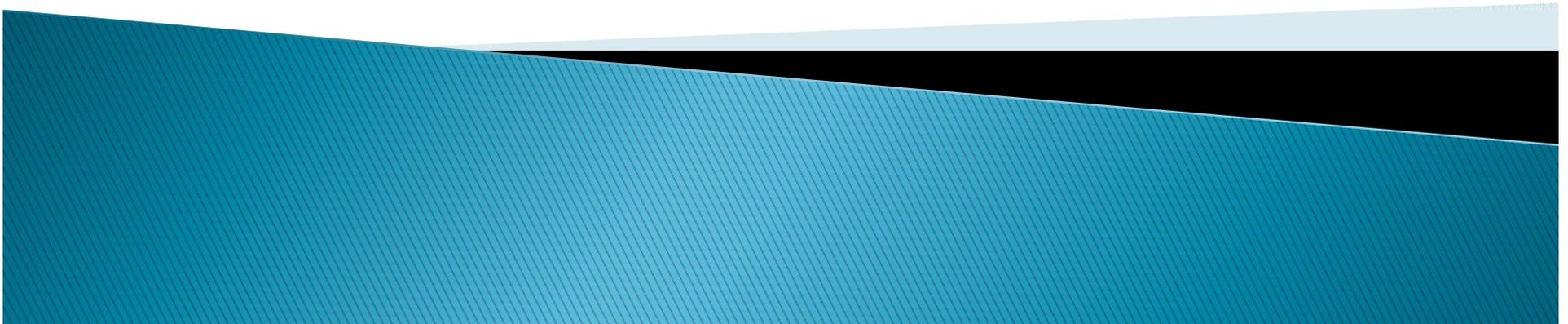


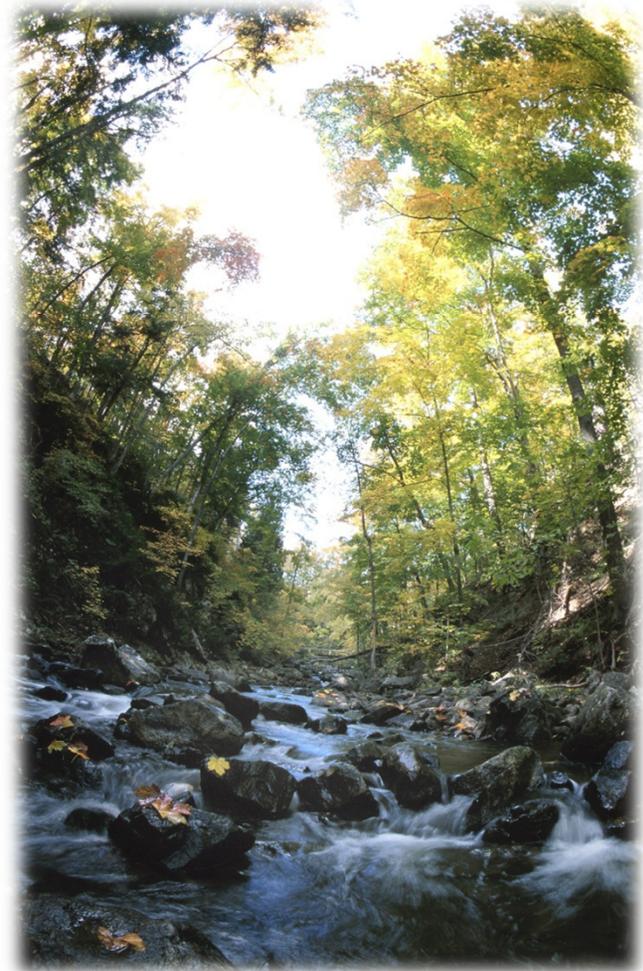
How Can We Determine if a Water Storage Project Will Pencil?

Brett Moore, P.E.
Anderson Perry & Associates, Inc.



