

Overview of the TROA Planning Enabled Operations Project in the Truckee River Basin

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— BUREAU OF —
RECLAMATION



PRECISION
WATER RESOURCES ENGINEERING





Truckee Basin Overview

	<u>Truckee Basin</u>	<u>Colorado Basin</u>
Drainage Area (mi²)	3,000	244,000
River Length (mi)	120	1,450

Closed Basin -

- Lake Tahoe Elevation ~ 6,225 ft
- Pyramid Lake Elevation ~ 3,803 ft

Truckee Carson Modeling Needs

U.S. Water Master / TROA Admin:

- Accounting (TROA §3.A.1)
- Short-term Operations (TROA §11.C)
 - Used to track and meeting “*operational objectives*”
- Seasonal Planning Purposes (TROA §11.C)
 - Used to track and meet “*seasonal objectives*” and “*annual goals*”

TROA Operations and Accounting RiverWare Model
Managed by Federal Water Master
Known as: Ops/Accounting Model

U.S. Bureau of Reclamation:

- Tool for stakeholders to assess strategies or policy changes over varying conditions
- Hydrology includes historical, climate change, and paleo scenarios
- Varying demand scenarios

TROA Planning RiverWare Model

Managed by US Bureau of Reclamation

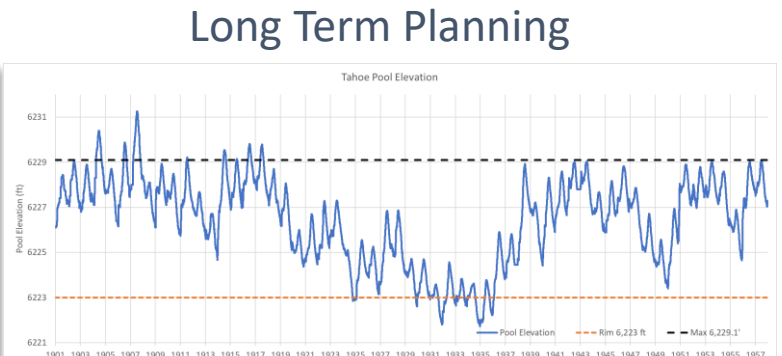
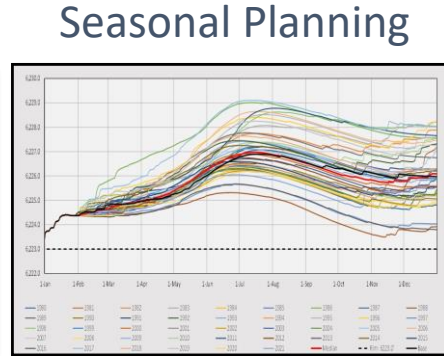
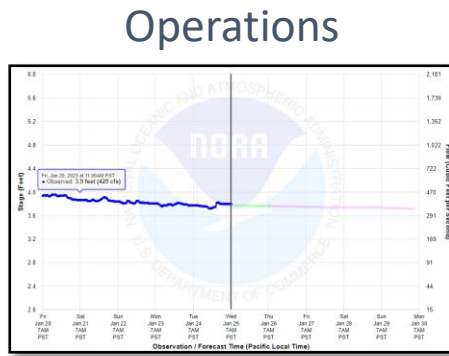
Known as: Planning Model

