

From field- to basin-scale:

Linking GIS analysis to administrative modeling in RiverWare for drought mitigation planning in the Colorado River Basin in Utah

Amber Spriggs

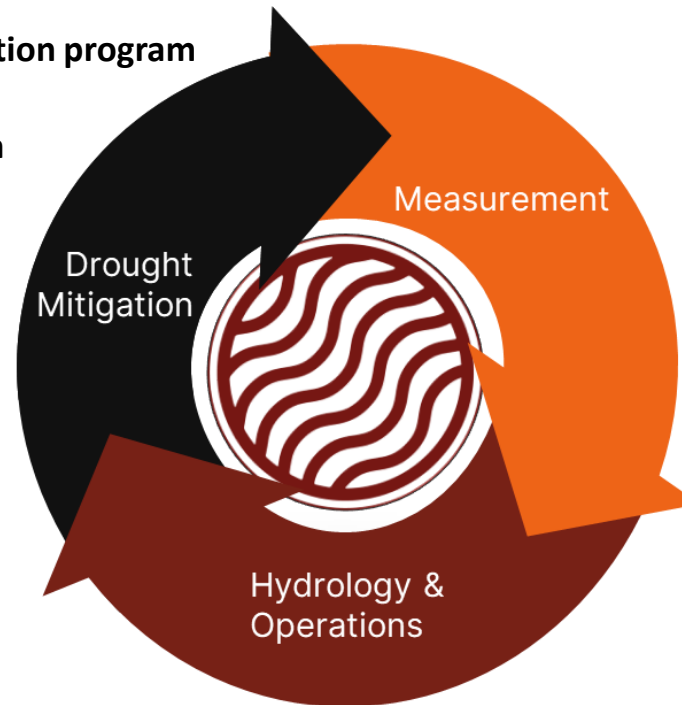
Precision Water Resources Engineering



The Colorado River Authority of Utah (CRAU)

CRAU's mission is to protect Utah's right to use waters from the Colorado River system.

- Irrigation water management education program
- Demand Management Pilot Program
- Drought mitigation planning model
- Agricultural research & irrigation efficiency studies



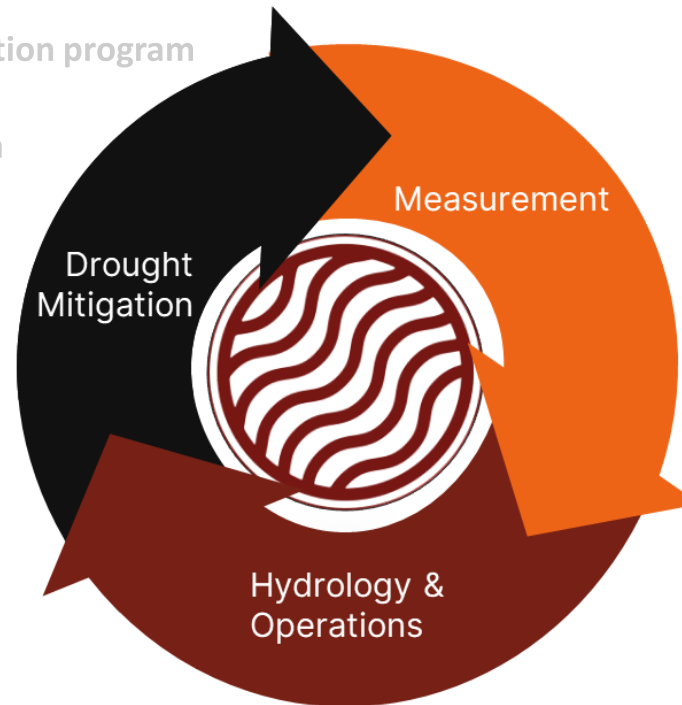
- **Evapotranspiration Measurement**
 - OpenET
 - Eddy Covariance stations
- Stream gaging
- Diversion Measurement and Telemetry Program

- Airborne Snow Observatories pilot project
- Short-, mid-, and long-term operations modeling
- Climate and hydrology research and instrumentation

