Attachment 1 - Water Needs

Out of Stream Needs

Needs to be met through the Integrated Plan are described for federally supplied agriculture, and for municipal and domestic water uses. Review needs every five years and update, as necessary, as part of an ongoing review conducted by the State. Adaptive management measures will be implemented to address changes in water needs.

Federally-Supplied Agriculture

The irrigation need to be met for single and multi-year droughts, based on recent hydrologic conditions, is estimated at 70% of the irrigation water right entitlement each year for Kittitas Reclamation District, Roza Irrigation District and Wapato Irrigation Project. These are the districts that have proratable water rights and are seeking drought relief directly through the Integrated Plan. In severe drought conditions, this need could be as high as 300,000 to 400,000 AF. Kennewick Irrigation District (KID) also has proratable water rights and partially relies upon return flows to meet supply needs. Supply improvements in the Integrated Plan should improve reliability for KID.

With potential climate change impacts and existing cropping patterns, the estimated need would increase an estimated additional 95,000AF[1] in non-drought years (less in drought years). This additional amount reflects the potential need for all Districts supplied water by Reclamation, based on rough estimates of increased consumptive use for existing crops in the Yakima Project. It does not take into account potential crop changes that could result from climate change response.

Municipal and Domestic Water Uses

For non-drought conditions, projected additional need by 2060, adjusted for water conservation and land conversion ranges from 41,000 (200 gpcd) to 49,000 AF (234 gpcd). During drought conditions, local curtailment policies can reduce these quantities. Needs are distributed across all three counties of the Yakima River Basin and enhanced supplies should be allocated, in part, on a geographic basis reflecting expected growth trends in the three counties.

Instream Needs

Flow targets, some qualitative and other quantitative, are provided below. Specific numbers aren't always provided because in many instances, scientific understanding of the relationship of flow to fish survival is limited, the objectives will vary with environmental conditions, and because in times of shortage, water that might have been directed to one ecological purpose may be more ecologically valuable elsewhere. This section is intended to explain at a coarse scale how flows within the river system should be managed for fish.

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[1] The consultant team received comments from the University of Washington Climate Impact Group stating their opinion that the increase in water demand would be more likely 3-5 percent, instead of the 7 – 9 percent used to arrived at the 95,000 AF increase (Stockle, C. Email to J. Vano and A. Graham, November 19, 2010). A 5 percent increase is approximately a 53,000 AF increase.

For many years, flow management has focused on protecting spring Chinook salmon redds in the upper watershed and on spring flows from Parker to the mouth. While each of these is important, the Integrated Plan seeks to improve other aspects of flow management as well.

Lower River

Despite the water supply facilities identified in the Integrated Plan, the fisheries managers (federal and state fish and wildlife agencies, and the Yakama Nation) recognize that flow volumes during the spring of the driest years will be largely unchanged from present conditions. It is expected, however that aquifer recharge efforts will improve water quality, particularly summer water temperatures in much of the lower river corridor. Flow targets for the lower river will be met as required in Title XII based on TWSA. In addition, flow pulses will be provided as recommended by the System Operations Advisory Committee (SOAC). The hydrologic modeling performed for the Integrated Plan demonstrated that an additional 15,000 acre-foot block of water can be provided for flow pulses during drought years. That water is provided in addition to the water needed to meet a 70% water supply for proratable water users and the volume required by Title XII. Such flow increases may either be pulsed, episodic (for a subset of the irrigation season), or static (as Title XII flows are presently managed), according to the recommendations of SOAC. In wetter years the modeling indicated there are larger blocks of water available for shaping but no analysis was performed of its use. It may be desirable to shape those larger blocks of water to improve our understanding of flow/survival relationships. As provided in the modeling results presented to the Workgroup, there will be times when unregulated discharge during the smolt migration is reduced relative to present conditions in order to fill new reservoirs. It will be important as part of a future effort to establish minimum flows to which reservoir refill will be subordinate.

