SJBHM Maintenance Release Modeling

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History of Maintenance Releases on the San Juan River

The San Juan River Recovery Implementation Program (SJRIP) recommends spring peak releases (SPRs) from Navajo Dam for the benefit of endangered fish. These peak releases are designed to target specific flows downstream in the critical habitat reach downstream of the confluence with the Animas River. To achieve the flow goals, the release must be maximized to Navajo Dam's upper limit of 5,000 cfs. Additionally, Reclamation's Dam Safety and US Army Corps of Engineers (USACE) provide flood control guidance to prevent dam overtopping or exceeding of safe channel capacity. Each of these entities utilize a maximum safe release from Navajo Dam of 5,000 cfs.

In recent years, the number of SPRs has dwindled due to basin wide drought and lack of water availability. The channel capacity downstream of Navajo Dam has decreased from 5,000 cfs. Much of this decrease can be attributed to the lack of sustained releases at peak, which clear the channel of sediment, prevent the establishment of channel vegetation, and deter floodplain construction.

The concept of a "Maintenance Release" (MR) was proposed to the SJRIP Program Office in 2016, as a potential mitigation measure to address the loss of channel capacity downstream of Navajo Dam. It was described as one of several mitigation strategies Reclamation was considering, along with channel surveys and public outreach (Appendix E). The one-week release was suggested by Reclamation's Technical Service Center in their 2016 report San Juan River Channel Processes and Flow Conveyance below Navajo Dam, NM (Appendix D).

In 2018, a potential MR was considered early in the year, as there was likely to be no SPR due to poor hydrology. As the spring winter continued to be poor, the MR plan was cancelled to save water.

The following year, 2019, was the first year a MR was conducted. A dry start to the year indicated the possibility of an MR, and as the snowpack continued to build, it became apparent that inflows would be sufficient to replenish the reservoir from the recent drought, with enough water for an short release as well. The MR was initially proposed at the January Navajo Operations and Coordination meeting. It was initially proposed as a 1-day at peak event, which was determined by the inflow forecast at the time. The MR was proposed again at the SJRIP's Biology Committee meeting in February of 2019. At this meeting, feedback to extend the length of the MR was taken into consideration, and the proposed release was extended to 5 days at a peak of 5,000 cfs.

The MR was timed to coincide with the Animas Peak, with the aim to meet some flow goals if possible. The 10,000 cfs flow goal was made for 6 of the recommended 5 days at Four Corners. The 8,000 cfs flow goal was met 9 out of the 10 recommended days.

Cross-sectional surveys were performed prior to the MR, and again after its conclusion. The surveys showed 0.5 to 1-ft of depth difference. Visual surveys along the river indicated scour and debris movement occurred during the release.

Description and Purpose

The SJRIP requested a modeling study on the impacts of various MR scenarios on the SJRBHM model to determine potential effects to operations and flow statistics in the San Juan River Basin. To accomplish this request, Reclamation and the SJRIP held a Hydrologic Modeling Technical Workgroup (HMTW) meeting in January of 2020. At this meeting, one of the agenda items was to develop and discuss a variety of potential MR guidelines and triggers that could be developed into scenarios for modeling.

A follow up document to the meeting provided six MR scenarios based on the concerns and discussion at the meeting. The SJRIP requested these scenarios be modeled to assess impacts to the flow recommendations under a variety of MR operations. The modeling results may be used to inform Reclamation and SJRIP on the potential impacts of any future MRs on the flow recommendations.

