Integrated Program Review
FCRPS Hydro Program

BPA Rates Hearing Room
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Table of Contents

1. Cover Page
2. Table of Contents
3. System Summary
4. Map of the System
5. FCRPS Hydro Strategy / Products and Services
6. FCRPS Integrated Business Management Model (IBMM)
7. Hydro Asset Planning Initiative: Long Term, Low Cost Power
8. Criticality of Plants
9. Current Performance – Low Cost Power – Benchmarks
10. Current Performance – Low Cost Power – Fully Allocated Cost
11. Current Performance – Power Reliability
12. Current Performance – Trusted Stewardship
13. Condition Assessment – hydroAMP Framework
14. Current Condition – hydroAMP Ratings
15. Condition – Change in Average hydroAMP Index w/o Investment
16. Risk – hydroAMP Condition Index vs. Likelihood of Equipment Failure
17. Risk – Current Profile of Equipment
18. Age – Current and Projected (at 2016) w/o Investment
19. Proposed Long Term Plan – O&M Program Forecast, FY2009 – FY2027
20. O&M Program Forecast, Average Annual FY2010 – FY2011
21. Proposed Long Term Plan – Large Capital Forecast w/ AFUDC, FY2009 – FY2015
22. Proposed Long Term Plan – Investment Program by Plant, FY2009 – FY2015
23. Large Capital Forecast w/ AFUDC, Average Annual FY2010 – FY2013
24. Extraordinary Maintenance Expense Forecast, Average Annual FY2010 – FY2011
25. Proposed Long Term Plan – Average hydroAMP Index at 2016
26. Proposed Long Term Plan – Risk Profile at 2016
27. Proposed Long Term Plan – Age of hydroAMP Rated Equipment
28. Proposed Long Term Plan – System Cost of Production
29. Proposed Long Term Plan – Risk and Uncertainties
30. Corps Direct Funded Expense
31. Reclamation Direct Funded Expense
32. Corps/Reclamation Direct Funded Capital
33. Discussion of Significant Cost Drivers

System Summary

Overview

The Federal Columbia River Power System (FCRPS) hydro program is a partnership between the US Army Corps of Engineers (Corps), the US Bureau of Reclamation (Reclamation), and Bonneville Power Administration (Bonneville). The program is financed through direct funding agreements between Bonneville and the Corps, and Bonneville and Reclamation, delivering power worth $4 billion annually to the people of the Pacific Northwest.

The program has a mandate to provide low cost, reliable power and effective resource stewardship to the Pacific Northwest region. Through direct funding agreements, it spends over $300 million annually on Capital Investment and O&M programs. In addition to delivering power and other services today, the partnership is challenged to effectively maintain and manage a substantial asset base for the long-term.

Statistics

The FCRPS hydro system consists of 31 hydroelectric plants with 209 turbine-generating units

System generating capacity is 22,059 MW, with an average generation of 76,354 GWh (8,716 aMW)

FCRPS hydro comprises about 80 percent of Bonneville Power Services generation

The plants have as few as 1 unit and as many as 33 units (Grand Coulee)

Generating unit sizes range from 1 MW to 805 MW

The oldest units were put into service in 1909 (Minidoka); the youngest in 1999 (Boise Diversion Rehabilitation)

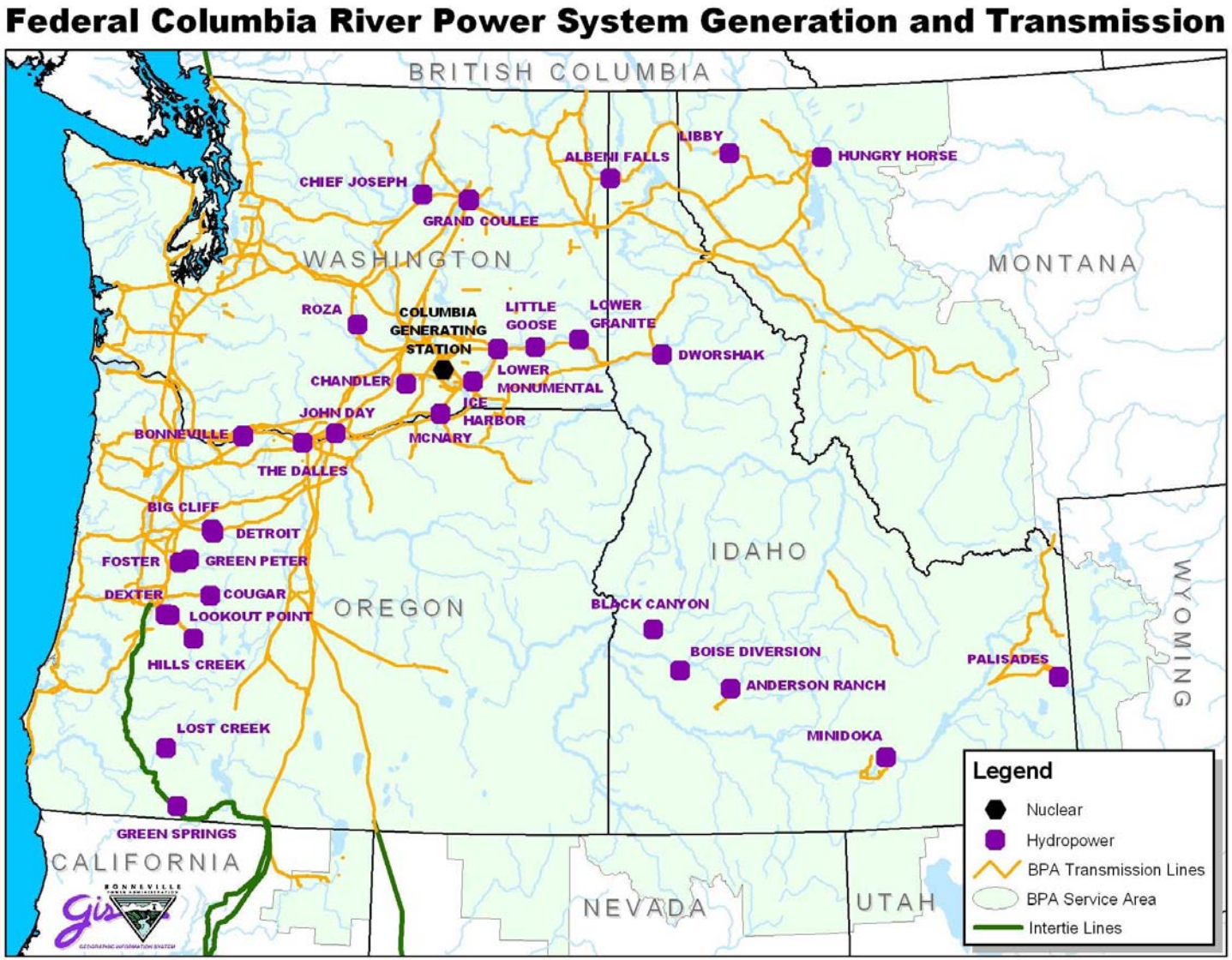
The cost of the hydro Direct Funded Program in 2007 was $338 million:

- Expense costs were 220 million
- Capital costs were $118 million

The program employs about 1,500 employees working on:

- Hydropower (power-specific and joint-use facilities)
- Fish & Wildlife O&M (joint-use)
- Cultural Resources (joint-use)

Map of the System



FCRPS Hydro Strategy / Products and Services

The FCRPS Hydro Strategy focuses on three goals:

- Low Cost Power;
- Power Reliability; and,
- Trusted Stewardship

The strategy is implemented through a set of Direct Funding Agreements to:

- Ensure that life safety and environmental requirements are met;
- Meet FCRPS commitments for fish and wildlife and cultural resource programs;
- Meet Bonneville's needs for a reliable supply of low-cost generation by ensuring power generating assets are properly operated, inspected, and maintained;
- Mitigate the risk of power generation component failures by replacing or refurbishing equipment and purchasing spares when warranted;
- Increase the efficiency &/or capability of power facilities where economically feasible; and
- Fund a portion of high priority multi-purpose projects, in accordance with Bonneville's direct funding agreements with the Corps of Engineers and Bureau of Reclamation.