Upper River High Summer Flows

Storing water in a network of more broadly distributed “buckets” affords additional operational flexibility. With the increased flexibility that the proposed Wymer Reservoir and a larger Bumping Reservoir could provide, Reclamation, consulting with SOAC, can attenuate unnatural high flows in the Cle Elum, upper Yakima, and Tieton Rivers, to the extent possible, without reducing pro-ratable water supplies below 70% during drought conditions. In addition, the Keechelus to Kachess pipeline would enable substantial reductions to the unnaturally high August flow regime below Keechelus Dam.

Winter Flows

Winter flows will be provided below the storage reservoirs as recommended presently (incubation flows for spring Chinook salmon will be maintained at or above spawning flows) or adjusted with better information. If providing higher flows is highly likely to reduce pro-ratable water supply below 70% during drought conditions, they may be reduced in consultation with SOAC.

Spring Flows

When water is available above that needed to provide a water supply of 70% of entitlements to proratable water users during drought conditions, Reclamation in consultation with SOAC may provide freshets to encourage emigration of smolts from heavily regulated reaches below the reservoirs. In addition, it is a high priority to provide high, normative spring migration flows in the reach below Roza Dam.

Tributary Flows

Project facilities will be used where warranted to deliver water either directly to tributary water users or to tributaries to replace tributary diversions.

The flow objectives and the associated prioritization framework identified Table 1 are the approximate instream flow needs/benefits to be met through the combination of Integrated Plan actions.

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Other Surface and Groundwater Considerations

The Integrated Plan will make major improvements in water supply and aquatic habitat conditions in the basin. However, some challenges will still remain and need to be addressed through other processes.

Recent studies conducted by the USGS conclude that the surface and groundwater systems of the basin are interconnected. Areas within the basin, especially the deep basalt aquifer, are seeing significant declines in groundwater levels, which in turn are affecting stream flow and water supply available for irrigation. While this condition is not directly addressed by the Integrated Plan, improvement in drought-year surface water irrigation supply will offset a portion of the existing groundwater demand. Meeting some of the future municipal and domestic needs through implementation of the Integrated Plan would also reduce future impacts to instream flows and federally supplied agricultural water demands. The USGS groundwater study early estimate of deep basalt aquifer depletion is around 30,000 AF annually (http://wa.water.usgs.gov/projects/yakimagw/summary.htm).

Additionally, flows in some tributary streams will not be improved by the Integrated Plan as projects in the plan cannot physically affect all geographic areas where improvements could be made.

Table 1 – Yakima River Basin Instream Flow Needs By Reach		
River Reach	**Flow Objective**	**Priority**
Keechelus Dam to Lake Easton	Improve summer rearing by reducing flows down to 450-550 cfs. Increase winter flow to 120 cfs (connection to side channels at that flow). Provide pulses in winter.	High
	High late summer flows reduced below 800 cfs 99.7 % of the time, as opposed to 54.7 % of the time under FWIP. In the winter, 120 cfs is exceeded 99.6 % of the time under the Integrated Plan as compared to 20.2 % of the time under the FWIP. Spring pulse flows of 7000 AF are released each year. Additional pulse flows will be available in most years as system carryover storage is increased by 160 kAF on average.	
Kachess River	No change proposed – lesser priority for improving river flow because of other objectives	
Easton Reach	Provide spring pulse of 1000 cfs for 48 hours during dry years, augment spring Q for channel maintenance occasionally (5-yr for riparian recruitment – bank full during wet years)	Medium
	Currently 180 cfs, start spawning flow at 220 cfs, increase to 250-300 cfs in winter, 250 cfs provides connection to side channels. Spawning flows at 220 cfs.	High
	Spring pulse flows provided in 18 out of 26 years under Integrated Plan; Average fall/winter flows increased from 407 to 462 cfs.	
Cle Elum River	Reduce flow, modify flip flop to give more gentle change in hydrograph. In wet years, spill earlier but hold water back in August to reduce flow (reduce by 1000 cfs). Also work to bridge peaks between spring and summer to improve cottonwood establishment.	High
	Increase to 500 cfs September through March. Side channels are thought to be activated around 500 cfs, and one was recently modified to activate at 200 cfs, provide pulse flows.	High
	Average summer flows have decreased from 2779 to 2280 cfs. Average fall/winter flows have increased to 436 from 325 cfs. Spring pulse flows are provided in non-drought years. Additional pulse flows or flow variability will be available in most years as system carryover storage is increased by 160 kAF on average.	
Cle Elum to Teanaway River	Reduce flows from 4000 cfs to 1000 cfs by late August. Ok to have high flow in July, as mimics unregulated hydrograph.	High
	Provide channel shaping flows every 5 years or so.	Medium
	Provide flow variability, see Cle Elum River.	Medium
	Average flow on August 31st has been reduced to 2174 from 3142 cfs. Pulse flows are provided from upstream reservoirs. Additional system carryover storage in Keechelus and Cle Elum reservoirs will allow additional pulse flow or increase in flow variability.	

