



COLORADO'S
Decision Support Systems
CWCB / DWR

Arkansas River Decision Support System (ArkDSS) Update

Project Manager: Brian Macpherson, P.E., CWCB

Technical Lead: Kelley Thompson, P.E., DWR

Colors of Water PM: John Rogers, P.E., DWR

Critical Staff: DWR Division 2 Staff, OIT App Dev

ARCA Annual Meeting / Engineering Committee – December 6, 2023

ArkDSS Progress



- Phase I:
 - GIS ✓ cdss.colorado.gov/gis-data/division-2-arkansas
 - Admin Tools ✓ div2waterops.com
 - Modeling cdss.colorado.gov/arkansas-river-dss
 - Evapotranspiration Dataset ✓
 - Surface Water Model **95% Complete (final cal+documentation)**
 - Trinidad Project Scenario **Year 2024**
- Phase II:
 - Colors of Water Viewer and Scenario Planner **95% Complete**
 - Groundwater **PLANNING**

ArkDSS Surface Water Model (STATEMOD) 2023 Efforts:



- Refining data inputs
 - Ensuring that all appropriate irrigation pumping records in Hydrobase are associated with a well that is attached in the irrigated acres
 - Ensuring that ArkDSS pumping nearly matches H-I Model pumping
 - Ensuring that H-I model acreage and crop information appropriately used for years without GIS irrigated acreage snapshots
 - Associating wells with augmentation plans
- Natural flow estimation given refined data inputs
 - Estimates natural flows (baseflow) by removing effects of man (diversions, RFs, reservoirs, etc)
 - Additional methods developed to address losing tributary reaches
- Currently in final calibration of historical model
 - Compare simulated results from the model to measured data at streamflow gages, diversions, and reservoir contents
 - Adjust primarily return flows and operations to improve calibration
- Baseline dataset will be developed to use for “What-If” scenarios
- Final / Complete documentation of model
 - Baseline model and documentation completed before Trinidad Project Scenario

ArkDSS –Groundwater Component



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- **Scope / RFP still under development**
 - Phase I
 - Compile Existing Data for Physical Parameters
 - Develop GIS based grids based on compiled data
 - Map drain locations and conditions, etc.
 - Evaluate Futile Call Areas and Hydraulic Disconnects
 - Link Administrative Documents Spatially
 - Phase II
 - Fill Identified Data Gaps and Redevelop Aquifer Extents and Grids
 - Install monitoring wells, run aquifer tests, etc.
 - Awaiting CWCB staffing changes

ArkDSS Colors of Water Tool



Transit Loss / Timing Model Engine

- Routing – Muskingum type
- Transit Loss - bank storage, evaporation, capture rules
- Network – nodes and reaches
- Livingston framework and routing/aquifer parameters
 - parameters recalibrated using calibration tool

Hydrobase

- release, diversion, telemetry records
- model output
- Network locations
- web interactions

Web Tool

- Data Viewer
- Scenario Planner
- Conductor / Manager

ArkDSS Colors of Water Progress



COLORADO'S
Decision Support Systems
CWCB / DWR

- **Data Viewer Webtool Deployed**
 - Show colors of all water in river in front of nodes (ie headgates etc)
 - Missing current/real-time release records
- **Scenario Planner Developed and Deployed**
 - Reservoir releases - Evaluate transit loss and design diversions patterns
 - Currently in final testing and documentation
 - Anticipated for use for 2024 Water Year
 - Replace use of TLAP for releases to ditches above JMR (and to JMR)
 - New use for deliveries to ditches below John Martin Reservoir
 - Hoping to use for Kansas stateline deliveries
 - Exchanges – this “extra” (non-Grant) capability build but not yet for use
- **Bureau of Reclamation SmartWater Grant wrapping up**

Colors of Water – Viewer



Colors of Water (all values in CFS)

Export Help My Account

Display Hide

Upstream-Downstream

Structures

Location
Division 2: Arkansas

Water Source
Arkansas River [00078956]

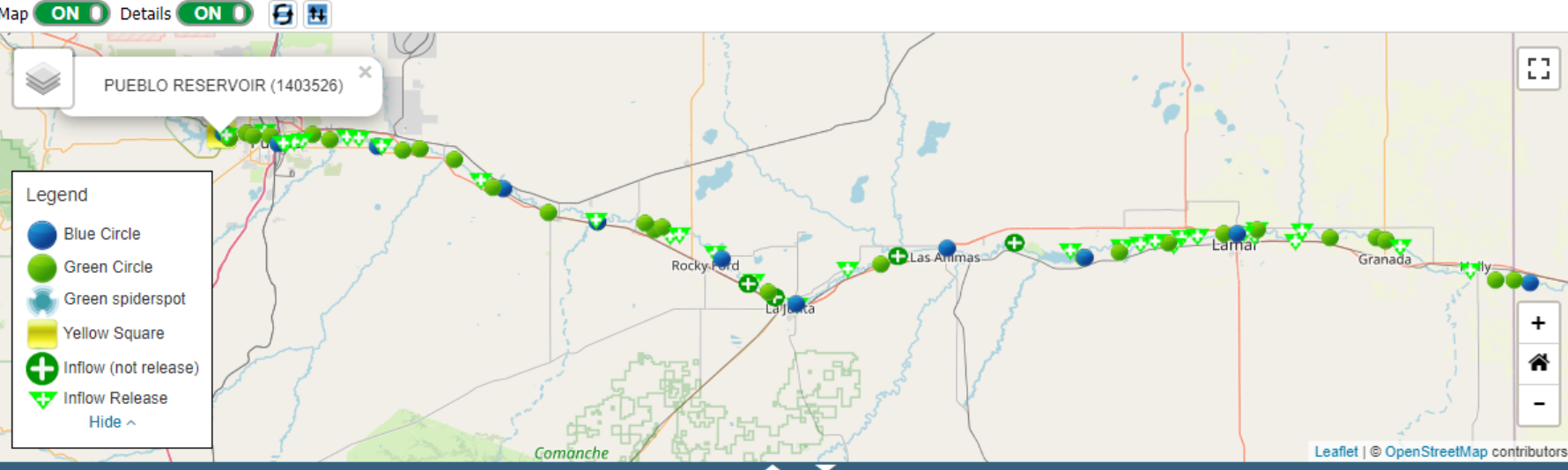
Upstream
PUEBLO RESERVOIR (1403526) mile 214.57