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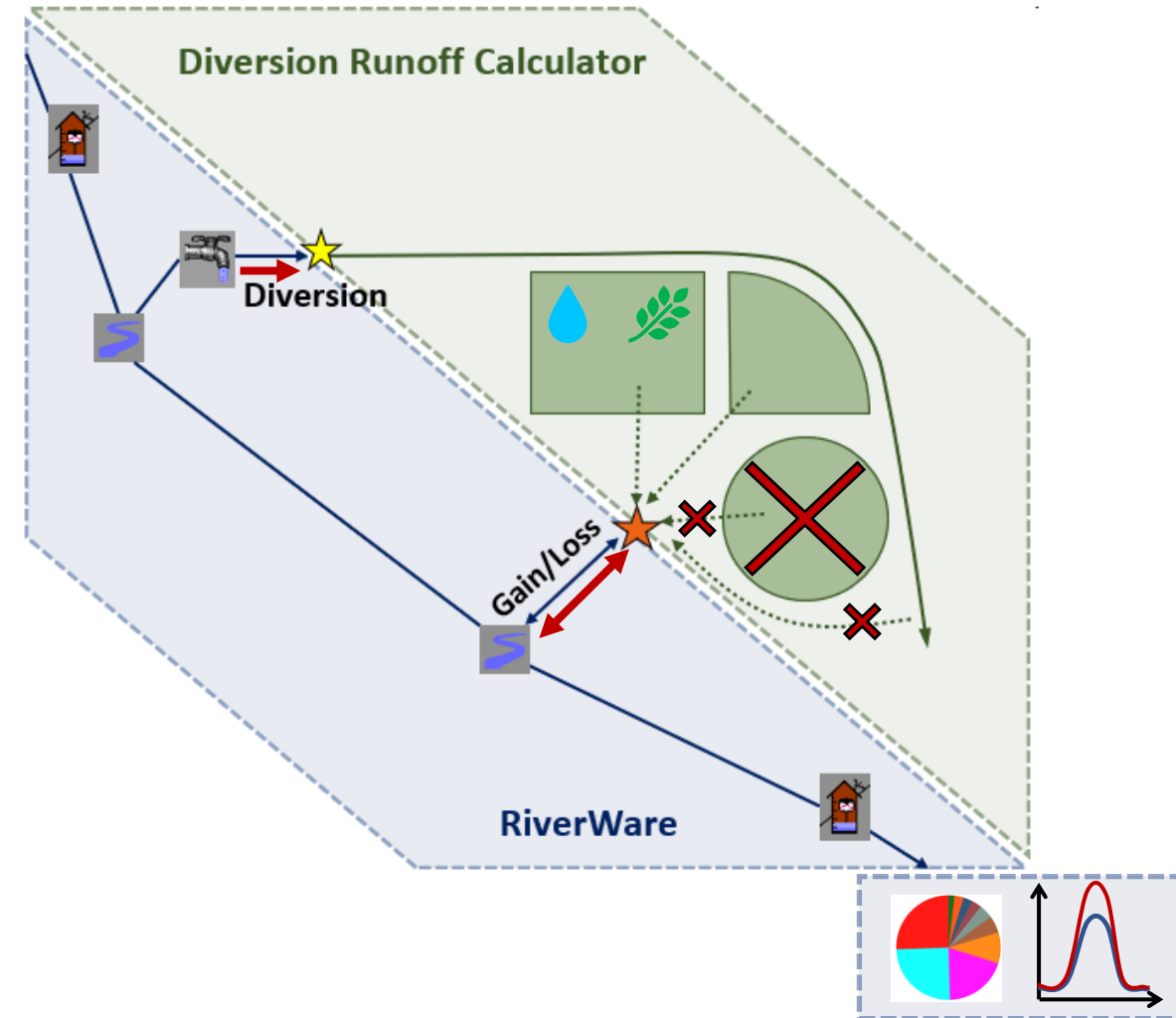


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The Utah-Colorado River Accounting and Forecasting Decision Support Tool (UCRAF-DST)

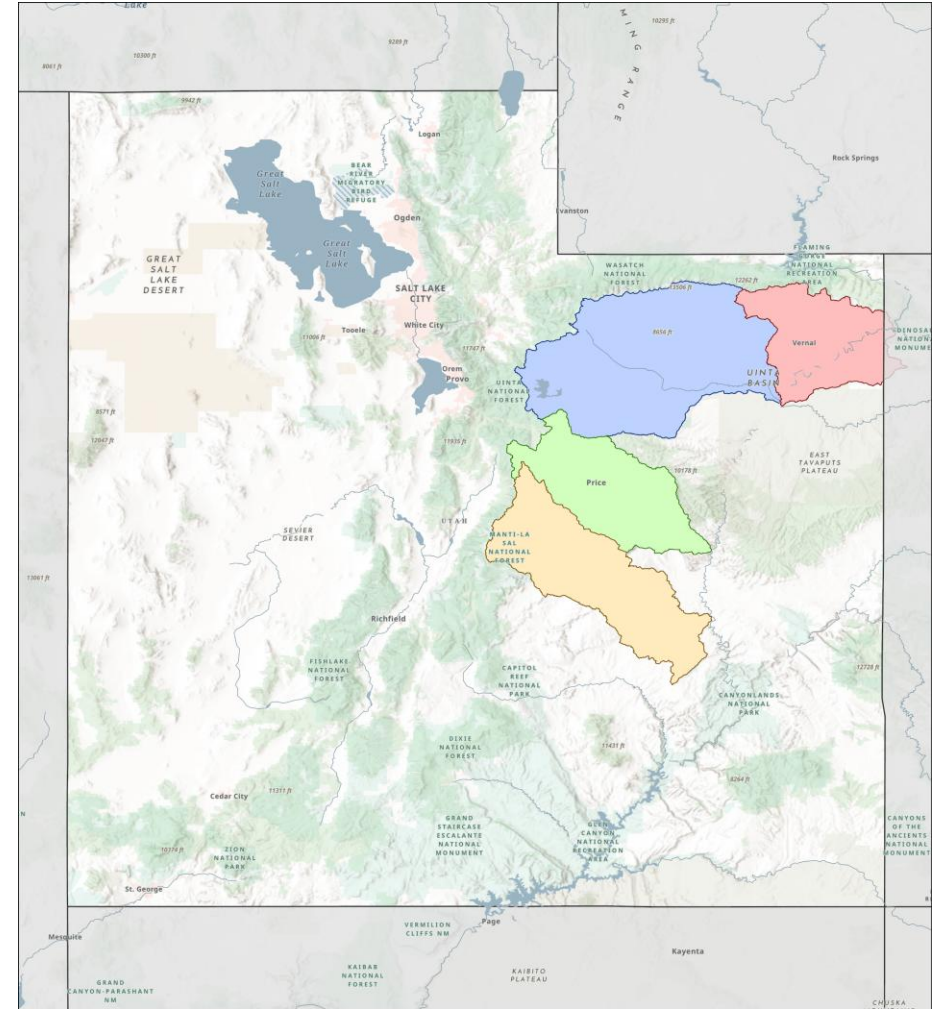
- The UCRAF-DST is a physically-based geospatial model (DRC) coupled with an administrative model (RiverWare).
- The tool is designed to help CRAU develop and compare small-scale projects and large-scale programs for drought mitigation, such as:
 - Changing crop type
 - Changing irrigation methods
 - Fallowing fields
 - Lining canals
- In RiverWare, these are realized as a change to diversion and return flow, then routed to estimate a change in basin outflow.



