run Control** dialog or the SCT, RiverWare now identifies situations in which you may have mistakenly omitted a run in the typical optimization run sequence (**Simulation → Optimization → Rulebased Simulation**). If an anomaly is noticed, a dialog will ask you if you want to continue. There are currently two specific scenarios that will be caught:

- A Rulebased simulation run followed by an Optimization run.
- A Simulation run followed by a Rulebased Simulation run (when there is an optimization policy set loaded).

11.5 Pool Elevation Approximation

In RiverWare optimization, pool elevation is approximated by storage. A constraint that only references pool elevation on a level reservoir is replaced by an equivalent storage constraint without approximation error. In all other cases pool elevation is replaced with a linear or piecewise-linear function of storage. A linear function is used when a constraint is of the form "Pool Elevation ± x = y," "Pool Elevation ± x >= y," or "Maximize Pool Elevation ± x" while a piecewise-linear function is used for the other cases, "Pool Elevation ± x <= y," or "Minimize Pool Elevation ± x." Linear replacement in general is either by selecting a point tangent to the nonlinear curve, or by choosing two points that form a secant with the curve. Each linear approximation uses one of these approaches.

Previously, RiverWare used the Tangent method for Pool Elevation. The code was changed to now use the Secant method. This change allows users to effectively have the same approximation for any form of a Pool Elevation constraint or objective function by specifying the same two points for Secant and Piecewise in the Pool Elevation LP Param table. All optimization users are likely to see different results as a result of this change from the Tangent approximation to the Secant approximation. To nearly replicate the previous results the Secant approximation points should be set very close to the Tangent point, but the points must be different. However, users may prefer the results obtained with different values of the secant points. Changing the points can improve or degrade approximation error depending on the nature of the solution.

11.6 Opt Input Evaporation Method

A new method was added to the **Optimization Evaporation Computation** category for reservoirs: **Opt Input Evaporation**. The method is analogous to the **Input Evaporation** method in simulation. It allows you to input **Evaporation Rate** and **Precipitation Rate** for each timestep and the method calculates **Evaporation** as the product of Evaporation Rate, Average Surface Area and Timestep length (similarly for Precipitation). Evaporation and Precipitation are then added to the mass balance constraint.

The **Use Elevation Approximation Points** method was added to the **Evaporation Linearization Automation** category. The method copies the storage values in the **Pool Elevation LP Param** slot to automatically populate the **Surface Area LP Param** slot.

12. Output and Plotting

12.1 Model Report

The Model Report output device provides a way to create an HTML document describing many aspects of a model. It was enhanced to provide additional content and formatting options as follows:

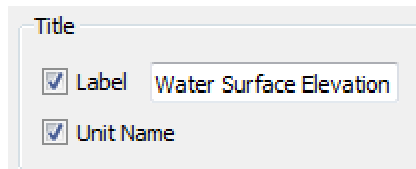
- **RPL Groups**: Show the contents of a RPL Group including a RPL Report Group. The contents of the subsections vary with object type, for blocks and rules it includes images of the frames (e.g., rule statements, function body). Click **HERE (Section 13.7)** for more information on Report Groups.
- **RPL Set:** Show all items in a RPL Set including the set description, if there is one. The same information is displayed as for a RPL Group item, but for all groups, plus the set description and settings.
- **Accounting slots**: Show accounting slots in report output.
- **Subbasins**: Show information on subbasins.
- **Series Slot Plots**: Show a plot of series slot data.
- **Timestamp**: Include a timestamp in the output file name, e.g., MyReport.11-19-2012.html.
- **Fonts and Text Size:** Control the fonts and appearance of text used within the report. This includes the body, title, and four heading fonts.

- **Preview Tab**: The preview panel was improved to be more functional with forward and back navigation buttons.
- **Log Tab**: A Log tab was added to display information and warnings that are posted during report generation.

For more information on Model Reports click **HERE (Output.pdf, Section 4)**.

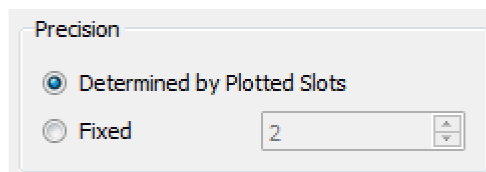
12.2 Plotting

12.2.1 Axis Labels and Precision



In the plotting utility, the axis configuration dialog was modified so that you can optionally enter a label for an axis and optionally specify a unit label. This separates the two concepts and allows axis titles to be, for example, Elevation, Elevation: ft, or just ft, depending on your preference. Separating these concepts allows for better behavior of the axis labels when units are changed.

Further, the precision displayed on the axis for a plot can now be:



- **Determined by Plotted Slots:** The most precise slot's precision is used for the axis precision. (Default)
- **Fixed**: You define the precision in the axis configuration.

12.2.2 AutoScale includes markers

The Plot Dialog's Auto-Scale feature scales and translates the plot to include the entire range of data including plot markers. Previously, markers were ignored in the scale computation.

12.3 Pie Chart Precision

Controls were added to the Pie Chart configuration to give you control over the precision of numbers displayed. Two options are available:

- Display precision of the slots for the display of their values.
- Display a fixed specified precision.

13. RiverWare Policy Language

13.1 Editing RPL Expressions

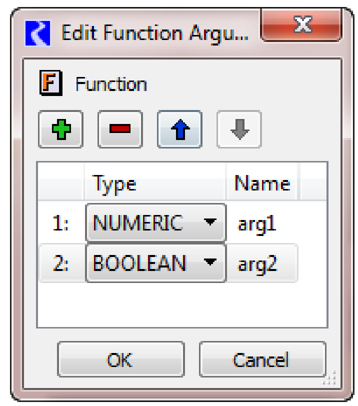
Following are changes made to the interface when editing RPL Expressions:

- RPL inline expression editing can now be canceled with the Escape key (Esc).
- You can now use the **Slot Selector** button on the RPL palette to specify a slot name as a STRING. For the expression **<object expr>.<string expr>**, click on <string expr> then click on the **Slot Selector** button on the palette and choose the slot by selecting a representative slot.

13.2 Expression Slots

For expression slots, the variable ThisObject was implemented. This variable can be used to access the containing Data Object. This variable was previously available for Object Level Accounting Methods.

13.3 Function Argument Editor



The RPL Function Argument Editor was re-implemented and enhanced to always show the pulldown menu controls. See the image to the right.

13.4 Hypothetical Simulation

The run time performance of models that contain many calls to the Hypothetical Simulation RPL functions was significantly improved. In a 10 year daily timestep test model with many calls to HypTargetSim, the run time was reduced by 53%. Note, the run time reduction is a function of the number of timesteps in the run, the number of calls to these functions, the number of objects in the subbasins, and the number of values being set on those objects within the hypothetical simulation.

13.5 Maximum Rule Executions per Timestep

Previously, the maximum rule executions per timestep was hard coded to 50. Now, you can control this value by setting the **Maximum Rule Executions Per Timestep** parameter in the **Rulebased Simulation Run Parameters** dialog accessed from the Run Control's View menu. The value limits the number of times any rule can execute during a timestep. If this limit is exceeded, the run is aborted with an error message. The default remains 50.

13.6 New RPL Predefined Functions

13.6.1 DispatchTime and DispatchCount

New RPL predefined functions, **DispatchTime** and **DispatchCount** were added. They return the time and count, respectively, of dispatch method executions that have occurred since the beginning of the current run. See also this similar functionality described **HERE (Section 13.8)** for the RPL Set Analysis tool.

Click **HERE (RPLPredefinedFunctions.pdf, Section 27)** and **HERE (RPLPredefinedFunctions.pdf, Section 29)** for more information on these functions.

13.6.2 GetSlotValsNanToZero and GetSlotValsByColNanToZero

Two new RPL Predefined Functions were added: GetSlotValsNanToZero and GetSlotValsByColNanToZero. These behave like GetSlotVals and GetSlotValsByCol, respectively, except that any NaN is replaced with zero and returned. Also these functions do not support Periodic Slots.

Click **HERE (RPLPredefinedFunctions.pdf, Section 85)** for more information.

13.6.3 ListDownstreamObjects

A new RPL predefined function **ListDownstreamObjects** was added. It takes two objects and returns an inclusive list of all linked main channel objects in upstream to downstream order. Click **HERE (RPLPredefinedFunctions.pdf, Section 109)** for more information.

13.6.4 SlotWeightedAverageOverTime

A new RPL predefined function **SlotWeightedAverageOverTime** was added. It computes a series slot's weighted average over a given time period, using another series slot’s values in that same time range as the weights.

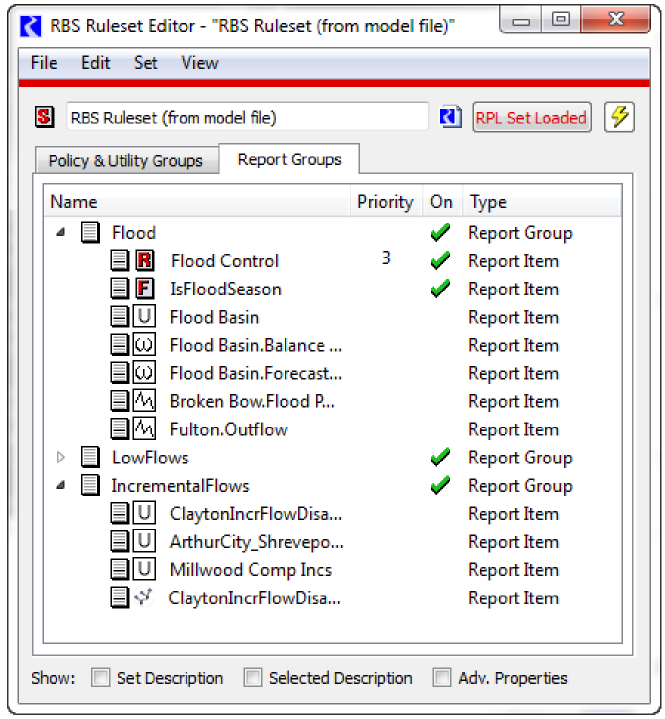
Click **HERE (RPLPredefinedFunctions.pdf, Section 165)** for more information.

13.6.5 SolveTurbineRelGivenEnergyInflow

A new RPL predefined function **SolveTurbineRelGivenEnergyInflow** was added. This function computes, on a Level Power Reservoir, the Turbine Release necessary to produce the specified Energy. If the Energy cannot be met, the maximum Turbine Release is returned.

Click **HERE (RPLPredefinedFunctions.pdf, Section 174)** for more information.

13.7 Report Groups



The RPL set editor has a new way to organize the contents of a RPL set. The Report Groups tab allows you to add and organize references to the following items:

- RPL functions
- RPL blocks (Rules, Goals, OLAM methods, etc...)
- Objects
- Slots
- Subbasins

Note, when added to a Report Group, the items are references to the existing item. One sample use of this tool is to organize items in a model that are related to a specific policy. The screenshot shows a Report Group that contains rules, functions, objects, subbasins, and slots related to Flood control.

Report Groups can be output to a Model Report at described **HERE (Section 12.1)**.

For more information on Report Groups, click **HERE (RPLUserInterface.pdf, Section 1.6.1)**.

13.8 RPL Analysis Tool

The **RPL Analysis** tool now shows two additional variables:

- **Dispatch Count:** For a Rulebased Simulation rule, this is the number of dispatch methods that have executed due to values being set by the rule.
- **Dispatch Time:** For a Rulebased Simulation rule, this is the time spent executing dispatch methods as a result of values being set by the rule

Use the **Window ➥ Column** menu to add these items. See also this similar functionality described **HERE (Section 13.6.1)**

14. Scenario Manager

14.1 General Enhancements

The Scenario Manager was reimplemented and enhanced as follows:

- Better sorting, display and access to slots in the input/output lists.
- A **Results to Compare** panel was added to allow the baseline model developer to pick slots of interest for output.
- There is now automatic generation of a special output snapshot object at the completion of a scenario run. The snapshot object has the same name as the scenario from which it was generated. A "BASELINE" snapshot is also generated for the baseline non-scenario) run. These actions occur only if the snapshot slot list template for scenarios is non-empty.
- Improved saving and re-loading of scenarios and the resulting data

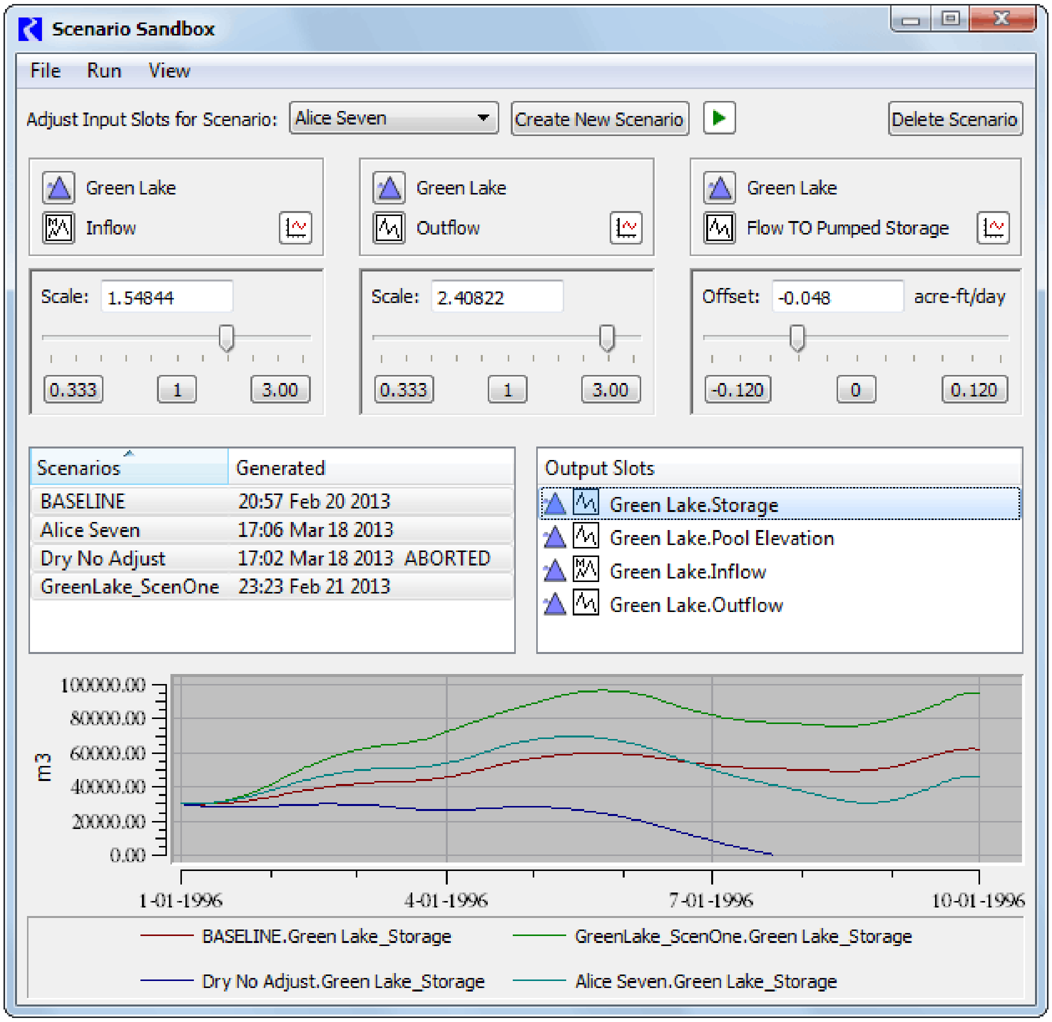
Click **HERE (ScenarioManager.pdf, Section 1)** for more information.

14.2 Scenario Sandbox

A **Scenario Sandbox** provides a convenient way for the scenario users (e.g. the stakeholders) to easily create and run scenarios and view results. The configuration of the sandbox is defined by the baseline creator. The Scenario Sandbox supports the following functionality:

- A single sandbox configuration can be defined within a baseline model.
- Up to three input scenario slots can be adjusted by the stakeholder.
- Slider controls are available to adjust the values of each of the three input scenario slots through scaling and offsetting.
- Plotting of scenario output slots is shown in a plot panel within the sandbox.

Following is a screenshot of an example sandbox:



Click **HERE (ScenarioManager.pdf, Section 3.1)** for more information.

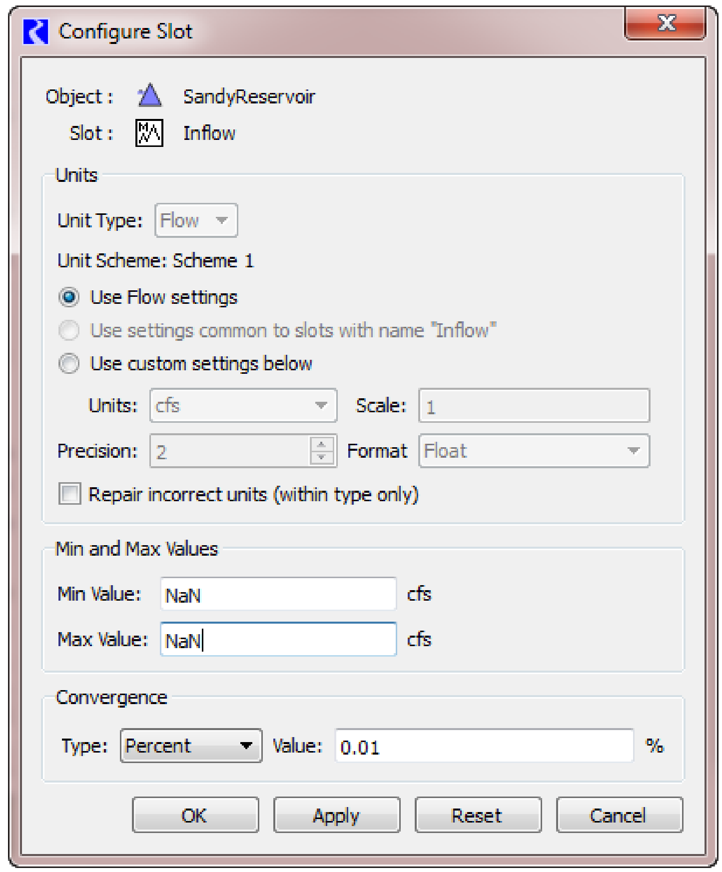
15. SCT

15.1 Warning on Close

A warning confirmation is now provided when you close an SCT. This should help to prevent inadvertent loss of an SCT that has not been saved.

16. Slots

16.1 Configuration Dialogs



As part of Unit Schemes (**HERE (Section 18.1)**), the slot configuration dialogs were re-implemented.

The scheme is now displayed and you choose to use the settings as follows:

- Use <UnitType> settings: Use the unit type rule.
- Use settings common to slots with name "<SlotName>": Use the Slot Name exception.
- Use custom settings below: Use a fully specified Object.Slot exception.

In the second two cases, an exception is added to the active unit scheme.

In addition, the sense/wording of **Convert slot value to new units and scale** was changed to **Repair incorrect units**. As this action does change underlying values, a confirmation was added.

Finally, an Is Integer check box was added for slots that are integers. This is available on Data Object slots. The primary use of this flag is to signal that values should always be displayed with 0 precision.

16.2 Configure Existing Slots Dialog

As part of Unit Schemes (**HERE (Section 18.1)**), the configure existing slots dialog (i.e. the Global Slot Configuration) was changed. Now only the following can be changed in this dialog

- Minimum and Maximum Values
- Convergence
- Unit Type for Slots on Data Object slots

Slot display attributes, which were previously supported on this dialog (Unit, Scale, Precision, Format), are now configured on the **Unit Scheme Manager.**

16.3 Multi-column Slot Configuration

Multi-column slots can now be configured from the View menu using one of the following options:

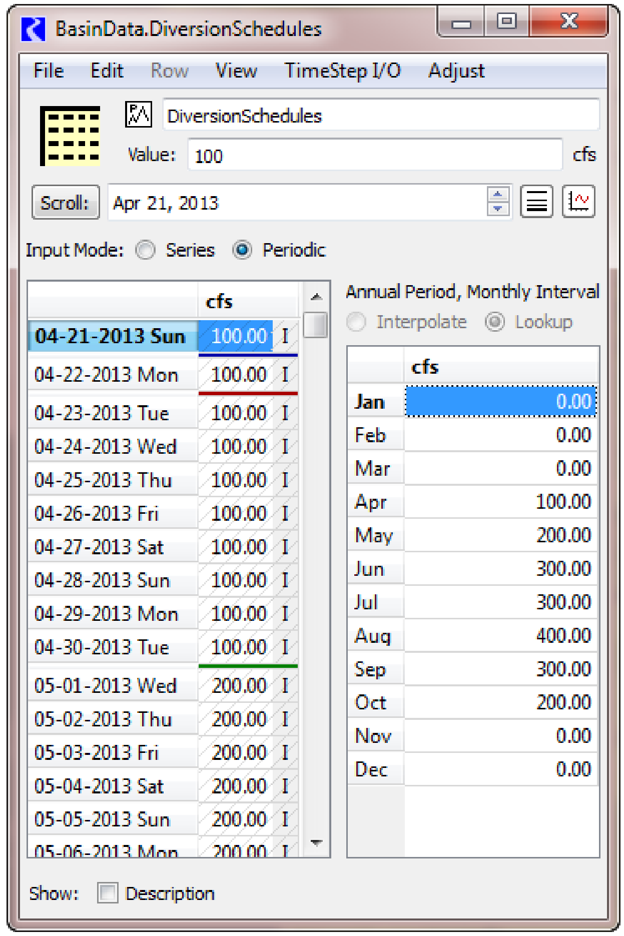
- Configure Columns Identically: configure all columns the same
- Configure Column: configure only the selected column.

Previously, this functionality was within the configuration dialog, not on the View menu.

16.4 New Types of Slots

16.4.1 Series Slots with Periodic Input

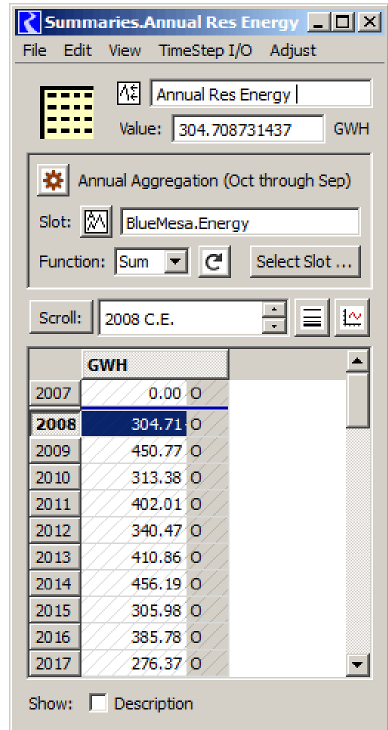
A new type of slot **Series Slot with Periodic Input** was added. This slot allows you to input data in series or periodic form and switch between the two.



You can create these slots on data objects. In addition, the following five slots on the Reservoir objects were converted to this type: **Irrigated Area Loss Rate**, **K Factor**, **Meadow Area Loss Rate**, **Pan Ice Switch**, and **Pan Evaporation.** Existing data in these slots is preserved.

For more information, click **HERE (Slots.pdf, Section 4.8)**.

16.4.2 Time Aggregation Series Slot



A new type of slot **Time Aggregation Series Slots** was added. **Time Aggregation Series Slots** temporally aggregate a selected series slot. For example, you might aggregate a daily flow to an annual average. They are created on data objects and can be recomputed manually or automatically at the end of a run. The configuration of a **Time Aggregation Series Slot** includes the following properties:

- The series slot to be aggregated
- The aggregation function, one of:
  - Sum
  - Average (mean)
  - Minimum
  - Maximum
  - First value
  - Last value
- Choice of aggregation period, one of:
  - Monthly
  - Annual -- Calendar Year
  - Annual -- Water Year

For more information, click **HERE (Slots.pdf, Section 4.7)**.

16.5 Notes on Accounting Multi Slots

An accounting multi slot (E.g. obj^account.Outflow, obj^account.Inflow, etc.) will now show a note if one is added to a linked supply. This allows you to annotate a supply and the note will show up on the linked upstream and downstream account slots. Click **HERE (Slots.pdf, Section 6.7)** for more information.

16.6 Changed Slot Types

The previous optimization system required that many slots have multiple columns, i.e. they were implemented as Aggregate Series Slots. This is no longer required, so many slots have been converted to plain Series Slots. When you first load your model, there will be diagnostic warnings alerting you to the changed slots. No further action is necessary.

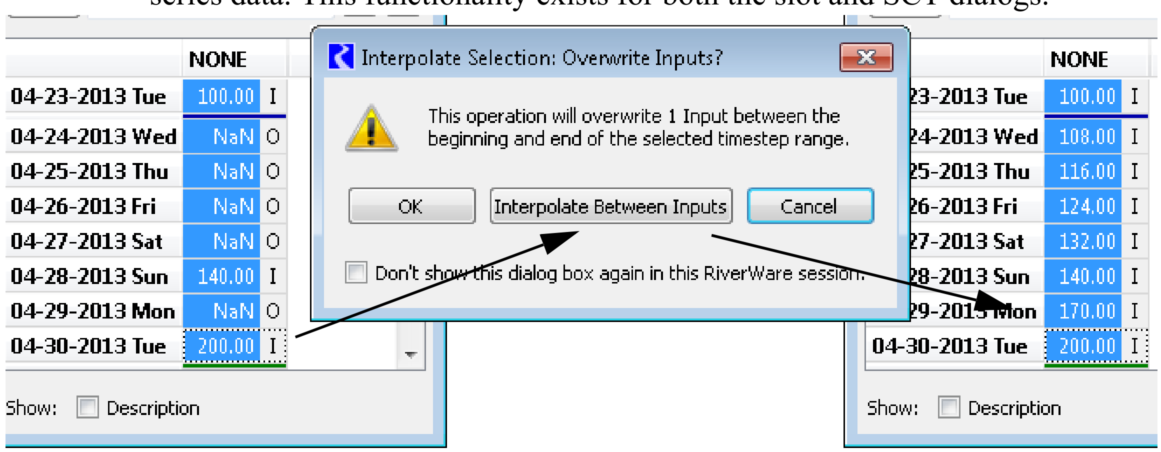
16.7 Mass Balance Summary Slot

The Mass Balance Summary Slot now has user controls for scale (pull down) and precision (View->Precision). These slots are controlled by Unit Schemes but you can create exceptions directly from the slot dialog.

Also, in prior versions, the Mass Balance Slot supported only Flow and Volume unit slots. It now supports Mass unit slots. All slots summed by a Mass Balance Slot must be either Flow or Volume units OR Mass units.

16.8 Interpolate between Inputs

The interpolate function (**Edit ➥ Interpolate**) now supports an operation to interpolate **between** (and not overwrite) intervening Inputs, if any are found. (See image below).One possible application of this is filling in gaps within series data. This functionality exists for both the slot and SCT dialogs.



17. Snapshots

17.1 Export/Import of Snapshots

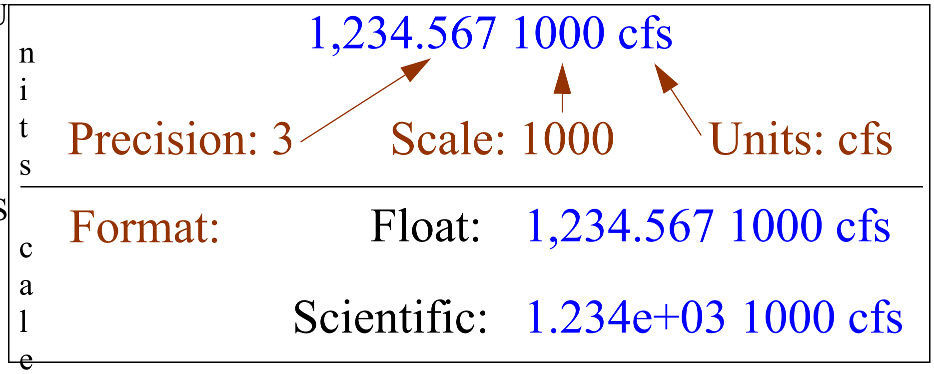
Exporting and re-importing Snapshot data objects was previously not fully supported: the associations of the Snapshot object's slots with the original slots had not been retained. This has been modified so that now snapshot objects can be imported and they will still refer to their source slots. Also, now Snapshot objects obtain their unit specifications from their source slot.

18. Units

18.1 Unit Schemes

A **Unit Scheme** describes how RiverWare will display numeric slot values in terms of four display attributes (collectively called “units”):

- Units
- Scale



- Precision
- Format

These four attributes are shown in the example to the right.

You can view and edit the Unit Scheme definitions and easily switch the active Unit Scheme using the Unit Scheme Manager (**Units ➥ Unit Scheme Manager** menu).

Following are some features of unit schemes:

- Unit Schemes are used to display all numeric values including slots, objects, account, SCT, plots, output devices, reports, RPL debugger, diagnostics.
- A unit scheme describes the attributes for each Unit Type. These are called **Unit Type Rules**.
- You can create exceptions to the unit type rule for all slots with a given name or for a particular slot.
- The units of any slot can be changed directly from the slot configuration or from the unit scheme manager.
- You can change the active scheme from the unit scheme manager or from the Workspace **Units** menu.
- When a previous model is first opened in RiverWare 6.3, a transitional scheme is created and activated to mimic the previous display attributes. **We advise that you investigate and clean up this transitional scheme for performance and usability reasons.**
- With Unit Schemes, the Resource Database or riverwareDB file has been removed and is no longer supported.

For more information on Unit Schemes click **HERE (Units.pdf, Section 2)**.

18.2 Units ksfd added

The volume user unit **ksfd** was added to the units file; 1 ksfd = 1000 cfs-day.

19. Water Quality - Salinity

Water Quality was enhanced to provide additional functionality when modeling Salinity. Following are the improvements. Additional Information can be found **HERE (WaterQuality.pdf, Section 1)**.

19.1 Additional Salt Mass Slots

The following salinity slots were added for completeness when checking mass balance of salt across many objects. Now each variable has a concentration and mass salinity slot:

- AggDiversionSite.Diversion Salt Mass
- Bifurcation.Inflow Salt Mass
- Bifurcation.Outflow1 Salt Mass
- Bifurcation.Outflow2 Salt Mass
- Reservoir.Reservoir Salt Mass
- Reservoir.Return Flow Salt Concentration
- Reach.Return Flow Salt Concentration

19.2 Linking on Aggregate Objects

On aggregate objects (Agg Reach, Distribution Canal, and Aggregate Diversion Site), salt slots are now automatically linked like the flow slots. For the Aggregate Diversion Site, the linking is based on the specified Linking Structure and the selected method on the aggregate. Warning and error messages are posted on model load if there is a problem linking the water quality slots.

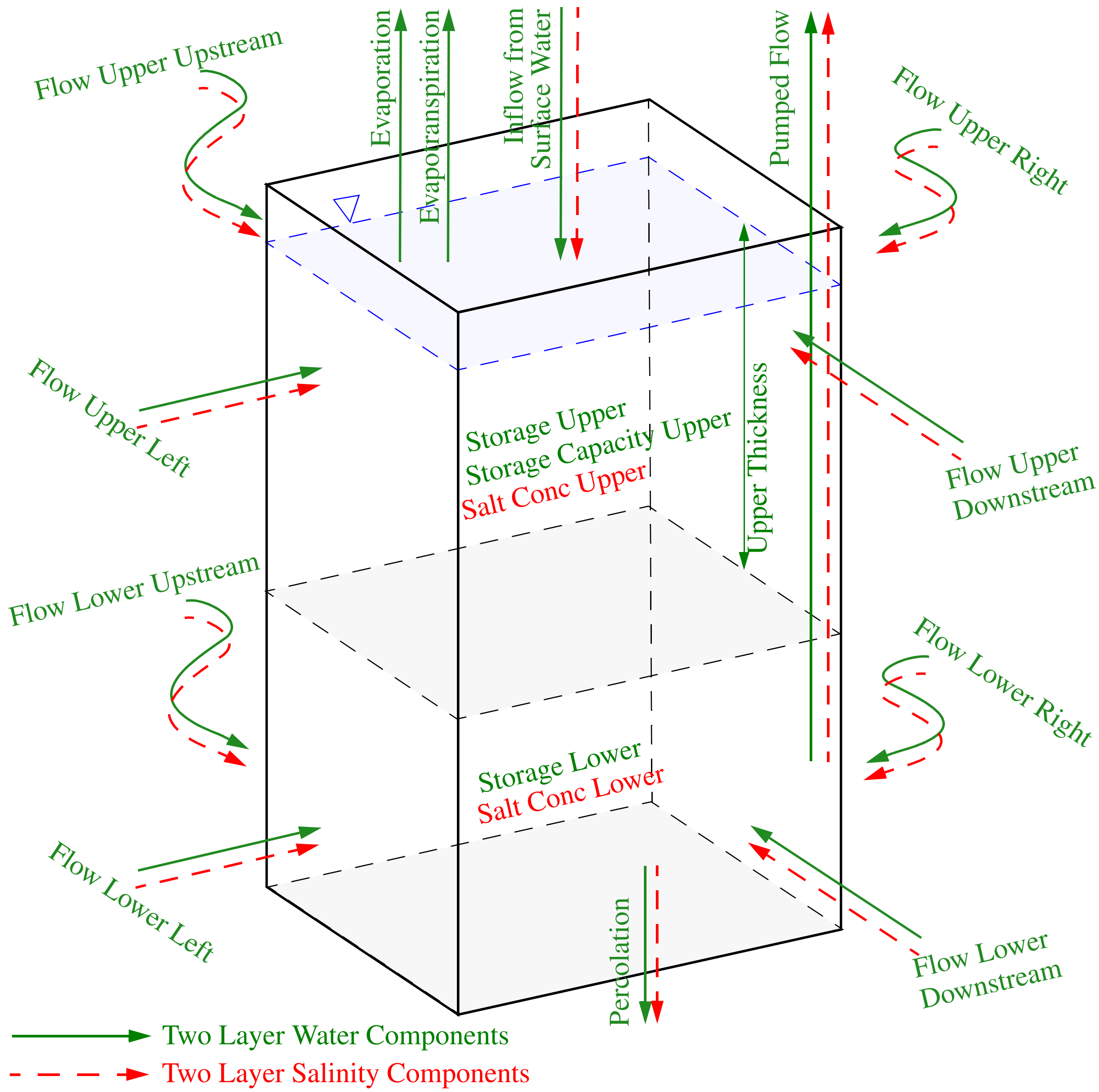
19.3 Layered / Discretized Salinity only

A "**Salinity**" only option was added to the Layered / Discretized solution approach. Many objects were improved or enhanced with methods to model salinity with this approach.

In addition, for all Layered/Discretized salt methods, now the Salt Concentration should be linked instead of Salt Mass. Any models will need to be updated.

Following is a summary of the changes made to each object:

- **Groundwater Object**: Water quality methods were added to model the head based groundwater object as two-layers, with a constant upper layer. Slots and solution equations were added to track the flow and storage of water and salt in both layers. Water and salt can flow to/from the upper or lower layer in four lateral directions: left, right, upstream and downstream. In addition, water and salt can enter/exit the object through Pumping, Deep Percolation, and Inflow from Surface Water. Evaporation and Evapotranspiration remove water but not salt. The following diagram shows a two layer groundwater object with the water and salinity components.



Flow into the object can be either negative or positive. When the flow is entering the groundwater object, the salt concentration propagates from the linked slot or must be specified. If the flow is out of the groundwater object, the concentration is set to the previous timestep's value to create an explicit solution.

For more information on this solution, click **HERE (WaterQuality.pdf, Section 13.3)**.

- **Bifurcation**: The two outflow salt concentrations are set equal to the inflow salt concentration.
- **Confluence**: Methods combine the two inflows and compute the flow weighted average Outflow Salt Concentration.
- **Distribution Canal** and **Agg Distribution Canal**: Methods route salt through the canal and divert water and salt to linked objects.
- **Diversion Object** and **Stream Gage:** Methods propagate concentration via a linkable Salt Concentration slot. If you previously modeled water quality on the Stream Gage, you will need to re-link slots and you may need to re-specify any input data and/or modify rules. You can link the constituent to both the upstream and downstream slot(s).
- **Reach**: The water quality routing and seepage method is automatically selected based on the flow and seepage routing method, respectively. A variable lag time salt routing method was added. Methods were also added to model salt when using head based seepage.
- **Reservoir**: Previously in Layered/Discretized, the temperature determined how inflows were distributed to hypolimnion and epilimnion. Since there is no Temperature in the Salinity only option, the following two methods were developed to distribute inflows:
  - **Specify Distribution** - Specify flow into one of the layers as input, rules, or links. The other is computed.
  - **Specify Fraction** - Input the fractional split on a series slot.
- **Water User** and **AggDiversion Site**: Methods were added to compute the return flow salt concentration based on the diversion, diversion salt concentration, and any specified salt additions.

20. Workspace

20.1 Geospatial View

Previously, on the Geospatial canvas of the workspace, you had to specify all of the information about the image and its projection. Now, if the image contains metadata about the projection, RiverWare will configure the geospatial view to show the image in the given projection. Also you can choose to view coordinates in latitude/longitude.

There are many supported image formats (RiverWare uses the GDAL/OGR libraries) but the three most common are:

- GeoTIFF

- JPEG 2000
- MrSID

In addition, to support these new map formats, the **Geospatial Canvas Configuration Dialog** was re-designed. It now shows three tabs for **Image and Coordinate System**, **Image and Canvas Location**, and **Additional Display Settings**. In the first tab, you can specify/show the projection information. If one of the above map formats is used, then you can also show and modify the geographic coordinates (Latitude and Longitude). The **Object Coordinate Manager** and the geospatial view status bar now shows these display geographic coordinates.

Finally, there is better support for transitioning existing models to use of the Geospatial view.

For more information, click **HERE (Workspace.pdf, Section 4.3.2.1)**.

21. Closed Bug Reports

The following bugs have been closed for this release. For more information on any bug, see the CADSWES website. The bugs are listed in order by bug number:

2816	3456	3896	4409	4420	4925	5035
5053	5069	5100	5109	5120	5135	5150
5157	5161	5169	5170	5191	5195	5201
5202	5204	5205	5206	5208	5209	5210
5214	5215	5217	5218	5219	5221	5222
5224	5225	5226	5227	5228	5229	5230
5231	5233	5235	5237	5238	5240	5243
5244	5245	5246	5247	5248	5249	5250
5251	5252	5253	5254	5255	5256	5257
5259	5260	5262	5263	5264	5265	5266
5268	5269	5270	5271	5272	5273	5274
5275	5276	5277	5278	5279	5280	5281
5282	5283	5285	5286	5287	5288	5289
5290	5291	5292	5296	5298	5299	5300
5301	5303	5304	5305	5306	5307	5308
5313	5315	5316				

Release Notes Version 6.4

1. Special Attention Notes

Following are special attention notes, indicating that:

- Functionality has changed that requires you to update models, or
- Results may differ.

If you have any questions, please contact riverware-support@colorado.edu.

1.1 Modified Names

Names were changed for the following category, methods, and slots. Existing model files will be updated automatically on load. Any RPL expressions or DMIs that reference changed slots will need to be updated.

Where	What	Previous Name	New Name
Aggregate Diversion Site	Category	Salinity Calculation	Return Flow Salt Calculation
	Method	No Salinity Calculation	None
	Slot	Return Flow Salinity Pickup	Return Flow Salinity Pickup Conc
	Slot	Water Quality Salt Debt	Salt Debt
Reach HERE (Section 7.3)	Category	routingMethodCategory	Routing
	Method	noMethod	removed
		noRouting	No Routing
		timeLagRouting	Time Lag
		variableTimeLagRouting	Variable Time Lag
		impulseResponseRouting	Impulse Response
		muskingumRouting	Muskingum
		kinematicRouting	Kinematic
		muskingumCungeRouting	Muskingum Cunge
		macCormackRouting	MacCormack
		noLocalInflow	No Local Inflow
		inputLocalInflow	Input Local Inflow
		contingentLocalInflow	Contingent Local Inflow
		LocalInflowDownstreamOnly	Local Inflow DownstreamOnly
		calcLocalInflow	Calc Local Inflow

1.2 Canal Object: Canal Flow Solution

A new solution algorithm was implemented for canal flow which can produce different results for models with a Canal object. The new method requires that the minimum and maximum values be set in the slot configuration for Pool Elevation on both reservoirs linked to the Canal object. Previously the slot minimum and maximum were only required on linked Slope Power Reservoirs. Also it is highly recommended that the slot convergence for all series slots on the Canal object be set to 0.00001%. More information can be found **HERE (Section 7.1.1)**.

1.3 Power Reservoir: Peak Power Methods

In the **Peak Power Equation** and **Peak Power Equation with Off Peak Spill** methods on Power Reservoir objects, changes were made in how Spill and Power Plant Cap Fraction are incorporated into the calculation of Peak Release. These changes could lead to different model results. More information can be found **HERE (Section 7.2.1)**.

1.4 Reach: Kinematic Routing Method

A small improvement was made in the finite difference approximation used to calculate outflows in the **Kinematic** routing method. This will produce small numeric differences in models using this method. More information can be found **HERE (Section 7.3.2)**.

1.5 Priorities Saved for all Slots

For rulebased simulation, slot priorities are now saved for all slots (when outputs are saved). Previously only slots on simulation objects were saved; data object and accounting slot priorities were not saved. Testing shows that this has a negligible effect on model size or save and load performance, but let CADSWES know if you notice any issues with this.

1.6 Water Quality - Reach - Simple Well-Mixed Salinity

A new periodic slot, **Maximum Salt Concentration**, is now a required value when using the **Mass Balance Salinity** method on a Reach.

Changes to the salinity mass balance on Reach objects could produce different model results. The changes particularly effect how the solution handles salt concentrations for flows very close to zero and negative flows. More information on the salinity mass balance on a Reach can be found **HERE (Section 15.1.2)**.

1.7 Thermal Object - Number of Hydro Blocks slot

A new scalar slot, **Number of Hydro Blocks**, was added to the **Calculate Block Economic Value** method. The value in this slot should be equal to the number of columns with valid values in the **Hydro Block Costs** slot. If **Number of Hydro Blocks** is greater than the number of **Hydro Block Costs** columns with valid values, the run will abort with an error message.

1.8 Weekly Timestep Removed

The weekly timestep is no longer available for selection in either the run control or slot range configurations. This rarely used timestep was not fully implemented so it has been removed from the interface. If you have a model or slots with a weekly timestep, they will behave as before.

2. Accounting

2.1 Multi-Account Method Selector

It is now possible to select Account Level Methods on many accounts in one action. From the Accounts Manager choose **Account ➥ Account Method Selector** to open the **Multiple Account Method Selector**. Click **HERE (, Section)** for more information.

2.2 Object Account Summary Dialog Improvements

The **Object Account Summary** dialog was improved as follows:

- When first opened, all accounts are selected. Previously, it was the first 10 in the list.
- The account list is initially closed so you can quickly see the account sum.
- There is a now a splitter between the two parts of the dialog.

For more information, click **HERE (, Section)**.

2.3 Renaming Accounts

It is now possible to rename many slots in one action. From the **Accounts Manager**, choose **Account ➥ Rename...** to change the name of the selected accounts. Click **HERE (, Section)** for more information.

2.4 OLAM Methods - Basin Specific

Rio Grande basin specific Object Level Accounting Methods (OLAMs) were enhanced to

- Allow for a monthly run timestep

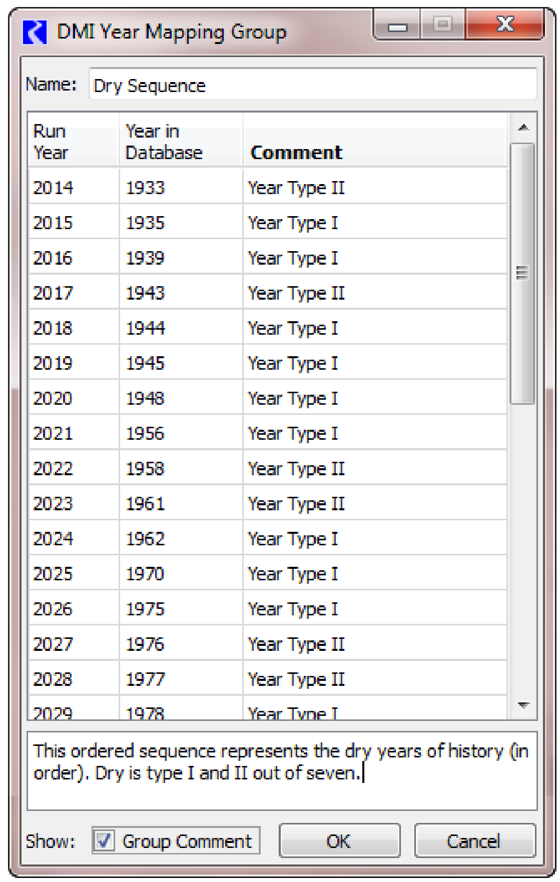
- Allow multiple Rio Grande Water Type accounts on Reaches, Confluences, and Stream Gages.

In addition, documentation was developed for these OLAMs and is included in: Basin Specific Object Level Accounting Methods (OLAMs).

As part of this work, the unit type for the slots PreRes Irrigated Area Loss Rate and PreRes Meadow Area Loss rate was changed from length to velocity. All models will be updated automatically upon load. The loss rate data was converted to the new unit type assuming the existing values represented a length/day loss rate. This unit type change will produce the same model results.

3. Data Management Interface

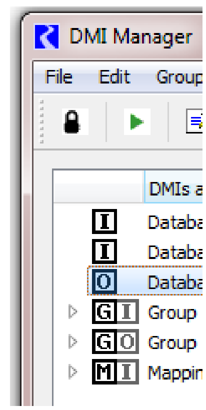
3.1 Year Mapping Groups



A new type of DMI group was added to the DMI manager. The **Year Mapping Group** allows you to import data from specified years in your database to years in your run. For example, you might want to run your 16 year run (e.g. run dates from 1/1/2014 to 12/31/2029) with data from 1992, 1933, 1935, 1939, etc. This tool, shown to the right, allows you to create the map between the year in the database and the years of your run. Mapping groups are available for DAILY timestep models with a range that starts on Jan 1st and ends on Dec 31st. Mapping groups may only contain Input Database DMIs (DSS, HDB, or Excel).

More information on this utility can be found **HERE (DMI.pdf, Section 2.2.4)**.

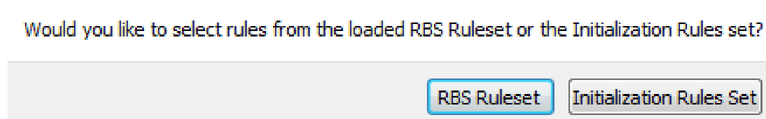
In addition, the DMI manager and menu on the workspace and SCTs now shows the groups and whether the member DMIs are all input, output or mixed. Also, in the DMI manager, you can double click a DMI in a group to edit the DMI.



4. Diagnostics

4.1 Initialization Rules Filtering

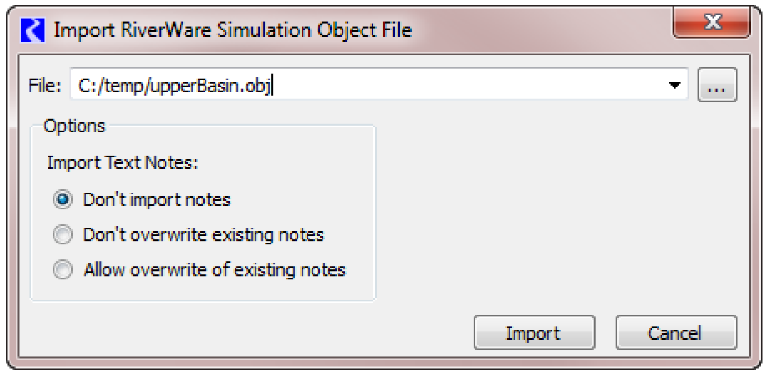
Previously, diagnostics for **Initialization Rules** were an all or nothing configuration. This could lead to voluminous output. Now you can filter on the Initialization Rule as well as Rulebased Simulation Rule names. When you choose to filter, the diagnostic manager will ask you which set you would like to use:



Then it will give you the appropriate rule selector.