Key products and services provided from federal hydro assets include the following:

- Power Generation and Delivery
  - Electricity Production (MWh)
  - Peak Electricity Capacity (MW)
  - Spinning and Non-spinning Reserves
  - Load Following
  - Voltage Support
  - System Restoration (e.g., Black Start)
- Non-Power Purposes
  - Flood Damage Reduction – Use reservoir storage to shape natural water flows to reduce impacts to communities, farmland, and industry located along rivers
  - Navigation – Enable an inland waterway through a series of locks on the Columbia and Snake rivers
  - Irrigation – Increase the acreage of arable land in the Pacific Northwest through the storage and diversion of water.
  - Recreation – Provide economic and social benefits by facilitating access to reservoirs and by making available parks and recreation areas.
  - Fish and Wildlife – Protect, mitigate and enhance fish and wildlife, including related spawning grounds and habitat, of the Columbia River and its tributaries.

FCRPS Integrated Business Management Model (IBMM)

The Integrated Business Management Model (IBMM) is used by the FCRPS partnership to provide a framework for ongoing asset-based planning and management. The IBMM consists of 12 business processes contained within four major areas - Strategic Planning, Asset Planning, Resource Management, and Performance Assessment.

Joint Operating Committees (Bonneville/Corps and Bonneville/Reclamation) are responsible for overseeing the operational management of the FCRPS. Sub-committees of the FCRPS JOCs are tasked with more direct oversight of specific aspects of the IBMM:

- Capital Investment Program
- O&M Program
- Benchmarking and Performance Indicators
- River Management
- Hydro Optimization
- Technical Coordination
- Cultural Resources
- Fish and Wildlife

Direction from OMB and the three agencies of the FCRPS is to increase the level of efficiency, visibility and accountability for key business processes. The JOC sub-committees are the primary management means for implementing this.

Asset Planning Initiative: Long Term, Low Cost Power

In 2005, the FCRPS hydro program conducted a process review of its operation under the IBMM.

- The review created an as-is snapshot of the IBMM processes and identified opportunities to improve hydro program effectiveness through the IBMM.
- Of the four major areas of the IBMM, Resource Management and Performance Assessment were found to be in generally good shape.
- Strategic Planning and, to a greater degree, Asset Planning were ranked behind.

Specifically, the review concluded that long term hydro system health depends on an effective Asset Planning framework, yet this framework was undeveloped.

- There was no ongoing, deliberate alignment of strategies related to power generation across the FCRPS agencies.
- It was widely perceived at a middle management level that the planning and spending focus was primarily short-term, and that a long term, life-cycle view of assets was not systematically factored in program decisions.
- Asset Planning was not well understood or valued.

There were several implications of the review conclusions.

- If an asset's long-term value is not well-understood, it can result in short-term decision making that restricts future options.
- Lack of a system-wide view of the cost and value of assets can result in sub-optimization of spending across the asset portfolio.
- In the absence of a mechanism to fully incorporate long-term asset strategic intent, value, and cost into current budget decisions, spending requirements can be pushed into future years creating unacceptable financial pressures or resource constraints.
- Lack of a life-cycle view may ultimately result in compromising the ability to meet long-term objectives, and can lead to higher long-term costs.

As a result of the process review, the hydro program implemented an initiative to improve the Asset Planning component of the IBMM.

- This effort led to an improved understanding of equipment condition, risks associated with condition, and long-term resource requirements for keeping the system productive for decades to come.
- The results of this initiative are used to support the proposed budget levels presented in this package.

Criticality of Assets

Strategic Classes: FCRPS hydro plants are grouped into four strategic classes depending on the role they serve in the hydro system:

Main Stem Columbia: plants that provide the majority of power, ancillary services, and non-power benefits to the Pacific Northwest.

Headwater/Lower Snake: plants that provide significant power and non-power benefits to the region.

Area Support: plants with a sub-regional impact that provide key power and non-power benefits to specific areas of the Pacific Northwest.

Local Support: plants that provide services primarily to local areas.

FCRPS Hydro Plant Classification

Relative Cost of Unavailability	Local Support	Area Support	Headwater/ Lower Snake	Main Stem Columbia
Severe				CHJ GCL MCN
Extreme			DWR	JDA
Major	AND, BCD BDD, MIN, ROZ, CDR, GSP	BCL, DEX, LOS, DET, GPR, LOP, HCR, CGR, FOS, ALF, PAL	LIB, HGH, IHR, LGS, LWG, LMN	BON TDA

Relative Cost of Unavailability. The criticality a hydro asset is based largely upon the quantity of energy produced, particularly at peak periods, and the financial impact of a loss of generation. Assets in the Main Stem Columbia and Headwater/Lower Snake strategic classes are generally more critical to Bonneville's power needs than are assets from the Area Support and Local Support classes. These first two classes provide more than 96 percent of energy and capacity for the system.

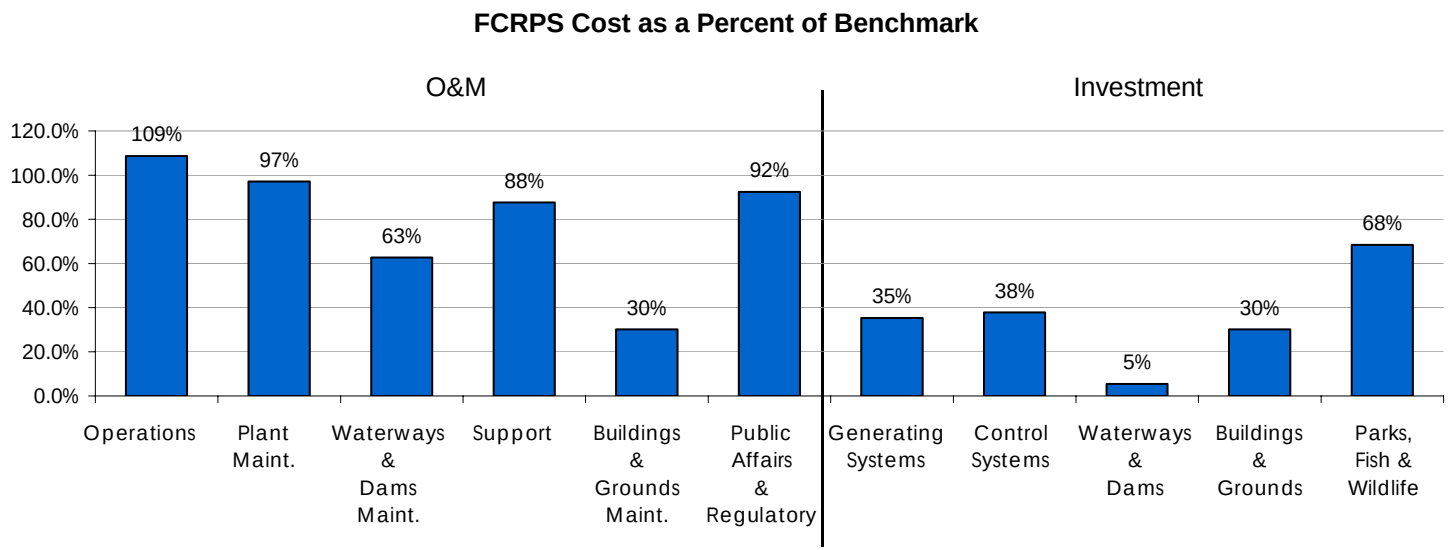
Five plants – Grand Coulee, McNary, Chief Joseph, John Day and Dworshak – are considered particularly critical to the power system based on the significant financial impact of a generating unit outage at these facilities. The figure to the left groups FCRPS hydro plants by their strategic class and relative cost of unavailability (RCU) to the power system. The relative cost of unavailability is the annual cost of replacing lost generation from the least-used generating unit, or first 20 percent of lost plant availability, whichever is larger. No costs are included for replacing lost capacity, ancillary services, or non-power benefits.