Truckee Carson Modeling



Gage Data

Today



Deterministic Forecast

Ensemble Forecast

POR, Climate Change, etc.
Hydrology

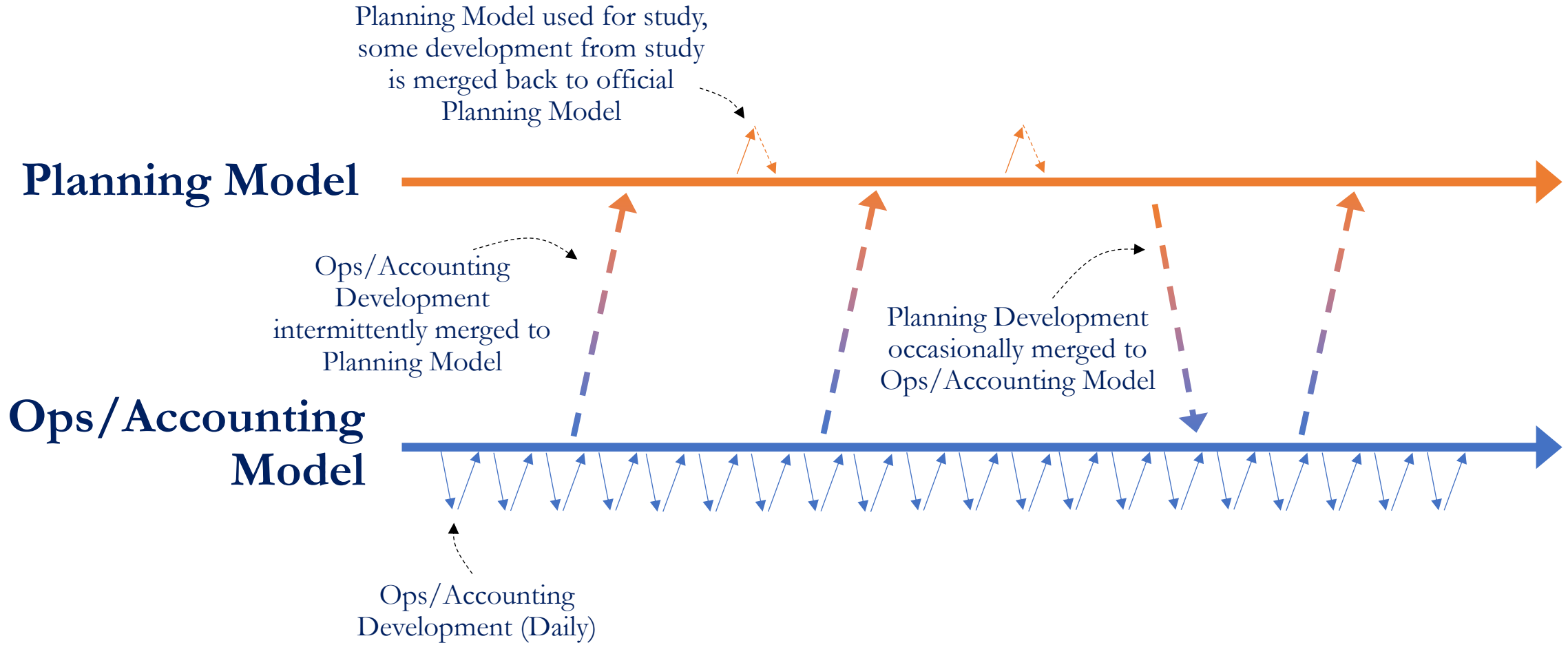
Annual Goals

Scenario Planning

Short-Term Scheduling

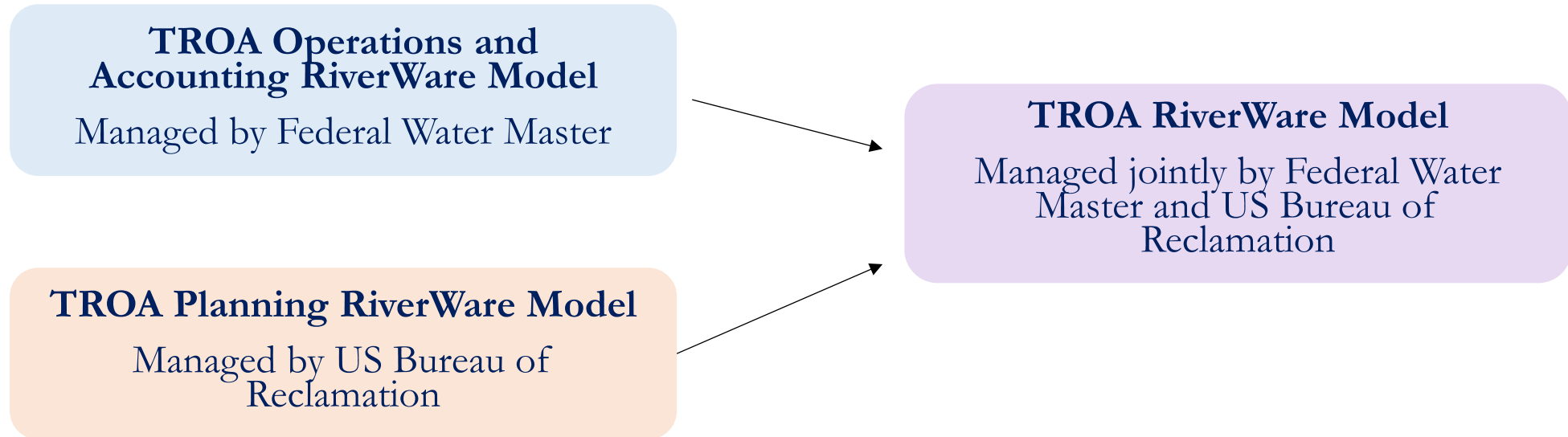
Basic Scheduling

Model Synchronization Challenges



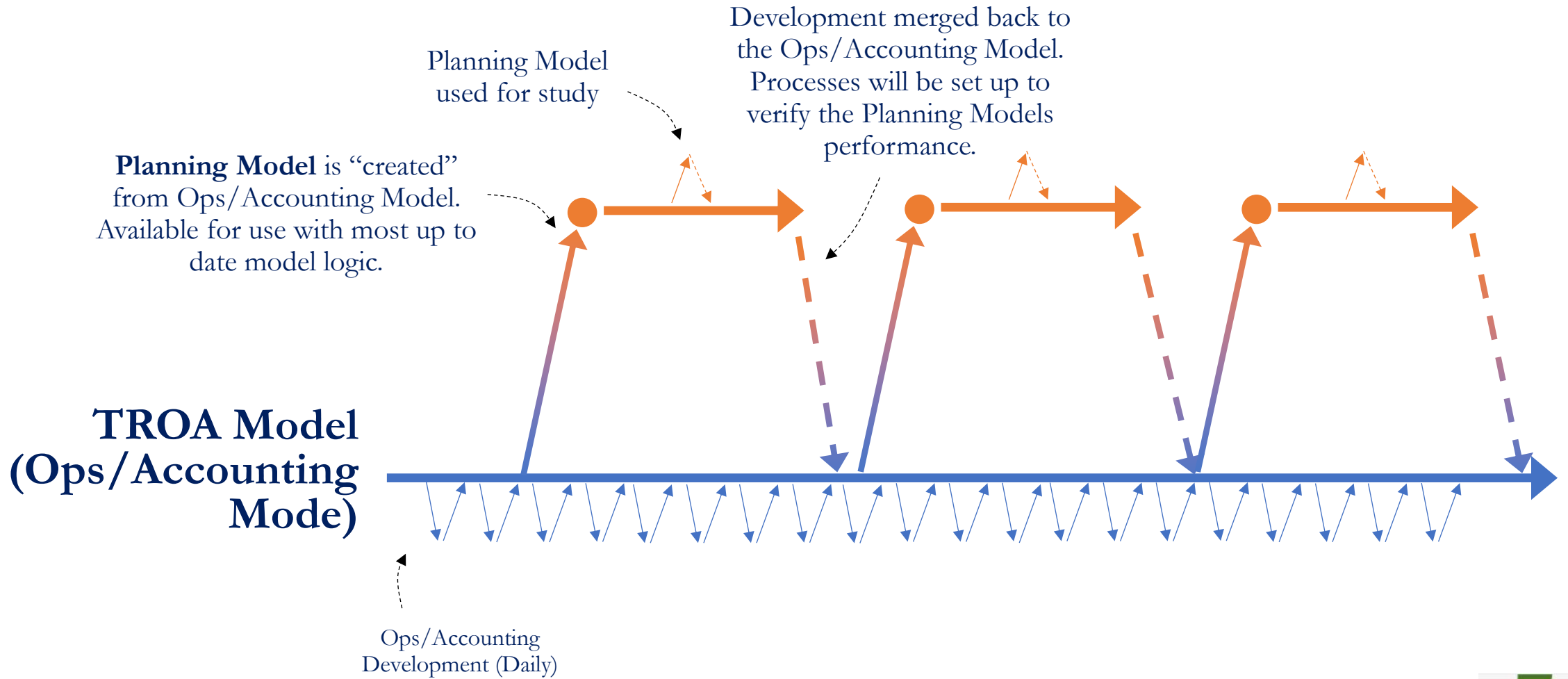
Recent Efforts: TROA Model

- Solution: Combined into a single model workspace known as the TROA Model



TROA Model

Model Synchronization: Proposed Paradigm



Scheduling Operations: Short-Term vs Basic

Short-Term Scheduling

- Guides model operations based on parties' preferred actions
- Updated through standard scheduling process/meeting cycle
- Typically assumed for ~30 days if no end date present

Basic Scheduling

- Logic that kicks in when there is no short-term scheduling
- Should be flexible to handle various conditions (e.g. dry/wet)
- Logic used for seasonal objectives through Planning Model studies

Modeling for Flexibility

- Meeting all these diverse uses requires flexibility
- Ops/Accounting:
 - Must be able to handle precise input for unique situations