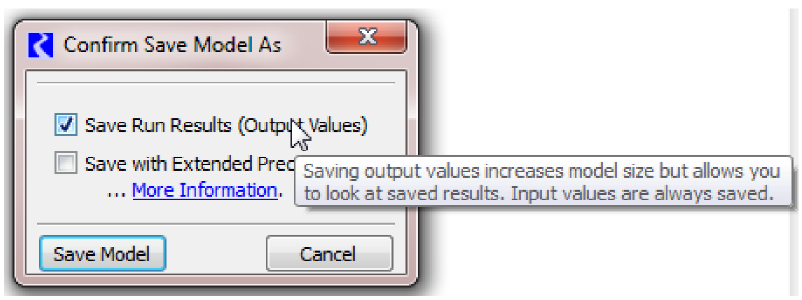
5. Model Files

5.1 File Choosers



Many of the File Choosers in RiverWare were re-implemented to use a common format. Dialogs like the **Object Import/Export** and **Workspace Image Export** dialogs now have a separate dialog to specify the options and choose the file as shown in the screenshot.

5.2 Save As Confirmation



The **Save As Confirmation** dialog was modified to be simpler but provide more information on the options. Use mouse-over tool tips to get more information on the options. Click the **More Information** link to learn about saving with **Extended Precision**.

6. Multiple Run Management

6.1 Improved Distributed Run Interface

The **Distributed Runs** tab of the MRM configuration was improved for simplicity and usability. In addition, the external RiverWare service (rwService.exe) is no longer necessary as all runs can be controlled within RiverWare and from the Remote Manager. For more information, click **HERE (MRM.pdf, Section 6)**.

7. Objects

7.1 Canal

7.1.1 Canal Flow Solution

An iterative, modified bisection algorithm has replaced the previous use of the Newton-Raphson Method when solving for canal flow. Testing has shown the new method to be more stable, quicker to converge and to have smaller error in the final calculation of Canal Flow. Full details regarding the new method can be found **HERE (Objects.pdf, Section 6.2.1)**.

The new method requires that the slot minimum and maximum in the Pool Elevation slot configuration be set for both linked reservoirs (previously only required if the linked reservoir was a Sloped Power Reservoir). Also it is recommended that the slot convergence value in the slot configuration for all series slots on the Canal object be set to 0.00001 Percent. The quality of the Canal solution is sensitive to this slot convergence, and setting the slot convergence to this recommended value can significantly improve the quality of the solution.

The new method will produce model differences as the new solution will tend to converge on slightly different values than the old solution.

7.2 Power Reservoir

7.2.1 Peak Power Equation with Off Peak Spill

The **Power Plant Cap Fraction** slot was added to the **Peak Power Equation with Off Peak Spill** method in the **Power Calculation Category**. If the slot value is not between 0 and 1, the run will abort. If no value is input, the Power Plant Cap Fraction defaults to 1.

Also, a correction was made to how Unregulated Spill gets incorporated into the calculation of Tailwater Elevation, Operating Head and Peak Release. These changes could produce different model results. Full details about this method can be found **HERE (Objects.pdf, Section 17.1.1.10)**.

7.2.2 Peak Power Equation

A correction was made to how Spill and Power Plant Cap Fraction get incorporated into the calculation of Tailwater Elevation, Operating Head and Peak Release. Also, the method previously could return a non-zero value for Power when Outflow was zero (though Energy was always zero when Outflow was zero). Now Power will always be zero if Outflow is zero. These changes could produce different model results. Full details about this method can be found **HERE (Objects.pdf, Section 17.1.1.9)**.

7.3 Reach

7.3.1 Local Inflow Solution Direction methods

A new method, **Calc Local Inflow or Solve Downstream** was added to the **Local Inflow Solution Direction** category. This method enables the two following dispatch conditions:

- solve for Outflow given Inflow and Local Inflow
- solve for Local Inflow given Inflow and Outflow

More information can be found HERE (Objects.pdf, Section 22.1.3.5).

7.3.2 Reach Kinematic Routing Method

In the **Kinematic** routing method, flow at a given segment is, in part, a function of the celerity (wave velocity) at that segment. In the finite difference approximation, the celerity used in this calculation was based on the flow at the previous timestep. Now celerity is calculated using the average of the previous timestep flow and the current timestep flow at the upstream segment. This improvement reduces the error in the mass balance calculation that is a result of using a finite difference approximation. Also, a correction was made in the calculation of Distributed Volume Output. These changes will produce differences in model results when this method is used. Details on this method can be found HERE (Objects.pdf, Section 22.1.1.10).

7.3.3 Reach Default Routing Method

The default method for the Routing category on Reach objects is now **No Routing**. Previously the default was **noMethod**, which required you to select one of the other Routing methods to avoid receiving an error message. Existing models will not be affected.

7.4 Thermal Object

7.4.1 Calculate Block Economic Value: Number of Hydro Blocks slot

A new scalar slot, Number of Hydro Blocks, was added to the **Calculate Block Economic Value** method. The value in this slot should be equal to the number of columns with valid values in the Hydro Block Costs slot. If Number of Hydro Blocks is greater than the number of Hydro Block Costs columns with valid values, the run will abort with an error message. The addition of this slot allows for more useful diagnostic messages to be returned when this method is used.

8. Optimization

8.1 Priority-Oriented Optimization Solution Analysis Tool

A new analysis tool has been added for optimization. The **Priority-Oriented Optimization Solution Analysis Tool** provides detailed information about:

- Objective values
- Satisfaction of derived objectives from Repeated Maximin constraints
- Constraints and variables frozen with each iterative solution
- Dual prices of constraints
- Reduced costs of variables

This information is valuable for understanding the drivers of the optimization solution and for debugging problems in optimization runs. Detailed information about the new analysis tool can be found **HERE (Optimization.pdf, Section 7.1)**.

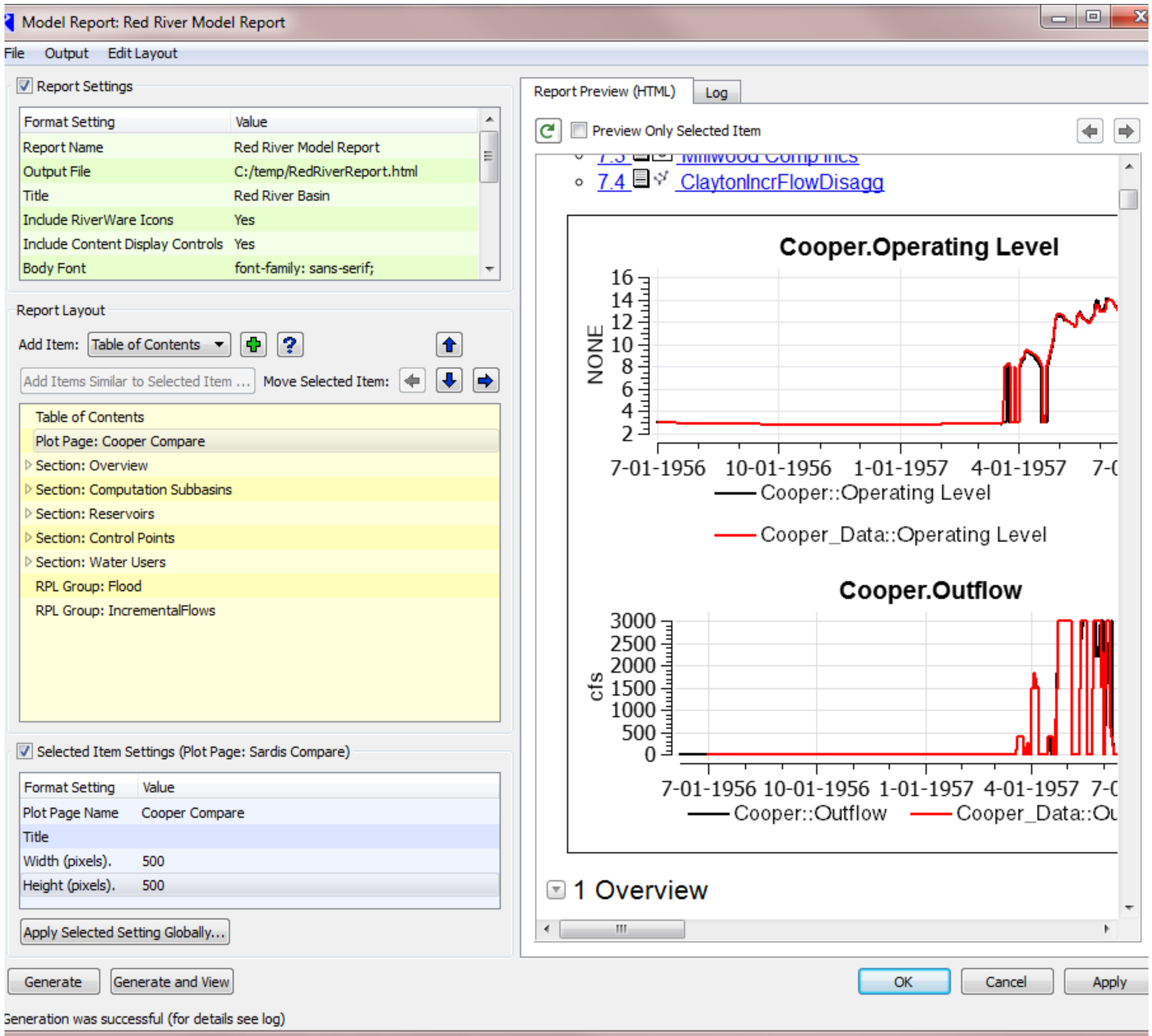
9. Output, Plotting, and Model Reports

9.1 Model Reports now include Plot Pages

Model Reports now allow you to include any saved Plot Page as an item in the report. In the Model Report, you add a “Plot Page” item to the report. Then you specify the name of the Plot Page, an optional title, and the dimensions to use in the report. When the report is generated, the plot page is generated (with current data and formatting) and inserted into the HTML report as a JPG image.

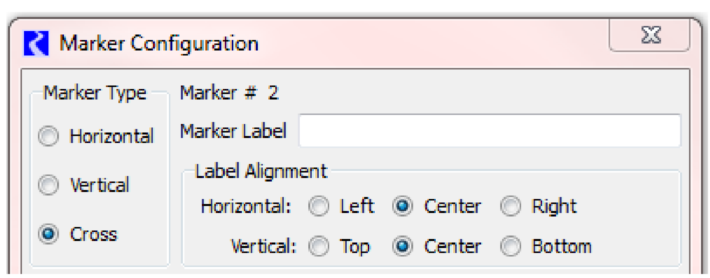
This enhancement makes Model Reports a very useful tool for sharing results, writing reports, and even for general analysis. You could create a model report with all of the plots you like to see and then generate this for analysis.

For more information click **HERE (Output.pdf, Section 4.2.3)**.

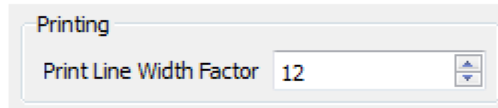


9.2 Plot Marker Configuration

The plot marker configuration was simplified. Now the label alignment allows you to choose **Left**, **Center**, or **Right** horizontal alignment and **Top**, **Center**, or **Bottom** for the vertical alignment



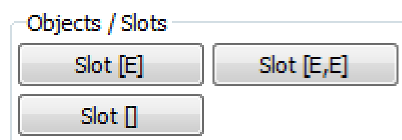
9.3 Printing Enhancements



Printing a Plot Page was improved so the line widths on the printed copy look more reasonable. Now there is a user specified factor that is applied to the line widths so that you have more control over the printed plot. For more information, click **HERE (Output.pdf)**.

10. RiverWare Policy Language

10.1 Editing RPL Expressions



When editing RPL logic using the palette, if you select an Object.Slot lookup, and then click on one of the other Object.Slot lookup buttons, it will reuse the expression so you do not need to re-specify the object and slot.

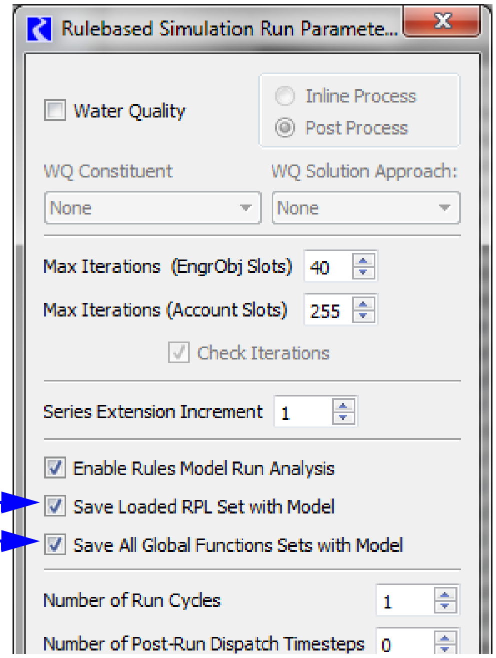
For example, you can change BigRes.Outflow[ ] to BigRes.Outflow[<expr>] without re-specifying BigRes.Outflow.

10.2 Initialization Rule Diagnostics

Initialization Rule diagnostic filtering has been improved. Click **HERE (Section 4.1)** for more information.

10.3 Global Function Sets Embedded in Model

You can now embed Global Function Sets (GFS) so they are saved with the model file. Previously this was possible with rulesets and goalsets. To save a GFS with the model file, use the **Run Control ➥ View ➥ Simulation Run Parameters** and then click on the check box to **Save All Global Function Sets** with Model.



Save Rulesets and Goalsets

Save Global Function Set

10.4 Saving Sets in Model File

When a model is loaded which contains an embedded ruleset or goalset, that set was at one point loaded. If it is now invalid, it cannot be re-loaded. Previously, if you saved the model in that state, it would lose the set. Now RiverWare continues to retain the set with the model file as long as there is no other loaded set and the **Save Loaded RPL Set with Model** option continues to be selected.

10.5 New RPL Predefined Functions

10.5.1 IntegerToString

A new function **IntegerToString** was added. This function takes a numeric and converts the integer portion of it to a string. For example IntegerToString(18.234 cfs) returns “18”. Click **HERE (RPLPredefinedFunctions.pdf, Section 102)** for more information.

10.5.2 NumberToYear

A new function **NumberToYear** was added. This function takes a numeric and converts the integer portion of it to a DateTime. For example NumberToYear(1932.00) returns @”Year 1932”. Click **HERE (RPLPredefinedFunctions.pdf, Section 133)** for more information.

10.5.3 OptValuePiecewise

A new function **OptValuePiecewise** was added. This function returns the piecewise approximation of an optimization variable. Click **HERE (RPLPredefinedFunctions.pdf, Section 149)** for more information.

10.6 RPL Palette Access

The RPL Palette can now be accessed from the **Workspace ➥ Policy** menu and from all RPL editors through the **Set** or **Group** menu. The shortcut Alt-P is also supported from all of these locations.

10.7 RPL Search and Replace

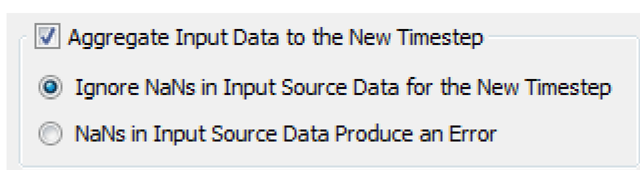
The RPL Search and Replace utility now searches for instances of the text in DateTimes, Numerics, and Booleans.

10.8 WARNING Statement

A new top level statement, WARNING was added to RPL sets. This statement, when executed in a run, posts the specified expression to the diagnostic output window in the brown warning text color. Unlike the PRINT statement, the message is shown regardless of diagnostic setting. Also, the WARNING does not stop the run like the STOP RUN statement.

11. Run Control

11.1 Aggregate Inputs during Timestep Change



When you change the run control to a certain larger timestep (i.e. daily to monthly), you now have the option to aggregate input slot values. The aggregation function is based on the unit type of the slot. For more information, click **HERE (RunControl.pdf, Section 7.1)**.

11.2 Weekly Timestep

The weekly timestep is no longer available for selection in either the run control or slot range configurations. This rarely used timestep was not fully implemented so it has been removed from the interface. If you have a model or slots with a weekly timestep, they will behave as before.

12. SCT

12.1 Color for Z flags

A separate color configuration was added for the Z flag. It initially starts as the same color as the I flag but is configurable in the settings dialog.

13. Slots

13.1 Notes on Series slots

13.1.1 Export/Import of Note Groups

The **Note Group Manager** (**HERE (Slots.pdf, Section 6)**) now allows you to import and export Note Groups. This allows many people who are working on the same model to share their Notes. For more information on Note Group Import/Export, click **HERE (Slots.pdf, Section 6.8)**.

13.1.2 Accounting Multislots Now Display Notes from Linked Supplies

When specifying a Note on an Accounting Supply, the note now is displayed on each end of the linked supply. This allows you to accumulate the notes on the accounting multi-slot for use in reports and other purposes. Click **HERE (Slots.pdf, Section 6.7)** for more information.

13.2 Statistical Table Slot Export Copy

The statistical table slot now allows you to export copy data from the table. It can then be pasted into another application like Excel.

14. Subbasins

14.1 Subbasin Manager Navigation

The subbasin manager now allows you to separately select member objects on the workspace and scroll to the member objects on the workspace. Previously these two actions were combined.

15. Water Quality - Salinity

15.1 Simple Well-Mixed Salinity Enhancements

15.1.1 Aggregate Diversion Site

The **Distributed Annual Salt Loading** method now allows **Return Flow Salinity Pickup Mass** to be specified as an input as an alternative to specifying concentration. The **Distributed Salinity Pickup Mass** slot was added to display the pickup mass that was re-distributed to each month by the method. Full details about the method can be found **HERE (WaterQuality.pdf, Section 5.1.2.5)**.

A new category, **Salt Removal**, was added with two new methods, **Salt Mass Removal** and **Salt Mass Removal With Debt**, to model water quality improvement projects. These methods allow the user to specify a requested amount of salt mass to remove from a linked Reach at each timestep. The method will not remove more salt than is available in the Reach. Full details about these methods can be found **HERE (WaterQuality.pdf, Section 5.1.4)**.

15.1.2 Reach

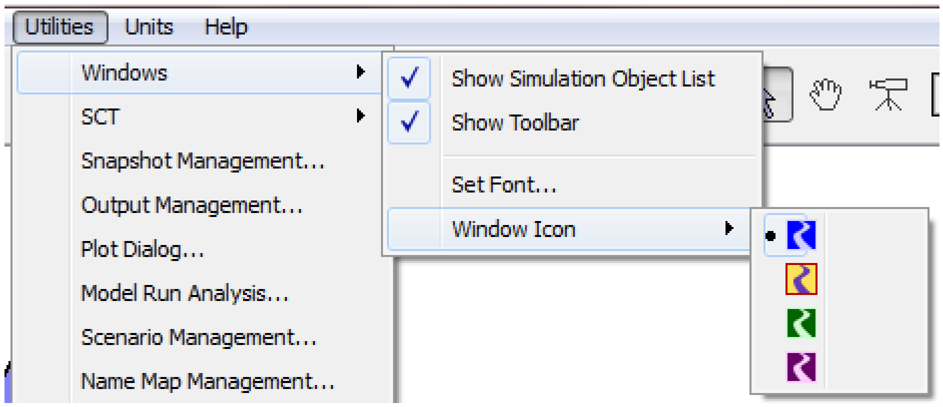
Maximum Salt Concentration, **Minimum Salt Concentration** and **Salt Storage** are three new slots on the Reach when the **Mass Balance Salinity** method is selected. **Maximum Salt Concentration** is a required input. Salt in excess of the max concentration will be "stored" in the **Salt Storage** slot and release on a later timestep. Two slots, **Salt Mass Removal** and **Salt Available For Removal** were also added to accommodate the new **Salt Removal** methods on the Agg Diversion Site.

The simple well-mixed salinity dispatch methods have been revised to now solve the salinity mass balance in terms of mass rather than concentration. They also now treat all flows less than a tolerance (10^{-8} m^3/s) as zero flow, in which case salt mass and concentration are always zero. These changes could result in model differences. A full description of the salinity dispatch methods, including how the new slots are incorporated into the salinity mass balance, can be found **HERE (WaterQuality.pdf, Section 15.2.2.19)**.

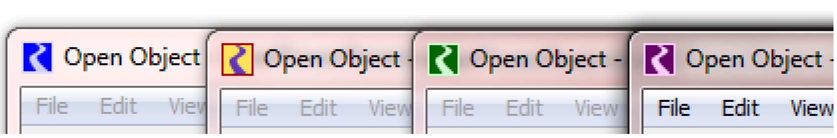
16. Workspace

16.1 Icon Colors

Are you often running two sessions of RiverWare? Now you are able to select the icon that is shown on all windows associated with that session. Use the **Utilities ➥ Windows ➥ Window Icon** Menu to select from the four options:



Then all windows and the task bar will use the selected icon for that session of RiverWare. Below are four separate RiverWare sessions showing the four icons:



16.2 Image Loading

Often, background maps are very large and can take a long time to load. This loading of background images on the workspace was improved to be faster. In addition, a grey background and a busy indicator are now shown while loading; you can operate the RiverWare interface while the image loads in the background.

16.3 Object List Navigation

On the workspace, the object list provides navigation to the objects. The following enhancements have been made:

- **Custom sorting**: define your own object order and preserve it in the model. You can easily switch between the predefined orders and your custom order. Click **HERE (Workspace.pdf, Section 3.5)** for more information.

- **Right click behavior**: When you right-click on an object in the list and choose to "**Open...**", it no longer scrolls the workspace. This allows you to keep the workspace focused at one part of your model while you open and view an object from the list.

17. Closed Bug Reports

The following bugs have been closed for this release. For more information on any bug, see the CADSWES website. The bugs are listed in order by bug number:

1704	1762	2820	2822	2898	3106	3419
3672	3723	3789	3917	3949	3955	4119
4433	4462	4513	4599	4600	4607	4634
4694	4719	4792	4856	4875	4915	4976
4992	5005	5014	5033	5054	5071	5073
5119	5142	5149	5154	5159	5161	5163
5166	5179	5187	5207	5212	5213	5216
5220	5234	5258	5267	5293	5294	5295
5302	5311	5316	5317	5318	5319	5320
5321	5322	5323	5324	5325	5326	5327
5328	5329	5330	5331	5332	5333	5334
5335	5336	5337	5338	5339	5340	5341
5342	5343	5344	5345	5347	5348	5349
5350	5351	5352	5353	5354	5355	5356
5357	5358	5359	5360	5361	5363	5364
5365	5366	5367	5368	5369	5370	5371
5372	5373	5374	5375	5376	5377	5378
5379	5380	5382	5383	5384	5385	5387
5389	5390	5391	5392	5393	5394	5397
5398	5400	5401	5402	5403	5407	

Release Notes Version 6.5

1. Special Attention Notes

Following are special attention notes, indicating that:

- Functionality has changed that requires you to update models, or
- Results may differ.

If you have any questions, please contact RiverWare-support@colorado.edu.

1.1 Category and Method Name Changes

Modifications were made to many category and method names on objects and accounts in order to adhere to a standard naming format. See the appendix, **HERE (Section 21)**, for a complete list of the changes. Expect many warning messages notifying you of the name changes the first time a model is loaded in RiverWare 6.5. There should be no change in model behavior or results.

1.2 Heron Inflow calculation

If you use the **Heron Inflow** calculation **Reservoir Account Slot Inflow** method, click **HERE (Section 8.5.3)** for model changes and updates.

1.3 K Factor Unit Type

The unit type was changed for the **K Factor** slot in the **Pan and Ice Evap** reservoir method from LENGTHPERTEMPERATURE_F to VELOCITYPERTEMPERATURE_F. These are automatically updated on model load and the scheme is set to display previously shown units. RPL expressions that reference this slot must be updated or unit type inconsistencies will occur.

1.4 Workspace Background Colors

Previously configured background colors are no longer used, you must reset them.The color will be saved in the model file instead of a user setting. Click **HERE (Section 20.2)** for more information.

1.5 Modifications to Water User and Agg Diversion Site Dispatch conditions

The dispatch conditions when solving given **Diversion** for these two objects was modified. Under certain situations, you could have additional results, but existing results should not be modified. Also, the error checks are less restrictive, so a run might succeed when it previously failed. Click **HERE (Section 8.6.1)** for more information on the Water User.

2. Accounting

2.1 Open Account Dialog

The Methods tab on the **Open Account** dialog now supports display of method categories in a default order. In this order, dependent categories/ methods appear below the superior categories. A new **Order** menu appears below the list.

2.2 Water Rights Solver

2.2.1 Improved Performance

The following improvements were made to the Water Rights allocation solver for performance improvements:

- The copying of values to cloned accounts is limited to only those that are needed in the water rights solution.
- The equal priority water right algorithm does not solve for accounts with no demand.
- Diversion accounts solution mechanism was improved to not solve unnecessarily.
- Accounts are prevented from solving recursively.

In the test model (22 year daily planning model), the total run time was reduced by 45%.

2.2.2 Negative Flow Appropriation

You can now allow negative flows in the water rights solver. This includes a new category, **Negative Flow Appropriation** and method, **Allow Negative Flows**, on the passthrough account on reaches, reservoirs and control points. When this method is selected, a new slot **Temp Available Before Appropriation** is added. It tracks the available water before each right is visited. If there are negative flows, upstream allocations cannot make a downstream senior more negative, but doesn't try to fix the negatives. Click **HERE (Section)** for more information.

3. Batch Mode

3.1 Output to Console

In batch mode, the command line keyword `console` was added to the `--log` argument. Using `--log console` shows a console window when RiverWare sends text to 'standard out' or 'standard error' when no log file is specified. Either `--log console` or `--log <file>` (OR no `--log` argument) can be used.

3.2 RequireVersion RCL Command

In batch mode, the following RCL command was added: `RequireVersion <major>.<minor>[.patch]` This command tests the version of RiverWare. It fails with an error if the current version is less than the specified version. Click **HERE (BatchMode.pdf, Section 4.4.19)** for more information.

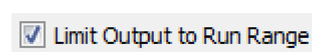
4. Data Management Interface

4.1 HDB Server

The HDB Server has been eliminated and Oracle connect code for HDB is now incorporated into RiverWare. The communications with HDB are faster and more robust. As a result, some configuration settings for HDB datasets are no longer relevant and have been removed. More information on the HDB interface can be found **HERE (DMI.pdf, Section 5.3.2)**.

4.2 Control File-Executable - Limit Output to Run Range

Control File-Executable DMIs can now be limited to only write output data for the run range (Start Timestep to Finish Timestep). Check the **Limit Output to Run Range** toggle on the DMI Editor.



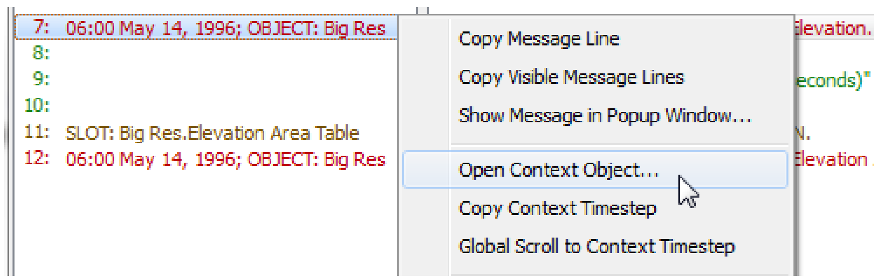
5. Diagnostics

5.1 Output Window

5.1.1 Filter Statistics

A **Show Filter Statistics** option was added to the **Settings** menu. When enabled, a single-line filter statistics panel appears below the message list. This indicates the total number of diagnostics messages and how many are shown and hidden due to message filtering.

5.1.2 Open Dialogs from Context



In this screenshot, BigRes's Open Object dialog would open.

The Diagnostics Output Window now supports the following three right-click context menu operations:

- **Open Context Object**: Open the dialog for the listed Object, Account, Slot, RPL Set, Rule, Goal, or Group.
- **Copy Context Timestep**: Copy the datetime to the clipboard
- **Global Scroll to Context Timestep**: Global scroll to the datetime

The Diagnostic Output Window's Message Popup Dialog previously supported an **Open Selected Named Item...** button which opened up the dialog for that object, account or slot. This capability was extended to support RPL Objects (Sets, Groups, Blocks, User-defined Functions).

For more information, click **HERE (Diagnostics.pdf, Section 1.4)**.

5.1.3 Performance Improvements

Performance has been improved when running with the diagnostics output window open. Also, during filtering operations that are expected to take more than four seconds, a progress bar and abort button are shown.

5.1.4 Tool Tips are Wrapped

In the diagnostics output, long diagnostic messages are shown as a wrapped tooltip when mousing over individual messages.

5.2 Dispatch Solution Diagnostics

Diagnostics were added in the **Dispatch Management ➥ Controller** category. After a method executes (and does not abort) one of the following two messages is posted, as appropriate:

- The dispatch method “Solve Given Inflow” successfully solved.
- The dispatch method “Solve Given Inflow” executed but did not solve.

This enables you to better diagnose when a dispatch method completes.

6. Multiple Run Management

6.1 Distributed MRM

6.1.1 Batch mode

When a Distributed Multiple Run is executed from batch mode, the MRM controller no longer shows a user interface. If you still wish to show the user interface, use the `--showui` argument.

6.1.2 Environment Variables

The distributed MRM working directory and configuration file now allow the use of environment variables.

6.2 Iterative MRM

In the **MRM Configuration** dialog, on the **Iterative Runs** tab, the label **Priority** was changed to **Index**. Iterative MRM rules are not strictly prioritized like Rulebased Simulation Rules, but they are indexed for organization. Click **HERE (Section 11.2)** to below

6.3 Ensembles in MRM

The capability to use ensembles as input and output was added to Multiple Run Management. A check box for using input ensembles now appears on the **Input** tab of the **MRM Configuration** dialog, which will add a new **Ensembles** tab to the dialog. You select input and output ensembles for use with the multiple run, and can choose particular traces for the input ensembles. The number of traces in input ensembles determine the number of runs in the multiple run. **In the initial implementation, only HDB datasets in Database DMIs will function as input ensembles.** HDB datasets have a radio button to make the dataset an ensemble type, allowing you to select an ensemble from the HDB database to associate with the dataset. Click **HERE (MRM.pdf, Section 4.7)** for more information.

7. Object Interface

7.1 Export Object

You can now export an object using the **File ➥ Export Object...** menu from the **Open Object** dialog.

8. Objects

8.1 Agg Diversion Site

When solving given **Diversion**, (**processSequential_givenDiversion** and **processLumped_givenDiversion**) **Incoming Available Water** was removed from the required knowns in the dispatch conditions.This isn't necessary to solve. Also, **Total Depletion**, **Total Diversion**, and **Total Unused Water** were added to the potential governing slots.

Click **HERE (Objects.pdf, Section 3.2.2)** for more information.

8.2 Inline Power Plant

8.2.1 Inline Turbine Release and Bypass method

A new **Inline Turbine Release and Bypass** category was added to the Inline Power Plant. The default **Specify Flows** method uses the previous approach to compute the **Bypass** and **Turbine Release**. The new **Flow Tables** approach uses two new tables **Flow vs Min Bypass** and **Flow vs Turbine Release**. This method performs lookups to get the appropriate flow values. Click **HERE (Objects.pdf, Section 15.1.1.2)** for more information.

On the **Flow vs Power Table**, the zeroth column label has been changed from **Turbine Release** (or very old **Inflow**) to **Flow** to make it generic. Old models will be updated automatically. Any RPL expression that reference this column by name will need to be modified. Click **HERE (Objects.pdf, Section 15.1.2.2)** for more information.

8.3 Power Reservoir

8.3.1 Peak Power with Off Peak Spill - New Slots

The following slots were added to the **Peak Power Equation with Off Peak Spill** power method.

- **Minimum Elevation for Power Operations**: This is an optional series slot with periodic input that provides elevation constraints that are applied within the **HydropowerRelease** RPL function. This function now computes the outflow necessary to get to the **Minimum Elevation for Power Operations** as part of the computation of the proposed outflow.
- **Plant Power Limit**: If the **Plant Power Limit** is valid and the computed power is greater than the **Plant Power Limit**, the power is reset to the **Plant Power Limit**. The **Turbine Release** and **Energy** are also cutback.

Click **HERE (Objects.pdf, Section 17.1.1.10)** for more information.

8.3.2 Plant Power Equation - Additional Functionality

The following slots were added to the **Plant Power Equation** power method.

- **Net Head vs Plant Efficiency:** This slot is an alternative way to specify the plant efficiency. The method computes the efficiency as follows:
  - If the 1X1 table slot **Plant Efficiency Value** is valid, it is used in all computations. This is the previous behavior and will not affect existing models.
  - Otherwise, the **Plant Efficiency Value** is not valid, so the method interpolates the efficiency on the **Net Head vs Plant Efficiency** table using previous timestep **Operating Head** minus **Head Loss**.
- **Plant Power Limit**: If the **Plant Power Limit** is valid and the computed power is greater than the **Plant Power Limit**, the power is reset to the **Plant Power Limit**. The **Turbine Release** and **Energy** are also cutback.

Click **HERE (Objects.pdf, Section 17.1.1.5)** for more information.

In addition, the **Input Energy Adjustment** category and **Reduce Input Energy** method are now available when the **Plant Power Equation Release** method is selected. If **Energy** is input and the resulting **Turbine Release** is greater than the maximum turbine release, the Max flag is set on **Energy** and the reservoir will recompute the maximum energy possible.

Click **HERE (Objects.pdf, Section 17.1.4.2)** for more information on the **Reduce Input Energy** method.

8.4 Reach

8.4.1 Default Routing Method - No Routing

Previously the default method in the **Routing** category was **No Method**, which was actually an invalid method and would produce an error. Now the default method is **No Routing**, **HERE (Objects.pdf, Section 22.1.1.1)**

8.4.2 Kinematic Reach Routing

On the Reach Routing category, there are now two versions of the Kinematic method:

- **Kinematic**: This is the original version of the Kinematic method as described **HERE (Objects.pdf, Section 22.1.1.9)**.
- **Kinematic Improved**: This modified version of the Kinematic method allows a smaller computational element length and reduces the mass balance error. It is described in more detail **HERE (Objects.pdf, Section 22.1.1.10)**.

8.5 Reservoir

8.5.1 Allow Excess Specified Outflows

A new method **Allow Excess Specified Outflow** was added to the **Input Outflow Adjustment** category on the Reservoirs. This method allows you to specify (I or Z) an **Outflow** that is larger than the computed (**Turbine**) **Release** plus **Spill**. When this happens, the extra outflow is set on the new **Outflow Exceeding Max** series slot.

Click **HERE (Objects.pdf, Section 17.1.11.3)** for more information.

8.5.2 Anticipated Storage Calculation

In the calculation of **Anticipated Storage** as part of the **Cumulative Storage Value Table** calculation in Simulation or Rulebased Simulation, if an intransit flow value (inflow on an upstream lagged reach) was missing, it could previously cause the run to abort with an error message. A missing intransit flow value could also result in the calculation of **Anticipated Storage** using Storage only without accounting for intransit water. Now a missing intransit flow value will result in Anticipated Storage remaining unsolved (NaN), and an informational diagnostic message will be posted in the User Methods diagnostic category. The run will no longer abort.

Click **HERE (Objects.pdf, Section 17.1.12.2)** for more information.

8.5.3 Heron Inflow calculation

The following changes were made to the **Heron Inflow** calculation Reservoir Account Slot Inflow method **HERE (, Section)**

- The **Heron Inflow Values** slot had the number of columns, column labels and units modified at one time. However, not all models had been converted to the new labels, and thus the old labels persisted in some model files:. A mechanism was added to check for the number of columns, column labels and units and correct them if necessary.
- The slots **Heron Inflow Totals** and **Heron Cumulative Inflow Values** columns with unit type of FLOW were changed to VOLUME as these represent sums of flows.- Within the `heronInflowCalc` and `findHeronRGInflow` methods, cumulative values are now calculated as volumes rather than flows.
- A correction was made to the calculation of `cumulNetGain` when the inflow ratio is less than or equal to zero. Now the `inflowRatio` (which is negative or zero) is added. This actually cancels out any negative `inflowRatio` from the calculation of `cumulNetGain` (`inflowRatio` is subtracted in an earlier step). This change makes the calculation consistent with the analogous version in

`findHeronRGInflow`. Note, this could change model results from previous versions.

8.5.4 K Factor Unit Type

The unit type was changed for the **K Factor** slot in the **Pan and Ice Evap** reservoir method from LENGTHPERTEMPERATURE_F to VELOCITYPERTEMPERATURE_F. These are automatically updated on model load and the scheme is set to display previously shown units. RPL expressions that reference this slot must be updated or unit type inconsistencies will occur.

8.6 Water User

8.6.1 Dispatch methods

In the solveSequential_givenDiversion and solveStandAlone_givenDiversion, **Incoming Available Water** was removed from the required knowns. This isn't necessary to solve. Also, **Depletion** and **Outgoing Available Water** were added to the potential governing slots.

For these two dispatch methods, the error checks if **Diversion** > **Incoming Available Water** and if **Diversion** > **Diversion Requested** were removed. These two checks made these dispatch methods unnecessarily restrictive.

This could affect existing models as it no longer errors in the above cases. Under certain situations, you could have additional results, but existing results should not be modified.

Click **HERE (Objects.pdf, Section 27.2.1.2)** for more information.

8.6.2 Specify Scheduled Requests

On the Water User, a new method was added to the **Diversion and Depletion Request** category called **Specify Scheduled Requests**. This method allows you to specify an initial scheduled amount (as either a series or periodic relationship) and then reduce the schedule to the requests. For more information, click **HERE (Objects.pdf, Section 27.1.1.11)**.

9. Optimization

9.1 Documentation and Help

The Optimization section of the RiverWare Help was enhanced. Click **HERE (Optimization.pdf, Section 1)**to access the help. Information was added to the following sections:

- Introduction and Overview
- Linearization, Approximation and Replacement
- RPL Goal Set

- Post-optimization Rulebased Simulation

9.2 Table Data Verification

The table data verification has been improved for optimization tables. Certain tables are checked for increasing values. Sometimes, these tables meet the more stringent requirements of optimization when a reservoir is within a "normal" operating region, but violate these conditions on the extreme parts of the curve, such as for a Probable Maximum Flood (PMF) when optimization would not be used. This enhancement allows you to limit optimization data checking to the normal region. If you have specified a minimum limit for data checking, data checking is skipped until the table exceeds the minimum value. If you have specified a maximum limit for data checking, the data checking ends once that limit is reached. For 3-dimensional tables, this logic may be applied both to the range of z values and to x or y within a block of constant z values. The following linearization and other tables used in optimization are now checked for this limited range.

Auto Max Turbine Q	**Plant Power Table**
Bypass Capacity Table	**Regulated Spill Capacity Table**
Bypass Table	**Regulated Spill Table**
Convolved Stage Flow Tailwater Table	**Stage Flow Tailwater Table**
Elevation Volume Table	**Tailwater Table**
Energy In Storage Table	**Unregulated Spill Linearization Table**
Marginal Storage Value Table	**Unregulated Spill Table**
Maximum Turbine Q	**Volume Area Table**

More information is available **HERE (Optimization.pdf, Section 6.7)**.

For Table Slots that are verified, you can configure the Min/Max from the **Slot Configuration** dialog **HERE (Slots.pdf, p61)** or the **Configure Existing Slots** dialog **HERE (Slots.pdf, Section 3.2)**. To locate the slots, use the selector's new **Supports Opt Limits** filter **HERE (Selector.pdf, Section 3)**.

You can also use Control File-Executable based DMI's to bring in the Min/Max from data files. Use the `scale`, `unit`, `opt_min`, `opt_max` data file keywords, **HERE (DMI.pdf, Section 3.3)**.

9.3 Priority Oriented Optimization Solution Analysis Tool

In a typical policy, most problem solutions are immediately followed by the freezing of solution limiting variables and constraints. This freezing occurs automatically but only for solutions that occurs during execution of a **Repeated Maximin** statement; for freezing to occur after solutions caused by statements of other types, the policy must contain an explicit **Freeze** statement.

When a problem solution is not immediately followed by a freeze before the next solution, it is sometimes useful to know which constraints and variables would have been frozen had a **Freeze** statement been executed. The solution analysis tool has been enhanced to report this information. When more than two solutions occur before a freeze, a single variable or constraint might have been frozen at multiple solutions, but is reported for only the earliest solution. For more information on the Priority-Oriented Optimization Solution Analysis Tool, click **HERE (Optimization.pdf, Section 7.1)**.

10. Output, Plotting, and Model Reports

10.1 Model Reports

Model Reports **HERE (Output.pdf, Section 4)** allow you to generate a customized HTML document describing various aspects of a model including the configuration, RPL policy, slots, and plots. In the **Model Report**, the following new **Item Types** have been added:

- Output Device: Pie Chart
- Output Device: Tabular Series Slot Report
- Account System Information
- Account Section
- Account Table
- Supply Table
- Account Method Table

Click **HERE (Output.pdf, Section 4.2.3)** for information on the **Item Types**.

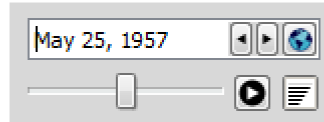
10.2 Periodic Slot Improved Plotting of Time Range

The plotting of Periodic slots has been improved so you no longer have to configure a time range to plot. Now, the periodic curve is shown for whatever range is plotted. If no other slots are plotted, the range defaults to the run range. Use the zooming tools to define the range including the **Scale to Specified** button to enter your desired range dates and apply it to many plots at once. This is describe more **HERE (Section 10.3)**.

Plotting of periodic slots is described **HERE (Output.pdf, Section 2.3.4.6)**.

10.3 Pie Charts

The following improvements were made to the **Pie Chart** output device **HERE (Output.pdf, Section 5)**:



- Controls were added to animate the pie chart over the run.
- Background colors are now configurable for both the display and when exported/ printed.
- Radial scale circles are dashed instead of solid.
- Commas are shown as the thousands separator.
- A right-click context menu was added to the configuration to allow you to **Copy Slots** and **Paste Slots** from/to the slot list.
- Pie charts were separated from their configuration dialogs; if the configuration is closed, the other is not.
- Redundant Pie Charts dialogs are no longer created when regenerating. Only one chart per device is shown.
- The stability of the pie chart was improved when the dialog is resized or changed to show a different timestep

10.4 Printing and Exporting

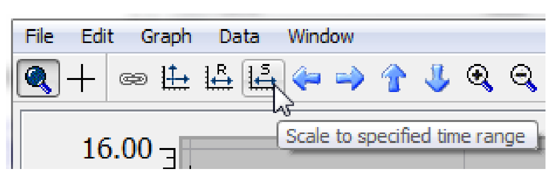
Plot Pages now have configurations options for the headers and footers that are shown when printed. Use the **File ➥ Print ➥ Printed Header/Footer Configuration...** For more information, click **HERE (Output.pdf, Section 2.8)**.

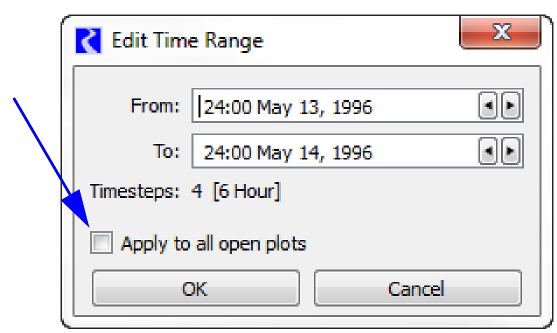
10.5 Redundant Plots

When regenerating a plot from the Output Manager, duplicate plots are no longer created. The existing plot is updated.

10.6 Scale to Specified Time Range

The **Scale to Specified Time Range** button is shown to the right. Clicking the button opens the dialog below. Now there is the option to **Apply to All Open Plots.** This sets the visible range of all open plots to the specified range. Each plot would need to be saved to preserve that range.





11. RiverWare Policy Language

11.1 Diagnostics and Debugging

11.1.1 WITH Statement Diagnostics

For WITH statements, the variable name is shown in the rule execution diagnostics.

11.2 Index vs Priority

The term **index** is now used to indicate the order of RPL rules/methods when the order of the rule/method in the set does not determine the priority or when there is no priority associated with the rule. The index is displayed in a new **Index** column of the RPL set editor for the following RPL sets:

- The Initialization Rules set (see the next section **HERE (Section 11.3)**)
- The Iterative MRM Rules set
- Object-level User Defined Accounting Method sets

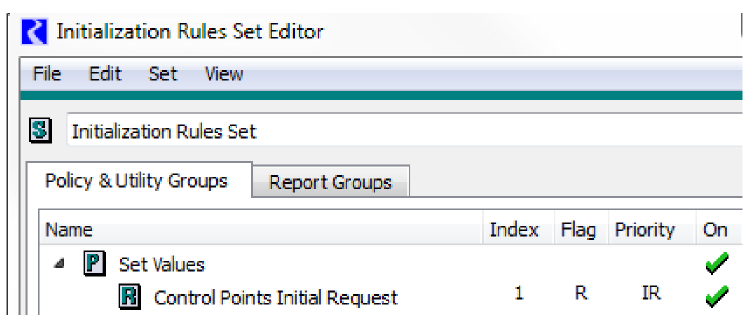
The RPL set editor no longer displays the priority column for sets to which the concept of priority does not apply:

- The Iterative MRM Rules set
- Object-level User Defined Accounting Method sets

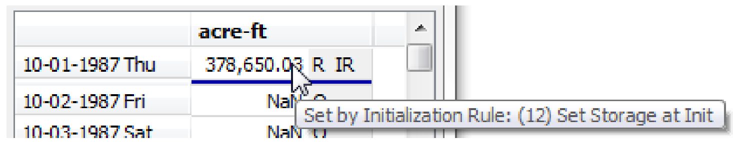
11.3 Initialization Rule Changes

The approach used by Initialization rules was modified to show which rule set a particular slot value. The Initialization Rules set editor now shows an **Index**, **Flag** and **Priority** column display.

- The **Index** is a unique identifier of the rule as described above.
- The **Flag** column indicates the flag which will be associated with the values set by that rule, R or Z, according to the rule configuration.
- The Priority column shows one of the following
  - 0 if the rule is configured to set the DMI Input (Z) flag,



- IR if the rule is configured to set the Rules (R) flag. IR will be shown on the slot values indicating it was set by an Init Rule.



You can now see a tool tip on any slot value display showing the Rule or Initialization Rule that set that value. Click **HERE (Section 16.2)** for more information.

11.4 RPL Expression Editing

11.4.1 Canceling Empty Expression

Cancelling editing of an empty expression is easier to cancel. You can now cancel these edits by pressing **Esc**, **Enter** or clicking away from the in-line editor menu.

11.4.2 Slot Lookups are Easier to Edit

When a slot lookup expression is selected, Slot[ ], Slot [E,E], or Slot [E], the slot expression is automatically selected, so you can immediately select the slot without an additional click.

11.4.3 Slot Name Selector

The RPL Palette **Slot Selector** now preserves your filter settings and prior selections.

11.4.4 RPL Comment Wrapping

The wrapping from the comment editor dialog is now retained and shown in the RPL editors. That is, when you hit enter in the comment editor OR the line wraps, the comment in the RPL editor will appear the same. Click **HERE (RPLUserInterface.pdf, Section 2.2.4)** for more information.

11.4.5 RPL Object Display

The display of OBJECTS in RPL was improved to **not** show the % symbol or quotation marks.

11.5 Predefined Functions

11.5.1 ColumnLabels and RowLabels

The following functions were added. They return a list containing all of the column or row labels of the input slot, respectively.