UCRAF-DST Project Status and Updates

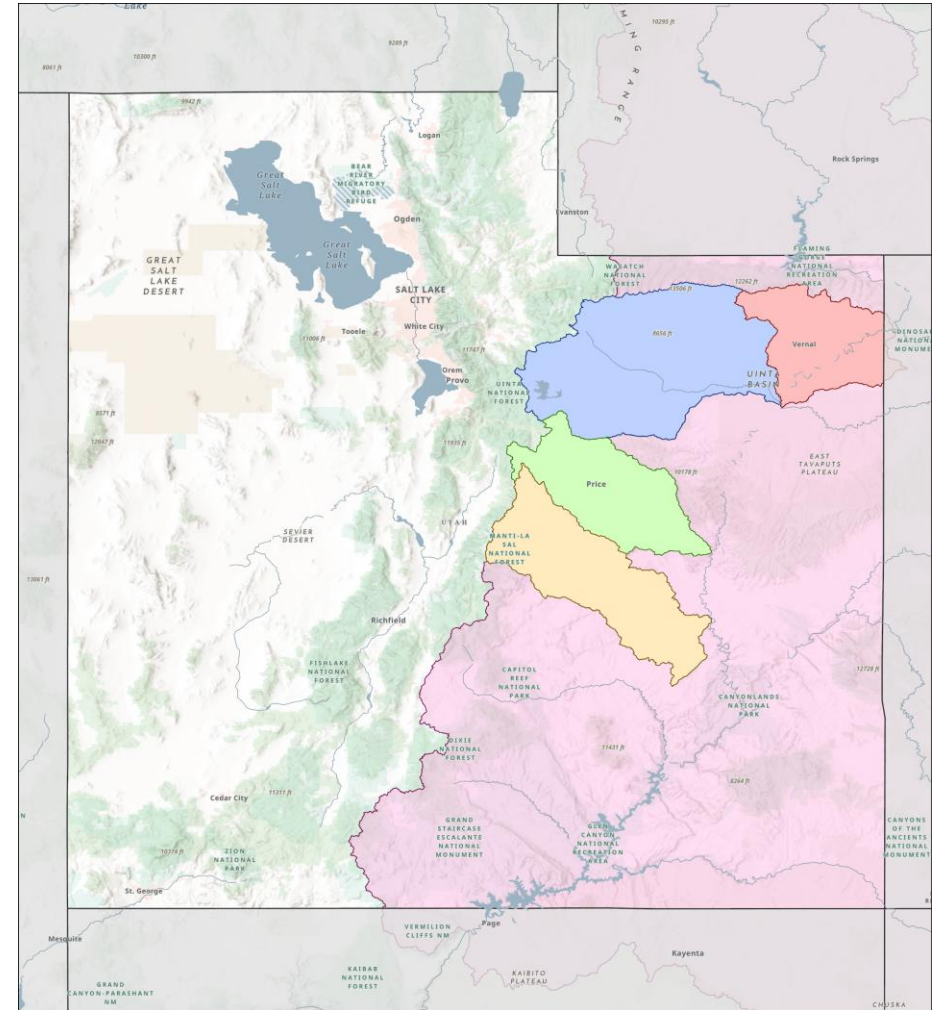
- At the 2025 RWUG Meeting, we shared updates on development across three subbasins (Duchesne, Price, and San Rafael) and discussed administrative nuances in each of these basins.

★ Since then, we have developed an additional subbasin administrative model for the Brush Creek and Ashley Creek systems.



UCRAF-DST Project Status and Updates

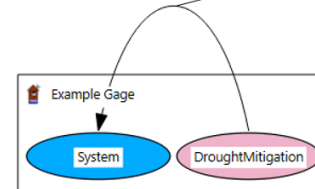
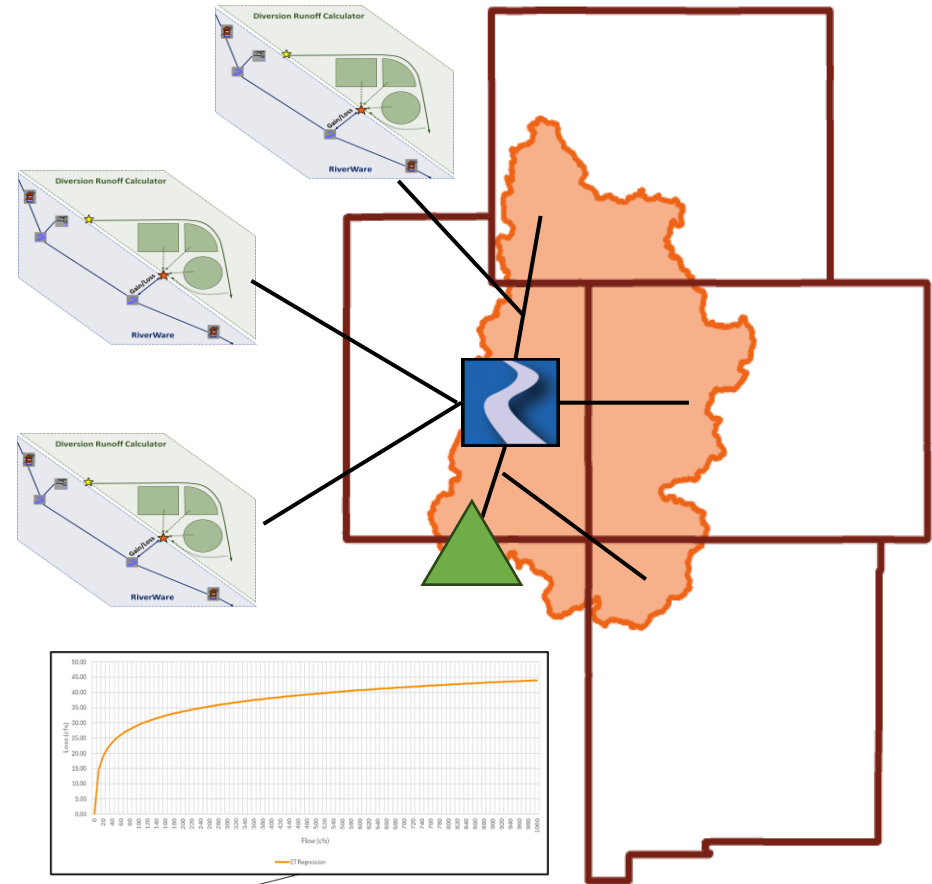
★ We have also developed a *Colorado Basin (CRB) Mainstem Model*, which accommodates Utah's CRB irrigated area outside of individual subbasin models.



