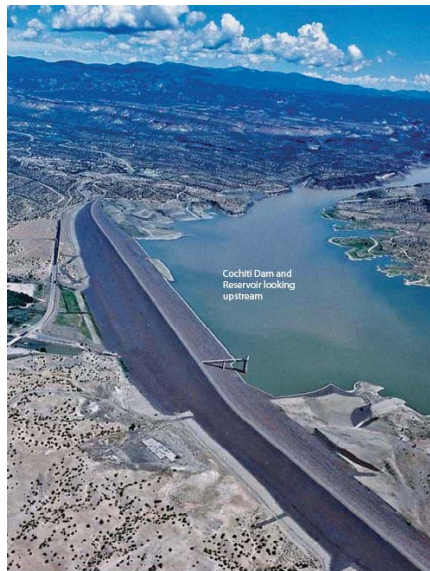


Aamodt Hydrologic Modeling

Using URGWOM to Evaluate Cochiti Recreation Pool Water Needs

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Background

- Part of Aamodt Litigation Settlement Implementation Project
- Use URGWOM to evaluate water needs for annual offset of evaporative losses from the Cochiti Reservoir Recreation Pool (Cochiti Rec Pool)
- URGWOM – Upper Rio Grande Water Operations Model
 - Daily-timestep RiverWare model
 - RiverWare is a general reservoir and river basin modeling tool developed by the Center for Advanced Decision Support for Water and Environmental Systems (CADSWES) at the University of Colorado at Boulder

Objectives

- Use URGWOM to evaluate the amount of SJ-C project water needed to offset evaporation from 1,200 acre recreation pool at Cochiti (return pool to 1,200 acres)
- Use five different paleo-based hydrologic sequences
 - Each sequence is 10 years in length
 - 10%, 30%, 50%, 70%, 90% exceedance
 - Same sequences used in Biological Assessment (BA)
 - Jesse Roach, Sandia National Laboratories, 2009
- Baseline and proposed scenario
 - 5,000 AF and 4,290 AF available annually for Cochiti Rec Pool
- Two delivery alternatives
 - USACE SOP method
 - Alternative – November and December delivery only

Model Run	Baseline Scenario (5000 af)	Proposed Scenario (4290 af)	Delivery Approach 1 (Supplement winter baseflows)	Delivery Approach 2 (USACE SOP)	Hydrologic Sequence
1	X		X		10%
2	X		X		30%
3	X		X		50%
4	X		X		70%
5	X		X		90%
6		X	X		10%
7		X	X		30%
8		X	X		50%
9		X	X		70%
10		X	X		90%
11	X			X	10%
12	X			X	30%
13	X			X	50%
14	X			X	70%
15	X			X	90%
16		X		X	10%
17		X		X	30%
18		X		X	50%
19		X		X	70%
20		X		X	90%

Other Items in SOW

- New elevation-area-capacity tables – in model
- New sediment parameters
 - New parameters not available
 - Sediment accumulation not modeled in this study
- Sediment deposition trends from latest bathymetry study using current and previous methods for determining ACAP tables
 - Study not available
 - Historical trends do not match modeled sediment – sediment disabled
- Quantification of Cochiti evaporation, seepage, and leakage
 - Evaporation is quantified
 - Seepage and leakage data not available

Modeling Assumptions

- Used “latest” URGWOM model used by Reclamation for accounting (July, 2013)
- The middle valley has not been calibrated so ET, CIR, and deep aquifer heads were extracted from the Biological Assessment (BA) URGWOM models
- Model configurations and settings were unchanged from those delivered by Craig Boroughs and used in the accounting model
- 2013 was completed with average hydrology (1998)
- First year of the hydrologic sequences is 2014 in the model
 - January 1, 2013 – December 31, 2023

Delivery Approaches

■ USACE SOP

- Water Control Manual for Cochiti Lake
- 600 AF in January; 2,000 AF in July; 1,200 AF in October; 600 AF in November and December
- These volumes approximate the 1 ft and ½ ft increments in Cochiti pool elevation described in the Water Control Manual
- In model, delivered in first 10 days of each month
- For 4,290 AF annual allocation scenarios, same monthly patterns used

Delivery Approaches

- **Alternative Method - Supplement Winter Base Flows**
 - All water delivered in November and December (2,500 AF each month)
 - Entire month used as delivery period

- **Assumptions for both methods**
 - If water remains on December 21 (and is needed at Cochiti to return to 1,200 acres), delivered at 100 cfs per day until 1,200 acres is reached at Cochiti or rec pool water in Heron runs out.
 - These schedules are for modeling purposes only. Actual operations require consideration of numerous factors when deciding when to deliver replacement water to Cochiti.
 - Releases are always subject to availability at Heron and requirement at Cochiti

Sedimentation

- In URGWOM, sediment always accumulates at the bottom of the reservoir
 - A large sediment inflow event pushes the entire content up and increases the surface area associated with a full Cochiti Rec Pool volume of 46,848 AF
- Two configuration switches in URGWOM for deliveries to re-fill Cochiti Rec Pool
 - Deliver water to return Cochiti Rec Pool to 1,200 acres
 - Deliver water to return Cochiti Rec Pool to 46,848 AF
 - Appears there were created to handle the way sediment accumulates
 - Neither approach seems to address the real-world situation

