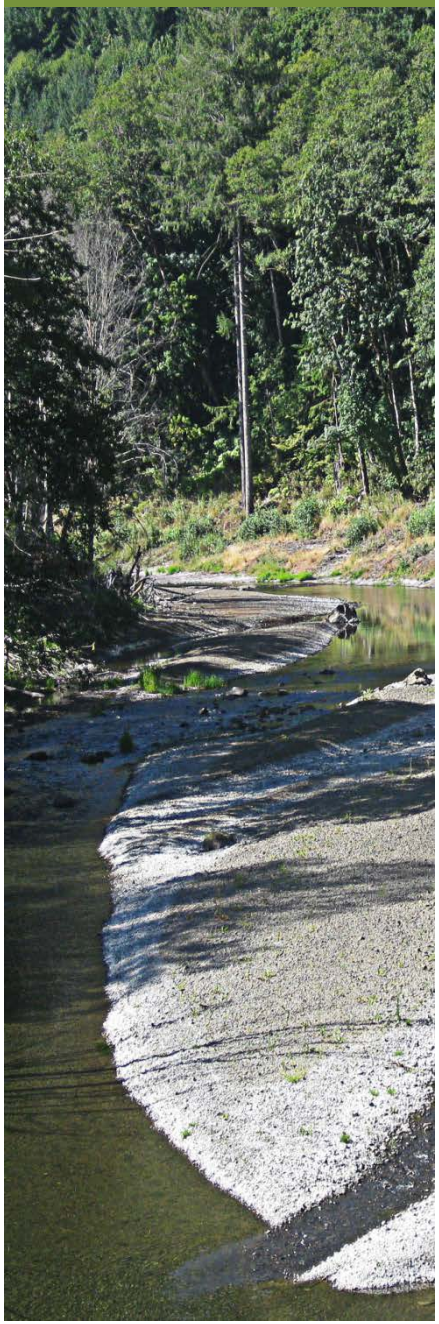
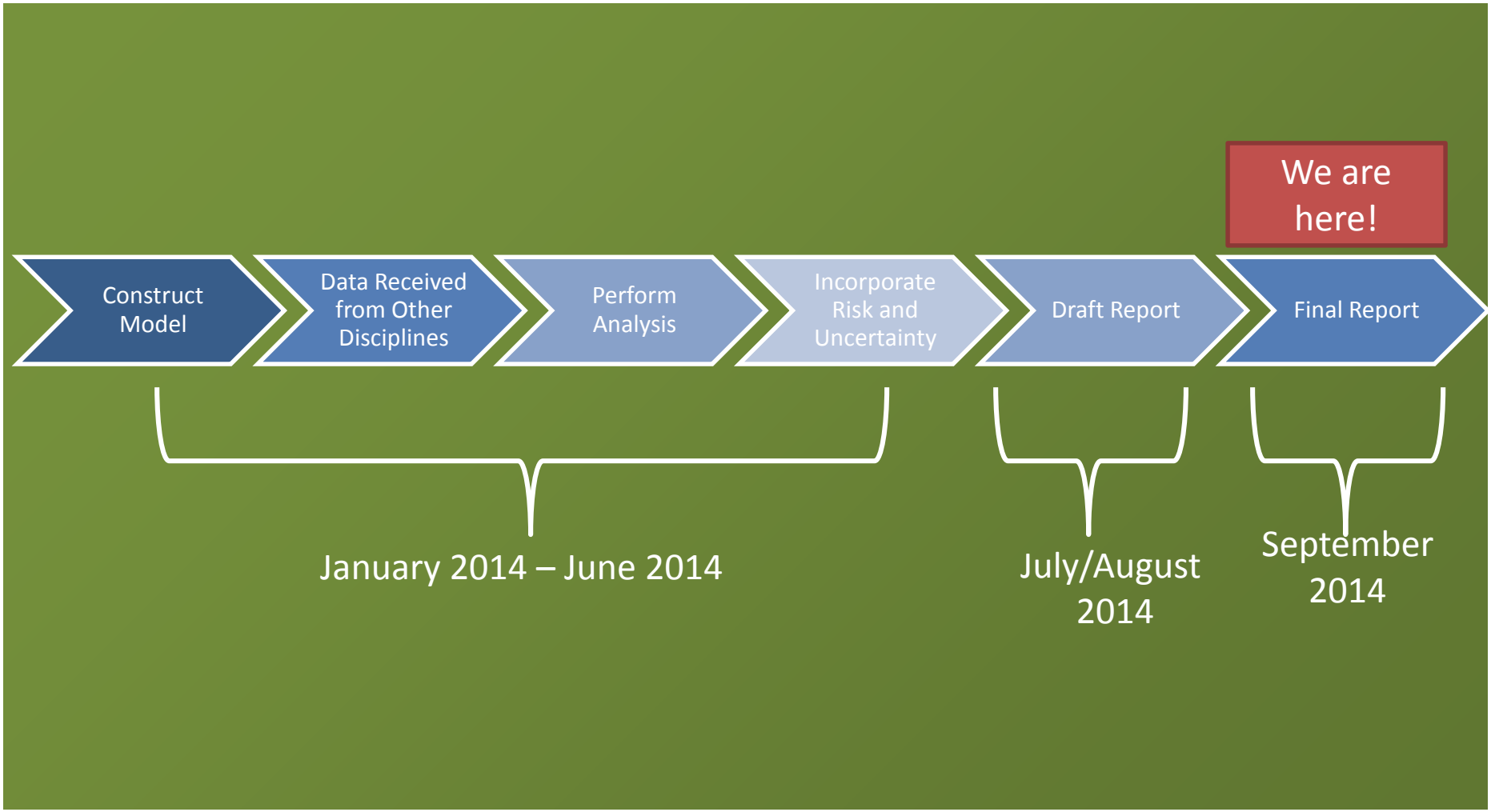
Chehalis Basin Strategy: Reducing Flood Damage and Enhancing Aquatic Species

Comparison of Alternatives

September 26, 2014



Analysis of Alternatives Timeline



Perspectives

	State	Basin-Wide	Federal
Geographic Area for Evaluating Impacts	State of WA	Lewis, Thurston, & Grays Harbor Counties	U.S.
Discount Rate	1.63%, range 0%-7%	1.63%, range 0%-7%	3.5%
Agriculture Crops	Value at State Prices	Value at State Prices	Value at National Prices
I-5 Delays	All Traffic	Local + internal/external traffic	All traffic
Structure & Content Value	Depreciated or Replacement	Depreciated or Replacement	Depreciated
Business Interruption	None	Included	None
Input-Output Modeling	State Model	County Model	None

Project Alternatives

- Flood Retention Only (FRO) Facility
- Multipurpose (MP) Facility
- I-5 WSDOT Project
- Small Projects (Flood Proofing)
- Aquatic Species Enhancement Programs

Project Alternatives

1. Flood Proofing Only
2. Low Enhancement Only
3. High Enhancement Only
4. I-5 Project plus Airport Levee, Flood Proofing, and Low Enhancement
5. I-5 Project plus Airport Levee, Flood Proofing, and High Enhancement
6. Flood Retention Only Storage plus Airport Levee, Flood Proofing, and Low Enhancement
7. Flood Retention Only Storage plus Airport Levee, Flood Proofing, and High Enhancement

Project Alternatives (cont'd)