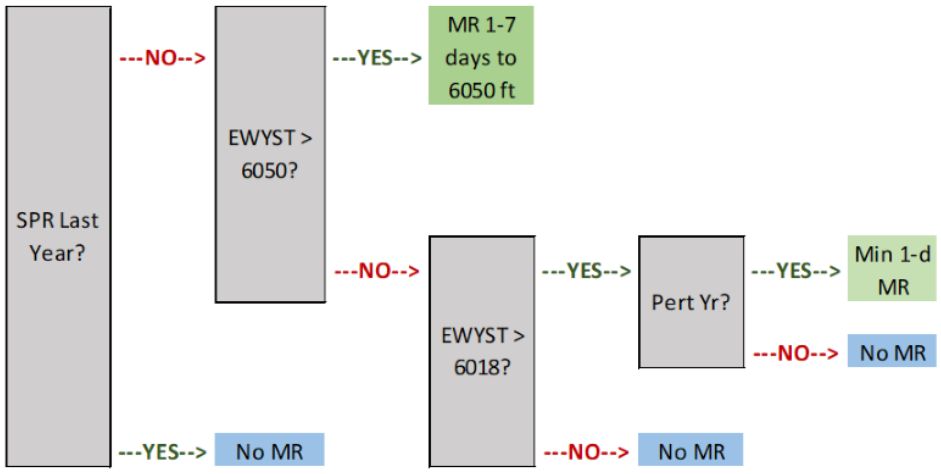
Modeling Scenarios

The MR scenarios are described below, with an additional no-MR scenario. Based on feedback from the Hydrologic Modeling Technical Meeting, each model run was completed under two demands conditions: Baseline (full buildout) demands and Current Conditions demands. For more information on these demands conditions, please refer to the documentation (reference). The analysis consisted of all eight scenarios, each run under baseline demands, and again under current conditions demands, for a total of 16 modeling runs.

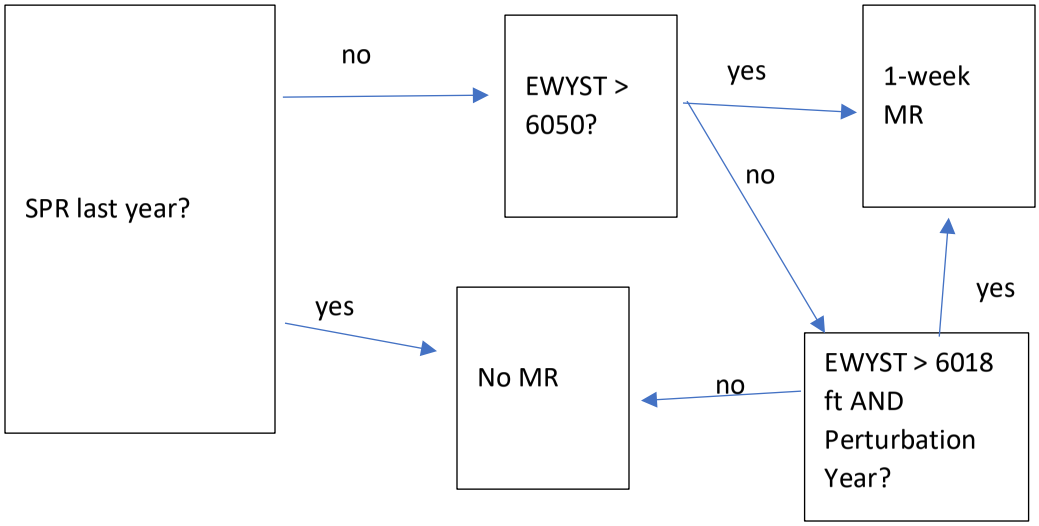
Scenario descriptions:

No MRs: No Maintenance Release modeled. This modeling run is equivalent to the Gen 4 model ruleset in its current state.

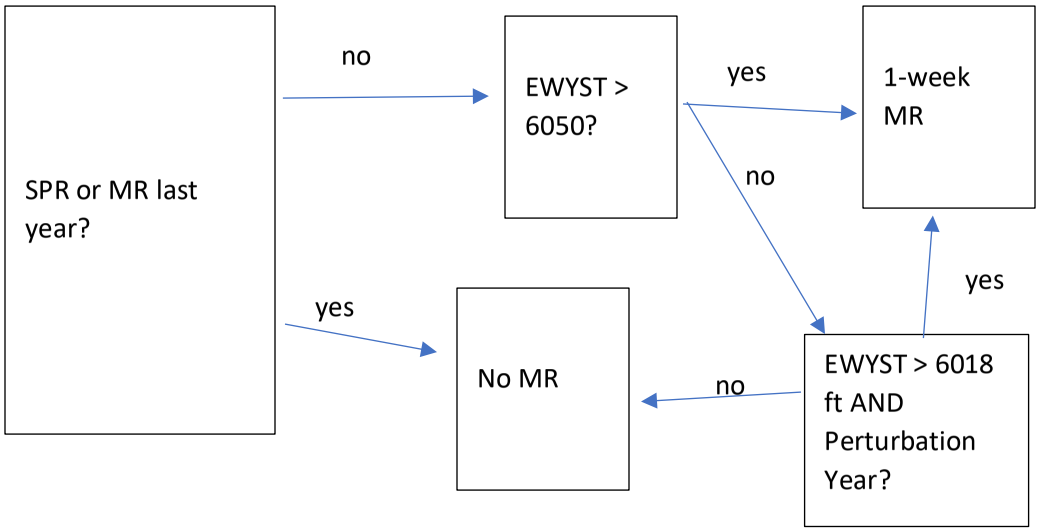
V1.0: This scenario releases a 1-7-day MR when it's been more than one year since an SPR, and when there is water available over the end of water year storage target (EWYST) of 6050 ft OR if there's at least water available over 6018 ft AND it's a perturbation year.