Major RCU is up to $10 million per year, and is based on Bonneville's long-term forward price forecast and average water conditions. Extreme RCU ranges from $10 to $20 million annually, while Severe RCU exceeds $40 million per year. The figure shows that Grand Coulee, McNary, Chief Joseph, John Day and Dworshak are the plants with the highest RCU.

Current Performance – Low Cost Power – Benchmarks

The FCRPS benchmarks its hydro program annually to identify areas of best practices and the potential for performance improvement. Costs benchmarked include Corps and Reclamation costs for hydropower, recreation, and joint-use purposes, and Bonneville costs for program coordination, planning, scheduling, generation dispatch, and fish and wildlife mitigation. Because Direct Funded program costs are only a subset of all costs benchmarked, one-to-one comparisons cannot be made between the Direct Funded program and the benchmarks. However, the benchmarking results do provide useful information on the allocation of costs within the program and how FCRPS costs compare with those of its peers.

The figure below shows that historical O&M Program costs in most functional areas are below those of benchmarking peers. The exception is Operations costs, which are nine percent higher than benchmarks, in part due to water management functions that reside in three FCRPS agencies, but also to the number of Corps plants with staffed control rooms. Much of the industry now has automated stations, which lowers Operations staffing costs significantly. Historical Investment costs are about a third that of benchmarking peers.



Current Performance – Low Cost Power – Fully Allocated Cost

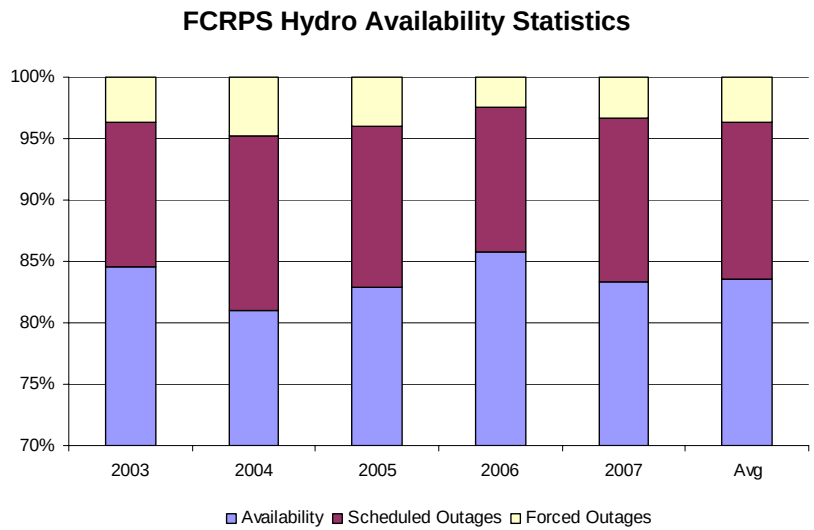
Name of Asset	Completed Plant	Net Utility Plant	CWIP	Accumulated Depreciation	FY 2007 Depreciation	FY 2007 O&M Expense	FY 2007 Interest	Outstanding Fed. Approp.	Capital Investment	Net Generation (GWH)	Production Costs ($/MWh)	Fully Allocated Cost ($/MWh)
	"Cumulative Capital cost" /a	"Useable value of plant" /b	"included in Net Utility Plant but not in Completed Plant"	"included in Net Utility Plant but not in Completed Plant"	"FY 2007 Accumulated Depreciation less FY 2006 Accumulated Depreciation"	"Annual expense" /c	"Interest for this year" /d	"Sum of remaining principle" /e	"Total Capital invested during the year"	"Average generation based on 50-year hydro regulation studies"	"FY 2007 O&M Expense divided by Net Generation"	"(FY 2007 O&M Expense + Interest - Depreciation) divided by Net Generation"
Main Stem Columbia												
Bonneville	$996,602	$712,296	$61,957	($346,263)	($17,376)	$18,135	$33,208	$487,987	$9,579	4,490	4.04	15.31
Chief Joseph	$573,304	$331,551	$30,640	($272,393)	($2,745)	$19,309	$14,989	$209,987	$4,990	12,154	1.59	3.05
John Day	$509,388	$317,968	$15,385	($206,805)	($10,927)	$16,001	$8,190	$116,584	$13,696	8,685	1.84	4.04
McNary	$340,079	$182,579	$28,898	($186,398)	($7,932)	$17,146	$681	$12,960	$9,635	5,033	3.41	5.12
The Dalles	$363,795	$224,838	$47,550	($186,507)	($7,977)	$15,740	$4,424	$73,426	$3,748	6,771	2.32	4.16
Grand Coulee	$1,308,161	$938,227	$45,074	($415,007)	($17,705)	$47,337	$37,440	$547,101	$16,710	21,872	2.16	4.69
Total Main Stem Columbia	**$4,091,328**	**$2,707,460**	**$229,505**	**($1,613,373)**	**($64,663)**	**$133,668**	**$98,933**	**$1,448,045**	**$58,358**	**59,003**	**2.27 $/MWh**	**5.04 $/MWh**
Headwater/Snake												
Dworshak	$294,855	$193,297	$5,446	($107,004)	($2,017)	$8,965	$10,890	$152,169	$3,622	1,873	4.79	11.68
Ice Harbor	$166,224	$96,943	$4,834	($74,115)	($3,408)	$7,174	$2,135	$32,530	$1,444	1,845	3.89	6.89
Libby	$431,523	$294,545	$9,735	($146,713)	($5,712)	$6,494	$16,684	$234,366	$3,355	2,086	3.11	13.85
Little Goose	$216,878	$124,600	$3,833	($96,111)	($1,688)	$7,220	$8,968	$125,599	$3,377	2,304	3.13	7.76
Lower Granite	$341,303	$231,173	$19,303	($129,434)	($5,325)	$9,565	$12,131	$170,464	$4,268	2,386	4.01	11.32
Lower Monumental	$239,050	$140,954	$6,091	($104,187)	($4,262)	$8,183	$7,429	$104,903	$5,207	2,435	3.36	8.16
Hungry Horse	$124,027	$76,667	$871	($48,232)	($1,851)	$3,086	$627	$11,951	$513	986	3.13	5.64
Total Headwater/Snake	**$1,813,860**	**$1,158,178**	**$50,113**	**($705,795)**	**($24,263)**	**$50,686**	**$58,863**	**$831,982**	**$21,786**	**13,915**	**3.64 $/MWh**	**9.62 $/MWh**
Area Support												
Albeni Falls	$43,318	$30,450	$8,002	($20,870)	$276	$4,291	$207	$2,991	$2,135	208	20.58	20.25
Cougar	$82,291	$75,714	$3,136	($9,713)	($1,515)	$779	$2,706	$52,087	$1,759	146	5.33	34.18
Detroit-Big Cliff	$50,949	$34,897	$9,889	($25,941)	($511)	$6,726	$84	$1,593	$14,864	519	12.97	14.12
Green Peter-Foster	$55,658	$34,014	$716	($22,360)	($915)	$2,931	$16	$260	$1,834	368	7.97	10.50
Hill Creek	$20,582	$10,349	$759	($10,992)	($507)	$738	$543	$7,977	$193	161	4.58	11.10
Lookout Point-Dexter	$61,049	$23,695	$3,472	($40,826)	($860)	$4,628	$730	$13,232	$530	410	11.29	15.17
Lost Creek	$28,522	$17,641	$4	($10,884)	($515)	$1,780	$1,006	$14,096	$0	317	5.61	10.41
Minidoka-Palisades	$113,275	$86,934	$113	($26,455)	($1,360)	$6,584	$3,686	$50,977	$1,382	841	7.83	13.83
Total Area Support	**$455,645**	**$313,693**	**$26,091**	**($168,042)**	**($5,907)**	**$28,458**	**$8,977**	**$143,213**	**$22,697**	**2,971**	**9.58 $/MWh**	**14.59 $/MWh**
Local Support												
Boise Diversion-Anderson Ranch-Black Canyon	$28,983	$20,576	-$54	($8,352)	($37)	$3,359	$291	$4,364	$479	253	13.27	14.57
Chandler-Roza	$6,143	$6,490	$3,580	($3,233)	($77)	$3,496	$63	$1,715	$2,559	161	21.69	22.56
Green Springs	$10,821	$2,965	$404	($8,260)	($39)	$514	$642	$11,145	$18	51	10.13	23.53
Total Local Support	**$45,947**	**$30,032**	**$3,930**	**($19,845)**	**($153)**	**$7,370**	**$996**	**$17,224**	**$3,056**	**465**	**15.84 $/MWh**	**18.32 $/MWh**
Total Power Assets	**$6,406,780**	**$4,209,363**	**$309,638**	**($2,507,056)**	**($94,986)**	**$220,183**	**$167,769**	**$2,440,464**	**$105,896**	**76,354**	**2.88 $/MWh**	**6.32 $/MWh**