 - Every rule has an exception
 - Every year is unique
- Planning/Ensembles
 - Evaluate many scenarios
 - Robustness is critical
 - Need to limit amount of input



Modeling for Flexibility

Basic/Planning Logic can input Scheduling, when not input

BocaData.BocaFRFillingCurve_Planning

File Edit Row Column View Adjust

BocaFRFillingCurve_Planning

Value:

	Stampede Does not Fill acre-feet	Stampede Fills acre-feet
0:00 Jan 1	32,868.00	32,868.00
0:00 Apr 11	32,868.00	32,868.00
0:00 May 21	40,868.00	32,868.00
0:00 Jun 25	40,868.00	40,868.00
0:00 Oct 1	40,868.00	40,868.00
0:00 Nov 1	32,868.00	32,868.00

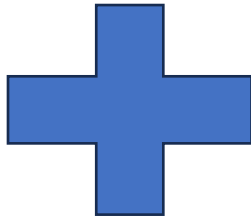
Show Description

This slot represents the Planning Model values for the Boca FR Fill Curve. When the model projects that Stampede will not fill, the "Stampede Does not Fill" column will be used. In this type of year, Boca FR will fill at a rate equal to the earliest fill as defined by the snow melt parameter. When the model projects that Stampede will fill, the "Stampede Fills" column will be used. In this type of year, Boca FR will fill in that pattern it filled in WY 2017.

