

Progress Report

Wind-Bighorn Basin Plan Update

Wind-Bighorn Basin Advisory Group

November 12, 2009



Wyoming Water Development Commission
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MWH

Presentation Outline

- Review Goals of Basin Plan Update
- General Progress Report
- Presentation of Draft Model Results
- Introduction to Project Opportunities Discussion
- Next Steps

All information and results contained herein are presented as DRAFT. All results are subject to change. Final results and information to be included in draft final Technical Memoranda and Basin Plan Report.



Goals of Basin Plan Update

- ***Update Planning Tools*** to Include Most Recent 5 Years (Extended Drought)
- ***Develop Strategies*** to Help Meet the Needs of the Basin as they are Identified by the Planning Process
- ***Promote and Enhance Stakeholder Dialog*** Through Basin Advisory Group Meetings



Scope-of-Work

• Tasks

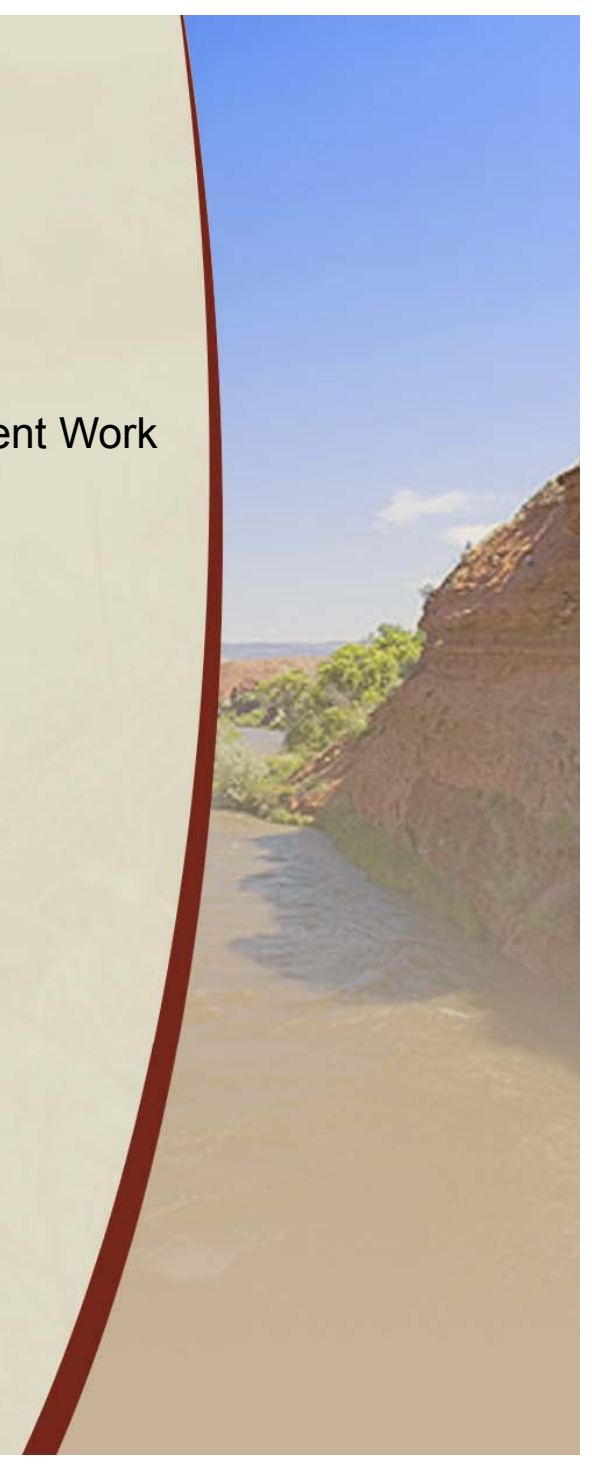
* Current Work

- Task 1. Meetings
- Task 2. Literature Review
- Task 3. Surface Water Profile Update *
- *Task 4. Available Surface Water Determination **
- *Task 5. Demand Projections **
- *Task 6. Future Water Use Issues and Topics **
- *Task 7. Strategies **
- Task 8. Presentation Tool
- Task 9. Discretionary Task
- Task 10. Basin Planning Report

• Deliverables

- Technical Memoranda
- Technical Analysis Products and Models

Basin Planning Report



Task 3. Surface Water Profile Update - Progress

Task	Title	Status
3A	Agricultural Water Use	Draft To Be Submitted Nov
3B	Municipal and Domestic Water Use	WWDC Review of Draft
3C	Industrial Water Use	WWDC Review of Draft
3D/3E	Recreational and Environmental Water Use	WWDC Review of Draft
3F	Water Use From Storage	WWDC Review of Draft
3G	BAG Water Related Concerns	WWDC Review of Draft
3H	Water Law and Water Administration	Received Comments From WWDC

Task 4. Available Surface Water Determination

Task	Title	Status
4A	Surface Water Hydrology	WWDC Review of Draft
4B	Spreadsheet Model and Hydrologic Database	Draft Underway
4C	Available Surface Water Determination	Draft Underway

Task 6. Future Water Use Issues and Topics

Task	Title	Status
6	Surface Water Hydrology	Draft Underway
6A	Issues Affecting Future Water Use Opportunities	Internal Draft Complete
6B	Water Quality Issues	Internal Draft Complete
6C	Climate	Internal Draft Complete
6D	Conservation	Internal Draft Complete
6E	Watershed Planning	Internal Draft Complete

Task 7. Strategies
Task 8. Presentation Tool
Task 10. Report

Task	Title	Status
7	Process for Developing Strategies	WWDC Review of Draft
8	Ongoing	To Be Completed – Feb 2010
10A	Draft Report	To Be Completed – Dec 2009
10B	Climate	To Be Completed – Feb 2010

Task 4

Available Surface Water Determination (Surface Water Modeling)



Introduction to Spreadsheet Models

- Purpose of This Model
 - Provide Database of Basin Information
 - Verify Water Use From Task 3
 - Determine Available Flow for Future Use
 - Assess Effects of Future Water Use
- Products
 - Surface Water Diversion Shortages
 - Available Flow given Compact Requirements and Instream Flows
 - Estimated Streamflow Within Reaches
 - General Effects of Tribal Futures Projects



Description of Spreadsheet Models

- Microsoft Excel Platform
- Hydrology
 - Dry, Average, Wet Year
 - 1973-2008
- Scenarios
 - Historical (Calibration)
 - Full Supply (Low Demand Scenario)
 - Full Supply With Riverton East (Mid Demand Scenario)
 - Full Supply With All Futures Projects (High Demand Scenario)



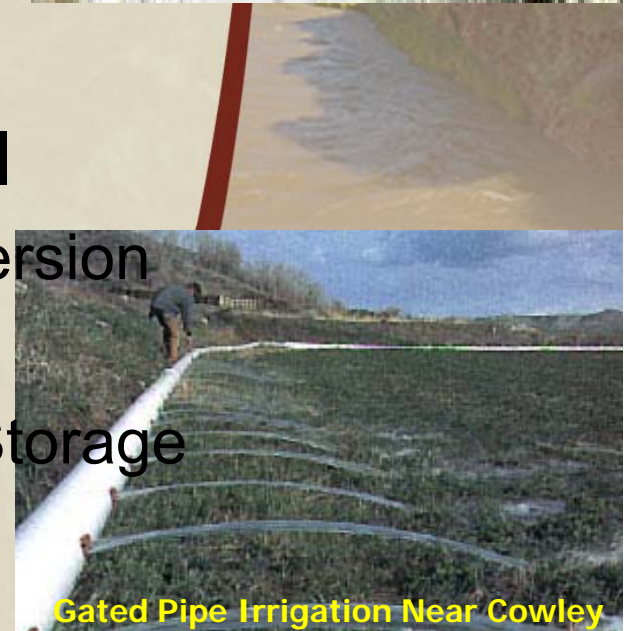
Wind-Bighorn Models

Basin	Sub-Basin	Number of Nodes
Yellowstone	Madison	5
	Yellowstone	22
Clarks Fork	Clarks Fork	75
Wind	Upper Wind	159
	Little Wind	68
	Popo Agie	83
	Lower Wind	117
Bighorn	Upper Bighorn	95
	Owl Creek	80
	Nowood	124
	Lower Bighorn	86
	Greybull	124
	Shoshone	189
Total	13 Total	1227



What The Model Does and Does Not Contain

- What **Is** Included in the Model
 - USGS/SEO Streamflow Gages
 - SW Diversions/Consumptive Use
 - Return Flows
 - Reservoirs Greater Than 500 ac-ft
 - Dry/Average/Wet Year Hydrology
- What **Is Not** Included in the Model
 - Irrigation Systems Past Point of Diversion
 - Municipal Water Systems
 - Time-Series Analysis of Carryover Storage
 - Explicit Modeling of Water Rights



Limitations of Spreadsheet Models

- Models Do Not “Operate” Storage – Historical Releases
 - Storage Will Not Operate Well for Substantial Changes from Historical Operations
- No Carryover Storage Analysis
 - No Simulation of Multi-Year Droughts
- No Water Rights
 - Shortage Results Generally Only Valid at Basin Level



Yellowstone River Compact

- Clarks Fork
 - 40% Wyoming, 60% Montana
 - Clarks Fork at Edgar (06208500)
 - Adjust for White Horse Canal
- Bighorn River
 - 80% Wyoming, 20% Montana
 - Bighorn River near Bighorn (06254500)
 - Remove Little Bighorn
 - Adjust for Yellowtail Contents

Note: Error in percentage of Clarks Fork to Wyoming (60%) and Montana (40%) was noted following presentation. Numbers to be adjusted accordingly

	Clarks Fork	Bighorn
Gaged Flow (ac-ft)	728,000	2,587,000
Adjusted Flow (ac-ft)	735,000	2,398,000
Wyoming Portion (ac-ft)	294,000	1,918,000