/a -- Sum of the initial capital and replacement costs; capital cost of retired equipment is deducted. [FY07 ASPRJ Summary-SUMMARY2007.xls: Completed Plant]
/b -- Completed plant (previous column) with accumulated depreciation deducted and CWIP added. [FY07 ASPRJ Summary-SUMMARY2007.xls: Net Utility Plant]
/c -- Annual expense cost by dam. [Summary2007.xls: Total O&M]
/d -- For the life of a debt, BPA pays interest annually, the principle is paid as a lump sum at the end of its payment period.
BPA refinanced its debt in FY1998, resulting in slightly higher interest rates. [Appropriated Interest FY07.xls: line 128]
/e -- Remaining unpaid principle [Appropriated Interest FY07.xls: line 66]

Current Performance – Power Reliability

Availability is a primary metric used to identify the reliability performance of hydroelectric assets. Availability represents the total percentage of time over a period that a generating unit is capable of producing power should it be called upon to do so. Plants lose availability through a combination of scheduled outages (for maintenance or capital investments) and forced outages (i.e., failures while in-service).

FCRPS hydro availability statistics have been fairly stable over the past five years. The availability factor averages 83.5 percent, ranging from 81 percent in 2004 to nearly 86 percent in 2006. The scheduled outage factor averages nearly 13 percent, 40 percent higher than the industry average of 9.3 percent, in part due to extended outages for extraordinary maintenance projects, capital projects, and fish screen maintenance. The forced outage factor is nearly 4 percent, also above the industry average of 2.6 percent, driven largely by persistent failures at two plants – The Dalles and Lower Granite. Problems causing forced outages at The Dalles and Lower Granite largely have been addressed, as indicated by their FY2007 forced outage factors of 1.6 and 0.9, respectively.



Other measures important to power reliability include the number of startup failures and number of forced outages. For the system, forced outages average about 2.5 per unit per year. Nearly 25 percent of forced outages are Fish and Transmission related.

Power Reliability Measures

Measure	2003	2004	2005	2006	2007	5-yr Avg.
Startup Failures	18	9	11	18	10	13
Forced Outages	475	443	587	521	479	501

Current Performance – Trusted Stewardship

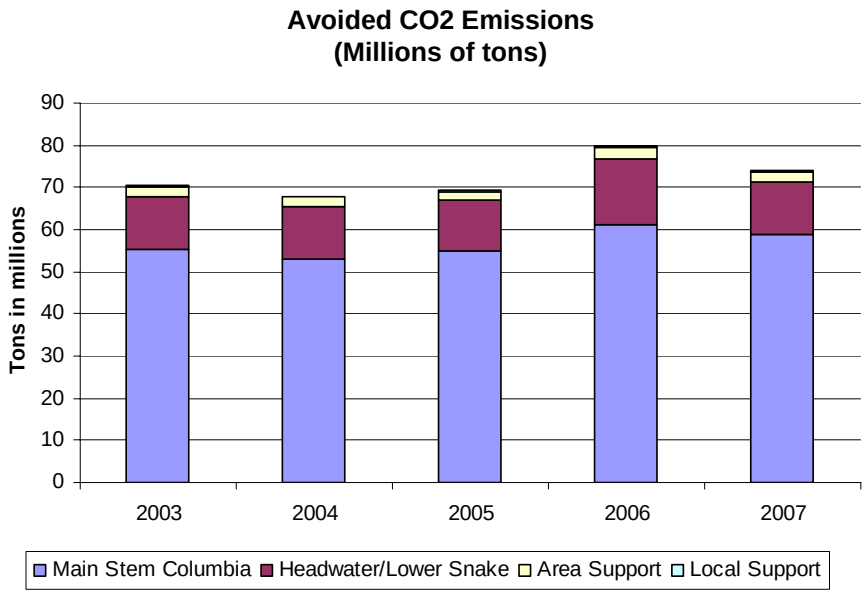
The FCRPS hydro program has a history of positive safety performance. The number of lost time accidents per 200,000 person-hours averaged 1.6 over the past five years. Safety continues to be a top priority for the FCRPS. The results show that management of the safety program remains effective even during this period of growth in the large capital and extraordinary maintenance expense programs. This work involves activities that are non-routine and higher risk, presenting increased challenges to the workforce safety environment. The safety program also faces additional challenges related to an aging workforce.

Lost Time Accidents per 200,000 person-hours

Measure	2003	2004	2005	2006	2007	5-yr Avg.
Lost Time Accident Rate	1.6	1.6	1.6	1.3	1.9	1.6

The U.S. economy produces six billion tons of CO2 emissions each year, one third of which is produced by the electric power sector. The majority of electricity derived CO2 is produced by coal-fired power plants, with considerably less produced by natural gas and petroleum generation.

FCRPS hydro delivers positive climate change benefits by reducing the amount of emissions for electricity that would be generated by other sources were the hydro system not available. In an average water year, the FCRPS reduces the CO2 footprint of a coal-fired alternative by 78 million tons – over one percent of total U.S. emissions. The figure on the right details the amount of avoided CO2 emissions for the past five years by strategic class.



Condition Assessment – hydroAMP Framework

Component condition is a key driver of maintenance and investment needs because the likelihood of failure increases as component condition degrades. Routine maintenance activities are intended to identify and address deficiencies prior to their posing threats to equipment reliability. However, even with effective maintenance programs, condition will eventually deteriorate to the point at which sustained outages will result. There are few redundant components in hydroelectric generating facilities and, as such, it is imperative that the condition of major components be understood and managed.

The FCRPS measures the condition of major components that comprise the power train, generating plant auxiliaries, and other site components. The FCRPS uses hydroAMP as its primary method of assessing equipment condition. HydroAMP is a framework developed by four organizations – Reclamation, the Corps, Bonneville and Hydro-Québec – and employs a two-tiered methodology for deriving condition ratings.

- Tier 1 indicators rely on test results and/or inspections that are normally obtained during routine maintenance activities. These Condition Indicators are weighed together to compute an equipment Condition Index. The index ranges from 10 to 0 and equates to a Good, Fair, Marginal or Poor rating.