Revised fill date for Stampede Fills scenario to be 6/25 based on when 1986, a 33% exceedance runoff, would be allowed to fill. - ce 4/19/24

1 Year Period (Base 1900)
Irregular Interval

Interpolate Lookup



RPL Viewer - RBS Ruleset (from model file) 9

File Edit Rule Statement View

Plan Boca FR Filling Curve

428 Plan Boca FR Filling Curve RPL Set Loaded

```

1 WITH ( DATETIME WYStart = @"t" ) DO
5   WITH ( DATETIME WYEnd = # If its the last water year, the last 3 months of the water year must be accounted DO
      # for, so the last loop will actually loop over 15 months as opposed to 12. PN
      # 7/26/2023
      IF ( Dec31ofYear ( OffsetDate ( WYStart , 1.000 , "1 Years" ) ) == RunEndDate ( ) ) THEN
          RunEndDate ( )
      ELSE
          OffsetDate ( WYStart , 1.000 , "1 Years" ) - 1.000 "day"
      END IF
24  WITH ( LIST dailyWYDates = GetDates ( WYStart , WYEnd , "1 Days" ) ) DO
31  WITH ( BOOLEAN WillStampedeFill = WillStampedeFill ( @"t" ) ) DO
36  WITH ( STRING column = IF ( WillStampedeFill ) THEN DO
41    "Stampede Fills"
      ELSE
42    "Stampede Does not Fill"
      END IF
43  FOR ( DATETIME date IN dailyWYDates ) DO
47  IF ( NOT IsInput ( BocaData.BocaFRFillingCurve , date ) ) THEN
52    BocaData.BocaFRFillingCurve [ date ] = BocaData.BocaFRFillingCurve_Planning [ date , column ]
      END IF
      END FOR
  
```

Show: Execution Constraint Description Notes Comments

Execute Rule Only When

```

1 NOT HasRuleFiredSuccessfully ( "This Rule" ) AND # If its the start of a new WY
6 @"t" == CompletePartialDate ( @"October 1" , @"t" )
  
```

Rule Description

This rule sets the Boca FR Fill Curve (BocaData.BocaFRFillCurve slot) for dates that do not have inputs by referencing the BocaData.BocaFRFillCurve_Planning slot. This slot contains patterns of Boca FR Fill Curves for years when



Slot Viewer (1 Day)

File Edit View TimeStep I/O

BocaData.BocaFRFillingCurve

Value: 32868 acre-feet Dec 31, 2024

BocaData .BocaFRFillingCurve acre-feet	
12-29-2024 Sun	32,868.00 I 0
12-30-2024 Mon	32,868.00 I 0
12-31-2024 Tue	32,868.00 I 0
01-01-2025 Wed	32,868.00 R 428
01-02-2025 Thu	32,868.00 R 428
01-03-2025 Fri	32,868.00 R 428
01-04-2025 Sat	32,868.00 R 428
01-05-2025 Sun	32,868.00 R 428
01-06-2025 Mon	32,868.00 R 428
01-07-2025 Tue	32,868.00 R 428

Show Description Synchronize Scrolling

DESCRIPTION:

This slot describes the maximum LT FR storage entitlement at any time (including WABSW). Any LT inflow that is stored that exceeds this storage entitlement will be stored as Fish water or waPOSW depending on what is in priority and the location of the inflow.