Table 1 – Yakima River Basin Instream Flow Needs By Reach		
River Reach	**Flow Objective**	**Priority**
Teanaway to Roza Dam	Reduce summer flows	High
	Provide channel shaping flows every 5 years or so	Medium
	Provide flow variability, time pulses to match natural events.	Medium
	Average summer flows have been reduced from 3204 to 2471 cfs. Pulse flows are provided from upstream reservoirs. Additional system carryover storage in Keechelus and Cle Elum reservoirs will allow additional pulse flow or increase in flow variability.	
Roza-Naches	Increase flow to about 1400 cfs for high and average water years from March through May[2].	High
	Increase to 1000-1400 cfs (use IFTAG flows). Link flows to habitat needs. Compare to 2-D habitat model for reach above Roza Dam.	High
	Provide flow variability	Low to medium
	The average spring flow has increased to 1385 from 1299 cfs. In the fall/winter the average flow is 926, as opposed to the FWIP average of 952 cfs. However, subordination was not modeled so additional flow would be provided if subordination of Roza Power plant flows is adopted.	
Bumping Dam—Lower Naches	Reduce flows by 70-100 cfs from August through October	Medium
	Average daily flow from August through October has decreased to 165 from 189 cfs. Spring pulse flows are provided every year and can be timed by biologists. A gradual reduction in the flow hydrograph is provided from July to September.	
Tieton River	Maintain minimum 125 cfs flow during winter months	High
	Reduce September flows as much as possible.	Medium
	Average winter flows have increased from 195 to 290 cfs. Average flow in September has decreased to 1166 from 1534 cfs.	
Lower Naches River	Change ramping rate from spring to summer. Increase summer low flow. Check habitat needs vs flow.	High
	Reduce September flows as much as possible. Look at releasing more in summer and reducing flip flop.	High

[2] The Yakima Basin Joint Board has been working with the Bureau of Reclamation and other partners to plan a study below Roza Dam to improve the biological basis for flow enhancements in this reach. Results are expected in 12 to 24 months.