Update to Spreadsheet Models

- Originally Developed in Previous Basin Plan
- Connection to Wind-Bighorn Database
 - New Database Developed as Part of Update
 - Houses All Model Data in Single File
 - Direct Connection Using
 - Allows Easy Updates of Data in Future
- Consolidation to Single Model for Each Condition
- Recalibration
 - Developed Auto Calibrate Feature
- Model Runs
 - Developed Batch Run Feature

Yellowstone and Clarks Fork

- Shortages

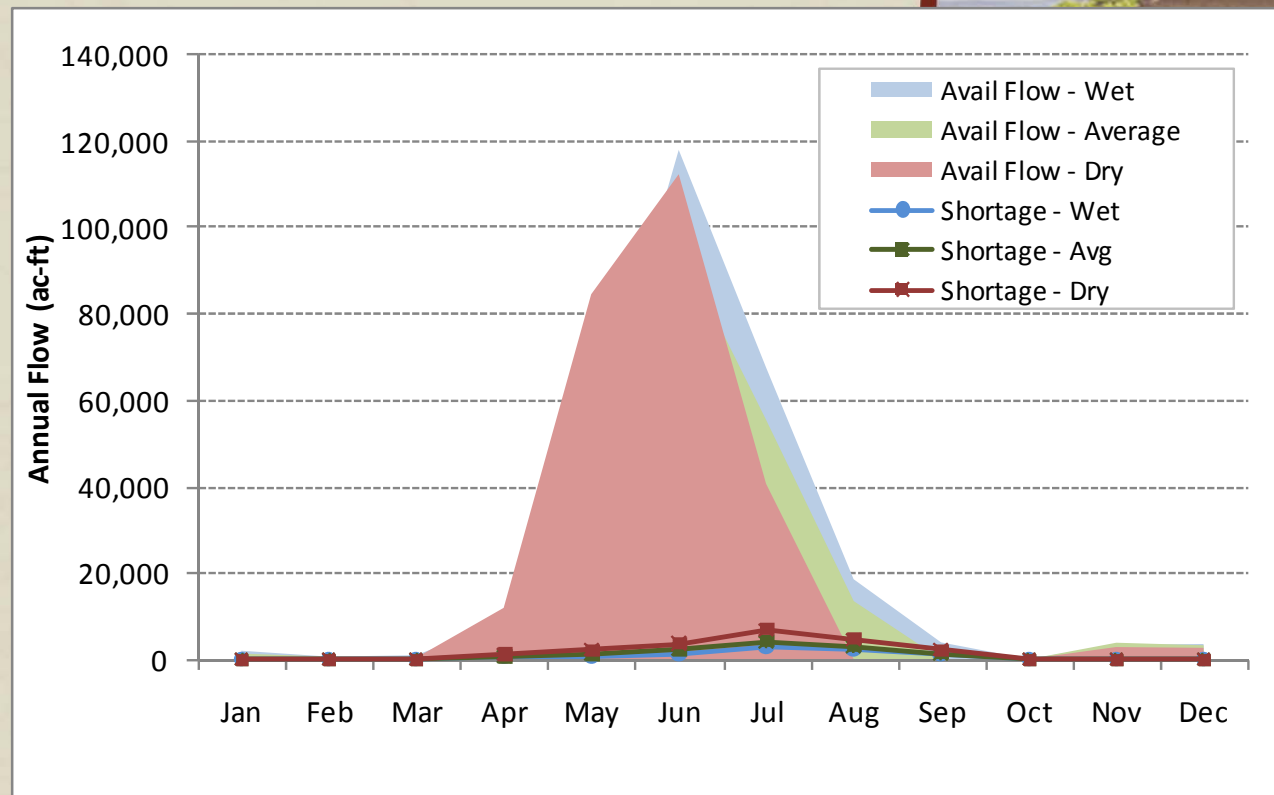
Basin	Full Model Diversions (af)	Basin Shortage (af)			Basin Shortage (%)		
		Dry	Avg	Wet	Dry	Avg	Wet
Madison/Gallatin	0	0	0	0	0%	0%	0%
Yellowstone	0	0	0	0	0%	0%	0%
Clarks Fork	66,187	21,170	13,028	8,531	32%	20%	13%
Sub-Total	66,187	21,170	13,028	8,531	32%	20%	13%

- Available Flow

Basin	Reach	Available Flow (af)		
		Dry	Avg	Wet
Madison/Gallatin	Reach 600: Madison River	428,664	428,664	428,664
Yellowstone	Reach 400: Yellowstone River above Lamar River Confluence	1,333,160	1,333,160	1,333,160
Clarks Fork	Reach 200: Clarks Fork River from Sunlight Creek to Bennett Creek	274,502	274,502	274,502

Yellowstone and Clarks Fork

- Minor Shortages in Tributaries
- Water Available on Mainstem and Tributaries



Wind - Shortages

- Full Supply (Low Demand)

Basin	Full Model Diversions (af)	Basin Shortage (af)			Basin Shortage (%)		
		Dry	Avg	Wet	Dry	Avg	Wet
Upper Wind	907,902	146,795	46,146	46,477	16%	5%	5%
Little Wind	345,299	72,804	38,105	27,799	21%	11%	8%
Popo Agie	143,343	16,391	10,747	9,364	11%	7%	7%
Lower Wind	67,540	18,672	14,631	10,292	28%	22%	15%
Sub-Total	1,464,084	254,661	109,629	93,933	17%	7%	6%

- Full Supply with All Futures (High Demand)

Basin	Full Model Diversions (af)	Basin Shortage (af)			Basin Shortage (%)		
		Dry	Avg	Wet	Dry	Avg	Wet
Upper Wind	1,061,639	329,901	116,472	87,934	31%	11%	8%
Little Wind	349,530	72,804	38,105	27,799	21%	11%	8%
Popo Agie	143,343	16,391	10,747	9,364	11%	7%	7%
Lower Wind	84,826	18,672	14,631	10,292	22%	17%	12%
Sub-Total	1,639,337	437,767	179,955	135,390	27%	11%	8%

Wind – Available Flow

- Full Supply (Low Demand)

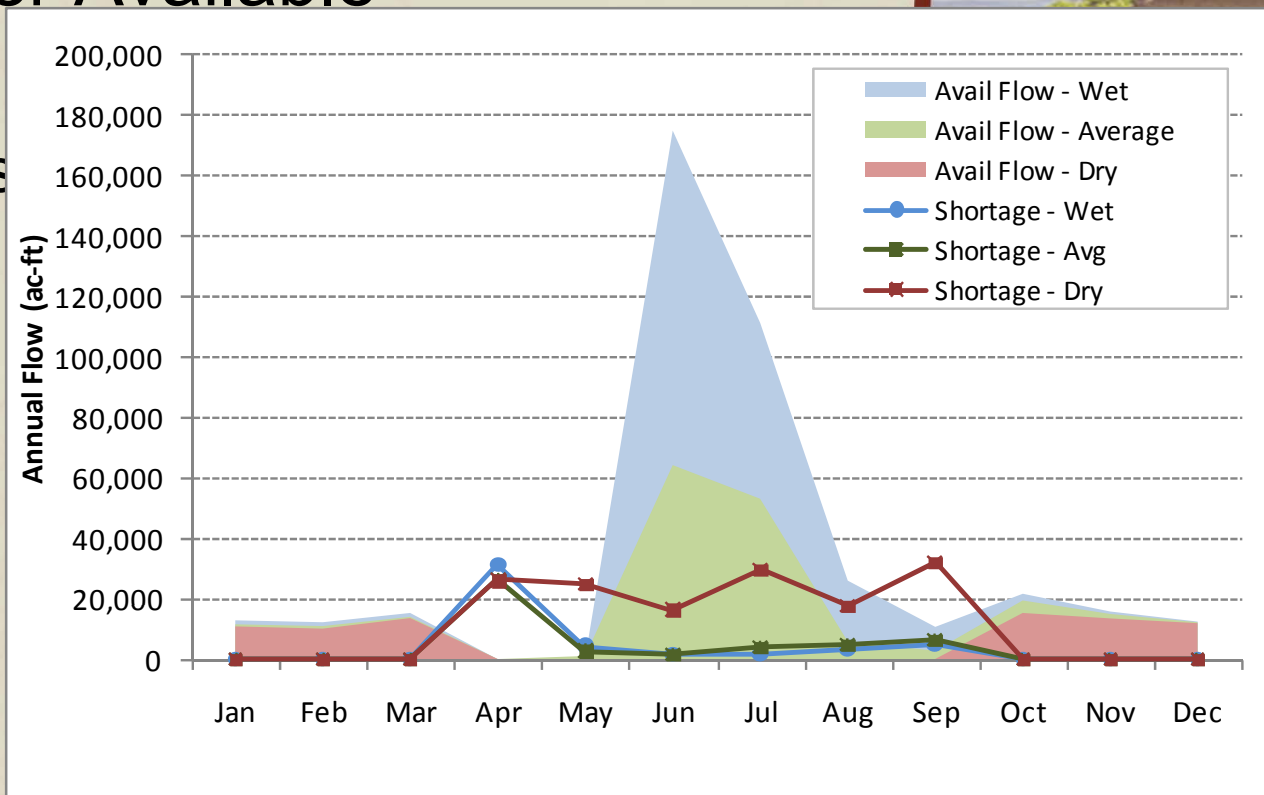
Basin	Reach	Available Flow (af)		
		Dry	Avg	Wet
Upper Wind	Reach 300: Wind River from East Fork to Bull Lake Creek	77,222	211,563	413,499
Little Wind	Reach 500: Little Wind River	38,520	79,677	128,122
Popo Agie	Reach 580: Popo Agie River	38,520	79,677	128,122
Lower Wind	Reach 600: Wind River from Little Wind Confluence to Boysen Reservoir	455,979	661,445	900,939

- Full Supply with All Futures (High Demand)

Basin	Reach	Available Flow (af)		
		Dry	Avg	Wet
Upper Wind	Reach 300: Wind River from East Fork to Bull Lake Creek	73,771	136,637	312,687
Little Wind	Reach 500: Little Wind River	38,520	79,677	128,122
Popo Agie	Reach 580: Popo Agie River	38,520	79,677	128,122
Lower Wind	Reach 600: Wind River from Little Wind Confluence to Boysen Reservoir	416,093	601,240	820,375