Factors to Consider

- ▶ Stream flow and volume
- ▶ Geography
- ▶ Geology
- ▶ Crop types or value of water

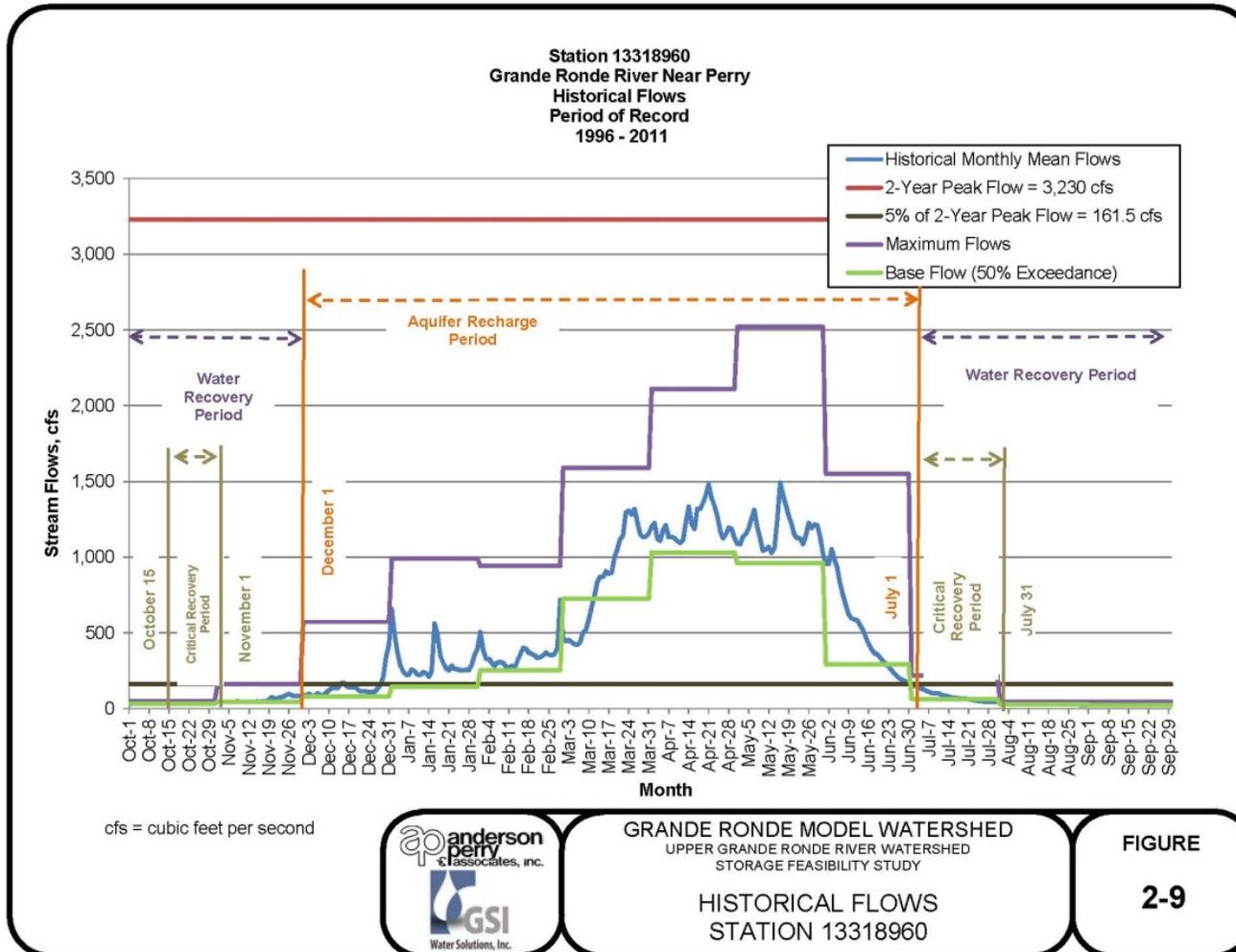


Stream Type and Size

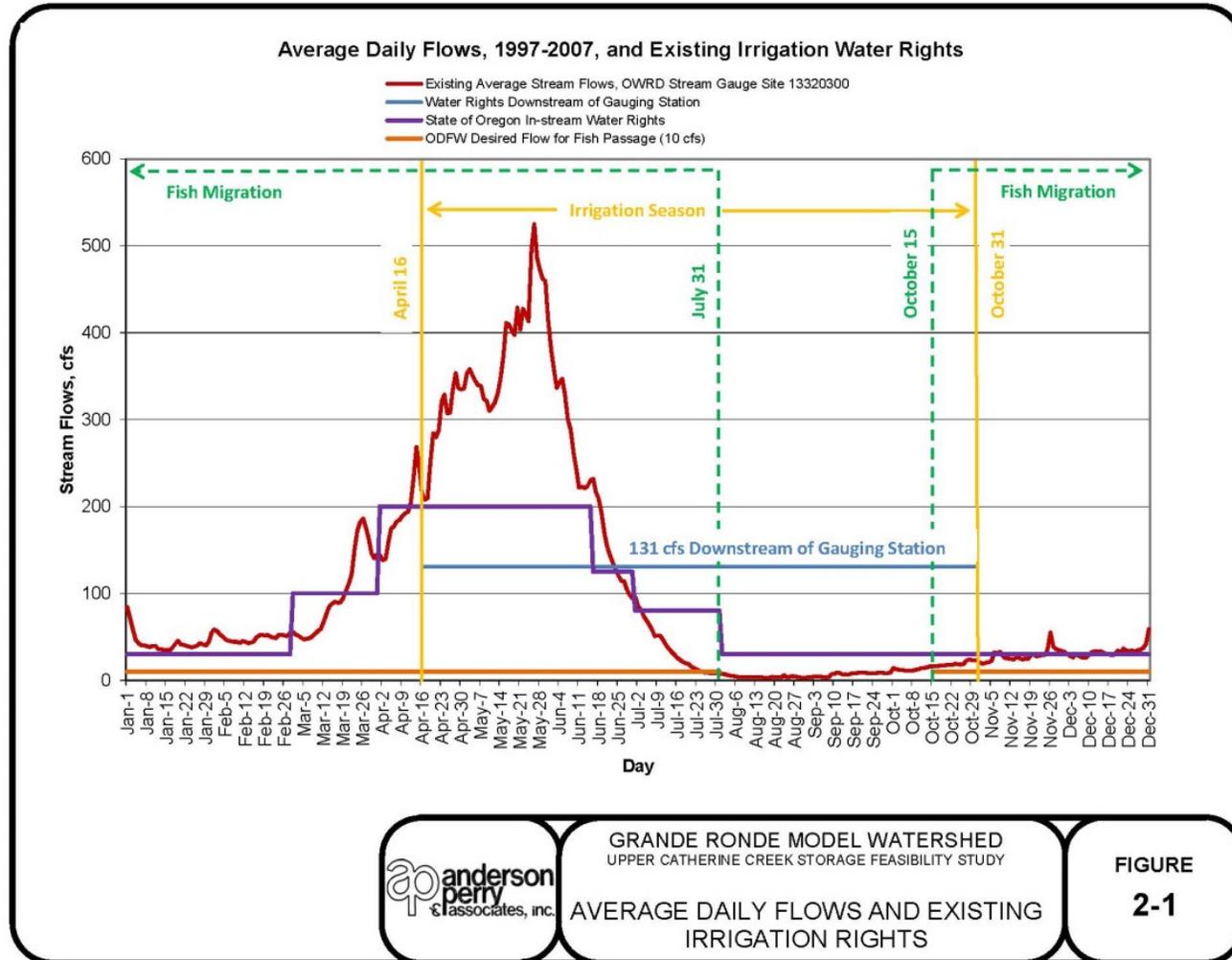
- ▶ Coastal streams – more consistent flow.
- ▶ Willamette Valley streams – consistent, but seasonally varied.
- ▶ Arid east streams – large seasonal variations. Can be dry from August through December (e.g., Rock Creek).
- ▶ High mountain streams – snow pack influence (i.e., Catherine Creek and the Grande Ronde River).