Downstream
ARKANSAS RIVER NEAR COOLIDGE, KS (6709510) mile 0

91 of 91 Structures Selected

| Structure | Water Source | Stream Mile |
|--|---------------------------|-------------|
| <input checked="" type="checkbox"/> PUEBLO RESERVOIR | Arkansas River [00078956] | 214.57 |
| <input checked="" type="checkbox"/> HAMP-BELL DITCH | Arkansas River [00078956] | 214.25 |
| <input checked="" type="checkbox"/> ARKANSAS RIVER ABOVE PUEBLO | Arkansas River [00078956] | 214.13 |
| <input checked="" type="checkbox"/> PUEBLO FISH HATCHERY OUTFLOW | Arkansas River [00078956] | 213.48 |
| <input checked="" type="checkbox"/> COMANCHE PUMP STATION | Arkansas River [00078956] | 212.92 |
| <input checked="" type="checkbox"/> PBWW NORTHSIDE INTAKE | Arkansas River [00078956] | 210.21 |
| <input checked="" type="checkbox"/> RIVERSIDE DAIRY DITCH | Arkansas River [00078956] | 209.36 |
| <input checked="" type="checkbox"/> PUEBLO WEST SEWAGE | Arkansas River | 208.51 |

Search



PUEBLO RESERVOIR (1403526) Arkansas River at mile 214.57

8/3/2021

Table Graph

Layout Default layout

| Structure Name | Stream Mile | Total Flow | Native Flow | Release Total |
|------------------------------|-------------|------------|-------------|---------------|
| PUEBLO RESERVOIR | 214.58 | 733.38 | 701.38 | 32 |
| HAMP-BELL DITCH | 214.25 | 1122 | 1059.33 | 63.33 |
| ARKANSAS RIVER ABOVE PUEBLO | 214.13 | 1122 | 1059.33 | 63.33 |
| PUEBLO FISH HATCHERY OUTFLOW | 213.48 | 1166.65 | 1104.22 | 63.16 |
| COMANCHE PUMP STATION | 212.92 | 1191.15 | 1128.94 | 63.14 |
| PBWW NORTHSIDE INTAKE | 210.21 | 1244.24 | 1184.05 | 62.39 |
| RIVERSIDE DAIRY DITCH | 209.36 | 1225.5 | 1126.38 | 62.03 |

100 items per page 1 - 82 of 82 items

Releases

| | |
|--|----|
| 1403526.217 S:2 F: U:Q T:7 G: To:1700557 Released 8/3/2021 | 10 |
| 1403526.241 S:2 F: U:Q T:7 G: To:1700542 Released 8/3/2021 | 22 |

Exchanges

| | |
|---|------|
| 1403526.006 S:2 F:1703525.154 U:0 T:1 G: To: Released 8/3/2021 | 5.09 |
| 1403526.176 S:1 F:1700800 U:0 T:1 G:1707700 To: Released 8/3/2021 | 1.05 |
| 1403526.237 S:8 F:1400662 U:0 T:1 G:1400662 To: Released 8/3/2021 | 0.96 |

Diversions

| | |
|--|------|
| STORAGE RECORD OF STRATMOOR FRY-ARK WATER TRACKED DOWN FOUNTAIN CREEK FOR STORAGE IN PUEBLO RES. | 0.17 |
| 1403526.234 S:8 F:1101200 U:0 T: G:1107015 To: Released | 0.08 |

Colors of Water – Spatial View



Colors of Water (all values in CFS)
Export Help My Account

Display Hide

Upstream-Downstream

Structures

Location
Division 2: Arkansas

Water Source
Arkansas River [00078956]

Upstream
PUEBLO RESERVOIR (1403526) mile 214.57

Downstream
ARKANSAS RIVER NEAR COOLIDGE, KS (6709510) mile 0

91 of 91 Structures Selected

| <input checked="" type="checkbox"/> | Structure | Water Source | Stream Mile |
|-------------------------------------|------------------------------|---------------------------|-------------|
| <input checked="" type="checkbox"/> | PUEBLO RESERVOIR | Arkansas River [00078956] | 214.57 |
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| <input checked="" type="checkbox"/> | ARKANSAS RIVER ABOVE PUEBLO | Arkansas River [00078956] | 214.13 |
| <input checked="" type="checkbox"/> | PUEBLO FISH HATCHERY OUTFLOW | Arkansas River [00078956] | 213.48 |
| <input checked="" type="checkbox"/> | COMANCHE PUMP STATION | Arkansas River [00078956] | 212.92 |
| <input checked="" type="checkbox"/> | PBWW NORTHSIDE INTAKE | Arkansas River [00078956] | 210.21 |
| <input checked="" type="checkbox"/> | RIVERSIDE DAIRY DITCH | Arkansas River [00078956] | 209.36 |
| <input checked="" type="checkbox"/> | PUEBLO WEST SEWAGE | Arkansas River | 208.64 |

Search

Map
Details

Legend

- Blue Circle
- Green Circle
- ⊗ Green spiderspot
- Yellow Square
- + Inflow (not release)
- + Inflow Release

Hide ^

TIMPAS - ARKANSAS CONFLUENCE (1729075) Arkansas River at mile 126....