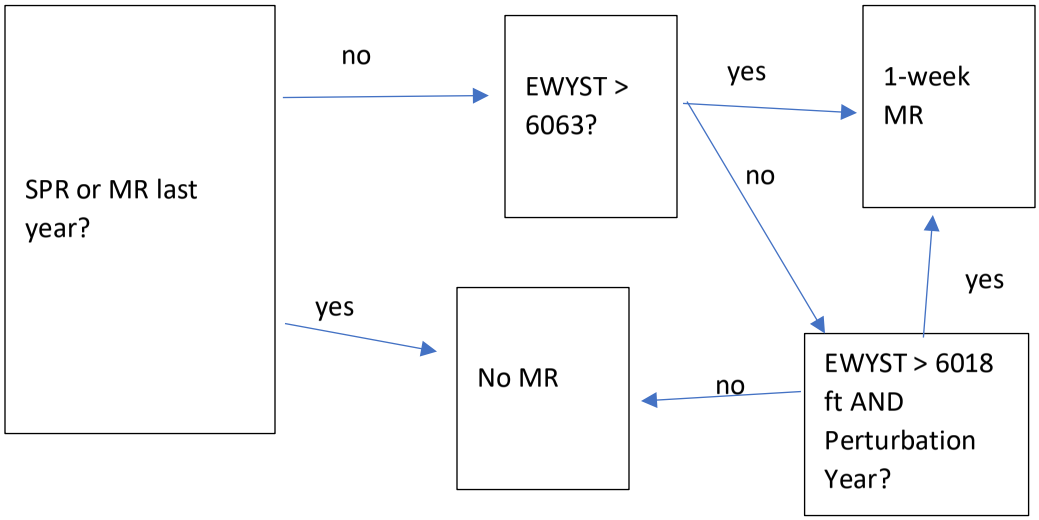
V1.1 This scenario is the same as v1.0 except all MR's have been set at a 1-week release.



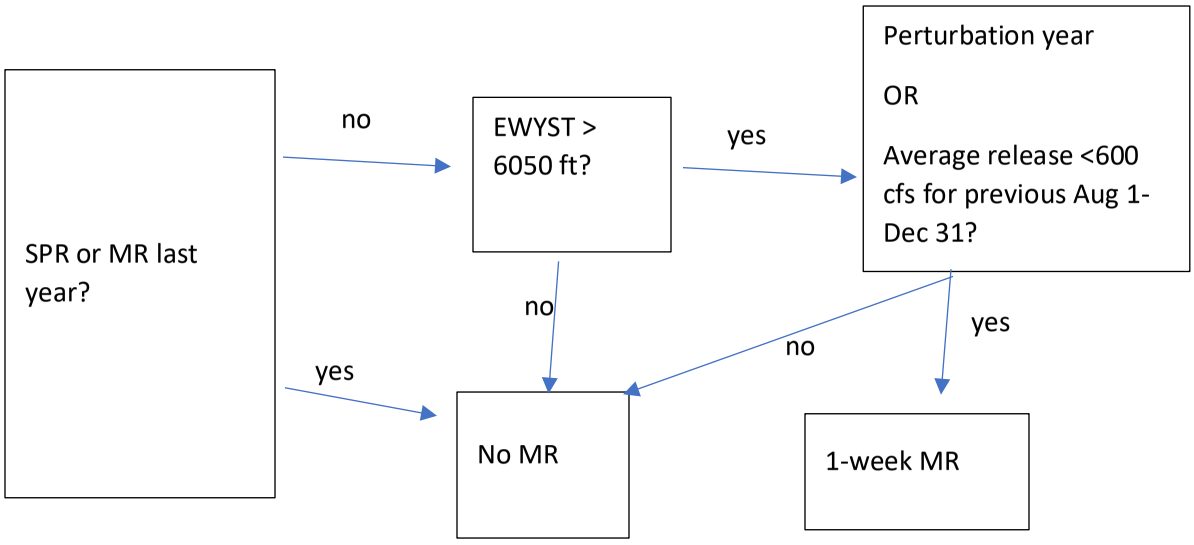
V1.2 This scenario is the same as v1.1, except now the initial trigger will accept a MR or a SPR in the previous year.