Normal values are: 4/11: 32,868, 5/21:40,868, Oct 1: 40,868, Oct 1 1:00 32,868

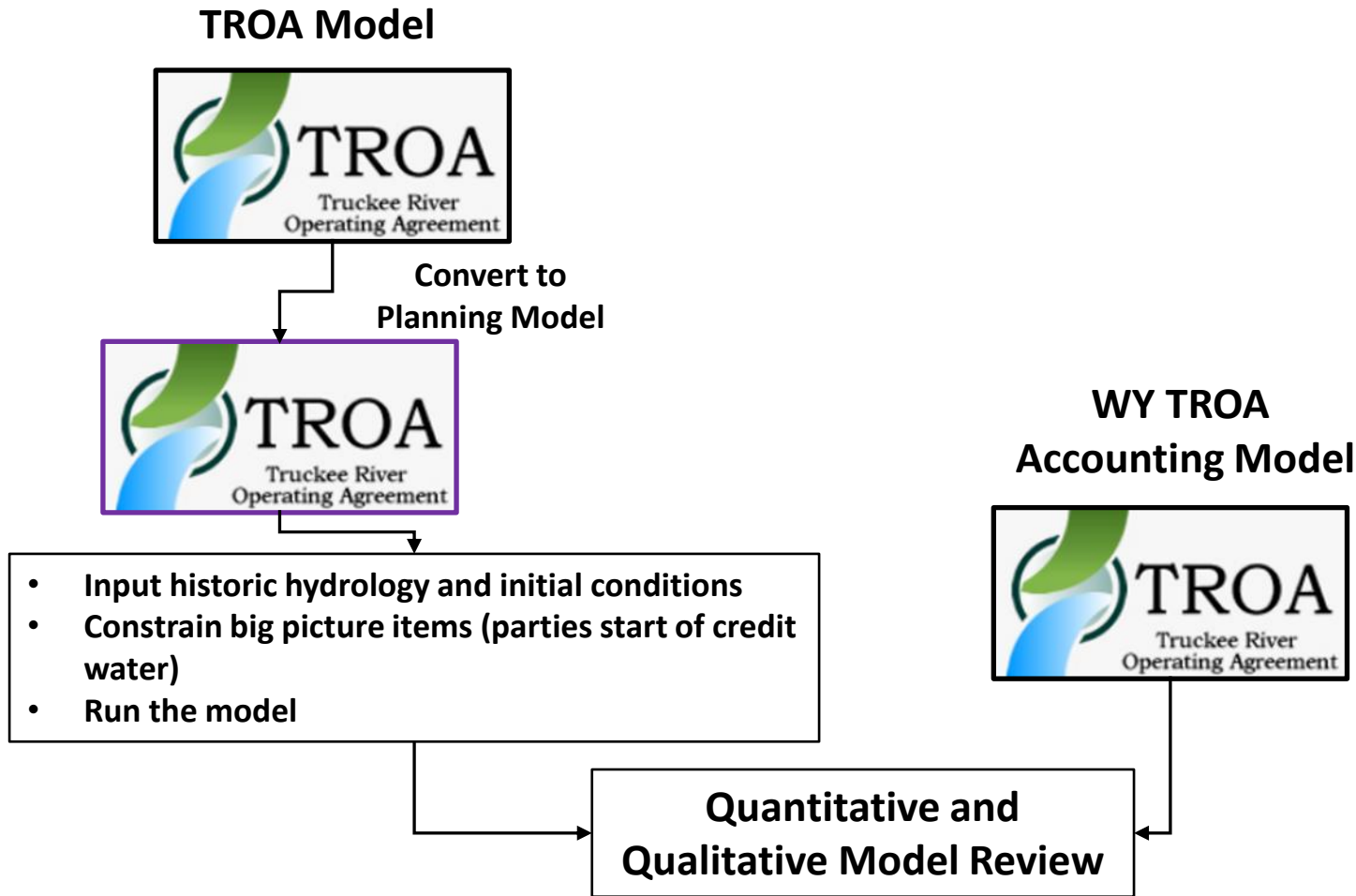
BocaData.BocaFRFillingCurve [@ 24:00 Decen 1 value: 32,868.00 [acre-feet] (Priority 0)

Verification Study

How well can the TROA Model planning logic reproduce historical operations?

- Verification study compares actual TROA operations to simulated basic scheduling logic in the TROA Model
- Quantitatively analyzes the model performance compared to historic operations
- Allows for all of us to identify what the basic logic does well and what may need improvement