7/15/2021

Y Min 0.00

Y Max 1,800.00

Log Scale OFF

Legend OFF

Table

Graph

| Upstream | | |
|------------|----------------|--------|
| + | Exchange Total | 78.64 |
| — | Total in River | 225.53 |
| + | Release Total | 30.94 |
| — | Native Flow | 194.67 |
| Downstream | | |
| + | Exchange Total | 74.96 |
| — | Total in River | 292.19 |
| + | Release Total | 30.86 |
| — | Native Flow | 261.32 |

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Colors of Water – Time Series View



Colors of Water (all values in CFS)
Export Help My Account

Display

Time Series ▼

Custom Dates ▼

From: 7/26/2021 To: 8/9/2021

Structures

Location
Division 2: Arkansas

Water Source
Arkansas River [00078956]

Upstream
PUEBLO RESERVOIR (1403526) mile 214.57

Downstream
ARKANSAS RIVER NEAR COOLIDGE, KS (6709510) mile 0

91 of 91 Structures Selected

| Structure | Water Source | Stream Mile |
|--|---------------------------|-------------|
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| <input checked="" type="checkbox"/> ARKANSAS RIVER ABOVE PUEBLO | Arkansas River [00078956] | 214.13 |
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| <input checked="" type="checkbox"/> RIVERSIDE DAIRY DITCH | Arkansas River [00078956] | 209.36 |
| <input checked="" type="checkbox"/> PUEBLO WEST SEWAGE | Arkansas River | 208.64 |

Search

Map Details
CATLIN CANAL (1700552)

CATLIN CANAL (1700552) Arkansas River at mile 150.78
8/2/2021

Y Min 0.00
Y Max 4,000.00
Log Scale OFF
Legend OFF

Table Graph

Account Details

Change Password

My Subscriptions

Web Service Token Manager

Portal Home

Sign out

Upstream

| | | |
|---|----------------|---------|
| + | Exchange Total | 22.22 |
| — | Total in River | 2135.95 |
| + | Release Total | 81.14 |
| — | Native Flow | 2054.81 |

Diversions

| | |
|---|--------|
| 1700552 S:1 F:U:1 T: G: To: | 278.29 |
| 1700552 S:2 F:1403526.056 U:1 T: G: To: | 0 |
| 1700552 S:2 F:1403526.059 U:1 T: G: To: | 16.71 |
| 1700552 S:8 F:1400993 U:Q T: G:1707151 To:1703529 | 3 |
| 1700552 S:8 F:1400993 U:Q T: G:1707030 To:1703529 | 3 |

Downstream

| | | |
|---|----------------|---------|
| + | Exchange Total | 22.22 |
| — | Total in River | 1841.32 |
| + | Release Total | 63.03 |
| — | Native Flow | 1778.29 |

Setup

| | | | | | |
|-----------------------|---|-------------------|-------------------------|-------------------|-----|
| Scenario Name:* | WD17_2023_ColoCanal_0724 | Scenario Type: | Release | Headgate Pattern: | YES |
| Water Source: | Arkansas River | River Flow Basis: | Actual River | | |
| Upstream Structure: | PUEBLO RESERVOIR (1403526) at mile 214.57 | Date Basis: | Upstream Release Dates | | |
| Downstream Structure: | COLORADO CANAL (1700540) at mile 179.45 | Rate Basis: | Upstream Release Blocks | | |
| Owner: | COLORADO SPRINGS | | | | |
| Water Class: | 1403526.342 S:2 F: U:Q T:7 G: To:1700540 | | | | |

Planned Major Delivery Steps

| Block | Date | Time | Rate (CFS) | |
|---------------------------|------------|----------|------------|---|
| 1 | 07/24/2023 | 06:00 PM | 100 | ⊗ |
| 2 | | | | ⊗ |
| 3 | | | | ⊗ |
| 4 | | | | ⊗ |
| 5 | | | | ⊗ |
| End | 07/25/2023 | 10:00 PM | | |
| Total (AF): 231.41 | | | | |

Optional Headgate Pattern and Transit Loss Settings

| Option | Value |
|--|------------------|
| <input type="checkbox"/> Flatten delivery blocks by varying release | |
| <input type="checkbox"/> Maximum release (CFS) when flattening | ##.## |
| <input type="checkbox"/> Maximum headgate step (CFS) | ##.## |
| <input type="checkbox"/> Minimum headgate step (CFS) | ##.## |
| <input type="checkbox"/> Limit hours of turnout and changes | Start: 8:00 AM |
| | End: 5:00 PM |
| <input type="checkbox"/> Transit loss percentage, override default | Percent per mile |
| <input checked="" type="checkbox"/> Gage / Baseflow Evaluation of past release | |
| <input type="checkbox"/> Is past event but is hypothetical (not in gage) | |

COW Scenario Planner – Graph Output

Scenario Name: **WD17_2023_ColoCanal_0724**

Table

Graph

| Totals (AF) | Release | Delivery | Headgate | Evaporation | Unconsumed TL | Gage Eval | Percent | Delivery TL | Potential TL | Gage Eval TL |
|-------------|---------|----------|----------|-------------|---------------|-----------|---------|-------------|--------------|--------------|
| | 231.41 | 165.96 | 165.96 | 2.33 | 63.12 | 159.64 | | 28.28 | 28.28 | 31.01 |