UCRAF-DST Project Status and Updates

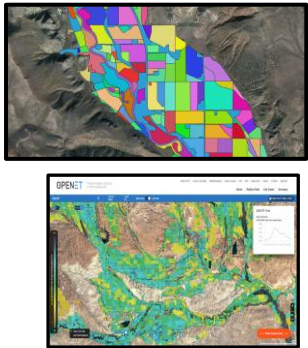
★ We have also developed a *Colorado Basin (CRB) Mainstem Model*, which accommodates Utah's CRB irrigated area outside of individual subbasin models.

- Combines subbasin model output with DRC output and tracks conserved water to Lake Powell.
- Includes a method for estimating and accounting for incremental transit loss associated with conservation water.
 - Uses a reach-specific flow & ET relationship.



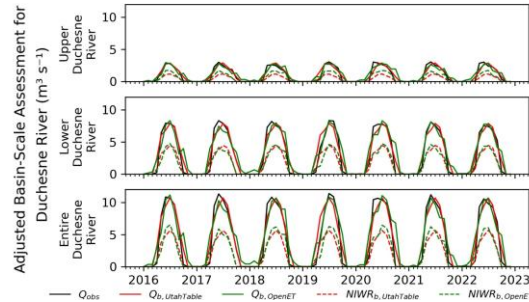
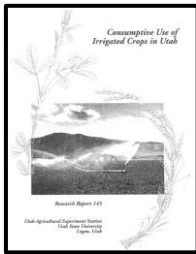
UCRAF-DST Project Status and Updates

Modeling System User-Interface

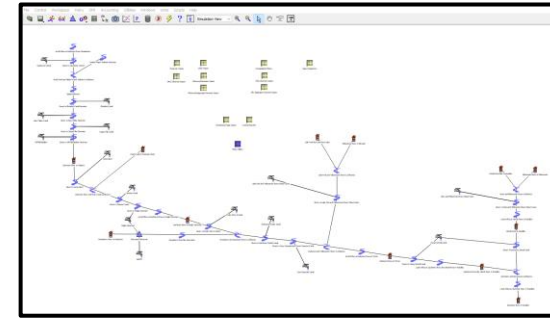


Diversion-Runoff Calculator (DRC)

1. Run Baseline Conditions
2. Evaluate Change Case

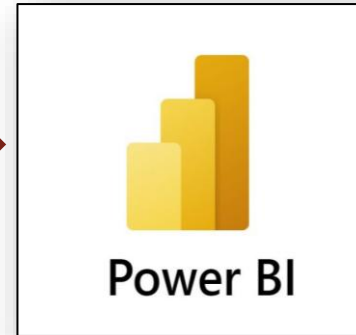


DRC Output



RiverWare©

1. Run Subbasin Model(s)
2. Run Mainstem Model



RiverWare Output

- The entire UCRAF-DST modeling workflow is scripted. The scripts can all be executed in via **custom ArcGIS Pro ArcToolbox**.
- These ArcTools need to be executed sequentially.

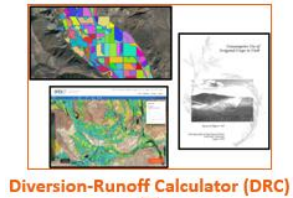
ArcGIS Pro Workspace

The screenshot displays the ArcGIS Pro interface with the following components:

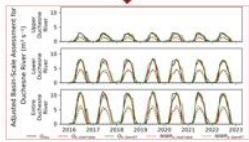
- Map View:** Shows a map of a region with labels like "Wellington", "Milling Creek", and "Marsing Wash". A red box highlights the "UCRAF.atbx" toolbox, which contains:
 - DRC Controller
 - 01 Populate Geodatabase
 - Run DRC (highlighted with a blue selection bar)
 - GIS Mapping Tool
 - Peripherals - DO NOT DELETE
 - RiverWare Controller
 - Terrain Processing
- Drawing Order Panel:** Located on the left, it shows a list of layers under the "WRLU_2023_RWUGDemo" map. The "LABEL" layer is expanded, showing various land use categories like ALF-F, ALF-S, ALF-W, etc.
- Catalog Panel:** Located on the right, it shows the project structure. The "UCRAF.atbx" file is highlighted in the "Toolboxes" section.
- Table View:** At the bottom, a table titled "WRLU_2023_RWUGDemo" displays data for 6 selected records. The table has columns: OBJECTID, Shape, Landuse, CropGroup, Descriptio, IRR_Method, Acres, LABEL, and State.