Upper Wind

- Early Season Shortages
- Dry-Year Shortages Year-Round
- Mainstem Water Available
 - Dry Years
 - Average Years
 - During Runoff

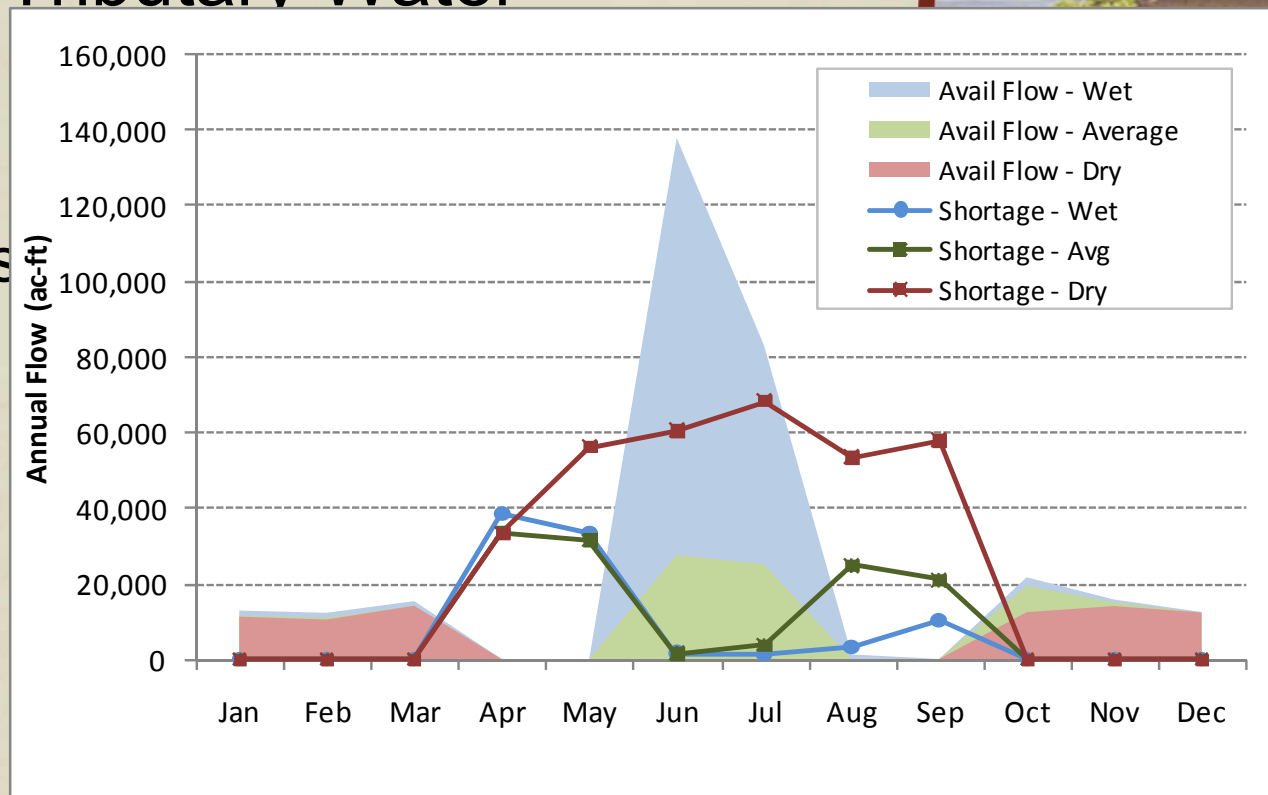


Upper Wind - All Futures Projects

- Early and Late Season Shortages
- Substantial Dry-year Shortages
- Mainstem and Tributary Water

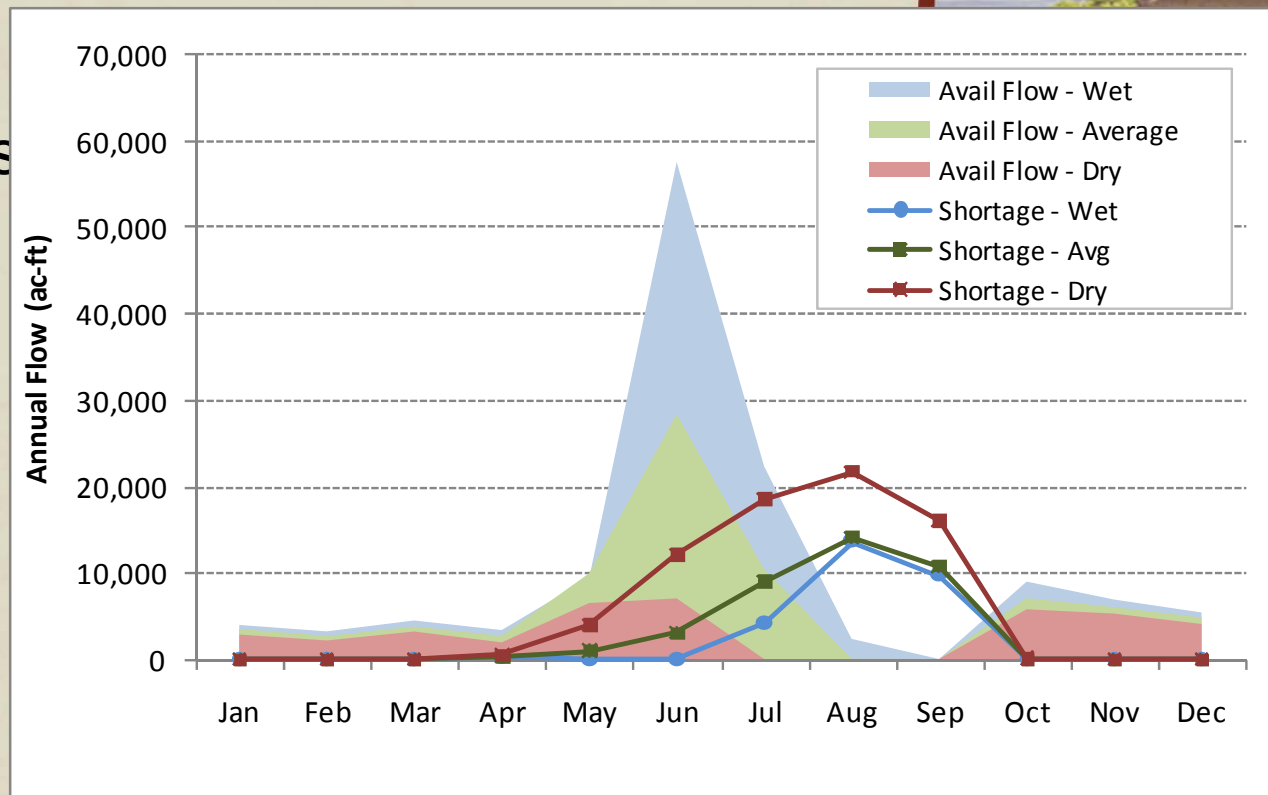
Available

- Wet Years
- Average Years
- During Runoff



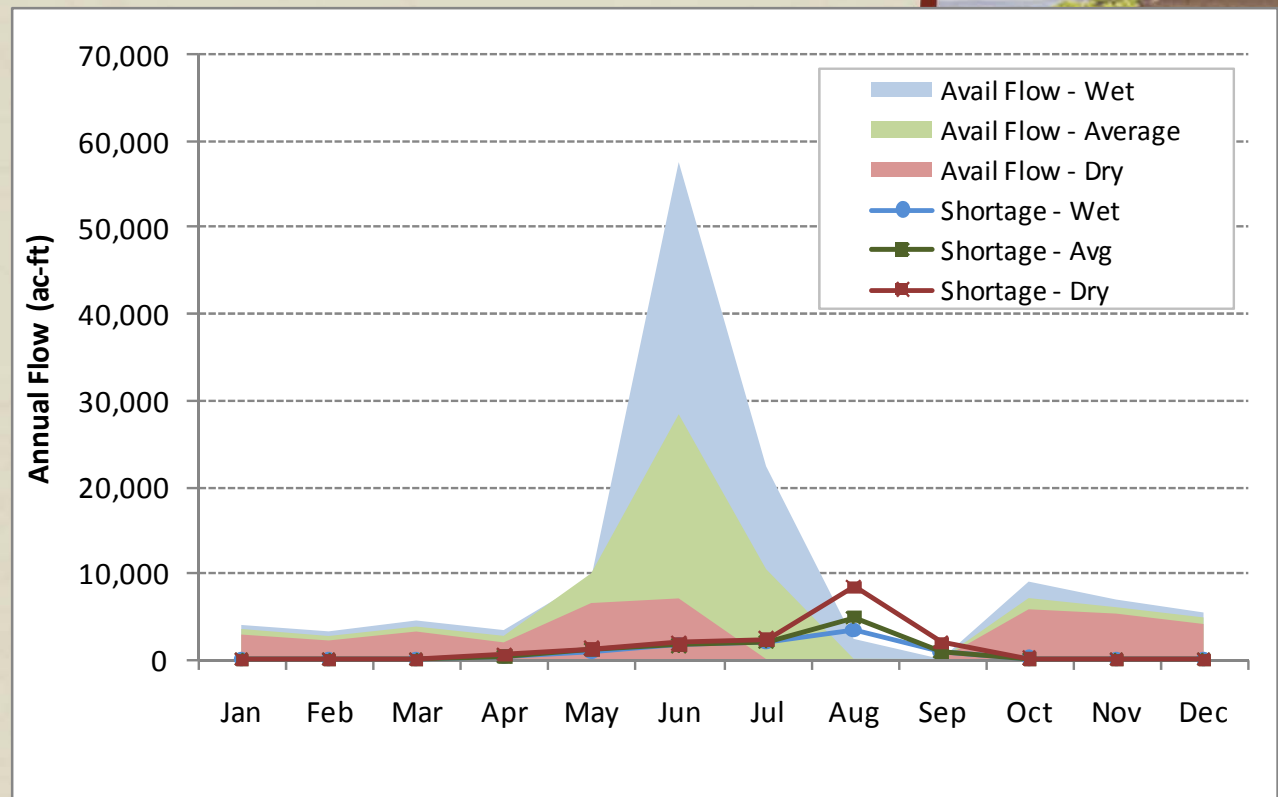
Little Wind

- Late Season Shortages – All Years
- Mainstem and Tributary Water Available
 - Wet Years
 - Average Years
 - During Runoff