8. Multipurpose Storage plus Airport Levee, Flood Proofing, and Low Enhancement
9. Multipurpose Storage plus Airport Levee, Flood Proofing, and High Enhancement
10. Flood Retention Only Storage, I-5 Project, Airport Levee, Flood Proofing, and Low Enhancement
11. Flood Retention Only Storage, I-5 Project, Airport Levee, Flood Proofing, and High Enhancement
12. Multipurpose Storage, I-5 Project, Airport Levee, Flood Proofing, and Low Enhancement
13. Multipurpose Storage, I-5 Project Airport Levee, Flood Proofing, and High Enhancement

Alternative Costs – Flood Proofing

EXPECTED CASE 100% RESIDENTIAL AND 25% ACHIEVABILITY FOR NON-RESIDENTIAL $2014					
	BUILDINGS IN 100-YEAR FLOODPLAIN	BASELINE	WITH I-5 PROJECT	WITH STORAGE	WITH I-5 PROJECT AND STORAGE
Residential Buildings	677	677	653	368	354
Non-Residential Buildings	446	112	95	71	64
Total Buildings Flood Proofed		789	748	439	418
Cost, Millions		$91.5	$87.3	$49.0	$46.8

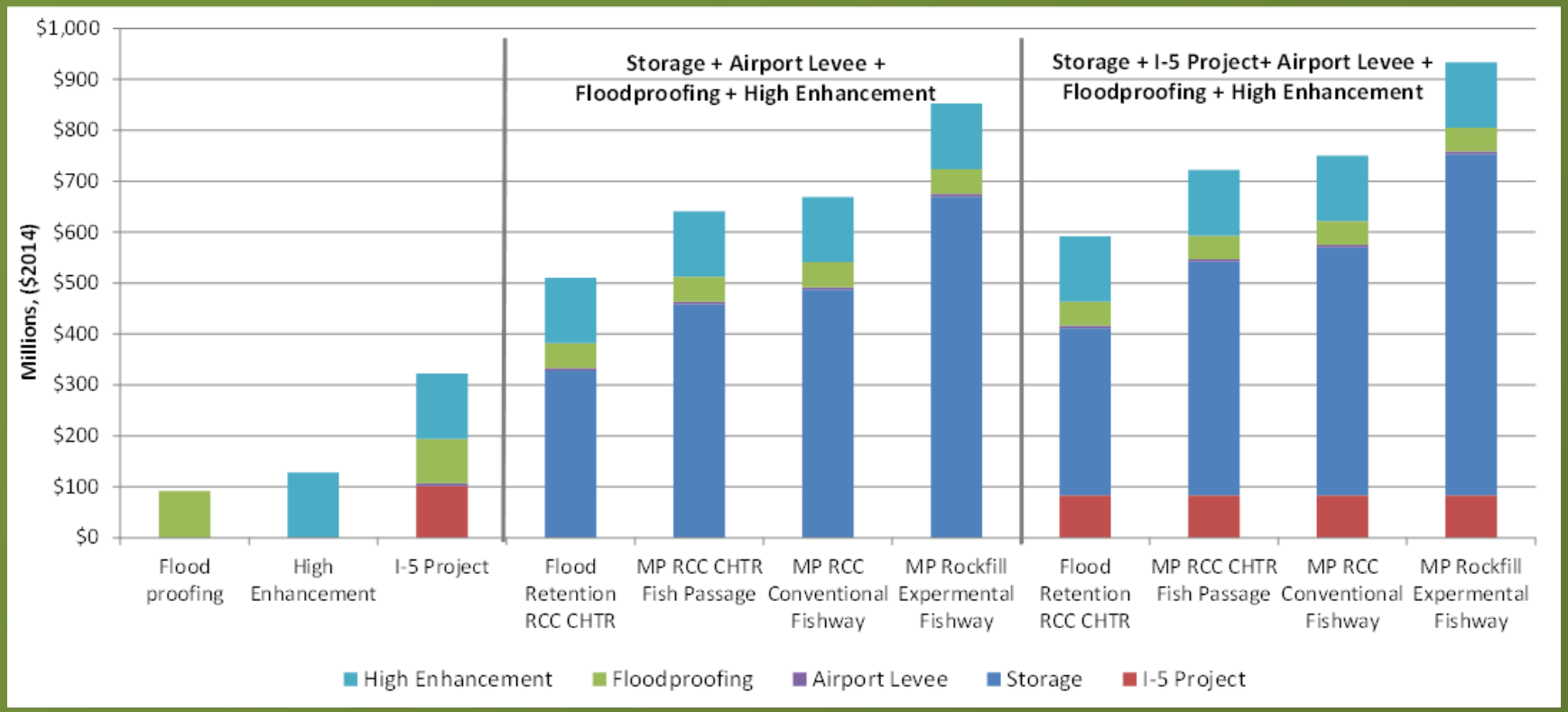
Alternative Costs – Enhancement

PROJECT NAME	CAPITAL[1]	ANNUAL O&M[2]	TOTAL PV COST
NMF-LWD50/50	$17,550,000	$95,000	$18,420,000
NMF-LWD50/75	$27,800,000	$143,000	$29,110,000
NMF-Riparian20/50	$43,240,000	$216,000	$45,220,000
NMF-Riparian20/75	$64,860,000	$324,000	$67,830,000
NMF-Riparian60/50	$43,240,000	$216,000	$45,220,000
NMF-Riparian60/75	$64,860,000	$324,000	$67,830,000
Culvert100	$29,970,000	$158,000	$31,420,000
Low Enhancement	$90,760,000	$469,000	$95,060,000
High Enhancement	$122,630,000	$625,000	$128,350,000