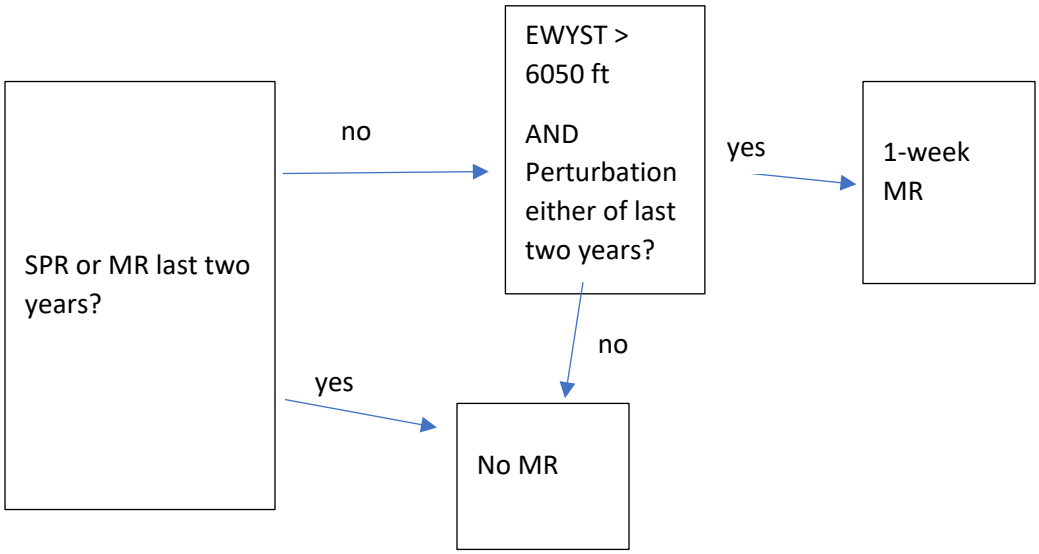
V1.3 This scenario is the same as v1.2 except it uses 6063 ft as the first EWYST decision point. This should result in prioritizing perturbation years over simple duration between releases.



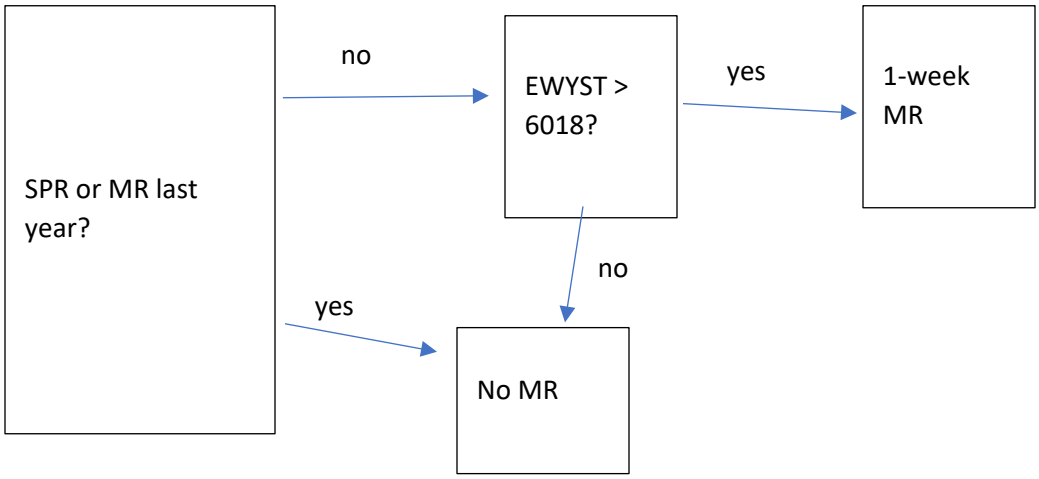
V1.4 This scenario goes back to a 6050 ft EWYST and then checks for either perturbation or above average summer and fall releases. While summer and fall releases are a consideration, it has been used in a more qualitative fashion, and would be used in conjunction with other triggers. The 600 cfs was only chosen as it is above average, but in a year-to-year process the summer releases would be more closely scrutinized to determine if they were likely to be moving enough sediment. That metric would likely need to be supported by channel surveys. Since models cannot model channel survey results, the combination of perturbation year and average summer/fall release are being used.