Table 1 – Yakima River Basin Instream Flow Needs By Reach		
River Reach	**Flow Objective**	**Priority**
	When compared to FWIP, the average summer flow has decreased by approximately 215 cfs, resulting in an average flow of 1029 cfs. Lower Naches was not targeted by reservoir operation rules. However, additional carryover storage of 190,000 AF on average is available for use on the Naches arm.	
Yakima River Naches River to Parker	Reduce high summer flows as much as possible	Low
	When compared to FWIP, the average summer flow has decreased by approximately 215 cfs, resulting in an average flow of 3185 cfs.	
Yakima River from Parker to Toppenish Creek (Wapato reach)	15,000 – 20,000 acre-feet to use specifically for smolt outmigration in dry years. See SOAC recommendations for pulse flows. Evaluate early and late pulse and opportunities to improve Sockeye passage also. Change ramping rate at end of high flows that occur in June-July in average-wet years.	High
	link to habitat needs	No priority assigned[3]
	Average summer flow under the integrated plan is 2683 cfs, as compared to an average flow of 2564 cfs under the FWIP. Additional pulse flows or flow variability will be available in most years as system carryover storage is increased by 160 kAF on average.	
Yakima River: Toppenish Creek to Prosser Dam	See Wapato Reach	See Wapato Reach
	Average spring flow has increased to 3578 from 3377 cfs, an increase of 201 cfs under the Integrated Plan.	
Yakima River—Chandler Reach	Need greater than 1000 cfs in September	Low
	Although some subordination occurs to provide 1000 cfs, need more flow	Low
	Average flow in July has increased from 682 cfs to 758 cfs under the Integrated Plan. Average September flow has decreased from 650 cfs to 492 cfs under the Integrated Plan. Average spring flows have increased by 188 cfs, resulting in an average spring flow of 2490 cfs. Subordination of Chandler Power plant was not modeled. Additional flow and survival benefits would occur if subordination is adopted.	
Lower Yakima River (Chandler	see Wapato Reach	Low
	link to habitat needs	Low

[3] This reach needs to better understanding of existing conditions. Design and implement research, monitoring and evaluation (RM&E) program to better understand improvements needed. Develop flow objectives from RM&E results.

Table 1 – Yakima River Basin Instream Flow Needs By Reach		
River Reach	**Flow Objective**	**Priority**
Powerplant to mouth)	Under the integrated plan, the average spring flow has increased by 196 cfs, resulting in an average flow of 3668 cfs.	
Tributaries		
Manastash, Taneum, Cowiche	Increase summer and early fall flows.	High
Big, Little	Increase summer and early fall flows.	Medium
Ahtanum	Increase summer and early fall flows.	High
Wenas	Increase summer and early fall flows.	Lower
North Side Kittitas Valley Tributaries	Improve passage	Lower
	The KRD south branch project will improve instream flow in Manastash Creek and Big and Little Ahtanum and Taneum.	

Attachment 2 - Water Supply Benefits

Based on RiverWare modeling results, the Integrated Plan (comprised of the actions describe above) will provide the benefits outlined in the following table for average water years, and single (2001, 2005) and multi-year (1993, 1994) drought conditions.

Integrated Plan Results for Benefits Evaluation

Resource indicator (measurement)	Future without Integrated Plan	Integrated Plan	Change from FWIP
WATER RESOURCES			
Average for water years 1981–2005 (maf)			
Water supply			
April 1 total water supply available (TWSA)	2.79	3.00	0.22
Water distribution			
April–September Parker flow volume	0.64	0.60	-0.04
April–September diversion	1.61	1.69	0.09
September 30 reservoir contents	0.23	0.58	0.34
Irrigation proration level	80%	92%	12%
1993 dry-year (maf)			
Water supply			
April 1 total water supply available (TWSA)	2.06	2.24	0.18
Water distribution			
April–September Parker flow volume	0.36	0.30	-0.06
April–September diversion	1.42	1.57	0.15
September 30 reservoir contents	0.05	0.26	0.21
Irrigation proration level	44%	70%	26%
1994 dry-year (maf)			
Water supply			
April 1 total water supply available (TWSA)	1.74	2.22	0.48
Water distribution			
April–September Parker flow volume	0.31	0.25	-0.07
April–September diversion	1.23	1.52	0.29
September 30 reservoir contents	0.05	-0.06	-0.11
Irrigation proration level	21%	70%	49%
2001 dry-year (maf)			
Water supply			
April 1 total water supply available (TWSA)	1.76	2.45	0.69
Water distribution			
April–September Parker flow volume	0.25	0.20	-0.05
April–September diversion	1.29	1.55	0.27
September 30 reservoir contents	0.06	0.22	0.16
Irrigation proration level	32%	70%	38%
2005 dry-year (maf)			
Water supply			
April 1 total water supply available (TWSA)	1.71	2.32	0.61
Water distribution			
April–September Parker flow volume	0.25	0.18	-0.06
April–September diversion	1.25	1.53	0.28
September 30 reservoir contents	0.08	0.13	0.05
Irrigation proration level	28%	70%	42%