Sedimentation

- With sediment enabled, if maintaining 46,848 AF Cochiti Rec Pool, surface area increases above 1,200 AF due to sediment and evaporative losses will be overestimated
- With sediment enabled, if maintaining 1,200 acre surface area, releases to offset losses at Cochiti Rec Pool will be underestimated by the model
 - Sediment pushes surface area far above 1,200 acres; may take more than one year to return to 1,200 acres

Figure 1: Example Scenario (not part of study): Cochiti Rec Pool Surface Area and Deliveries from Heron to Cochiti Rec Pool (Targeting 46,848 acre-ft). 10% exceedance hydrologic sequence (wettest), 5000 af Allocation, SOP method, With Sedimentation

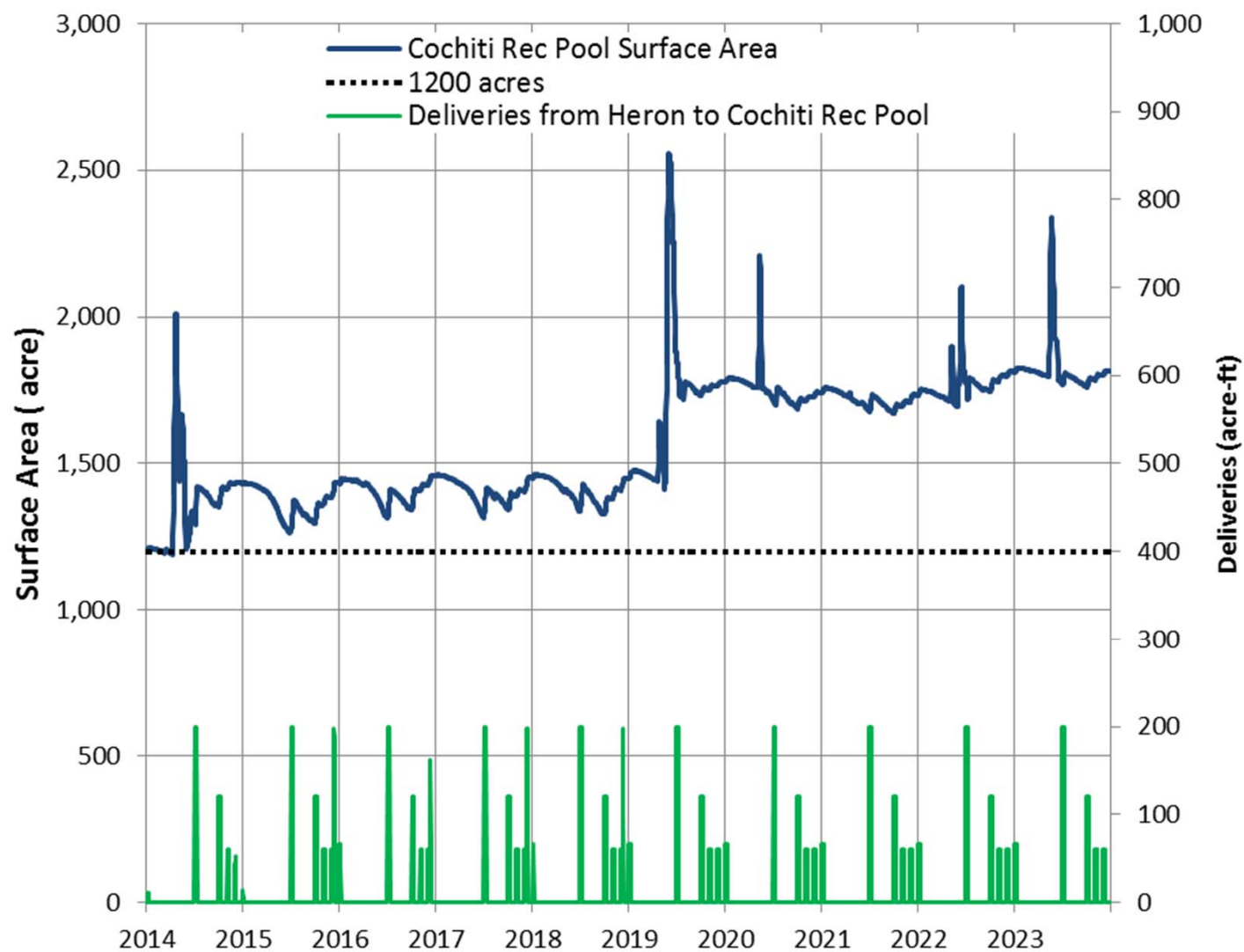


Figure 2: Example Scenario (not part of study): Cochiti Rec Pool Storage, Cochiti Rec Pool water in Heron, and Deliveries from Heron to Cochiti Rec Pool (Targeting 1200 acres). 10% exceedance hydrologic sequence (wettest), 5000 af Allocation, SOP method, With Sedimentation