- **ColumnLabels**: **HERE (RPLPredefinedFunctions.pdf, Section 18)**
- **RowLabels: HERE (RPLPredefinedFunctions.pdf, Section 160)**

11.5.2 GetColumnIndex and ColumnLabel

The following functions now support Agg Series slots:

- **GetColumnIndex:** HERE (RPLPredefinedFunctions.pdf, Section 49)
- **ColumnLabel:** HERE (RPLPredefinedFunctions.pdf, Section 17)

11.5.3 Get3DTableVals

A new function, Get3DTableVals was added. The function returns the values from a 3D table in a list. For more information, click HERE (RPLPredefinedFunctions.pdf, Section 44).

11.5.4 HasRuleFiredSuccessfully

The HasRuleFiredSuccessfully was enhanced to behave as follows:

- Rulebased Simulation rules: has rule fired in current timestep.
- Initialization Rules: has rule fired in current single run.
- MRM rules: has rule fired in current MRM iteration (single run).
- Global functions set: the behavior for the caller's application.
- Other: not applicable, abort with an error message.

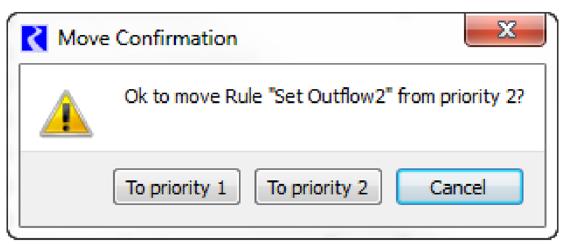
Click HERE (RPLPredefinedFunctions.pdf, Section 95) for more information.

11.6 RPL User Interface

11.6.1 Add to Report Group

RPL set and group editors have a new **Add To Report Group...** operation. A RPL object selector is presented for you to identify the destination **Report Group**.

11.6.2 Move RPL item to the first priority



When dragging at item to the first item within the list, the confirmation dialog now provides an additional option to place the dragged item in the first position.

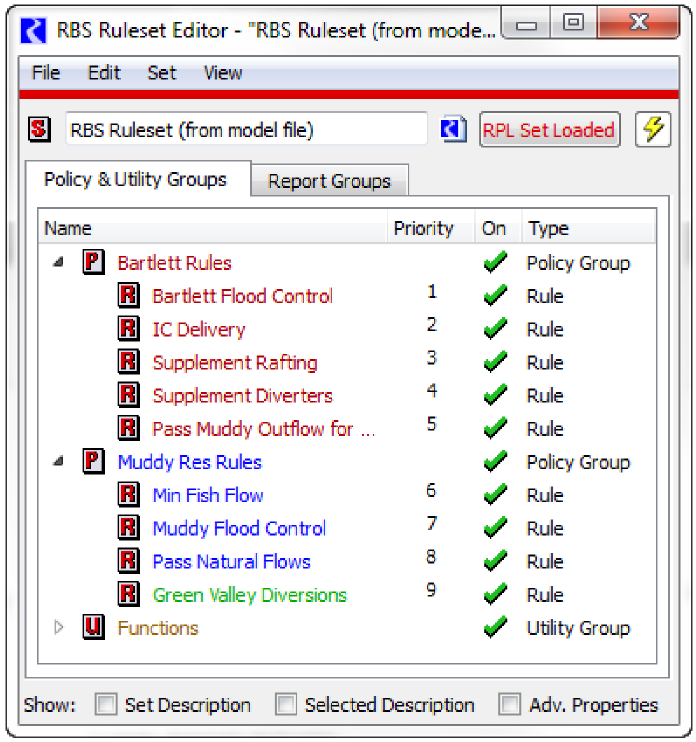
11.6.3 RPL Object Selector

A name filter was added to the RPL Object Selector dialog. This dialog is used when selecting rules/goals from diagnostics and when selecting RPL objects in a model report.

11.6.4 RPL Set Analysis Tool

Index and **Flag** columns were added to the RPL set analysis tool under the **Window ➥ Columns** menu

11.6.5 RPL Set Name Colors



You can now change the color of the text shown for RPL Objects (Rule, Group, Function, etc) in a RPL set. Rules and functions inherit their color from the group unless they are explicitly changed.

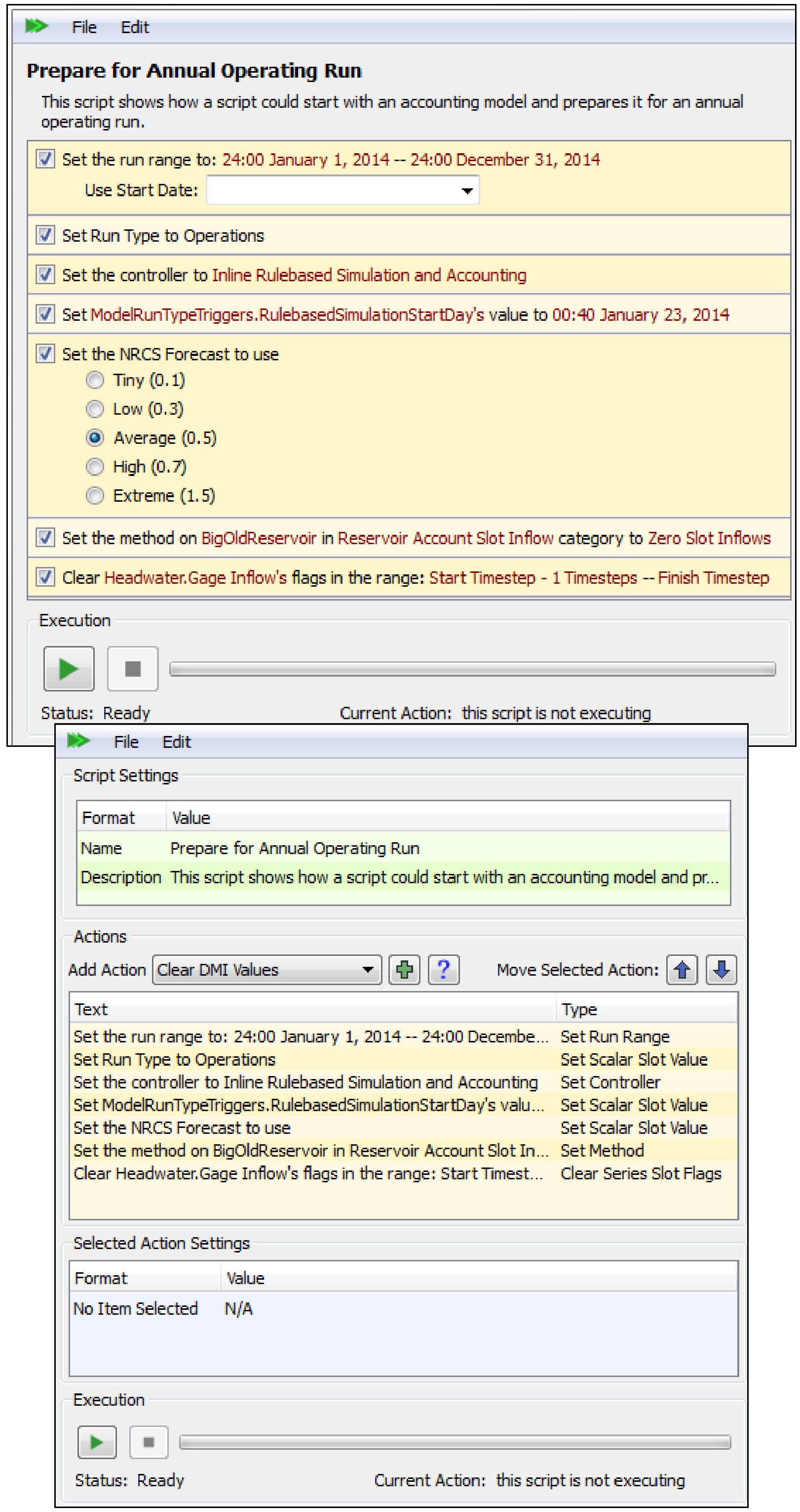
12. Run Control

12.1 Resume Run Functionality Removed

The Resume Run capability has been removed from the user interface. Note, it is still possible to **Pause** and **Continue** a run. But it is no longer possible to **Resume** a run after the run aborted or after clicking the **Stop** button.

13. Script Management

Script Dashboard



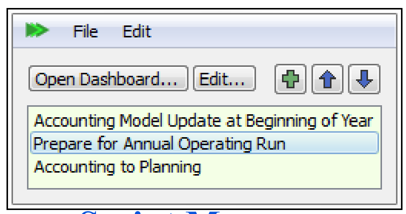
Script Editor

Scripts are an exciting new feature that allow you to automate many of the tasks involved in operating your model. Scripts are organized sequences of actions that you configure and execute.

Create a script to update your operations model to a new water year. Use a script to convert an accounting model to a planning model. Run a script to prepare your model for a run by setting the time range, importing values, and even executing the run. The opportunities are endless.

Scripts are created by a model developer in the **Script Manager** and the **Script Editor**. They are executed by a model user through the **Script Dashboard** which provides an interface where the user can set values through sliders, buttons and editors. Actions can even be hidden from the dashboard so only the desired pieces of information are shown.

In the initial implementation, there are over twenty action types you can add to your scripts. This framework is extensible so additional actions can be added in the future.



Script Manager

For more information on Scripts, click **HERE (ScriptManagement.pdf, Section 1)**.

14. SCT

14.1 6-hour Time Dividers

The SCT has supported optional time dividers between the common time intervals. Now 6-hour time dividers are supported within hourly models. They use the same user-configurable color as 4-hour dividers. Note, 4-hour or 6-hour dividers can be shown, but not both.

14.2 Aggregation Label Row Alignment

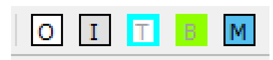
The SCT's aggregated, horizontal timestep view now supports an alignment option for detail row header text. That row header text used to be just right aligned; now it can be left aligned.

14.3 Confirmation dialog during Close

When closing the SCT, the confirmation dialog is no longer shown if the SCT is locked and hasn't been unlocked during that session.

14.4 Flag button appearance

The Flag buttons were improved so it is clear when they are enabled and disabled.



14.5 Flag Letters for Accounting Slots

The SCT now shows 'P', 'm' and 'A' series flag letters for accounting outputs.

14.6 Navigation and Import Paste for Horizontal Orientation

When in Horizontal Timestep Axis Orientation, the navigation was modified so that when you hit **Enter**, it goes to the next cell in the series. This is not necessarily the cell immediately below.

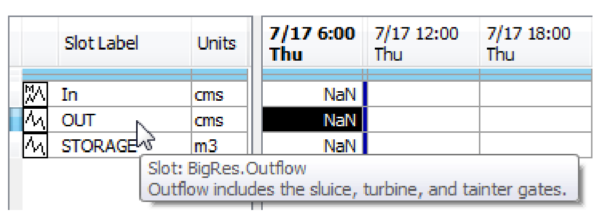
Similarly, when you import paste a column (or row) of data, there is now an option to **Paste clipboard column into Series Slot.** When this option is selected, the pasted data will go only into the specified series regardless of the aggregation. Uncheck the box to paste across multiple cells instead of within a single series.

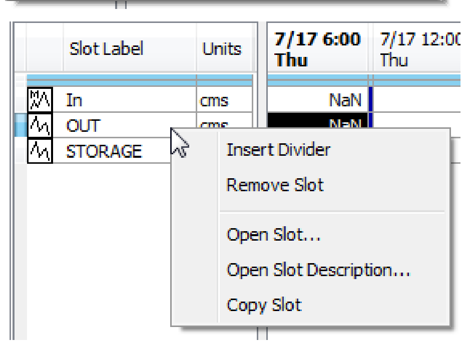
14.7 Series Slot Value Information

Tool tips now provide additional information about how individual values were set. In particular, when you hover the mouse over a value for which the relevant information is available, tool tips display which rule, DMI, or other method set the value. For rules, right click and choose to **Open Rule N** from the menu. Click **HERE (Section 16.2)** for more information.

14.8 Show Slot Descriptions

The SCT was enhanced to show slot descriptions from the SCT:





- **Tooltips on slot names/labels:** Hover over the slot's name or label and the slot's description, when defined, will be displayed as a tooltip.
- **Open Slot Description...** context menu: Right click and choose to **Open Slot Description**. This

shows the slot's **Open Slot** dialog with the Description panel open. This is where slot descriptions are provided by the user.

14.9 Timestep Size

If all existing series slots within the SCT have the same timestep size, the following adjustments are automatically made to the SCT configuration's **Timestep Size Override**.

- If the common slot timestep size **differs** from the model's timestep size, the Timestep Size Override is set to that common slot timestep size, and the override is turned on.
- If the common slot timestep size **matches** the model's timestep size, the Timestep Size Override is turned off.

15. Selector

15.1 Filters

The following enhancements were made to the slot selector filters:

- The **Slot Column Label** filter was enhanced to hide the multiple-column slots not having any columns with labels matching the specified wildcard pattern.
- A **Table (Multiple Cell)** selection option was added to the **Slot Type** filter.
- The **Slot Timestep** filter now also matches Periodic Slots configured with a regular time interval.
- A new filter, **Supports Opt Limits** was added as described **HERE (Section 9.2)**.

15.2 Copy List of Slots from the Selector

The selector panels now allow you to right-click and choose to **Copy Selected <Items>**. This copies the list of selected items to the clipboard. Also, on the most specific panel, you can **Trim Selection**. It deselects items in the superior parts of the selection which don't contribute to the final selection.

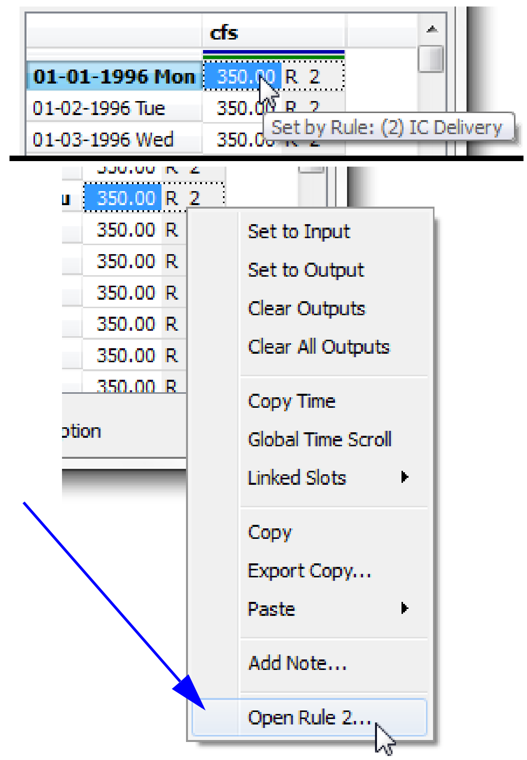
16. Slots

16.1 Agg Series Slot Columns

It is now possible to insert a column in an agg series slot including before the first column.

16.2 Series Slot Value Information

For dialogs that display Series Slot values, like the **Open Slot, Open Account** and **SCT** dialogs, tool tips now provide additional information about individual values. In particular, when you hover over a value for which the relevant information is available, one of the following tool tips is displayed:



- `Set by DMI: <DMI name>` The value was set by an input DMI that was configured to record invocations. Example: `Set by DMI: Import Lake Levels`
- `Set by Initialization Rule: (<rule index>) <rule name>` The value was set by the listed Initialization Rule. Example: `Set by Initialization Rule: (3) Provide Default Hydrology`
- `Set by Rule: (<rule priority>) <rule name>` The value was set by the listed rule Example: `Set by Rule: (18) Long Lake Fishery Releases`
- `Rule (<rule priority>) <rule name>` Displayed when the value was solved for as a result of a rule setting a value elsewhere in the system. That is, the value was set during dispatching because a rule set a value somewhere. Example: `"Rule: (18) Long Lake Fishery Releases"`.

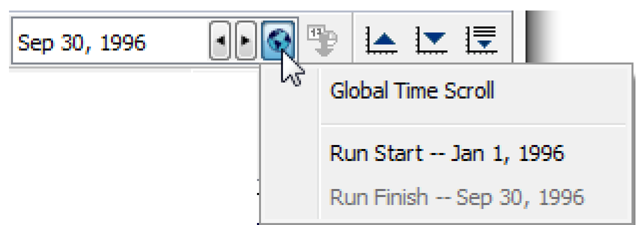
For the last three two rule items, right click and choose to “Open Rule N” from the menu. Click **HERE (Slots.pdf, p28)** for more information.

16.3 Table Slot Row/Column Labels

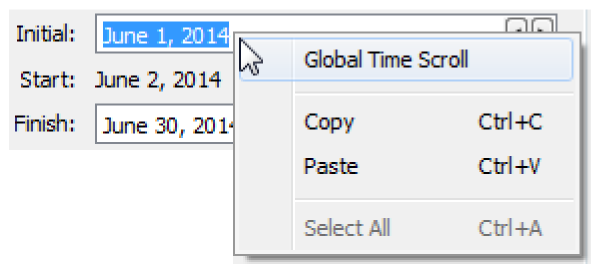
A right-click context menu was added to the Table Slot Row/Column Label Editor Dialog. It is used for editing either Row or Column labels for a particular Table Slot. The dialog presents a single column of editable cells, one cell per Table Slot row or column. You can use the new menu to copy, paste, or clear the labels.

17. Timestep Navigation

17.1 Datetime Controls and Global Time Scroll



Datetime Global Time Controls



Datetime Right-click Context Menu

Timestep navigation was improved by re-implementing the datetime controls in many dialogs including series slots, plots, and the run control. The controls now include left and right arrows (instead of up and down arrows) and a new global icon used to global scroll to the selected timestep. The screenshot shows the controls available on the plot In addition, every datetime control has a right-click context menu allowing you to **Global Time Scroll**, **Select All**, and **Copy**/ **Paste** the datetime.

18. Units

18.1 Units Added

The following units were added:

- Length: survey_ft (US Survey Foot)
- Volume:
  - survey_acreft (US Survey Acre-foot)
  - MCM (Million Cubic Meters)
  - TCM (Thousand Cubic Meters)
- Flow:
  - survey_acreft/day, survey_acreft/month, survey_acreft/year
  - MCM/day, MCM/month, MCM/year,

- TCM/day, TCM/month, TCM/year

19. Water Quality

19.1 Reach Simple Well-Mixed Salinity

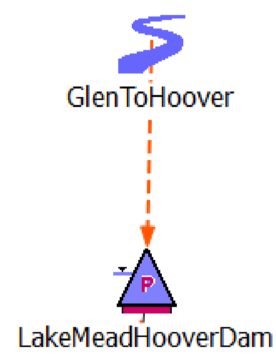
The Reach's Simple Well-Mixed Salinity methods were enhanced for better handling of salt mass for flows near zero. Also, the methods allow **Diversion Salt Mass** to be greater than **Inflow Salt Mass** to accommodate modeling techniques employed by some users.

Improved Simple Well-Mixed Reach Salinity Modeling when solving upstream. Previously, the **Return Flow Salt Mass** could only be linked to the same object to which the **Diversion Salt Concentration** was linked or an error would occur. Now, this is allowed, but the **Return Flow Salt Mass** must be known or the reach will exit the dispatch method and wait for more information. For more information, click HERE (WaterQuality.pdf, Section 15.3.2.7).

20. Workspace

20.1 Arrows on Links

It is now possible to show arrow heads on links on all three canvases. Link **Arrows** are controlled through user-defined **Link Display Groups**. Click HERE (Workspace.pdf, Section 7.1) for more information.



20.2 Background Colors Saved with Model File

Workspace background colors for the **Simulation** and **Accounting Views** are no longer user-based settings. Instead, the background color is saved with the model. Previously set background colors are no longer used, you must reset them.

20.3 Export Full Workspace Image

The Export Full Workspace Image function now supports a **Background Image Only** option.

20.4 Extended Selection

The Workspace now provides the following object selection behavior:

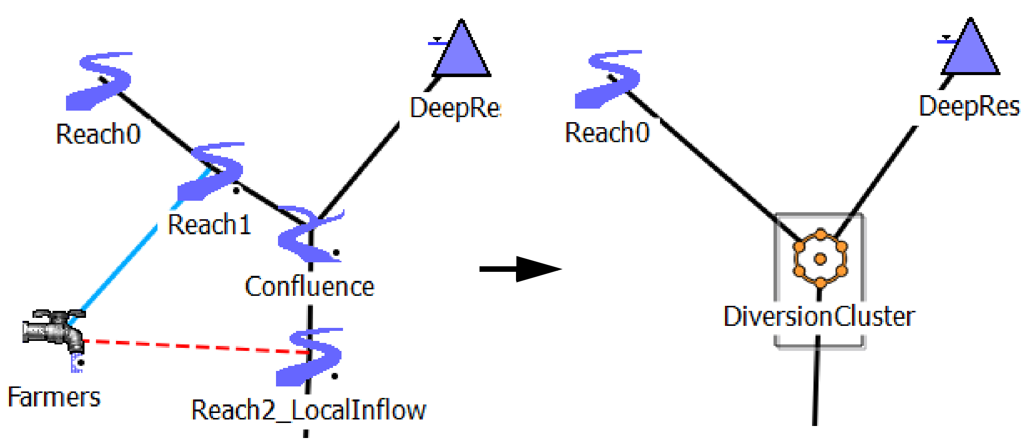
- Select objects by dragging a rectangle around one or more objects.
- Control-click an object to toggle the clicked object in and out of the selection
- Shift-click and drag a rectangle to the add objects to the selection.
- Right-click an object (to show its context menu) also adds the object to the selection.

20.5 Icon Colors Saved with Model File

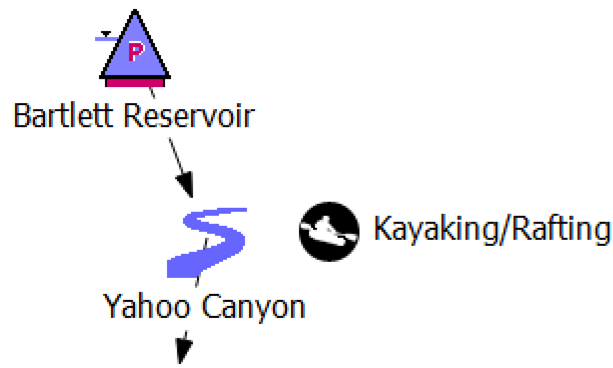
The setting for the RiverWare window icon, which is set from the Workspace **Utilities ➥ Windows ➥ Window Icon** menu (four options), is now saved with the RiverWare model file. Click **HERE (Workspace.pdf, Section 2.2)** for more information.

20.6 Object Clusters

Object Clusters allow you to group together simulation objects on the workspace and show only a single icon. Clusters are for display purposes only, they have no effect on the model solution. It is easy to switch between showing the objects or the cluster. Click **HERE (Workspace.pdf, Section 8)** for more information.



20.7 Text / Images on the Canvas



You can now add **Text** or small **Images** on the Simulation and Accounting Canvases. Use the right click context menu and choose **Add Text...** or **Add Image...** Specify the text or an image, respectively. In the screenshot, the rafting icon and label have been added as an image and text, respectively. For more information, click **HERE (Workspace.pdf, Section 2.7)**.

21. Appendix - Category and Method Name Changes

Modifications were made to a large number of category and method names on objects and accounts in order to adhere to a standard naming format. This included formatting all names in title case, including spaces between all words, removing terms such as “category”, “calculation” or “calc” from the names and in some cases making the name more descriptive of what the method does. Expect a large number of warning messages notifying you of the name changes the first time a model is loaded in RiverWare 6.5. These messages will include the text “Replacing old category name” or “Replacing old method name” for each changed name on each object. There should be no change in model behavior or results. Once the model is saved in RiverWare 6.5, the warning messages will not appear for subsequent model loads.

All name changes are listed below in the following six tables:

- Name Changes on All Reservoir Object Types, **HERE**
- Name Changes on All Power Reservoir Object Types, **HERE**
- Name Changes on Storage, Slope Power and Pumped Storage Reservoirs, **HERE**
- Name Changes on Reach Objects, **HERE**
- Name Changes on Other Objects, **HERE**
- Name Changes on Accounts, **HERE**

21.1 Name Changes on All Reservoir Object Types

What	Previous Name	New Name
Category	hydrologicInflowCalculationCategory	Hydrologic Inflow
Method	noHydrologicInflow	None
Method	No Forecast	None
Method	Coefficient and Exponent Hydrology	Coefficient and Exponent
Category	Calculate Incremental Hydrologic Inflows on Subbasin	Incremental Hydrologic Inflows on Subbasin
Method	Compute Forecast Period Incremental Hydrologic Inflows	Forecast Period
Method	Compute Full Run Incremental Hydrologic Inflows	Full Run
Category	Sediment Calculation	Sediment
Method	CRSS Sediment Calc	CRSS Sediment
Category	bankStorageCalcCategory	Bank Storage
Method	NoBankStorage	None
Method	InputBankStorage	Input Bank Storage
Method	CRSSBankStorageCalc	CRSS Bank Storage
Method	AveStageChangeBankStorage	Average Stage Change
Category	Seepage Calculation	Seepage
Method	No Seepage	None
Method	Linear Seepage Calc	Linear Seepage
Category	spillCalculationCategory	Spill
Method	noSpillCalc	None
Method	monthlySpillCalc	Monthly Spill
Method	unregulatedSpillCalc	Unregulated
Method	regulatedSpillCalc	Regulated
Method	regPlusUnregSpillCalc	Regulated and Unregulated
Method	regPlusBypassSpillCalc	Regulated and Bypass
Method	regPlusBypassPlusUnregSpillCalc	Regulated, Bypass and Unregulated
Method	Bypass, Reg, and Unreg Spill	Bypass, Regulated and Unregulated
Category	Optimization Spill Computation	Optimization Spill
Method	optNoSpillCalc	None
Method	optMonthlySpillCac	Opt Monthly Spill
Method	optUnregulatedSpillCalc	Opt Unregulated
Method	optRegulatedSpillCalc	Opt Regulated
Method	optRegPlusUnregSpillCalc	Opt Regulated and Unregulated

21.1 Name Changes on All Reservoir Object Types

What	Previous Name	New Name
Method	optRegPlusBypassSpillCalc	Opt Regulated and Bypass
Method	optRegPlusBypassPlusUnregSpillCalc	Opt Regulated, Bypass and Unregulated
Method	optBypass, Reg, and Unreg SpillCalc	Opt Bypass, Regulated and Unregulated
Category	FutureValueCalcCategory	Future Value
Method	noFutureValueCalc	None
Method	calculateFutureValue	Cumulative Storage Value Table
Category	Optimization Future Value Computation	Optimization Future Value
Method	optNoFutureValueCalc	None
Method	optCalculateFutureValue	Opt Cumulative Storage Value Table
Method	No Evaporation	None
Category	Optimization Evaporation Computation	Optimization Evaporation
Method	No Diversion	None
Category	targetOperationCalculationCategory	Target Operation
Method	noTargetCalc	None
Method	simpleTarget	Simple Target
Method	laggedTarget	Lagged Target
Category	Sediment Transport Calculations	Sediment Transport
Category	surfaceFluxCalculationCategory	Surface Heat Flux
Method	noCalcSurfaceFlux	None
Method	defaultCalcSurfaceFlux	Energy Balance
Category	Surcharge Release Calculation	Surcharge Release
Category	Elevation Maximum Duration Constraints	Elevation Max Duration Constraints
Category	Flood Control Release Calculation	Flood Control Release
Method	Heron Inflow Calculation	Heron Inflow
Method	Heron Gain Loss Calculation	Heron Gain Loss
Method	El Vado Loss Calculation	El Vado Gain Loss
Method	Nambe Falls Loss Calculation	Nambe Falls Gain Loss
Method	Elephant Butte Loss Calculation	Elephant Butte Gain Loss
Method	Abiquiu Loss Calculation	Abiquiu Gain Loss
Method	Jemez Loss Calculation	Jemez Gain Loss
Method	Cochiti Loss Calculation	Cochiti Gain Loss
Category	Bank Storage Salt Category	Bank Storage Salt
Method	No Bank Storage Salt	None

21.2 Name Changes on All Power Reservoir Object Types

What	Previous Name	New Name
Category	powerCalculationCategory	Power
Method	noPowerCalc	None
Method	plantPowerCalc	Plant Power Coefficient
Method	plantEfficiencyCurve	Plant Efficiency Curve
Method	plantPowerEquation	Plant Power Equation
Method	unitGeneratorPowerCalc	Unit Generator Power
Method	PeakBasePowerCalc	Peak and Base
Method	PeakPowerCalc	Peak Power
Method	PeakPowerEquation	Peak Power Equation
Method	LCRPowerCalc	LCR Power
Method	Unit Power	Unit Power Table
Category	Optimization Power Computation	Optimization Power
Method	independentLinearizations	Independent Linearizations
Method	lambdaMethod	Lambda Method
Category	powerReleaseCalcCategory	Power Release
Method	getNoPowerRelease	None
Method	getPlantPowerRelease	Plant Power Coefficient Release
Method	getPlantEfficiencyRelease	Plant Efficiency Curve Release
Method	getPlantPowerEqnRelease	Plant Power Equation Release
Method	get Peak Power Equation with Off Peak Spill Release	Peak Power Equation with Off Peak Spill Release
Method	getLCRPowerRelease	LCR Power Release
Method	getUnitGeneratorPowerRelease	Unit Generator Power Release
Method	get Unit Power Release	Unit Power Table Release
Method	No Energy Adjustment	None
Category	tailwaterCalculationCategory	Tailwater
Method	noTailwaterCalc	None
Method	TWValueOnly	Linked or Input
Method	TWbaseValueOnly	Base Value Only
Method	TWbaseValuePlusLookupTable	Base Value Plus Lookup Table
Method	TWstageFlowLookupTable	Stage Flow Lookup Table
Method	tailwaterCompare	Compare to Avg Base Value
Method	hooverTailwater	Hoover Tailwater
Category	Optimization Tailwater Computation	Optimization Tailwater

21.2 Name Changes on All Power Reservoir Object Types

What	Previous Name	New Name
Method	optTWValueOnly	Opt Linked or Input
Method	optTWBaseValueOnly	Opt Base Value Only
Method	optTWBaseValuePlusLookupTable	Opt Base Value Plus Lookup Table
Method	optTWStageFlowLookupTable	Opt Stage Flow Lookup Table
Category	Ramping Modeling	Ramping
Method	trackRamping	Track Ramping
Category	Additional Hydropower Release Calculation	Additional Hydropower Release
Method	No Additional Release	None
Method	noEstimatedHead	None
Method	estimatedHead	Estimated Head
Method	variableHead	Variable Head

21.3 Name Changes on Storage, Slope and Pumped Storage Reservoir Objects

Where	What	Previous Name	New Name
Storage Reservoir	Category	Tailwater Calculation	Tailwater
	Method	Cubic Bank Storage Calc	Cubic Bank Storage
Slope Power Reservoir	Category	slopeStorageCategory	Slope Storage
	Method	noSlopeStorageCalc	None
	Method	SlopeStorageCalc	Storage Segments
	Category	slopeStorageCoefficientsCategory	Slope Storage Coefficients
	Method	Impulse Response Coeffs	Impulse Response
	Method	Weighting Coeffs	Weighting Coefficients
	Category	Optimization Partition Category	Optimization Partition
	Category	targetSlopeStorageCategory	Target Slope Storage
	Method	TargetSlopeStorageCalc	Lumped Mass Balance
	Category	Optimization Backwater Computation	Optimization Backwater
	Method	independentLinearizations	Independent Linearizations
	Method	lambdaMethod	Lambda Method
	Category	Backwater Lambda Computation	Optimization Backwater Lambda

21.3 Name Changes on Storage, Slope and Pumped Storage Reservoir Objects

Where	What	Previous Name	New Name
Pumped Storage Reservoir	Category	pumpPowerCalculationCategory	Pump Power
	Method	noCalcUnitPumpPower	None
	Method	calcUnitPumpPower	Unit Pump Power
	Method	No Gate Setting Calc	None
	Method	Calculate Gate Setting	Best Gate Setting Table

21.4 Name Changes on Reach Objects

What	Previous Name	New Name
Method	No Parameters	None
Category	Local Inflow Solution Direction	Local Inflow and Solution Direction
Method	No Local Inflow	No Local Inflow, Solve Inflow or Outflow
Method	No Local Inflow, Downstream Only	No Local Inflow, Solve Outflow
Method	Input Local Inflow	Specify Local Inflow, Solve Inflow or Outflow
Method	Local Inflow Downstream Only	Specify Local Inflow, Solve Outflow
Method	Calc Local Inflow	Solve Inflow, Outflow or Local Inflow
Method	Calc Local Inflow or Solve Downstream	Solve Local Inflow or Outflow
Method	Contingent Local Inflow	Contingent Local Inflow or Solve Outflow
Method	No Forecast Local Inflows	None
Method	Coefficient and Exponent Forecast Inflow	Coefficient and Exponent
Category	Evaporation Calculation	Reach Evaporation
Method	No Evaporation	None
Method	Inflow Exponent Pan Evap	Inflow Exponent Pan Evaporation
Category	depthtoFlowMethod	Depth to Flow
Method	noDepthtoFlowMethod	None
Method	depthtoFlowManningTrapezoid	Manning Trapezoid
Method	depthtoFlowManningWideRect	Manning Wide Rectangle
Method	depthtoFlowPowerFunction	Power Function
Category	Stage Calculation	Stage
Method	No Stage Calc	None
Category	Volume Calculation	Volume
Method	No Volume Calc	None
Category	GainLoss Calculation	Gain Loss
Method	No GainLoss	None

21.4 Name Changes on Reach Objects

What	Previous Name	New Name
Method	Constant GainLoss	Constant Gain Loss
Method	Variable GainLoss	Variable Gain Loss
Method	Seasonal GainLoss Flow Table	Seasonal Gain Loss Flow Table
Method	Interpolated Flow GainLoss	Interpolated Flow Gain Loss
Method	Periodic GainLoss	Periodic Gain Loss
Category	Apply GainLoss	Apply Gain Loss
Category	Seepage Calc	Reach Seepage
Method	No Seepage	None
Category	Reach Conductance Specification	Reach Conductance
Category	Drain Elevation Calc	Drain Elevation
Method	No Drain Elevation	None
Method	Drain Flow/Elev Interpolation	Flow Elevation Interpolation
Method	Reach/Drain Elev Interpolation	Stage Elevation Interpolation
Category	Reach Bank Storage Calculation	Reach Bank Storage
Method	No Bank Storage	None
Method	No Adjustment	None
Method	No Diversion	None
Category	Minimum Diversion Bypass	Min Diversion Bypass
Method	Input Diversion Bypass	Input Min Bypass
Method	Periodic Minimum Bypass	Periodic Min Bypass
Category	WQ Routing	Water Quality Routing
Method	TimeLagTempModel	Time Lag; Temperature
Method	TimeLagSaltTempModel	Time Lag; Salt and Temperature
Method	TimeLagTempDOModel	Time Lag; Temperature and DO
Method	TimeLagSaltTempDOModel	Time Lag; Salt, Temperature and DO
Method	NoRoutingTempModel	No Routing; Temperature
Method	NoRoutingSaltTempModel	No Routing; Salt and Temperature
Method	NoRoutingTempDOModel	No Routing; Temperature and DO
Method	NoRoutingSaltTempDOModel	No Routing; Salt, Temperature and DO
Method	ControlVolumeExplicitTemp	Control Volume Explicit; Temperature
Method	ControlVolumeExplicitSalt	Control Volume Explicit; Salt
Method	ControlVolumeExplicitSaltTemp	Control Volume Explicit; Salt and Temp
Method	ControlVolumeImplicitTemp	Control Volume Implicit; Temperature
Method	ControlVolumeImplicitSalt	Control Volume Implicit; Salt

21.4 Name Changes on Reach Objects

What	Previous Name	New Name
Method	ControlVolumeImplicitSaltTemp	Control Volume Implicit; Salt and Temp
Category	Seepage WQ	Reach Seepage Water Quality

21.5 Name Changes on Other Objects

Where	What	Previous Name	New Name
Aggregate Diversion Site	Method	noStructure	No Structure
	Method	sequentialStructure	Sequential Structure
	Method	lumpedStructure	Lumped Structure
	Category	conjunctiveUse	Aggregate Conjunctive Use
	Method	No Conjunctive Use	None
	Category	Optimization Requests Category	Aggregate Optimization Requests
	Method	optInputRequests	Opt Input Requests
	Method	optPolicyRequests	Opt Policy Requests
	Method	Return Flow Salt Calculation	Return Flow Salt
	Category	salt Pickup Category	Salt Pickup
	Method	Variable Salt Pickup with Debting	Variable Salt Pickup with Debt
	Method	Salt Mass Removal With Debt	Salt Mass Removal with Debt
	Category	Maximum Supplemental Request	Aggregate Max Supplemental Request
	Method	Input Maximum Request	Input Max Request
	Method	GW Elevation Maximum Request	GW Elevation Max Request
Aggregate Reach	Method	noWQ	None
Bifurcation	Category	Outflow Calculation	Bifurcation Outflow
Canal	Category	CanalFlowCalculationCategory	Canal Flow
	Method	noCanalFlow	None
	Method	TellicoCanalEquation	Tellicao Canal Equation
	Method	BarkleyCanalEquation	Barkley Canal Equation

21.5 Name Changes on Other Objects

Where	What	Previous Name	New Name
Computational Subbasin	Method	No Method	None
	Category	Diversions From Reservoirs	Diversions from Reservoirs
	Method	Share Proportionally With Limits	Share Proportionally with Limits
	Category	Account Initial Request Calculation	Account Initial Request
	Category	GroundWater Computation	Groundwater Computation
	Category	Reach GainLoss	Reach Gain Loss
	Category	GroundWater Elevation	Groundwater Elevation
	Category	GroundWater Lateral Flux	Groundwater Lateral Flux
	Category	Calculate Incremental Local Inflows	Incremental Local Inflows
Control Point	Category	Local Inflow Calculation	Local Inflow
	Method	No Local Inflow	None
	Method	No Forecast Local Inflow	None
	Method	Flooding does not constrain hydropower releases	Releases Not Constrained by Flooding
Distribution Canal	Category	Canal Maximum Capacity	Canal Max Capacity
	Method	Maximum Capacity	Input Max Capacity
	Category	Storage Calculation	Canal Storage
	Method	Seepage Calc	Proportional Seepage
	Method	Variable Seepage Calc	Variable Seepage
Diversion Object	Method	Solve For Outflow	Solve for Outflow
	Category	Available Flow Calculation	Available Flow
	Method	none	None
	Category	Diversion Request Calculation	Diversion Request
	Category	Energy Calculation	Diversion Pump Energy
	Method	Energy Calc	Energy Equation and Cost

21.5 Name Changes on Other Objects

Where	What	Previous Name	New Name
Groundwater Storage Object	Category	Groundwater Outflow Calculation	Groundwater Outflow
	Method	Impulse Response Outflow	Impulse Response
	Category	Negative Outflow Adjust	Negative Outflow Adjustment
	Method	No Adjustment	None
	Method	Excess Storage To Outflow	Excess Storage to Outflow
	Category	Previous Elevation Calc	Previous Elevation
	Method	Storage Elevation Table Interpolation	Storage Elevation Interpolation
	Category	Pumping Calc	Groundwater Pumping
	Method	No Pumping	None
	Method	No Percolation	None
	Category	Groundwater Conductance Specification	Groundwater Conductance
	Category	Evapotranspiration	Groundwater Evapotranspiration
	Method	No Evapotranspiration	None
	Category	Evaporation	Groundwater Evaporation
	Method	No Evaporation	None
Inline Power Plant	Category	Solution Direction	Inline Power Solution Direction
	Category	Power Calculation	Inline Power
	Method	No Power Calc	None
	Category	Turbine Ramping	Inline Turbine Ramping
	Method	No Ramping	None
	Method	No Spill Cost	None
	Method	Spill Cost Calc	Unit Spill Cost
	Method	holeCuts	Use Hole Cuts
Inline Pump	Method	No Hydraulics	None
	Category	Energy Calculations	Inline Pump Energy
	Method	No Energy Calculations	None
Pipe Junction	Method	No Hydraulics	None
Pipeline	Category	Head Loss Calculation	Pipeline Head Loss
	Method	No Head Loss	None
	Method	Hazen-Williams Head Loss	Hazen-Williams Equation
Stream Gage	Category	Conditional Flow Calc	Conditional Flow

21.5 Name Changes on Other Objects

Where	What	Previous Name	New Name
Thermal	Category	LoadCategory	Load
	Method	No Load	None
	Method	Use Hourly Load	Hourly Load
	Category	Modified Load Evaluation	Modified Load
	Method	No Evaluation	None
	Method	No Preferred Customers	None
	Method	No Method	None
	Method	No Objective	None
	Category	Smooth Energy Category	Smooth Energy
	Method	No Smoothing	None
Water User	Category	returnFlowCalculation	Return Flow
	Method	Limit By Reservoir Level	Limit by Reservoir Level
	Method	No Routing	None
	Category	returnFlowSplitCalculation	Return Flow Split
	Method	No Split	None
	Method	No Conjunctive Use	None
	Method	Input Maximum Request	Input Max Request
	Method	GW Elevation Maximum Request	GW Elevation Max Request
	Category	Optimization WU Requests Category	Optimization Requests
	Method	optInputRequests	Opt Input Requests
	Method	optPolicyRequests	Opt Policy Requests

21.6 Name Changes on Accounts

Where	What	Previous Name	New Name
Diversion Account	Category	Calculation of Initial Request	Initial Request
	Method	Initial Request is Input	Specify Initial Request
	Method	Maximum Permitted	Max Permitted
	Category	Minimum Bypass	Min Bypass
	Method	No Minimum Bypass	None
	Method	Fraction of Flow above Minimum Flow	Fraction of Flow Above Min
	Method	Diversion minus Depletion	Diversion Minus Depletion
	Method	Return Flow Is Input	Specify Return Flow
	Category	Maximum Legal Request	Max Legal Request
In Stream Flow Account	Category	Calculation of Initial Request	Initial Request
	Method	Initial Request is Input	Specify Initial Request
Storage Account	Category	Calculation of Initial Request	Initial Request
	Method	Initial Request is Input	Specify Initial Request
	Method	Fill Conservation Pool With Diversions	Fill Conservation Pool with Diversions
	Category	Minimum Bypass	Min Bypass
	Method	No Minimum Bypass	None
	Method	Fraction of Flow above Minimum Flow	Fraction of Flow Above Min
	Category	Cons Pool Fill Factor	Conservation Pool Fill Factor

22. Closed Bug Reports

The following bugs have been closed for this release. For more information on any bug, see the CADSWES website. The bugs are listed in order by bug number:

418	626	775	793	809	856	888
956	1008	1251	1834	1841	2011	2248
2322	2548	2574	2592	2653	2699	2826
2903	2945	2991	3015	3062	3133	3204
3274	3300	3316	3511	3542	3612	3693
3718	3734	3771	3864	3960	3975	3977
4178	4184	4247	4252	4413	4425	4977
5033	5067	5071	5106	5122	5284	5346
5381	5399	5405	5406	5408	5409	5410
5411	5412	5414	5415	5417	5418	5419
5420	5421	5422	5423	5424	5425	5426
5427	5428	5429	5430	5431	5432	5433
5435	5436	5437	5438	5439	5440	5441
5442	5443	5444	5445	5446	5448	5449
5450	5451	5452	5453	5454	5455	5456
5458	5459	5460	5461	5462	5463	5464
5465	5466	5468	5469	5470	5471	5472
5473	5474	5475	5477	5479	5480	5482
5483	5484	5485	5486	5487	5489	5490
5492	5493	5494				

Release Notes Version 6.6

1. Special Attention Notes

Following are special attention notes, indicating that:

- Functionality has changed that requires you to update models, or
- Results may differ.

If you have any questions, please contact RiverWare-support@colorado.edu.

1.1 Water Quality Method Selection and Names

Water Quality constituent selection and method names were modified. Existing models should be automatically updated. Click **HERE (Section 14.1)** for more information.

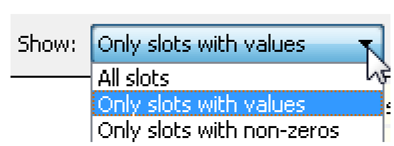
1.2 Reimplemented DSS connectivity

The DSS connectivity was re-implemented to use Java. When installing RiverWare, you are given the choice of whether to install the complete package (with Java) or install only RiverWare (without the Java files). **To use the DSS Database DMIs, you must install RiverWare with Java.**

2. Accounting

2.1 Accounting Dialogs - Show Only Non-Zero slots

The **Object Account Summary** and **Edit Account** dialogs were improved with a **Show** menu at the bottom of the dialog. The **Show** menu allows you to specify whether to show:



- **All Slots**
- **Only Slots with values** (non NaNs)
- **Only slots with non-zeros**

Click **HERE (, Section)** for more information.

3. Batch Mode

3.1 Reorder an Optimization Goal Set

A new RCL command **ReorderGoalSet** was added. This command allows you to reorder items (goals, groups, or certain statements) within the currently loaded optimization goal set. Click **HERE (BatchMode.pdf, Section 4.4.20)** for more information.

4. Data Management Interface

4.1 Reimplemented DSS connectivity

The DSS connectivity was re-implemented to use Java. When installing RiverWare, you are given the choice of whether to install the full package (with Java) or install only RiverWare (without the Java files). **To use the DSS Database DMIs, you must install RiverWare with Java.** Other than the installation, there should be no noticeable differences with the java implementation of the DSS connectivity.

4.2 Control File-Executable DMIs

4.2.1 Table row label import

A row label can now be imported along with the data into a table slot via a control file DMI. The label must be the first entry in the data file line for the row, and is recognized as a label when the number of items in the row is one more than the number of columns in the table. If there are spaces in the label, it must be surrounded by quotes to be recognized as a complete label item.

4.2.2 Control Files allow Quoted Values

DMI Control Files now support quoting of values, typically to embed spaces in file paths. For more information, click **HERE (DMI.pdf, Section 3.2)**.

```
BigRes.Pool Elevation: file="C:\Data\BigRes.Pool Elevation"
```

The DMI must be configured to allow spaces in file paths.

5. Model Files

5.1 RiverWare Model Package Functionality

A “package” file can now be created from RiverWare that contains

- A model file
- Multiple SCT files
- Workspace image files
- RPL sets, (rulesets, optimization goal sets, and global functions sets).

The package file allows all of these file types to be easily moved together as a single file. For more information, click **HERE (ModelFiles.pdf, Section 6)**.

6. Multiple Run Management

6.1 netCDF and CSV output from MRM

MRM can now output per-run NetCDF files and comma-separated value (CSV) files. Both new Output types are configured in the Output tab of the MRM configuration dialog. CSV files are formatted for direct use in the Tableau data visualization software. For more information on CSV output, click **HERE (MRM.pdf, Section 4.8.3)**. For more information on netCDF output, click **HERE (MRM.pdf, Section 4.8.4)**.

7. Object Interface

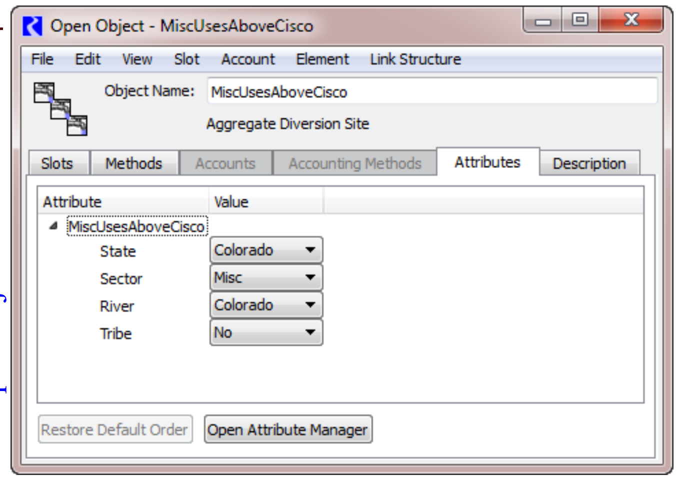
7.1 Object Attributes

Object Attributes are user defined Object meta data that allow you to define an Attribute for one or more types of objects. You then define values and assign those value to specific objects. For example, you might have 300 water users in your system. With this functionality, you can define, for example, a “Sector” attribute and a “State” attribute. Then you can specify for each water user, its Sector, i.e. Municipal, Industrial, or Agricultural, and its State, i.e. “CO”, “NM”, “TX”, etc. Each Attribute and Value is user defined and customized, both the text that you use and which objects types and specific objects to which they apply.