Attachment 3 - Fisheries Benefits

Fisheries benefits were estimated using existing fisheries models developed for the Basin, including Ecosystem Diagnosis and Treatment (EDT), All H's (hydropower, harvest, hatcheries and habitat) Analyzer (AHA) and spawning per hectare (Sockeye only) models. The benefits of the Integrated Plan to spring Chinook, steelhead, coho fall Chinook, summer Chinook, and sockeye are significant. The models reflect the habitat restoration actions and fish passage included in the Integrated Plan. These improvements would likely result in a range of total adult salmon recruitment between 235,0000 during low survival years and more than 800,000 adults in years of high survival. Harvest would be three or more times greater than the future without the Integrated Plan. The number of fish reaching the spawning grounds would grow from a maximum return of 91,000 adults if the plan were not implemented to 273,000 if this Integrated Plan is implemented.

Annual Adult Salmon Run Size	**Future without Plan**			**Integrated Plan**		
	Min	**to**	**Max**	**Min**	**to**	**Max**
Recruitment[4]	18,581	to	131,343	236,404	to	836,060
Harvest	5,148	to	37,260	23,635	to	108,470
Yakima R. Mouth	15,103	to	106,619	71,392	to	324,336
Total Escapement	**12,139**	**to**	**91,228**	**59,618**	**to**	**273,354**

Bull trout would benefit but also could potentially be negatively impacted by actions identified in the Integrated Plan without appropriate mitigation measures. If the effects of moderate climate change to precipitation and water use patterns occur as identified in two of the three future climate change scenarios, conditions in Lake Kachess will have to be managed or modified in a manner to ensure that adult bull trout are able to access and spawn in Box Canyon Creek and the Kachess River.

[4] Recruitment is defined as ocean population at the mouth of the Columbia River.

The following identifies the Yakima Basin Fisheries Managers expected changes in bull trout population viability with Integrated Plan implementation.

Population	Plan
Ahtanum	+
Indian Creek	++
South Fork Tieton	+++
North Fork Tieton	+++
American	+
Crow Creek	+
Rattlesnake Creek	+
Deep Creek	-
Bumping River	-
Kachess River	-
Box Canyon Creek	-
Gold Creek	+++
Cle Elum/Waptus	+
Upper Yakima	++
Teanaway	+

- = Negative impact (would require mitigation)
+ = Some benefit from habitat actions or Bull Trout Task Force
++ = Additional benefit, either re-connectivity as dam passage is addressed, or another project that addresses a specific limiting factor for a population (e.g. SF Tieton falls, Gold Creek Hydrological Assessment).
+++ = Multiple passage or population specific projects

Attachment 4 - Plan Costs

Costs were determined in accordance with the Reclamation Cost Estimating Handbook. Based on 10% engineering design or less, the material and quantities; mobilization and demobilization; site preparation; and labor required to build the project were estimated. All costs were estimated at an appraisal level and within -20% and +40% of the estimate. Design and permit costs were assumed to be 30% of the construction costs. Annual O&M Costs includes anticipated staff, electrical and routine maintenance.

Benefit/cost analysis still needs to be completed for these projects along with cost allocations. This will occur as part of the Reclamation/Ecology administrative review (final planning report and programmatic NEPA/SEPA/ESA review) discussed in Section 1.0 of the Summary Integrated Plan document.