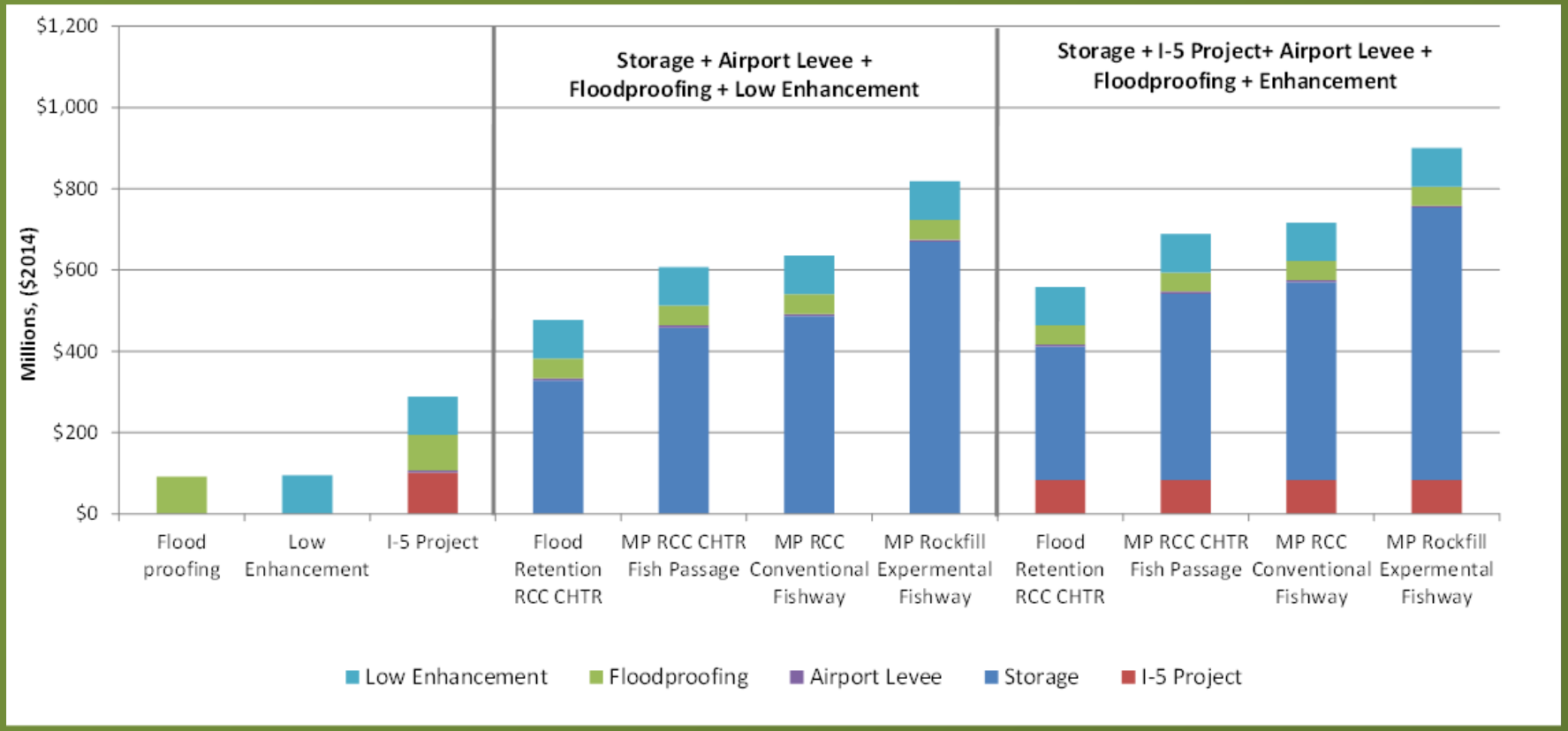
Alternative Costs – Individual

MIDRANGE COSTS	CAPITAL COSTS	ANNUAL O&M
Flood Proofing Only	$91,500,000	$0
Low Enhancement Only	$90,760,000	$470,000
High Enhancement Only	$122,630,000	$625,000
I-5 Project	$100,000,000	$5,000
Airport Levee	$4,500,000	$8,000
Flood Retention RCC with CHTR Fish Passage	$280,250,000	$793,000
Multipurpose RCC with CHTR Fish Passage	$370,350,000	$1,539,000
Multipurpose RCC with Conventional Fishway	$405,350,000	$1,391,000
Multipurpose Rockfill with Experimental Fishway	$574,100,000	$1,624,000

Project Alternative Costs – State with High Restoration (100 Year NPV)



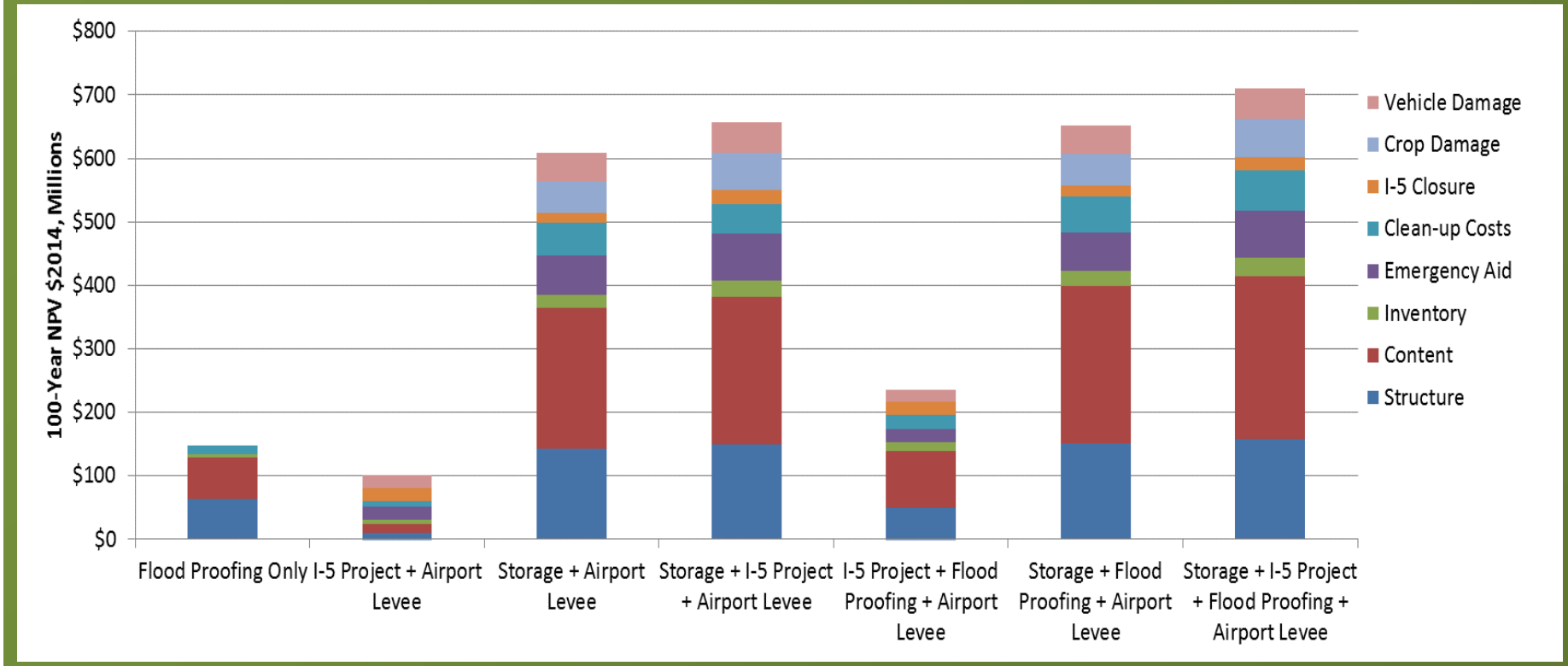
Project Alternative Costs – State with Low Restoration (100 Year NPV)



Impacts Evaluated

- Flood Damage to Structures, Content, and Inventory
- Clean-Up Costs for Buildings and Agricultural Acreage
- Vehicle Damages
- Loss of Agriculture Crops or Crop Damage
- Transportation Delays on I-5
- Temporary Relocation Costs for Evacuated Residents
- Public Assistance for Emergency Protective Measures for Bridges, Utilities, Water Control Facilities, or Debris Removal
- Business Interruption
- Tribal Fishing
- Commercial Fishing
- Sport Fishing
- Economic Development

Non-Environmental Impacts



Non-Environmental Benefits

Non-Environmental Impacts 100 Year NPV ($2014), Millions							
	Flood Proofing Only	I-5 Project + Airport Levee	Storage + Airport Levee	Storage + I-5 Project + Airport Levee	I-5 Project + Flood Proofing + Airport Levee	Storage + Flood Proofing + Airport Levee	Storage + I-5 Project + Flood Proofing + Airport Levee
Structure	$64	$11	$142	$150	$49	$150	$158
Content	$65	$13	$223	$231	$89	$248	$256
Inventory	$5	$7	$21	$27	$14	$25	$29
Emergency Aid	$0	$20	$61	$73	$20	$61	$73
Clean-up Costs	$14	$10	$52	$47	$23	$57	$64
I-5 Closure	$0	$21	$16	$21	$21	$16	$21
Crop Damage	$0	$0	$50	$60	$0	$50	$60
Vehicle Damage	$0	$19	$45	$48	$19	$45	$48
Subtotal	**$148**	**$100**	**$609**	**$657**	**$236**	**$651**	**$710**