Verification Study



Quantitative Review

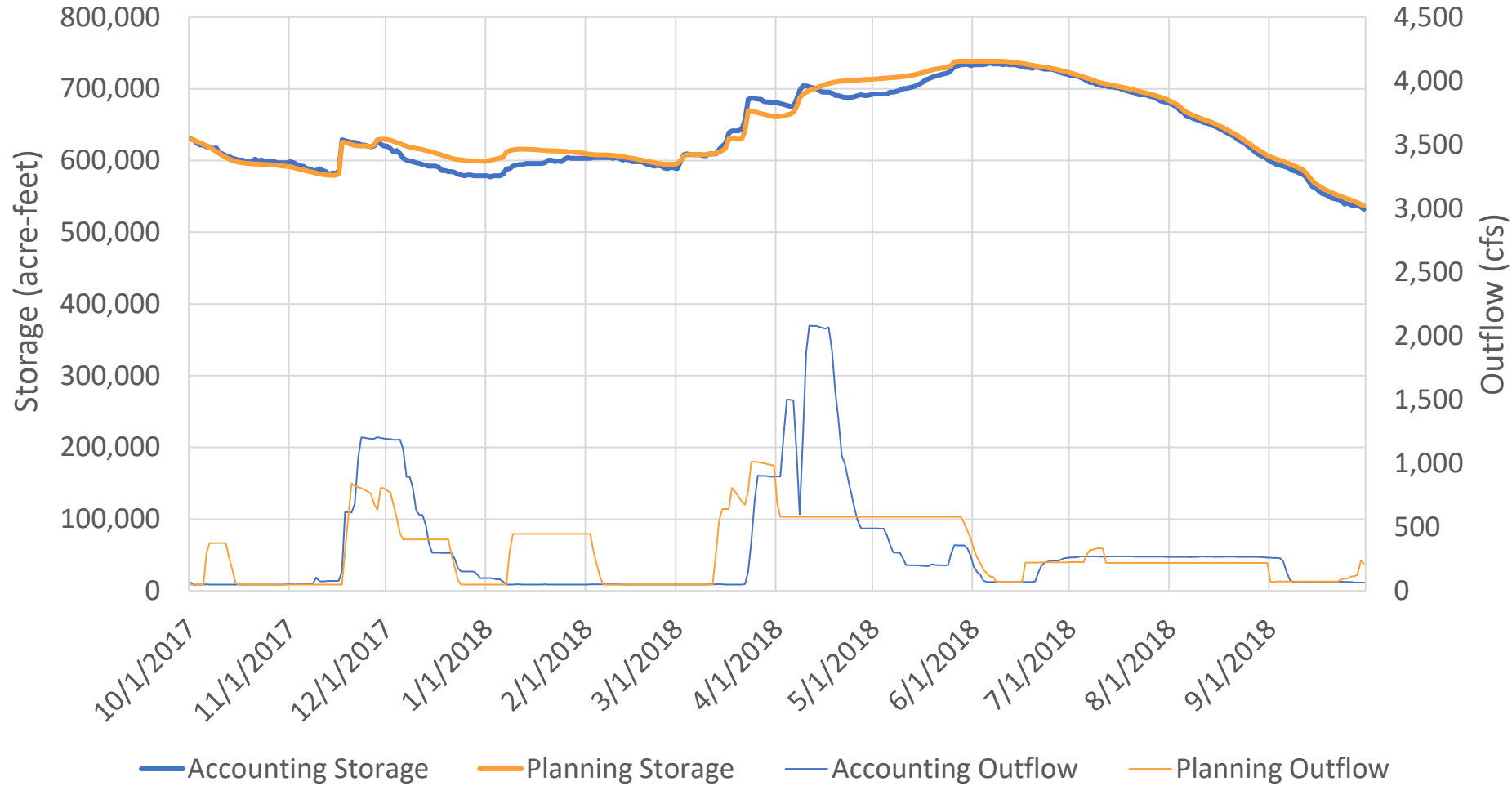
- Nash-Sutcliffe Efficiency (NSE)
- Percent bias (PBIAS)
- Kling-Gupta Efficiency (KGE)

Qualitative Analysis

- Reviewing Party objectives
- Does this look right?
- TROA Parties review

Verification Study: SAMPLE RESULTS

WY2018: Tahoe



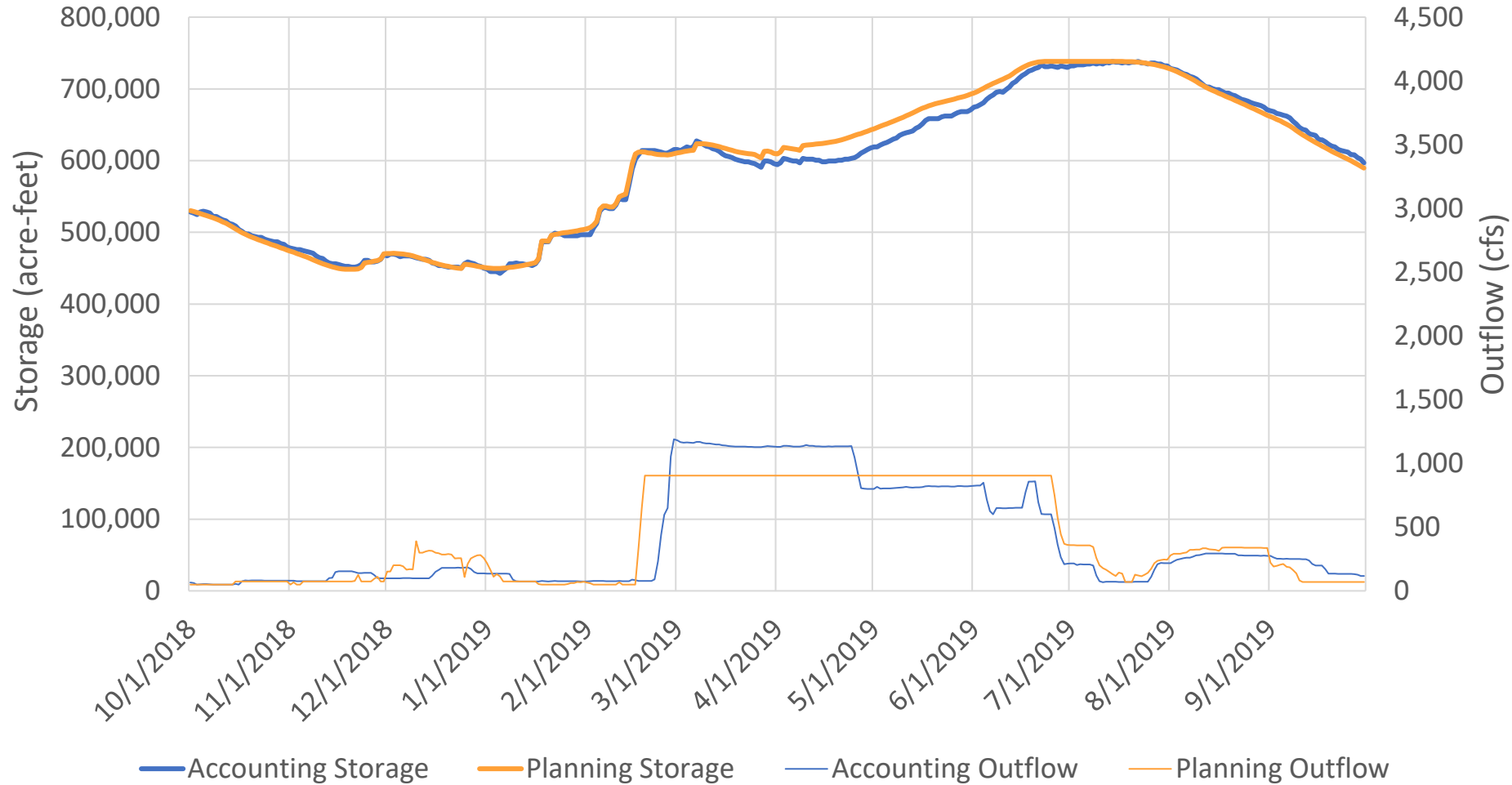
	Summary Metrics		
	NSE	PBIAS	KGE
Tahoe.Storage	0.96	0.84	0.98
Tahoe.Outflow	0.35	-2.29	0.42