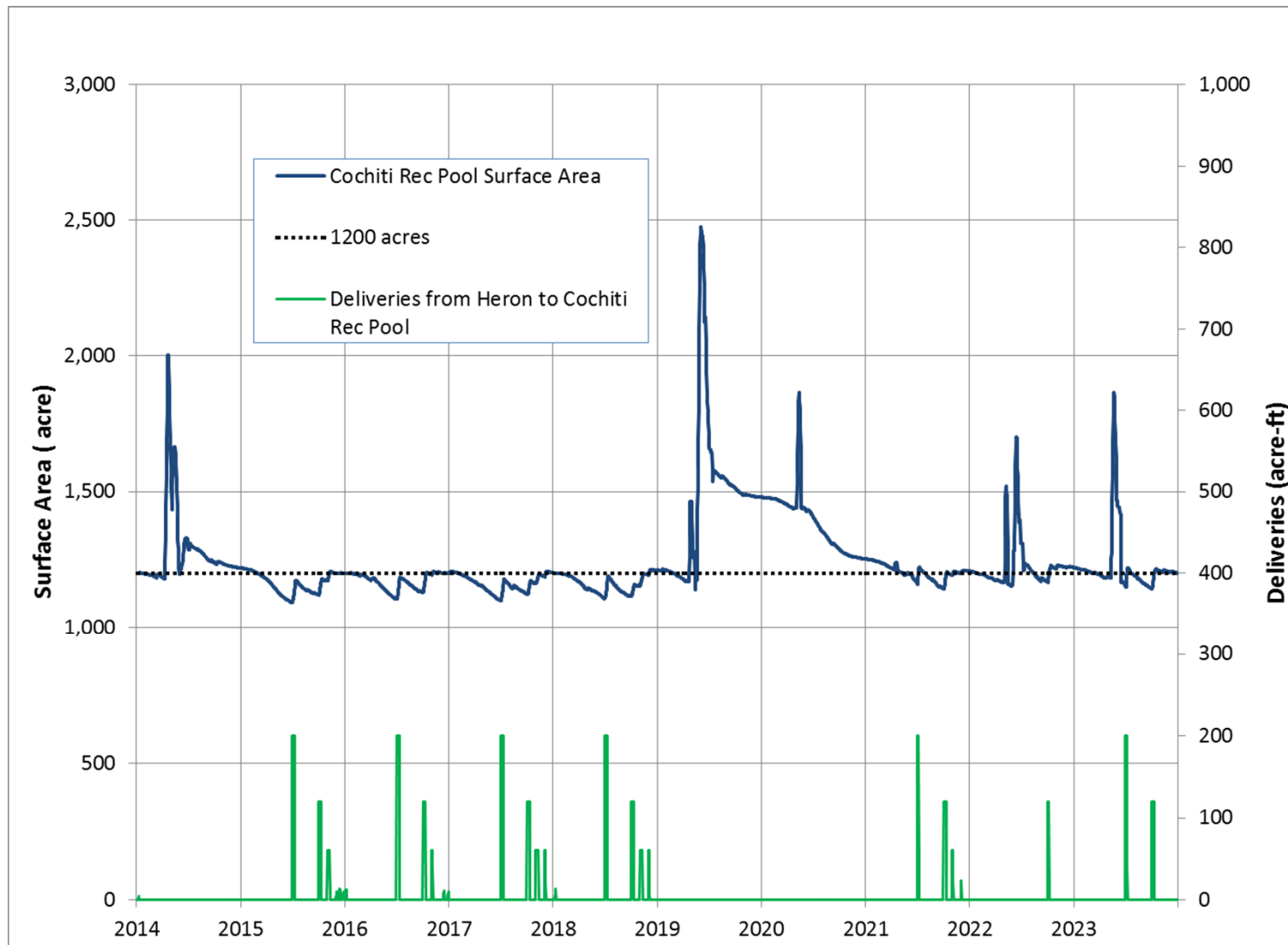
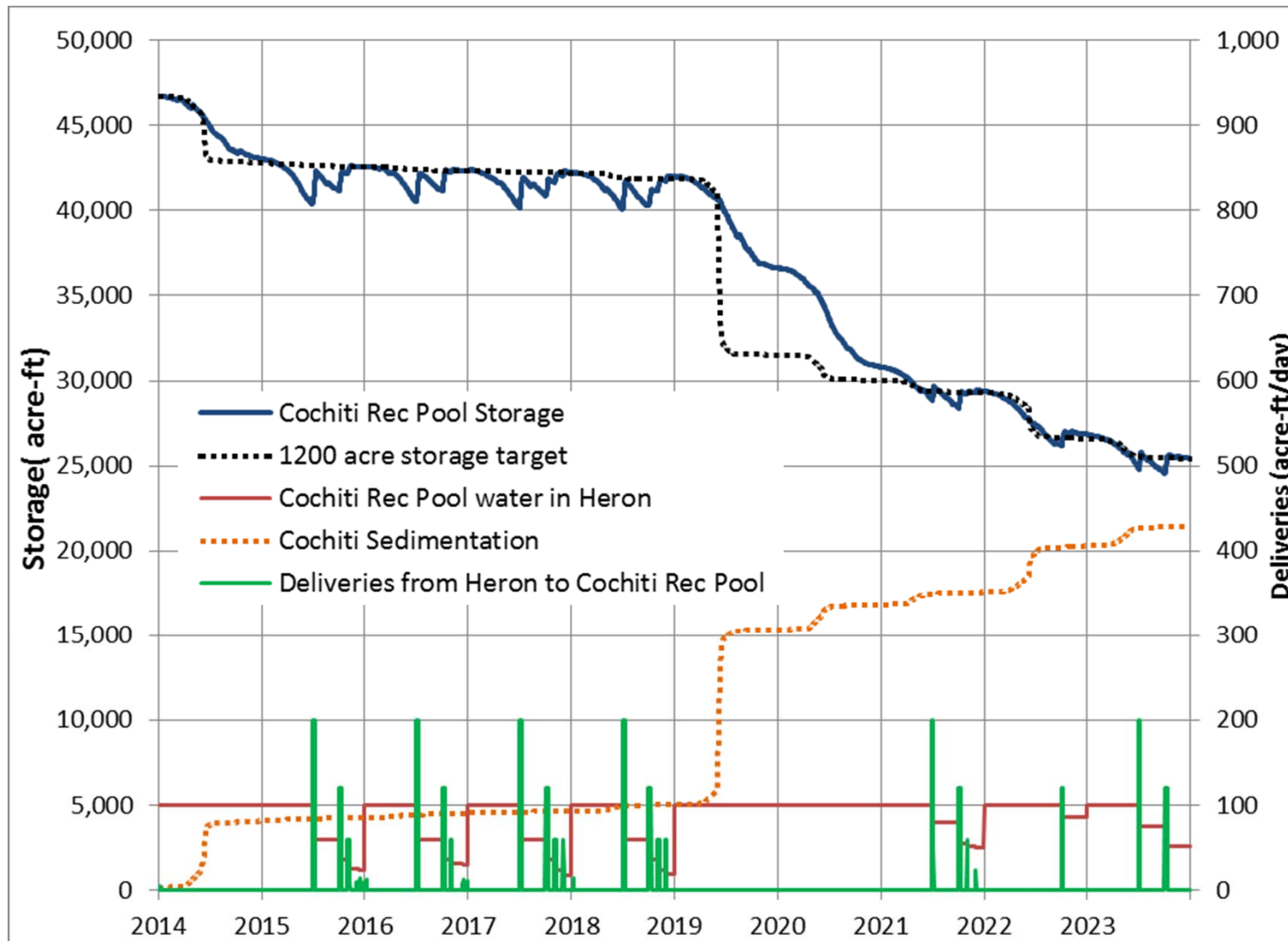