OBJECTID	Shape	Landuse	CropGroup	Descriptio	IRR_Method	Acres	LABEL	State
1	Polygon	Agricultural	Hay/Turf	Alfalfa	Flood	25.223828	ALF-F	Utah
2	Polygon	Agricultural	Hay/Turf	Alfalfa	Flood	0.9319	ALF-F	Utah
3	Polygon	Agricultural	Hay/Turf	Alfalfa	Flood	2.30446	ALF-F	Utah
4	Polygon	Agricultural	Hay/Turf	Alfalfa	Flood	1.277904	ALF-F	Utah
5	Polygon	Agricultural	Hay/Turf	Alfalfa	Flood	12.851661	ALF-F	Utah
6	Polygon	Agricultural	Hay/Turf	Alfalfa	Flood	3.984206	ALF-F	Utah

Step 1: Running the DRC



Diversion-Runoff Calculator (DRC)



DRC Output



RiverWare®



Power BI

RiverWare® Output

The screenshot shows the RiverWare® software interface. The main map displays the Wellington area with various land use categories. A data table is open, showing the following fields:

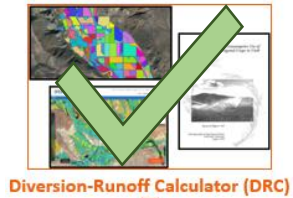
Field	Total_NIWR	NEAR_UTtable_FID	NEAR_DIST	Sta_Name	New_Desc	New_IRR_Me
1	43.46544	39	21272.646943	HIAWATHA	Alfalfa	Flood
2	38.032259	39	24472.516807	HIAWATHA	Alfalfa	Sprinkler
3	38.032259	39	25874.924394	HIAWATHA	Alfalfa	Sprinkler
4	38.032259	39	23107.859426	HIAWATHA	Alfalfa	Sprinkler
5	38.032259	39	15820.267213	HIAWATHA	Alfalfa	Sprinkler
6	38.032259	39	22497.13472	HIAWATHA	Alfalfa	Sprinkler

A dropdown menu is open, showing the following options:

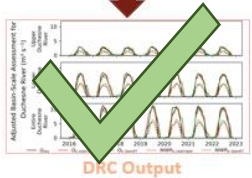
- DRYGHAY
- DRYALF
- DRYCORN
- DRYGRN
- DRYOAT
- DRYLAND
- BEAN-S
- BEAN-F
- HORT-S
- HORT-F
- VEG-S
- VEG-F
- Fallow/Idle
- SRGM-F
- SRGM-S
- DRYSRGM
- ALF-F
- ALF-S
- ALF-S
- ALF-S
- ALF-S
- ALF-S

Disclaimer: these fields are selected for demonstration purposes only. Results are not representative of any current or proposed programs in Utah.

Step 2: Running RiverWare



Diversion-Runoff Calculator (DRC)



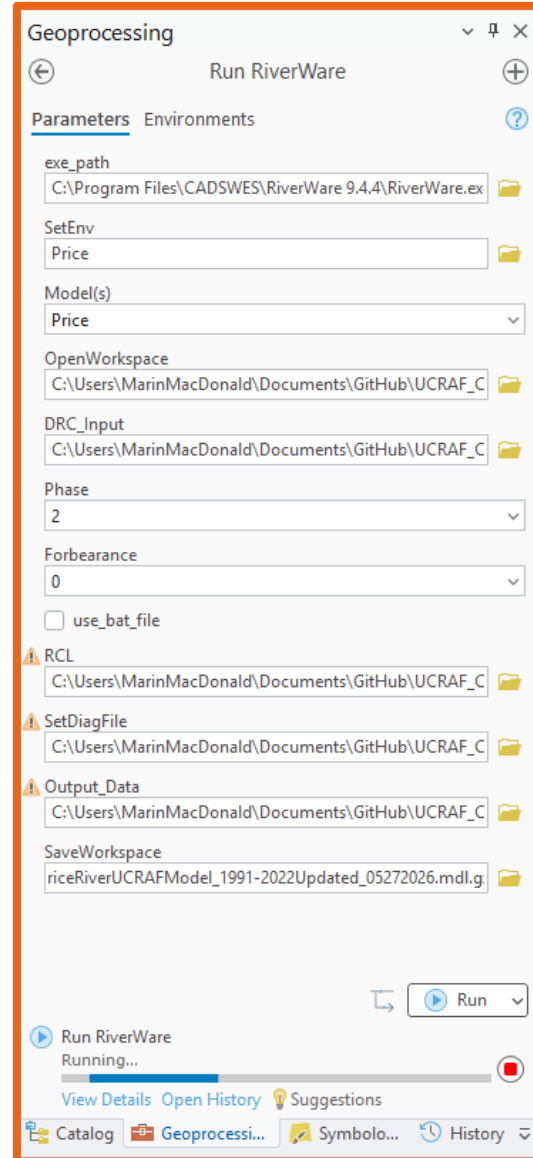
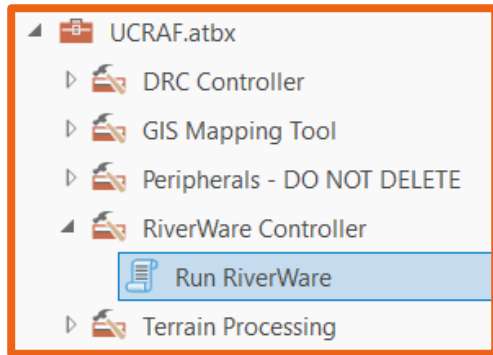
DRC Output



RiverWare®



RiverWare® Output



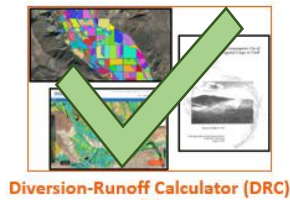
Run RiverWare:

1. Collects user inputs from tool dialog. This includes the DRC output data, which becomes RiverWare input.
2. Generates an RCL script for the user-specified model run.
3. Launches RiverWare headless in batch mode and streams run status back to ArcGIS Pro.