EOY Storage (AF)	
Accounting	532,001
Planning	536,826
Difference	4,825

WY Outflow Vol (AF)	
Accounting	226,226
Planning	221,052
Difference	-5,174

Verification Study: SAMPLE RESULTS

WY2019: Tahoe



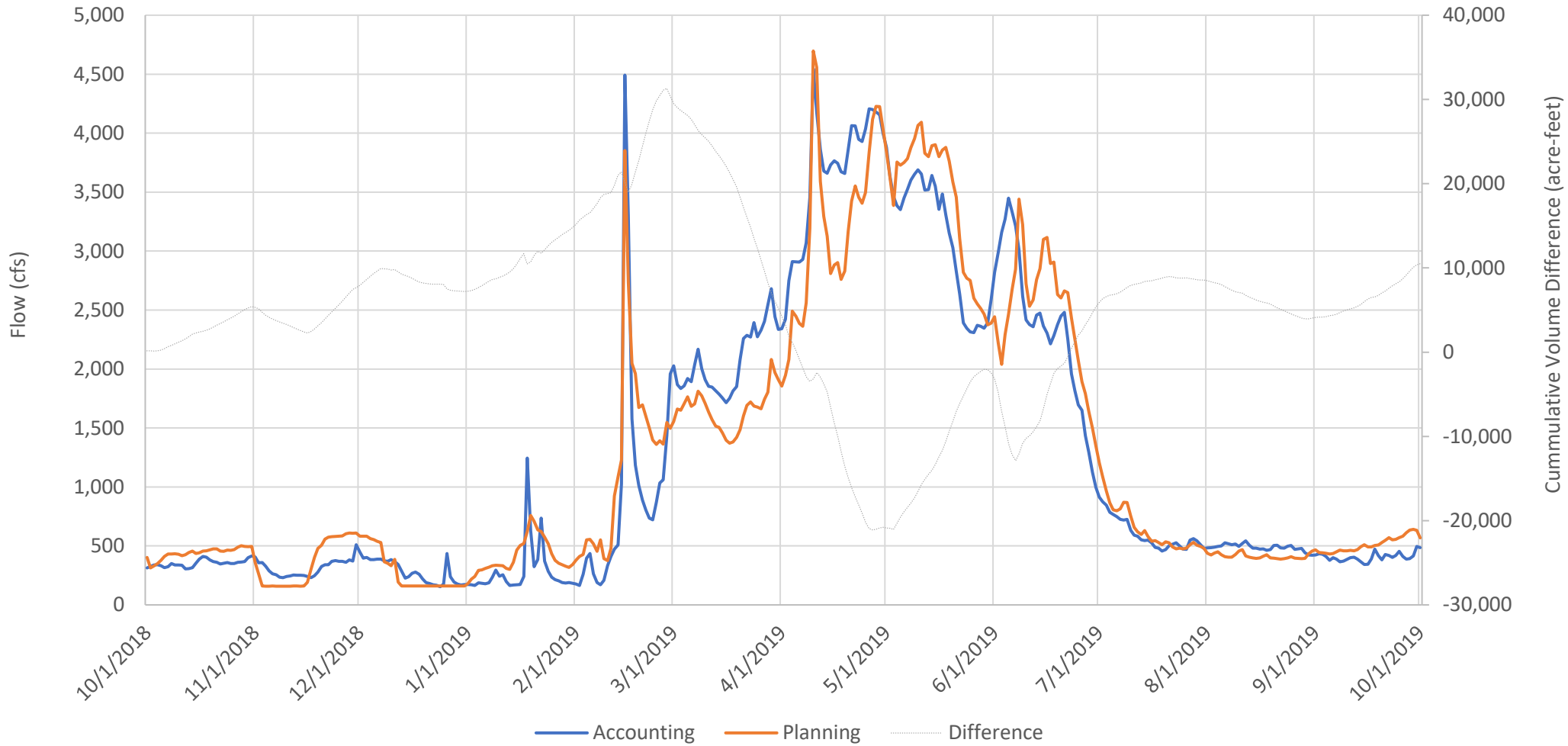
	Summary Metrics		
	NSE	PBIAS	KGE
Tahoe.Storage	0.99	0.69	0.97
Tahoe.Outflow	0.83	2.99	0.88