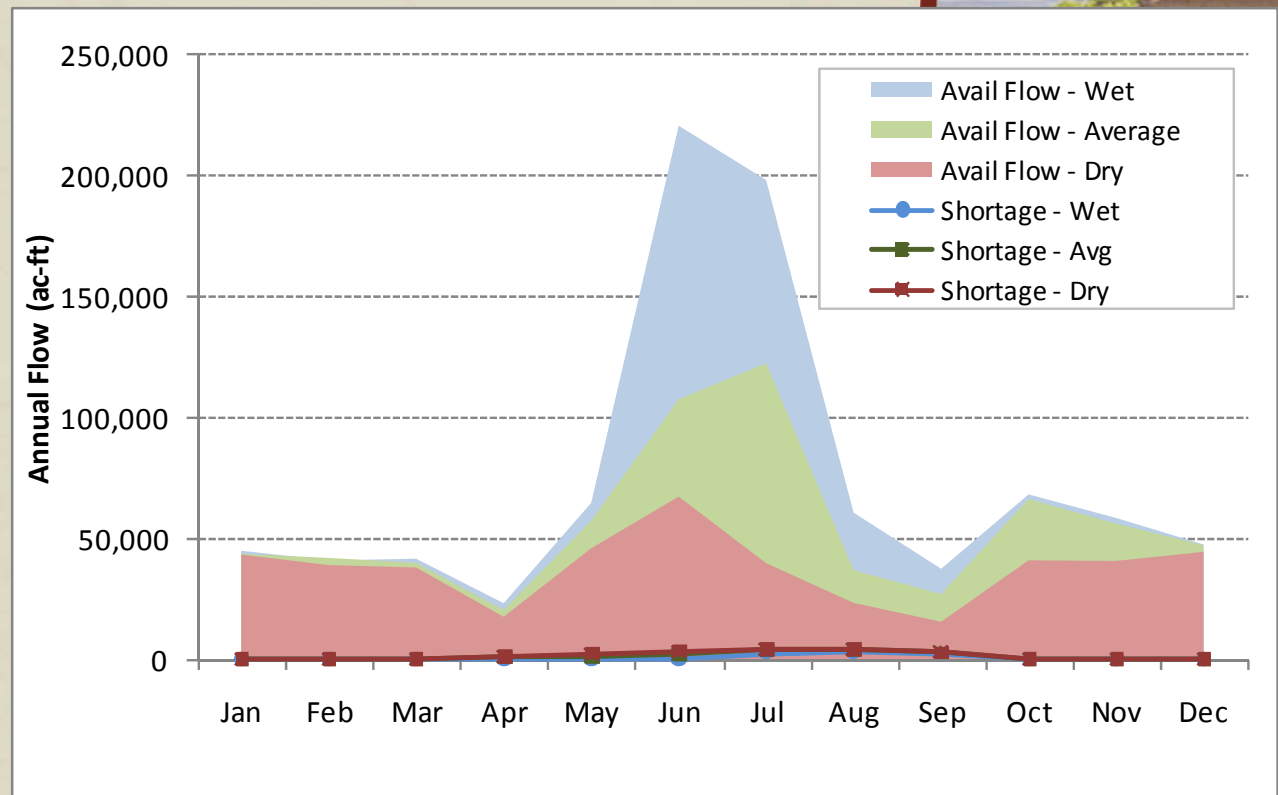
Popo Agie

- Minor Late Season Shortages
- Available Flow During All Years



Lower Wind

- Minor Tributary Shortages
- Water Available on Mainstem and Tributaries



Bighorn - Shortages

- Full Supply (Low Demand)

Basin	Full Model Diversions (af)	Basin Shortage (af)			Basin Shortage (%)		
		Dry	Avg	Wet	Dry	Avg	Wet
Upper Bighorn	389,741	17,303	10,242	6,738	4%	3%	2%
Owl Creek	110,562	53,947	25,949	22,328	49%	23%	20%
Nowood	130,577	13,628	9,739	8,019	10%	7%	6%
Lower Bighorn	152,178	29,782	16,544	10,324	20%	11%	7%
Greybull	518,816	134,814	69,556	48,089	26%	13%	9%
Shoshone	693,892	23,041	12,753	4,902	3%	2%	1%
Sub-Total	1,995,765	272,514	144,782	100,399	14%	7%	5%

- Full Supply All Futures (High Demand) - Same As Low Demand

Bighorn – Available Flow

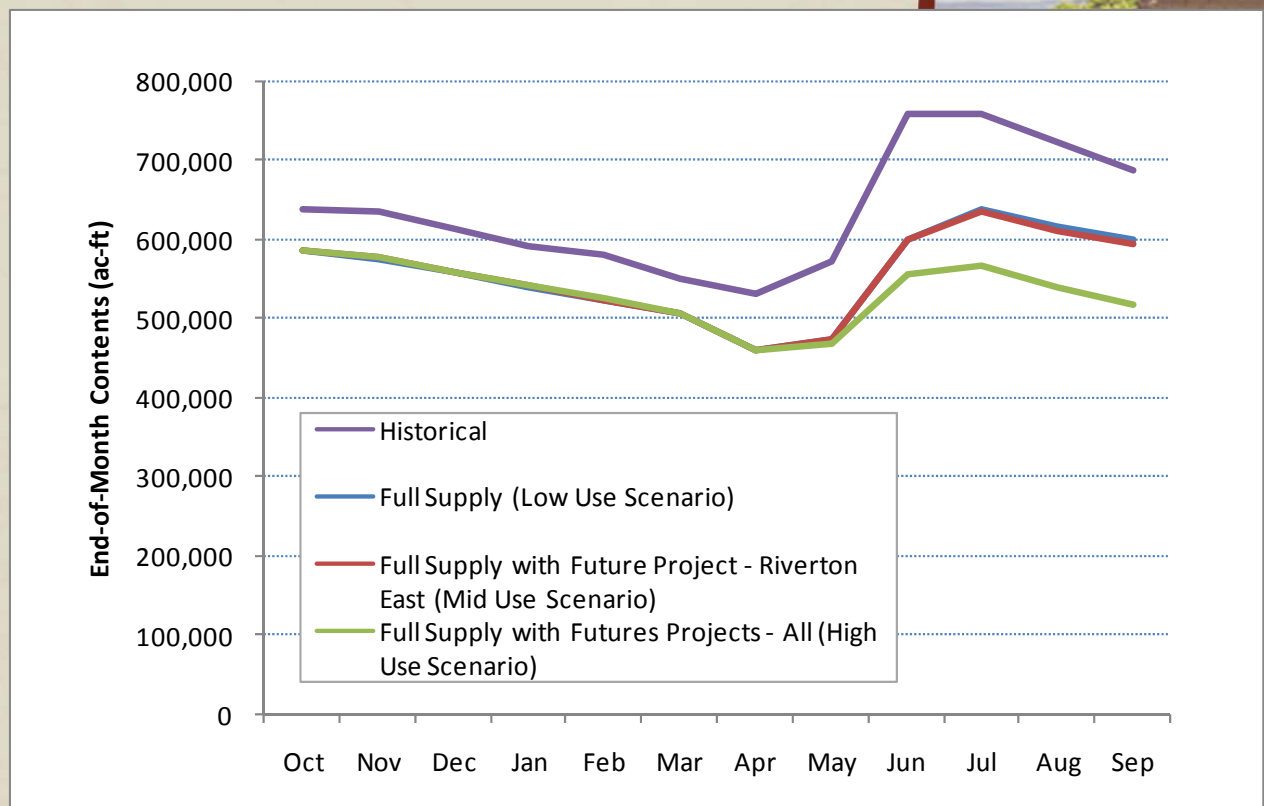
- Full Supply (Low Demand)

Basin	Reach	Available Flow (af)		
		Dry	Avg	Wet
Upper Bighorn	Reach 100: Bighorn River to Owl Creek	640,445	955,665	1,369,559
Owl Creek	Reach 200: Owl Creek from N. & S. Fork Conf. To Mud Cree Conf.	3,648	13,512	18,825
Nowood	Reach 700: Nowood River from Ten Sleep Ck. To Paint Rock Ck.	158,385	189,052	215,459
Lower Bighorn	Reach 1500: Bighorn River at Shell Creek	873,455	1,269,323	1,800,826
Greybull	Reach 1300: Greybull River below Wood River	45,769	67,941	109,852
Shoshone	Reach 2300: Shoshone River below Buffalo Bill Reservoir	309,358	504,126	581,368