Grande Ronde River



Catherine Creek



Catherine Creek

Water Availability, Storage, and Recovery Volumes and Recharge Rates

Month	Water Availability in Catherine Creek				1 cfs Flow Augmentation						10 cfs Flow Augmentation					
	Total Availability (Storage Reservation and 50% Exceedance Flow at Union)		Storage Reservation Only		Recovery Period		7-Month Recharge Period		5-Month Recharge Period		Recovery Period		7-Month Recharge Period		5-Month Recharge Period	
	Flow (cfs)	Volume (AF)	Flow (cfs)	Volume (AF)	Recovery Rate (cfs)	Recovery Volume* (AF)	Recharge Rate (cfs)	Recharge Volume* (AF)	Recharge Rate (cfs)	Recharge Volume* (AF)	Recovery Rate (cfs)	Recovery Volume (AF)	Recharge Rate (cfs)	Recharge Volume* (AF)	Recharge Rate (cfs)	Recharge Volume* (AF)
January	18.7	1,150	18.7	1,150	0.0	0.0	0.7	40	0.9	56	0.0	0	6.5	401	9.1	561
February	27.6	1,697	27.6	1,697	0.0	0.0	0.7	40	0.9	56	0.0	0	7.2	401	10.1	561
March	24	1,476	24	1,476	0.0	0.0	0.7	40	0.9	56	0.0	0	6.5	401	9.1	561
April	55.4	3,296	55.4	3,296	0.0	0.0	0.7	40	0.9	56	0.0	0	6.7	401	9.4	561
May	151	9,284	0	0	0.0	0.0	0.7	40	0.0	0	0.0	0	6.7	401	0.0	0
June	93	5,534	0	0	0.0	0.0	0.7	40	0.0	0	0.0	0	6.7	401	0.0	0
July	0	0	0	0	1.0	61.5	0.0	0	0.0	0	10.0	615	0.0	0	0.0	0
August	0	0	0	0	1.0	61.5	0.0	0	0.0	0	10.0	615	0.0	0	0.0	0
September	0	0	0	0	1.0	59.5	0.0	0	0.0	0	10.0	595	0.0	0	0.0	0
October	9.3	572	9.3	572	1.0	61.5	0.0	0	0.0	0	10.0	615	0.0	0	0.0	0
November	0	0	0	0	0.0	0.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
December	15.6	959	15.6	959	0.0	0.0	0.7	40	0.9	56	0.0	0	6.5	401	9.1	561
	NA	23,968	NA	9,150		244		281		281		2,440		2,806		2,806

Note: * Assumes permitted recovery percentage of 85 percent.

Red font = Recharge rates calculated to achieve monthly recharge volume exceed 0.75 x recovery rate, which is less than optimal for removal of suspended solids introduced into the aquifer. Injection rates can be minimized by increasing the period of injection