EOY Storage (AF)	
Accounting	597,010
Planning	589,636
Difference	-7,374

WY Outflow Vol (AF)	
Accounting	295,550
Planning	304,386
Difference	8,836

Verification Study: SAMPLE RESULTS

WY2019: TruckeeAtNixon.Gage Outflow

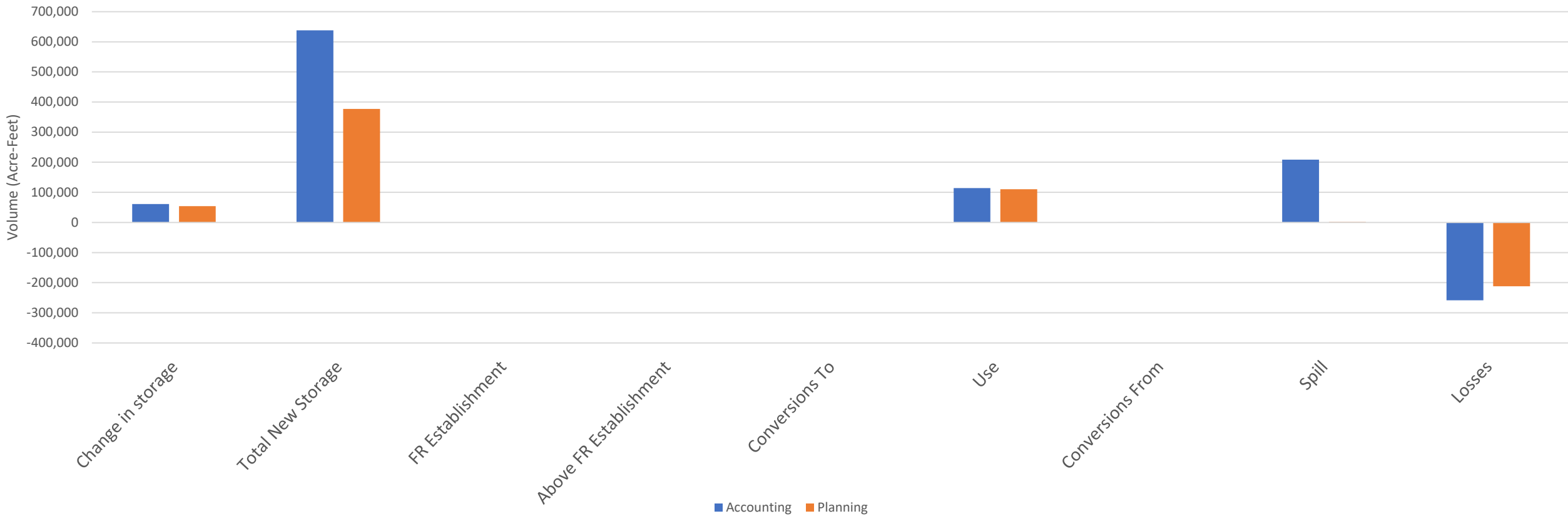


Metric	Value
NSE	0.93
PBIAS	1.16
KGE	0.94

WY Vol (AF)	
Accounting	893,427
Planning	903,947
Difference	10,520
Percent Diff.	1.18%

Verification Study: SAMPLE RESULTS

WY2019: FR



The Accounting model counted water being passed through the reservoirs as New Storage and simultaneous Spill while the Planning model just counts the amount stored as New Storage without labeling Spill. The amount in storage is the same with the two methods.

Conclusions: TROA Model

- Benefits of TROA Model:
 - Frequent development in Ops/Accounting Model available to Planning Model simulations
 - Capabilities of Planning Model available to Ops/Accounting Model for ensembles and when scheduling is unavailable
 - More rigorous verification/validation processes
 - More robust/resilient modeling framework
- Improved efficiency for all Truckee Basin Modeling efforts!

Note: TROA Model is current under review by basin stakeholders.

Questions?

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