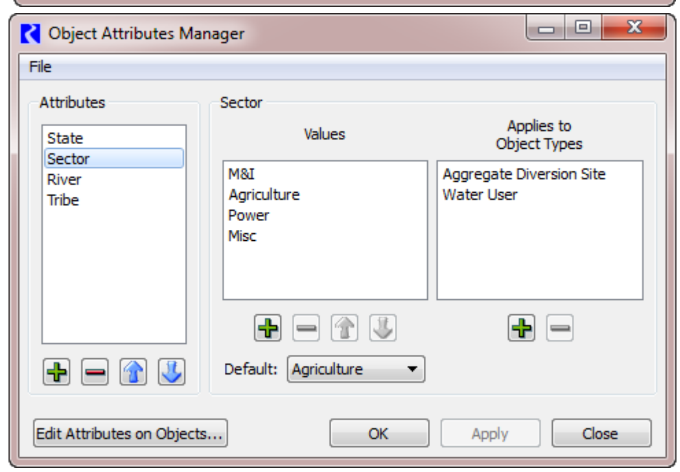
Attributes are displayed on each Open Object dialog on a new Attributes tab (top image). You manage the model’s attributes through the Object Attribute Manager (middle image). You can view, assign and organize attributes on multiple objects using the Edit Attributes Dialog (bottom image).

For more information, click **HERE (ObjectDialogs.pdf, Section 3.1)**.

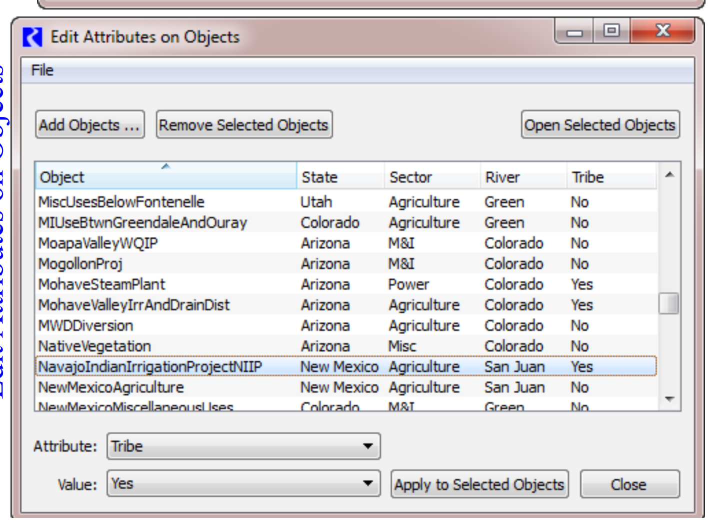
Open Object Attributes tab



Object Attributes Manager



Edit Attributes on Objects



8. Objects

8.1 Inline Power Plants

The Inline Power Plant object's calculation for the Flow Tables method was modified. Now the Power Plant Cap Fraction is applied to both the Turbine Release and the computed Power when the flow is above Max Turbine Release times the Power Plant Cap Fraction. It is not applied when the flow is less than Max Turbine Release times the Power Plant Cap Fraction. This change affects only Inline Power Plants using the Flow Tables method. Click **HERE (Objects.pdf, Section 15.1.1.2)** for more information.

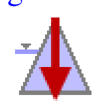
8.2 Level Power and Storage Reservoirs

8.2.1 Unregulated Conditions

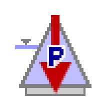
For some users, it is necessary to compute the flows in the basin that would have existed if reservoirs were not in place. To meet this need, the **Pass Inflows** method in the **Disable Reservoir Processes** category was created: The **Pass Inflows** method as described **HERE (Objects.pdf, Section 24.1.30.2)** does the following:

- Changes the Workspace Icon: When this method is selected, the icon on the workspace is modified to indicate the Reservoir is not calculating storage as shown to the right.
- Enables an alternative dispatch method: When this method is selected, only the **Outflow Equals Sum of Inflows** dispatch method is available. This dispatch method sets the Outflow = Σ Inflows and does no further physical process modeling.

Storage Reservoir



Level Power Reservoir



Using scripts (or manually), you can make a model run of your system with the reservoirs in place and executing all the operating policy (rules), then select these methods and re-run the model to get the unregulated conditions. Snapshots can be used to preserve the results between runs. This process and additional information on these methods can be found **HERE (USACE_SWD.pdf, Section 4)**.

8.3 Water User

Methods were added to track the Soil Moisture on the Water User object and meet any remaining depletion requests with soil moisture. The new methods are:

- **Irrigation Requests with Soil Moisture** in the **Diversion and Depletion Request** category: This method computes the diversion and depletion request to meet irrigation demands and refill the soil moisture. Click **HERE (Objects.pdf, Section 27.1.1.5)** for more information.
- **Proportional Shortage with Soil Moisture** in the **Return Flow** category: This method computes the amount of water used from the diversion and from the soil moisture. A

new soil moisture volume and return flow are computed. Click **HERE (Objects.pdf, Section)** for more information.

- **Supplement Diversions including Soil Moisture** in the **Conjunctive Use** category: This method computes the supplemental water required and then tries to meet that request. If there is surplus supplemental water, then it can be used to refill the soil moisture. Click **HERE (Objects.pdf, Section 27.1.8.3)** for more information.

9. Optimization

9.1 Power Reservoir

9.1.1 Power Surface Approximation method

The new Power Surface Approximation (PSA) method was added to the Optimization Power category. The method allows for the modeling of dynamic Operating Head to be incorporated into Optimization Power modeling. The method introduces a new variable, PSA Head Factor, which represents the weighted contributions of Storage, Spill and Tailwater Base Value (if applicable) to Operating Head. The method generates a set of planes to constrain power as a function of Turbine Release and the new PSA Head Factor. The method provides a significant improvement in the Power approximation error for projects that exhibit a wide range of Operating Head over the course of the run. Full documentation of the new method can be found **HERE (Optimization.pdf, Section 5.5.2.15.4)**

9.1.2 Optimization Reserves Category and Method

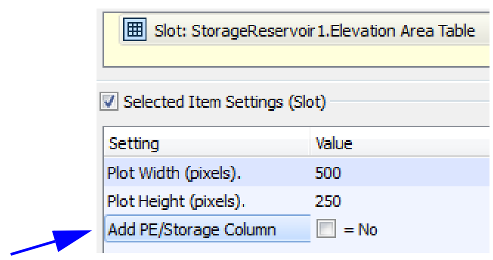
A new category, Optimization Reserves, was added to Power Reservoirs. The category is dependent on the Optimization controller being selected and either Plant Power Coefficient or Plant Efficiency Curve being selected in the Power category. The new Constraint Based Single Timestep method in the category allows users to account for power reserve requirements in the optimization policy. The method introduces a set of duplicate variables that represent the value of standard variables assuming full deployment of either upward or downward reserves. In the RPL Optimization Goal Set, the users can then write parallel constraints using the duplicate reserve variables for any constraint that cannot be violated while deploying reserves. The purpose of the new variables and their parallel constraints is so that the only reserves that are credited to a hydropower project are those that can actually be reasonably deployed. In other words, it will not “count” reserves that could not be deployed without violating specified constraints. The new method also introduces new variables for upward and downward reserves, which allow the user to write policy on the reserves themselves, for example, minimum reserve requirements at individual reservoirs or total system reserve requirements. Full documentation of the new method can be found **HERE (Optimization.pdf, Section 5.5.2.21)**.

10. Output, Plotting, and Model Reports

10.1 Model Reports

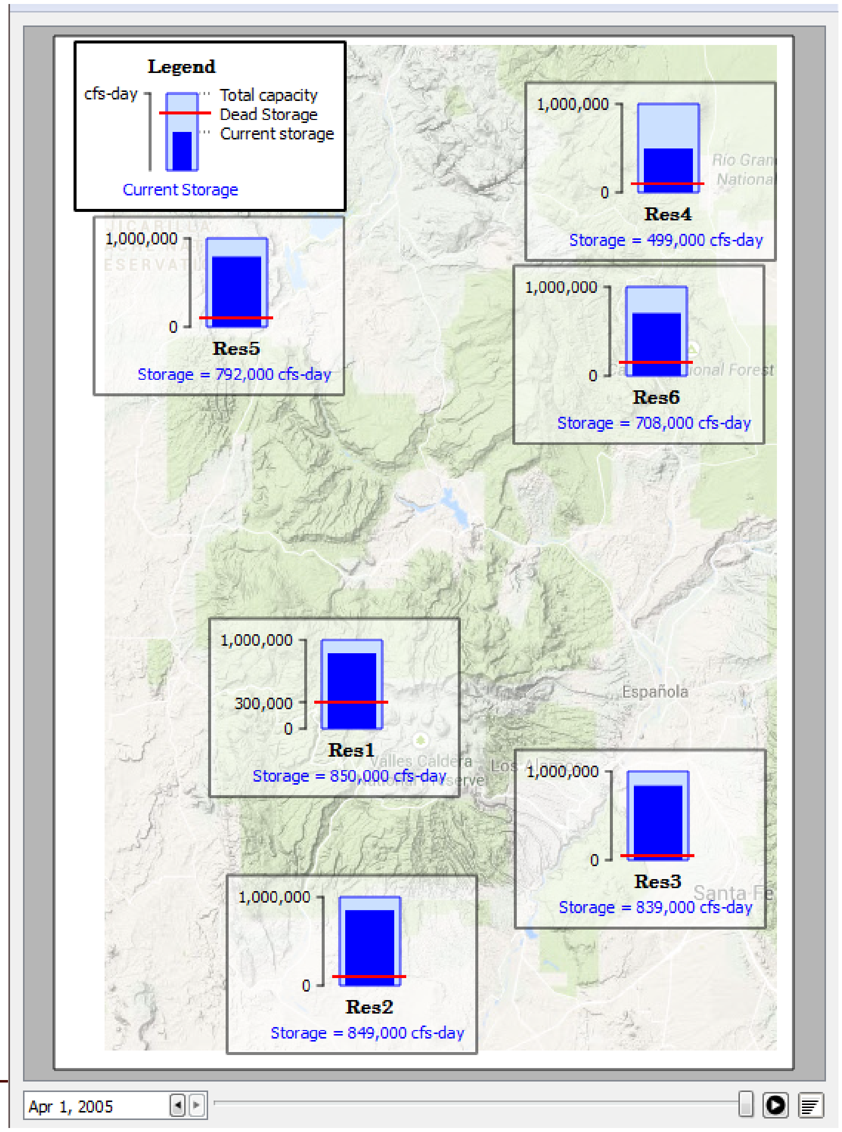
Model Reports **HERE (Output.pdf, Section 4)** allow you to generate a customized HTML document describing various aspects of a model including the configuration, RPL policy, slots, and plots.

10.1.1 Optional PE/Storage column



The Model Report's **Slot** item displays a table slot's values as delimited data in the HTML report. For slots like the **Elevation Area Table** slot (Pool Elevation vs Area), it also shows a column of **Storage** values that corresponds to each **Pool Elevation**. This **Storage** was unconditionally shown. Now there is a setting in the **Slot** item to specify if you want to see this extra column of data. Use the **Add PE/Storage Column** to disable showing the extra information.

10.2 Output Canvas and Teacups



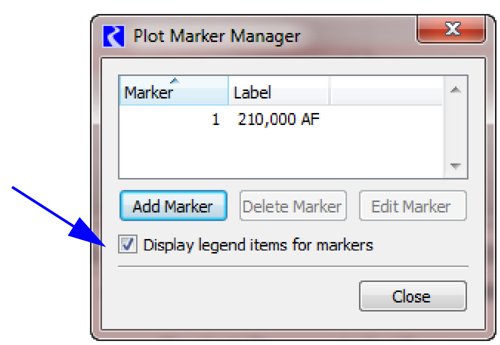
An **Output Canvas** is a new output device which shows spatially distributed output information. In the initial implementation, you can create Teacups that show, for example, the current reservoir storage against the reservoir's full storage. On the teacups you can show marker lines representing important levels and text providing slot values or other useful information. In addition, you can add a legend to annotate the teacups and images representing a map or photos of the reservoir. You can animate the teacups as they change through the run period and export the canvas to an image file

For more information, click **HERE (Output.pdf, Section 6)**.

10.3 Plotting

10.3.1 Show Markers in the Legend

You can now show Markers as an item in the legend. In the **Plot Marker Manager**, shown to the right, use the **Display legend items for markers** check box.



10.3.2 Toggle off curves on a graph.

In the graph legend, you can now left click on an item to temporarily hide the curve. When hidden, the legend item is shown in a disabled state. When the plot is saved, this disabled setting is preserved for future use in the same session, but not saved to the model file. When you open a saved model, all curves are shown regardless.

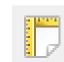
Legend for curve that is shown: 

Legend for curve that is hidden: 

Finally, as part of the above change, the context menus on the legend items have been moved from the left-click to the right-click. This is more standard and intuitive.

10.4 Plot Print Preview and Margin Settings

A plot print preview was added as an option from the **File ➡ Print Preview** menu. Within this preview, you can also configure the page layout including page margins. Use the page setup button to access the margins:

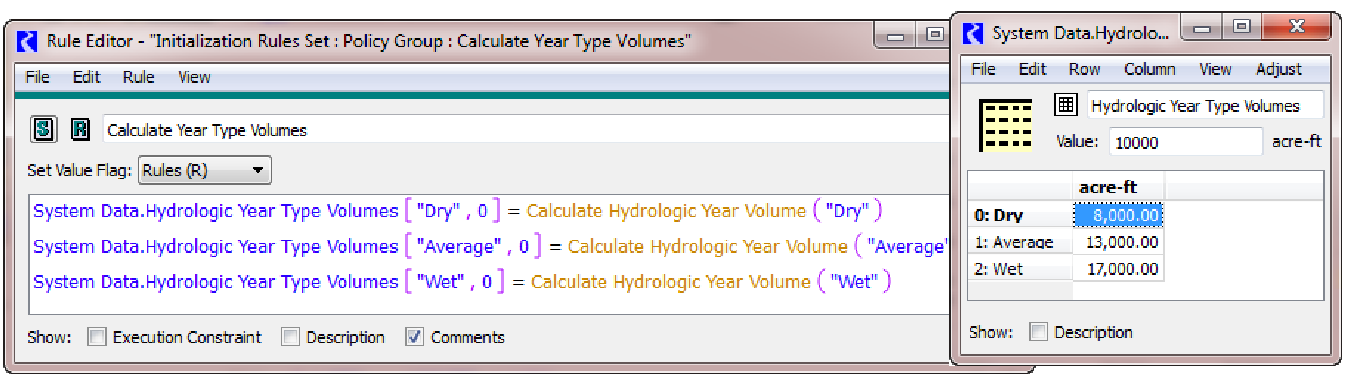


For more information, click **HERE (Output.pdf, Section 2.8.1)**.

11. RiverWare Policy Language

11.1 Initialization Rules - Setting Table Slots

Initialization rules can now set Table Slot values. For more information on Initialization rules, click **HERE (Simulation.pdf, Section 5.1.2)**. The following screenshot shows an initialization rule that is setting three values on the accompanying table slot.



11.2 Predefined Functions

The following RPL predefined functions were added to support Object Attributes (**HERE (Section 7.1)**):

- **ObjectAttributeValue**: Returns the value (as a string) of the specified attribute on the specified object. Click **HERE (RPLPredefinedFunctions.pdf, Section 136)** for more info.

- **ObjectHasAttributeValue**: Return a boolean of whether the particular object has the specified attribute value. Click **HERE (RPLPredefinedFunctions.pdf, Section 137)** for more info.
- **ObjectsFromAttributeValue**: Return a list of all of the objects that have the specified value for the specified attribute. Click **HERE (RPLPredefinedFunctions.pdf, Section 140)** for more info.

In addition, the RPL function **SolveTurbineRelGivenEnergyInflow** was improved to work with more of the power methods. This function returns the turbine release necessary to meet the specified energy and inflow. If the energy cannot be met, the maximum turbine release is returned. The function correctly deals with **Plant Power Limit**, **Power Plant Cap Fraction**, and other constraints, as applicable to the chosen power method.

11.3 RPL Statement Names

It has previously been possible to give RPL statements names. To do so:

- In the RPL set editor select **View ➥ Show Statements**
- Select a statement in the RPL set
- Right click, select **Rename** and enter a new name

Now, these names persist across a save/load of the set. In addition, the now all statements have their type as the default. You can change the name and that will be saved, otherwise the name will be the default. This represents a change in behavior and a loss of one functionality and a gain of other functionality.

Now that RPL statements can be named, the RPL Search and Replace dialog does match on RPL statement names.

11.4 Performance Improvement in RPL

A performance improvement was made within RPL evaluation when looking up slots on the workspace. Now the slot is cached and is referenced in future look ups. In one test model with many slot look ups, this improvements reduced run times by approximately 10%.

12. Script Management

For more information on Scripts, click **HERE (ScriptManagement.pdf, Section 1)**.

12.1 Changes to Existing Actions

12.1.1 Memo action

For the Memo action, a new setting, “Pause Execution” was added to control whether or not memo execution pauses script execution. A new setting, “Show Explanation in Dashboard”, was added to control whether or not the memo's explanation text is included with the memo name in the dashboard. The name of the setting "Show Explanation Dialog" was changed to "Show Memo Dialog".

12.1.2 Set Method

The Set Method action was modified to operate on a selection of objects instead of a single objects. This allows you to set many objects' methods with one action.

12.1.3 Save Model Action

A "Confirm Overwrite" setting was added to Save Model actions. If the value of this setting is true and the file already exists when the action is executed, the user is presented with a dialog and asked what they would like to do: replace the existing file, ignore the action, or abort script execution.

12.2 New Actions

The following actions were added to the script manager.

12.2.1 Reorder RPL Set

Reorder a RPL set according to the values defined in a Table Slot.

12.2.2 Enable RPL Item

Turn on or off a RPL item like a Rule, Goal, or a Policy Group.

12.2.3 Create Snapshot

Create a Snapshot of the specified slots and give it the specified name. Settings allow you to specify whether to overwrite existing snapshots.

12.3 User interface Changes

The following changes were made to the Script Manager, Editor, and Dashboard for usability:

- When editing check boxes, the change is applied when a click is made elsewhere.
- Improved combo-box editing of settings
- Script execution progress bars are not re-set when the script execution ends.
- Improved selection of output device settings.
- Making edits in the edit dialog is now disabled when the script is executing.
- On the Dashboard, menu actions were added to **Enable All Actions** and **Disable All Actions**.
- Vertical space was added between the actions in the script.

12.4 Improved Error and Warning handling

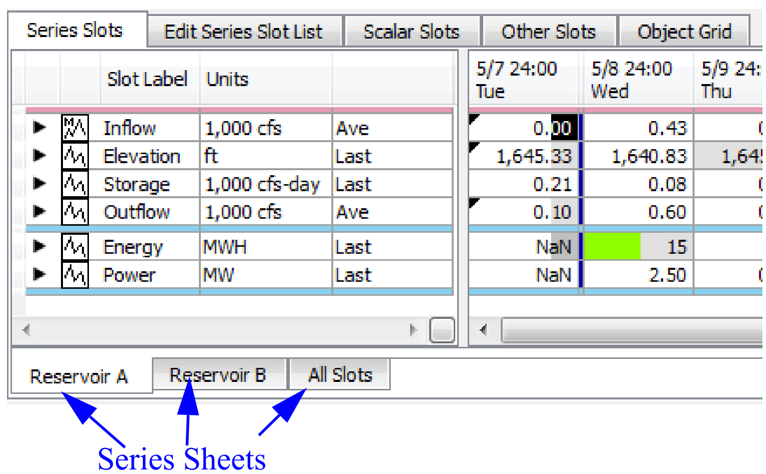
The following changes were made to improve errors that occur within an action:

- If an error occurs during script execution, the script halts execution.
- Execute DMI actions now deal with warnings from DMI invocation.
- Synchronize Objects/Slots actions now abort if the set of objects/slots is empty.
- Improved error reporting in batch execution was added (aborted execution was not reported as an error in diagnostics)

13. SCT

13.1 Series Sheets

It is now possible to create multiple series slot sheets on a single SCT. These sheets are configured by adding new “**Sheet Dividers**” to the SCT on the **Edit Series Slot List** tab. Each divider/sheet can be renamed as desired. There is always an “All Slots” sheet.



For more information, click **HERE (SCT.pdf, Section 4.1.2)**.

13.2 Custom Time Aggregation Summary Rows

You can now add custom time aggregation summary rows when in time-aggregated, vertical timestep view (where slots are columns). You can specify one or more custom **Summary Rows** at the end of **each** time aggregation.The following example has eight custom rows (including dividers as the first and last custom summary rows).

My Sum	Thu	58	40	176	336	314	507.4	35,844
My Max	Thu	24	12	56	90	74	30.3	3,134
My Diff	Thu	35	28	120	246	241	477.1	32,710
My Min	Thu	0	0	0	0	0	18.6	461
My Ave	Thu	2	2	7	14	13	21.1	1,494
MEL	Thu	42	11	87	135	147		

For more information, click **HERE (SCT.pdf, Section 4.7.3)**

13.3 Navigation from the Diagnostics Output

From the Diagnostic Output window, there is now a right-click menu to **Scroll Open SCT's to Context**. When selected, this navigates any open SCTs to the context timestep and slot/object whenever possible.

14. Water Quality

14.1 Constituent Selection, Method Structure, and Names

The selection process for Water Quality parameters was moved from the Run Control parameters to the objects themselves. Now each object that models water quality has a user selectable method. On aggregate objects, the aggregate usually controls the methods and links on the elements, so the methods are not shown on the elements.

With this change it is now possible to mix constituents and solution approach within a model. For example, you could model well mixed salinity on most objects, but use a layered approach to model salinity and temperature on a single reservoir.

In addition, the water quality method names were modified to be more intuitive. The term Layered is still used on reservoirs and groundwater objects where there is layering. Discretized is used on reaches. Other objects have methods called "Propagate" indicating that the water quality information is passed through.

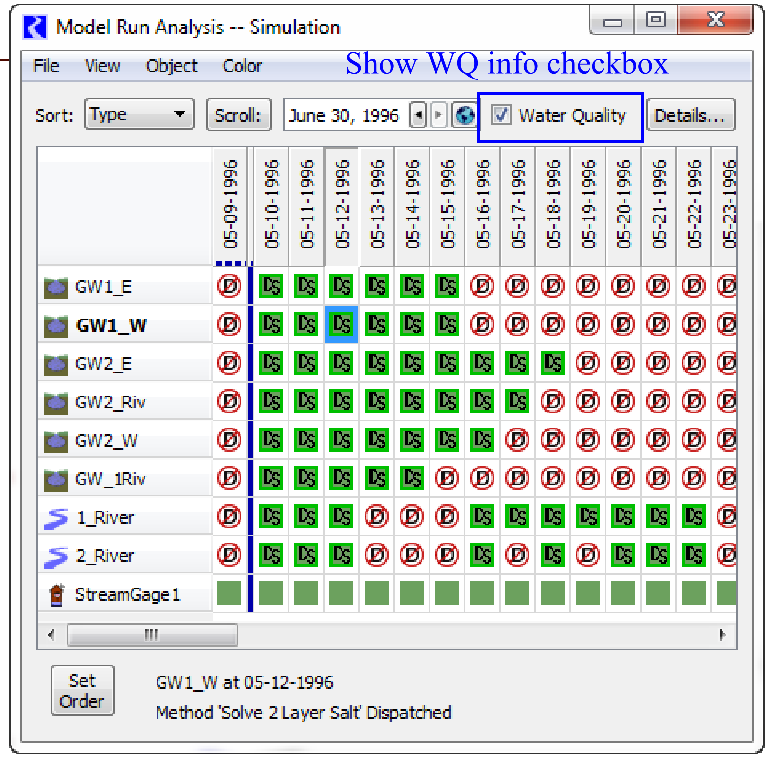
All existing models should update automatically without any user changes.

For more information, click **HERE (WaterQuality.pdf, Section 1)**.

14.2 Run Analysis for Water Quality Dispatching

The Model Run Analysis tool was improved to show Water Quality dispatching information. When Water Quality is enabled, a toggle is shown in the upper part of the Model Run Analysis tool. When checked, information on the water quality dispatching is shown instead of the usual simulation dispatching. This information is also shown on the Dispatch Details dialog.

For more information, click **HERE (WaterQuality.pdf, Section 3.2)**



15. Closed Bug Reports

The following bugs have been closed for this release. For more information on any bug, see the CADSWES website. The bugs are listed in order by bug number:

4956	5362	5481	5498	5524	5525	5526
5527	5528	5530	5531	5533	5536	5538
5539	5540	5542	5543	5544	5545	5546
5550	5551	5552	5553	5555	5556	5558
5559	5560	5562	5564	5566	5567	5573

Release Notes Version 6.7

1. Special Attention Notes

Following are special attention notes, indicating that functionality has changed that requires you to update models or that results may differ. If you have any questions, please contact RiverWare-support@colorado.edu.

1.1 Earliest Dispatch Timestep - Stream Gage changes

Certain objects like the Reach, Confluence, and Control Point determine the first allowable timestep at which they can dispatch by searching upstream to find the earliest input value. Previously, if the search encountered a Stream Gage, it would stop the search. Now the search continues upstream through the gage. As a result, some downstream objects may be able to dispatch earlier if there is a gage upstream and there are inputs on or upstream of the gage. In some models this can lead to errors if the user has input values on the gage or other objects to solve at these pre-simulation timesteps. Often clearing the inputs is all that is required. The values will propagate from upstream.

1.2 License Manager Upgrade

The license manager was upgraded to a newer version. For floating licenses, you must restart the license server with the newer version. Click HERE (Section 6.1) for instructions.

1.3 Inline Power, Flow Tables and Flow Power

The **Flow Tables** and **Flow vs. Power Table** method was modified to use the **Min Turbine Release at Max Generation** as its constraining value. This is obtained from the **Flow vs Power Table** by finding the max power and then using the corresponding flow. More information is available HERE (Section 9.1).

1.4 Series Slot Bounds Terminology and Warnings

The semantics for the slot **Min Value** and **Max Value** were changed to **Lower Bound** and **Upper Bound** as described HERE (Section 15.2). In addition, warning messages that values are outside of these bounds are no longer posted by default. If you wish to see these warning messages, check the **Warn when Values are out of Bounds** toggle in the Run Parameters as described HERE (RunControl.pdf).

1.5 Time Aggregation Series Slot Computations

Time Aggregation Series Slots were enhanced to better calculate averages for monthly flows that are aggregated to an annual timestep. Results for these calculations will change. In addition, slots with **FLOW** or **VELOCITY** unit types (per time and/or rate types) can not use the **Sum** function as this aggregation does not make sense. Click **HERE (Section 15.4.3)**.

2. Accounting

2.1 Negative Transfers Out allowed

Previously, the storage account **Transfers Out** slot value had to be positive or the account would not solve. This check was removed for **Transfers Out** so that now all transfers between two accounts on the same object can be positive or negative.

3. Batch Mode

3.1 New RCL Commands

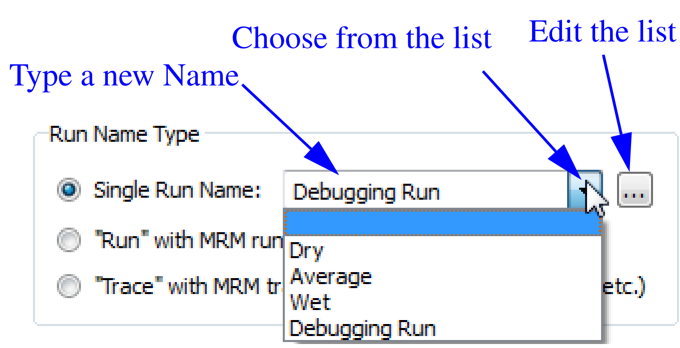
The following RCL commands were added:

- **EnableInfoDiag** - Set the **Enable Informational Diagnostics** checkbox in the diagnostics manager dialog. For more information, click **HERE (BatchMode.pdf, Section 4.4.3)**.
- **ExportOptAnalysisAsCSV** - Export the optimization analysis information as a comma-separated values file. For more information, click **HERE (BatchMode.pdf, Section 4.4.5)**.
- **HDB_EnsembleID** - Assign an ensemble id to an HDB dataset. For more information, click **HERE (BatchMode.pdf, Section 4.4.8)**.
- **HDB_ModelRunID** - Assign a model id into an HDB dataset. For more information, click **HERE (BatchMode.pdf, Section 4.4.9)**.

4. Data Management Interface

4.1 Excel Dataset Run Name List

The **Excel Dataset** configuration has been enhanced to support a user-configurable list of available **Single Run Names**. You can either choose from this list or you can directly edit the **Single Run Name** text. For more information, click **HERE (DMI.pdf)**.



4.2 Trace Directory DMI

A new type of DMI, **Trace Directory DMI**, was added to support multiple runs involving Traces. This DMI requires a specific structure of subdirectories named with the trace number: trace1, trace2, trace3, etc. Each trace directory should contains data files, one for each slot.

You provide a control file which specifies the slots to be imported/exported and optional keywords specifying scale, units, etc. for the slots. But, the `file=` keyword is not required in this control file because the directory is known from the specified DMI directory and the trace number being processed. In addition, no executable is required for the Trace Directory DMI.

For more information, click **HERE (DMI.pdf, Section 4)**.

4.3 Export RBS and Opt Run Analysis information

Support was added for the writing of rulebased simulation and optimization run information by **Control File-Executable** DMIs. Two new control file keyword/value pairs were added:

- slot_set_info = true/false
- slot_opt_sol_info = true/false

5. Diagnostics

5.1 Output Window - Copy Formats

For the various forms of “Copy Message” operations in the Diagnostics Output dialog, the relevant messages lines are now copied to the system clipboard in two formats:

- regular text lines (as before)
- a multi-column HTML table.

When pasting into Microsoft Word or Excel, both “unformatted” and “formatted” options appear in the menu; the formatted option presents the Line Numbers (if shown), Context, and Message in different columns. When pasting into a simple application which supports only text, like a text editor, only the unformatted plain text is pasted.

6. Licensing

6.1 License Manager Upgrade

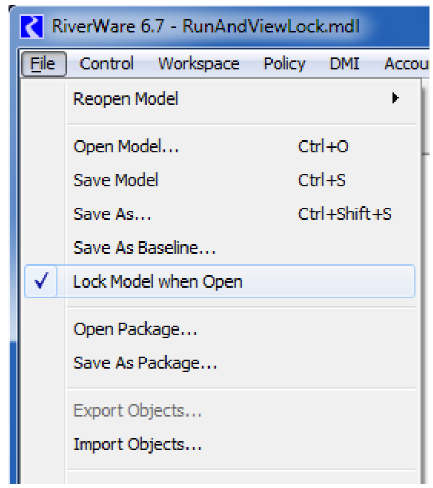
The license manager was upgraded to a newer version. For floating licenses, you must use the newer version. Please shut down the current license server and re-start with the newer version of the license server program files (rlm.exe, rlmutil.exe, cadswes.exe, and cadswes.set) and your current license file. These files are located in the sub folder “reprise” in the 6.7 installation directory. For more detailed instructions: click **HERE.**

Note, this new license manager is backward compatible; for example, you can still run RiverWare 6.6 with the new license manager.

There are no changes needed for node-locked licenses and no new license files are needed for either node-locked or floating licenses.

7. Model Files

7.1 Locking Model while Open



If more than one user is working on a model, then you may want to lock the model when open to prevent others from simultaneously changing the file. To do this, use the **File ➥ Lock Model when Open** menu item and then save the model. A lock file is created in the same directory as the model. If another instance of RiverWare opens the model, the user is notified that the model file is locked and cannot be overwritten.

For more information, click **HERE (ModelFiles.pdf, Section 3)**.

8. Multiple Run Management

8.1 HDB Ensembles

HDB Ensembles within MRM were improved as follows:

- Select Ensembles at MRM Start - A new option was added so that the ensemble id for an HDB ensemble dataset can be selected at the start of a multiple run instead of being pre-specified in the dataset's configuration.
- **GetEnsembleTraceValue** and **GetEnsembleValue** RPL Predefined Functions - These functions were added to query current ensemble and trace meta-data to get the meta-data value for a given meta-data keyword.This was implemented to work for ensemble meta-data information imported during multiple runs and also single runs.
- Creation of New Ensembles in HDB from RiverWare - This allows editing an existing ensemble or creating a new one when ensemble ids are chosen for HDB ensemble datasets, either during dataset configuration or when an MRM run is started.
- Agency ID as User-Selected Parameter - allows the user to optionally choose an agency id from HDB in an ensemble dataset configuration, and write that agency id to its ensemble when executed in an output ensemble DMI.

More information on HDB ensembles is provided **HERE (MRM.pdf, Section 4.7)**.

8.2 MRM Descriptors

Within MRM, new keyword/value descriptors can now be included. The descriptors are defined in the MRM configuration on the **Description** tab. There is now also an option to output the descriptors to both the CSV and netCDF output files from MRM. In CSV, descriptor keywords become column headers and descriptor values become the data value for the column. In netCDF, the descriptor keywords become the name of a global attribute in the file and the descriptor value becomes the value for the attribute.

For more information, click **HERE (MRM.pdf, Section 4.2)**.

8.3 netCDF File Size Improvement

The NetCDF output file from multiple runs was changed from a netCDF4 file with two unlimited dimensions (time and traces) to a netCDF3 file with one unlimited dimension (time). In one example, this resulted in a dramatic reduction in the output file size (from 20 MB to 11 KB). For more information on netCDF output, click **HERE (MRM.pdf, Section 4.8.4)**.

9. Objects

9.1 Inline Power Plant - Flow Tables and Flow vs Power Tables method

The **Flow Tables** and **Flow vs. Power Table** method was modified to use the **Min Turbine Release at Max Generation** as its constraining value. This is obtained from the **Flow vs Power Table** by finding the max power and then using the corresponding flow.

The algorithm is documented **HERE (Objects.pdf, Section 15.1.1.2)**.

9.2 Stream Gage - Stage Methods

A new category, **Stream Gage Stage,** and method, **Stage Table Lookup,** were added to the Stream Gage to compute the **Stage** associated with the flow at the stream gage by looking up the flow on a table that relates flow to stage. In addition, a dispatch method was added to trigger this solution.

For more information, click **HERE (Objects.pdf, Section 25.1.2)**.

9.3 Earliest Dispatch Timestep

Certain objects like the Reach, Confluence, and Control Point determine the first allowable timestep at which they can dispatch by searching upstream to find the earliest input value. Previously, if the search encountered a Stream Gage, it would stop the search. Now the search continues upstream through the gage. As a result, some downstream objects may be able to dispatch earlier if there is a gage upstream and there are inputs on or upstream of the gage. In some models this can lead to errors if the user has input values on the gage or other objects to solve at these pre-simulation timesteps. Often clearing the inputs is all that is required. The values will propagate from upstream.

For more information, click **HERE (Simulation.pdf, Section 5.1.1)**.

9.4 Power Reservoirs

9.4.1 Power Method: Plant Efficiency Curve modifications

In the Plant Efficiency Curve power method, the Plant Power Table data was previously required to be concave. This check was removed for the beginning of Simulation and Rulebased Simulation but is still performed at the beginning of an Optimization run.

9.4.2 Tailwater Method: new Coefficients Table method

A new **Tailwater** method was added: **Coefficients Table**. This method models the tailwater using a series of coefficients that are applied to the Outflow, Tailwater Base Value, and Tailwater Elevation at the current and/or previous timestep. For more information, click **HERE (Objects.pdf, Section 17.1.7.7)**.

9.5 Water User - Soil Moisture Methods

A new slot **Soil Moisture Gain Loss** was added to track the soil moisture water lost when the irrigated acreage is reduced from the previous timestep. In the **Irrigation Request with Soil Moisture**, the method calculates the volume lost by the reduced area. This volume is then included in the water balance when the water user solves for the current Soil Moisture.

More information can be found **HERE (Objects.pdf, Section 27.1.1.5)**.

10. Optimization

10.1 Optimization Solution Analysis Export

It is now possible to export optimization analysis information (as displayed in the Priority-Oriented Optimization Solution Analysis Tool) to a file in a Comma-Separated Values (CSV) format. You can do this interactively or through batch mode as described **HERE (Section 3.1)**. The export includes options on which types of information to export and an option to omit rows with values that are zero. For more information, click **HERE (Optimization.pdf, Section 7.1)**.

In addition, you can now save the entire optimization analysis information (i.e. the problem) for later use by selecting the **File ➥ Save Problem** menu.

10.2 Power Reservoir Methods

10.2.1 Optimization Power method: Power Surface Approximation modifications

The **Power Surface Approximation** method was extended to account for tailwater effects, particularly if the **Tailwater Base Value** is linked to another reservoir’s **Pool Elevation**.

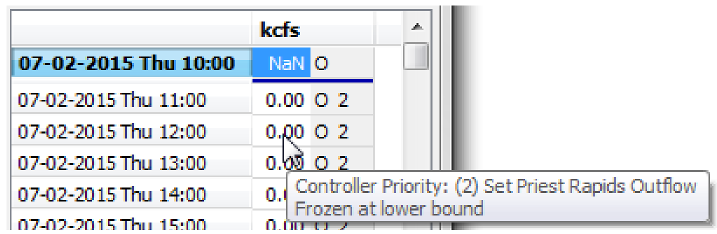
In addition, a scalar slot, **PSA Constraint Coefficient Tolerance**, was added. This slot is used to avoid numerical instability. For more information, click **HERE (Optimization.pdf, Section 5.5.2.15.4)**

10.2.2 Optimization Tailwater method: new Opt Coefficients Table method

A new method was added to the **Optimization Tailwater** category: **Opt Coefficients Table**. This method sets up the physical tailwater constraints using the same equation and coefficients used in the **Coefficients Table** tailwater method. For more information, click **HERE (Optimization.pdf, Section 5.5.2.19.5)**.

10.3 Slot Tool Tips show Optimization Solution Information

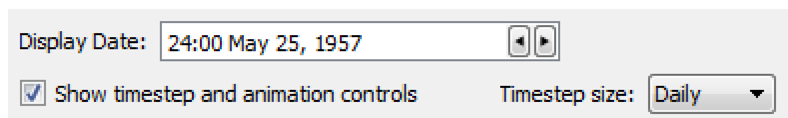
If a slot variable is frozen, the information is shown on the slot and SCT dialogs in the tool tip. For more information, click **HERE (Optimization.pdf, Section 7.2)**.



11. Output, Plotting, and Model Reports

11.1 Charts - Timestep Size

Pie Charts now have a configuration setting so that you can specify the timestep size to use for the animation and timestep controls. You can choose any timestep greater than or equal to the timestep of the selected data. For example, for a chart showing hourly data, you may only want to step through the pie chart at a daily timestep.



For more information, click **HERE (Output.pdf)**.

11.2 Comma-Separated Values Output Device

A new output device, Comma-Separated Values (CSV) file was added. This device provides options on which fields should be included in the output file and which slots to include. This new file has a format that can easily be imported into Excel or Tableau for further analysis:

```
Object.Slot, Timestep, Slot Value, Object Name, Unit, Year, Month
Pella.Outflow,02-29-1920 24:00:00,120.23,Pella,1 cfs,1920,February
Pella.Outflow,03-31-1920 24:00:00,133.21,Pella,1 cfs,1920,March
...
```

For more information on the format or configuration, click **HERE (Output.pdf, Section 1.4.3)**.

11.3 Model Reports

Model Reports **HERE (Output.pdf, Section 4)** allow you to generate a customized HTML document describing various aspects of a model including the configuration, RPL policy, slots, and plots. Following are items that have been added to Model Reports

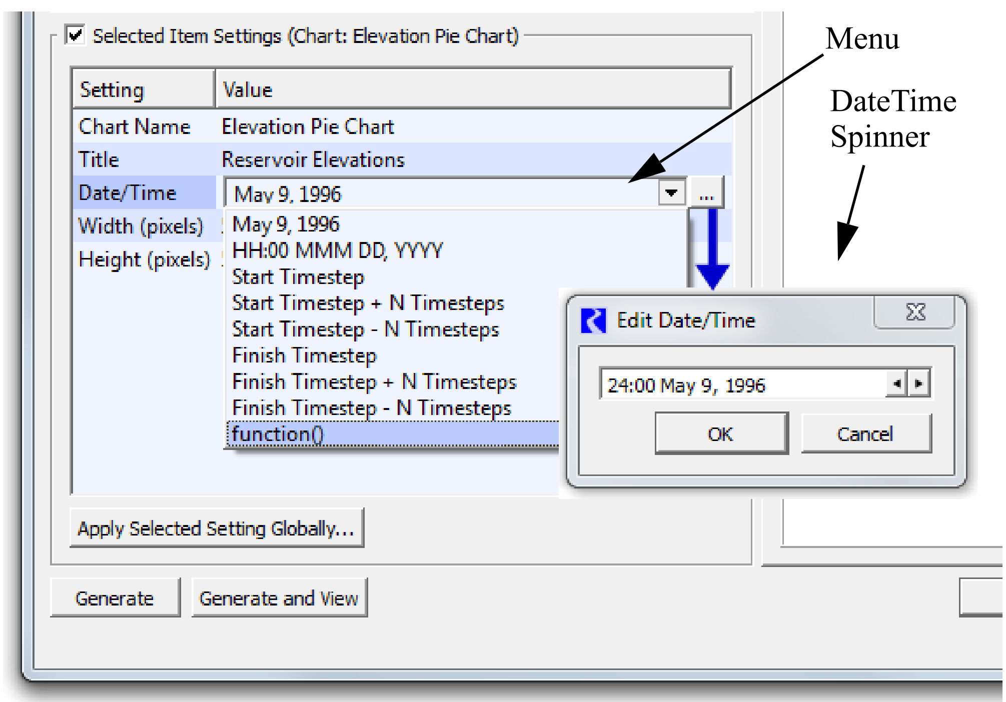
11.3.1 Date/Time Overrides on Output Items

For output devices shown in a Model Report, you can now symbolically specify an override date (or start and end dates). This is possible for the following items within a Model Report:

- Chart
- Output Canvas
- Tabular Series Slot Report
- Plot Page
- Slot item (time series slot plots)

You can specify the dates as absolute dates or symbolic dates using either a common format, a RPL Date/Time or a RPL global function that returns a date/time.

Why use this functionality? Perhaps you have an operations model that is advanced forward in time every day. With these settings, the report can automatically update the output information to show the new operating range without having to manually change the dates.



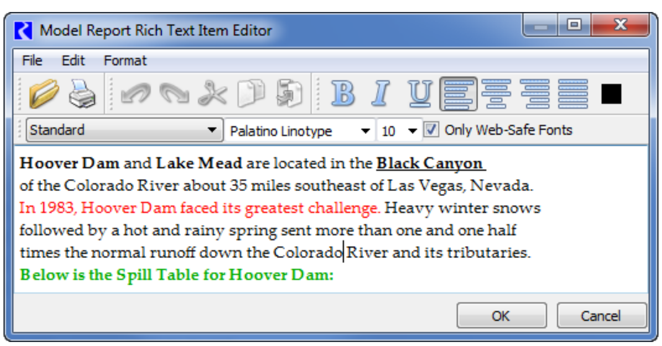
For more information, click **HERE (Output.pdf)**.

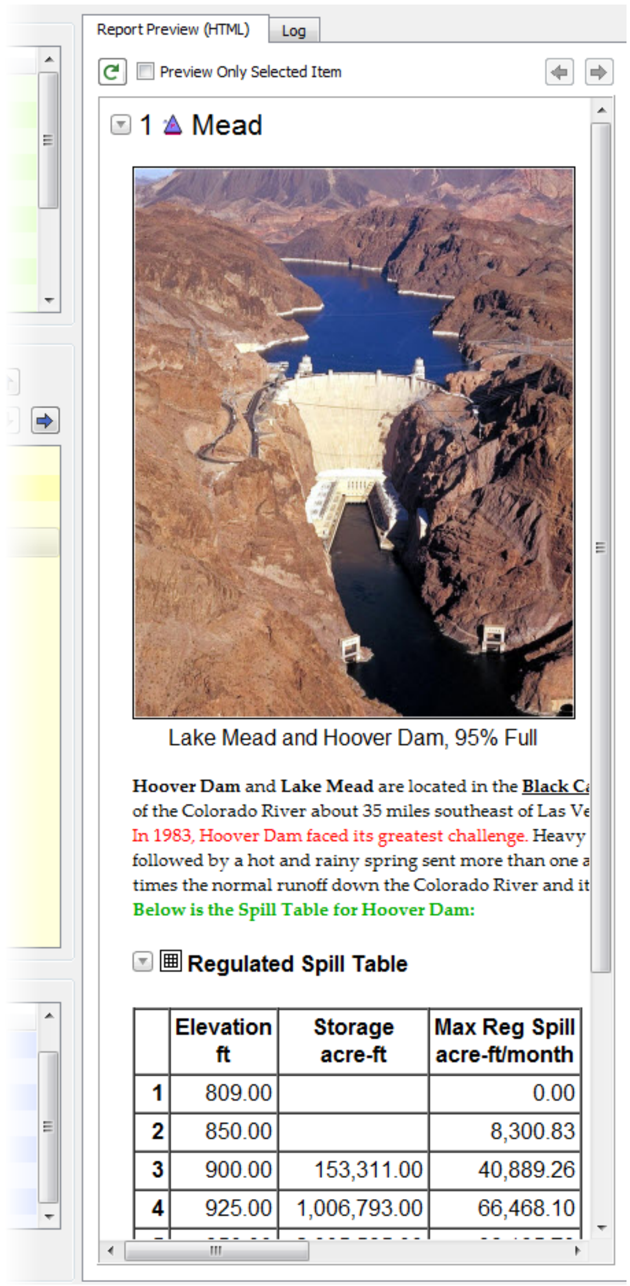
11.3.2 Images in Model Reports

You can now add **Image** items to a Model Report. The **Image** item import an Image file (jpg or png), into a Model Report (the image is stored in the model file) and supports an optional caption text string that will be shown below the image in the generated HTML report. An example screenshot is shown to the right.

11.3.3 Rich Text in Model Reports

The Model Report Text item now support a **Rich Text** mode for basic HTML-based formatting. The provided Rich Text editor (shown below) allows you to apply formatting such as bold, italics, font, size, and even bullets and alignment. Further, copied text from external applications, like Microsoft Word, will retain much of their formatting when pasted. This allows you to copy rich text from an external document and paste it into the model report.





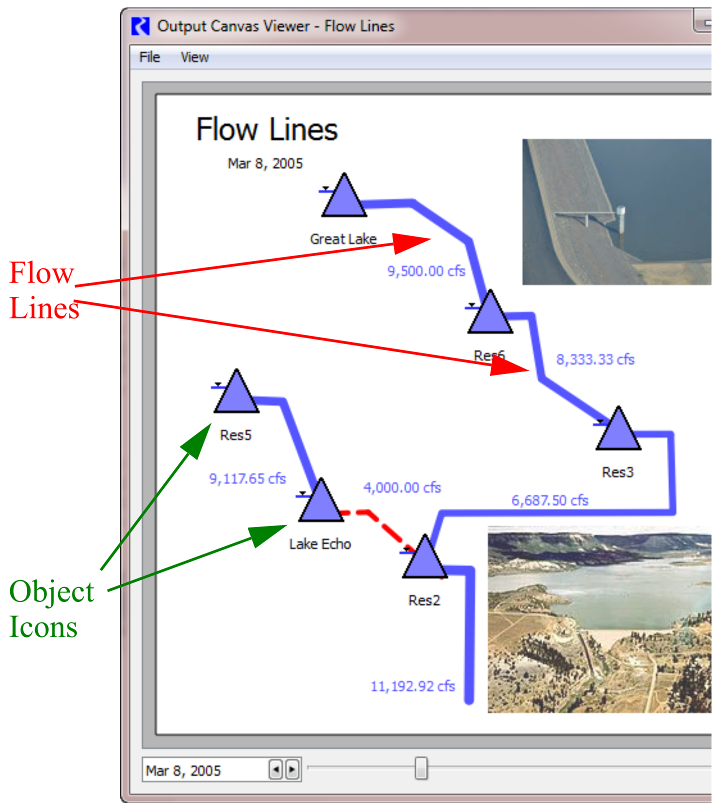
Example Model Report showing an Image, Rich Text and a Table

11.4 Output Canvas

The Output Canvas, described **HERE (Output.pdf, Section 6)**, allows for visualization of outputs in a spatially distributed way. Previously, you could show teacups, images, and basic text. The following features were added.