Base Case Expected Damages

BASELINE FLOOD DAMAGES 100-YEAR NPV EXPECTED DAMAGES ($2014), MILLIONS	
Structure	$872
Content	$1,403
Inventory	$143
Public Assistance	$473
Temporary Relocation Assistance	$70
Clean-Up Costs: Debris	$78
Clean-Up Costs: Structures	$67
Clean-Up Costs: Agriculture Fields	$197
Clean-Up Costs: Agriculture Re-seeding	$6
I-5 Transportation Delay	$21
Agriculture: Crop Damage	$50
Vehicle Damage	$169
Subtotal	**$3,546**

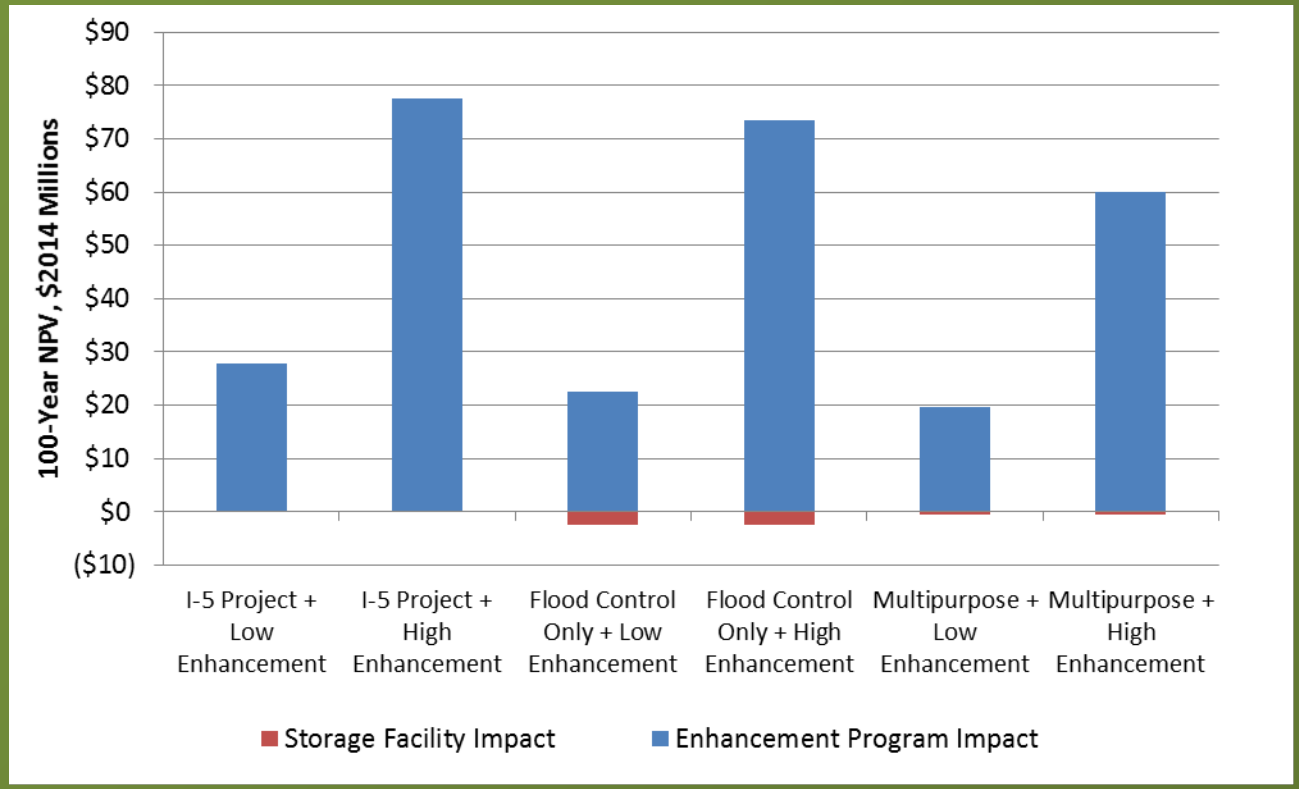
Environmental Impacts

SPECIES	% CHANGE IN FISH POPULATION WITH FLOOD RETENTION FACILITY (50% Impact)	% CHANGE IN FISH POPULATION WITH MULTIPURPOSE FACILITY
Spring Chinook	-8.1%	6.5%
Fall Chinook	-1.1%	0.3%
Steelhead	-4.0%	-7.4%
Coho	-1.9%	-0.6%
Total	**-2.1%**	**-1.1%**

Environmental Impacts (cont'd)

SPECIES	LOW RIPARIAN ENHANCEMENT	HIGH RIPARIAN ENHANCEMENT	FR050 + LOW ENHANCEMENT	MULTIPURPOSE + LOW ENHANCEMENT	FR050 + HIGH ENHANCEMENT	MULTIPURPOSE + HIGH ENHANCEMENT
Spring Chinook	49.6%	184.3%	21.9%	25.8%	164.7%	109.7%
Fall Chinook	8.4%	25.2%	6.5%	5.8%	22.8%	17.9%
Steelhead	14.3%	34.6%	9.7%	3.1%	32.1%	19.3%
Coho	23.0%	60.9%	19.7%	17.1%	58.5%	49.4%
Total	**20.1%**	**54.8%**	**16.2%**	**13.7%**	**51.9%**	**41.9%**

Environmental Impacts (Use Values)



Environmental - Low Enhancement

PROJECT ALTERNATIVE IMPACT NET PRESENT VALUE $2014, MILLIONS							
	LOW ENHANCEMENT IMPACT, USE VALUES	STORAGE IMPACT USE VALUES	TOTAL IMPACT USE VALUES	LOW ENHANCEMENT IMPACT, PASSIVE USE VALUES	STORAGE IMPACT PASSIVE USE VALUES	TOTAL IMPACT PASSIVE-USE VALUES	TOTAL IMPACT (USE+PASSIVE USE)
I-5 Project	$27.8	$0.0	**$27.8**	$953	$0	**$953**	**$981**
Storage, Flood Retention	$22.5	($2.6)	**$20.0**	$771	($99)	**$673**	**$693**
Storage, Multipurpose	$19.6	($0.6)	**$19.0**	$649	($47)	**$602**	**$621**
Storage, Flood Retention + I-5 Project	$22.5	($2.6)	**$20.0**	$771	($99)	**$673**	**$693**
Storage, Multipurpose + I-5 Project	$19.6	($0.6)	**$19.0**	$649	($47)	**$602**	**$621**