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PDF



TL Rule: Cutoff at 10% of average release

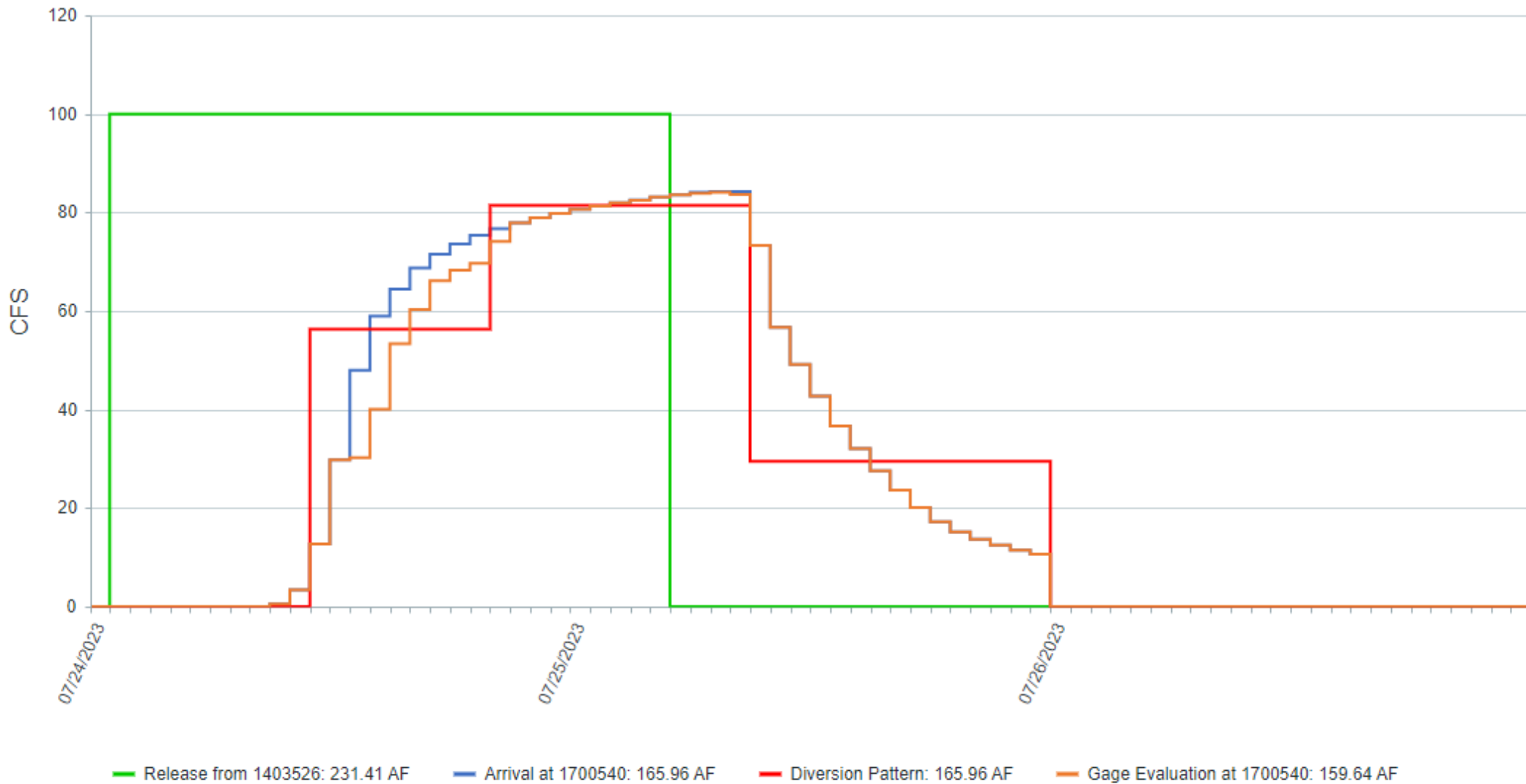


Table **Graph**

| | Release | Delivery | Headgate | Evaporation | Unconsumed TL | Gage Eval | Percent | Delivery TL | Potential TL | Gage Eval TL |
|--------------------|---------|----------|----------|-------------|---------------|-----------|---------|-------------|--------------|--------------|
| Totals (AF) | 231.41 | 165.96 | 165.96 | 2.33 | 63.12 | 159.64 | | 28.28 | 28.28 | 31.01 |

TL Rule: Cutoff at 10% of average release

PDF SUMMARY LOCK SCENARIO CSV

| Structure | Type | Date | Amount |
|------------------|---------------|---------------------|--------|
| PUEBLO RESERVOIR | Release (CFS) | 07/24/2023 05:00 PM | 0.00 |
| PUEBLO RESERVOIR | | | |
| PUEBLO RESERVOIR | | | |
| COLORADO CANAL | | | |
| COLORADO CANAL | | | |
| COLORADO CANAL | | | |
| COLORADO CANAL | | | |
| COLORADO CANAL | | | |

100 items per page

Totals (AF)

| Release | Delivery | Headgate | Evaporation | Unconsumed TL | Gage Eval |
|---------|----------|----------|-------------|---------------|-----------|
| 231.41 | 165.96 | 165.96 | 2.33 | 63.12 | 159.64 |

Totals (%)