11.4.1 Flow Lines

Flow Line Groups and **Flow Lines** was added to the Output Canvas. Simply, a flow line is a poly-line on the output canvas that is typically associated with a slot value, often the flow in a river. You can configure the flow lines to change width based on the flow compared to other values in the group and change color and line type as the flow crosses thresholds defined on each particular flow line. For more information, click **HERE (Output.pdf, Section 6.3.5)**



11.4.2 Object Icons

This new type of output canvas graphic object displays the **Object Icon** associated with a particular simulation object. Object icon groups support optional dynamic text items which can include values of slots on the object or the related data object.

12. RiverWare Policy Language

12.1 Initialization Rules - Setting Scalar Slots

Initialization Rules can now assign values to Scalar Slots along with Series Slots and Table Slots. The structure to set a scalar slot is: Object.ScalarSlot[ ] = <numeric expr>

12.2 Predefined Functions

The following RPL predefined functions were added:

Name	Description	More Info*
getEnsembleTraceValue	Returns the value for an ensemble keyword for the current run.	Section 59
getEnsembleValue	Returns the value for a trace keyword for the current trace executing in a run.	Section 60
GetLowerBound	Returns the lower bound for the given slot	Section 63
GetLowerBoundByCol	Returns the lower bound for the given slot and column	Section 64
GetUpperBound	Returns the upper bound for the given slot	Section 90
GetUpperBoundByCol	Returns the upper bound for the given slot and column	Section 91
IsControllerRBS	Returns true if and only if the current controller is Rulebased Simulation or Inline Rulebased Simulation and Accounting	Section 104
OptValueByCol	Returns the optimal value as calculated during the last Optimization run for a given column and date of an aggregate series slot	Section 148

* Links lead to the section in RPLPredefinedFunctions.pdf

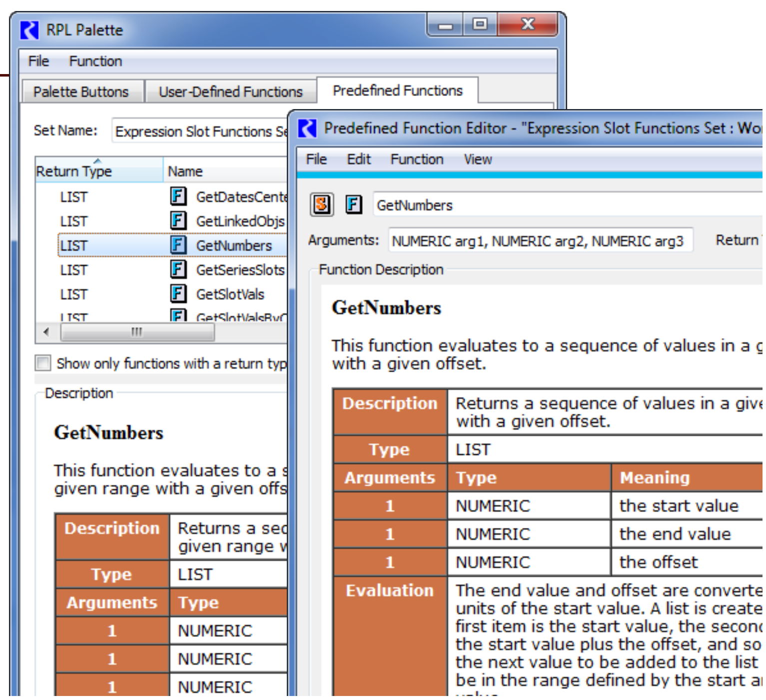
The following predefined function names were modified. The previous names will continue to load and be supported, but new instances will use the new names:

- NetSubbasinDiversionRequirement
- SolveSubbasinDiversions
- ToCelsius

12.3 Predefined Function Documentation

The RPL predefined function help content is now shown within the RiverWare interface in the following dialogs:

- Predefined Function Editor dialog. (Below Right)
- RPL Palette, on the **Predefined Functions** tab. (Below Left)
- RPL Set Editor when **Show Predefined Groups** and **Show Descriptions** are checked.



12.4 RPL Parameters

The following parameter setting were removed as they no longer incur performance overhead.

- The **Collect RPL Set Performance Information** checkbox in the RPL Parameters dialog. RiverWare will now always collect performance information.
- The **Enable Rules Model Run Analysis** checkbox on the Rulebased Simulation Run Control settings. The **Rules Model Run Analysis** is always enabled.

13. Script Management

13.1 New Actions

The following actions were added:

Name	Description	More Info*
Configure MRM Index Sequential	For the specified MRM configuration, modify the MRM Index Sequential settings.	Section 3.3.4
Configure MRM Input DMI	For the specified MRM configuration, modify the Input DMI settings, particularly the repeat count.	Section 3.3.5
Configure MRM Output	For the specified MRM configuration, modify the MRM Output settings.	Section 3.3.6
Enable MRM Distributed Runs	For the specified MRM configuration, specify whether to distribute concurrent runs to multiple processors on the same machine.	Section 3.3.10
Set Excel Dataset Run Name	For the specified Database DMI Excel Dataset, set the run name type and/or specify a new single run name.	Section 3.3.33
Set MRM Descriptor	For the specified MRM configuration, set the specified keyword, value pair MRM Descriptor.	Section 3.3.37
Set MRM Ruleset	In a given MRM configuration, set a new file path to a ruleset.	Section 3.3.38
Set MRM Run Range	Set the time range of the run (i.e. the Run Start and End dates) for the specified MRM configuration.	Section 3.3.39

* Links lead to the section in ScriptManagement.pdf

For more information on Scripts, click **HERE (ScriptManagement.pdf, Section 1)**.

14. SCT

14.1 Custom Summary Rows

Some **Custom Summary Rows** (described **HERE (SCT.pdf, Section 4.7.3)**) aggregation values can be misleading. Now there is an option to right click on a custom summary cell and **Hide Aggregation Value**.

Navigation was improved from a Custom Summary Row using a **Slot Reference** configuration. A context menu operation has been added to the context menu for those SCT cells: **Open Custom Summary Slot...**

15. Slots

15.1 Import Paste Negative Values from Excel

Negative numbers in Excel can be displayed with parenthesis instead of a negative sign. Previously, during an Import Paste, such values weren't recognized as numbers. With this change, the Import Paste now recognizes these correctly as negative numbers.

15.2 Min/Max Changed to Bounds

The semantics for the slot min and max values was changed as follows:

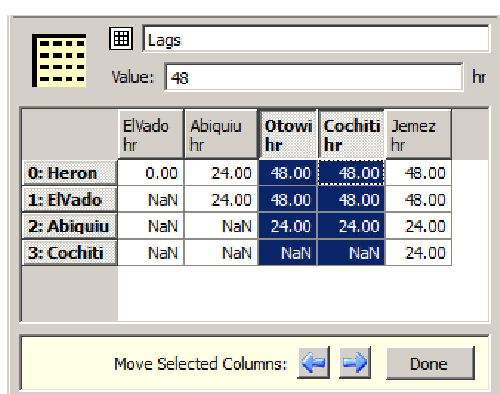
- On Series, the **Min Value** / **Max Value** was changed to be **Lower Bound** / **Upper Bound**, respectively.
- On table slots, **Optimization Min/Max Values** (available on certain table slots) was changed to be **Optimization Limits for Table Verification**, **Lower** and **Upper Limit**.

The **Configure Slot** and **Configure Existing** (Multiple) **Slots** dialogs were changed to reflect the new terminology. These bounds and limits are used primarily in Optimization models. In the future, this will be further required.

Finally, warning messages that values are outside of these bounds (Min/max) are no longer posted by default. If you wish to see these warning messages, check the **Warn when Values are out of Bounds** toggle in the Run Parameters as described **HERE (RunControl.pdf)**.

15.3 Table Slot - Move Columns and Rows.

A new **Column ➥ Move Columns** operation is available for multiple-column table slots and periodic slots on data objects. A new **Row ➥ Move Row** operation is available for multiple-row table slots on data objects

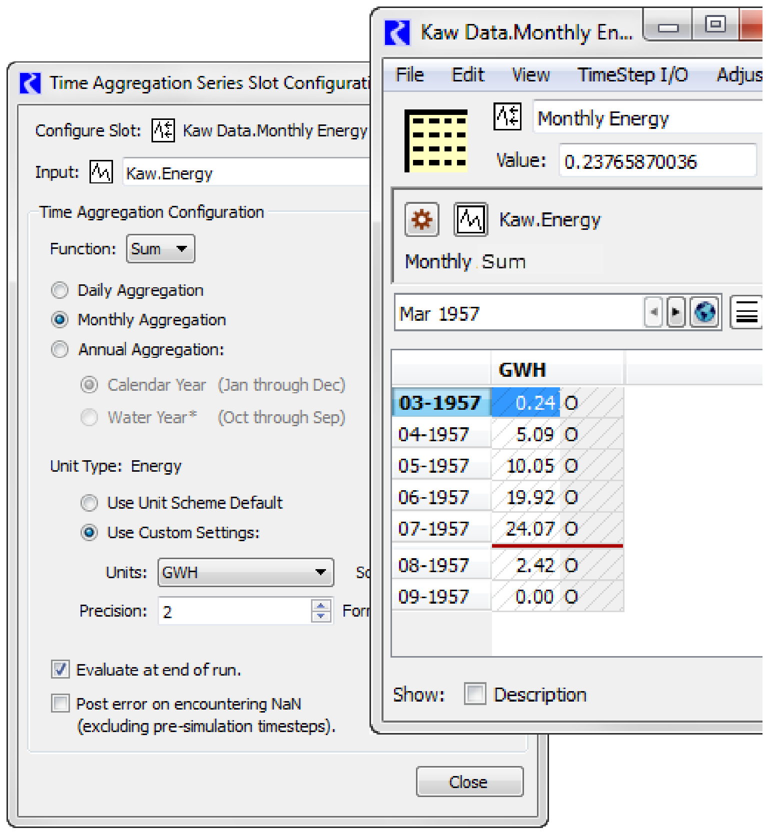


15.4 Time Aggregation Series Slots

Time Aggregation Series Slots are documented **HERE (Slots.pdf, Section 4.7)**. Following are changes made to this type of slot:

15.4.1 Daily Aggregation

Time Aggregation Series Slots can now be used to aggregate hourly, 6hr, and 12hr timestep slots up to a daily aggregation timestep. Thus, daily, monthly, and annual (calendar and water year) aggregation are now supported.



15.4.2 Configuration Dialog

The slot's aggregation configuration dialog was re-implemented. Now the input slot specification, aggregation function, and aggregation period are all specified in the configuration dialog. This configuration also includes unit specification for better control over the units shown.

15.4.3 Modifications to Aggregation Computations

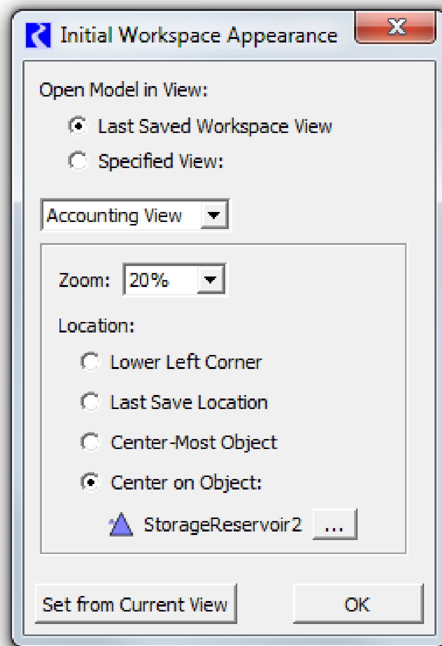
Time Aggregation Series Slots were enhanced to better calculate averages for monthly flows that are aggregated to an annual timestep. Results for these calculations will change.

In addition, slots with **FLOW** or **VELOCITY** unit types (per time and/or rate types) can not use the **Sum** function as this aggregation does not make sense. The **Sum** function is no longer available. Instead, use the **Ave** function and modify the units shown. For example, average daily flows in cfs to monthly flows and show the results in acre-feet/month.

16. Workspace

16.1 Initial Workspace Appearance

You can now configure the workspace appearance when the model is first opened, in terms of the view, zoom, and scroll location. On the workspace, use the **Workspace ➥ Initial Appearance...** menu. The dialog shown to the right opens.



In this dialog, you specify the initial view setting, either the last saved view or a specific view. Then for each view, specify the zoom level and the location at which the model should open. Choices include the

- Lower left corner
- Last saved location
- Center-most object
- Center on object

This functionality applies on model load and provides settings so you can configure the appearance when the model opens.

More information is available **HERE (Workspace.pdf, Section 3.6)**.

17. Closed Bug Reports

The following bugs have been closed for this release. For more information on any bug, see the CADSWES website. The bugs are listed in order by bug number:

3348	3609	4181	4206	5476	5481	5511
5523	5532	5534	5537	5547	5548	5557
5574	5575	5576	5577	5578	5579	5580
5581	5582	5583	5584	5585	5587	5590
5591	5594	5597	5600	5601	5605	5606
5607	5609	5611	5613	5614	5616	5622
5623	5626	5628	5629	5630	5632	5633
5634	5636	5638	5639	5641	5642	5643
5644	5645	5647	5648	5655	5657	5661
5662	5663	5660	5612			

Release Notes Version 6.8

This document describes new features, enhancements, and changes in RiverWare Version 6.8.

1. Data Management Interface

1.1 Excel DMIs for DateTime values

The Excel Database DMI was modified so that export/import of values that have the DateTime unit type are translated to/from the Excel date representation. This allows dates to display correctly in both RiverWare and in Excel. For more information, click **HERE (DMI.pdf)**.

2. Licensing

2.1 Licensing for 32 bit RiverWare

The 32 bit version of RiverWare is now available only on a password protected website. Please contact installation support (installsupport@colorado.edu) for access information. The 64 bit version continues to be available on the RiverWare.org website with no login or password required.

3. Objects

3.1 Reach

3.1.1 New Routing method: Modified Puls

A new routing method, **Modified Puls**, was implemented in the reach **Routing** category. This method computes the Outflow of a segmented reach as a function of previous Inflows, Outflows, Storages and current Inflows. The Storage is a function of Outflow as defined in the Storage Outflow Table and the derived Storage Outflow Indication Table. For more information, click **HERE (Objects.pdf, Section 22.1.1.16)**.

3.1.2 Table Series Slots are now Temporary

On the reach, table series slots are used by the distributed routing methods to preserve intermediate results. When there are many segments in a reach, these could lead to large model sizes, even when not saving outputs. To fix this issue, the following table series slots were changed to temporary slots so that the slots and values are no longer saved in the model file:

- **Distributed Flow Output**
- **Distributed Previous Flow Output**
- **Distributed Xsectional Area Output**
- **Distributed Velocity Output**
- **Distributed Depth Output**
- **Distributed Volume Output**
- **Distributed TopWidth Output**
- **Distributed Celerity Output**
- **Distributed Courant Output**
- **Distributed Reynolds Output**
- **Distributed Salt Concentration Output**
- **Distributed Temperature Output**
- **Distributed Total Surface Flux Output**
- **Segment Outflow**

The slots are still available and are viewable after a run, but they are not saved in the model file.

3.1.3 Pan Evaporation

For the Reach **Pan Evaporation** method, the **Reach Pan Coefficient** can now be greater than 1.0. Previously the Reach issued an error if this value was greater than 1.0. Click **HERE (Objects.pdf, Section 22.1.19.3)** for the documentation of this method.

3.2 Reservoir

On Storage and Level Power Reservoirs with unregulated spillways, when solving given **Inflow** and **Outflow**, the **Unregulated Spill** is now constrained to be no larger than the volume of water above the spillway crest.

3.3 Power Reservoirs

3.3.1 Plant Power Table with Units method

A new category, **Power Unit Information** and method **Plant Power Table with Units** was added. This method adds a fourth column to the **Plant Power Table**. During the power calculation, the **Number of Units Generating** is computed by looking up the **Operating Head** and **Turbine Release** on the table to find the number of units that are generating. This category is available for the **Plant Power Efficiency** and **Plant Power Coefficient** methods.

3.3.2 Power method slots incorrectly displayed

Due to an error in method dependencies, unused slots may be shown if you switched to the Optimization controller and then switch back to another controller. To fix this, a default **None** method was added to the **Optimization Power** category. To implement the fix and not see these unused slots, switch the controller to Optimization, and then select **None** in the **Optimization Power** category. Then, switch back to Simulation or another controller and you will no longer see the **Plant Power Table** and other unnecessary slots.

3.3.3 Dispatch Slot: LCR Input Efficiency

The **LCR Input Efficiency** slot was converted into a dispatch slot. Now when it is set, it will trigger the object to consider dispatching.

3.4 Groundwater Storage

In certain situations, the Groundwater Storage object incorrectly computed negative storage due to **Head Based Percolation**. Now, the **Head Based Percolation** is limited to be less than the previous **Storage**, converted to a flow. In addition, the Groundwater **Available for Pumping** is constrained to be greater than or equal to zero.

4. Optimization

4.1 Power Reservoir Power Coefficient Method

A new method, **Power Coefficient**, was added to the **Optimization Power** category. This method provides a new approach to linearize **Power** for Optimization. You specify input values in the **Power Coefficient Estimate** slot and **Power** at each time step is then defined as:

$$\text{Power} = \text{Turbine Release} \times \text{Power Coefficient Estimate}$$

For more details on the **Power Coefficient** method click **HERE (Optimization.pdf, Section 5.5.2.15)**

5. Output: Model Reports, Output Canvas and Plotting

5.1 Model Reports

Model Reports, described **HERE (Output.pdf, Section 4)**, allow you to generate a customized HTML document describing various aspects of a model including the configuration, RPL policy, slots, and plots. The following improvements have been added to Model Reports:

- A control was added to show or hide the table of contents section.
- Level 5 Font Configuration settings were added. This provides an additional level of model report header font customization.
- Heading text was always bold, even when a normal font style (weight) was specified. This has been fixed so that now you can have any combination of weights and italics.
- Series data with a unit type of **DateTime** are now displayed correctly in a Model Report and Tabular Series Slot Reports.

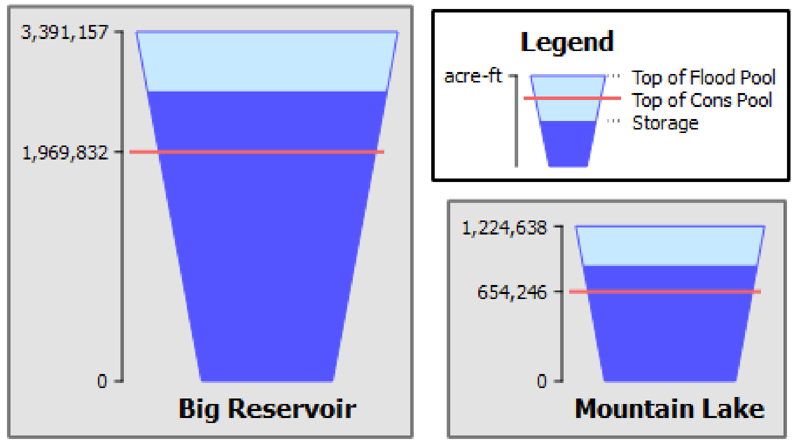
5.2 Output Canvas

The Output Canvas, described **HERE (Output.pdf, Section 6)**, allows for visualization of outputs in spatially distributed teacups and flow lines. The following improvements have been added to the Output Canvas:

5.2.1 *Trapezoidal Teacups*

Settings have been added to a Teacup Group allowing you to specify the **Teacup Geometry**. You can choose from the following shapes:

- Rectangular
- Trapezoidal, Congruent (shown to the right)
- Trapezoidal, Constant Top and Bottom Widths



For more information, click **HERE (Output.pdf, Section 6.3.4)**.

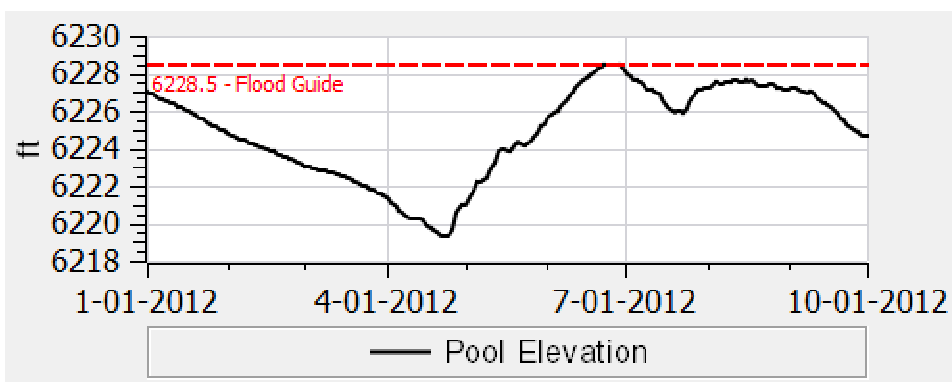
5.2.2 *Additional Settings*

Show Gap: A configuration setting was added to optionally show or hide a side gap between the inner *current* rectangle/trapezoid and the outer *maximum* rectangle/trapezoid.

Overflow pattern: When the *current* value is larger than the *maximum* value (i.e. overflow), a distinct dotted pattern fill is now shown. Previously, the overflow value was drawn larger than the maximum value, but was indistinguishable in certain cases on the new trapezoidal teacups. The new dotted pattern is now shown for all teacups.

5.3 Plotting - Appearance

In the plotting utility, curves are shown using anti-aliasing so that the curves appear smoother. In addition, the border and padding around the plot area was removed to simplify the appearance of the plots.



6. RiverWare Policy Language

6.1 Expression Editing

The interface for editing RPL expressions was improved to be more robust and easier to use, especially when editing existing expressions. Following are descriptions of the changes:

6.1.1 Logical Operator Replacement

The editing mechanism was enhanced to retain the expressions when you switch a logical comparison operator (>, >=, <, <=, ==, !=). Thus, if you select an existing expression that contains one of these operators, and then choose a different one, the left and right sub expressions are retained for the new operator. This makes it easy to switch an operator from one to the other as shown in the following example:

res2.Outflow [] < rulesData.minFlow [] → res2.Outflow [] > rulesData.minFlow []

6.1.2 Function Argument Reuse

Similarly, when you select a different function, the interface now retains the arguments whenever possible. This makes it easy to swap in similar functions; for example, changing from Min to Max:

Min (res2.Outflow [] , rulesData.minFlow []) → Max (res2.Outflow [] , rulesData.minFlow [])

Checkboxes were added to the user defined and predefined function tabs of the RPL Palette that allow you to indicate if you want to retain function arguments, where possible, when one function is replaced with another. The arguments must have the same type, in left to right order, to re-use them. In addition, if the number of arguments is different, then they will be reused whenever possible. Click **HERE (RPLTypesPalette.pdf)** for a description of the checkbox.

6.1.3 User-Defined Function Renaming

The interface was improved to make it easier to update references when you change the name of a **User-Defined Function**. Functionality has been added so that when a function is renamed, you are asked if you want to also rename calls to the function in RPL sets where it is used. Click **HERE (RPLUserInterface.pdf, Section 2.6.2)** for more information.

6.2 Initialization Rules Set Management

The ability to save and load initialization sets to/from files and to remove RPL sets from a model was added. A menu item, **Save Initialization Rules Set As** allows you to save the Initialization rules set to a file. **Replace Initialization Rules Set from File** menu allows you to replace the existing set with a set that is saved as a file. Any existing initialization rules are cleared and new ones then loaded from the file. For more information, click **HERE**

(RPLUserInterface.pdf, Section 1.4.2). In addition, script actions were added to **Replace Initialization Rules Set from File** and **Remove RPL Set** as described **HERE (Section 7.1)**.

6.3 New Predefined Function - GetSelectedUserMethod

A new function, **GetSelectedUserMethod**, was added. This function returns the name of the selected method for a given category name on a given object. For more information, click **HERE (RPLPredefinedFunctions.pdf, Section 81)**.

6.4 RPL Search and Replace

RPL Search and Replace allows you to find a text string and then replace the text. More information on this utility can be found **HERE (RPLUserInterface.pdf, Section 2.5)**. The following enhancements or changes were made to this utility:

6.4.1 Search in All Sets at Once

The RPL Search and Replace dialog was enhanced to provide an option to search **All RPL Sets** at once. In addition, a new menu item was added to the Policy menu of the RiverWare workspace to access the RPL Search and Replace dialog. Accessing it in this way configures the dialog to search all RPL sets, providing a streamlined way for the user to make global replacements in all sets.

6.4.2 Change Object/Slot names

The **Open Object** and **Open Slot** dialogs were modified so that when the Object or Slot name is changed, you are asked if they want to search all RPL sets for the old name. If yes, a search is performed in all RPL sets for the old name and the **RPL Search and Replace** dialog is opened to display the results. The old name is shown in the dialog as the search string and the new name as the replace string. You can easily select occurrences of the old name and replace them with the new one. This is a two step process so that you can review the occurrences and replace them as desired.

6.4.3 Display of Rule Names

In the **RPL Search and Replace** dialog, RPL statement names were incorrectly shown. Now rule/block/method names are correctly shown instead of statement names.

7. Script Management

7.1 New Actions

The following actions were added:

Name	Description	More Info*
Remove RPL Set	This actions removes the specified RPL set from the model. For example, for RBS sets, it unloads and closes the set.	Section 3.3.26
Replace Initialization Rules Set from File	Clears any existing initialization rules and loads a new one from the specified file.	Section 3.3.28

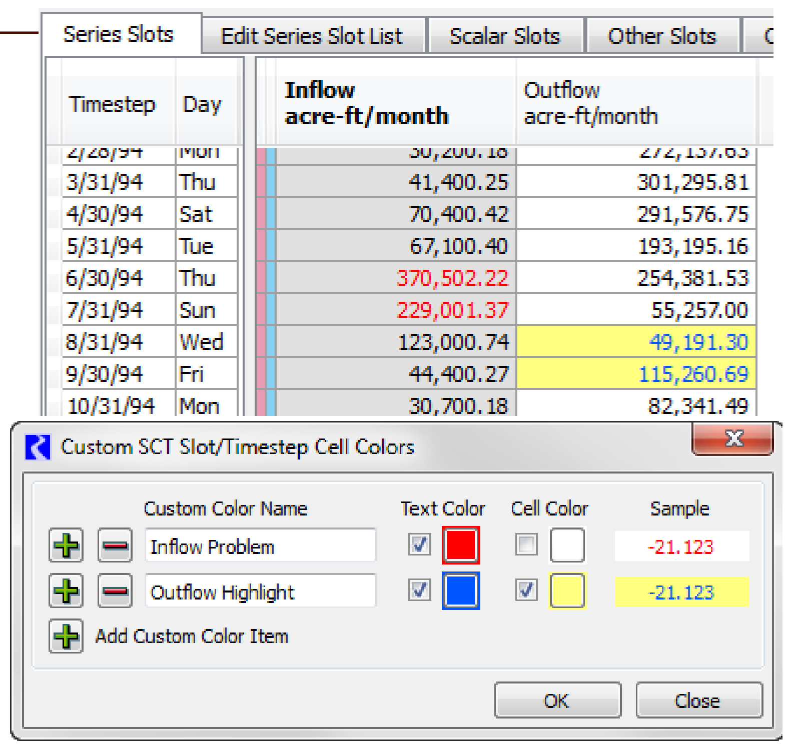
* Links lead to the section in ScriptManagement.pdf

For more information on Scripts, click **HERE (ScriptManagement.pdf, Section 1)**.

8. SCT

8.1 SCT Custom Cell Colors

The SCT's series slot tab now supports the application of custom text (foreground) and/or background colors to arbitrary slot/timestep cells as shown to the right. This can override the background cell colors which indicate the series timestep flag. Flag letters can still be shown.

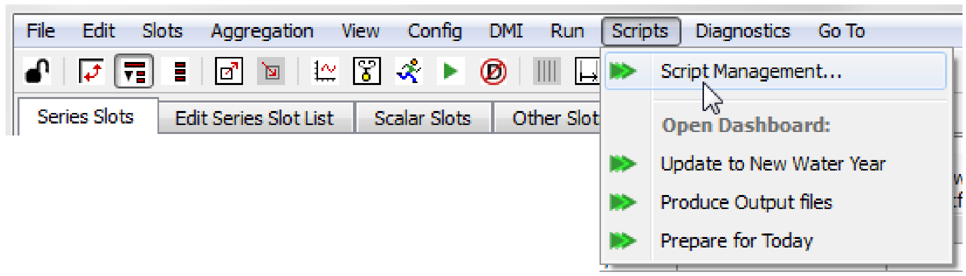


The set of available colors is defined in a separate dialog (bottom right) and then the **Custom Color Name** is chosen on the SCT.

For more information, click **HERE (SCT.pdf, Section 8.12)**

8.2 Script Menu

A **Scripts** menu was added to the SCT. This allows you to access scripts directly from the SCT.



9. Slots

9.1 Improved Copy/Paste of Slots to Data Objects

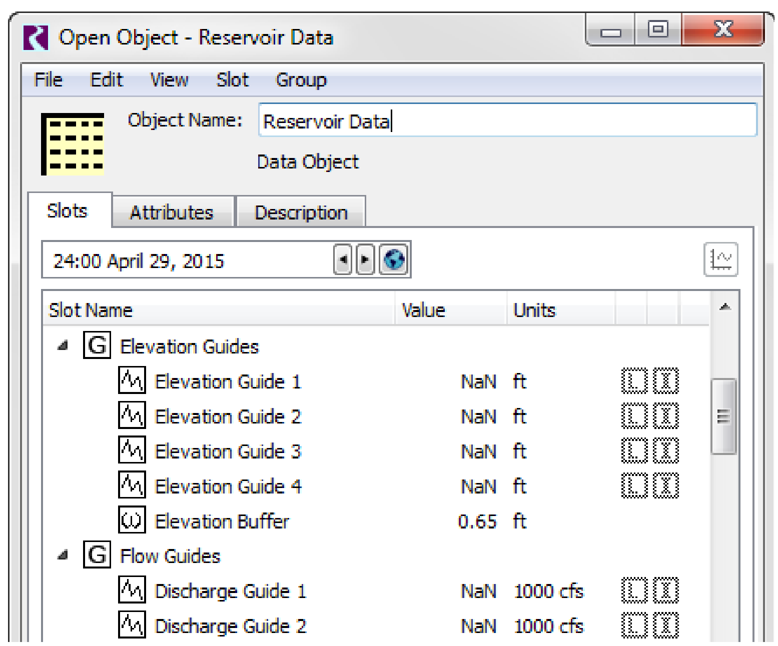
The process of coping and pasting slots to data objects was improved as follows:

- The **Copy Slots** and **Paste Slots** operations now have keyboard shortcuts: **Ctrl-C** and **Ctrl-V**, respectively.
- New operations were added to **Duplicate** selected slots.
- A new operation was added to **Copy slots to Data Objects...** This allows you to copy a set of slots from one object and paste copies of the slot to many different data objects in one action. For more information, click **HERE (ObjectDialogs.pdf, Section 2.2.7)**.

9.2 Slot Groups on Data Objects

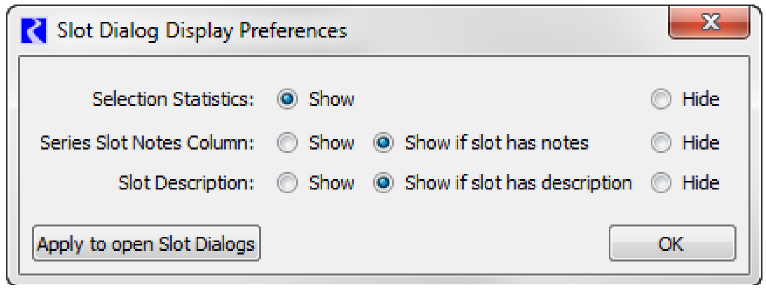
Slots on data objects can now be grouped together within the **Open Object** dialog in named slot groups. These groups can be used for organizational purposes and for the new **Copy slots to Data Objects...** described above.

For more information, click **HERE (ObjectDialogs.pdf, Section 2.2.5)**.



9.3 Display Preferences

You can now specify preferences for the default visibility of the following **Open Slot** dialog features:

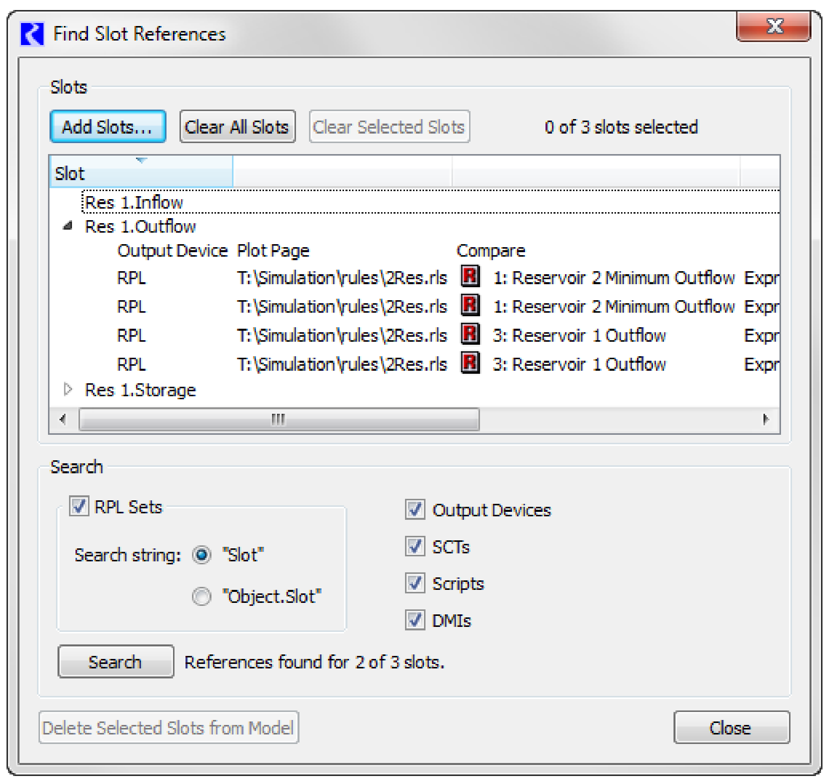


- **Selection Statistics** panel
- Series Slot **Notes Column**
- Slot **Description** panel

This allows you to configure your model to always show these items when you open a slot dialog. For more information, click **HERE (Slots.pdf, Section 2.1.5.2)**.

9.4 Find Slot References

A new utility called **Find Slot References** was implemented to allow you to find references to selected slots within various locations in the model. This dialog provides a streamlined way to see where slots are used and delete those that are no longer needed (slots on data objects).



You choose a set of slots and then search for references to these slots in RPL sets, Output Devices, SCTs, Scripts, and DMIs. When a reference is found, the utility shows information about the reference and allows you to open the dialog for that reference. You can delete the slots (on data objects) directly from the utility.

For more information, click **HERE (Slots.pdf, Section 7)**.

10. USACE-SWD Algorithms

10.1 Improved Debugging Diagnostics

The following changes were made to the Control Point and Computational subbasin USACE-SWD Flood Control methods for better debugging:

- Unnecessary debugging diagnostics that print the routing coefficients were removed.
- Debugging diagnostics for the target balance level computation were enhanced. This computations a bisection method, so now the diagnostics show the starting conditions and the total empty space to fill. It then prints messages on each iteration in the bisection. Finally, when a target is found, diagnostics are posted showing the storage above the balance level and the final computed share value.
- Formatting of debugging diagnostic messages was improved to show an appropriate level of precision.

10.2 Alternative Routing on Subbasin

In some USACE-SWD models, alternative routing is specified on the computational subbasin to modify the routing coefficients used during high (or low) flow events. Previously, to use this method, you had to specify the following methods:

- Reach: **Variable Step Response**
- Control Points: **Compute Aggregate Coefficients**
- Computational Subbasin: **Compute Aggregate Coefficients**

The reach stores the alternative coefficients and is used as the location where the flow conditions are measured. The subbasin and control points compute their coefficients at the beginning of each timestep by aggregating the coefficients from each upstream reservoir to the control point. This limited the dispatching to only use the **Variable Step Response** method and no other methods.

To allow **Variable Step Response** for flood control, but a different routing for simulation, a new category and reach was added to the reach: **Alternative Routing on Subbasin** category and **Variable Step Coefficients** method. This method allows the **Variable Lag Coefficients** to exist on the reach for use in the computation of aggregated Control Point coefficients while the actual simulation routing uses an alternative routing method. For more information, click **HERE (Objects.pdf, Section 22.1.21)**

In addition, on the Control Point, the name of the **Temp Routing Coefficients** slot was changed to **Computed Routing Coefficients**. It was also configured to show that it is generated from other data and is read-only. This slot is recomputed in each run so existing models will not be affected unless RPL logic references this lot. For more information, click **HERE (Objects.pdf, Section 9.1.19.2)**.

11. Water Quality

11.1 Reservoir method for Salinity

11.1.1 Two Layer Segmented

A new method was added to the reservoir objects in the **Reservoir Water Quality** category called **Segmented 2 Layer Salt**. In this method, the reservoir is discretized into two vertical layers with a constant Thermocline Elevation and a user defined number of longitudinal segments. **Inflows** and **Outflow** from each layer are distributed according to user specified proportions. Flow between segments and layers is used to model reservoir salinity.

Click **HERE (WaterQuality.pdf, Section 16.4.48)** for details of this method.

11.1.2 Specify Outflow Fraction

A new method was added to the **WQ Distribute Outflow** fraction, **Specify Outflow Fraction**. The new method allows the user to specify periodic or series of fractions defining the percentage of **Outflow** that comes from each layer. For more information, click **HERE (WaterQuality.pdf, Section 16.2.3.3)**.

11.1.3 Specify Fraction changes

In the **Specify Fraction** method, the **Inflow to Hypolimnion Fraction** slot was changed from a series slot to a series slot with periodic input. This allows the Inflow to Hypolimnion Fraction to be specified as either a series or a periodic set of data. For more information, click **HERE (WaterQuality.pdf, Section 16.2.2.4)**

12. Closed Bug Reports

The following bugs have been closed for this release. For more information on any bug, see the CADSWES website. The bugs are listed in order by bug number:

5515	5589	5637	5656	5665	5667	5668
5669	5670	5671	5673	5675	5676	5679
5681	5683	5684	5685	5686	5687	5688
5689	5690	5692	5694	5695	5696	5701
5702	5703					

Release Notes Version 6.9

This document describes new features, enhancements, and changes in RiverWare Version 6.9.

1. Documentation Searching

A more accessible and faster search utility was added to the RiverWare documentation. To fully use the search utility, use the latest version of Adobe Acrobat Reader, DC. This free PDF reader is available from **Adobe**. Additional information on the search utility and a Quick Guide of the help system can be found **HERE (HelpOverview.pdf)**.

2. Data Management Interface

2.1 Year Mapping Groups

A **Year Mapping Group** allows you to import data from the specified years in your database to years in your run. Previously this was limited to a run that began on January 1st and ended on December 31st. Now the run can start and finish on any day in the year. As before, only daily timestep models are supported. For more information, click **HERE (DMI.pdf, Section 2.2.4)**.

3. Objects

3.1 Control Point

A new method called **Compute Aggregate Coeffs every Timestep** was added to the Control Point's **Variable Routing Coefficients** category. The new method populates the **Computed Routing Coefficients** table slot at the start of every timestep. This was implemented as the existing **Compute Aggregate Coefficients** method re-computes the coefficients only when the flow is above the lowest threshold in all upstream reaches. Otherwise it copies the values in the **Routing Coefficients** slot. The new method computes the coefficients for any flow condition. For more information, click **HERE (Objects.pdf, Section 9.1.19.3)**.

3.2 Soil Moisture Method Improvements

Enhancements were made to the soil moisture methods on the Agg Diversion Site and Water User as described below.

3.2.1 Agg Diversion Site

On the Agg Diversion Site, the following enhancements were made:

- Dispatch method names were modified with better names.
- A new dispatch method, **HERE (Objects.pdf, Section 3.2.3)**, was added to **Process Sequential given Depletion Requested.**

3.2.2 Water User

On the Water User, the following enhancements were made:

- A new **Return Flow** method, **Variable Efficiency with Soil Moisture** (**HERE (Objects.pdf, Section 27.1.4.6)**, was added to compute return flow using an efficiency based approach that also includes soil moisture storage. The **Supplement Diversion including Soil Moisture** was also modified to behave correctly when this new efficiency based return flow method is selected.
- With the **Irrigation Requests with Soil Moisture** method, a modification was made to compute the **Depletion Requested** at the beginning of timestep for the current through N future timesteps. This allows the water user to solve for a number of future timesteps, as defined on the **Soil Moisture Future Timesteps** slot.
- Dispatch method names on the Water User were modified with better names.
- A new dispatch methods was added to the Water User to solve given **Depletion Requested**. When the **Irrigation Requests with Soil Moisture** method is selected, the available dispatch methods are now:
  - **Solve (Stand Alone or Sequential) given Depletion Requested**
  - **Solve (Stand Alone or Sequential) given Diversion**
- Slots were added to the appropriate soil moisture methods to model
  - **Excess Effective Precipitation**
  - **Consumptive Use from Delivered Flow**
  - **Consumptive Use from Soil Moisture**
  - **Consumptive Use from Supplemental**
  - **Efficiency including Soil Moisture.**

4. Optimization

4.1 With Reward Table Statement

A new statement type is available for Optimization goals: **With Reward Table**. The statement can be added within a Summation soft constraint set. It allows a piecewise linear reward function to be applied to satisfaction variables within the objective to maximize the satisfaction of the soft constraints. Conceptually this can be thought of as applying a penalty function on violations. For example, it could be used to minimize the sum of squared violations. Applying an appropriate reward function within a Summation objective tends to improve the solution quality by "smoothing out" violations at a smaller magnitude over longer time periods whereas the standard Summation solution tends to concentrate larger violations on a few time periods. The reward function is expressed in a table slot that is provided as an argument to the With Reward Table statement. For more information, click **HERE (Optimization.pdf, Section 4.1.3.5)**.

4.2 Improved Percent Satisfaction Reporting

Previously there were cases in which the percent satisfaction reported for a goal could be higher than the actual percent satisfaction from the user's perspective. This is because RiverWare skips the addition of a constraint to the optimization problem when it will not change the solution. This most often occurs when a lower priority constraint has the same left-hand-side as a higher priority constraint that was already frozen. In these cases, the satisfaction reporting would only report on the constraints that were formally added to the optimization problem at that priority; it would not account for the constraints that were omitted. Thus it was possible for a goal to report 100% satisfaction even though, from the users perspective, there were constraints at that priority that were violated. The percent satisfaction reporting for these cases has been improved in the following manner:

- For Summation soft constraint objectives, RiverWare now reports the average satisfaction as if the skipped constraint(s) were included, i.e., percent satisfaction is defined from the user's perspective.
- For Maximin and Repeated Maximin soft constraint objectives, if a constraint was skipped and would have been violated at that priority, the satisfaction will be flagged with a tilde (~) to indicate that the satisfaction from the user's perspective is actually lower than what is being reported. For example a satisfaction reported as ~100% will indicate that there were actually violations at that priority.

This improved satisfaction reporting applies to diagnostic messages, the Priority-oriented Optimization Solution Analysis Tool (POSAT) and optimization analysis CSV files exported from POSAT.

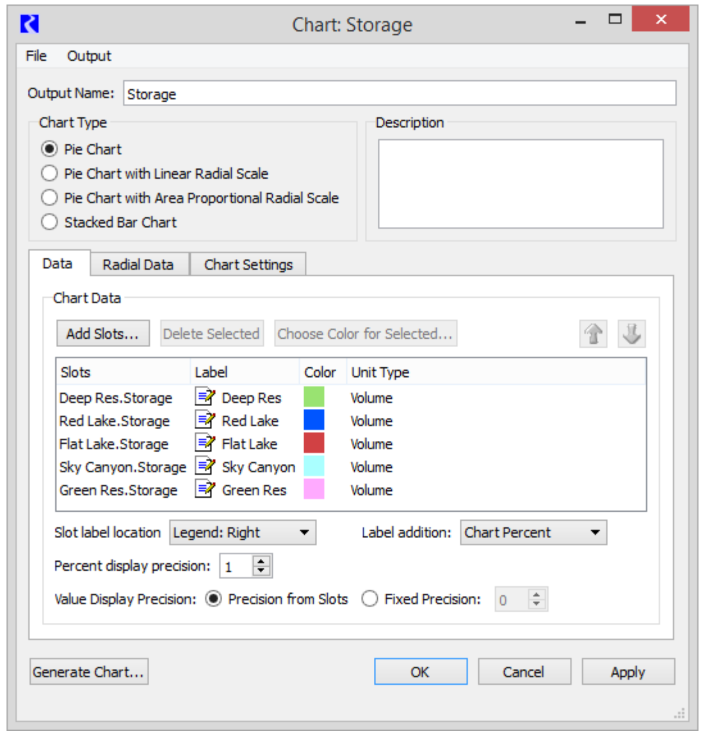
4.3 Tailwater Base Value Infeasibility Fixed

In some cases, **Tailwater Elevation** values calculated in Simulation were causing an infeasibility in Optimization. This occurred for the **Opt Linked or Input** method when an upstream Power Reservoir **Tailwater Base Value** was linked to a downstream **Pool Elevation**, and the upstream reservoir dispatched in Simulation while the downstream reservoir did not dispatch. The resulting **Tailwater Base Values** were based on earlier time step **Tailwater Elevation** values and, due to the link, resulted in **Pool Elevation** values downstream that were inconsistent with the flows. This behavior has been modified for the **Opt Linked or Input** and **Opt Base Value Only** methods in the **Optimization Tailwater** category.

5. Output: Charts, Model Reports, and Plotting

5.1 Charts

For more information on any of these Chart enhancements, click **HERE (Output.pdf, Section 5)**.

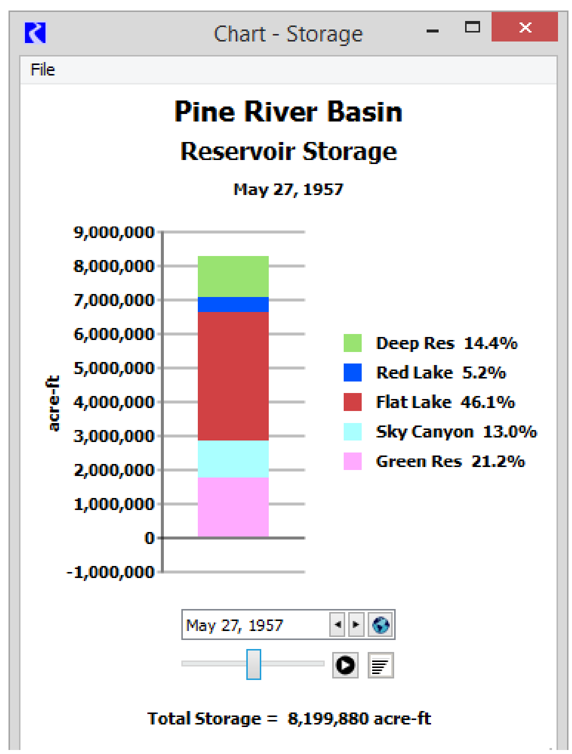


5.1.1 Configuration Dialog Reorganization

The Chart configuration dialog was reorganized into three tabs to reduce the overall size of the dialog. The tabs are **Data**, **Radial Data**, and **Chart Settings**.