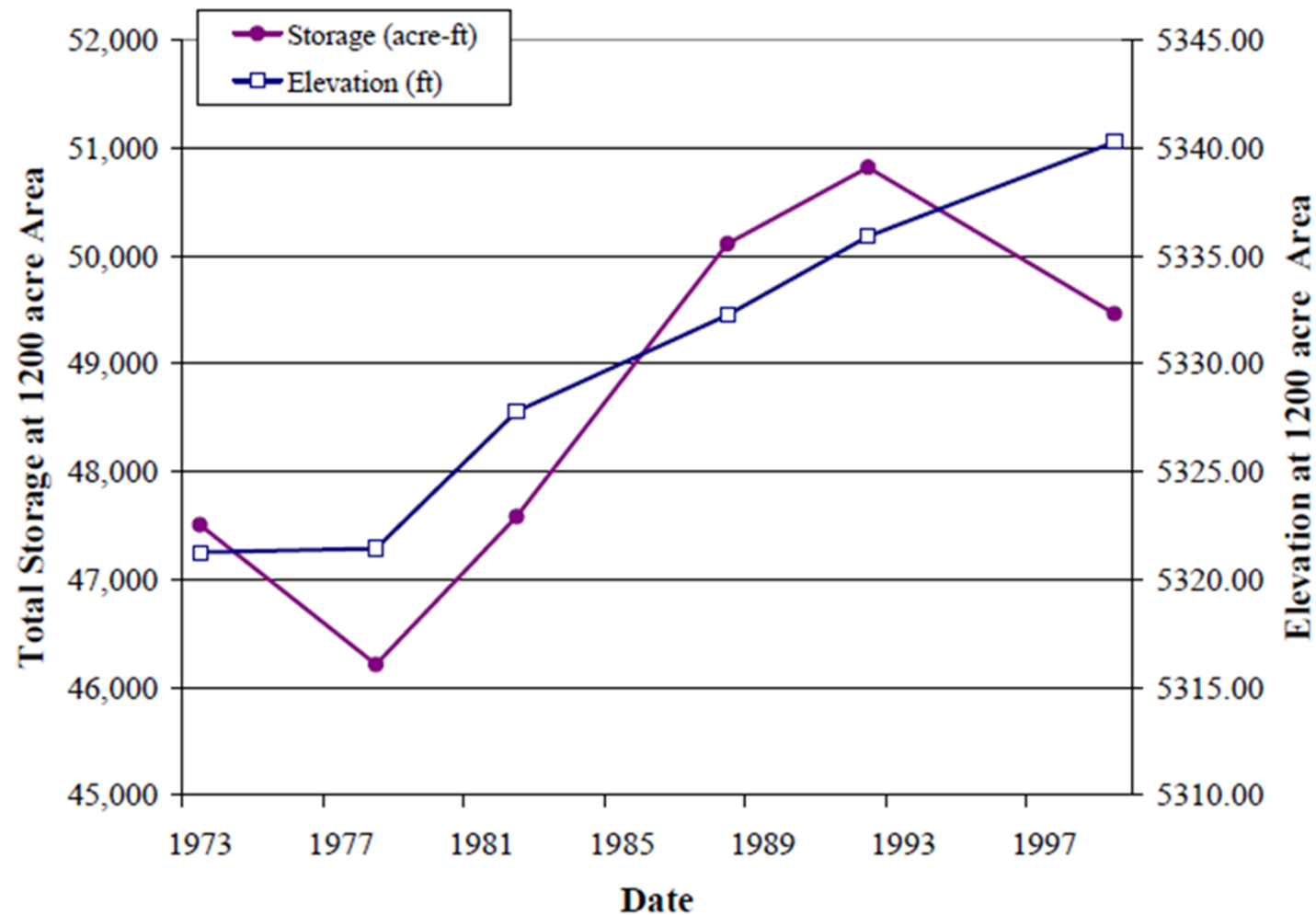