- Tier 2 indicators are used to further investigate abnormal Tier 1 results and rely on more in-depth, non-routine tests and inspections requiring specialized knowledge, diagnostic equipment or outages. Tier 2 results refine or adjust the Tier 1 Condition Index.

The criteria for scoring the Condition Indicators under Tier 1 and for adjusting the Condition Index as part of Tier 2 are detailed in equipment assessment guides. Currently, there are 11 hydroAMP assessment guides on the equipment identified below. The guides provide consistent techniques for evaluating component condition and refining methods.

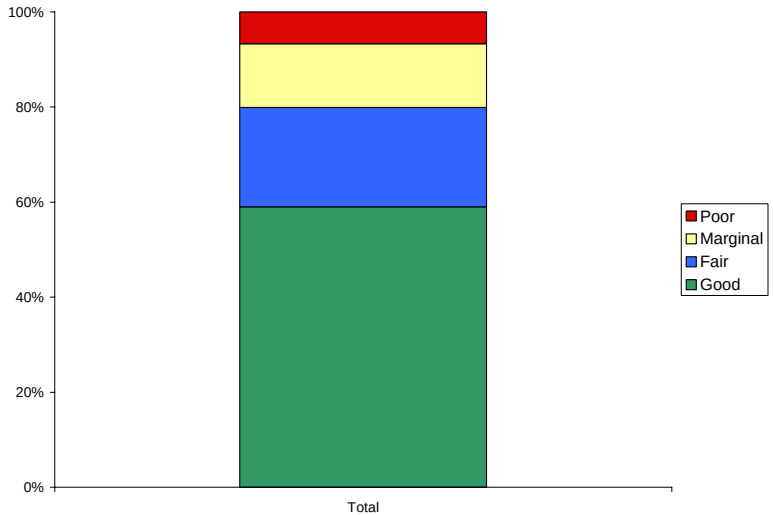
hydroAMP Equipment Assessment Guides

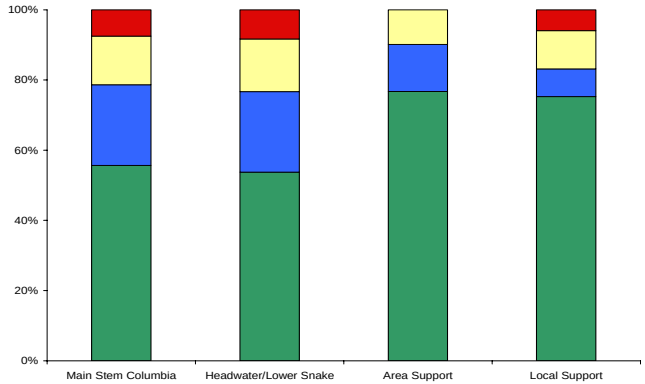
Power Train	Other
Generator Stator/Rotor	Battery System
Excitation System	Compressed Air System
Transformer	Emergency Closure Gate/Valve
Turbine	Crane
Circuit Breaker	Surge Arrester
Governor	

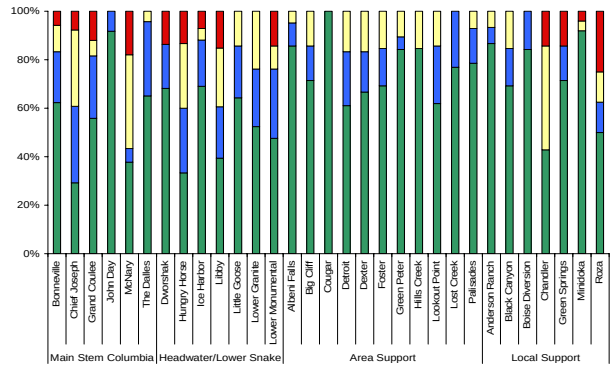
Current Condition – hydroAMP Ratings

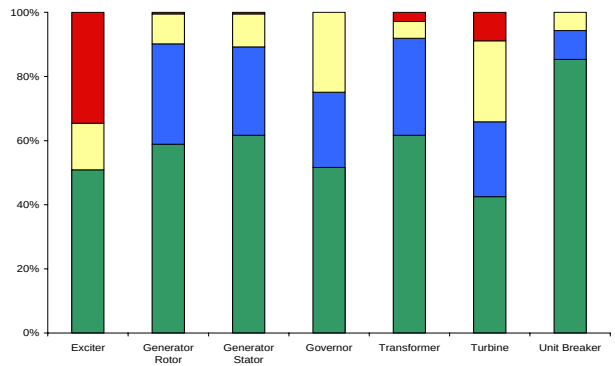
HydroAMP ratings have been collected for power train equipment since 2004. Results are stored in a central data repository and are updated at least annually. As a result, the FCRPS hydro program is able to identify the condition of the major components in all 209 generating units in the system.

Current condition profile shows that, system-wide, about 80 percent of equipment is in Good or Fair condition. Among strategic classes, Main Stem Columbia and Headwater/Lower Snake have the lowest overall condition ratings, with McNary having the lowest rating among all plants. Overall, unit breakers have the highest condition ratings, a result of a system-wide breaker replacement program that is now nearing completion. For other categories, roughly half of the equipment has a rating of Good, with all but exciters having an additional 25 percent of equipment rated as Fair.