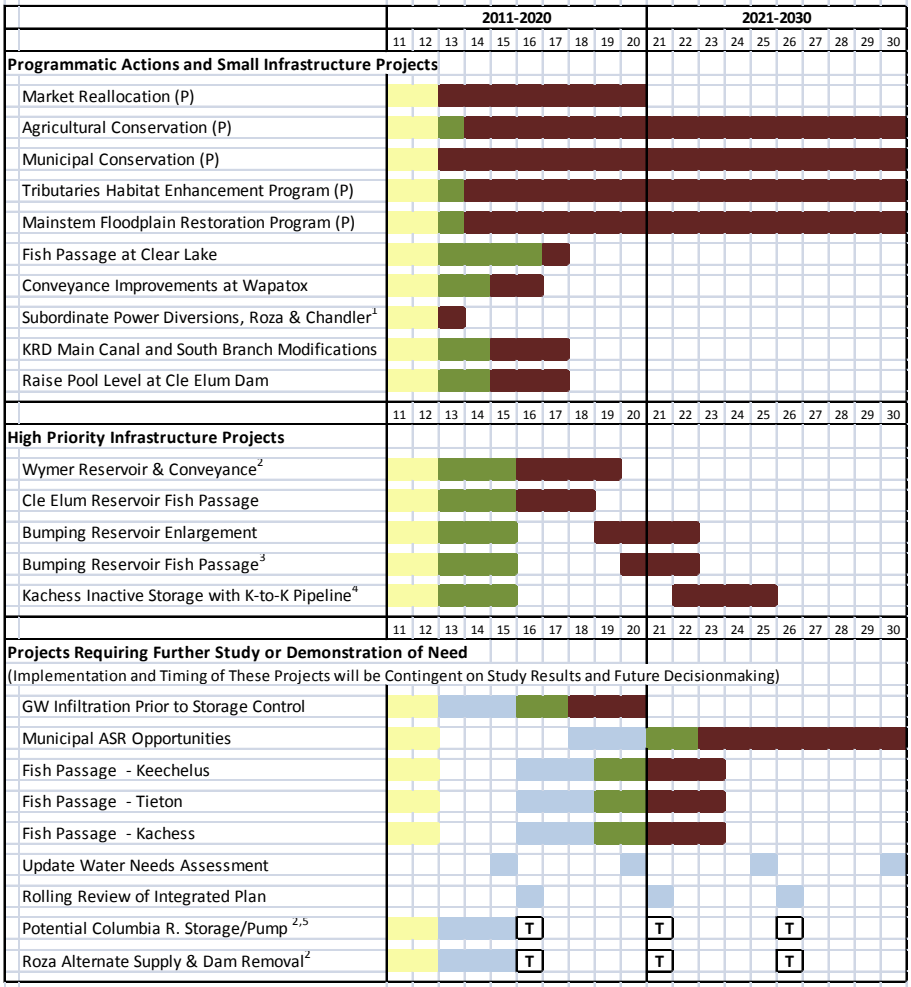
Project	Construction Cost	Range		Construction w/Design & Permit	Range		Annual O & M
		Lower	Upper		Lower	Upper	
Cle Elum Improvements - 3' Pool Raise	$12,956,605	$10,365,284	$18,139,247	$16,843,587	$13,474,869	$23,581,021	$500,000
Keechelus to Kachess Pipeline	$146,669,278	$117,335,422	$205,336,989	$190,670,061	$152,536,049	$266,938,086	$90,000
Kachess Inactive Storage Alt 1 - Tunnel	$195,243,377	$156,194,702	$273,340,728	$253,816,390	$203,053,112	$355,342,946	$270,000
Kachess Inactive Storage Alt 2 - Pump Station	$173,619,609	$138,895,687	$243,067,453	$225,705,492	$180,564,393	$315,987,688	$590,000
Wymer Reservoir, Pump Station and Powerplant	$1,007,490,102	$805,992,082	$1,410,486,143	$1,309,737,133	$1,047,789,706	$1,833,631,986	$3,980,000
Thorp, KRD Canal, Siphon and Tunnel/Pipeline	$416,338,052	$333,070,442	$582,873,273	$541,239,468	$432,991,574	$757,735,255	$3,390,000
Bumping Lake Dam Enlargement	$309,613,882	$247,691,106	$433,459,435	$402,498,047	$321,998,437	$563,497,265	$210,000
KRD Canal South Branch Modifications	$27,621,368	$22,097,094	$38,669,915	$35,907,778	$28,726,223	$50,270,890	$25,000
Wapatox Canal Option 1	$45,638,595	$36,510,876	$63,894,033	$59,330,174	$47,464,139	$83,062,243	$210,000
Wapatox Canal Option 2	$63,178,672	$50,542,938	$88,450,141	$82,132,274	$65,705,819	$114,985,183	$210,000
Fish Passage Cle Elum	$74,185,375	$59,348,300	$103,859,525	$96,440,988	$77,152,790	$135,017,383	$500,000
Fish Passage Bumping	$20,473,111	$16,378,489	$28,662,355	$26,615,044	$21,292,035	$37,261,062	$500,000
Fish Passage Clear Lake	$2,302,732	$1,842,186	$3,223,825	$2,993,552	$2,394,841	$4,190,972	$70,000
Fish Passage Box Canyon	$2,500,000	$2,000,000	$3,500,000	$3,250,000	$2,600,000	$4,550,000	$70,000
Fish Passage (Tieton, Kachess, Keechelus)	$150,000,000	$120,000,000	$210,000,000	$195,000,000	$156,000,000	$273,000,000	$1,500,000
Enhanced Agriculture Conservation	$313,333,333	$250,666,666	$438,666,666	$407,333,333	$325,866,666	$570,266,666	$0