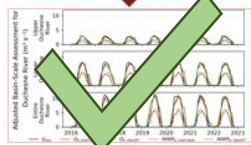
Step 3: Visualizing Outputs in PowerBI

Example Subbasin Model Results

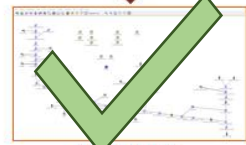
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Diversion-Runoff Calculator (DRC)



DRC Output

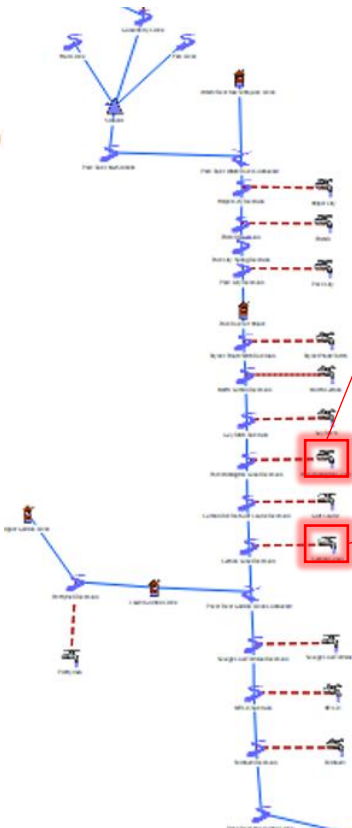


RiverWare®

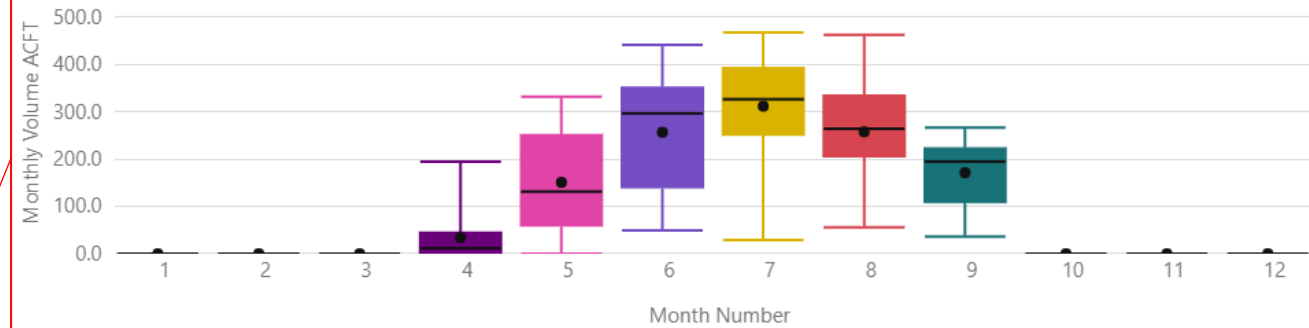


Power BI

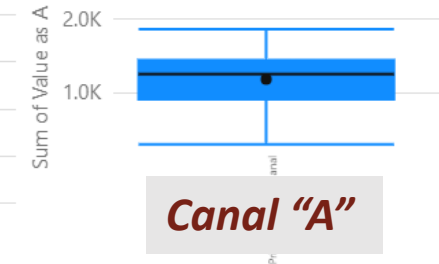
RiverWare® Output



TOTAL Monthly Volumes of Drought Mitigation Water From Natural, Project, and Losses

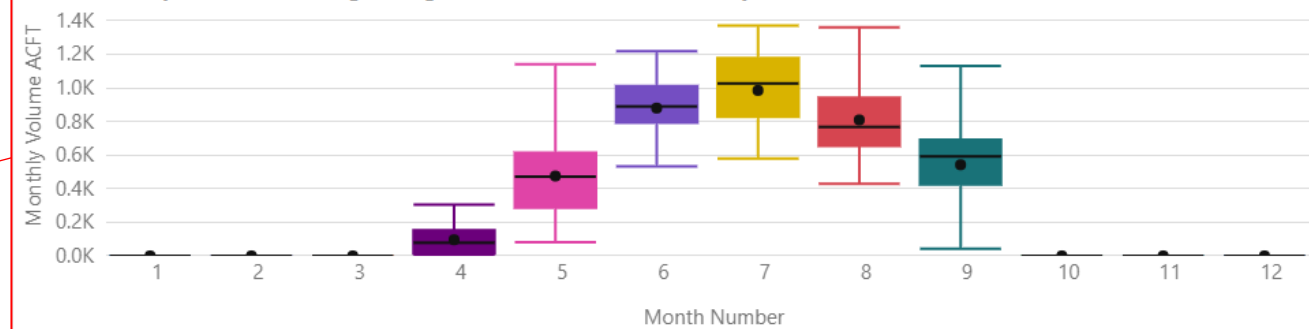


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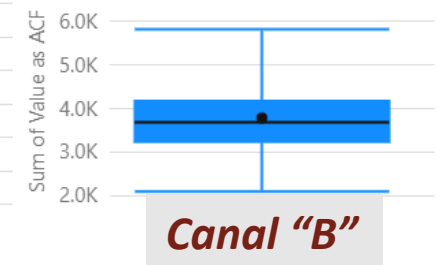


Canal "A"

TOTAL Monthly Volumes of Drought Mitigation Water From Natural, Project, and Losses