Figure 2: Example Scenario (not part of study): Cochiti Rec Pool Storage, Cochiti Rec Pool water in Heron, and Deliveries from Heron to Cochiti Rec Pool (Targeting 1200 acres). 10% exceedance hydrologic sequence (wettest), 5000 af Allocation, SOP method, With Sedimentation



Sedimentation

Deposition trends and effect on Cochiti storage volume and pool elevation associated with 1200 acre surface area – based on historical bathymetry surveys



Carryover

- URGWOM includes two carryover options
 - Carry over all water remaining in Cochiti Rec Pool account at Heron on January 1
 - Carry over no water on January 1; water remaining in Cochiti Rec Pool account at Heron reverts to the federal pool

- If carryover is enabled, water accumulates from year to year in Cochiti Rec Pool account
 - Reclamation and Tech Team advised disabling carryover

- Possible to use waiver to carryover until April
 - Model is not currently configured to do this

Carryover

- Close approximation in model...
- On December 21, water remaining in Cochiti Rec Pool account at Heron is delivered at a rate of 100 cfs
 - Through December 31 or until remaining water is depleted
 - Only if water is needed at Cochiti (Cochiti is below 1,200 acres)
- For alternate delivery method, November and December deliveries only; waiver until April would not be used
- For SOP method, possible that waiver water could be used to offset evaporative losses in January
- Brings up interesting idea: deliver all remaining water to Cochiti at end of year regardless of whether it's needed

Results

- Average over all sequences all years (50 years)

	4290af allocation		5000af allocation	
	SOP	Alt	SOP	Alt
Average annual Cochiti Rec Pool Evaporation	3,952	3,861	3,958	3,870
Average annual delivered from Heron to Cochiti Rec Pool	4,041	3,983	4,057	3,996
Average annual volume that arrives at Cochiti Rec Pool from Heron	3,947	3,891	3,962	3,904
Average end-of-year shortage(-)/excess(+) at Cochiti Rec Pool	1	252	100	315
% of years with end-of-year shortage	16%	10%	0%	0%

Results

		December 31st Cochiti Surface Area (acre)				
		<i>4290af, SOP delivery method</i>				
Year	Analysis Year	10%	30%	50%	70%	90%
2014	1	1201	1202	1200	1173	1206
2015	2	1201	1202	1213	1205	1208
2016	3	1200	1207	1205	1203	1208
2017	4	1201	1203	1205	1200	1174
2018	5	1202	1197	1201	1211	1203
2019	6	1200	1203	1202	1221	1213
2020	7	1169	1205	1212	1208	1179
2021	8	1204	1202	1211	1212	1152
2022	9	1203	1201	1202	1205	1169
2023	10	1204	1201	1200	1202	1173
Average		1198	1202	1205	1204	1188
AVERAGE ALL		1200				

Results

		December 31st Cochiti Surface Area (acre)				
		<i>4290af, alternative delivery method</i>				
Year	Analysis Year	10%	30%	50%	70%	90%
2014	1	1210	1215	1225	1181	1214
2015	2	1218	1223	1219	1225	1229
2016	3	1220	1229	1223	1223	1223
2017	4	1223	1225	1225	1213	1196
2018	5	1227	1225	1223	1229	1225
2019	6	1225	1208	1227	1223	1219
2020	7	1200	1225	1230	1228	1188
2021	8	1226	1223	1219	1219	1167
2022	9	1209	1206	1223	1223	1196
2023	10	1222	1219	1225	1223	1213
Average		1218	1220	1224	1219	1207
AVERAGE ALL		1217				

Results

		December 31st Cochiti Surface Area (acre)				
		<i>5000af, SOP delivery method</i>				
Year	Analysis Year	10%	30%	50%	70%	90%
2014	1	1201	1202	1200	1223	1206
2015	2	1201	1202	1213	1207	1208
2016	3	1200	1207	1205	1201	1202
2017	4	1201	1203	1205	1200	1213
2018	5	1207	1206	1201	1210	1202
2019	6	1205	1203	1207	1224	1213
2020	7	1221	1205	1211	1210	1224
2021	8	1207	1202	1211	1211	1223
2022	9	1206	1201	1202	1205	1202
2023	10	1204	1201	1205	1202	1202
Average		1205	1203	1206	1209	1209
AVERAGE ALL		1207				