Environmental – High Enhancement

PROJECT ALTERNATIVE IMPACT NET PRESENT VALUE $2014, MILLIONS							
	HIGH ENHANCEMENT IMPACT, USE VALUES	STORAGE IMPACT USE VALUES	TOTAL IMPACT USE VALUES	HIGH ENHANCE-MENT IMPACT, PASSIVE USE VALUES	STORAGE IMPACT PASSIVE USE VALUES	TOTAL IMPACT PASSIVE-USE VALUES	TOTAL IMPACT (USE+PASSIVE USE)
I-5 Project	$77.5	$0.0	**$77.5**	$2,630	$0	**$2,630**	**$2,708**
Storage, Flood Retention	$73.5	($2.6)	**$70.9**	$2,493	($99)	**$2,395**	**$2,466**
Storage, Multipurpose	$59.9	($0.6)	**$59.3**	$2,018	($47)	**$1,972**	**$2,031**
Storage, Flood Retention + I-5 Project	$73.5	($2.6)	**$70.9**	$2,493	($99)	**$2,395**	**$2,466**
Storage, Multipurpose + I-5 Project	$59.9	($0.6)	**$59.3**	$2,018	($47)	**$1,972**	**$2,031**

Overall Results

Results: State

Expected Case – Individual Alternatives

Expected, Depreciated Values 100-Year NPV 1.63% Discount Rate ($2014), Millions								
	Impacts							
	Flood Damage Reduction	Environmental (Use Values)	Environmental (Passive Values)	Project Implementation Costs	Net Benefit (Use Value)	Benefit/Cost (Use Value)	Net Benefit (Use and Passive Value)	Benefit/Cost (Use and Passive Value)
Floodproofing Only	$148	$0	N/A	$92	$56	1.6	N/A	N/A
Low Enhancement Only	$0	$28	$953	$95	-$67	0.3	$886	10.3
High Enhancement Only	$0	$78	$2,630	$128	-$51	0.6	$2,579	21.1
Flood Retention RCC with CHTR Fish Passage (AL)	$609	-$3	-$99	$333	$273	1.8	$175	1.5
Multipurpose RCC with CHTR Fish Passage (AL)	$609	-$1	-$47	$463	$145	1.3	$98	1.2
Multipurpose RCC with Conventional Fishway (AL)	$609	-$1	-$47	$492	$117	1.2	$70	1.1
Multipurpose Rockfill with Experimental Fishway (AL)	$609	-$1	-$47	$675	-$66	0.9	-$113	0.8

Results: State

Expected Case – I-5

Expected, Depreciated Values 100-Year NPV 1.63% Discount Rate ($2014) Millions					
	Impacts				
	Flood Damage Reduction	Environmental (Use Values)	Project Implementation Costs	Net Benefit	Benefit/Cost
I-5 Project Alternative Variations					
I-5 Alternative + Airport Levee + Floodproofing + Low Enhancement	$236	$28	$289	-$26	0.9
I-5 Alternative + Airport Levee + Floodproofing + High Enhancement	$236	$78	$322	-$9	1.0

Results: State

Expected Case – Storage

Expected, Depreciated Values 100-Year NPV 1.63% Discount Rate ($2014), Millions					
	Impacts		Project		
	Flood Damage Reduction	Environmental (Use Values)	Implementation Costs	Net Benefit	Benefit/Cost
Upper Chehalis Storage Alternative Variations					
Storage + Airport Levee + Floodproofing + Low Enhancement					
Flood Retention RCC with CHTR Fish Passage	$651	$20	$477	$194	1.4
Multipurpose RCC with CHTR Fish Passage	$651	$19	$608	$62	1.1
Multipurpose RCC with Conventional Fishway	$651	$19	$636	$34	1.1
Multipurpose Rockfill with Experimental Fishway	$651	$19	$819	-$149	0.8
Storage + Airport Levee + Floodproofing + High Enhancement					
Flood Retention RCC with CHTR Fish Passage	$651	$71	$511	$211	1.4
Multipurpose RCC with CHTR Fish Passage	$651	$59	$641	$69	1.1
Multipurpose RCC with Conventional Fishway	$651	$59	$669	$41	1.1
Multipurpose Rockfill with Experimental Fishway	$651	$59	$852	-$142	0.8