5.1.2 Stacked Bar Chart

A new stacked bar chart type was implemented as shown in the screenshot to the right. This new type of chart shows negative values much better than the existing pie chart.



5.1.3 Labels or Legend Location

For charts, you can now choose to label items using a separate legend. For each chart, you choose from the following labeling options:

- **Legend: Right** (shown)
- **Legend: Below**
- **Legend: Lower Left**
- **Legend: Lower Right**
- **Label Pie Slices** (for pie charts only)

5.2 Model Reports

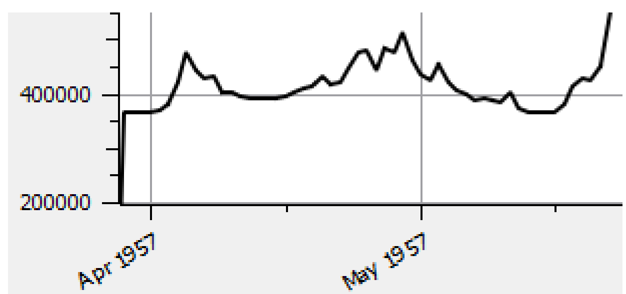
Model Reports, **HERE (Output.pdf, Section 4)**, allow you to generate a customized HTML document describing various aspects of a model including the configuration, RPL policy, slots, and plots. The model report utility was enhanced as follows:

- Two new slot items were added:
  - **Scalar Slot Grid**: shows as grid of scalar values with objects as rows and slot names as columns.
  - **Periodic Slot Table:** shows a table of periodic slots, where columns are distinct Periodic Slots. All periodic slots have the same period, but possibly different sets of intervals.
- The **Slot** item for slots computed by RPL expression now shows the expression formula in addition to a time series plot for series or the value for scalar slots.
- A new item **Link Table** was added to show a table of the physical links.
- A new item **RPL Rule/Goal** was added to show individual RPL Rules or Goals added.

5.3 Plotting

5.3.1 Axis Label Rotation

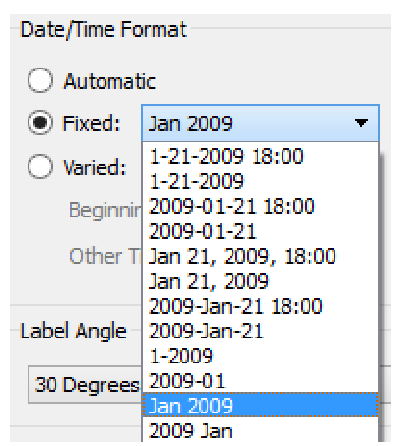
On plot axis, you can now rotate text labels, individually on all four axes. Rotation is supported in both directions to 30, 45, and 90 degrees. The screenshot to the right shows the dates rotated 30 degrees counterclockwise.



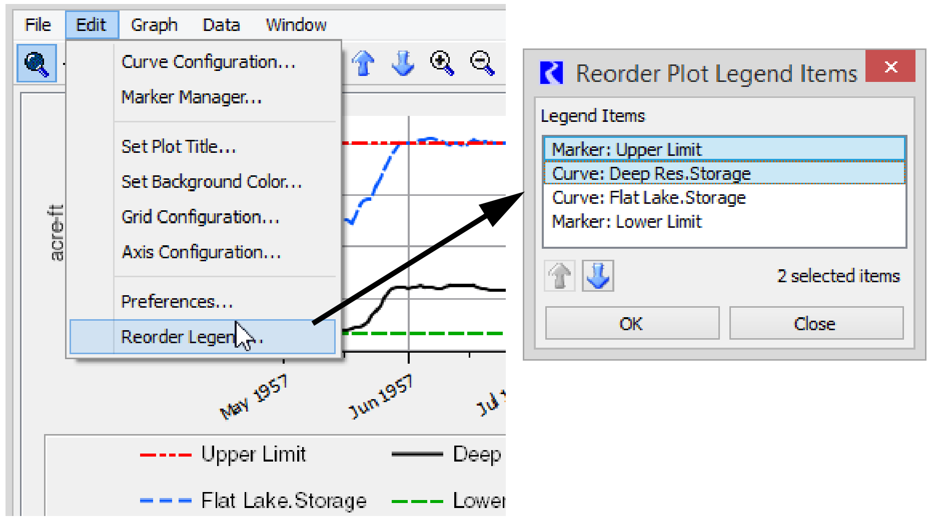
5.3.2 Date Time Formats

For axes that have Date/Time units, you can now configure the format of the Date/Time. This is supported with three distinct format selection algorithms: **Automatic**, **Fixed** and **Varied**. For example, the screenshots to the right and above right shows a **Fixed** Month Year configuration.

Click **HERE (Output.pdf)** for more information.



5.3.3 Legend Reorder



Plot legend items, for slot curves and markers, can now be reordered. A **Reorder Legend...** menu item appears in the **Edit** menu and in the context menu for slot curve and marker legend items. For more information, click **HERE (Output.pdf)**.

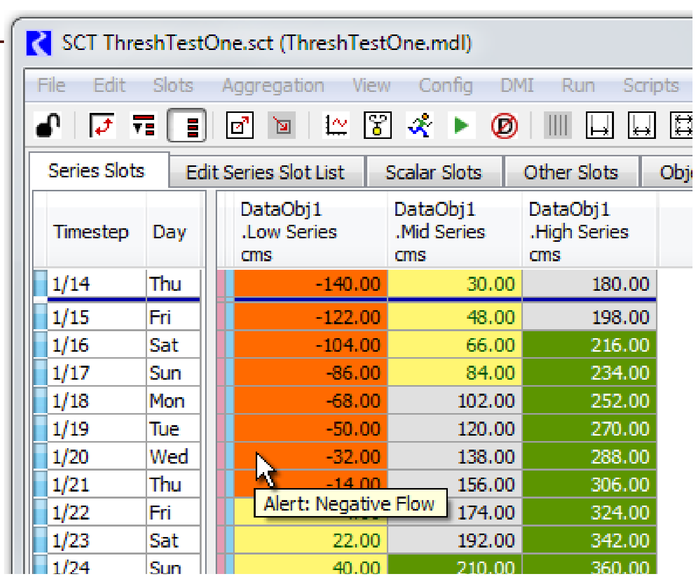
6. Script Management

6.1 Set Dataset File Action

A new action, **SetDatasetFile,** was added to the Script Manager. This action sets the file path for the specified DSS or Excel Dataset. More information can be found **HERE (ScriptManagement.pdf, Section 3.3.33)**.

7. SCT

7.1 Color Alerts / Conditional Formatting



The System Control Table (SCT) was enhanced to support coloring of individual cells based on the numeric value compared to user defined intervals. The set of value intervals and the associated cell colors can be specified individually for each series slot in the SCT. Each interval can be associated with a custom color specification (a foreground/ background color pair) or the default color indicating flag value. Following is a sample screenshot showing four different color definitions. For more information, click **HERE (SCT.pdf, Section 5.2)**.

8. Water Quality

8.1 Total Dissolved Gas (TDG) modeling

Water Quality methods have been added to Reservoirs, Reaches and Computational Subbasins to model Total Dissolved Gas (TDG) in both Simulation and Optimization. High TDG concentrations can reduce the population of some fish species. These effects are most pronounced in the tailwater of reservoirs during spill operations. The TDG concentrations are increased by spills; the turbulent nature of the spill creates air bubbles that are then forced deep into the tailwater. The deep water has higher pressure which cause gases in the bubbles to dissolve in the water. Once dissolved, the gas propagates downstream.

For more information, click **HERE (WaterQuality.pdf, Section 16.4.49)**.

9. Workspace

9.1 Import Cluster Configuration

The grouping of simulation objects into Object Clusters can now be replicated from one RiverWare model to another RiverWare model.

Export the objects including the clusters from one model and then import them into another more. The workspace **Import Objects** operation now supports two modes of operation for **Object Cluster Import**. The choices are:

- Import member objects and cluster configuration
- Import cluster configuration only

9.2 Improved Zooming

Better zooming has been implemented on the Simulation and Geospatial workspace views. Simulation object icons and their attached labels are scaled only when zooming out to see a broader view of the model.When zooming in beyond the standard zoom level of 100%, icons and labels remain zoomed at 100%. This allows you to see more detail around closely clustered objects without showing large pixelated object icons.

10. Closed Bug Reports

The following bugs have been closed for this release. For more information on any bug, see the CADSWES website. The bugs are listed in order by bug number:

5404	5608	5700	5704	5705	5706	5708
5709	5711	5712	5715	5717	5719	5721
5723	5726	5728	5730	5731	5732	5734
5736						

Release Notes Version 7.0

This document describes new features, enhancements, and changes in RiverWare Version 7.0.

1. Special Attention Notes

Following are special attention notes, indicating that functionality has changed that requires you to update models or that results may differ. If you have any questions, please contact RiverWare-support@colorado.edu.

- **Input values on slots not in use:** It is possible to change method selection such that input linked series slots are no longer "in use" on the object. The slots and data still exists on the object in case you wish to revert the method selection. Previously, the input values that were not in use would still propagate across the link and could be used by the linked object. This was misleading and has been changed. Now, if a slot is not in use, no propagation of input values will occur at beginning of run. This could change model results if you have inputs on slots that are not in use. If this is the case, modify method selection, change input location, or reconfigure your links.
- **Slope Power Reservoir; Max Outflow computations changes:** If you use either the Max Capacity flag on outflow or the GetMaxOutflowGiven... RPL functions on a Slope Power Reservoir, see the changes described **HERE (Section 5.2.2)**.
- **Reach; No Local Inflow, Solve Outflow method changes:** On a Reach using the **No Local Inflow, Solve Outflow** method (in the Local Inflow and Solution Direction category), it was possible to specify or propagate an Outflow that was inconsistent with the lagged Inflow. This is now an error.

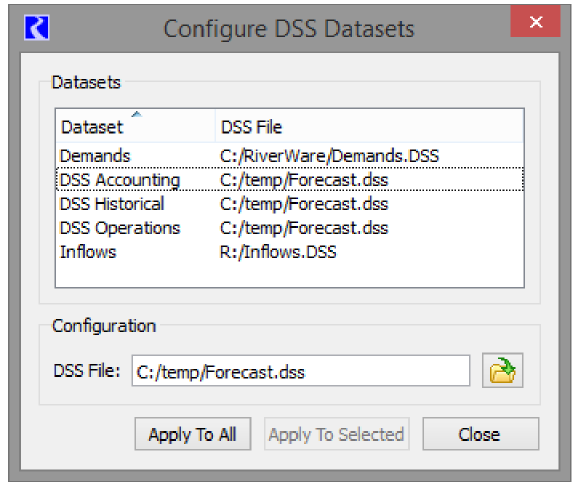
2. Batch Mode

2.1 RCL changes

Within Batch Mode and the RiverWare Command Language (RCL), the SetRunInfo command can be used to change the run range. A new argument !StartDate was added to this command. This argument can be used as an alternative to the !InitDate argument.

3. Data Management Interface

3.1 Configure Datasets Utility



A new utility was added to the Database DMI that allows you to configure multiple DSS dataset file paths simultaneously.

For more information, click **HERE (DMI.pdf, Section 5.2.3.1)**.

3.2 Database DMI Copy/Paste

Copying a Database DMI from the DMI Manager was modified to allow for two options:

- **Copy Database DMI Only**: This option copies only the top level Database DMI, but none of the Datasets or Name Maps. When pasted, the new DMI refers to existing Datasets and Name Maps. This was the previous behavior.
- **Copy Database DMI, Datasets, and Name Maps:** This option provides a “deep copy” of the Database DMI and all of the Dataset and Name Maps it accesses. For this option, when pasted, the new Database DMI is connected to newly pasted Datasets and similarly, Name Maps.

For more information, click **HERE (DMI.pdf, Section 2.2.1)**.

3.3 Database DMI Export/Import

The Database DMI Import/Export functionality was improved such that importing a DMI modifies the connections to any Datasets and Name Maps that are also imported. This allows you to take an entire Database DMI, Dataset, and Name Map and move it from one model to another and preserve the connections. For more information, click **HERE (DMI.pdf, Section 5.5)**.

3.4 Excel Database DMI supports Table, Periodic and Scalar slots.

The Excel Dataset and Database DMI now allows you to import or export Table, Periodic and Scalar slot values. Previously, only series slots could be imported or exported. With this new functionality, you can use the **Ranges** approach to specify a range or list of cells in Excel to use or you can use the **Headers** approach and configure your Excel sheet in a specific format.

For more information, click **HERE (DMI.pdf)**.

4. Multiple Run Management

4.1 Input DMI Repeat Count

The MRM input DMI was limited to a maximum repeat count of 999. Now the maximum number of input DMI repetitions and number of traces is limited to 99,999.

4.2 Ordering of Slots in an RDF file

The order of slots in a RiverWare Data Format (RDF) output file now matches the order in the output control file.

4.3 Saved Distributed MRM Run Configurations

With distributed MRM, it is possible to save the configuration file RiverWare creates to a named file and then start distributed multiple runs from the configuration file, thus bypassing the RiverWare interface. This is controlled through the optional **Save Distributed Run Configuration As** field in the MRM configuration dialog. For more information, click **HERE (MRM.pdf, Section 6.1.1.2)**.

Configuration files saved with RiverWare 6.9.7 or earlier will not be compatible with RiverWare 7.0. You will need to regenerate the configuration file through the RiverWare interface.

5. Objects

5.1 Reach - Solve Outflow method with Lagged Inflows

On a Reach using the **No Local Inflow, Solve Outflow** method (in the **Local Inflow and Solution Direction** category), it was possible to specify or propagate an Outflow that was inconsistent with the lagged Inflow. Now, this circumstance will result in an error.

5.2 Reservoirs

5.2.1 Dispatch Slots

The Reservoir slots **Evaporation Rate** and **Precipitation Rate** were added to the list of dispatch slots. Now they are linkable and a new value (input, propagated, set by a rule) will trigger the object to redispatch, if possible.

5.2.2 Max Outflow Calculation on the Slope Power Reservoir

The max outflow computation iterates to find the Storage in the Slope Power Reservoir. This calculation uses the current outflow as one of the parameters in the computation (in Impulse Response slope storage calculation especially). Previously, it used the values on the **Outflow** slot which came from a previous dispatch. Once the max computation is complete, it sets the **Outflow** slot. Within the rest of the dispatch, it then uses that **Outflow** as the current value in the slope storage calculation. Since this is different, the **Storage**, **Pool Elevation**, and headwater are all different, thus leading to a different max **Turbine Release** and **Spill**.

The code was changed to use the values that are computed within the iteration for the current **Outflow**. In a test model, this does slightly change results. For example, in one test model, the flow on one timestep went from 293.50 (1000cfs) to 293.52 (1000cfs). The pool then changed by 0.0001ft. On the final timestep, the pool was 0.001ft different. They are not significantly different, but these can compound over time as the storage changes.

5.2.3 Reservoir Accounting Methods

The following two Table Series Slot columns were duplicated on separate Series Slots:

- **Est Sed Deposition** - Accumulated Perm Sediment column was duplicated on the **Accumulated Permanent Sediment** slot. This slot is added by the **Total Vol Sed (Post2000)** method in the **Sediment Transport Calculations** category.
- **Rio Grande Pools** - Carryover Content column was duplicated on the **Carryover Content** slot. This slot is added by the **Abiquiu Gain Loss**, **Jemez Gain Loss** or the **Cochiti Gain Loss** methods in the **Reservoir Account Gain Loss** category.

These series of data are duplicated on the individual series slots. The series slots hold the values used in the calculation but the data is also shown in the original table series slot. (This allows any existing output devices to continue working without changes.) In addition, if the value on series slot is not known, but the value on the table series slot is known, the table series slot value is copied to the series slot at the initial timestep and set as an input. This will preserve it for future runs and when aggregating to monthly.

In addition, previously on the **Present Condition** Table Series Slot, the **River Channel Area** and **Barren Area** values were required inputs on the initial timestep for a monthly run. These are now computed from other data. This slot is part of the **Abiquiu Gain Loss**, **Jemez Gain Loss** or the **Cochiti Gain Loss**, **El Vado Gain Loss**, **Nambe Falls Gain Loss**, and **Elephant Butte Gain Loss** (both variations) methods in the **Reservoir Account Gain Loss** category.

5.3 Reach and Reservoir - Coeff and Exponent and Forecast methods

Within the **Coefficient and Exponent** method on the reach (**Generate Local Inflows** category) and reservoirs (**Generated Forecast Hydrology** category), a minimum deterministic inflow was implemented. Now the **Lower Bound** on the **Deterministic Local/Hydrologic Inflow** slot is used as a minimum value in the computation. Any absolute values smaller than the minimum values behave as though the value is zero; that is, the deterministic value is used directly in place of a forecast value. For more information click **HERE (Objects.pdf, Section 22.1.4.4)** on the reach and **HERE (Objects.pdf, Section 24.1.10.4)** on the storage reservoir.

5.4 Water User

5.4.1 Soil Moisture Modifications

The Water User soil moisture return flow methods **Proportional Shortage with Soil Moisture** and **Variable Efficiency with Soil Moisture** were modified with a new slot, **Surface Runoff.** In addition, the **Supplement Diversion including Soil Moisture** method in the **Conjunctive Use** category was modified to have an additional slot, **Supplemental Runoff**.

These slots represent water that is applied that is higher than max infiltration rate and runs off directly. If these slots are linked, the corresponding **Return Flow** does NOT include that water as it goes elsewhere. If they are not linked, the **Return Flow** does include that water and these two slots are for informational purposes. This distinction is needed as the quality of this water is different than the water that moves through the soil. For more information on new water quality salinity methods on the water user, click **HERE (Section 14.2)**.

5.4.2 Water User Performance Improvement

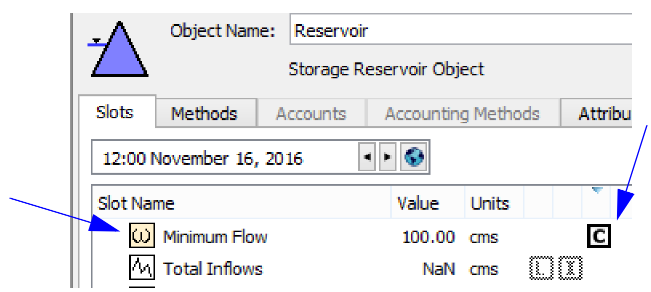
The run time performance of the Water User's **SW GW Impulse Response** return flow routing method was improved. In one test model, the run time was reduced by 27%.

6. Object Dialogs

6.1 Custom Slots on Simulation Objects

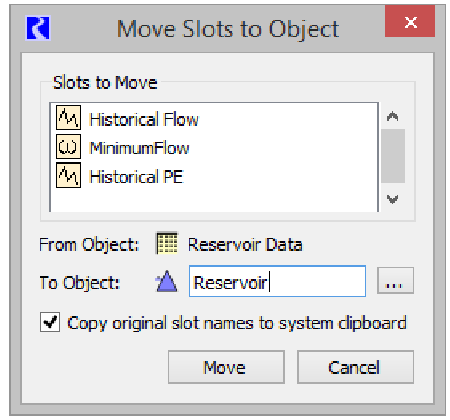
You can now create custom slots on any object including Simulation Objects. Previously, custom slots were only allowed on Data Objects. Having custom slots on Simulation objects allows you to locate your custom slots with the object to which they refer. This also makes RPL logic, Scripts, Output Devices, and DMIs much easier. For example, instead of referring to a reservoir's minimum outflow on an accompanying data object, **ReservoirData.MinFlow[ ]**, you can move the minimum flow custom slot onto the reservoir and refer to it directly: **Reservoir.MinFlow[ ]**.

With this enhancement, the Open Object dialog was improved as follows:



- A custom column was added with a **C** icon to indicate a slot is custom. Click on the header to sort and show all custom slots together.
- Custom slots are shown with icons that have a pale yellow background.
- Slot Groups are now allowed on any simulation objects except Aggregate objects.

6.2 Move Slots Utility



- A new **Move Slots** utility was added that allows you to move one or more slots from one object to another. To move slots using the new functionality:
  - Open the object containing the slots that you would like to move
  - Select the slots to be moved.
  - Select the **Move Slots to Object...** menu from the Slots menu or right-click context menu.
  - This will open the **Move Slots to Object** dialog.
  - Select the destination object.
  - Click on the **Move** button.
  - A confirmation dialog is presented; if the action is confirmed and successful, the destination object dialog is opened and the moved slots selected.

7. Optimization

7.1 Negative Hydrologic Inflows

On the Slope Power Reservoir, negative hydrologic inflows are now allowed in optimization.

7.2 Preferred Units

Preferred optimization units were added for the PowerPerFlow unit type: 1 MW/cms.

7.3 Improved Performance for Shrinking Constraints

The efficiency of the internal algorithm for shrinking a constraint to a higher priority constraint with the same left-hand-side was significantly improved. In one large test model, this reduced the overall run time by approximately 25%.

8. Output Devices

8.1 Charts: Video File Animation Generation

Chart animation video files can be generated directly from RiverWare. Basic settings include the frame sampling timestep size, frames per seconds, and format. Four video formats are supported:

- MP4,
- WEBM,

- WMV, and
- animated GIF

In addition, there are advanced settings available for complete customization of the export process.

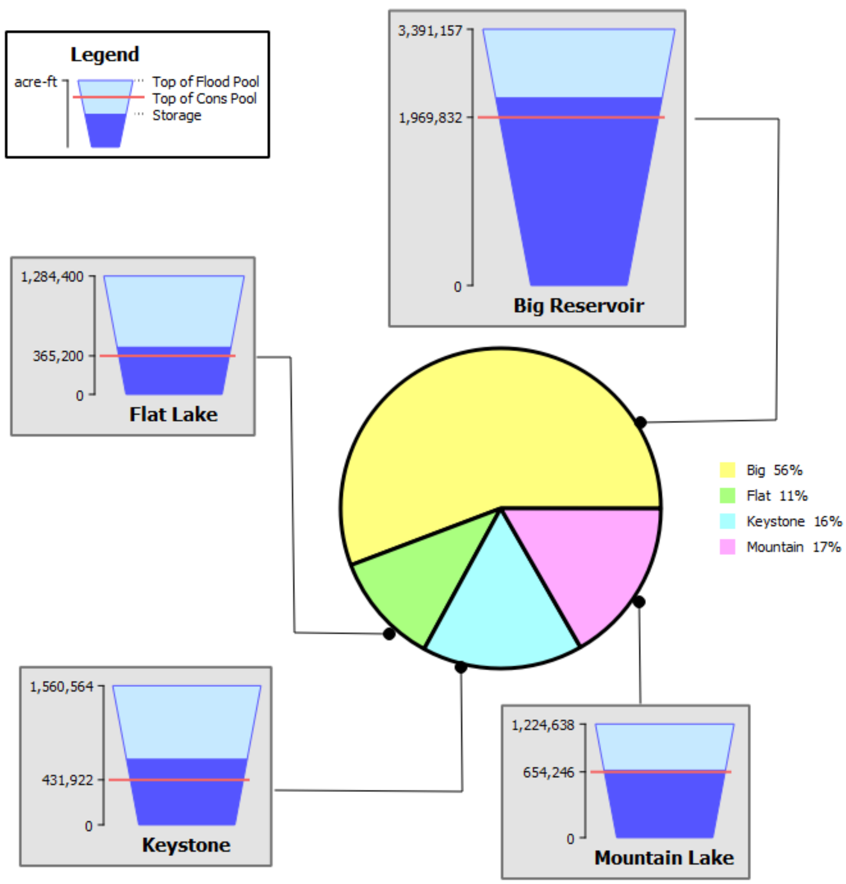
For more information, click **HERE (Output.pdf, Section 5.5.3)**.

8.2 Output Canvas

The Output Canvas, described in **Output.pdf, Section 6**, allows for visualization of outputs in spatially distributed teacups and flow lines. The following improvements have been added to the Output Canvas:

8.2.1 Canvas Lines

Canvas Lines provide generic lines on the canvas. You can use these for many purposes but were designed to provide pointers to locations on the canvas. You can add end symbols including dots (shown to the right), triangles, and arrow heads. More information is available in **Output.pdf, Section 6.2.3.13**.



8.2.2 Charts on an Output Canvas

Charts can now be placed on an Output Canvas and will animate at the same time as the canvas. Handles are available for resizing and scaling the selected chart. Geometry fixes to avoid clipping of the chart image due to the chart size specified within the Output Canvas configuration were also implemented. More information is available in **Output.pdf, Section 6.2.3.17**.

8.2.3 Miscellaneous Enhancements

Following are three miscellaneous enhancements made to the Output Canvas:

- Precision overrides were added for numeric values shown in Teacup, Object Icon, and Text Groups. This setting allows you to control how many digits are shown after the decimal.
- Plain-Text items now allow you to enter multiple lines of text as configured in the editor.
- In Slot Value Text Items, the RPL Priority value can now be shown.

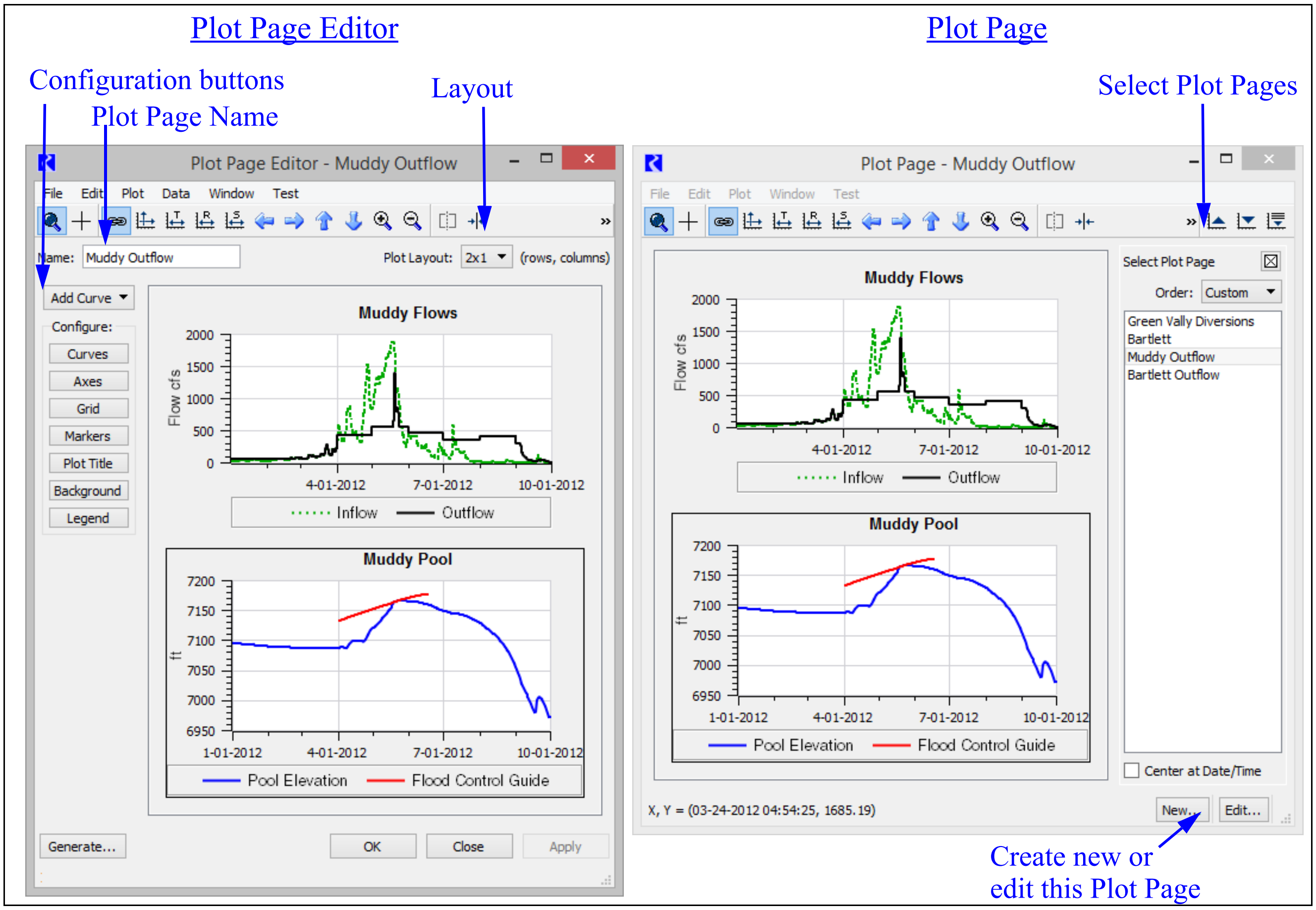
8.3 Plotting

8.3.1 New approach to View and Edit Plot Pages

The Plotting utility was modified to remove the Save approach. Now there is a separate **Plot Page Editor** used to configure the plots and then the **Plot Page** used to view and interact with a plot.

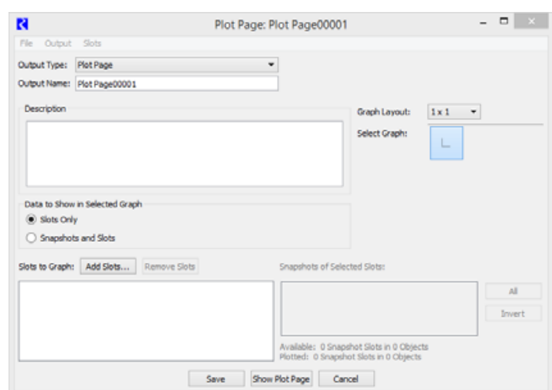
- **Plot Page Editor**: The editor is used to modify the slots shown and the appearance of the plot (colors, line types, markers, etc). New buttons on the left side provide access to add curves and configure the plots. This is shown below on the left.
- **Plot Page:** The **Plot Page** displays the plots and provides interaction with multiple plots. This is shown below on the right.

For more information, click **HERE (Output.pdf, Section 2)**.



In addition, the original plot page dialog (shown to the right), used to select a list of slots to plot, was removed. all configuration is performed in the Plot Page Editor shown in the above left screenshot.

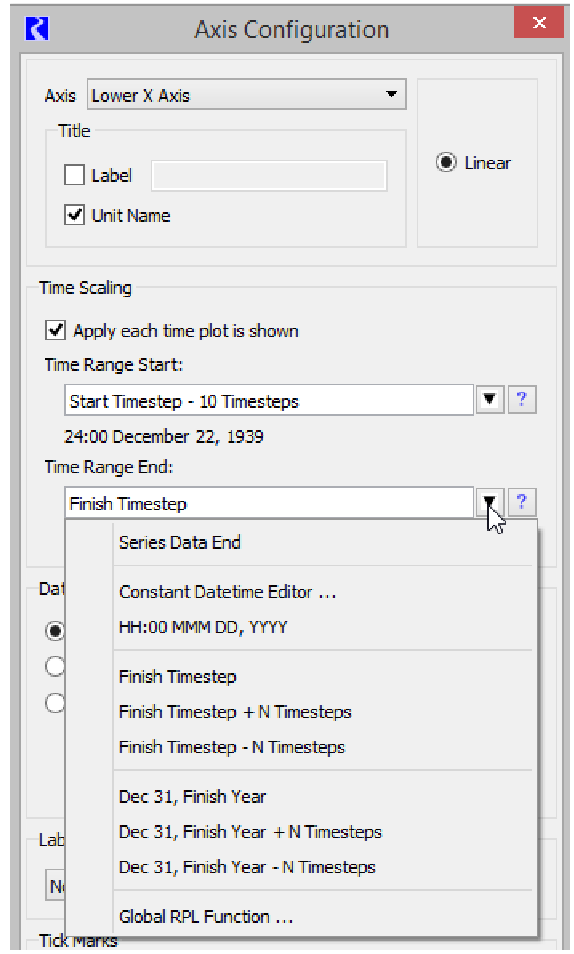
As a result, all snapshot slots can be added directly to a Plot as a unique curve. There is no longer an associated show “Snapshots and Slots” option.



8.3.2 Plotting Scalars

Scalar Slots can now appear in time series plots.
Scalars with datetime units are shown as vertical lines. Scalars with any other unit type are shown as horizontal lines.

8.3.3 Time Scaling



The plotting utility now supports a new configurable **Time Scaling** feature for time series plots. This includes the following provisions:

- Time axis configuration options support symbolic dates, for example, Run Start or Finish, plus or minus a specified number of timesteps or basic time units. In addition, any fully specified RPL datetime or global RPL datetime function can be specified. The screenshot to the right shows the axis configuration with time options shown.
- A new time scaling operation (T button, , and Plot menu operation) sets the time range of a graph to the configured datetimes.
- There is an option to automatically apply this configured time scaling to a graph each time the graph is shown.
- The default axis preferences also support this time scaling setting, to be applied to newly created graphs. This replaces a simpler default configuration provision which provided two choices for the initial time range of newly created graphs.
- The **Scale to specified time range** toolbar button (S button,) now has a shift-click option. When the button is shift-clicked, all open plot dialogs brought to the front and are synchronized to the specified time range of the clicked plot dialog.

More information is available **HERE (Output.pdf)**

8.4 Tabular Series Slot Reports - Environment Variables

You can now use environment variables in Tabular Series Slot Report file specifications. For more information, click **HERE (Output.pdf, Section 3.2.4)**.

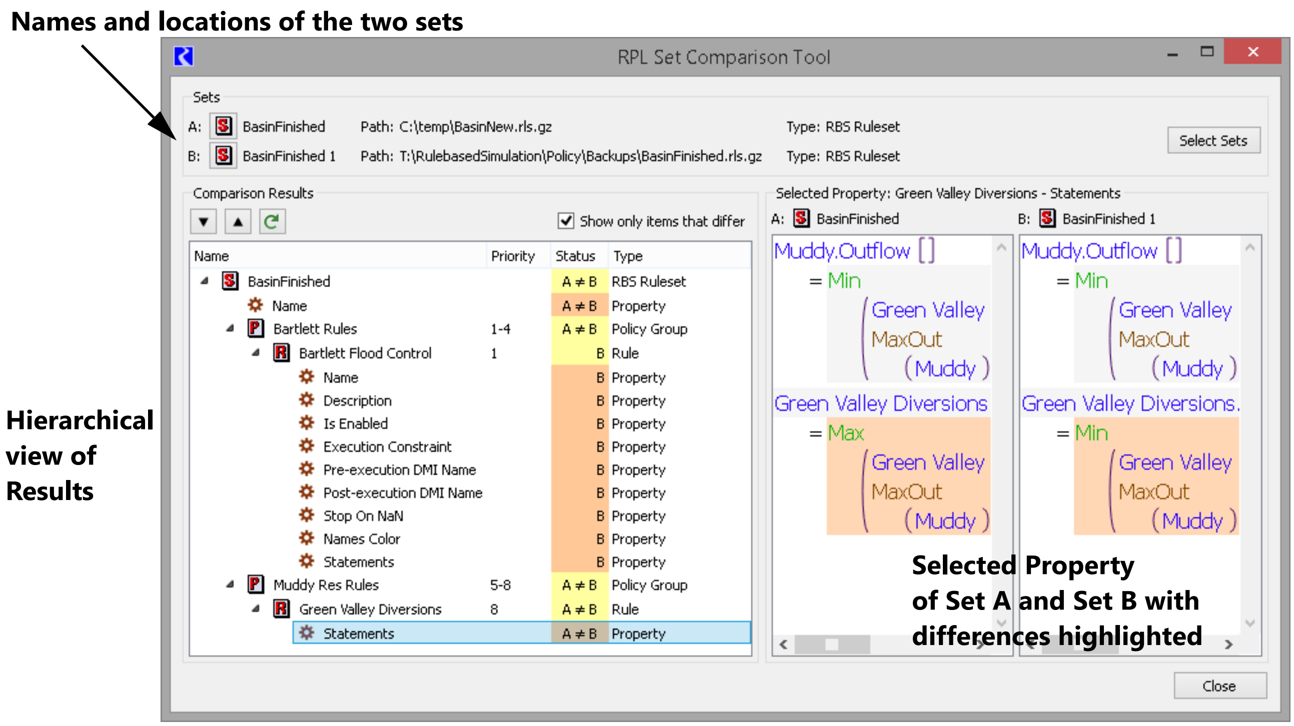
9. RPL

9.1 RPL Set Comparison Tool

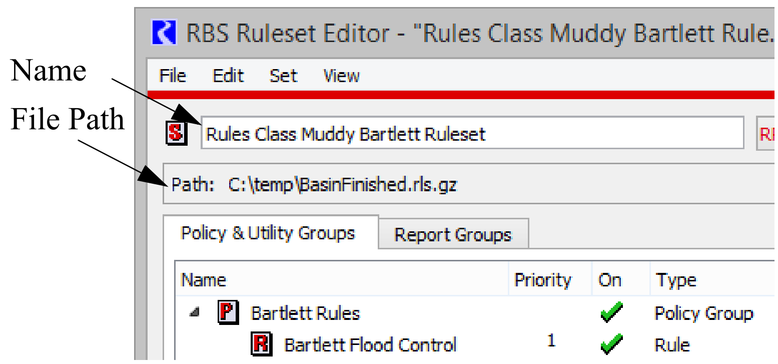
The new **RPL Set Comparison Tool** compares two RPL sets and shows you the differences between the sets. This allows you to see where items are different, what the specific differences are, and allows you to easily access the RPL set dialogs so that you can change one or both sets.

This tool is very useful in the RPL set development processes over time and across multiple developers. It allows the comparison and understanding of development of a RPL set. In addition, it helps assist with merging of changes by providing quick access to the RPL editors and copy/paste functionality.

A screenshot of the tool is shown below. For more information, click **HERE (RPLUserInterface.pdf, Section 1.7)**.



9.2 RPL Set Name vs Path



All RPL sets now maintain both a name and a file path (if saved as a separate file). Previously, these two concepts were intermixed. This allows you additional flexibility as follows:

- Sets saved to a separate file can have a meaningful name that describes the set, like “Operations Ruleset”. The path can then be used strictly as a file name, C:\Operations\OpsSet.v1.2.rls.gz
- Sets saved within the model file have a name that can be used for improved nomenclature. For example an Initialization ruleset could be named “Operations Initialization Set”.

Locations in RiverWare that refer to a set, now uses the set name. For example, in a Model Report, in the **RPL Set** item, you now choose the name of the set, not the path or location.

For more information, click **HERE (RPLUserInterface.pdf, Section 1.2)**.

9.3 RPL Search and Replace Utility

The **RPL Search and Replace** utility, **HERE (RPLUserInterface.pdf, Section 2.5)**, allows you to search for and replace items within a RPL set. The following enhancements were made:

9.3.1 Next / Previous buttons

Buttons were added for advancing forwards or backwards through the search results. These can also be activated using keyboard short cuts:

- **Next Item**: F3
- **Previous Item**: Shift +F3

9.3.2 Scroll To and Select Match

When a match is opened (by double-clicking on that row or by using the next/previous item operation), the relevant dialog is now scrolled so the match is in view and the item is selected.

9.3.3 Expression Slot Descriptions are Searched

Expression slot descriptions are now included in searches when the RPL Expression Slot Functions set is searched and when the **Descriptions** options is checked.

9.4 RPL Editing

9.4.1 Auto-correct of Typed Values

When you double-click on a RPL expression (i.e., on a RPL value or an empty expression in a panel for displaying and editing RPL statements and expressions), a small, in-line editor window is opened at that location, allowing you to type in a value with which to replace the existing expression. If the value provided is not a valid replacement for the expression, RiverWare now attempts to coerce the input string into one that is valid.

This auto-correction process is guided by the types that can legally replace the existing expression. It tries a series of variations on the specified values, where each variation is an attempt to coerce the input into a different value type. Types are considered in the following order: **DATETIME**, **OBJECT**, **SLOT**, **STRING**, and **LIST**. If a valid auto-correction is found, it is used to replace the existing expression; if not, an error notification is presented, describing the problem with the input.

For example, consider the statement

```
WITH (STRING val = <string expr>) DO
      PRINT "value: " CONCAT <expr>
END WITH
```

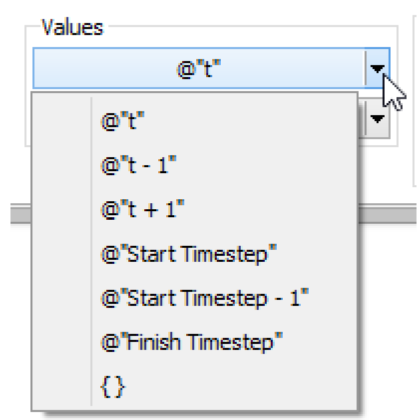
If the text 't + 1' is entered as the variable value in the With expression, it is interpreted as the String “t + 1” because that is the only legal type for that expression; whereas the same text entered as the right-hand side of the `CONCAT` expression is interpreted as the DATETIME @“t + 1", because all types are valid in that location and a DATETIME conversion is considered first.

9.4.2 Common Values

Two new operations were added to provide common values when editing RPL expressions.

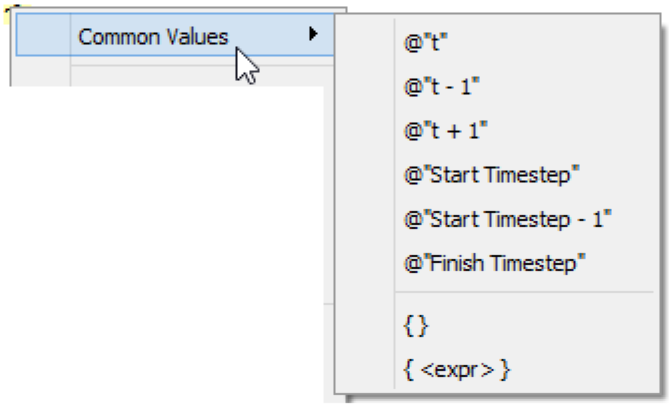
- A new “Values” button group was added to the palette to support insertion of common values and Flag Values.

New Palette Buttons:



- A right-click context menu on any selected RPL expression provides a **Common Values** menu.

Right-click Context Menu:



9.4.3 Copy and Paste from Variable and Argument Declaration

A RPL variable declaration name can now be copied and pasted into expressions as appropriate.

Within the function editor, you can copy an argument name and paste it into an expression. This works slightly differently. To copy an argument select the argument name by double-clicking on it in the arguments panel, then perform the copy operation using either the right-click context menu or by typing Control + C. You can then paste this argument into an expression in the function using the Control+V keys or right click menus. Note that the Edit->Copy menu does not work to copy the function argument.

9.4.4 Improved History

When you double-click on a literal value or an empty expression, a small, in-line editor window is opened at that location, allowing you to type in a value or select a value from the menu of items previously entered in the frame. Previously, this history menu was sometimes missing entries (especially those that were not a valid value to insert). Now, the history includes all previous entries (except empty strings).

9.4.5 Improved Pasting of Statements with Variables

RPL statements that define a variable (i.e., WITH and FOR statements), now allow better copy and pasting. For example, consider the following logic:

```
WITH (OBJECT res = % "res1") DO
     IF (res & "Inflow" [] == 0.0) THEN
        WITH (NUMERIC flow = 0.0) DO
           PRINT res
        END WITH
     END IF
```

```
END WITH
```

Pasting the If statement onto itself previously caused the inner WITH statement to have an validity issue where the reference to “res” within the new Print statement would be reported as invalid. This has been improved so that copy and paste of these types or statements works as expected.

9.4.6 RPL Item Delete Confirmation

Deleting an item from a RPL editor tree view now presents a confirmation dialog.

9.4.7 Stop on NaN for Initialization Rules

The existing **Stop on NaN** property of a rule (**HERE (RPLUserInterface.pdf, Section 2.2.6)**) allows you to specify that the run should abort instead of having the rule terminate early when a NaN is found in a slot value. This can be used to stop the run when missing data is expected but not found.

If an invalid value (NaN) is encountered while executing an initialization rule with the “Stop on NaN” property enabled (and the RPL debugger is not enabled), the run no longer immediately aborts, but rather posts an error and continues to execute any subsequent statements in the initialization rule and any subsequent rules in the initialization rules set. After all initialization rules have executed, the run is aborted with the message:

```
Aborting the run because one or more initialization rules with the
“Stop On NaN” property set encountered an invalid value (NaN).
```

If multiple statements access data which are missing, the new behavior allows a single RiverWare run to identify all of these statements. Previously, you would need to resolve the first issue and conduct another run in order to be alerted to the next issue. But, the new behavior can report invalid values that are not in fact independent data issues (i.e., report false negatives), but are rather later rules accessing a value set by an earlier rule that has missing data.

If the RPL Debugger is enabled when an invalid value is encountered by an initialization rule with the “Stop on NaN” property set, RPL execution is paused just before the run is aborted, and the RPL debugger is presented, displaying the error message that is about to be posted.

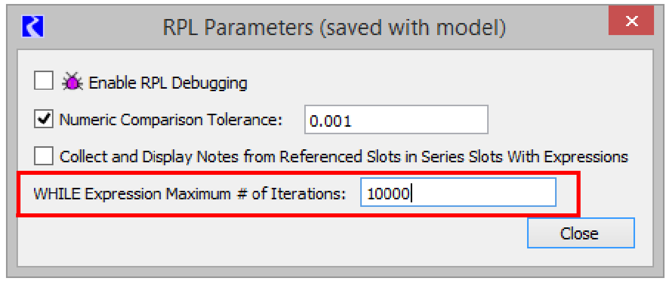
Note that this represents a change in behavior for existing models, though not for runs that currently complete successfully.

9.5 RPL Predefined Functions - New IntegerWithUnitsToString function

A new RPL Predefined function, IntegerWithUnitsToString, was added. This function allows you to convert the integer portion of a NUMERIC value with the specified units into a string. This provides more flexibility than the existing IntegerToString function that only uses internal units.

For more information on IntegerWithUnitsToString, click **HERE (RPLPredefinedFunctions.pdf, Section 103)**.

9.6 RPL WHILE Expression Maximum Iterations



The RPL **WHILE** expression (added from the palette) is now limited to loop no more than the maximum number of iterations. The maximum iterations is a model specific parameter saved in the RPL Parameters. The default maximum iterations is 10,000 but may be changed using the **Policy ➥ RPL Parameters...** menu on the workspace. If maximum iterations are exceeded, the run is aborted. Click **HERE (RPLTypesPalette.pdf, Section 2.6)** for more information on the **WHILE** expression.

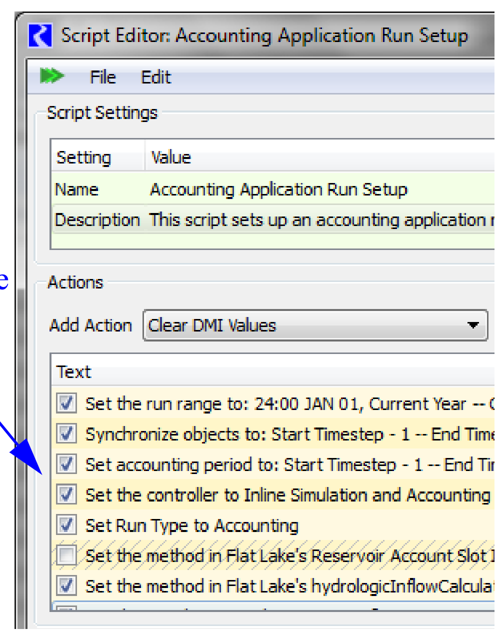
10. Script Management

10.1 Disabling Actions

Previously, actions could be disabled (omitted from script execution) in the **Script Dashboard**. When reopened or if changes were applied from the **Script Editor**, all action checkboxes were turned back on.