Results

		December 31st Cochiti Surface Area (acre)				
		<i>5000af, alternative delivery method</i>				
Year	Analysis Year	10%	30%	50%	70%	90%
2014	1	1210	1223	1225	1224	1225
2015	2	1223	1223	1219	1231	1231
2016	3	1213	1229	1223	1223	1223
2017	4	1223	1225	1225	1213	1204
2018	5	1227	1225	1223	1229	1225
2019	6	1225	1207	1227	1223	1219
2020	7	1223	1226	1230	1228	1224
2021	8	1219	1223	1219	1219	1223
2022	9	1209	1206	1223	1223	1225
2023	10	1222	1223	1225	1223	1223
Average		1219	1221	1224	1224	1222
AVERAGE ALL		1222				

Results

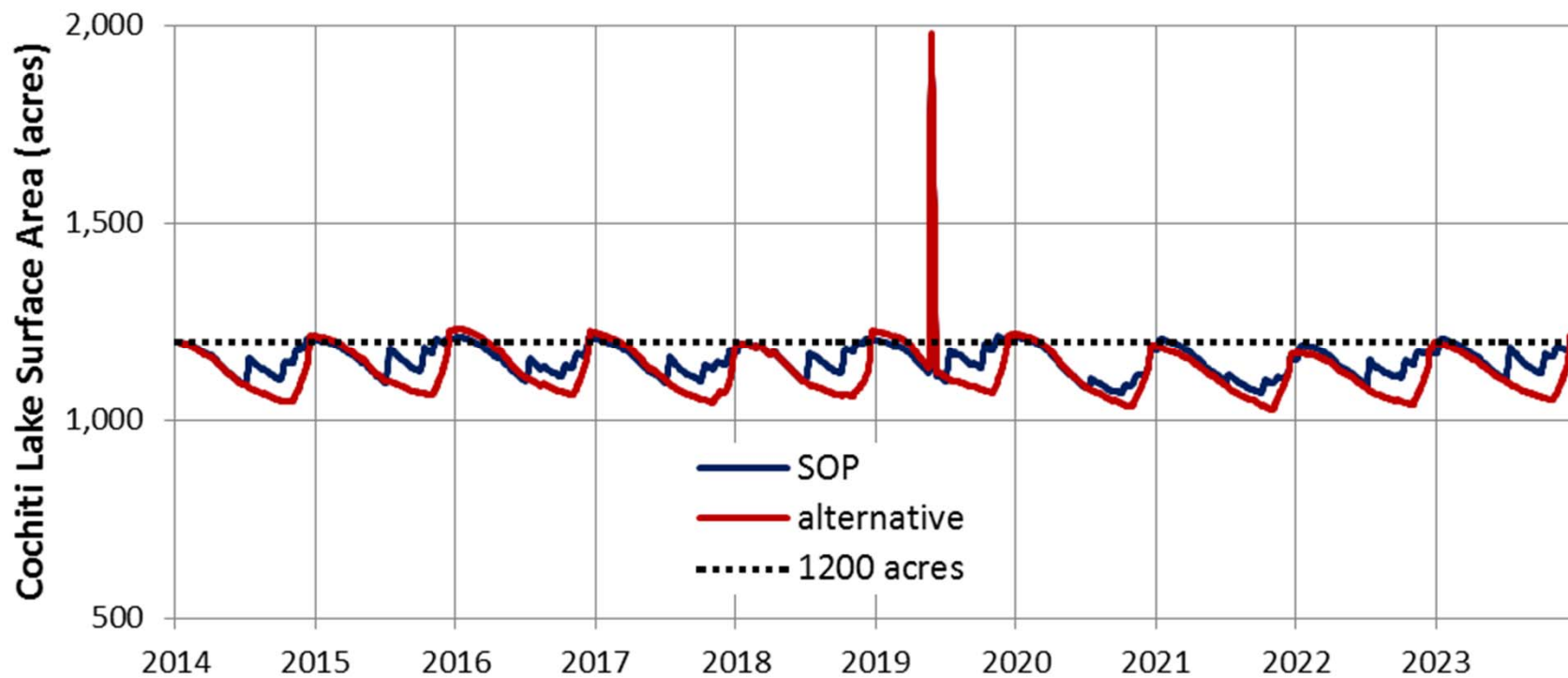
		Following January 12th Cochiti Surface Area (acre)				
		<i>4290af, SOP delivery method</i>				
Year	Analysis Year	10%	30%	50%	70%	90%
2014	1	1199	1205	1200	1208	1202
2015	2	1200	1207	1210	1208	1212
2016	3	1204	1207	1201	1199	1204
2017	4	1199	1200	1208	1200	1193
2018	5	1200	1204	1200	1214	1200
2019	6	1200	1201	1199	1218	1209
2020	7	1209	1201	1209	1205	1207
2021	8	1200	1200	1208	1210	1190
2022	9	1199	1205	1200	1210	1208
2023	10	1204	1201	1200	1202	1173
Average		1201	1203	1203	1207	1200
AVERAGE ALL		1203				