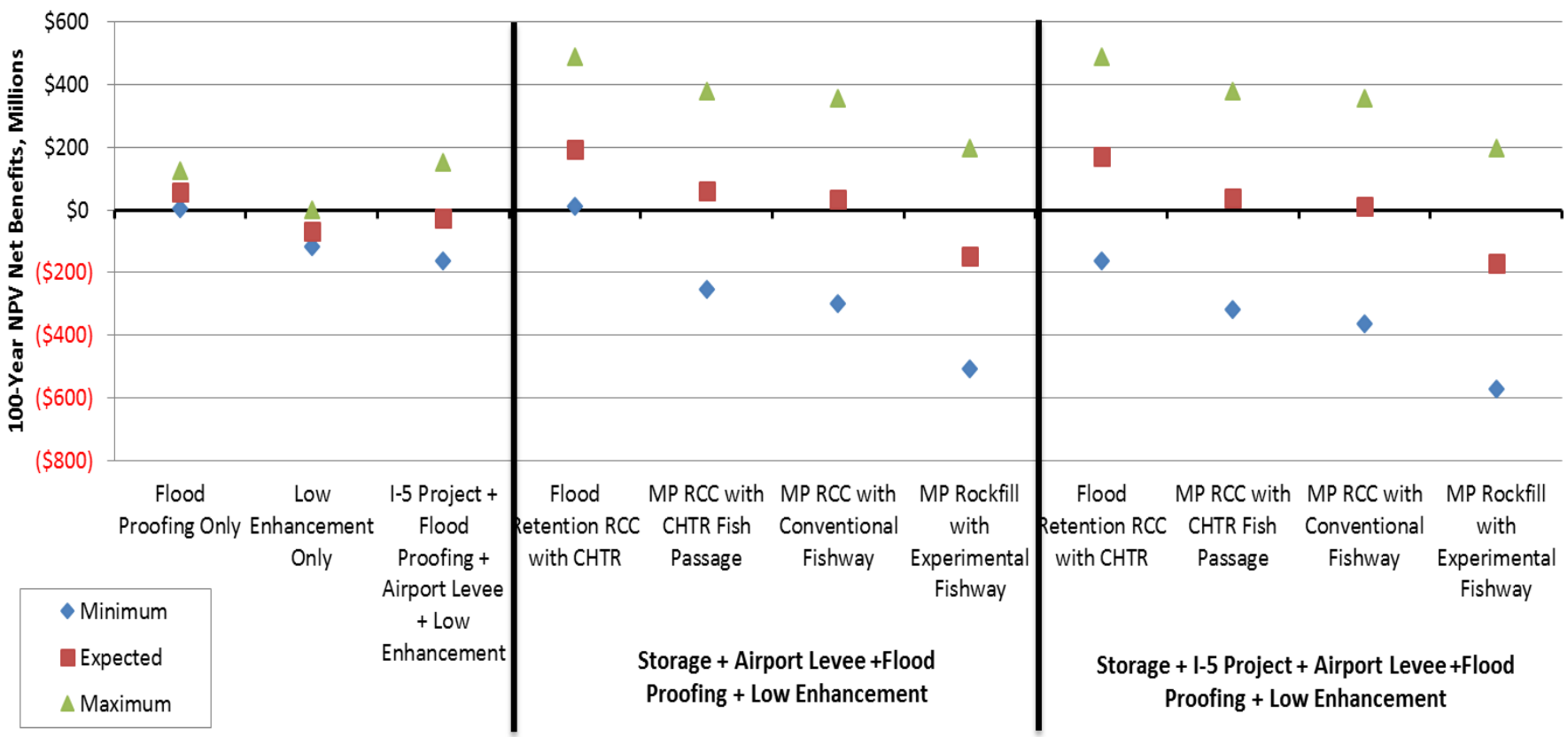
Results: State

Expected Case – Storage & I-5

Expected, Depreciated Values 100-Year NPV 1.63% Discount Rate ($2014), Millions					
	Impacts		Project		
	Flood Damage Reduction	Environmental (Use Values)	Implementation Costs	Net Benefit	Benefit/Cost
Storage + I-5 Project Alternative Variations					
Storage + I-5 Alternative + Airport Levee + Floodproofing + Low Enhancement					
Flood Retention RCC with CHTR Fish Passage	$710	$20	$559	$171	1.3
Multipurpose RCC with CHTR Fish Passage	$710	$19	$689	$40	1.1
Multipurpose RCC with Conventional Fishway	$710	$19	$717	$12	1.0
Multipurpose Rockfill with Experimental Fishway	$710	$19	$900	-$171	0.8
Storage + I-5 Alternative + Airport Levee + Floodproofing + High Enhancement					
Flood Retention RCC with CHTR Fish Passage	$710	$71	$592	$189	1.3
Multipurpose RCC with CHTR Fish Passage	$710	$59	$722	$47	1.1
Multipurpose RCC with Conventional Fishway	$710	$59	$750	$19	1.0
Multipurpose Rockfill with Experimental Fishway	$710	$59	$933	-$164	0.8

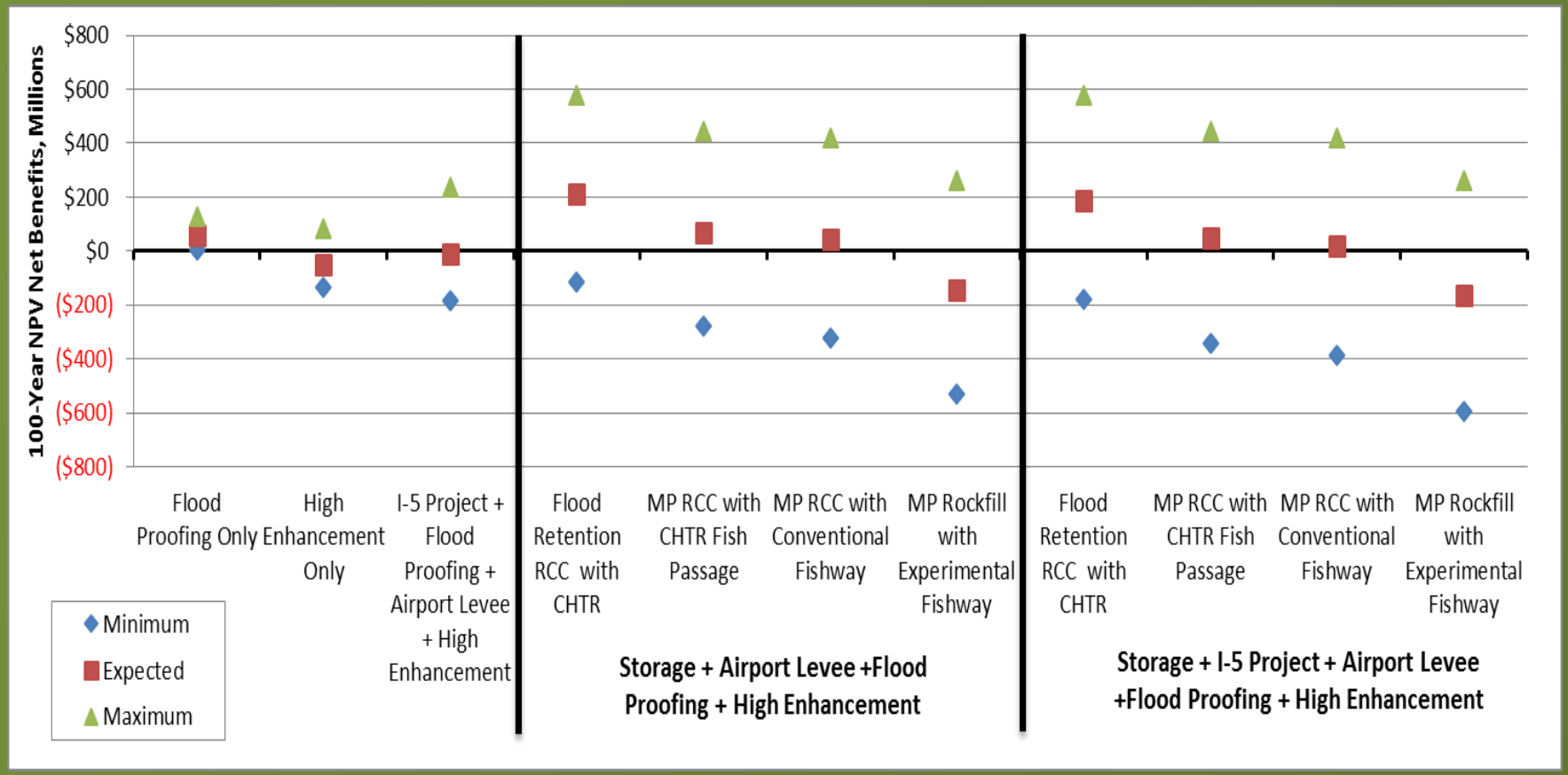
Uncertainty – State

Low Enhancement



Uncertainty – State

High Enhancement



Results: Federal

Expected Case – Individual Alternatives

Expected, Depreciated Values 100-Year NPV 3.5% Discount Rate ($2014), Millions								
	Impacts							
	Flood Damage Reduction	Environmental (Use Values)	Environmental (Passive Values)	Project Implementation Costs	Net Benefit (Use Value)	Benefit/Cost (Use Value)	Net Benefit (Use and Passive Value)	Benefit/Cost (Use and Passive Value)
Floodproofing Only	$83	$0		$92	-$8	0.9		
Low Enhancement Only	$0	15		$95	-$80	0.2		
High Enhancement Only	$0	42		$128	-$86	0.3		
Flood Retention RCC with CHTR Fish Passage (AL)	$377	-$1		$321	$55	1.2		
Multipurpose RCC with CHTR Fish Passage (AL)	$377	$0		$437	-$60	0.9		
Multipurpose RCC with Conventional Fishway (AL)	$377	$0		$469	-$90	0.8		
Multipurpose Rockfill with Experimental Fishway (AL)	$377	$0		$650	-$273	0.6		

Results: Federal

Expected Case – I-5

Expected, Depreciated Values 100-Year NPV 3.5% Discount Rate ($2014) Millions					
	Impacts				
	Flood Damage Reduction	Environmental (Use Values)	Project Implementation Costs	Net Benefit	Benefit/Cost
I-5 Project Alternative Variations					
I-5 Alternative + Airport Levee + Floodproofing + Low Enhancement	$109	$15	$290	-$167	0.4
I-5 Alternative + Airport Levee + Floodproofing + High Enhancement	$109	$42	$324	-$173	0.5