Groundwater Infiltration (Pilot study : 2 areas)	$1,338,000	$1,070,400	$1,873,200	$1,739,400	$1,391,520	$2,435,160	$600,000
Groundwater Infiltration (Full scale :160-500 acre	$56,100,000	$44,880,000	$78,540,000	$72,930,000	$58,344,000	$102,102,000	$2,145,000
Columbia River Pump Station Study	$3,800,000	$3,040,000	$5,320,000	$3,800,000	$3,040,000	$5,320,000	$0
Municipal Conservation	$0	$0	$0	$0	$0	$0	$1,000,000
Tributary Habitat				$180,000,000	$144,000,000	$252,000,000	$0
Mainstem Habitat				$279,700,000	$223,760,000	$391,580,000	$0
Total	***$2,770,605,360***	***$2,200,818,750***	***$3,906,262,195***	***$4,060,346,967***	***$3,227,912,374***	***$5,720,124,853***	***$14,720,000***

Attachment 5 – Provisional Schedule: Timing, Sequence and Triggers

The graphic below shows the provisional implementation schedule. Colors are used in the graphic to show four stages of activity: 1.) Authorization; 2.) Studies; 3.) Project Environmental Review, Permitting and Design; and 4.) Project Construction or Program Activation.

Timing, Triggers and Sequence, Yakima Basin Integrated Plan

(subject to refinement as implementation pathway is further defined)



(P) = Programmatic Actions

T = Assessment of triggers for possible implementation.

[1] Further power subordination subject to approval by Reclamation, BPA, and either Roza or Kennewick ID as applicable.

[2] Roza alternate supply to permit removal of Roza Dam also to be considered as part of Wymer Project and in study of any large storage/pump exchange projects such as Columbia River supply.

[3] Timing of fish passage at Bumping Lake could be advanced to an earlier date if a new reservoir is not authorized.

[4] I-90 crossing of K-to-K Pipeline to be constructed early (2012), in conjunction with WSDOT construction project.

[5] Step 1 in feasibility study of future storage/pump exchange projects, from Section 3.3.4 of Support Document.

Color Codes:

- Authorization (for "trigger" projects, authorize studies)
- Studies
- Project environmental review, permitting & design
- Project Construction or Program Activation