- Full Supply All Futures (High Demand)
Same as Low Demand

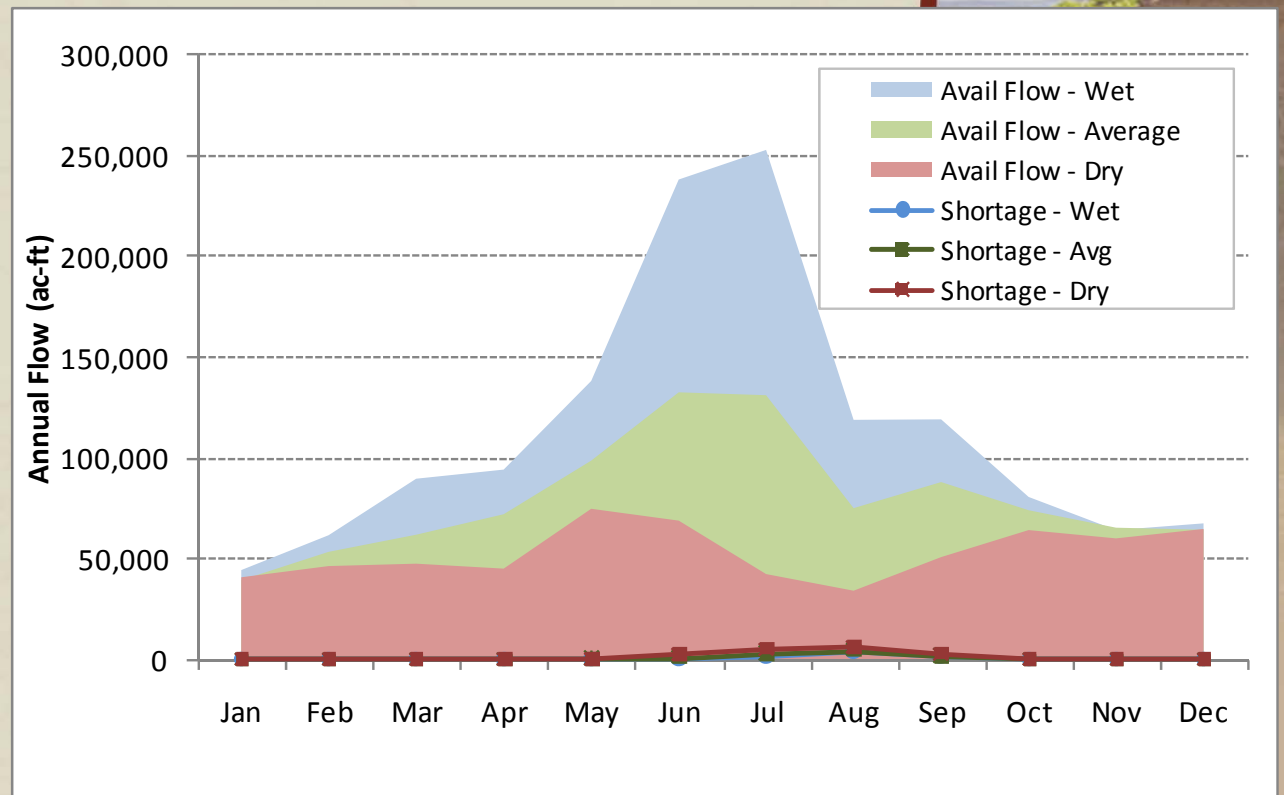
Boysen Storage Comparison

- Model Does Not Account for Effects Below Boysen
- Futures Projects Will Cause Decline in Storage



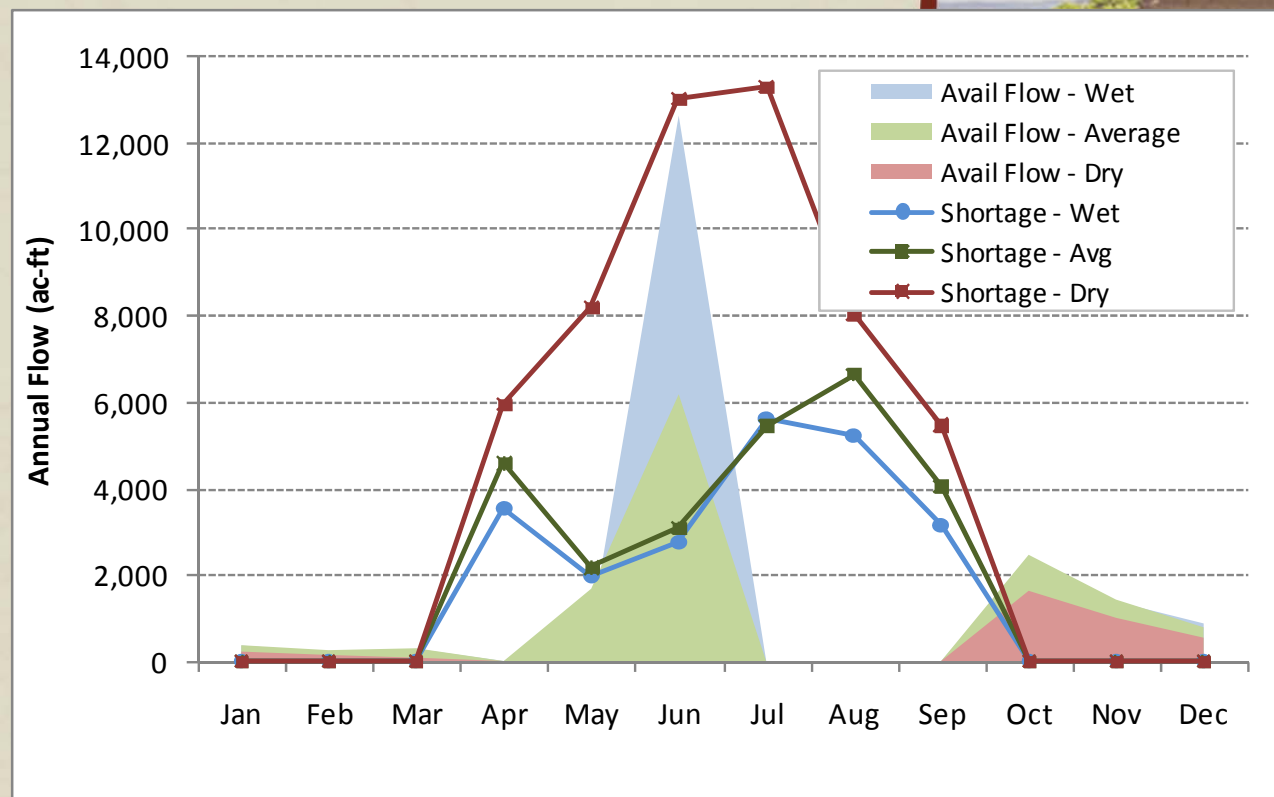
Upper Bighorn

- Minor Shortages in Tributaries
- Available Flow on Mainstem and Tributaries



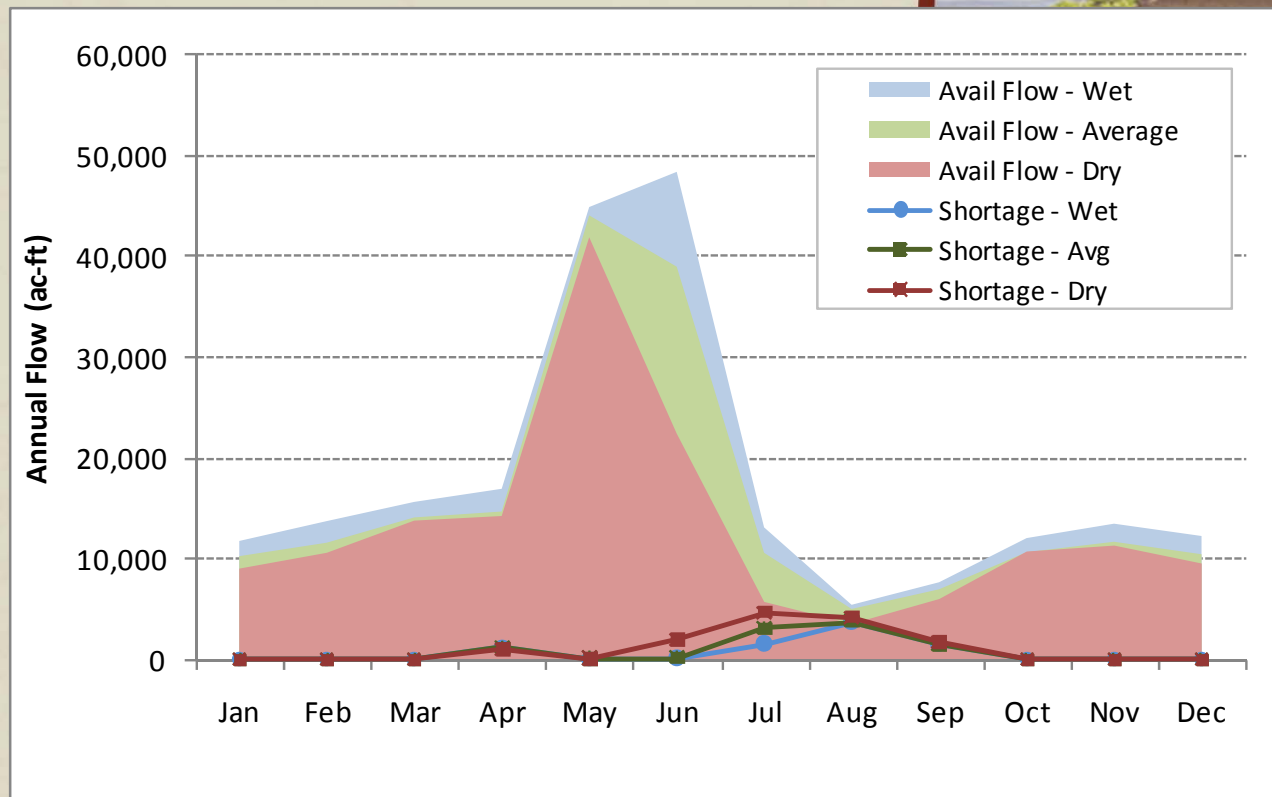
Owl Creek

- Substantial Shortages During All Years
- Inadequate Available Flow to Meet All Demands