Results: Federal

Expected Case - Storage

Expected, Depreciated Values 100-Year NPV 3.5% Discount Rate ($2014), Millions					
	Impacts		Project		
	Flood Damage Reduction	Environmental (Use Values)	Implementation Costs	Net Benefit	Benefit/Cost
Upper Chehalis Storage Alternative Variations					
Storage + Airport Levee + Floodproofing + Low Enhancement					
Flood Retention RCC with CHTR Fish Passage	$401	$11	$465	-$53	0.9
Multipurpose RCC with CHTR Fish Passage	$401	$10	$581	-$169	0.7
Multipurpose RCC with Conventional Fishway	$401	$10	$613	-$202	0.7
Multipurpose Rockfill with Experimental Fishway	$401	$10	$794	-$383	0.5
Storage + Airport Levee + Floodproofing + High Enhancement					
Flood Retention RCC with CHTR Fish Passage	$401	$39	$498	-$59	0.9
Multipurpose RCC with CHTR Fish Passage	$401	$32	$614	-$181	0.7
Multipurpose RCC with Conventional Fishway	$401	$32	$646	-$213	0.7
Multipurpose Rockfill with Experimental Fishway	$401	$32	$827	-$394	0.5

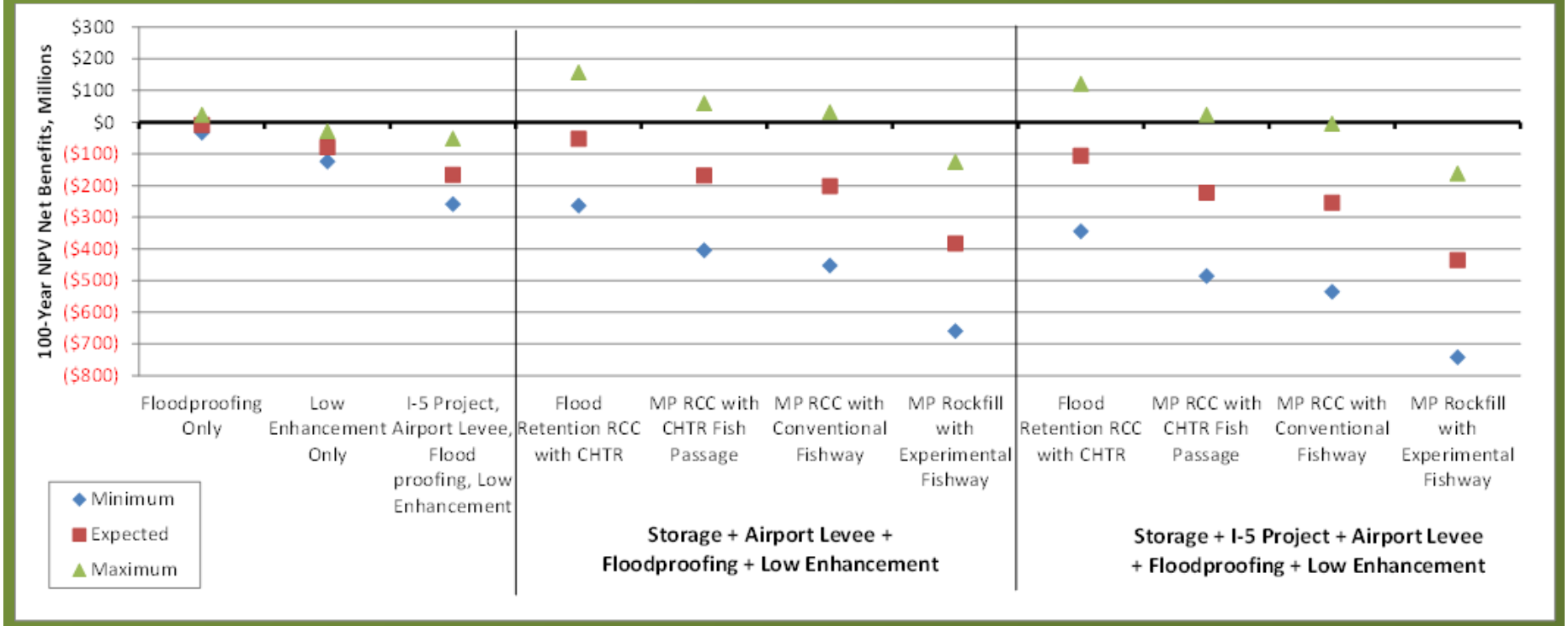
Results: Federal

Expected Case – Storage & I-5

Expected, Depreciated Values 100-Year NPV 3.5% Discount Rate ($2014), Millions					
	Impacts		Project		
	Flood Damage Reduction	Environmental (Use Values)	Implementation Costs	Net Benefit	Benefit/Cost
Storage + I-5 Project Alternative Variations					
Storage + I-5 Alternative + Airport Levee + Floodproofing + Low Enhancement					
Flood Retention RCC with CHTR Fish Passage	$430	$11	$548	-$106	0.8
Multipurpose RCC with CHTR Fish Passage	$430	$10	$663	-$223	0.7
Multipurpose RCC with Conventional Fishway	$430	$10	$696	-$255	0.6
Multipurpose Rockfill with Experimental Fishway	$430	$10	$877	-$436	0.5
Storage + I-5 Alternative + Airport Levee + Floodproofing + High Enhancement					
Flood Retention RCC with CHTR Fish Passage	$430	$39	$581	-$112	0.8
Multipurpose RCC with CHTR Fish Passage	$430	$32	$697	-$234	0.7
Multipurpose RCC with Conventional Fishway	$430	$32	$729	-$266	0.6
Multipurpose Rockfill with Experimental Fishway	$430	$32	$910	-$447	0.5