Results

		December 31st Cochiti Surface Area (acre)				
		<i>4290af, SOP delivery method</i>				
Year	Analysis Year	10%	30%	50%	70%	90%
2014	1	1201	1202	1200	1173	1206
2015	2	1201	1202	1213	1205	1208
2016	3	1200	1207	1205	1203	1208
2017	4	1201	1203	1205	1200	1174
2018	5	1202	1197	1201	1211	1203
2019	6	1200	1203	1202	1221	1213
2020	7	1169	1205	1212	1208	1179
2021	8	1204	1202	1211	1212	1152
2022	9	1203	1201	1202	1205	1169
2023	10	1204	1201	1200	1202	1173
Average		1198	1202	1205	1204	1188
AVERAGE ALL		1200				

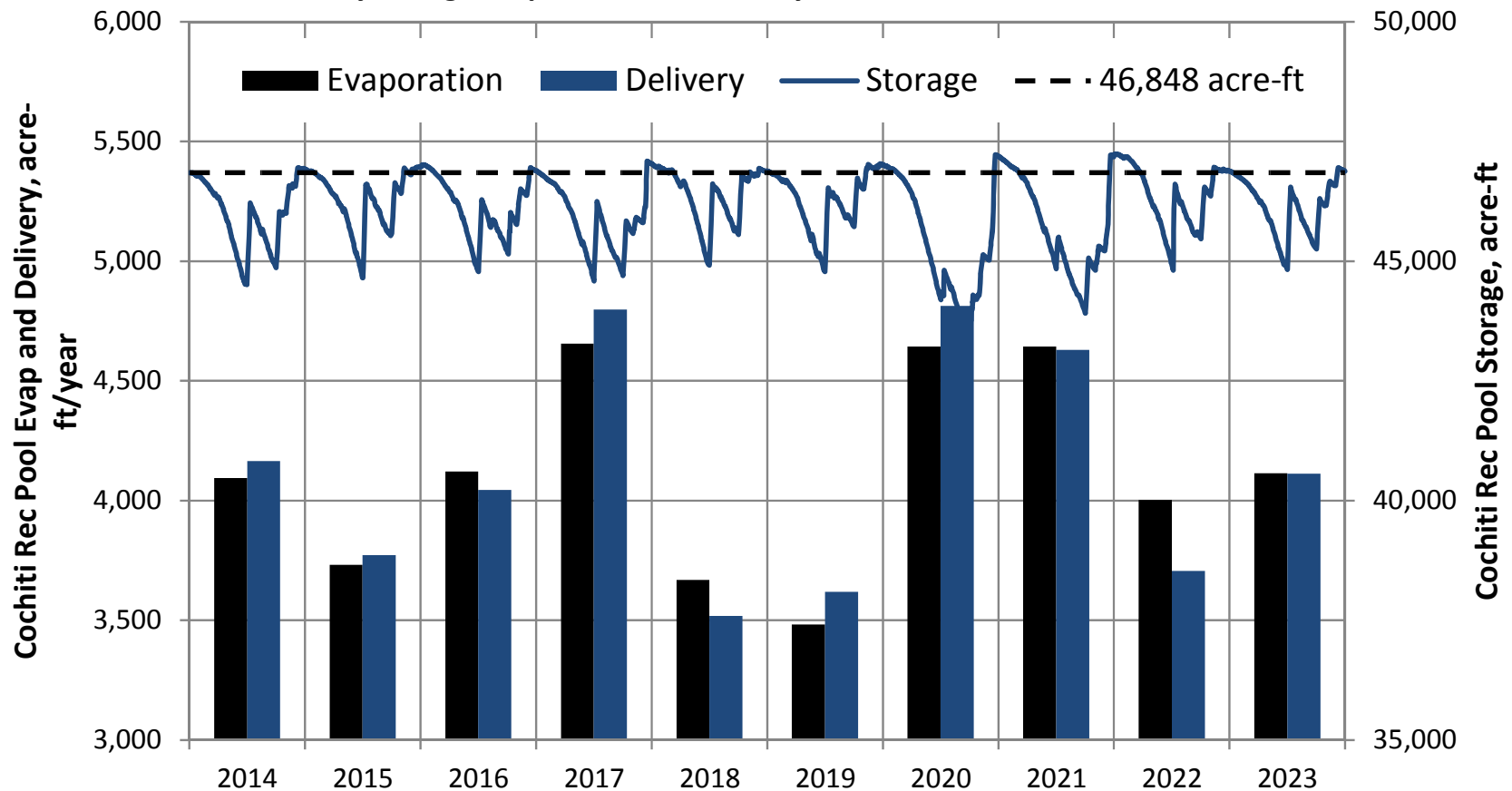
Results

- Cochiti Reservoir surface area; 90% exceedance (driest); 4,290 acre-ft annual allocation