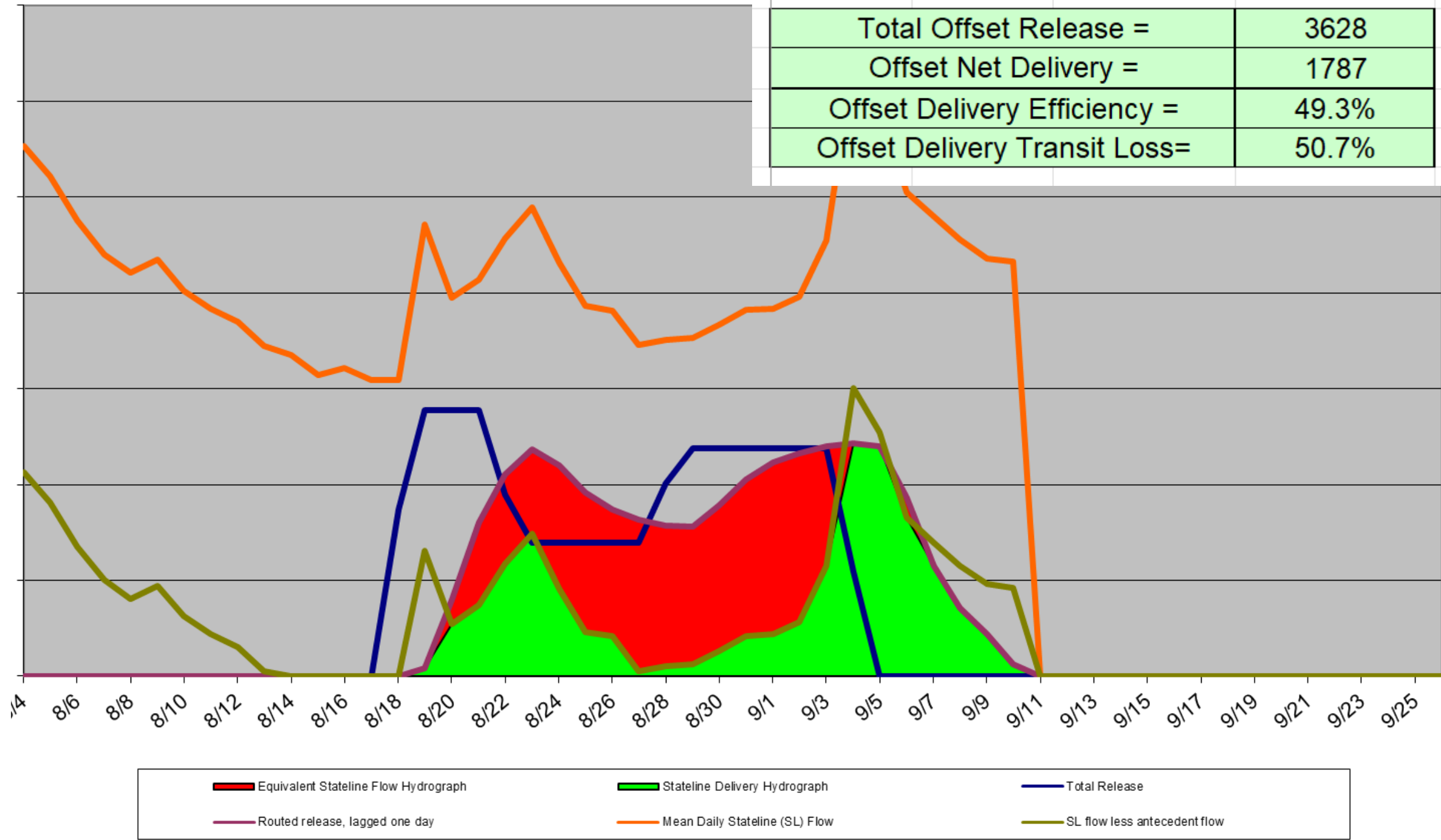
| Delivery Transit Loss | Potential Transit Loss | Gage Eval Transit Loss |
|-----------------------|------------------------|------------------------|
| 28.28 | 28.28 | 31.01 |

Infrequent

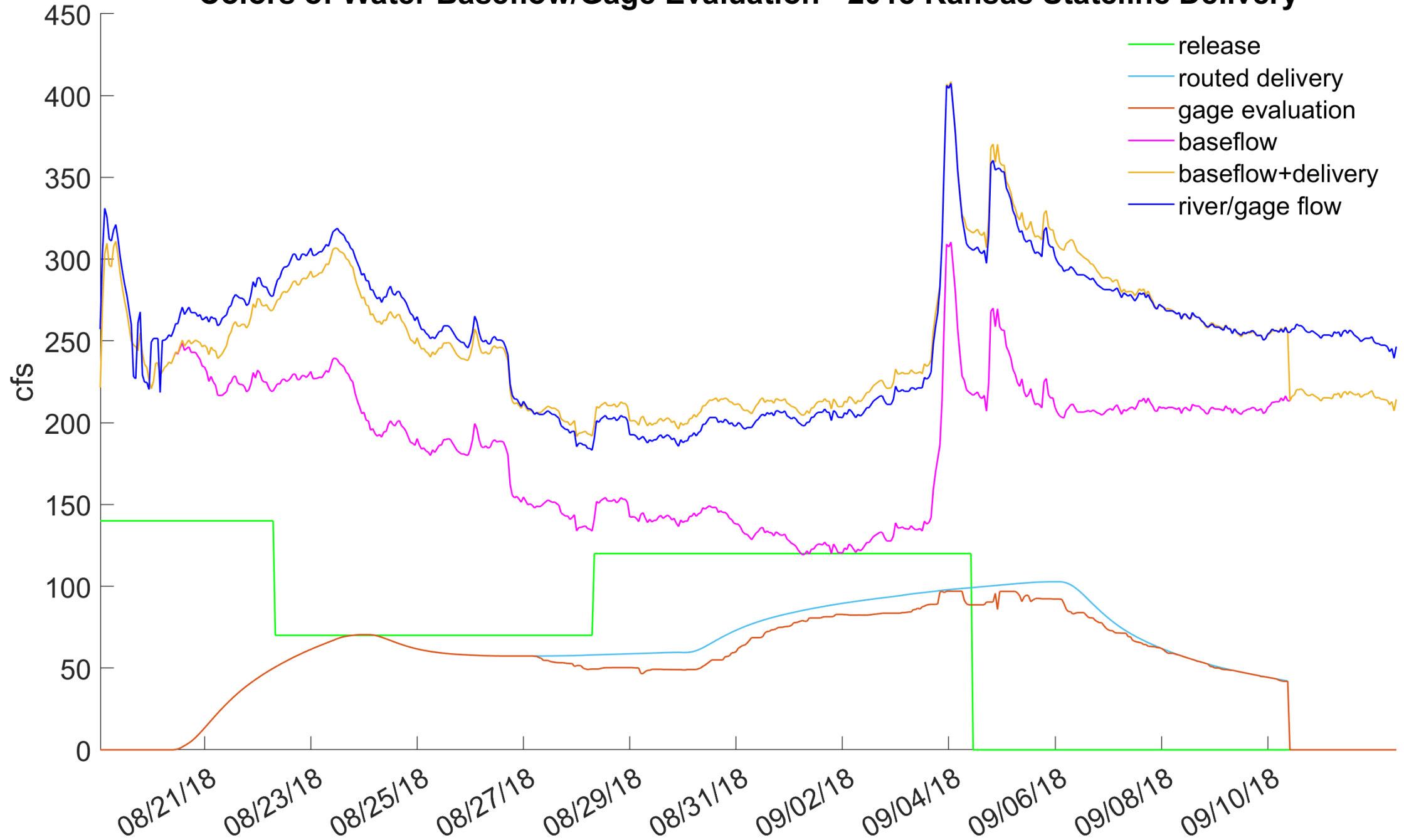
| Structure | Type | Date | Amount (CFS) |
|----------------------------|----------------------|---------------------|--------------|
| PUEBLO RESERVOIR (1403526) | Release (CFS) | 07/24/2023 05:00 PM | 0.00 |
| PUEBLO RESERVOIR (1403526) | Release (CFS) | 07/24/2023 06:00 PM | 100.00 |
| PUEBLO RESERVOIR (1403526) | Release (CFS) | 07/25/2023 09:00 PM | 0.00 |
| COLORADO CANAL (1700540) | Headgate Intake(CFS) | 07/25/2023 03:00 AM | 0.00 |
| COLORADO CANAL (1700540) | Headgate Intake(CFS) | 07/25/2023 04:00 AM | 56.32 |
| COLORADO CANAL (1700540) | Headgate Intake(CFS) | 07/25/2023 01:00 PM | 81.46 |
| COLORADO CANAL (1700540) | Headgate Intake(CFS) | 07/26/2023 02:00 AM | 29.48 |
| COLORADO CANAL (1700540) | Headgate Intake(CFS) | 07/26/2023 05:00 PM | 0.00 |