Now, action enabledness can also be controlled in the **Script Editor** with checkboxes now appearing with each action item. Action enabledness is now part of the script configuration, and persists when applied from the **Script Editor** and if the model is saved to a model file.

Disable/Enable Action Checkboxes



10.2 New Action Types

Following are new action types added to the Script Manager:

- **Enable Dispatching**: Enable or disable dispatching of the specified set of objects.
  More information is available **HERE (ScriptManagement.pdf, Section 3.3.9)**.
- **Evaluate Expression Slots**: Evaluate one or more specified Expression Slots.
  More information is available **HERE (ScriptManagement.pdf, Section 3.3.12)**.
- **Open Object**: Open the dialog for the specified object(s).

More information is available **HERE (ScriptManagement.pdf, Section 3.3.23)**

10.3 Set Slot Value Actions

10.3.1 Setting DateTime values

All three slot-setting action types, when used to assign values to DATETIME slots now allow the specification of symbolic DATETIMES, including the name of a Global RPL Function returning a DATETIME value. This applies to these three script action types:

- Set Scalar Slot Value
- Set Series Slot Values
- Set Table Slot Value

10.3.2 Initial/Default Value

The slot value setting for those same three slot-setting Script Action types is now initially NaN, and can be set to NaN. This is supported in both the Script Editor and Script Dashboard.

10.4 Show Dialog Settings

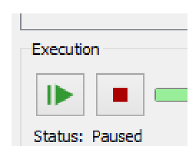
These four existing Script Actions now have a **Show Dialog (Yes/No)** setting:

- Load Goal Set
- Load Ruleset
- Open Global Functions Set
- Replace Initialization Rules Set from File

When this setting is “Yes”, the set dialog for the relevant RPL Set is shown after opening the set.

10.5 Improved status and execution buttons

In both the **Script Editor** and **Script Dashboard**, the icon of the **Play** button changes to a **Resume** icon when the script is paused (e.g. in a Memo script action which has paused script execution).



When the **Script Memo** dialog is closed, the main dialog from which the script execution was started is shown, and raised to the top. This indicates that you should control execution of script from that dialog.

10.6 Improved Navigation

Both the **Script Editor** and **Script Dashboard** action items support new context menus (right-click) to allow you to directly open the dialog for these various objects types (e.g. slots) referred to within the action's configuration settings.

In addition, in the Script Editor, an adjustable “Splitter” was added between the Actions panel and the Selected Action Settings panel.

10.7 Removal of Obsolete Settings

A number of unnecessary or obsolete script action settings were removed. When you first load you model in 7.0, you may see diagnostics indicating these settings were removed. Once saved in 7.0, the messages will on longer be posted.

11. SCT

11.1 Column Width

The SCT now preserves the per-sheet column width specifications for the two relevant SCT row header columns: Slot Label and Slot Units.These are now preserved.

In addition, the scroll position is maintained when switching sheets.

12. Slots

12.1 Custom Slots on any Object

You can now create custom slots on any object including Simulation Objects. Previously, custom slots were only allowed on Data Objects. See **HERE (Section 6.1)** for more information on changes to the interface when viewing custom slots. In addition, the **Slot Selector** now has a filter called **Is Custom** to allow you to filter by custom slots.

13. Units

13.1 Unit Schemes and Slot Copy Paste

When slots are copied and pasted, the Unit Scheme exceptions are also updated accordingly so that the display attributes of the new slots match those of the original slots.

14. Water Quality

14.1 Pipe Junction

A new **Pipe Junction Water Quality** category was added. In the **Propagate Salt** method, the Pipe Junction methods behave like the confluence object in that it sums salt mass: **Flow 1 Salt Mass** + **Flow 2 Salt Mass** = **Flow 3 Salt Mass**. Salt concentrations are a flow weighted average. For more information, see **HERE (WaterQuality.pdf, Section 14.1.1.2)**.

14.2 Water User

On the Water User, two methods were implemented for the new **Salt Storage** category:

- **Soil Moisture Salt Storage (WaterQuality.pdf, Section 18.1.2.5)**
- **Soil Moisture Salt Storage with Supplemental Flow (WaterQuality.pdf, Section 18.1.2.6)**

These methods model the diversion and return flow salt mass and concentration including the storage of salt mass in the soil moisture volume. They are the same except the latter also computes supplemental flow salt and adds it into the salt mass balance.

15. Workspace

15.1 Tool Tips

Tooltips were added or improved on most of the toolbar and other buttons on the Workspace, the SCT, and the Run Control.

16. Closed Bug Reports

The following bugs have been closed for this release. For more information on any bug, see the CADSWES website. The bugs are listed in order by bug number:

3976	5478	5488	5516	5529	5535	5549
5561	5565	5570	5571	5572	5604	5610
5617	5624	5627	5635	5649	5653	5654
5659	5677	5691	5693	5698	5710	5716
5720	5722	5725	5733	5737	5738	5739
5740	5741	5742	5743	5744	5747	5748
5750	5751	5752	5753	5754	5755	5756
5757	5758	5759	5760	5762	5765	5766
5767	5768	5769	5770	5771	5772	5773
5774	5775	5776	5777	5778	5779	5782
5783	5784	5785	5786	5787	5788	5789
5790	5791	5793	5794	5795	5796	5797
5798	5799	5800	5802	5803	5804	5805
5807	5808	5809	5810	5811	5812	5814
5815	5816	5818	5819	5821	5822	5823
5824	5825	5827	5828	5829	5830	5832
5833	5834	5835	5836	5838	5840	5842
5843	5844	5845	5846	5847	5848	5849
5850	5851	5852	5854	5855		

Release Notes Version 7.1

This document describes new features, enhancements, and changes in RiverWare Version 7.1.

1. Batch Mode

1.1 InvokeDssDMI RCL Command

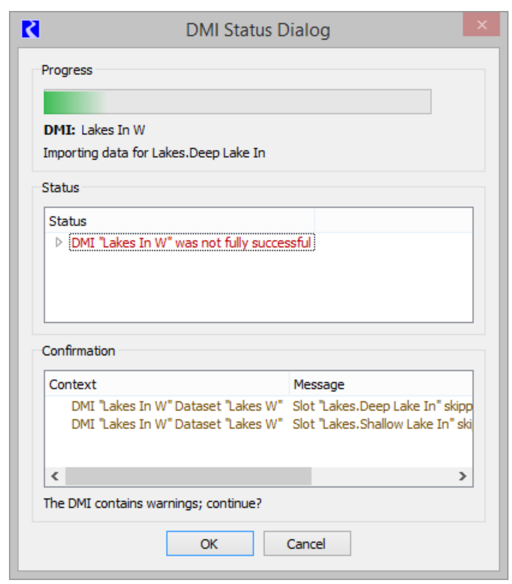
The batch mode command InvokeDssDMI was generalized to set the DSS File path or F Part. The syntax is described **HERE (BatchMode.pdf, Section 4.4.11)**.

2. Data Management Interface

2.1 HDB: Reading and displaying of Metadata

HDB Database DMIs were improved to read a per-timestep validation character and display it as a series slot note. This allows per timestep metadata (like P for provisional or A for approved) to be brought into RiverWare and shown on a slot as a **Series Slot Note**. For more information, click **HERE (DMI.pdf, Section 5.3.2.2)**.

2.2 Status and Progress Dialog



The DMI interface was improved by merging progress and confirmation information into a single dialog. This new dialog also provides the status of the DMI execution, for example 8 slots were processed successfully while 2 slots were processed unsuccessfully (missing values).

Thus the new dialog provides:

- DMI Progress
- DMI Status
- Warnings and Confirmations

For more information, click **HERE (DMI.pdf, Section 2.5.2)**

3. Multiple Run Management

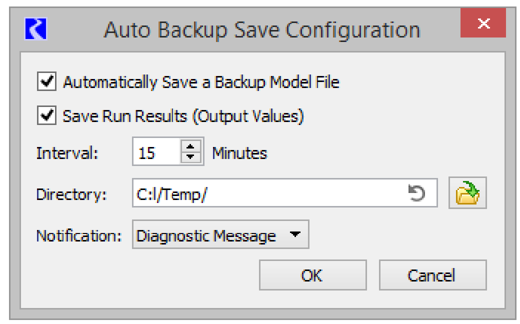
3.1 HDB Output Ensemble Names for MRM

When using HDB output ensembles for MRM, a diagnostic message is now issued at the beginning of MRM to notify the user of the names of the ensembles being used.

4. Model Files

4.1 Auto Backup Save

A new utility has been added to auto-save the model file to a backup file location. When enabled, at a specified interval, the model file is saved to a backup file in a specified directory. Click **HERE (ModelFiles.pdf, Section 4.6)** for more information.



4.2 Model Info and Run History

The **File ➥ Model Info** dialog was enhanced to show:

- **Save History** showing information about the last save
- **Run History** about one or more runs as described **HERE (ModelFiles.pdf, Section 2.2)**.

5. Objects

5.1 Canal - Dispatching

Within Rulebased Simulation, reservoirs linked to a Canal object are now forced to redispatch the same method within a timestep. This change was made to address a problem where rule and slot priorities led to the reservoirs dispatching the incorrect method.

5.2 Inline Power Plant - Specify Units Generating

A new method, **Specify Units Generating**, was added to the **Inline Power** category. In this new method, you specify the generating capacity for each unit, and the fraction of capacity at which each unit is generating. The method then calculates the **Unit Power** and **Unit Energy** as well as the total plant **Power** and **Energy**.

For more information, click **HERE (Objects.pdf, Section 15.1.2.3)**.

5.3 Power Reservoirs - Specified Power Coefficient

On power reservoirs using the **Plant Power Coefficient** or **Plant Efficiency Curve** methods, **Hydro Capacity**, **Best Hydro Capacity**, and **Energy** with the **Best** flag are now calculated correctly when the Power Coefficient is input or set by a rule.

5.4 Reach Routing Method - Muskingum with Segments

A new routing method was added to the Reach object. The **Muskingum with Segments** method allows you to route using the standard Muskingum equation, Outflow = C0 Inflow (t) + C1 Inflow (t-1) + C2 Outflow (t-1), but further discretize the reach into sub-segments. Each segment uses the same routing parameters as specified in the Routing Parameters category. In addition, this method has fewer requirements for initial data than the original Muskingum method; if the initial Outflow is not known, it is set to the Inflow. For more information, click **HERE (Objects.pdf, Section 22.1.1.8)**

5.5 Slope Power Reservoir - Weighting Coefficients Interpolation

The Slope Power Reservoir was improved to not issue table interpolation errors during intermediate calculations. This change affects iterative algorithms including max outflow computations and RPL functions like **SolveSlopeStorageGivenInflowHW**, **SolveSlopeStorageGivenInflowOutflow** and **TargetSlopeHWGivenInflow.**

The fix includes introducing two new slots:

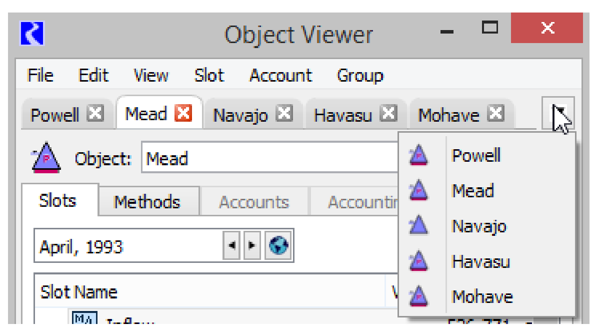
- **Partition BW Table Auto Max**
- **Partition BW Table Auto Min**

These two slots use the **Partition BW Table** to show the largest and smallest headwater values for each flow parameter. The tables are used within the slope storage calculations to check that values are valid.

6. Object Dialogs

6.1 Object Viewer

A new **Object Viewer** dialog was created to show multiple **Open Object** dialogs as tabs in a single dialog. Objects can be dragged off of the viewer to show in the standard Open Object dialog and then re-docked as desired.



For more information, click **HERE (ObjectDialogs.pdf, Section 1)**.

7. Optimization

7.1 Impulse Response Reach Routing

In Optimization, the **Impulse Response** method can now be selected for the Routing category on Reach objects. The formulation is the same as for simulation:

Outflow(t) = C0 Inflow(t) + C1 Inflow(t-1) + C2 Inflow(t-2) + ... + Total Gain Loss

Refer **HERE (Optimization.pdf, Section 5.7.2.5.3)** for details about the slots associated with this method.

7.2 Slope Power Backwater Lambda Approximation

Previously a sloped power reservoir using the backwater lambda approximation technique was unnecessarily writing input constraints when the reservoir had already dispatched successfully in the pre-optimization simulation run. In some cases, this caused an infeasibility. To resolve this problem, input constraints are no longer written for the Pool Elevation slot at timesteps for which prior dispatching was successful. In addition, the automatic setting of approximation points was improved to make use of known values when the object already dispatched successfully for some timesteps.

8. Output Devices

8.1 File Size Reduction of Generated Images

A significant reduction of the size of generated image files was applied to:

- Image files generated for model reports.
- Image files created as part of the chart animation video generation.

In some cases, the file sizes were reduced by a factor of 30 without any impact on image quality.

8.2 Charts

The following changes were made to Charts:

- Within the configuration, a new tab has been added for setting fonts on all chart labels.
- A checkbox option was added to show/hide the chart date.
- An option was added to not to show the legend on the chart.
- On bar charts, sizing options were provided to configure the bar width proportion.

For more information, click **HERE (Output.pdf, Section 5.2)**.

8.3 Model Reports

Model Reports provide a way to export information about a RiverWare model or run to an HTML file. Following are changes and improvements to the Model Report:

8.3.1 Embed Images in HTML

A new Model Report setting was added: E**mbed Images in HTML File** with options: **Yes**/**No** Selecting **Yes** (the default on new reports) embeds images in the HTML file. This makes it easier to send the generate HTML file via email or file transfer. Selecting **No**, creates a sub folder in the specified directory where all images are stored. For more information, see **HERE (Output.pdf, Section 4.2.1)**.

8.3.2 Ensure HTML and add HTML to File chooser

To make it easier to define the HTML file to use, the following changes were made:

- Automatically add .html extension if not specified.
- Provide a file selection filter for efficient selection of HTML files.

8.3.3 Text Items

The Model Report Text item (**HERE (Output.pdf, Section 4.2.3.28)**) allows you to add rich/formatted text to your report. The following enhancements have been implemented:

- **Superscript** and **Subscript** formatting is supported under the **Format** menu.
- Using the Tab key, four space characters are added to mimic a tab.

8.3.4 Show/Hide individual Descriptions and Comments

Finer control was added to allow you to specify which **Descriptions** or **RPL Comments** are shown in the report. Yes/No settings for showing descriptions and RPL comments were added to Object, Slot, RPL Set, RPL Group and RPL Rule/Goal items.

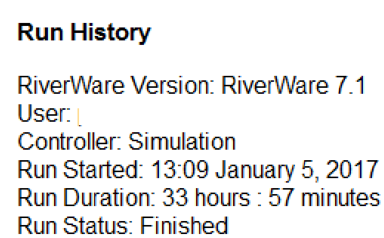
In a large model report, it could be quite time consuming to turn on or off all of these new settings. For this reason, the following four operations, have been provided under a new **Settings** menu.

- Show All Descriptions
- Hide All Descriptions
- Show All RPL Comments
- Hide All RPL Comments

8.3.5 Run History Item

A new **Run History** item was added to allow you to optionally show the following pieces of information in a report:

- RiverWare Version
- User
- Controller
- Run Start Time
- Run Duration
- Run Status



See **HERE (Section 4.2)** for more information on the new Run History. See **HERE (Output.pdf, Section 4.2.3.19)** for information about this report item.

Output Canvas

8.4 Output Canvas

The Output Canvas, described in **Output.pdf, Section 6**, allows for visualization of outputs in spatially distributed teacups and flow lines. The following improvements have been added to the Output Canvas:

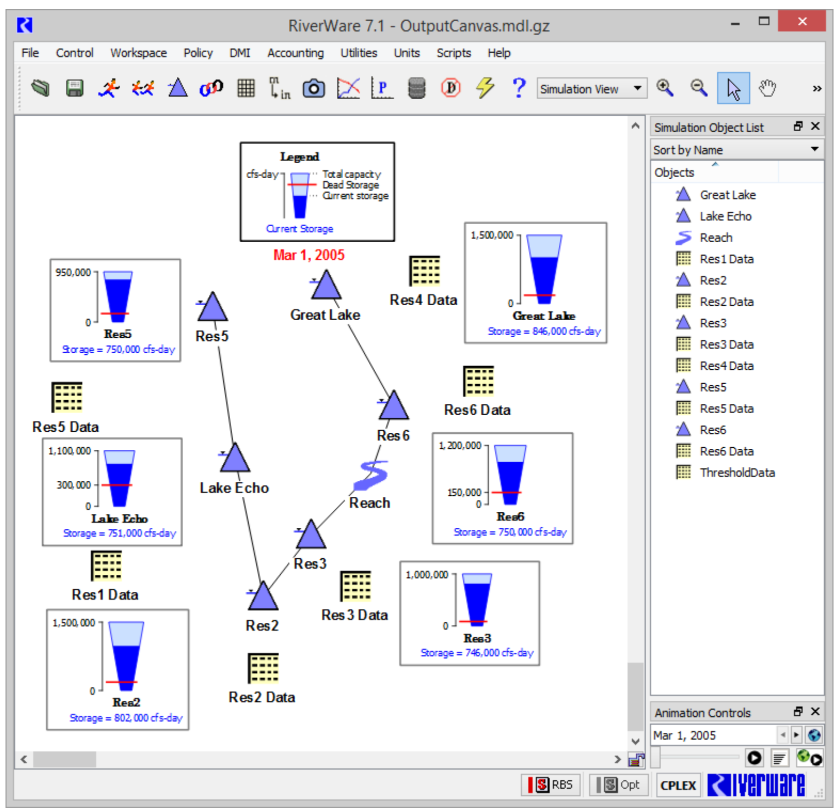
8.4.1 Resizable charts, icons, and images

A scaling factor has been added to the Output Canvas configuration for individual icons and images. In addition, an anchor point feature has been added to charts for resizing the chart on the canvas.

8.4.2 Printing to Paper and to PDF

Print Preview and **Print** submenus have been added to the generated output canvas **File** menu. If you have a PDF print driver, you can print the Output Canvas directly to a PDF file

8.4.3 Teacups / Charts / Text shown on workspace

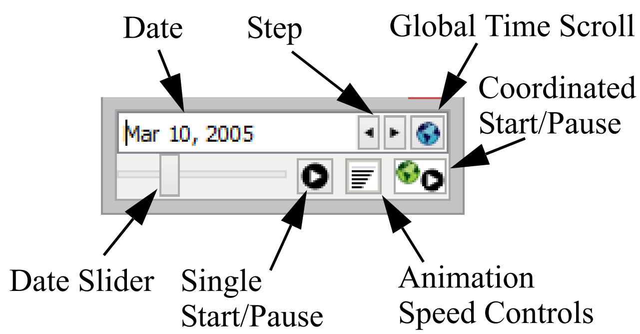


New Output Canvas settings were added to **Show on Simulation View** and **Show on Geospatial View**. When enabled, the canvas teacups, charts and text are shown on the appropriate workspace canvas views. You can move the items on the workspace, but all other configuration is performed on the Output Canvas editor. For more information, click **HERE (Output.pdf, Section 6.6)**.

As part of this work, the datetime spinner and animation controls were added to the workspace as a dockable panel below the object list. Use this to advance canvas items through time. For more information click **HERE (Workspace.pdf, Section 2.8)**

8.5 Coordinated Animation

Charts and Output Canvas can be animated through the run period. Now, there is a Coordinated Start button that allows all relevant dialogs to animate together. When the icon is pressed, all slider/spinners move together in coordinated time. For more information, click **HERE (Output.pdf, Section 6.6)**.



8.6 Plotting

8.6.1 Inconsistency for Patterned Line Appearance

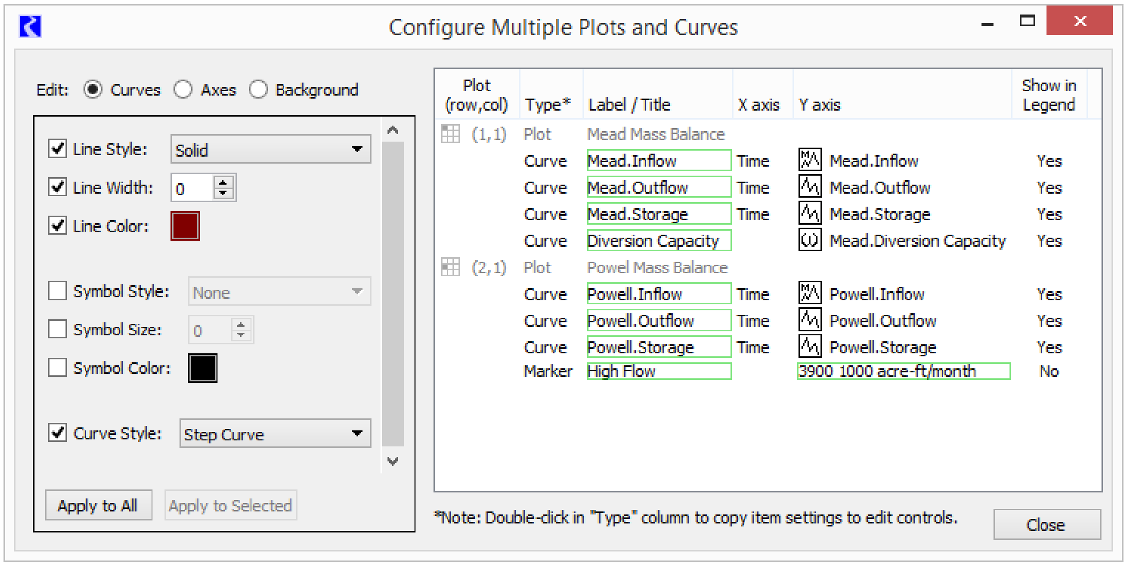
Plots with patterned lines (dash, dot, etc) with a width of two pixels or more were displaying differently on the plot versus the legend. To remedy this inconsistency, the display of curves on the plot was improved to match the legend. As a result, existing plots may look different than in previous versions.

8.6.2 Marker Labels

Previously, marker labels were tied to the marker line. They did not display unless a line style was selected. Now Marker Labels can be shown without a line; that is, they can be shown to label a specific point on the plot without a line.

8.6.3 Editing Multiple Curves and Graphs

The new **Configure Multiple Plots and Curves** dialog provides centralized plot editing controls. Most plot settings for the supported nine separate plots within a plot page are editable within the new **Configure Multiple Plots and Curves** dialog. You can select multiple items within a plot page, e.g. curves and markers, and apply selected settings to those items in a single operation. For more information, click **HERE (Output.pdf, Section 2.3.6)**.



8.6.4 *User Specified Axis Units*

Each axis is now associated with a particular unit type (e.g. flow) rather than being limited to a specific scaled unit. The user can switch the scaled units associated with an axis between:

- the scaled units of the first slot assigned to the axis,
- user-specified scale and units (among the units supported for the axis' unit type).

More information can be found **HERE (Output.pdf, Section 2.3.2.4)**.

8.6.5 *Copy/Paste of slots to/from the slot clipboard*

Copy and Paste of slots from the slot clipboard was reinstated. Slot curves are added to the plot as long as axes having the slot curves' unit types are available.

8.7 Tabular Series Slot Reports

8.7.1 *Omit Slots Behavior*

Tabular Series Slot reports now have an improved **Omit slots** behavior. The change in filtering is as follows:

- old behavior: omit slots containing only NaNs or zeros (exact value)
- new behavior: omit slots displaying only NaNs or zeros as values

The important difference is in the checking for values that are exactly zero versus values that are displayed as zero. With the new functionality, the display precision is taken into account when checking for zero values. The new **Omit slots** options are now as follows:

- displaying only NaNs
- displaying only NaNs or zeros as values

More information is available **HERE (Output.pdf, Section 3.2.2)**.

9. RPL

9.1 Diagnostics for Rules/Goals

For rule diagnostics, the rule's priority was added to the display text. For initialization rule contexts, the initialization rule's index was added to the display text.

Now, the formats are:

- Optimization goal: GOAL: (<priority>) <goal name>
- RBS rule: RULE: (<priority>) <rule name>
- Initialization rule: RULE: (#<index>) <rule name>

Within the RBS and Optimization diagnostic settings dialogs, the rule and goal filters were enhanced to include and show the new context information.

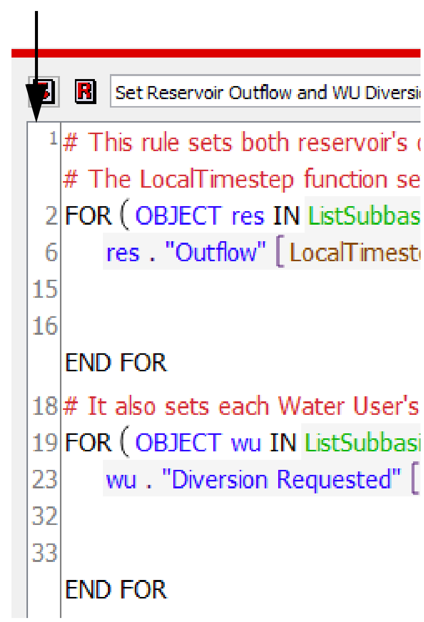
9.2 Display Settings

RPL Display Settings, including **Font**, **Colors**, and **Line Breaks**, are now saved in the model file instead of in user settings. When you first open and save your model in this version, the RPL Display Settings will be saved in the model. You can export or import settings as needed. For more information, click **HERE (RPLUserInterface.pdf, Section 6.2)**.

9.3 Element Numbering

To make it easier to find and communicate about RPL logic, you can now number the statements and expressions with which rules and functions are composed. **RPL Element Numbers** can be optionally shown in a column along the left side of each RPL frame or as a right click context menu. Show these numbers from the RPL Display Settings.

For more information, click **HERE (RPLUserInterface.pdf, Section 6.2.4)**.



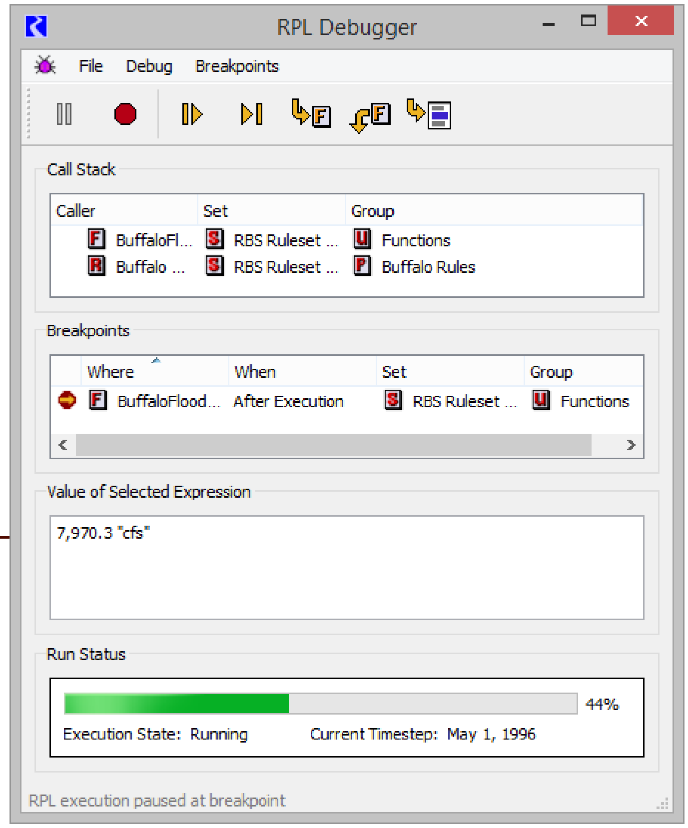
9.4 ELSE IF Branches

ELSE IF operators were added to both RPL Expression and the RPL Statements. You can add these operators to any IF or ELSE expression or statement as new ELSE IF branches.

9.5 RPL Debugger

The following changes were made tot he RPL debugger:

- The Run Status is now shown as part of the RPL Debugger as shown to the right.
- Long lists are no longer truncated in the **Value of Selected Expression** panel. The debugger now displays the full list.
- Commas in numbers are now shown in the RPL Debugger.



9.6 Rename Variable or Argument

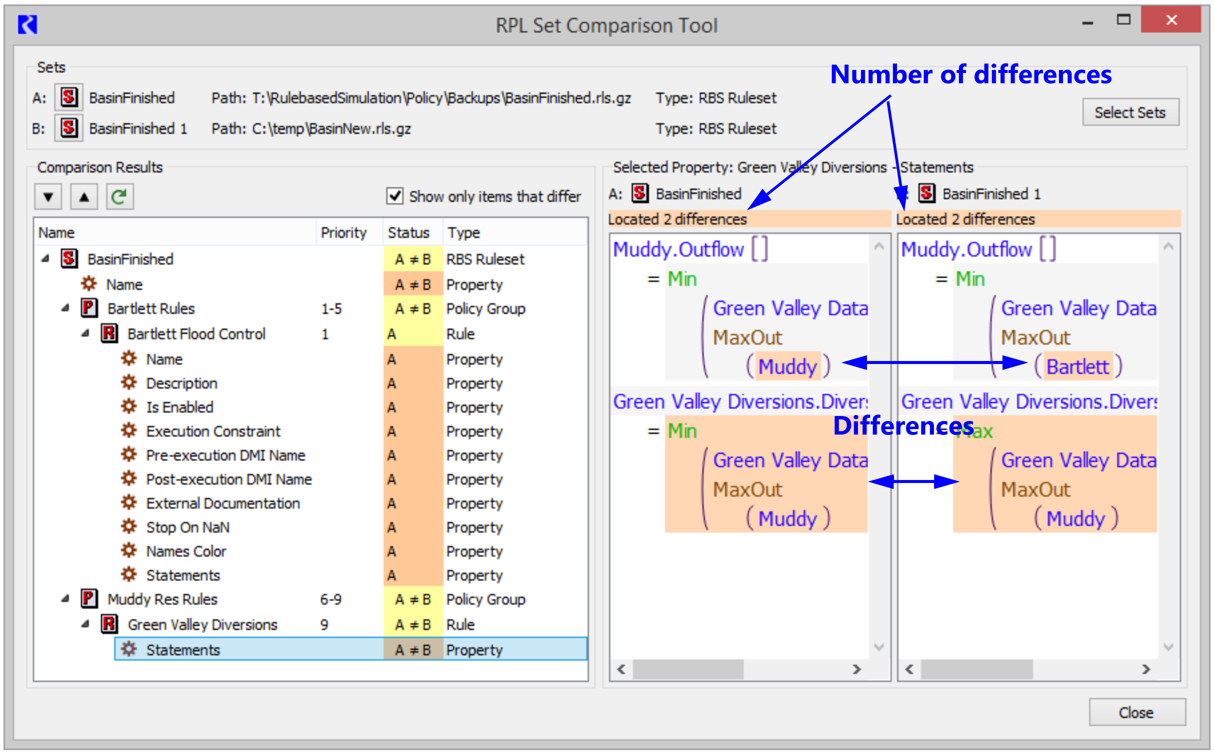
A new right-click "**Rename...**" operation was added to RPL to provide an easy way to rename all the occurrences of the selected variable or argument name.

Variables are associated with statements (FOR and WITH), expressions (FOR and WITH), or functions (argument names). For more information, click **HERE (RPLUserInterface.pdf, Section 2.4.6)**.

9.7 RPL Set Comparison Tool

The **RPL Set Comparison Tool** compares two RPL sets and shows you the differences between the sets. This allows you to see where items are different, what the specific differences are, and allows you to easily access the RPL set dialogs so that you can change one or both sets.

The comparison tool was improved to highlight multiple differences within the same item and note how many differences occur.



For more information, click **HERE (RPLUserInterface.pdf, Section 1.7.3)**.

9.8 RPL Notes

On RPL dialogs, a new **Notes** panel was added. **Notes**, like **Descriptions**, can be entered in a panel at the bottom of the dialog. Notes can be used when you have information about the RPL item that you want to enter that doesn't belong in the **Description** field. For example, development information (E.g. who, why, when changed) could be entered in the **Notes** panel. Notes can be included in model report outputs using the RPL items and the **Show Notes** setting.

Notes are described **HERE (RPLUserInterface.pdf, Section 2.2.3)**.

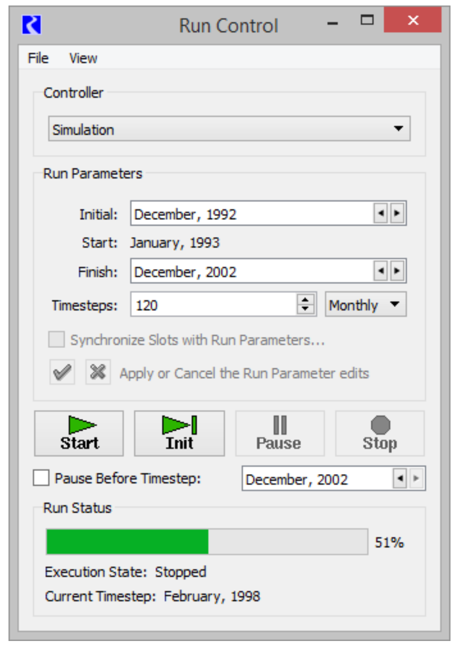
9.9 RPL Dialog - Description and Notes Indicators

The RPL dialogs were improved to better show

Descriptions, Notes, and the presence of non-default values in the row of toggles. Now, when the description or notes panel contains text, the checkbox label is bold. When the panel is empty, the text is grey. In addition, when a description or notes exists, the tooltip on the text and checkbox shows the first 140 characters of the text.

10. Run Control

10.1 Run Status Panel



A run status panel was added to the bottom of the **Run Control** and **Multiple Run Control** dialogs as shown to the right. A separate run status dialog no longer opens automatically but can be manually opened from the View menu if desired.

For more information, click **HERE (RunControl.pdf, Section 1)**

11. Script Management

11.1 New Actions

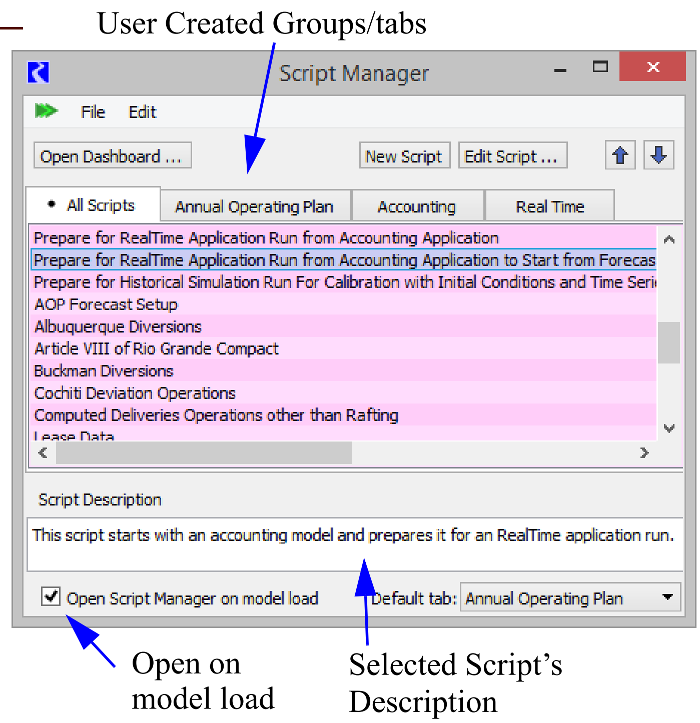
11.1.1 Execute Script

A new Execute Script action was added to the Script Manager. **This allows a script to execute another script**. Note, the script called by this action cannot have additional Execute Script actions; that is, only one level of Execute Script calls is allowed. For more information, click **HERE (ScriptManagement.pdf, Section 3.3.16)**.

11.1.2 Set Run Timestep

A new script action was added that sets the run timestep size. This action is analogous to changing the run control timestep size. Options include whether to synchronize objects, exclude slots, aggregate input data and how to handle NaNs when aggregating. For more information, click **HERE (ScriptManagement.pdf, Section 3.3.41)**.

11.2 Script Manager Enhancements



The Script Manager was re-designed and enhanced to provide more functionality. For more information on these topics, click **HERE (ScriptManagement.pdf, Section 2.2)**.

11.2.1 Script Groups

Scripts can now be organized into script groups. The Script Manager appearance was modified to include a tabbed panel, with each tab corresponding to a particular script group. The user selects a group's tab to manage the group and view its list of scripts.

11.2.2 Show Descriptions

Whenever a script is selected in the Script Manager or associated dialogs, its description is displayed in a panel below the list of scripts.

11.2.3 Open on Model load

The Script Manager can be configured to automatically display its window upon loading a model. One can also specify which script group tab is initially displayed when the Script Manager window is initially opened (either upon model load or manually).

11.3 Export/Import Multiple Scripts and Groups

Multiple Scripts and Script Groups can now be exported to and imported from a single file. For exporting, an additional dialog is now provided by the Script Manager via the existing **File ➥ Export** menu item. This dialog allows the user to select multiple scripts and/or groups at the same time, and to save them all to a single file. For importing, the existing **File ➥ Import** menu item now also supports opening files containing multiple scripts and/or groups.

For more information, click **HERE (ScriptManagement.pdf, Section 2.4)**

12. SCT

12.1 Column Widths per sheet

When the SCT is shown with slots as rows and timesteps as columns (horizontal time), column widths are now preserved on a per-sheet basis. In addition, the following column width adjustment operations now operate on a per-sheet basis:

- Resize Columns: Set All to Selected Column Width
- Grow Columns: Fit Data
- Resize Columns: Fit Data
- Resize Columns: Fit All

For more information on these options, click **HERE (SCT.pdf, Section 8.10)**.

12.2 Font Specification

The default font choice in the SCT Configuration dialog's **Font** tab has been renamed to **Workspace Font**, and the effect of that choice has been simplified. When **Workspace Font** is selected, the SCT uses the font of the RiverWare Workspace (which is used also by most other parts of the RiverWare user interface). With this selection, any changes to the Workspace's font are immediately reflected in the SCT.

The font-related settings associated with SCT configurations include:

- **Workspace Font**
- The user-defined **Font A**
- The user-defined **Font B**

12.3 Go To Next NaN

A new menu item, **Go to next NaN,** now appears on the **View** menu. **Go to next NaN** navigates directly from one NaN value to the next through timesteps first then through the timesteps on subsequent slots. A new shortcut, Ctrl+Shift+N, also carries out the new **Go to next NaN** action.

12.4 Go To Menu improvements

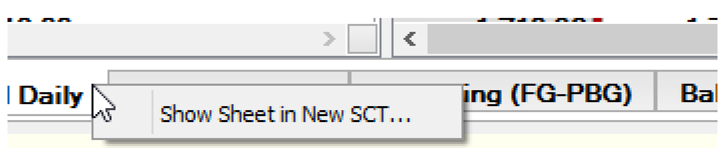
The Go To menu on the SCT was improved to show a menu based on Series Slot Sheets (when available) instead of integer submenus. For more information, click **HERE (SCT.pdf, Section 2.12)**.

12.5 Navigation at bottom of the Sheet

When entering values in a sequence of cells using the enter key, the navigation now stops at the final SCT timestep instead of wrapping around to the next series slot.

12.6 Show Sheet in New SCT

You can now “tear off” a Series Sheet to create a new SCT. This allows you to see multiple sheets at once. On the Series Slots tab, right-click on the sheet tab and choose **Show Sheet in New SCT...** For more information, click **HERE (SCT.pdf, Section 8.5)**.



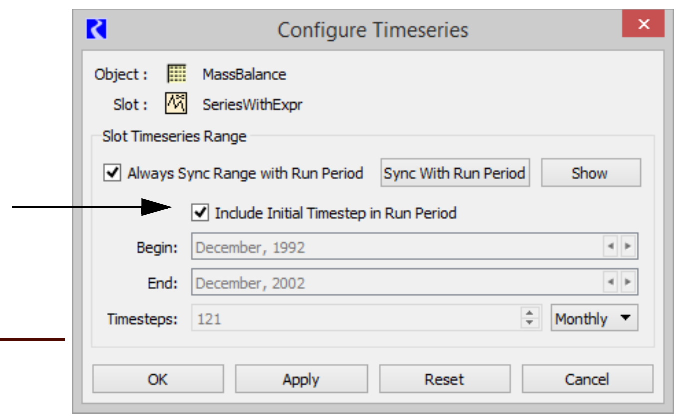
13. Slots

13.1 Expression Slot Evaluation Keyboard Shortcut

On the expression slot, the “Evaluate” shortcut key was changed to F9 due to the previous shortcut (Alt-E) conflicting with other operations.

13.2 Expression Slot Evaluation Range

On the expression slot, you can now automatically include the initial timestep in the evaluation range. Use the Include Initial Timestep in Run Period toggle as shown.

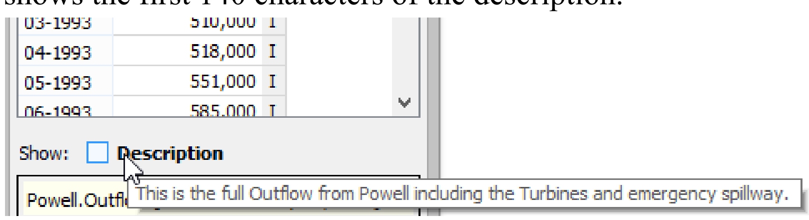


13.3 Go To Next NaN

A new menu item, **Go to next NaN** now appears on the **View** menu. **Go to next NaN** navigates directly from one NaN value to the next through timesteps first then through the timesteps on subsequent columns within the dialog. A new shortcut, Ctrl+Shift+N, also carries out the new **Go to next NaN** action.

13.4 Slot Description Indicator

The Slot dialogs were improved to better show slot **Descriptions**. Now, when the description panel contains a description, the checkbox label text color is black and the font is bold. When the description panel is empty, the text is grey and the font weight is normal. The border was removed. In addition, when a description exists, the tooltip on the Description text and checkbox shows the first 140 characters of the description.



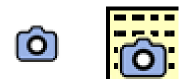
13.5 Text Series Slots

A new type of series slot was added that stores text. The **Text Series Slot** can be added to any object from the **Slot** menu. More information can be found **HERE (Slots.pdf, Section 4.5)**.

14. Snapshots

14.1 New Icon for Snapshots

A new icon was implemented for Snapshots on the workspace tool bar, Snapshot object, and within the Snapshot Manager.



15. USACE-SWD Methods

15.1 New Debugging Slots

Enhancements were made to the reservoir and computational subbasin objects for better debugging and usability of Flood Control methods. The enhancements include:

- Added a debugging slot on the reservoir object, **Downstream Control Point Share,** for reporting a reservoir's share contribution at one or more downstream control points.
- Added a debugging slot, **Forecasted Operating Levels,** to the computational subbasin to show each reservoir object's forecasted operating levels. Also a new default **None** method was added to the **Priority Determination** category so that the default method does not have this new slot as a dependency.
- Modified the reservoir object's rating curve table to use elevation rather than storage as the lookup reference for a specified release. A new category, **Rating Curve Modification**, was added. This category is shown when **Flat Top Surcharge** is used. This category has the default **None** method and the new **Specify Rating Curves using Elevation** method. When this second method is selected, the new **Rating Curves using Elevation** slot is used to generate the **Rating Curves** slot (which shows Storage). The **Rating Curves** slot is also marked as having a source slot.

16. Units

16.1 New Units: Billion Cubic Meters

The volume unit BCM, or Billion Cubic Meters, was added. In addition, flow units BCM/day, BCM/month, and BCM/year were also added.

16.2 FlowPerTime RPL Units

RPL Units were added for the FlowPerTime unit type. This allows RPL Policy to reference slots with this unit type.

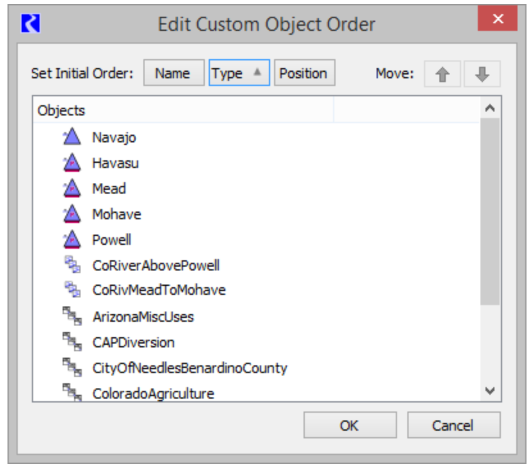
16.3 Unit Converter with DateTime Units

The unit converter was enhanced to allow conversion of DateTime values (as stored on slots) to and from their underlying numeric values. For more information, click **HERE (Units.pdf, Section 3.2)**.

17. Workspace

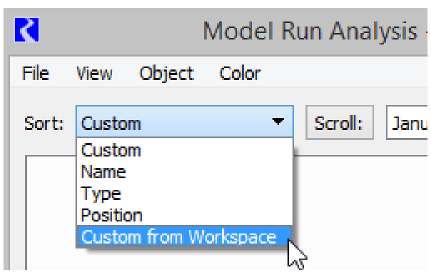
17.1 Custom Object Order Dialog

A new dialog was created to provide a mechanism for reordering simulation objects using click and drag, sort-by buttons, and up and down arrows. This is accessed from the workspace **Simulation Object List** using the **Sort ➥ Edit Custom Order** option.



For more information, click **HERE (Workspace.pdf, Section 3.5)**.

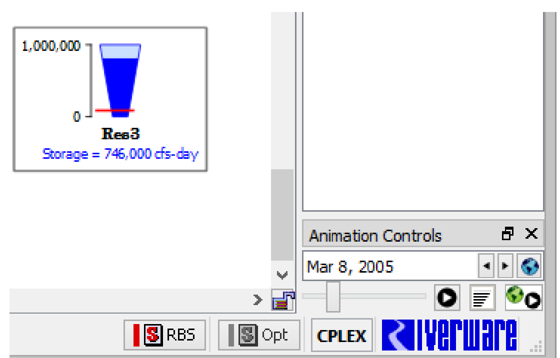
The **Model Run Analysis** and workspace **Object Coordinates** dialog were enhanced to allow you to use the workspace custom order in those dialogs too.



17.2 Output Canvas Items Shown on Workspace

Output Canvas Teacups, Charts, and Text can now be shown on the Simulation and Geospatial workspace views as described **HERE (Section 8.4.3)**.

As part of this work, the datetime spinner and animation controls were added to the dockable panel below the object list. Use this to advance the canvas items through time.



18. Closed Bug Reports

The following bugs have been closed for this release. For more information on any bug, see the CADSWES website. The bugs are listed in order by bug number:

5588	5650	5654	5678	5713	5718	5801
5813	5837	5839	5856	5858	5860	5861
5862	5863	5864	5865	5867	5868	5870
5871	5872	5874	5875	5876	5877	5878
5880	5881	5884	5885	5886	5888	5890
5891	5892	5896	5899	5900	5901	5902
5903	5905	5908	5911	5912	5913	5914
5915	5916	5917	5922	5923	5924	5925
5926	5927	5930	5931	5933	5935	5938
5939	5942	5943	5945	5946	5947	5948
5950	5951	5952	5953	5954	5956	5957
5958	5959	5961	5962	5963	5967	5968
5969	5970	5972	5974	5975	5976	5978
5983						

Release Notes Version 7.2

This document describes new features, enhancements, and changes in RiverWare Version 7.2.