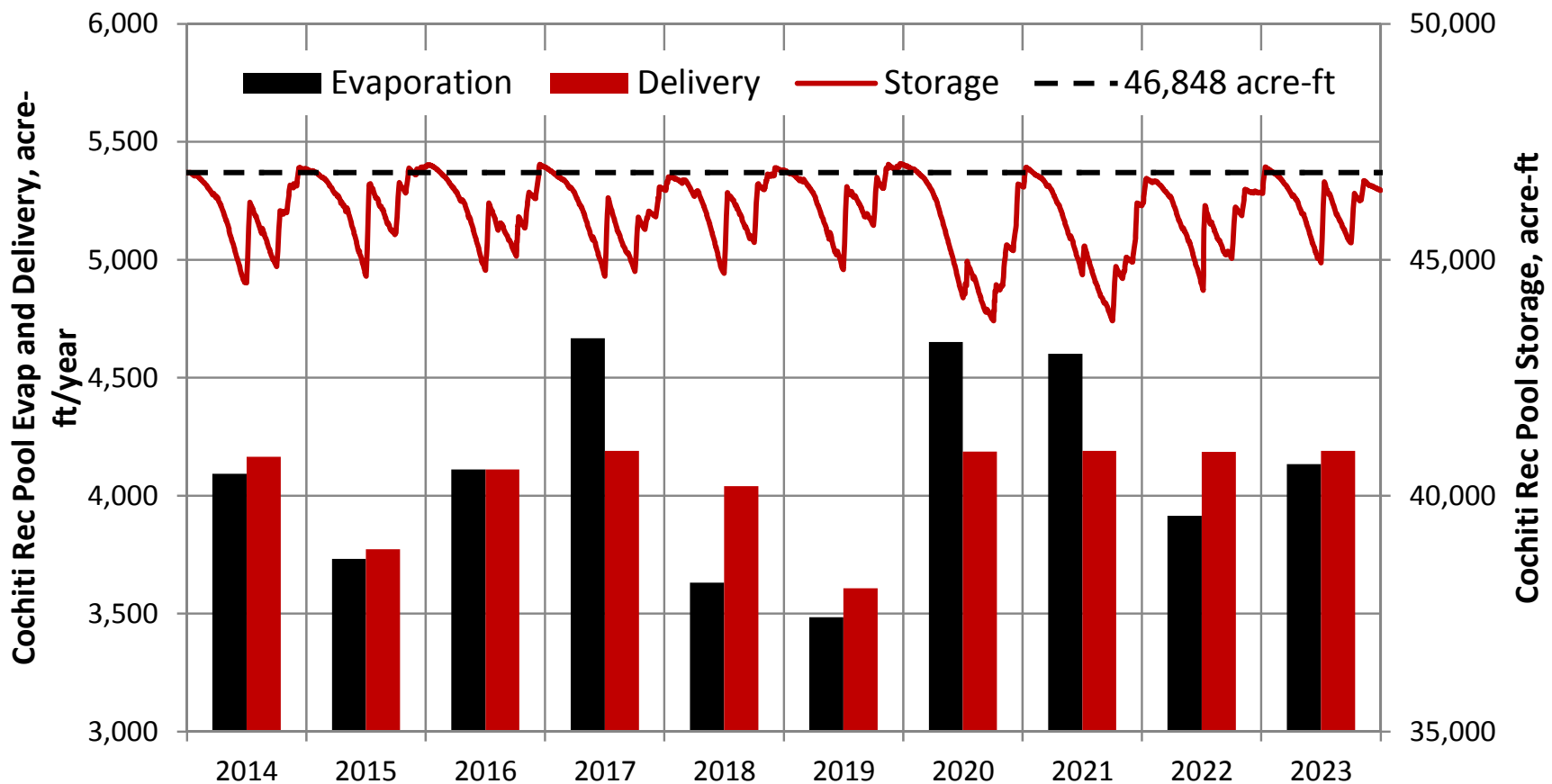
Results

Figure 1: Cochiti Rec Pool annual evaporation and delivery, and daily storage. 90 % exceedance hydrologic sequence, SOP delivery, 5000 af allocation



Results

Figure 1: Cochiti Rec Pool annual evaporation and delivery, and daily storage. 90 % exceedence hydrologic sequence, SOP delivery, 4290 af allocation



Summary

- SOP delivery method results in greater evaporative losses because it maintains a higher pool
- SOP method is not as efficient as alternative
- However, due to January deliveries, the mid-January results are more favorable compared to alternative method at end-of-year

Summary

- SOP – 5,000 AF Allocation: 1,200 acres met 100% of year
- Alternative – 5,000 AF Allocation: 1,200 acres met 100% of year
- SOP – 4,290 AF Allocation: 1,200 acres met 84% of year
- Alternative – 4,290 AF Allocation: 1,200 acres met 90% of year
- By January 12: SOP – 4,290 AF Allocation: 1,200 acres met 94% of year

Other thoughts...

- Model considers evaporative losses at Chochiti Reservoir only
 - Seepage/Leakage at the dam is not in the model
 - Could significantly increase the delivery requirements to return pool to 1,200 surface acres
- One operating idea is to release all Cochiti Rec Pool water in Heron at the end of the year regardless of whether or not it's needed at Cochiti (up to a reasonable limit)
 - Limit shortages if the following year is dry