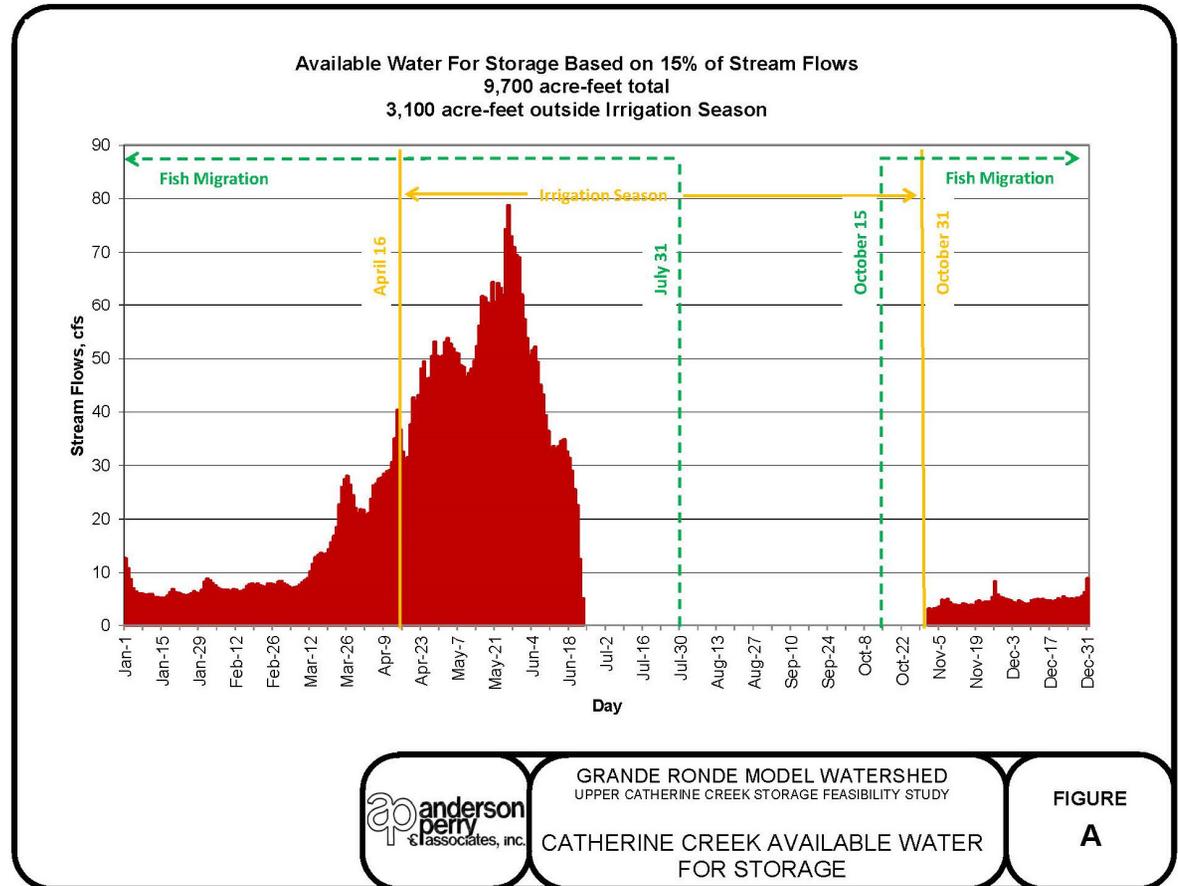


GRANDE RONDE MODEL WATERSHED
UPPER CATHERINE CREEK STORAGE FEASIBILITY STUDY
WATER AVAILABILITY, STORAGE, AND RECOVERY
VOLUMES AND RECHARGE RATES

TABLE
2-1

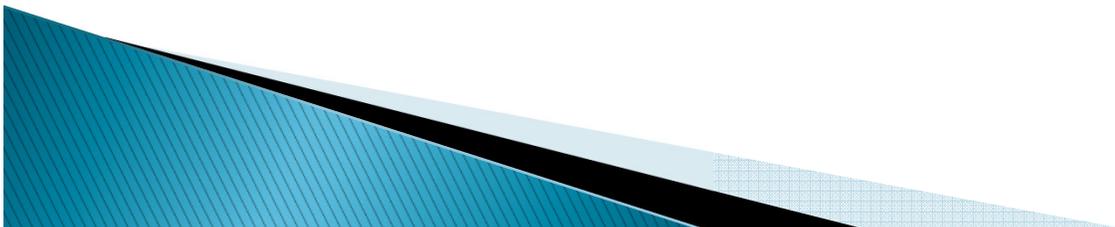
Diversification Methods and Challenges

- ▶ 15 percent of natural flow
 - Limits on volume available, some operational challenges
 - Effects of irrigation season



Stream Size for Viable Project

- ▶ Fifteen-Mile Watershed
 - 13,000 acre-feet natural flow
 - 1,000 acre-feet at 15 percent outside irrigation season (approximately 340 acres of irrigation)
 - 5,000 acre-feet storage reservation (approximately 1,700 acres of irrigation)



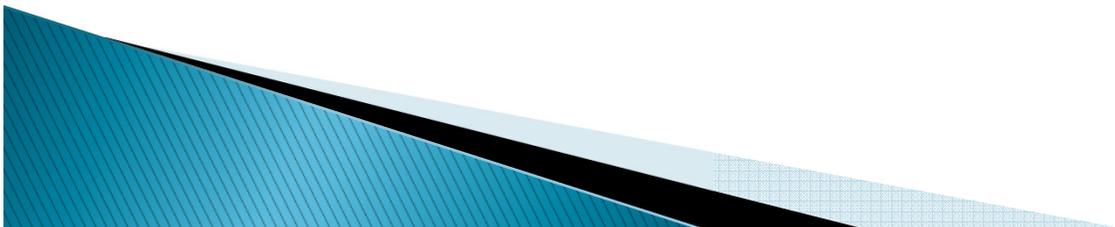
Diversion Methods and Challenges

- ▶ Fixed diversion percentage, varying flow rate
- ▶ Fixed diversion rate, varying flow percentage
- ▶ Flows above bankfull (Flood Flows)



Diversion Methods and Challenges

- ▶ Fixed diversion percentage, varying flow rate
 - Low Reliability – Unpredictable volume of water
 - Rate of Fill – Unpredictable and variable
 - Volume of Fill – Lower than current methods



Diversion Methods and Challenges

- ▶ Fixed diversion rate, varying flow percentage
 - More reliable – more predictable volume of water as long as flows are a minimum level
 - Rate of fill – more predictable
 - Volume of fill



Diversion Methods and Challenges

- ▶ Flows above bankfull (flood flow)
 - What is ecological value of excessive flood flows?
 - Climate change creating flashy systems?



Cost Effectiveness

- ▶ Municipal
 - Must consider water quality and reliability
- ▶ Irrigation
 - Crop type
 - Need about 3 feet per acre in east
- ▶ In-stream
- ▶ Managed underground storage
 - Subsurface withdraw



How Does Diversion Method Affect Feasibility?

- ▶ Volume of water available
- ▶ Value of Water
- ▶ Type of diversion
- ▶ Operational challenges
 - Water quality during diversion
 - Rapidly fluctuating systems



Further Considerations

- ▶ Storing flood flows
- ▶ Limited economic benefit in small watersheds