V1.5 This simplistic rule minimizes MRs and allows two years of no release before initiating an MR. It will then only fire if either of those years were perturbation years AND the EWYST is over 6050 ft.



V1.6 This simplistic rule fires MRs in any year that an SPR is not triggered, so long as the EWYST is above 6018 ft. If it doesn't put the reservoir into a shortage in that year, it triggers a release.



Results

Modeling results from the SJBHM had a similar pattern to the preliminary modeling presented at the HMTW meeting. The scenarios produced anywhere from 6 to 19 MR's throughout the 85 year modeling run under Baseline demands, and 0 to 11 MR's under Current Conditions Demands.

A summary of the model results is shown in Tables 1 and 2 below. Detailed scenario output of flow statistics is in Appendix A.

Table 1. BASELINE DEMANDS								
Maintenance Release Scenario	**No MRs**	**V1.0**	**V1.1**	**V1.2**	**V1.3**	**V1.4**	**V1.5**	**V1.6**
Basin Total Depletion including Offstream (AF)	884,000	882,600	882,400	882,600	880,000	882,700	883,900	882,300
Number of Years (out of 85) with SPR/MR	35	52	51	45	53	43	41	49
% of Years with SPR/MR	41%	61%	60%	53%	62%	51%	48%	58%
Average SPR/MR Frequency (years)	2.4	1.6	1.7	1.9	1.6	2.0	2.1	1.7
# of Yrs with 'Regular' SPRs	35	35	35	35	34	35	35	34
# of Years with MRs	0	17	16	10	19	8	6	15
# of Years with Excess Water > 6063'	22	17	17	17	18	17	18	18
Average SPR/MR "Peak" Length (days)	63	42	43	49	42	51	54	45
Average Days/Year > 2500 at Four Corners	43.5	43.3	43.3	43.3	43.7	43.1	43.0	43.5
Average Days/Year > 5000 at Four Corners	29.6	30.2	30.2	30.0	30.6	30.0	29.8	30.3
Average Days/Year > 8000 at Four Corners	14.9	15.2	15.3	15.2	15.1	15.3	15.3	15.2

Average Days/Year > 10000 at Four Corners	4.4	4.6	4.6	4.6	4.4	4.7	4.7	4.6
Number of Shortage Sharing Years	1	2	2	2	3	2	1	3
Average Navajo Reservoir PE (ft)	6054.2	6052.4	6051.9	6052.6	6051.3	6053.2	6053.7	6052.0

Table 2.	CURRENT CONDITIONS DEMANDS							
Maintenance Release Scenario	**No MRs**	**V1.0**	**V1.1**	**V1.2**	**V1.3**	**V1.4**	**V1.5**	**V1.6**
Basin Total Depletion including Offstream (AF)	718,800	718,700	718,600	718,700	717,500	718,700	718,800	718,600
Number of Years (out of 85) with SPR/MR	50	57	56	54	60	52	50	57
% of Years with SPR/MR	59%	67%	66%	64%	71%	61%	59%	67%
Average SPR/MR Frequency (years)	1.7	1.5	1.5	1.6	1.4	1.6	1.7	1.5
# of Yrs with 'Regular' SPRs	50	49	49	49	49	50	50	49
# of Years with MRs	0	8	7	5	11	2	0	8
# of Years with Excess Water > 6063'	23	21	21	23	22	21	23	22
Average SPR/MR "Peak" Length (days)	60	52	53	55	50	57	60	52
Average Days/Year > 2500 at Four Corners	52.8	52.3	52.4	52.4	52.6	52.6	52.8	52.6