+ Daily and Hourly Data

2018 Kansas Delivery Calculation



Colors of Water Baseflow/Gage Evaluation - 2018 Kansas Stateline Delivery



Scenario Name: WD67_2018_KS_0818 



Setup

| | | | | | |
|-----------------------|---|-------------------|---------------------------|-------------------|--------------------------|
| Scenario Name:* | WD67_2018_KS_0818 | Scenario Type: | Release ▼ | Headgate Pattern: | <input type="radio"/> NO |
| Water Source: | Arkansas River ▼ | River Flow Basis: | Actual River ▼ | | |
| Upstream Structure: | JOHN MARTIN RESERVOIR (6703512) at mile ... ▼ | Date Basis: | Upstream Release Dates ▼ | | |
| Downstream Structure: | ARKANSAS RIVER COMPACT(COLORADO-KAN... ▼ | Rate Basis: | Upstream Release Blocks ▼ | | |
| Owner: | KANSAS ▼ | | | | |
| Water Class: | 6703512.035 S:2 F: U:Q T:7 G: To:6799999 ▼ | | | | |

Planned Major Delivery Steps

| Block | Date | Time | Rate (CFS) | |
|---------------------------|------------|----------|------------|--------------------------|
| 1 | 08/18/2018 | 09:00 AM | 140 | <input type="checkbox"/> |
| 2 | 08/22/2018 | 09:00 AM | 70 | <input type="checkbox"/> |
| 3 | 08/28/2018 | 09:00 AM | 120 | <input type="checkbox"/> |
| 4 | | | | <input type="checkbox"/> |
| 5 | | | | <input type="checkbox"/> |
| End | 09/04/2018 | 11:00 AM | | |
| Total (AF): 3629.8 | | | | |

Optional Headgate Pattern and Transit Loss Settings

| Option | Value |
|--|--|
| <input type="checkbox"/> Flatten delivery blocks by varying release | |
| <input type="checkbox"/> Maximum release (CFS) when flattening | ##.## ▼ |
| <input type="checkbox"/> Maximum headgate step (CFS) | ##.## ▼ |
| <input type="checkbox"/> Minimum headgate step (CFS) | ##.## ▼ |
| <input type="checkbox"/> Limit hours of turnout and changes | Start: 8:00 AM  |
| | End: 5:00 PM  |
| <input type="checkbox"/> Transit loss percentage, override default | Percent per mile ▼ ##.## ▼ |
| <input checked="" type="checkbox"/> Gage / Baseflow Evaluation of past release | |
| <input type="checkbox"/> Is past event but is hypothetical (not in gage) | |

SAVE

UNDO

RUN

COW Scenario Planner – Graph Output

Scenario Name: WD67_2018_KS_0818

Table

Graph

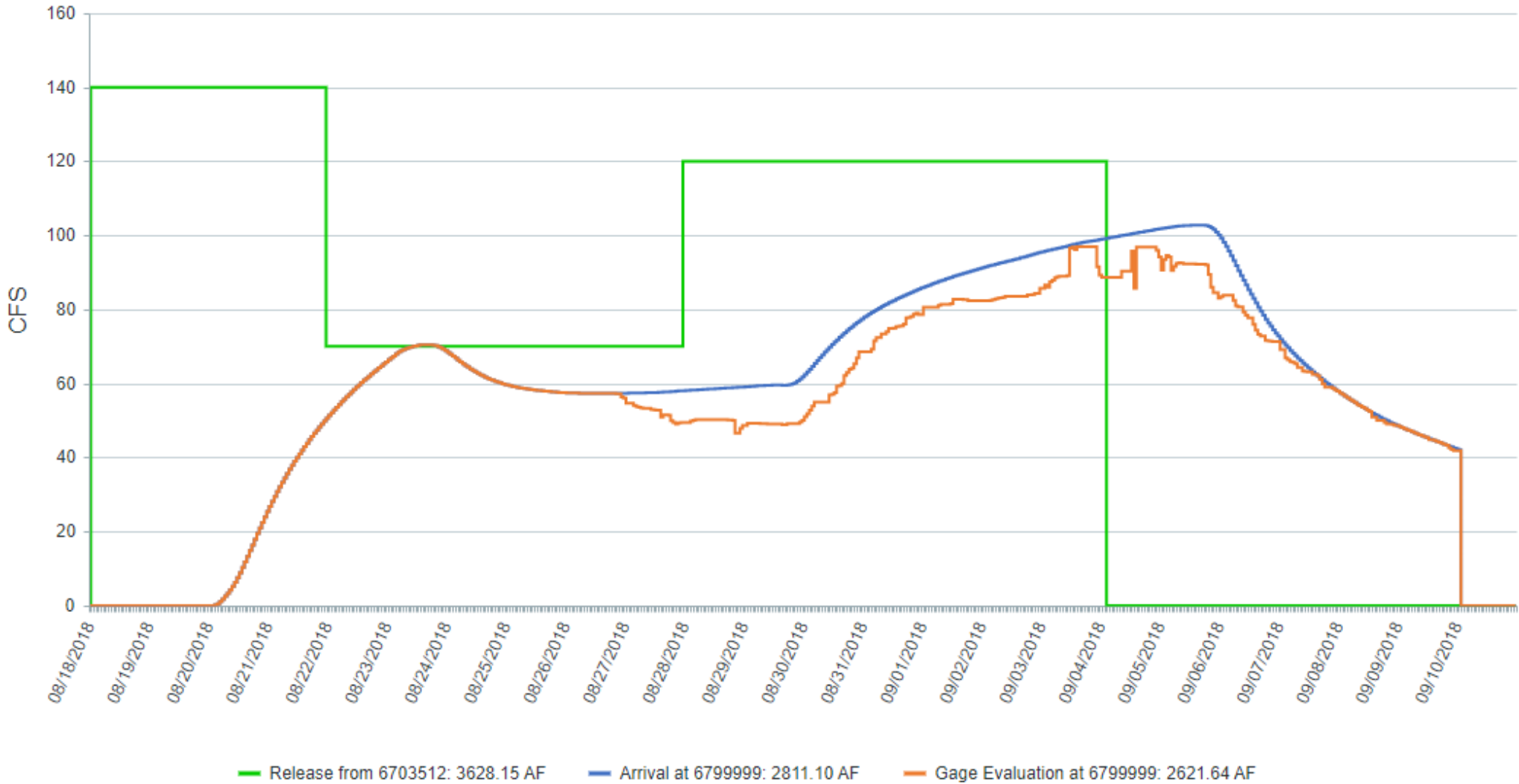
| Totals (AF) | Release | Delivery | Headgate | Evaporation | Unconsumed TL | Gage Eval | Percent | Delivery TL | Potential TL | Gage Eval TL |
|-------------|---------|----------|----------|-------------|---------------|-----------|---------|-------------|--------------|--------------|
| | 3628.15 | 2811.1 | N/A | 94.35 | 722.7 | 2621.64 | | 22.52 | 22.52 | 27.74 |