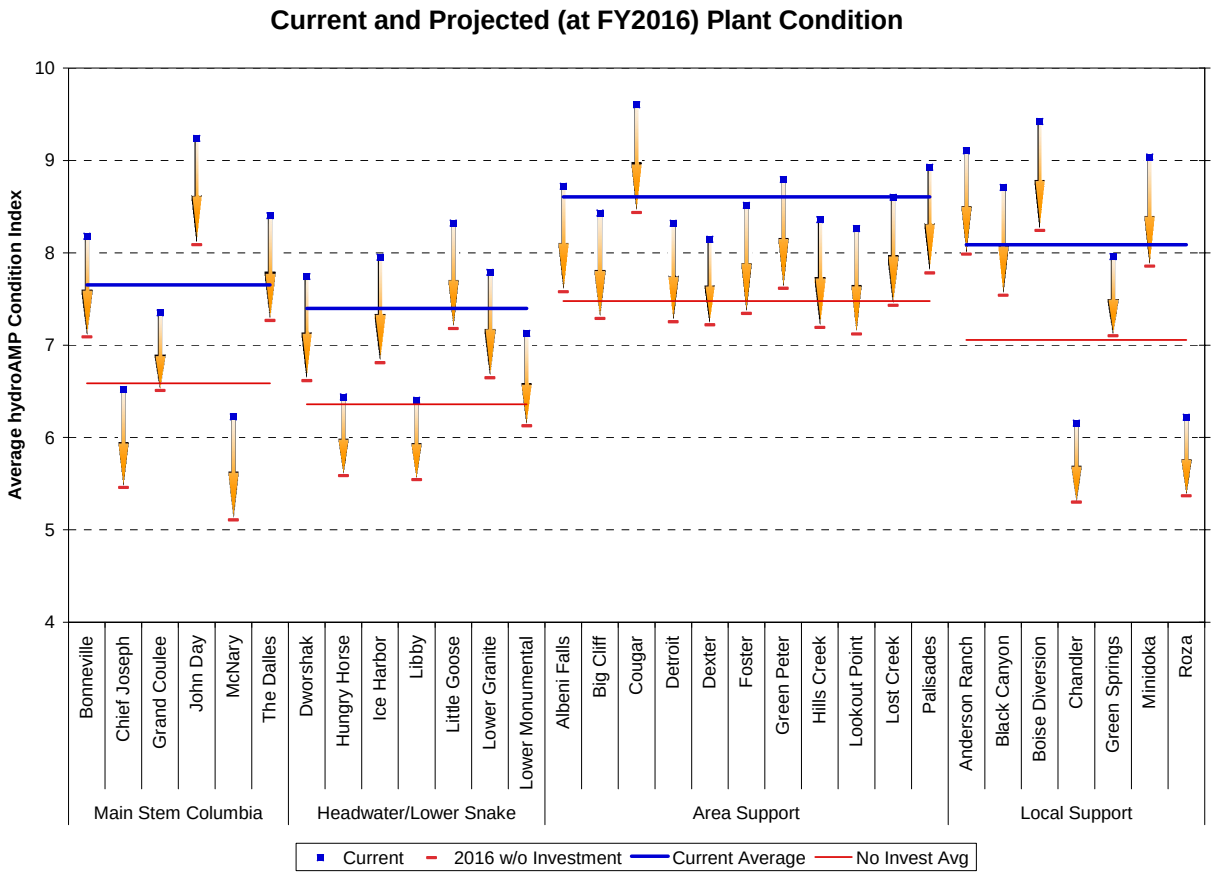


Condition – Change in Average hydroAMP Index w/o Investment

Current and historical hydroAMP data was studied using regression analysis to determine the rate at which hydroAMP ratings decrease over time. The analysis yielded degradation rates for each hydroAMP component type, which enabled the creation of projected hydroAMP ratings in the future if no investments are made to improve condition.

Current and projected condition ratings are shown on the figure to the right. Four items are shown on the chart:

- The current average hydroAMP condition index for all power train components at the plant (e.g., the average condition index for the 283 components at Grand Coulee is 7.3);
- The projected average hydroAMP condition index for each plant at the start of FY2016 if no investments are made to improve condition;
- The current average condition index for all power train components in each strategic class, and
- The projected average condition index in FY2016 by strategic class without investment.



Risk – hydroAMP Condition Index vs. Likelihood of Equipment Failure

HydroAMP is an important tool for evaluating performance risk of power train equipment. The FCRPS hydro program correlates a hydroAMP condition rating with the likelihood of the equipment failing to perform as expected within the planning window (FY2009 – FY2015). Equipment with a low condition index has a higher likelihood of failure than one with a higher condition rating. The correlation is shown below.

Likelihood	Condition Rating	Description
Almost Certain	0 to 0.9	Poor
	1 to 1.9	
Likely	2 to 2.9	
	3 to 3.9	Marginal
Possible	4 to 4.9	
	5 to 5.9	
Unlikely	6 to 6.9	Fair
	7 to 7.9	
Rare	8 to 8.9	Good
	9 to 10	

Risk – Current Profile of Equipment

To evaluate risk, the likelihood of failure is mapped against the associated consequence of not having a generating unit available to produce electricity. This risk map is segmented into a five-by-five grid; with five levels of likelihood and five levels of consequence. The consequence identified on the map is the value of the generation that would be lost from the time a piece of equipment fails – taking the generating unit out of service – until it is repaired or replaced and the unit is returned to service. Direct costs to repair or replace equipment are not included here, but are used later in evaluating the risk treatment. Consequences are characterized as insignificant if they are less than $10,000 to extreme if they exceed $10 million.

The risk map is further segmented into four levels of risk: High, Medium-High, Medium, and Low. The figure on the right summarizes the hydroAMP rating and lost generation consequence for FCRPS power train equipment and provides a basis for identifying risk mitigation strategies. The number preceding each equipment type listed in the grid corresponds to the number of equipment items. For example, five transformers on the system are in Poor condition and almost certain to fail by 2016 with an extreme (greater than $10 million) consequence.

Risk Map at FY2008

Likelihood	Insignificant	Minor	Moderate	Major	Extreme	hydroAMP Index	
	< $ 10K	$ 10K to $ 100K	$ 100K to $ 1 M	$ 1 M to $ 10 M	> $ 10 M		
Almost Certain	6 Exciter	3 Exciter 2 Non-Power Train	55 Exciter 2 Turbine 9 Non-Power Train	6 Exciter 1 Transformer 3 Turbine 7 Non-Power Train	5 Transformer 3 Non-Power Train	0 to 0.9 1 to 1.9	Poor
Likely	1 Non-Power Train	1 Governor 25 Non-Power Train	14 Exciter 1 Generator Rotor 4 Governor 4 Turbine 34 Non-Power Train	3 Exciter 1 Generator Stator 1 Transformer 12 Turbine 19 Non-Power Train	1 Transformer 4 Non-Power Train	2 to 2.9 3 to 3.9	Poor Marginal
Possible		2 Exciter 3 Generator Stator 8 Governor 23 Non-Power Train	13 Exciter 20 Generator Rotor 3 Generator Stator 40 Governor 1 Transformer 25 Turbine 7 Unit Breaker 79 Non-Power Train	1 Exciter 14 Generator Stator 5 Transformer 27 Turbine 32 Non-Power Train	2 Generator Stator 5 Transformer 18 Non-Power Train	4 to 4.9 5 to 5.9	Marginal
Unlikely	2 Generator Rotor	3 Generator Rotor 2 Generator Stator 32 Governor 5 Turbine 26 Non-Power Train	56 Generator Rotor 14 Generator Stator 18 Governor 7 Transformer 37 Turbine 19 Unit Breaker 26 Non-Power Train	6 Generator Rotor 43 Generator Stator 54 Transformer 8 Turbine 18 Non-Power Train	6 Transformer 21 Non-Power Train	6 to 6.9 7 to 7.9	Marginal Fair
Rare	2 Exciter 5 Governor 2 Turbine 2 Unit Breaker	32 Exciter 34 Generator Rotor 2 Generator Stator 47 Governor 4 Turbine 34 Unit Breaker 7 Non-Power Train	64 Exciter 91 Generator Rotor 32 Generator Stator 51 Governor 1 Transformer 72 Turbine 127 Unit Breaker 2 Non-Power Train	13 Exciter 1 Generator Rotor 95 Generator Stator 7 Governor 128 Transformer 13 Turbine 17 Unit Breaker 15 Non-Power Train	3 Generator Stator 18 Transformer 3 Non-Power Train	8 to 8.9 9 to 10	Fair Good