Average Days/Year > 5000 at Four Corners	39.8	40.0	40.0	39.9	40.3	39.9	39.8	40.1
Average Days/Year > 8000 at Four Corners	19.5	19.8	19.8	19.7	19.9	19.7	19.5	19.7
Average Days/Year > 10000 at Four Corners	6.1	6.2	6.2	6.2	6.1	6.2	6.1	6.2
Number of Shortage Sharing Years	1	1	1	1	1	1	1	1
Average Navajo Reservoir PE (ft)	6055.6	6055.2	6055.0	6055.2	6054.0	6055.5	6055.6	6054.5

When analyzing the results and cost-benefits of various scenarios in the above Tables, the main parameters considered were:

1. Number of years with excess water over 6063 ft.
2. Average Days at 8,000 cfs at Four Corners
3. Average Days at 10,000 cfs at Four Corners
4. Number of Shortage Years
5. Average frequency of SPR/MR

Those parameters are shown in Tables 3 and 4 below. The most desireable outcomes would be to:

1. Increase the frequency (lower the average years between events) of large releases,
2. Minimize the loss of years without excess water over 6063 ft (used for adaptive management),
3. Improve, or at least maintain flow statistics at Four Corners, especially for the higher targets of 8,000 and 10,000 cfs, and
4. Minimize any impact on shortage sharing.

A discussion of each parameter follows:

BASELINE DEMANDS								
Maintenance Release Scenario	**No MRs**	**v 1.0**	**v 1.1**	**v 1.2**	**v 1.3**	**v 1.4**	**v 1.5**	**v 1.6**
Average SPR/MR Frequency (years)	**2.4**	1.6	1.7	1.9	1.6	2.0	2.1	1.7
# of Years with Excess Water > 6063'	**22**	17	17	17	18	17	18	18

Average Days/Year > 8000 at Four Corners	**14.9**	15.2	15.3	15.2	15.1	15.3	15.3	15.2
Average Days/Year > 10000 at Four Corners	**4.4**	4.6	4.6	4.6	4.4	4.7	4.7	4.6
Number of Shortage Sharing Years	**1**	2	2	2	3	2	1	3

CURRENT CONDITIONS DEMANDS								
Maintenance Release Scenario	**No MRs**	**v 1.0**	**v 1.1**	**v 1.2**	**v 1.3**	**v 1.4**	**v 1.5**	**v 1.6**
Average SPR/MR Frequency (years)	**1.7**	1.5	1.5	1.6	1.4	1.6	1.7	1.5
# of Years with Excess Water > 6063'	**23**	21	21	23	22	21	23	22
Average Days/Year > 8000 at Four Corners	**19.5**	19.8	19.8	19.7	19.9	19.7	19.5	19.7
Average Days/Year > 10000 at Four Corners	**6.1**	6.2	6.2	6.2	6.1	6.2	6.1	6.2
Number of Shortage Sharing Years	**1**	1	1	1	1	1	1	1

Baseline

Average frequency in years for an SPR or MR: This metric is important for channel maintenance purposes, as the more often a high release of 5,000 cfs is put into the channel, the more likely it is that the channel will be able to safely hold 5,000 cfs. A lower average frequency number is a sign that SPRs and MRs are occurring on a more frequent basis. Under baseline depletions, scenarios 1.0 and 1.3 offer the best frequency rates, though any of the MR scenarios improve this metric. It is important to note that v1.0 is the only scenario that allowed MRs lower than 7 days to be triggered.

Number of years with Excess Water > 6063 ft: This shows how many years there is sufficient water for adaptive management purposes. Under all scenarios, this number is reduced, as water that would have been "moved" for adaptive management purposes, is now moved for MRs under the scenarios. Interestingly, the reduction in years of excess water is very similar for all scenarios (from 22 with no MRs to 17-18). Therefore, there is not much variance from scenario to scenario on the impact of MRs to the ability to utilize flows for adaptive management.

Average days per year > 8,000 cfs at Four Corners: The addition of MRs produced a slight improvement in the 8,000 cfs flow goal statistics. Overall the increase may not be statistically significant, except to note that there was not apparently a negative impact on the flow statistics.