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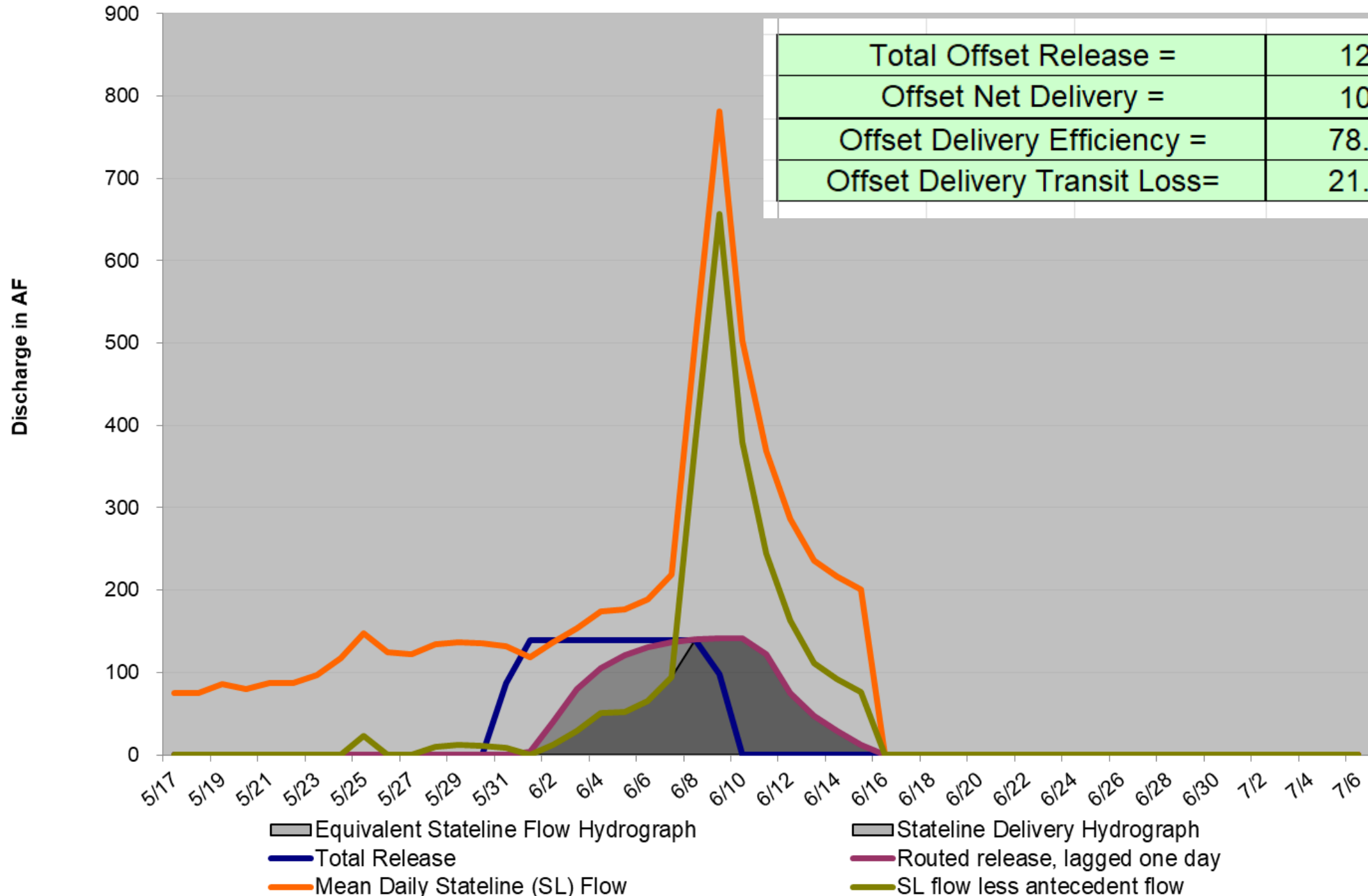
PDF