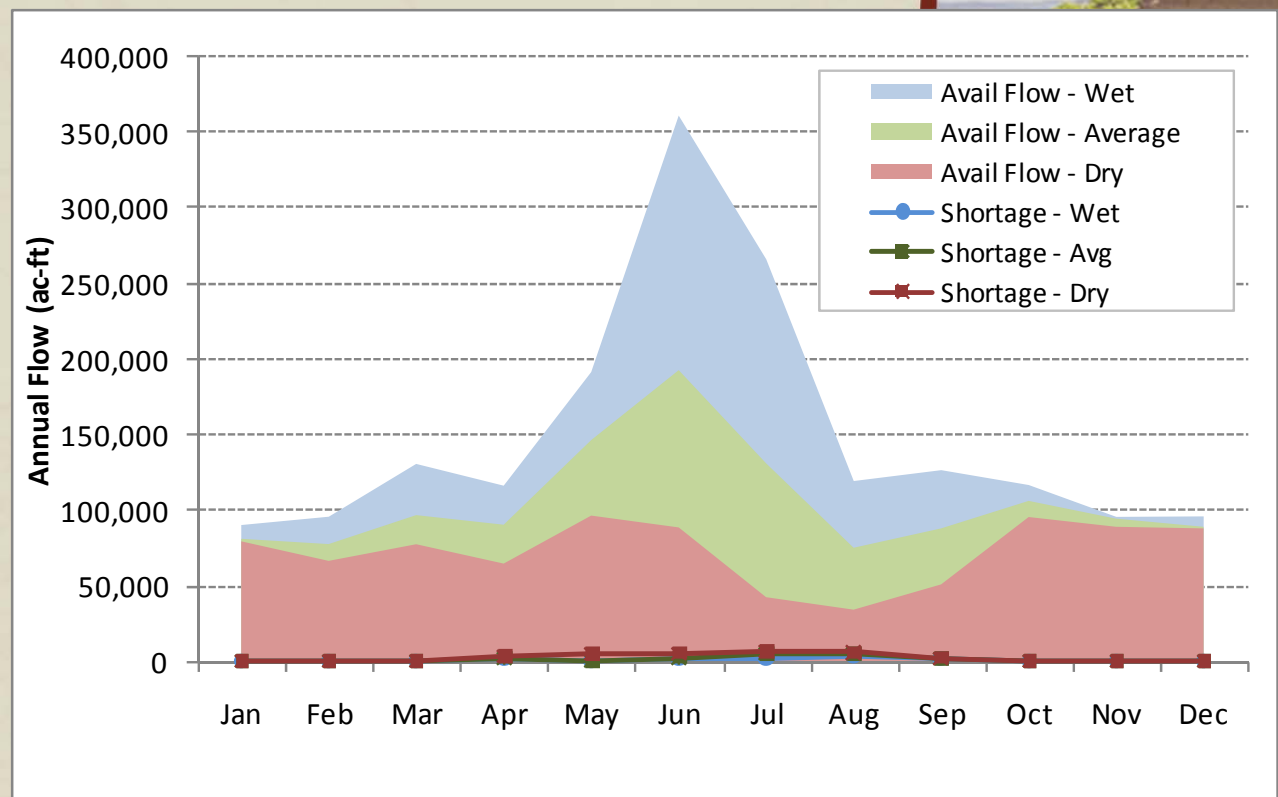
Nowood

- Late Season Shortages Primarily on Tributaries
- Available Flow On Mainstem



Lower Bighorn

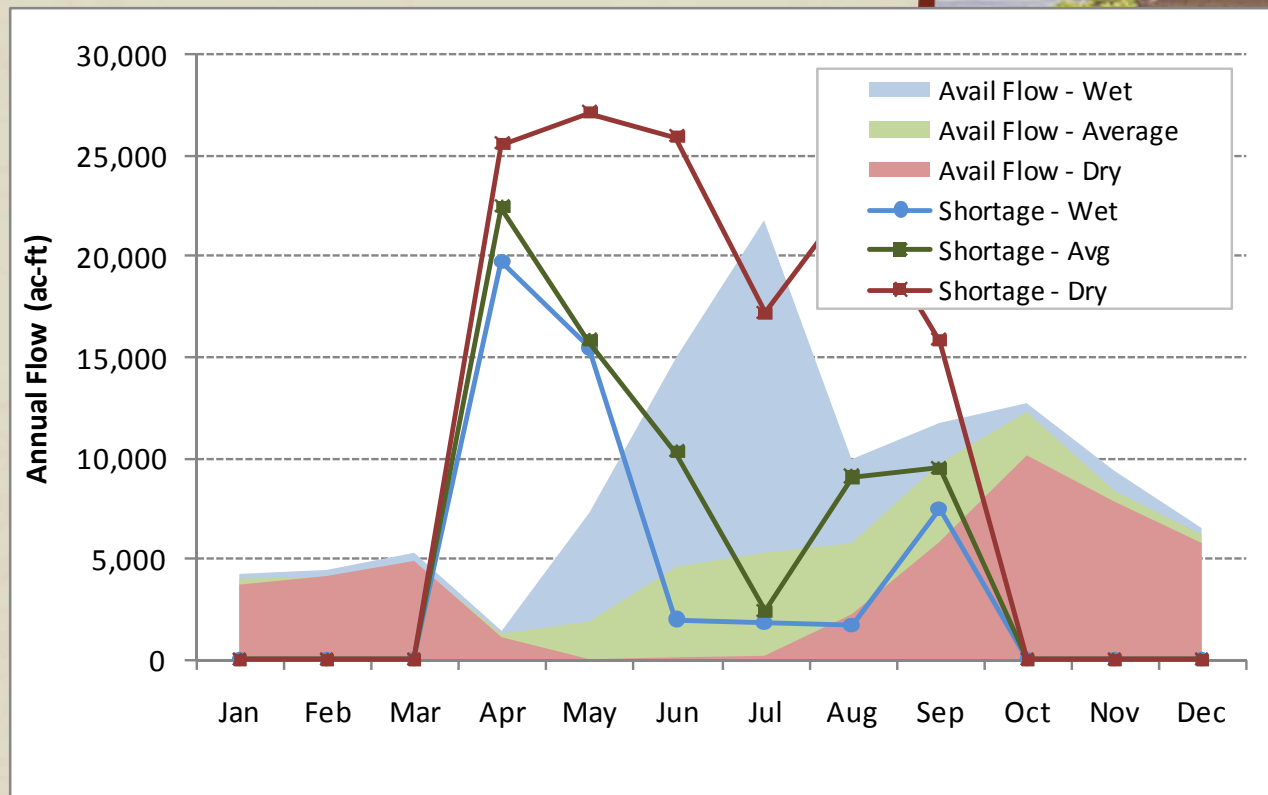
- Minor Shortages in Tributaries
- Available Flow on Mainstem and Tributaries



Greybull

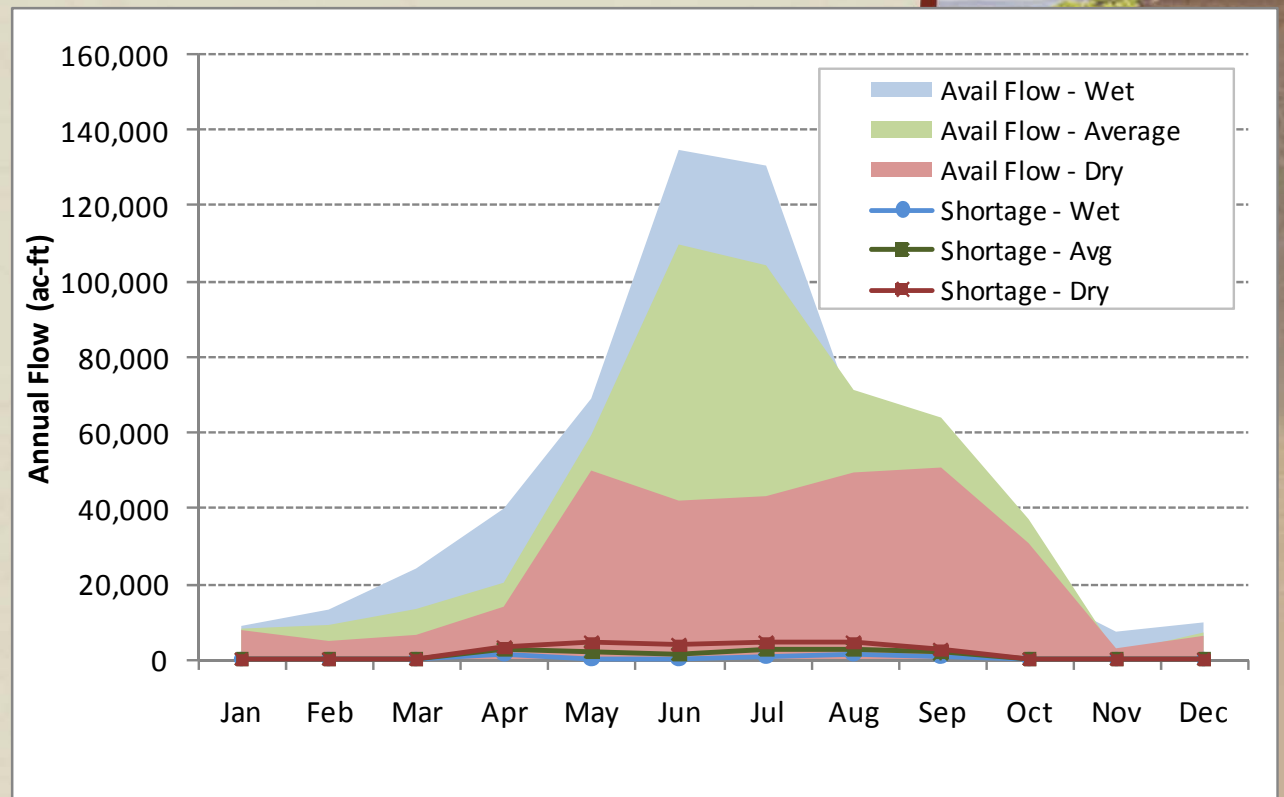
Note: Results Do Not Include
Greybull Valley Reservoir

- Tributary Shortages
- Greybull Valley Storage
 - Will Satisfy Most Mainstem Shortages in Average and Wet Years



Shoshone

- Minor Shortages in Tributaries
- Available Flow on Mainstem and Tributaries



Differences from Previous Plan

- Available Flow

Basin	Reach	Available Flow (af)		
		Dry	Avg	Wet
Upper Wind	Reach 300: Wind River from East Fork to Bull Lake Creek	3%	-15%	-12%
Little Wind	Reach 500: Little Wind River	44%	-10%	-6%
Owl Creek	Reach 200: Owl Creek from N. & S. Fork Conf. To Mud Creek Conf.	-33%	-22%	-30%
Nowood	Reach 700: Nowood River from Ten Sleep Ck. To Paint Rock Ck.	8%	12%	-14%
Shell Ck	Reach 1600: Shell Creek	75%	12%	6%
Shoshone	Reach 1900: South Fork Shoshone River below Bob Cat Creek	54%	7%	-10%