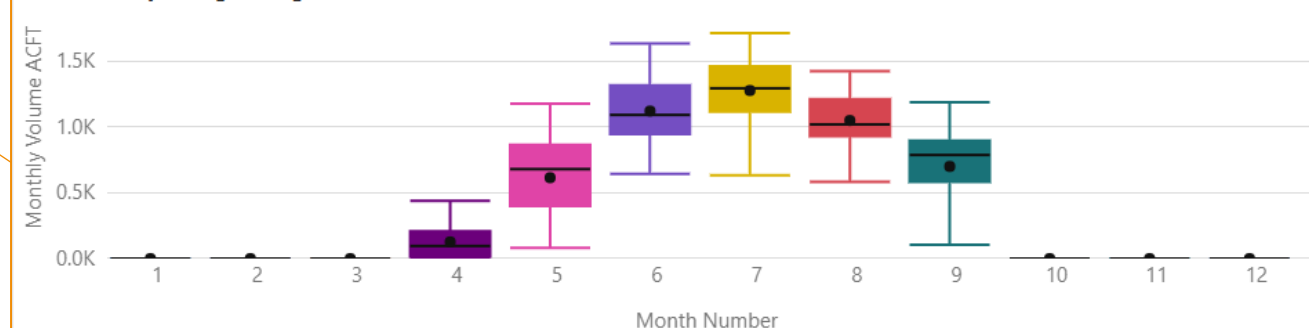


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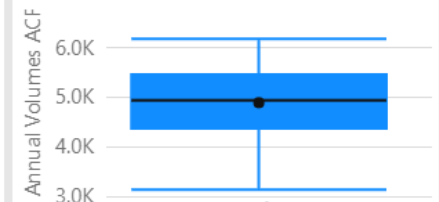


Canal "B"

Total Monthly Drought Mitigation Volumes



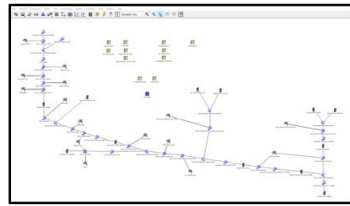
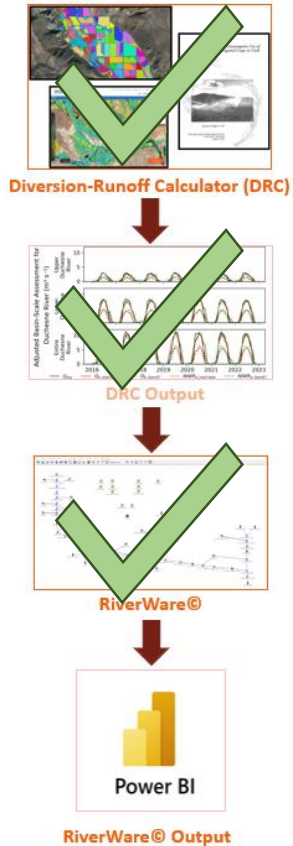
Total Annual Drought Mitigation Volumes



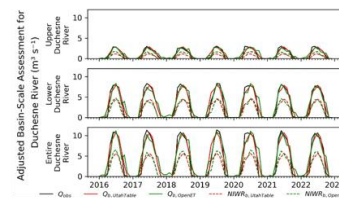
Downstream Gage

Step 3: Visualizing Outputs in PowerBI

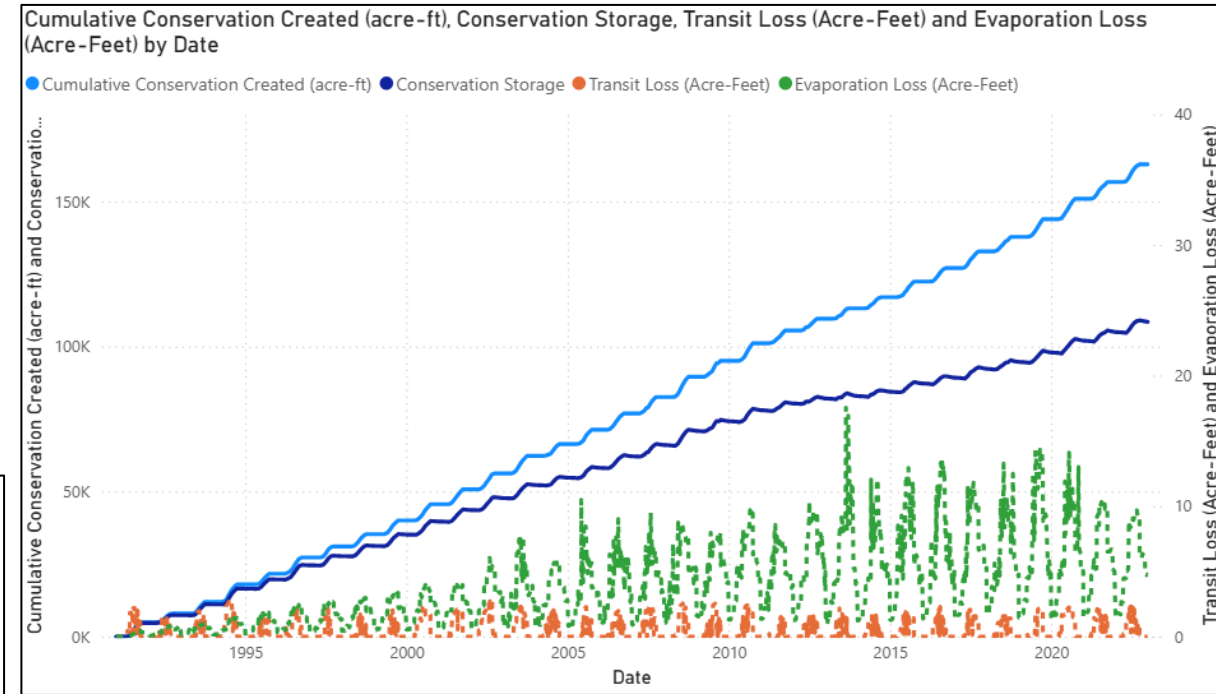
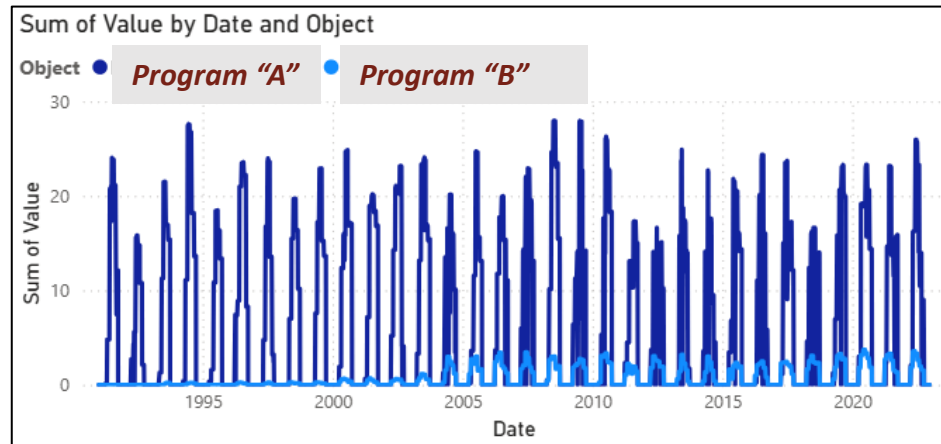
Example Mainstem Model Results