1. Special Attention Notes

Following are special attention notes, indicating that functionality has changed that requires you to update models, that results may differ, or you might get a warning message when you first load a model in 7.2:

- **Save Precision**: When saving model files, there is no longer an option to save with "extended precision" or regular precision. Instead, now **input** values are always saved with full precision (17 digits) while **output** values are saved with a user specified precision. Because saving full precision of input values will increase model size, you may want to decrease the precision of saved output values. This will allow you to offset model size growth as desired. The **Confirm Save Model** dialog gives you an indication of the uncompressed size of series data as you change the output precision.
- **Groundwater Solution:** The Head Based Groundwater solution was modified to prevent negative storage. The new application of **Percolation**, **Evaporation** and **Evapotranspiration** are always applied and thus, could result in model differences for models that previously produced negative Groundwater Storage values.
- **Inline Power Pre-simulation Dispatching:** The **Inline Power Plant** is now able to dispatch before the start of the run. As a result, if your model has pre-simulation inputs, you may need to clear those out to prevent an over determination error.
- **Obsolete Optimization Categories:** The unused **Optimization WU Request Category** and the **Aggregate Optimization Requests** category were removed from the Water User and from the Agg Diversion Site, respectively. Warning messages are posted when a model is first loaded in 7.2.
- **Three Dimensional Table Interpolation changes:** Within three dimensional table interpolation, the "convex hull" test was loosened. But if the test fails, it is now a fatal error. This could cause existing models to abort when previously they did not. If an abort occurs, modify your 3 dimensional table by editing or adding data points.
- **CompletePartialDate with Offset:** Previously, the **CompletePartialDate** RPL Predefined Function could return an incorrect value when the reference date had an offset. For example: CompletePartialDate(@"October 1", @"t + 1 year") This problem (Issue #6038) has been corrected, but the change could lead to model differences in models that use an offset within the **CompletePartialDate** function.

If you have any questions, please contact RiverWare-Support@Colorado.edu.

2. Data Management Interface

2.1 DSS Database DMI Reliability

The DSS Database DMI was modified to improve processing of large data sets. Previously, a timeout could occur unexpectedly. This change makes the DSS DMI more reliable and robust.

2.2 Database DMI On/Off States

The Database DMI on/off status was improved as follows:

- Turning off a dataset causes its slot selections to be shown as off.
- Turning off all slot selections causes the dataset to be shown as off.
- The dataset is shown as a tristate (on, off, partially on) based on the state of its slot selections.

In addition, the on/off state is preserved in the model file when saved.

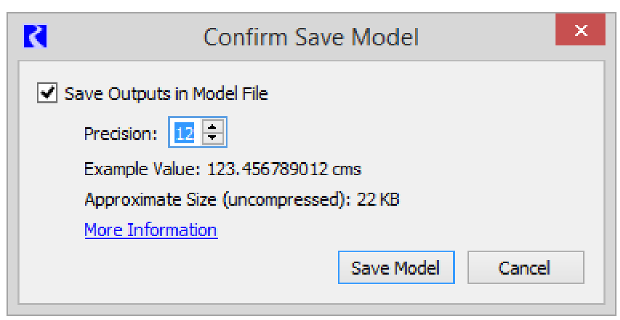
More information can be found **HERE (DMI.pdf, Section 5.2.2.4)**.

2.3 HDB Database DMI Importing Series Slot Notes

The HDB Database DMI was modified to ignore certain exceptions when importing metadata as Series Slot Notes. In addition, the utility now better recognizes missing metadata information.

3. Model Files

3.1 Precision of Values Saved in Model files



When saving model files, there is no longer an option to save with "extended precision" or regular precision. Instead, now **input** values are always saved with full precision (17 digits) while **output** values are saved with a user specified precision. Because saving full precision of input values will increase model size, you may want to decrease the precision of saved output values. This will allow you to offset model size growth as desired. The **Confirm Save Model** dialog gives you an indication of the uncompressed size of series data as you change the output precision.

Following are details of this change:

- Non-series data (e.g scalars, tables, etc) are always saved with full precision.

- Series values with the I, Z, or i flag are always saved with full precision.
- Series values with the O, R or other flags are saved with the user specified precision. The image above shows the configuration dialog.
- Slot value editors display a maximum of 15 digits.
- Optimization models no longer require "Extended Precision" as input values are always saved with maximum precision.

For more information, click **HERE (ModelFiles.pdf, Section 4)**.

4. Objects

4.1 Distribution Canal: Request Routing

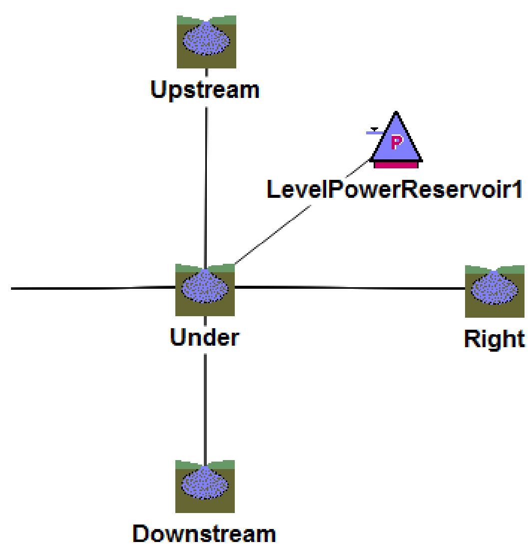
The Distribution Canal now allows a monthly model to propagate requests if the lag is set to zero.

4.2 Groundwater

4.2.1 Linking to a Reservoir

A new solution type was added to model the interaction between a Reservoir and the groundwater beneath the reservoir. This "under reservoir" Groundwater object propagates the elevation and flows, but does not track storage. On the Groundwater object, select the new **Head Based Boundary Condition** method in the **Solution Type** category. Then link previous elevations and flow slots. The Groundwater object can then be linked to other Groundwater objects that use the **Head Based Groundwater Grid** method in the **Solution Type** category.

More information can be found **HERE (Objects.pdf, Section 14.1.1.3)**.



4.2.2 Preventing Negative Storage

For Groundwater objects with a Solution Type of **Head Based Groundwater Grid**, the calculation of **Storage** was revised to prevent negative values. The calculation of **Percolation**, **Evaporation** and **Evapotranspiration** are now limited so that they will not cause **Storage** to be negative. Additionally, a new set of slots called **Flow Factor Upstream/Downstream/Left/Right** can optionally be linked to the corresponding **Flow Factor** slot on adjacent Groundwater objects. The **Flow Factor** slots, when linked, compute and limit the lateral flows from one Groundwater object to another when **Storage** is close to zero.

The new application of **Percolation**, **Evaporation** and **Evapotranspiration** are always applied and thus, **could result in model differences** for models that previously produced negative Groundwater Storage values.

Details about how **Storage** is calculated on Groundwater objects with the **Head Based Groundwater Grid** solution can be found HERE (Objects.pdf, Section 14.2.2).

4.2.3 Specified Inflows

The Groundwater object was enhanced to allow a **Specified Inflow**. This ungaged flow can be used to add or remove a series of inflows (can be specified as periodic data) to the Groundwater object. More information is available HERE (Objects.pdf, Section 14.1.1.2).

In addition, water quality salinity slots were added to model the addition or subtraction of salt via these flows. Documentation is available HERE (WaterQuality.pdf, Section 13.2.1.2.4).

4.3 Inline Power

4.3.1 Pre-simulation Dispatching

The **Inline Power Plant** is now able to dispatch before the start of the run. As a result, if your model has pre-simulation inputs, you may need to clear those out to prevent an over determination error.

In addition, the computational subbasin **Initialize flow slots for Routing** was changed to now look downstream through the Inline Power object. Previously, it stopped at this object. Finally, the **Outflow** slot is no longer backcasted, but the Inflow slot will be backcasted if it is not linked.

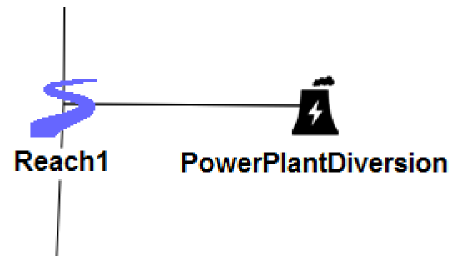
4.3.2 Specify Units Generating: Unit Turbine Release is Now Included

When the **Specify Units Generating** method was originally implemented for RiverWare 7.1, it only included **Generation Capacity**; the **Power** calculation was independent of **Turbine Release**. Now **Unit Turbine Capacity** has been added to the **Unit Capacity** slot, and you can optionally input the **Unit Turbine Capacity**. Also a new **Unit Turbine Release** slot was added which can be optionally input. If you do not input **Unit Turbine Release**, it is calculated by the method by multiplying the **Unit Turbine Capacity** by the **Unit Generation Fraction**. The method also now sets the total plant **Turbine Release**.

As part of this enhancement, the **Unit Capacity** table slot was converted from a 1xN slot with one column for each unit's generation capacity to a Nx2 table with a row for each unit. The first column is now **Unit Turbine Capacity** (flow), and the second column is now **Unit Generation Capacity** (power). If this method was previously implemented in a model using RiverWare 7.1, it will be necessary to repopulate the **Unit Capacity** slot with data the first time the model is loaded in the new version of RiverWare.

See HERE (Objects.pdf, Section 15.1.2.3) for more information.

4.4 Power Plant Diversion and Generator Object



A new aggregate object was added: the **Power Plant Diversion**, and its **Generator** elements. Often these are used to model the diversions and depletions required for power plant cooling. This object will divert from a reach, reservoir or aggregate distribution canal to meet the requests. Diversion and depletion requests are computed by one or more linked **Generator** element objects. User selectable methods compute the required diversion and depletion based on generator characteristics. More information on the **Power Plant Diversion** can be found **HERE (Power Plant Diversion)** while information on the **Generator** can be found **HERE (Generator)**.

4.5 Reservoirs

4.5.1 Linking to Groundwater

A new solution type was added to model the interaction between a Reservoir and the groundwater beneath the reservoir. This "under reservoir" groundwater object propagates the elevation and flows, but does not track storage.

More information on the new **Linked Seepage** method and linking to a Groundwater object can be found **HERE (Section 4.2.1)**.

4.5.2 Diversion Power

New categories were added to the reservoirs that enable you to model power produced through the **Diversion** slot. Three new categories were added to the Reservoirs. Each has a default method of None and one new non-default method:

- Diversion Power: **Diversion Power Efficiency Curve**
- Diversion Tailwater: **Diversion Base Value Plus Lookup**
- Diversion Power Bypass: **Diversion Power Bypass Capacity Table**

See **HERE (Objects.pdf, Section 17.1.27)** for more information.

4.5.3 Max Iterations - Default Value

The **Max Iterations** slot on a Reservoir previously had a default value of 20. It is common for iterative solutions to require more than 20 iterations, so the value has been increased to 100. This will not affect existing models. It will only affect new Reservoir objects. Corresponding warning messages were also adjusted. Previously a warning was issued if the slot value was greater than 100. Now the warning is only issued if the slot value is greater than 1000.

4.6 Water User

4.6.1 Dispatch Slots

On the Water User, the **Return Flow Salt Mass** was added as a linkable dispatch slot. This slot should be linked for certain salinity modeling approaches, described **HERE (WaterQuality.pdf, Section 18.1.1.2)**.

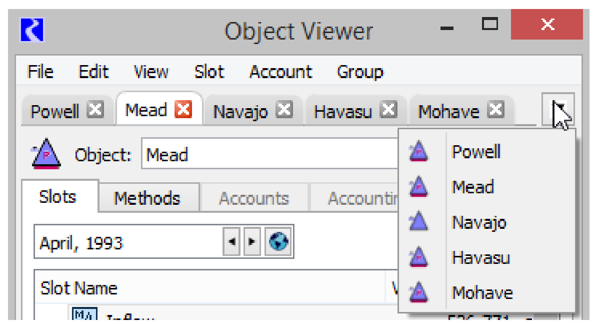
4.6.2 Removal of Unused Optimization Categories

The unused **Optimization WU Request Category** and the **Aggregate Optimization Requests** category were removed from the Water User and from the Agg Diversion Site, respectively. Warning messages are posted when a model is first loaded in 7.2.

5. Object Dialogs

5.1 Object Viewer

The **Object Viewer** now persists within a RiverWare session. You can close the **Object Viewer**, and when you re-open it, the objects will still be there. Use the **Object Viewer** button in the lower right of the workspace to re-show the viewer.



In addition, closing an Open Object dialog or the Object Viewer no longer also closes member Slot dialogs but instead gives you the option to close the slots.

More information, see **HERE (ObjectDialogs.pdf, Section 1)**.

5.2 Custom Slots on Element Objects

You can now add custom slots on to an element of an aggregate object. For example, you can create an expression slot on a Reach element of an Aggregate Reach object.

6. Optimization

6.1 Summation Satisfaction Scaling - Numerical Stability Improvement

For Summation derived objectives, the internal scaling was improved for satisfaction variables, reward variables (if using a Reward Table), and objective function coefficients. This results in better freezing of constraints by reducing the number of constraints with dual prices close to the freezing tolerance and improves numeric stability. In some models, this corrects cases of infeasible solutions and reduces solution time. In some optimization models, this could contribute to different results due to a different set of constraints getting frozen.

6.2 Single Derived Objective per Goal

Previously, you were not prevented from including multiple derived objectives (Soft Constraint Sets) in a single goal; however, when this was the case, the resulting derived objectives could have unexpected behavior, and the solution could be incorrect. Now each priority is limited to solving only a single derived objective. If it tries to solve a second derived objective at the same priority, the run will abort with an error message. Any models that currently solve multiple derived objectives in the same goal should be revised so that each derived objective is in its own goal.

6.3 Incompatible Units in Constraints and Objectives

Previously, it was possible to write constraints or objectives with incompatible unit types, and they were not flagged as an error. For example, comparing units of Flow and Volume:

```
ADD CONSTRAINT Res.Outflow[t] <= 100 Acre-Feet
```

This has been corrected by adding a check when the constraint or objective is evaluated (fix to Issue #5906). Now when such cases are encountered, the run will abort with an appropriate error message about incompatible units. This will affect existing models if they currently include constraints or objectives with incompatible units. These constraints and objectives should be corrected to use the appropriate units.

6.4 New Message for Skipped Goals

In some cases a goal is effectively skipped (does not solve the optimization problem) because all constraints that would be added by the goal shrink to constraints that are already frozen. Now in these cases, a new green diagnostic message will be issued stating that this has occurred (fix to Issue #5196).

6.5 Simplified Objective for Seed-postponed Problem

When using a seed to skip the solution of initial goals, the first problem solved involves all of the constraints that were skipped and previously used an objective that was the weighted sum of all of the individual goal objectives. For reasons of numerical stability, the objective now uses equal weighting for all of the individual goal objectives (i.e. a weight of 1.0 for all goals). With this change, two Optimization parameters in the Seed Parameters category were removed because they are no longer used:

- POSTPONED PROBLEM OBJECTIVE METHOD
- SEED MAX OBJECTIVE WEIGHT

Existing models that contain a non-default value for one of these parameters will issue a warning message when they are loaded in 7.2. The parameters will be removed from the model once it is saved in 7.2.

6.6 POSAT Display Improved

In the Priority-oriented Optimization Solution Analysis Tool (POSAT), the three different categories of frozen constraints (New Constraints, Prior Constraints, Physical Constraints) are now displayed on separate tabs in order to make it easier to view lists of multiple frozen constraints. Previously they were three panels on the same tab. See **HERE (Optimization.pdf, Section 7.1)**.

6.7 Save CPLEX Problems Selectively

Previously if you wanted to save the CPLEX problems or CPLEX minimax subproblems from an Optimization run, you had to select that option in Optimization Run Parameters before the start of the run, and the problems for all priorities were saved. This could slow down the run significantly. Now the Save CPLEX Problems parameters are available during the run (this fixes Issue #933), which makes it possible to selectively save CPLEX problems and thus reduce the time required. For example, to see the problems associated with only a single goal, you could start a run, pause before the goal of interest, check the box to Save CPLEX Problems, continue and execute the goal, then pause and uncheck the box and continue the run.

7. Output Devices

7.1 Model Reports - Slot Selections Support Wildcards

Model Reports provide a way to export information about a RiverWare model or run results to an HTML file. See **HERE (Output.pdf, Section 4)** for information about this report item.

Many of the items that allow selection of objects, slots, or accounts were modified to allow wild-carding within the selection.

The following model report item types were modified:

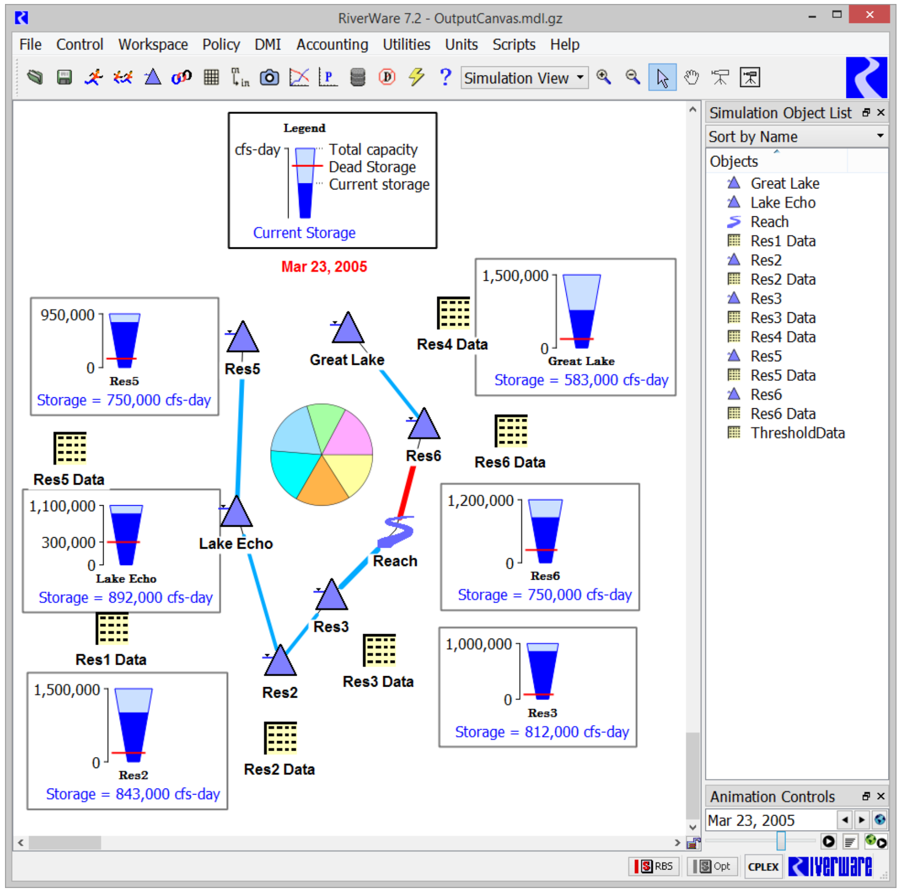
- Slot Value Table
- Account Table
- Supply Table

This change only impacts editing of new script actions and new model report items; the behavior of existing model report items is unaffected.

7.2 Output Canvas - Flow Lines and Canvas Lines Shown on Workspace

The Output Canvas, described in **Output.pdf, Section 6**, allows for visualization of outputs in spatially distributed teacups and flow lines. The following improvements have been added to the Output Canvas:

In RiverWare 7.1, settings were added to the Output Canvas to optionally show teacups, charts, and text on the geospatial and simulation views. In 7.2, now you can also see Canvas Lines and Flow Lines on the workspace views.



Models previously saved that displayed output canvas items on the workspace may look different when opened. Now, the workspace will automatically display Canvas Lines and Flow Lines from that canvas as well.

For more information, click **HERE (Output.pdf, Section 6.7)**.

7.3 RDF Files - Improved Performance

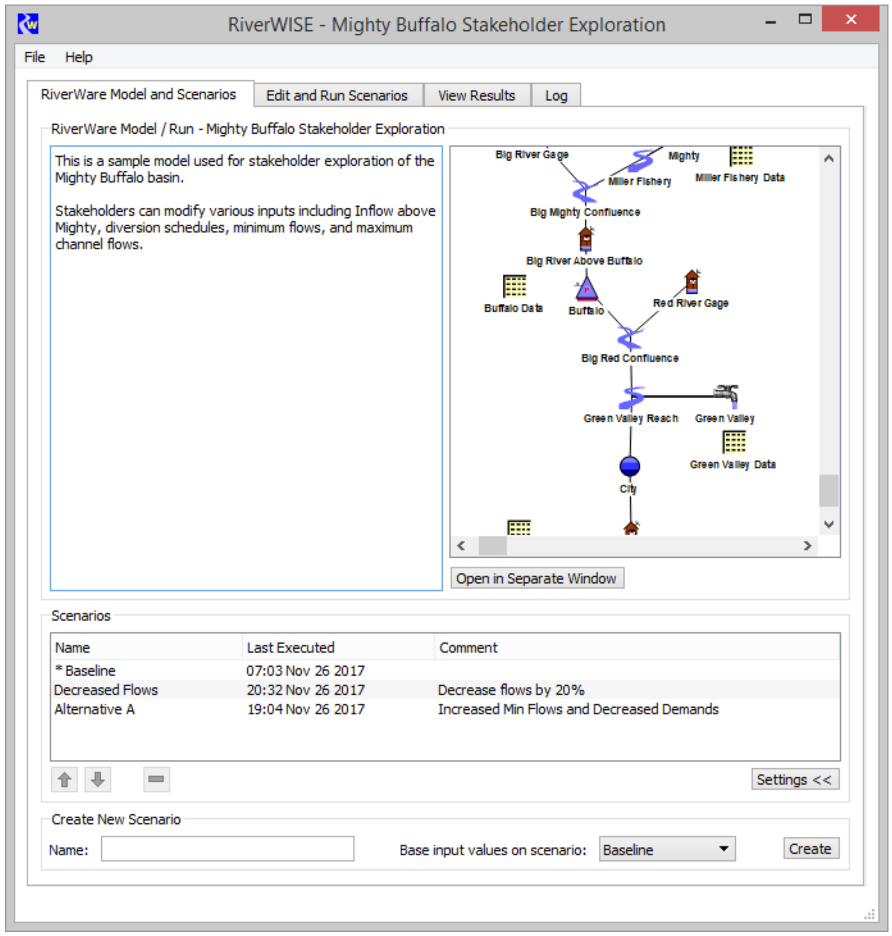
Performance was improved when writing RDF output through MRM outputs, RDF File Output devices, and Excel Output devices. There is a reasonable improvement when writing to a local disk and a significant improvement when writing to network locations.

8. RiverWISE

A new application called the **RiverWare Interactive Scenario Explorer** (**RiverWISE**) is now available. **RiverWISE** will allow stakeholders to view an exported version of a RiverWare model and to explore alternative scenarios within constraints specified by the model developer. Documentation is available **HERE (RiverWISE.pdf, Section 1)**.

RiverWISE

A typical scenario exploration process consists of activities involving a **model developer** and a **stakeholder**. The process begins within RiverWare, with a model developer exporting a RiverWISE file that contains a model description, results from a baseline run of that model, a list of the slots whose values will be visible from within RiverWISE, and a list of the slots whose values can be changed from within RiverWISE. The developer provides the RiverWISE file to a stakeholder.



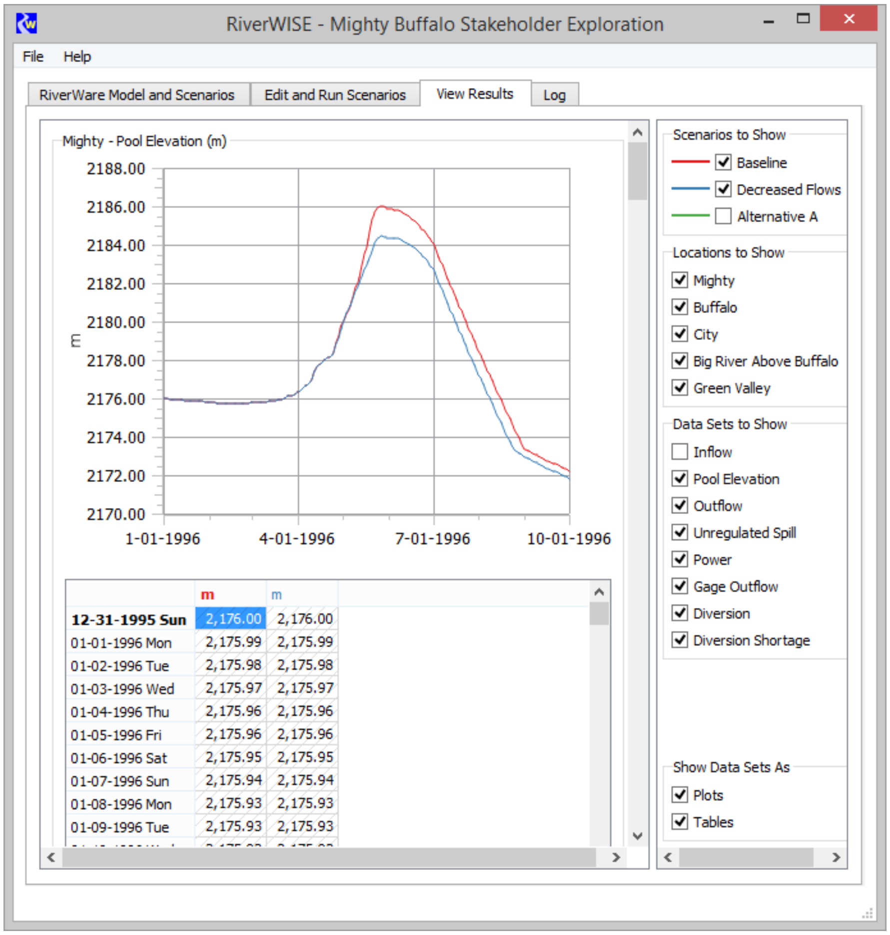
RiverWISE: "RiverWare Model and Scenario" tab showing a description and layout of the model and list of scenarios.

The stakeholder must download and install RiverWISE and obtain a free RiverWISE license, which is available on the RiverWare.org website (site coming soon). Once the stakeholder has opened the RiverWISE file, she can

- view baseline run data
- change input slot values
- re-run the simulation
- compare scenario results
- export results
- save scenarios

The stakeholder could then provide the developer with feedback on the baseline model including the scenarios she developed.

Following is a screenshot of the results tab showing results for two scenarios:



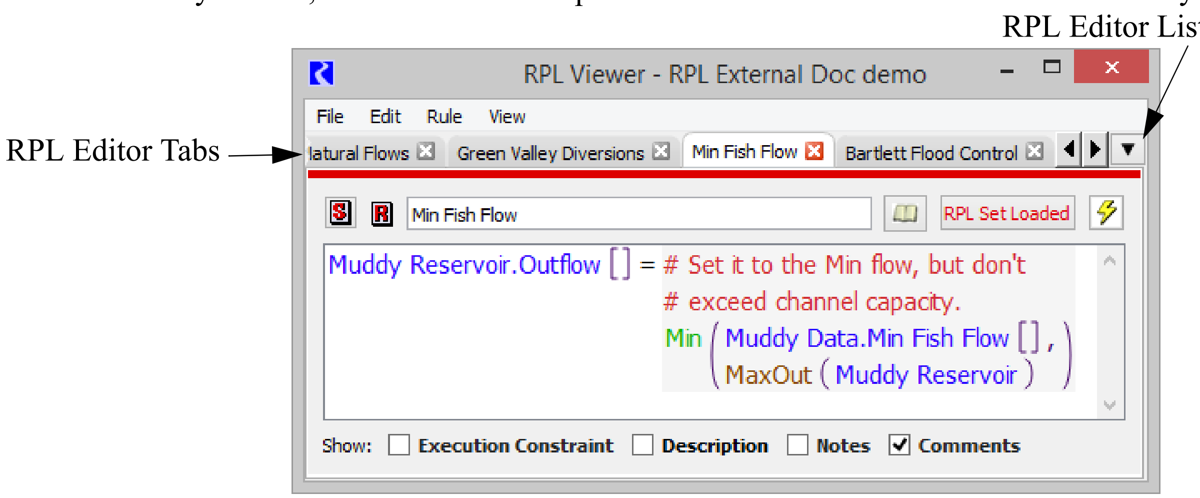
RiverWISE: “View Results” tab showing modeled results for multiple scenarios.

RiverWISE

9. RPL

9.1 RPL Viewer

A new tabbed RPL Viewer, has been created for editing Rules, Goals, Methods, and Functions. By default, these RPL editors open as tabs in the Viewer but can be removed by



dragging the tab off the Viewer. Dock the dialogs by dragging the R, G, M, or F icon onto the viewer. For more information, click **HERE (RPLUserInterface.pdf, Section 2.1)**.

9.2 New RPL Predefined Function: ListSlotSet

The new **ListSlotSet** function evaluates to a list of the slots in a given Slot Set. Slot Sets are described **HERE (Section 15.2)**.

For more information on this function, click **HERE (RPLPredefinedFunctions.pdf, Section 110)**.

9.3 Rule Execution of DMIs

When adding a Pre-execution or Post-execution DMI to a rule, you can now select the DMI from a menu that lists all of the DMIs available in the model. Previously you had to type in the name of the DMI. For more information, click **HERE (RPLUserInterface.pdf, Section 2.2.5)**.

9.4 CompletePartialDate with Offset

Previously, the **CompletePartialDate** RPL Predefined Function could return an incorrect value when the reference date had an offset. For example:

CompletePartialDate(@“October 1”, @“t + 1 year”)

This problem (Issue #6038) has been corrected, but the change could lead to model differences in models that use an offset within the **CompletePartialDate** function.

10. Run Control

10.1 Aggregate Inputs During Timestep Size Change

When you change the run control to a certain larger timestep (e.g. daily to monthly), you have the option to aggregate input slot values. Additional options are now provided on how to deal with NaNs and Output values. For more information, click **HERE (RunControl.pdf, Section 7.1)**.

11. Scenario Manager

With the introduction of **RiverWISE**, described **HERE (Section 8)**, the **Scenario Manager** has been deprecated. The **Scenario Manager**, described **HERE (ScenarioManager.pdf, Section 1)**, is still fully supported in RiverWare 7.2, but may be disabled in RiverWare 7.3 or later. If you use the Scenario Manager, please contact RiverWare-Support@colorado.edu with any questions.

12. Script Management

12.1 New Action: Global Time Scroll

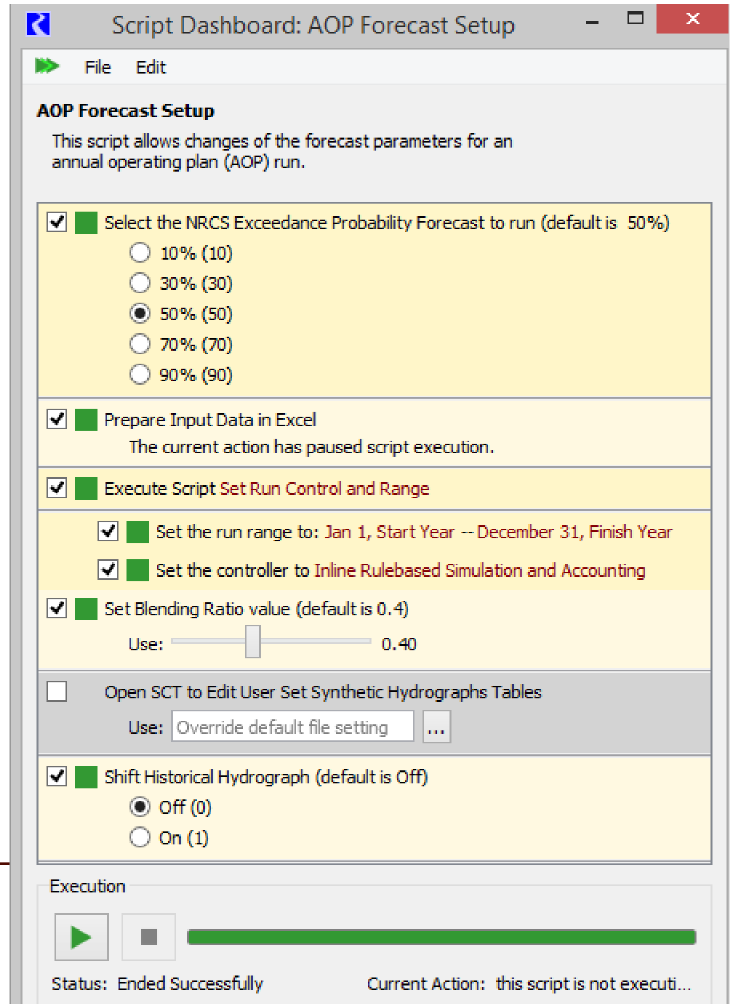
A new **Global Time Scroll** script action was added to set the date at which all time displays are scrolled. The setting allows a specified timestep or a symbolic DateTime. More information is available **HERE (ScriptManagement.pdf, Section 3.3.18)**.

12.2 Progress Indicators and Display of Actions

To make script execution more informative, the Script Dashboard has been enhanced to provide visual indicators of the currently executing action and the result of the action. .

In addition, sub-script actions (using the **Execute Script** action) are displayed indented under the calling script action. Progress indicators for subscript actions are the same as top level.

More information on the dashboard is provided **HERE (ScriptManagement.pdf, Section 4)**



12.3 Slot Selections support wildcards

Many of the items that allow selection of objects, slots, or accounts were modified to allow wildcarding within the selection.
The following script action types were modified:

Clear Scalar Slot Value	Set Method
Clear Table Slot Value	Set Scalar Slot Value
Create Snapshot	Set Series Slot Flags
Evaluate Expression Slots	Set Series Slot Values
Open Objects	Set Table Slot Value
Open Slots	Synchronize Objects

This change only impacts new script actions; the behavior of existing script actions is unaffected.

13. SCT

13.1 Edit Text Series Slots

Text Series Slots were introduced in RiverWare 7.1. Now, they are fully editable from the SCT, including the setting of a multiple cell selection either by typing or entering text in the editor at the top of the SCT.

13.2 Set Slot Labels

In the SCT's **Edit Series Slot List** tab, you can now set the labels for multiple slots in one operation. Right click on a selection and choose to **Set Labels to**:

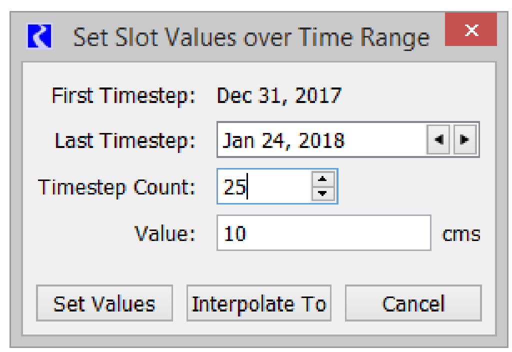
- **Full Slot Names**
- **Slot Names**
- **Slot Column Names**
- **Slot and Column Names**

Click **HERE (SCT.pdf, Section 8.10)** for more information.

13.3 Set Values over Time Range

A new operation on the SCT, **Set Values over Time Range** allows you to specify values on many timesteps at once.

- Set all the timesteps in that range to a specified value, or
- Interpolate the values over that time range to that specified value.

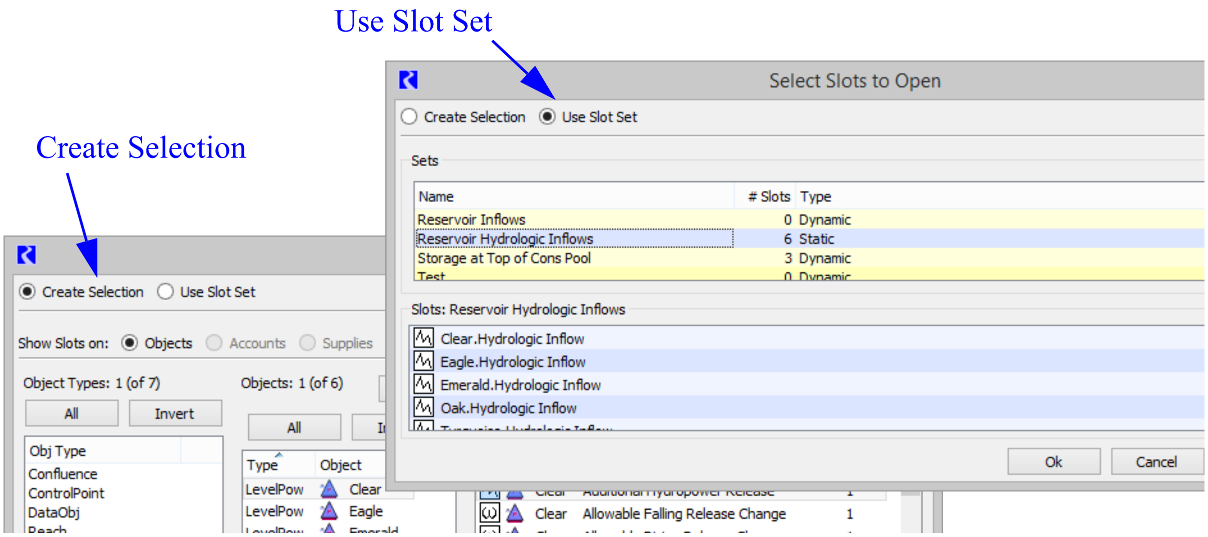


Click **HERE (SCT.pdf, Section 9.3)** for more information.

14. Selector

14.1 Accessing Slot Sets

The selector has been modified to allow you to use a defined Slot Set. The new Slot Set functionality is described **HERE (Section 15.2)**. The selector now has options at the top to either **Create Selection** or **Use Slot Set**

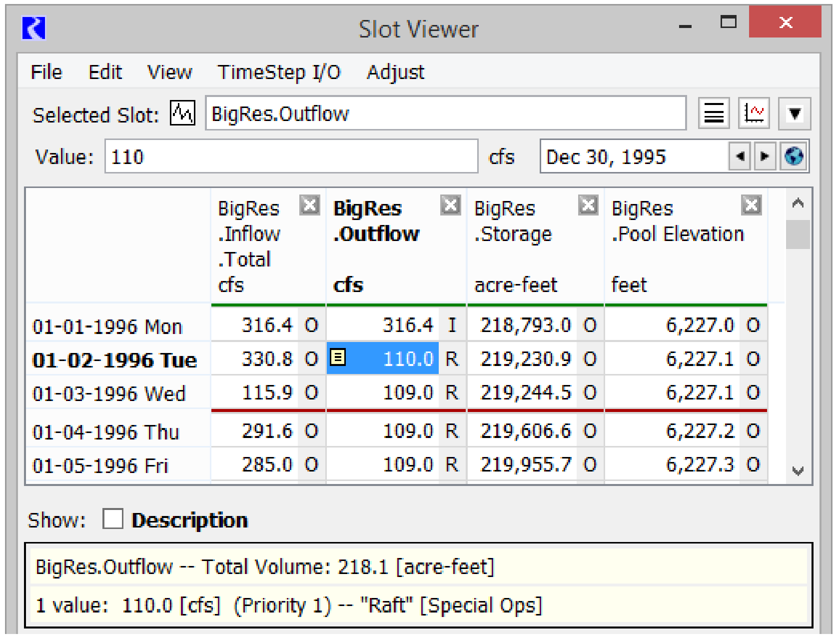


The use of the selector with Slot Sets is described **HERE (Slots.pdf, Section 8.2.1)**.

15. Slots

15.1 Slot Viewer

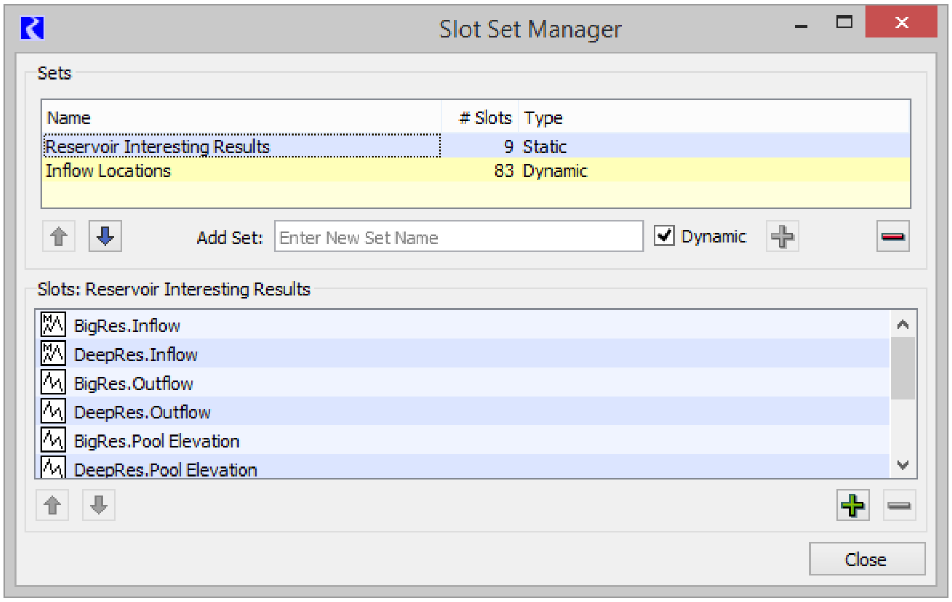
The **Slot Viewer** is now the primary way to look at series slots. It is an ad-hoc tool to view multiple series slots in a single dialog. The slots shown and their order is not persistent in any way on the viewer. Each time a series slot is opened from anywhere in RiverWare, it is added as a column to the **Slot Viewer**. From the **Slot Viewer**, any slot can be "torn off" or dragged off to be shown as an individual **Slot** dialog.



For more information, click **HERE (Slots.pdf, Section 4.1.2)**.

15.2 Slot Sets

A new utility called **Slot Sets** can be used to define and name a static or dynamic collection of slots. The named **Slot Set** can then be referenced in contexts that require a user-specified set of slots, such as Script actions, DMIs, and Output Devices. **Slot Sets** can eliminate duplication and ensures consistency across the multiple uses. Within RPL, **Slot Sets** provide a re-usable collection of slots that can be referenced by the new RPL function **ListSlotSet**, described **HERE (Section 9.2)**. For more information on **Slot Sets**, click **HERE (Slots.pdf, Section 8)**.



15.3 Expression Slot - Symbolic Date Ranges

A new time series range configuration dialog has been introduced for **Series Slots with Expression**. This new dialog provides the following ways to specify the start and finish dates including:

- Symbolic date functionality
- Selection of RPL Datetime function
- Static Datetime entry.

Series Slots with Expressions saved prior to RiverWare 7.2 that were synced with the run start or the initial date will be transformed to use the syntax “Start Timestep” and “Start Timestep - 1 Timestep”, respectively. Expression slots with no specified start dates will be transformed to a symbolic start date of “Start Timestep”.

More information is available **HERE (Slots.pdf, p49)**.

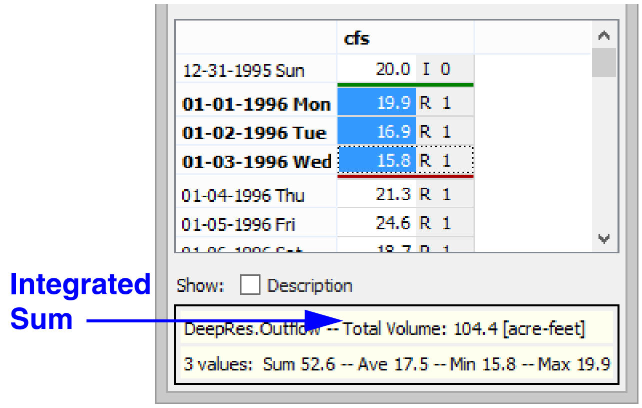
15.4 Series Slot Notes on Accounting Slots

When adding or pasting a series timestep note to an account multislot, you are given the option of instead applying the note to a linked Supply. This is often the intended behavior so that the note appears on the two account multi-slots on both sides of the Supply.

15.5 Selection Statistics: Sum Flows to Volume

The numeric statistics shown on slot dialogs and SCTs now show a time-integrated sum for slots having “rate” units (i.e. Flow to Volume, Power to Energy, Velocity to Length.

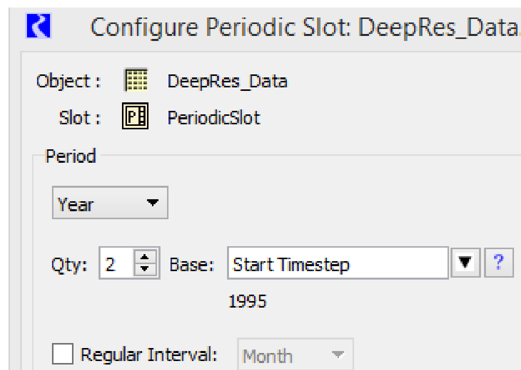
The total value is shown using the active unit scheme's scale and unit for the time-integrated unit type (i.e. Volume, Energy or Length).



15.6 Periodic Slot - Base Year Symbolic Dates

Periodic Slots now support a symbolically specified base year, as shown in the screenshot:

More information is available **HERE (Slots.pdf, Section 4.12.1)**.



15.7 Time Aggregation Series Slot: NaN Behavior

Time Aggregation Series Slots allow you to temporally aggregate another series slot. Options were added on how to deal with NaN values in the input slot data. Now you can choose to not aggregate periods that are partially NaN. For more information, see **HERE (Slots.pdf, Section 4.7.1)**.

15.8 3D Table Interpolation

Within three dimensional table interpolation, the “convex hull” test was loosened. But if the test fails, it is now a fatal error. This could cause existing models to abort when previously they did not. If an abort occurs, modify your 3 dimensional table by editing or adding data points.

16. Units

16.1 New Unit Type: VolumePerEnergy

A new unit type, Volume Per Energy, was added. User units include, for example, m3/MWH (default), gal/GWH, ft3/KWH, cfs/MW.

16.2 New Flow and Volume Units

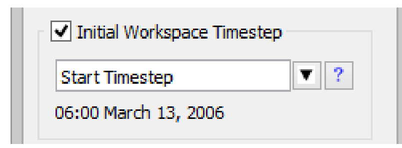
Three new units are now available:

- Flow: **MGD** (million gallons per day) was added. This is identical to **mgd** but a different capitalization.
- Flow: **gal/day** (gallons per day) was added.
- Volume: **MG** (million gallons) was added.

In addition, the conversion factors used for conversions to units involving gallons were made more precise.

17. Workspace

17.1 Initial Workspace Timestep



The **Initial Workspace Appearance** dialog now includes an **Initial Workspace Timestep** check box containing a symbolic datetime setting. If enabled, this static or symbolic time is used in these two ways:

- When the model is loaded, a **Global Time Scroll** to the datetime value is made.
- The drop down menu shown with time navigation datetime spinners includes the initial workspace timestep

This is described in detail **HERE (Workspace.pdf, Section 3.6)**.

17.2 Middle Button Pans Workspace

You can now use the middle mouse button to pan the workspace views. Middle-click and drag to pan in the Simulation, Accounting and Geospatial Views.

17.3 Showing Flow Lines and Canvas Lines on the Workspace

Flow Lines and Canvas Lines can be shown on the Simulation and Geospatial Views of the workspace. You create the lines on an Output Canvas and then specify that they should be shown on the workspace. This is described **HERE (Section 7.2)**.

18. Closed Bug Reports

The following bugs have been closed for this release. For more information on any bug, see the CADSWES website. The bugs are listed in order by bug number:

933	3067	3323	3618	3660	3713	3820
3962	4067	4233	4260	4267	4321	4328
4351	4464	4671	4889	5196	5203	5211
5236	5261	5309	5467	5520	5541	5631
5651	5652	5674	5699	5727	5735	5746
5749	5761	5781	5792	5806	5817	5820
5837	5841	5857	5866	5869	5879	5883
5887	5889	5894	5895	5898	5906	5907
5909	5910	5915	5918	5919	5920	5921
5928	5929	5932	5934	5936	5937	5949
5955	5964	5965	5966	5973	5977	5979
5980	5981	5982	5984	5985	5986	5987
5988	5989	5990	5991	5992	5993	5995
5996	5997	5998	5999	6000	6001	6002
6003	6004	6005	6006	6007	6008	6009
6010	6011	6012	6013	6014	6015	6016
6017	6019	6020	6021	6022	6023	6024
6025	6026	6028	6029	6030	6031	6032
6033	6034	6035	6036	6038	6039	6042
6047	6048	6049	6052	6053	6057	6059
6061	6062	6063				