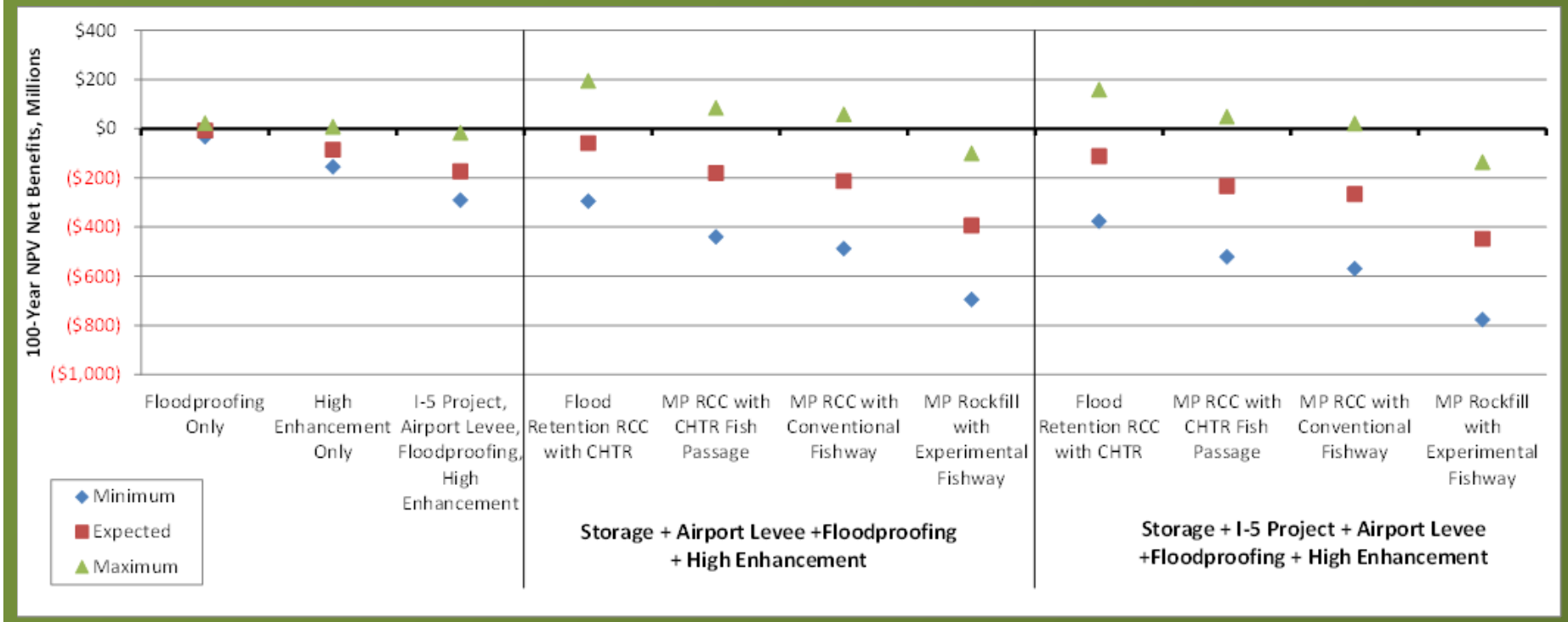
Uncertainty – Federal

Low Enhancement



Uncertainty – Federal

High Enhancement



Hydro Analysis

- 4.6 MW Turbine
- Generates on Average 23,856 MWh
- Capital Costs Include Permitting Costs

Hydro Analysis (cont'd)

- Without REC and CAP & Trade

($2014)			
	EXPECTED	BEST CASE	WORST CASE
Capital	$22,500,000	$20,000,000	$25,000,000
OM&R	$13,410,000	$13,410,000	$13,410,000
IDC	$620,000	$550,000	$690,000
Total Expenses	$36,540,000	$33,970,000	$39,110,000
Market Value	$36,420,000	$44,150,000	$24,430,000
Net Benefit	-$120,000	$10,190,000	-$14,680,000
Benefit/Cost	1.00	1.30	0.62

Qualitative Impacts

- Rail Service
- Livestock
- Environmental Justice
- Cultural Impacts
- Property Values
- Economic Growth
- Health and Safety
- Non-Salmonid Fish and Non-Fish Species

Climate Change

- Results in Appendix M
- Two Scenarios were Modeled
  - 18% increase hydrology
  - 90% increased hydrology
- No Change in Alternative Definitions
- Thinking About the Construct, the Baseline Damages Increase, and the With Alternative Damages Increase, but Costs Stay the Same.

Climate Change: 18%

EXPECTED, DEPRECIATED VALUES 100-YEAR NPV 1.63% DISCOUNT RATE ($2014), MILLIONS					
	IMPACTS				
	FLOOD DAMAGE REDUCTION	ENVIRONMENTAL (USE VALUES ONLY)	PROJECT IMPLEMENTATION COSTS	NET BENEFIT	BENEFIT /COST
Flood Proofing Only	$195	$0	$92	$104	2.1
Low Enhancement Only	$0	$28	$95	-$67	0.3
High Enhancement Only	$0	$78	$128	-$51	0.6
I-5 Project Alternative Variations					
I-5 Alternative + Airport Levee + Flood Proofing + Low Enhancement	$873	$28	$289	$612	3.1
I-5 Alternative + Airport Levee + Flood Proofing + High Enhancement	$873	$78	$322	$628	2.9
Upper Chehalis Storage Alternative Variations					
Storage + Airport Levee + Flood Proofing + Low Enhancement					
Flood Retention RCC with CHTR Fish Passage	$1,058	$20	$477	$600	2.3
Multipurpose RCC with CHTR Fish Passage	$1,058	$19	$608	$469	1.8
Multipurpose RCC with Conventional Fishway	$1,058	$19	$636	$441	1.7
Multipurpose Rockfill with Experimental Fishway	$1,058	$19	$819	$258	1.3
Storage + Airport Levee + Flood Proofing + High Enhancement					
Flood Retention RCC with CHTR Fish Passage	$1,058	$71	$511	$618	2.2
Multipurpose RCC with CHTR Fish Passage	$1,058	$59	$641	$476	1.7
Multipurpose RCC with Conventional Fishway	$1,058	$59	$669	$448	1.7
Multipurpose Rockfill with Experimental Fishway	$1,058	$59	$852	$265	1.3

Climate Change: 90%

EXPECTED, DEPRECIATED VALUES 100-YEAR NPV 1.63% DISCOUNT RATE ($2014), MILLIONS					
	IMPACTS				
	FLOOD DAMAGE REDUCTION	ENVIRONMENTAL (USE VALUES ONLY)	PROJECT IMPLEMENTATION COSTS	NET BENEFIT	BENEFIT /COST
Flood Proofing Only	$362	$0	$92	$271	4.0
Low Enhancement Only	$0	$28	$95	-$67	0.3
High Enhancement Only	$0	$78	$128	-$51	0.6
I-5 Project Alternative Variations					
I-5 Alternative + Airport Levee + Flood Proofing + Low Enhancement	$901	$28	$289	$640	3.2
I-5 Alternative + Airport Levee + Flood Proofing + High Enhancement	$901	$78	$322	$657	3.0
Upper Chehalis Storage Alternative Variations					
Storage + Airport Levee + Flood Proofing + Low Enhancement					
Flood Retention RCC with CHTR Fish Passage	$2,137	$20	$477	$1,680	4.5
Multipurpose RCC with CHTR Fish Passage	$2,137	$19	$608	$1,549	3.5
Multipurpose RCC with Conventional Fishway	$2,137	$19	$636	$1,520	3.4
Multipurpose Rockfill with Experimental Fishway	$2,137	$19	$819	$1,337	2.6
Storage + Airport Levee + Flood Proofing + High Enhancement					
Flood Retention RCC with CHTR Fish Passage	$2,137	$71	$511	$1,697	4.3
Multipurpose RCC with CHTR Fish Passage	$2,137	$59	$641	$1,556	3.4
Multipurpose RCC with Conventional Fishway	$2,137	$59	$669	$1,527	3.3
Multipurpose Rockfill with Experimental Fishway	$2,137	$59	$852	$1,344	2.6

Indirect Benefits

- Implan Model Used to Determine the Economic Impact of Avoiding Flooding Damage
- Five Impacts Modeled
  - Project expenditures
  - Property damage reduction
  - Business loss reduction
  - Lost household income
  - Other project impacts (commercial & sports fishing)
- Overall Increase Net Benefits Significantly

Key Findings

- Flood Proofing Viable Solution to Damage Reduction for Residential Structure and Content, however, It Does Not Solve Issue of Flooded Roads, Commercial Buildings and Agricultural Lands
- Enhancement Programs are not Cost-Effective if Only Use Values are Included; however, Adding in Passive Values and Considering Qualitative Benefits Result in Economic Benefits that Far Exceed Costs

Key Findings (cont'd)

- Alone or Combined with Other Projects, a Flood Storage Facility Provides Positive Net Benefits Under the State and Basin Perspectives
- Under the Federal Perspective, a Flood Retention Only Facility has a Positive Net Benefit With and Without Flood Proofing

Key Findings (cont'd)

- The Biggest Driver of Benefits Comes from Reducing Damage to Structures, Content and Inventory
- No Option Will Mitigate All Flooding Damages from the Basin
- Including Climate Change Increase Benefits for Most Project Alternatives

Questions