Consequence

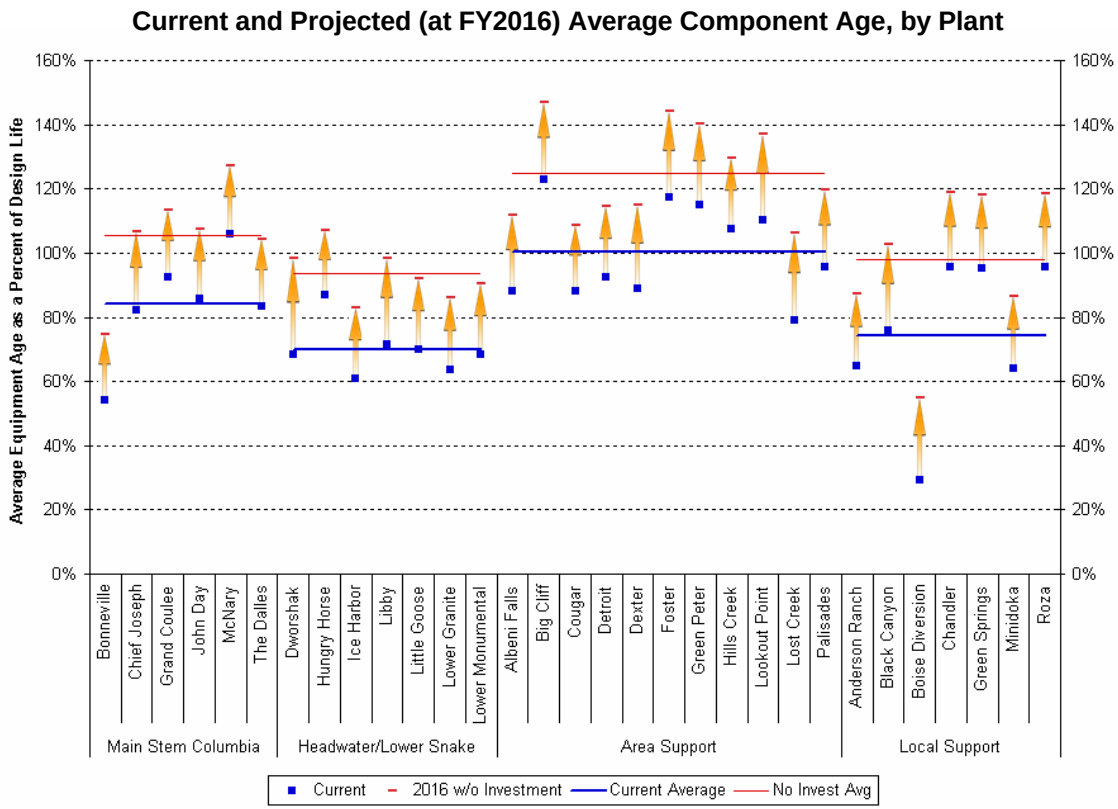
Risk Level	Low	Medium	Medium High	High

Age – Current and Projected (at 2016) w/o Investment

While near term investment needs are driven primarily by component condition, the ability to accurately forecast condition decreases as the time frame increases. As a result, understanding component age helps to establish if a component is nearing the end of its useful life and will soon present an unacceptable risk to asset performance. Furthermore, when age is profiled for the entire equipment portfolio it can become a tool for informing how near-term investment strategies influence longer-term investment needs, financial requirements, and resource constraints.

The FCRPS has created age profiles of its facilities using "percent of design life" as a primary measure. For example, a 30 year old component with a design life of 40 years is represented as being at 75 percent of design life. This allows comparison across component types, recognizing that design life can vary considerably across component types or designs.

This figure shows the current age for each plant, expressed as the average percent of design life for all components in the facility. Average age for each strategic class is also shown, represented as a horizontal line. In addition, plant and class ages are projected at 2016 assuming no investment in asset replacement over the planning horizon.

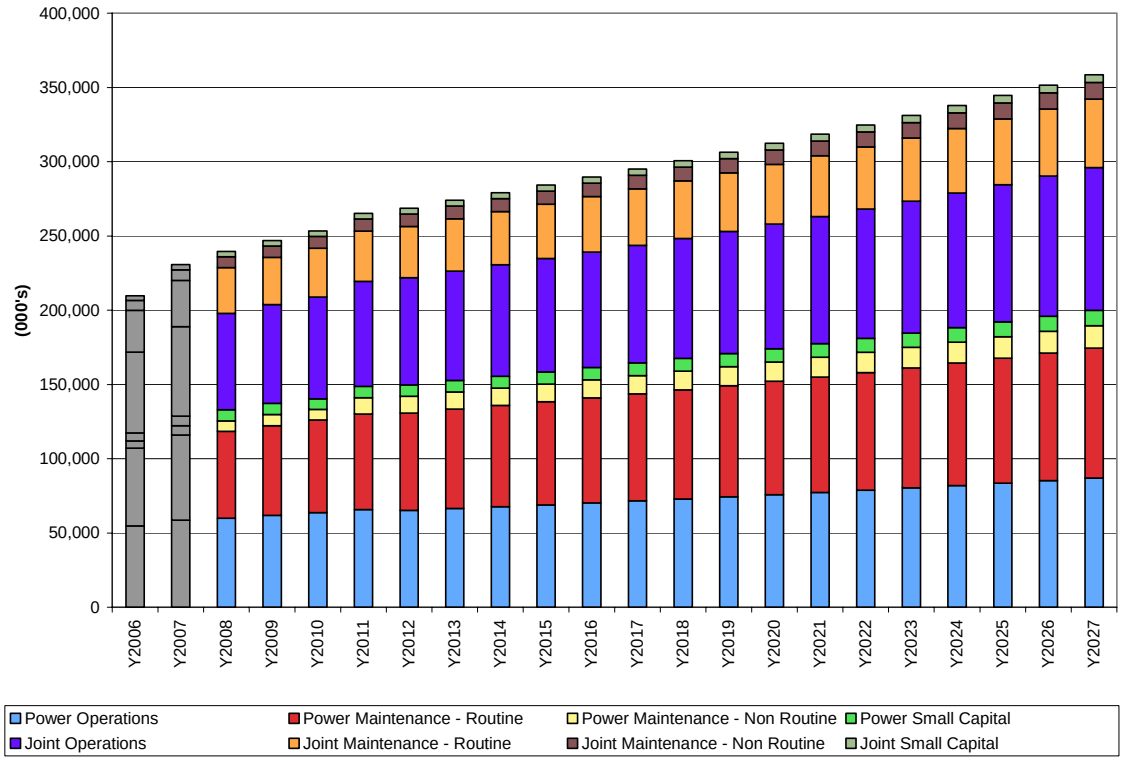


Proposed Long Term Plan – O&M Program Forecast FY2009 – FY2027

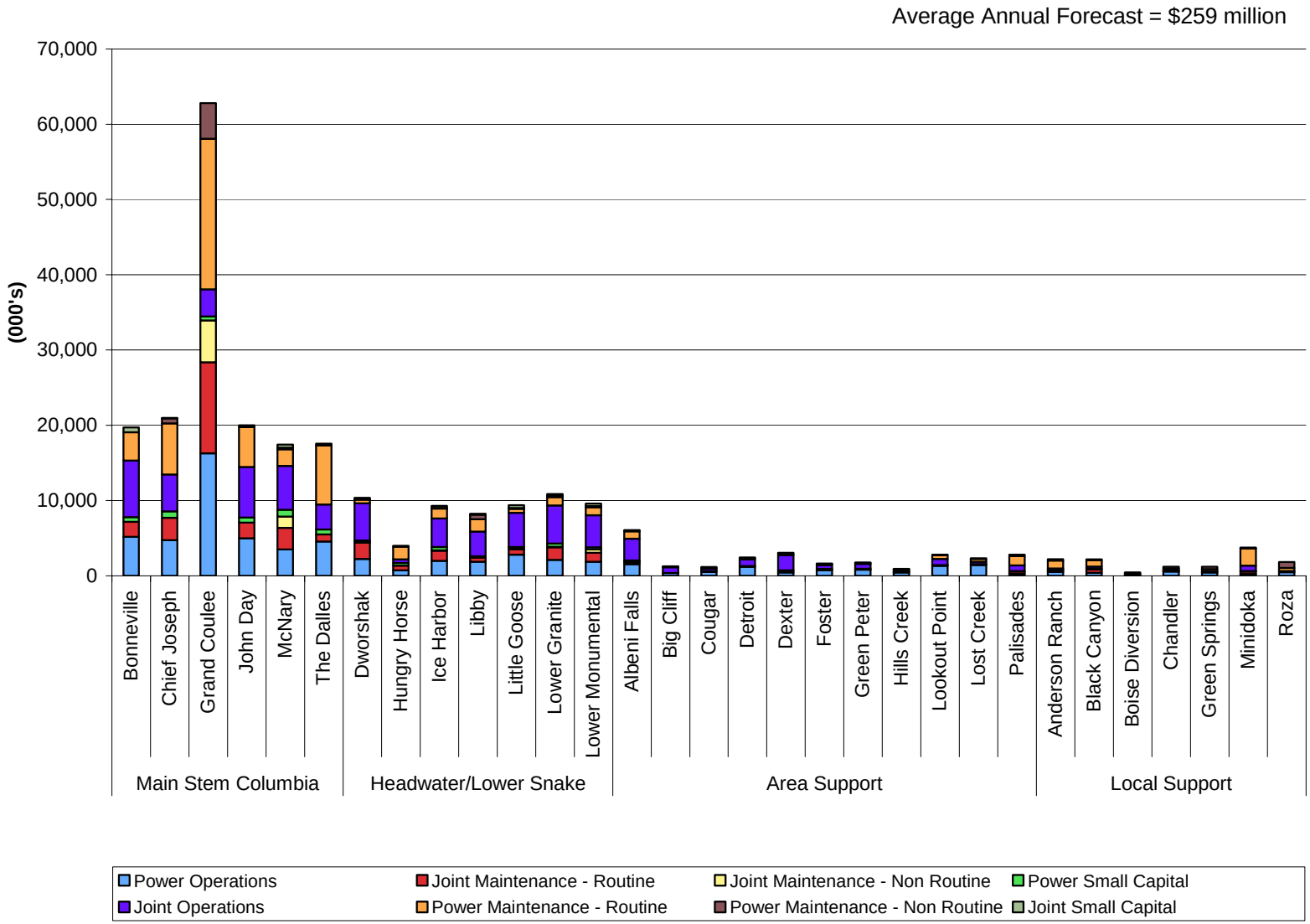
Forecasts for FY2009 to FY2011 increase at 3.1 percent per year to account for wage rate increases. From FY2012 to FY2027, forecasts increase with inflation, averaging 2 percent per year.