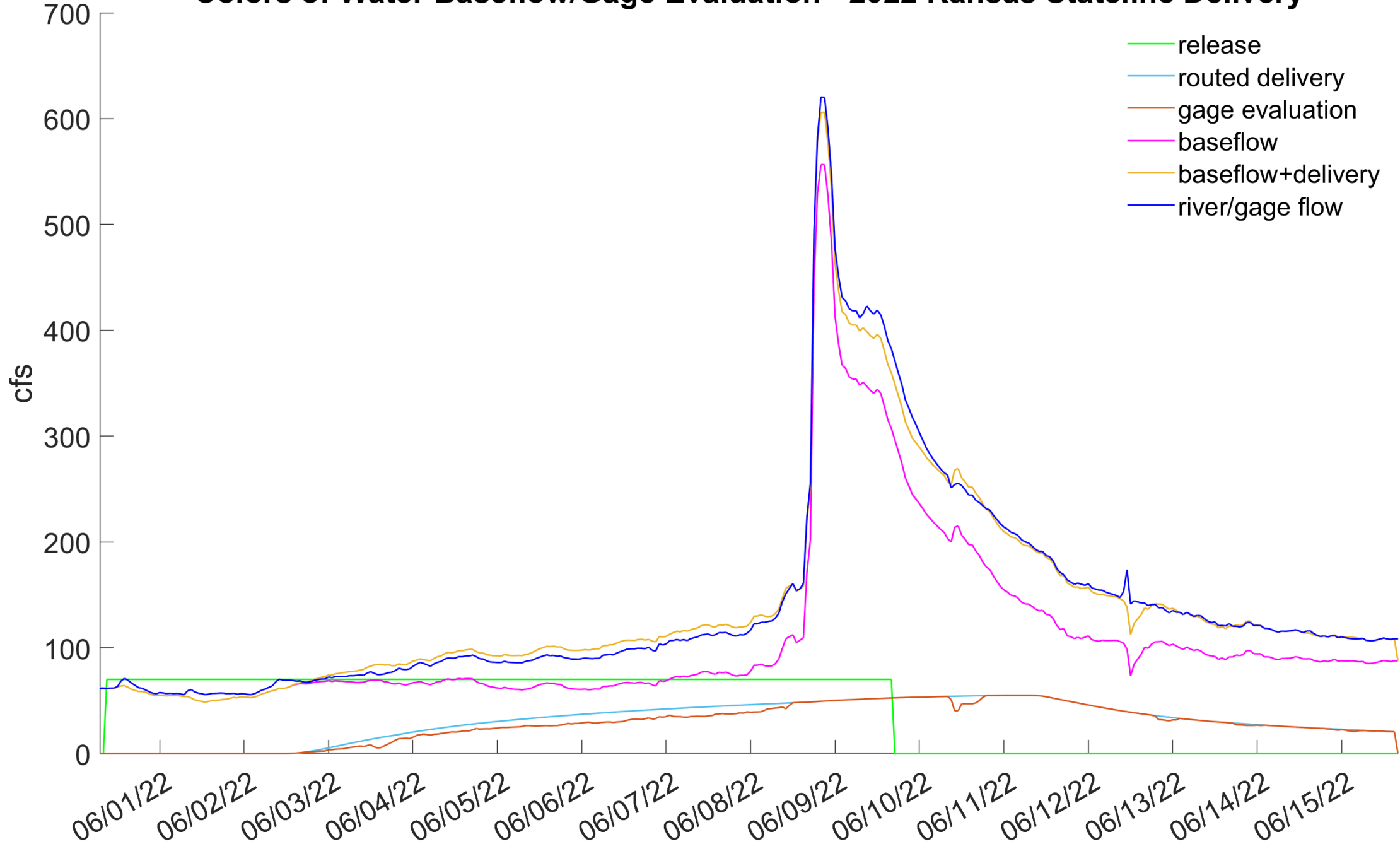
TL Rule: Cutoff 6-days after release end



2022 Kansas Delivery Calculation



Colors of Water Baseflow/Gage Evaluation - 2022 Kansas Stateline Delivery



Scenario Name: **WD67_2022_KS_0531**

Setup

Scenario Name:*

Water Source:

Upstream Structure:

Downstream Structure:

Owner:

Water Class:

Scenario Type: Headgate Pattern: NO

River Flow Basis:

Date Basis:

Rate Basis:

Planned Major Delivery Steps

| Block | Date | Time | Rate (CFS) | |
|----------------------------|------------|----------|------------|--|
| 1 | 05/31/2022 | 09:00 AM | 70 | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| End | 06/09/2022 | 08:00 AM | | |
| Total (AF): 1243.82 | | | | |

Optional Headgate Pattern and Transit Loss Settings

| Option | Value |
|--|---|
| <input type="checkbox"/> Flatten delivery blocks by varying release | |
| <input type="checkbox"/> Maximum release (CFS) when flattening | ##.## |
| <input type="checkbox"/> Maximum headgate step (CFS) | ##.## |
| <input type="checkbox"/> Minimum headgate step (CFS) | ##.## |
| <input type="checkbox"/> Limit hours of turnout and changes | Start: 8:00 AM |
| | End: 5:00 PM |
| <input type="checkbox"/> Transit loss percentage, override default | Percent per mile <input type="text" value="##.##"/> |
| <input checked="" type="checkbox"/> Gage / Baseflow Evaluation of past release | |
| <input type="checkbox"/> Is past event but is hypothetical (not in gage) | |

COW Scenario Planner – Graph Output

Scenario Name: WD67_2022_KS_0531

Table Graph

| | Release | Delivery | Headgate | Evaporation | Unconsumed TL | Gage Eval | | Delivery TL | Potential TL | Gage Eval TL |
|-------------|---------|----------|----------|-------------|---------------|-----------|---------|-------------|--------------|--------------|
| Totals (AF) | 1243.82 | 888.3 | N/A | 52.01 | 303.5 | 804.32 | Percent | 28.58 | 30.64 | 35.33 |

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TL Rule: Cutoff 6-days after release end