Differences from Previous Plan

- Shortages

Basin	%Short - Original			% Short - Updated Plan		
	Dry	Avg	Wet	Dry	Avg	Wet
Clarks Fork	29%	18%	11%	32%	20%	13%
Wind	23%	8%	6%	17%	7%	6%
Bighorn	14%	6%	4%	14%	7%	5%
Total	18%	7%	5%	16%	8%	6%

Task 6

Future Water Use Issues and Opportunities

Issues Affecting Future Water Use Opportunities

- Permitting and Regulations
- Water Quality
 - Federal Watershed Programs (6) and Plans (8)
 - Impaired Waterways (27 reaches, 1 lake)
 - Mostly Bacteria
- Climate
- Conservation
 - Municipal and Agricultural
- WWDC Watershed Planning



Climate Analysis

- General Climate Data Resources
- Recorded Data Summary
- WWDC Weather Modification Program
- Drought Management
- Climate Change
- Glaciers
- Tree Rings
- Bark Beetle

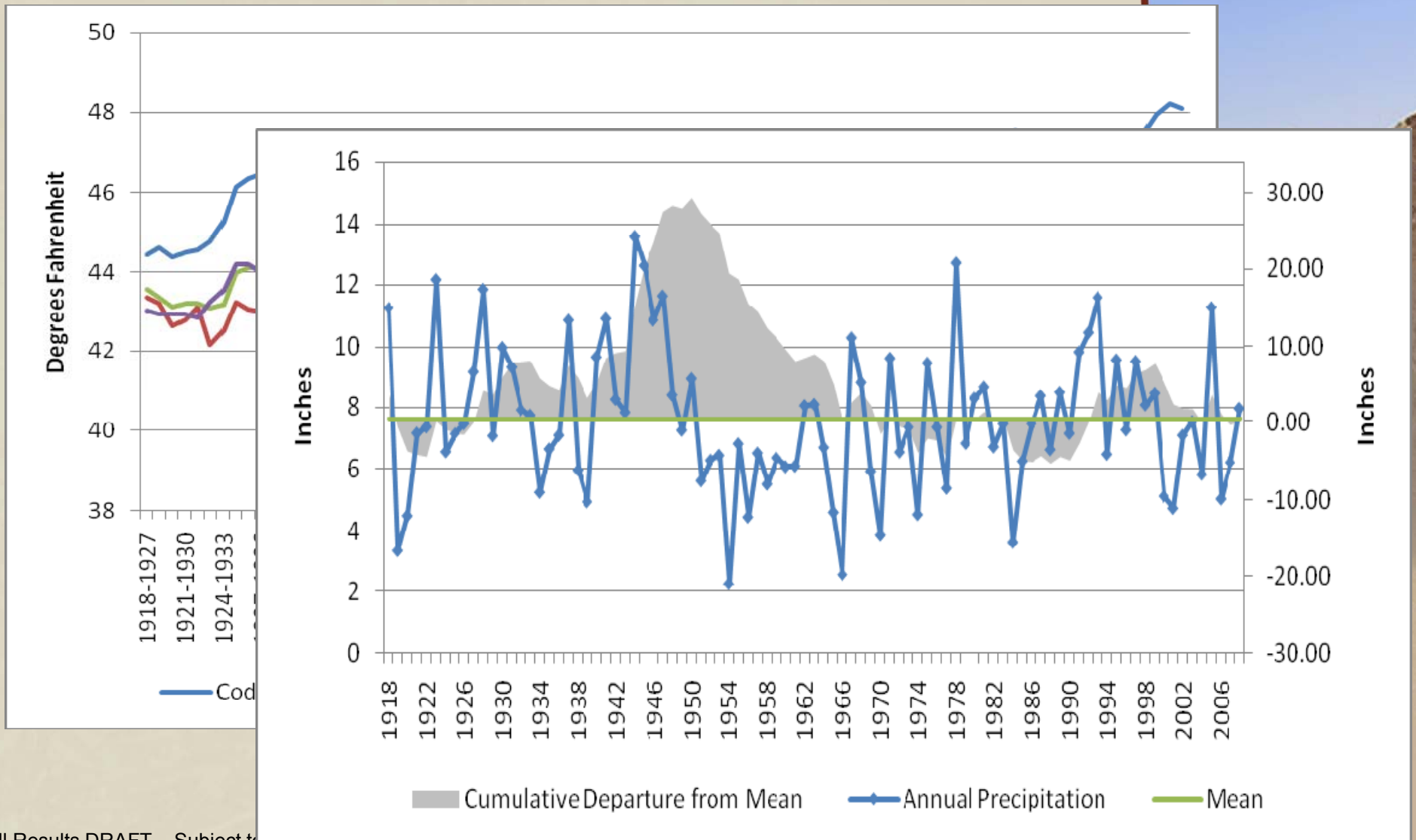


Climate Variability

- Global Scale Studies (EPA/IPCC)
 - 4° to 6 ° Degree Increase by 2100
 - 0% to 30% Increase in Precipitation
- Agricultural Effects
 - Wheat Yields Increase by 35% – 48%
 - Grass Hay and Pasture Yields
 - Dryland Decrease by 13%
 - Irrigated Increase by 12%



Data Trends



Paleohydrology (Tree Rings)

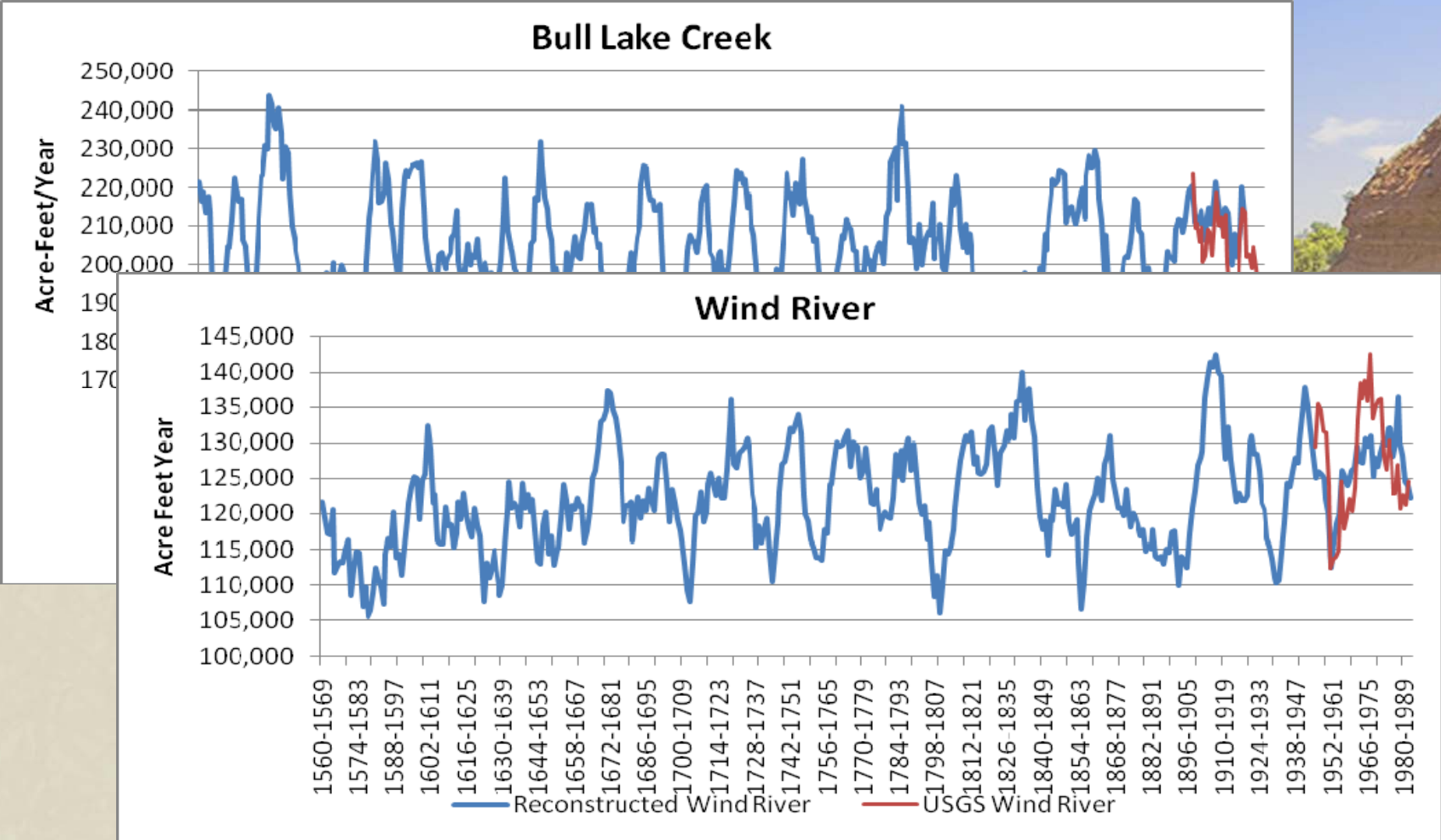
- UW 2004 Study in Wind River Range
- Used Tree-Ring Data to Reconstruct Precipitation and Streamflow Since 15000



TABLE 4. Driest 10-, 15-, and 20-yr periods in the 1260–1998 A.D. proxy record, based on inferred MAP over the respective intervals. The driest periods in the twentieth century are shown for comparison.