Price RiverWare® Model



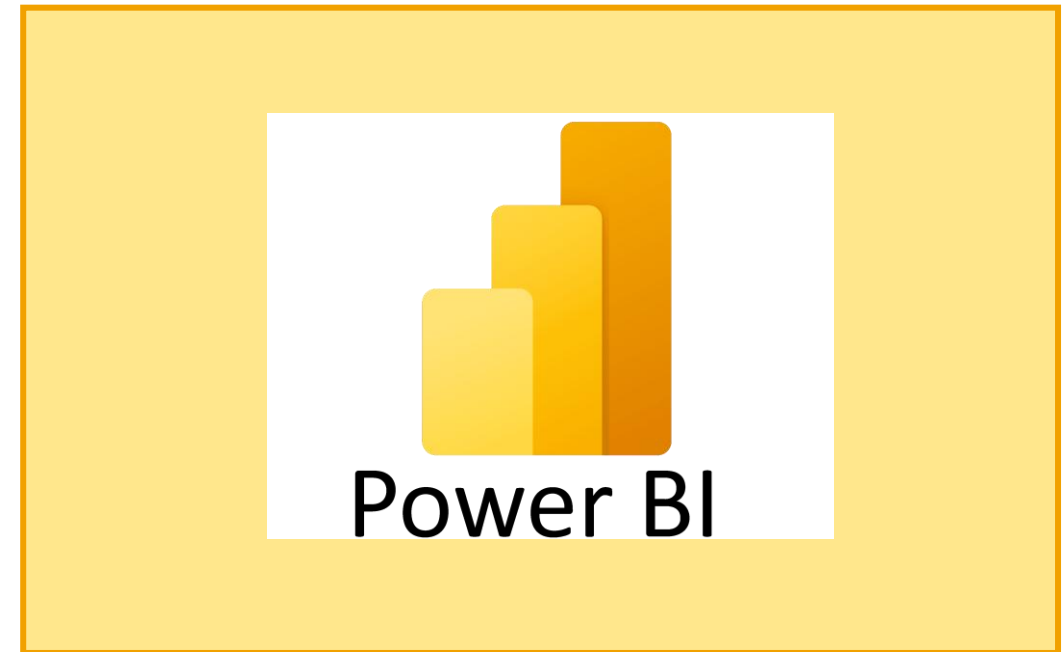
DRC Output



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Conclusions

- The interactive user interface for UCRAF-DST is built to match CRAU staff's existing workflows and software familiarity.
 - RiverWare's RCL scripting makes this possible: the model and the interface can be developed independently and adapted to client needs.





Many thanks to:

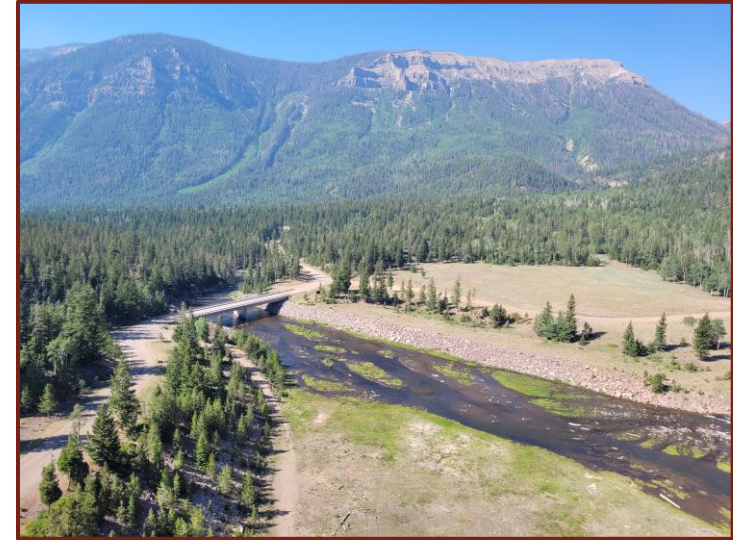
The Colorado River Authority of Utah

Utah Division of Water Rights

Emery Water Conservancy District

Uintah Water Conservancy District

Central Utah Water Conservancy District



PWRE Staff would be happy to discuss this project further. If you have any questions or comments, find us during a break or at Happy Hour!