Average days per year > 10,000 cfs at Four Corners: Similarly, a small improvement in the 10,000 cfs flow goal was noted in all MR scenarios. Though the improvement is small, it is likely due to short releases occurring in years where the Animas was able to contribute. Because the 10,000 cfs flow goal only needs to occur for 5 days, and most of the MR's modeled are 7 days long, the model is able to meet the 10,000 cfs flow goal with a shorter release like an MR.

Number of Shortage Sharing Years: Nearly all scenarios experienced an increase in the number of years the basin went into shortage. Under the No MR scenario, there is one shortage year (2002). Under all MR scenarios except v1.5, the shortage increased slightly to also include 2003 with a small shortage. Two scenarios, v 1.3 and 1.6, were the most extreme with 3 years of shortage. It should be noted that while additional years qualified as "shortage", the additional shortages were small.

Current Conditions

Average frequency in years for an SPR or MR: Under current conditions, v1.3 produced the lowest average frequency in years between SPRs or MRs.

Number of years with Excess Water > 6063 ft: In scenario v1.2 and v1.5, there was no change to the number of years with excess water for adaptive management. Following closely behind was v1.3 and 1.6, with only a one-year reduction.

Average days per year > 8,000 cfs at Four Corners: Similar to the modeling done under Baseline demands, there was a small but consistent statistical improvement on the 8,000 cfs flow goal at Four Corners. None of the scenarios caused a reduction in this metric.

Average days per year > 10,000 cfs at Four Corners: Again, a small improvement was noted in the 10,000 cfs flow goal, and none of the scenarios caused a reduction in this metric. Scenario v1.3 showed no change to this metric.

Number of Shortage Sharing Years: There was no change to the number of years in shortage under any scenarios with Current Conditions demands.

Conclusions

The scenarios with the most desirable outcomes change from Baseline to Current Conditions demands scenarios. Therefore, what is the most beneficial MR scenario now, may not be the same when depletions reach Baseline.

Under baseline depletions, v 1.5 has the lowest impact to shortage sharing and adaptive management water but does not provide much of an increase in high release frequency. Scenarios v1.0 and v1.1 produce improvements to high release frequency, however, they both result in an additional year of shortage sharing. Since v1.0 includes short duration (<7 days) releases, some releases may not be long enough to provide the desired benefits to the channel Therefore, v1.1 is considered the "next best" scenario under Baseline demands.

Under current conditions, v1.3 has the most benefit to the frequency of releases, while minimizing impacts to shortage and adaptive management water, however, it reduces the total number of years with adaptive management water by 1 year. Scenarios 1.2 and 1.5 provide very similar (though slightly longer) average frequency between high releases, but do not have impacts to adaptive management water. Version 1.5 produced no MR's during the entire run under current conditions.

Overall, the addition of MR's in any scenario produced similar results across each scenario. The variance between No MRs and any scenario was high, and the relative impact to years of excess water and flow statistics was relatively low between scenarios. This is summarized below:

Baseline Demands:

Average Frequency improved by 0.4 to 0.8 years.

Years with excess water > 6063 ft decreased by 4-5 years

Average Days per year > 8,000 cfs at Four Corners improved by 0.2 to 0.4 days

Average days per year >10,000 cfs at Four Corners improved by 0 to 0.3 days

Number of Shortage Sharing years increased by 0-2 years.

Current Conditions Demands:

Average Frequency improved by 0 to 0.3 years.

Years with excess water > 6063 ft decreased by 0-2 years

Average Days per year > 8,000 cfs at Four Corners improved by 0 to 0.4 days

Average days per year >10,000 cfs at Four Corners improved by 0 to 0.1 days

Number of Shortage Sharing years did not change under any scenario.

As was pointed out during the Hydrologic Modeling Technical Workgroup Meeting in January, a major limitation to this study is the lack of sedimentation analysis preceding and informing this modeling. While Riverware does not have the ability to process sediment motion at this time, Reclamation recognizes that these results may change once proper sedimentation studies are performed.

Appendices

A. Complete Results: Depletion tables and Flow Statistics
B. Proposed MR Scenarios
C. WMJ comments
D. San Juan River flow processes technical memo 2016
E. Proposed Navajo Channel Capacity Strategy 2016