Driest 10-yr period	Rank	MAP (cm)	Driest 15-yr period	Rank	MAP (cm)	Driest 20-yr period	Rank	MAP (cm)
1738–47	1	22.4	1580–94	1	23.3	1262–81	1	23.6
1272–81	2	22.6	1267–81	2	23.4	1579–98	2	23.7
1735–44	3	22.6	1268–82	3	23.4	1263–82	3	23.8
1271–80	4	22.8	1734–48	4	23.4	1261–80	4	23.9
1273–82	5	22.9	1579–93	5	23.5	1580–99	5	23.9
—	—	—	—	—	—	—	—	—
1951–60	28	23.7	1948–62	68	24.5	1917–36	149	25.0

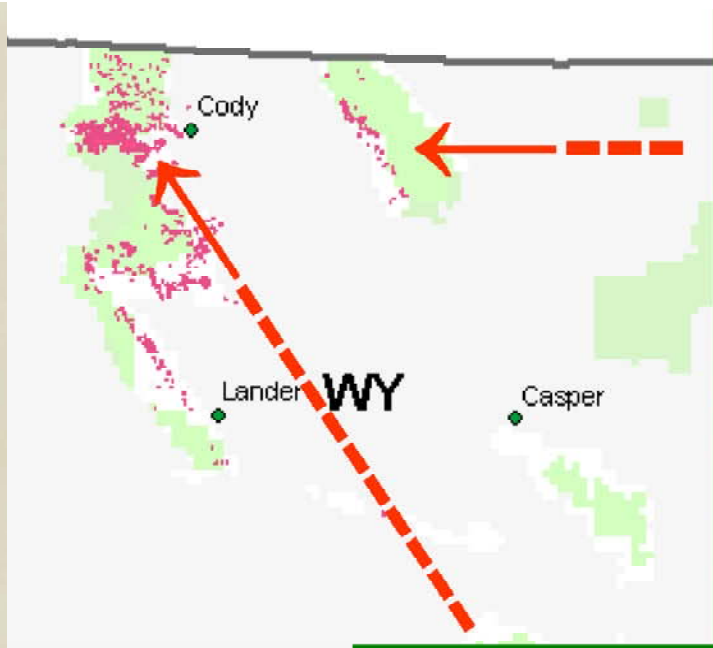
Reconstructed Streamflow



Bark Beetles

- Substantial Infestation in 2000's
 - Shoshone NF - 449,900 acres (35% of forested acres)
- Impacts on Hydrology Unclear
 - Even Aged Treestands, Little Understory
→ Increased Yields
 - Uneven Aged Treestands, More Understory → Decreased Yields



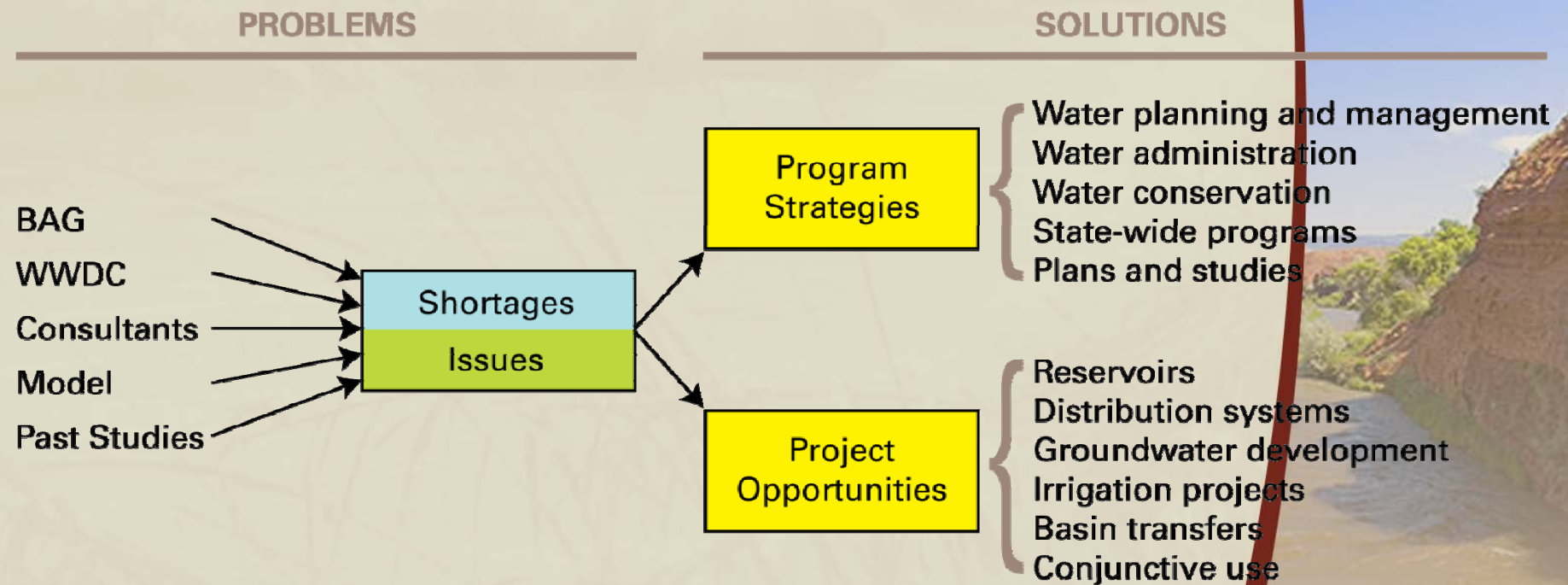


Bighorn National Forest, Wyoming



Shoshone National Forest, Wyoming

Future Water Use Opportunities and Strategies



Future Water Use Opportunities and Strategies

- **Project Opportunities**
 - Specific Projects Tied to Specific Areas or Locations
 - Identifiable On-the-Ground Activities
- **Program Strategies**
 - Generally State or Regional Level approaches
 - Activities Performed by WWDC or Other State/Federal Agencies;
 - Management Approaches Rather Than Project Approaches
 - Includes General Ideas or Concepts



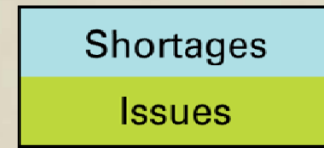
Process for Developing Project Opportunities

- Review Hydrologic Modeling
- Begin With Original Basin Plan Short-List
- Incorporate Framework Plan
- Augment Short-List Based on Model
- Review Short-List with BAG
- Develop Final List

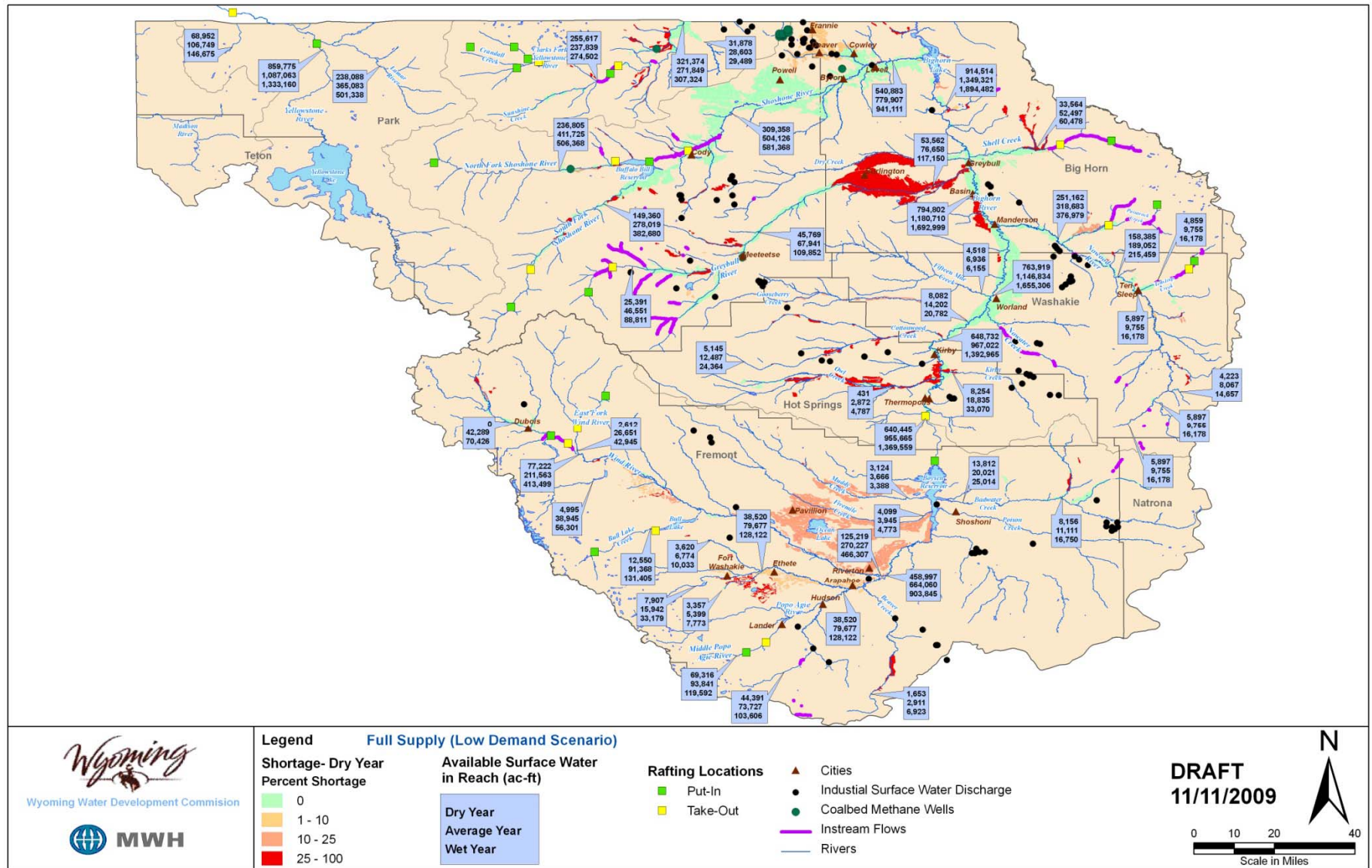


“Breakwork”

- Review Shortages and Issues
 - Current and Previous Presentations
 - Maps of Shortages, Available SW
 - Handout of Issues and Strategies
 - Staff Questions and Answers
- Review Program Strategies
 - Handout of Issues and Strategies
- Brainstorm Project Opportunities
 - Handout of Preliminary Opportunities
 - Talk Amongst BAG
 - Specific Project, Specific Location



Description of Maps



Upcoming Activities

- Complete Task 4 Tech Memos
- Complete Task 6 Tech Memos
 - Opportunities
 - Strategies
- Complete Draft Final Report



Break Time!
THANK YOU!