O&M Program costs are segmented into Power (for spending on hydropower components) and Joint (for spending on equipment that serves multiple purposes which are partially funded by Bonneville through Direct Funding agreements). In addition, four additional categories of work are identified:

- Operations, which addresses day-to-day costs for operating facilities;
- Routine Maintenance, which addresses day-to-day costs for inspection, preventive maintenance, and unscheduled repairs;
- Non-Routine Maintenance, which addresses recurring maintenance that is performed on a cycle greater than one year, and
- Small Capital, which provides an allowance for maintenance-related replacement of small components but by virtue of accounting treatment is capitalized.



O&M Program Forecast, Average Annual FY2010 – FY2011



Proposed Long Term Plan – Large Capital Forecast w/ AFUDC FY2009 – FY2015

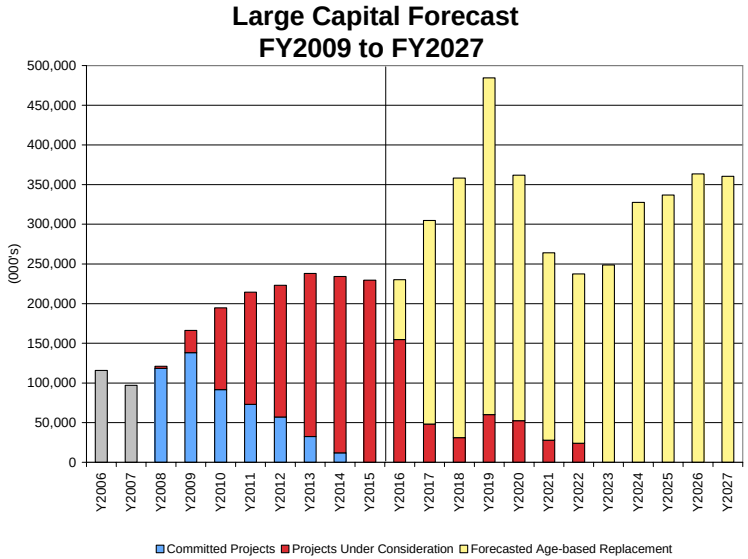
The proposed Large Capital Investment Program increases from past expenditure levels in order to address several issues:

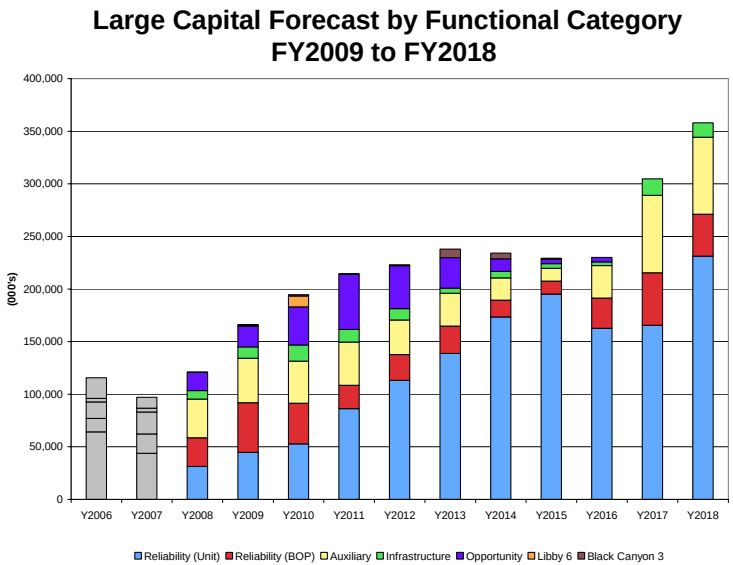
- Condition of FCRPS hydro equipment and associated performance risks;
- Significant increases in materials costs and orders for hydro generation equipment from a limited number of international suppliers; and,
- Devaluation of the US Dollar.

The large capital component of the Investment Program averaged $103 million per year from FY2003 to FY2007. The proposed plan for FY2009 to FY2015 totals $1.5 billion, averaging $214 million per year.

Over $500 million of the plan is for projects that are already committed. The remainder is for identified projects under consideration, driven by condition, risk, or economic opportunity. Known deficiencies and opportunities comprise all the spending over the FY2009 to FY2015 period. Forecasts for end-of-life, age-based equipment replacement are included in the spending outlook beyond FY2015 as the ability to forecast condition-related replacement decreases.

Funding requirements beyond FY2018 are expected to remain at or above the levels proposed in this plan. This projection is based on the forecast of age-related equipment replacement. While the accuracy of such long-term projections may be doubtful, they do illustrate that replacement of aging components is a question of "when", not "if", and that failure to address near-term condition issues will prolong the problem.



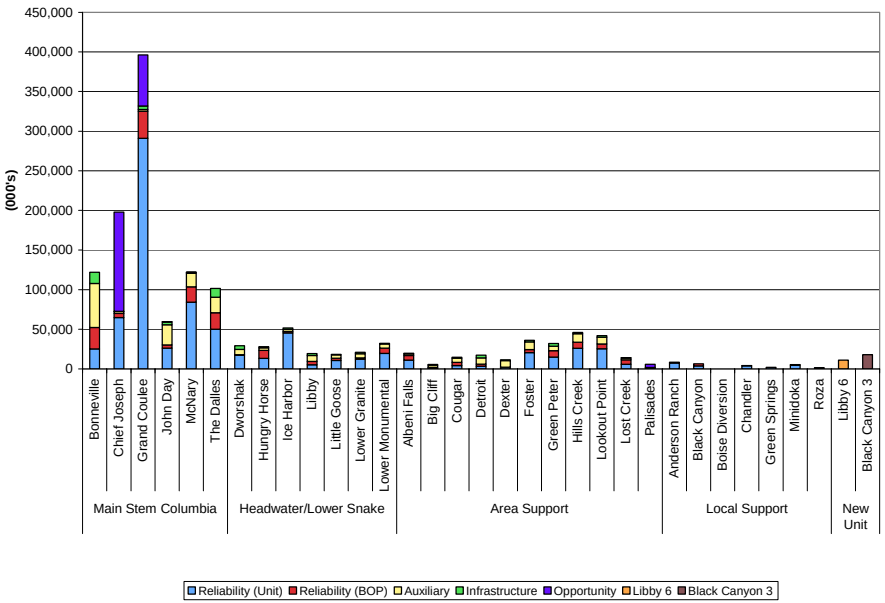


Proposed Long Term Plan – Investment Program by Plant FY2009 – FY2015

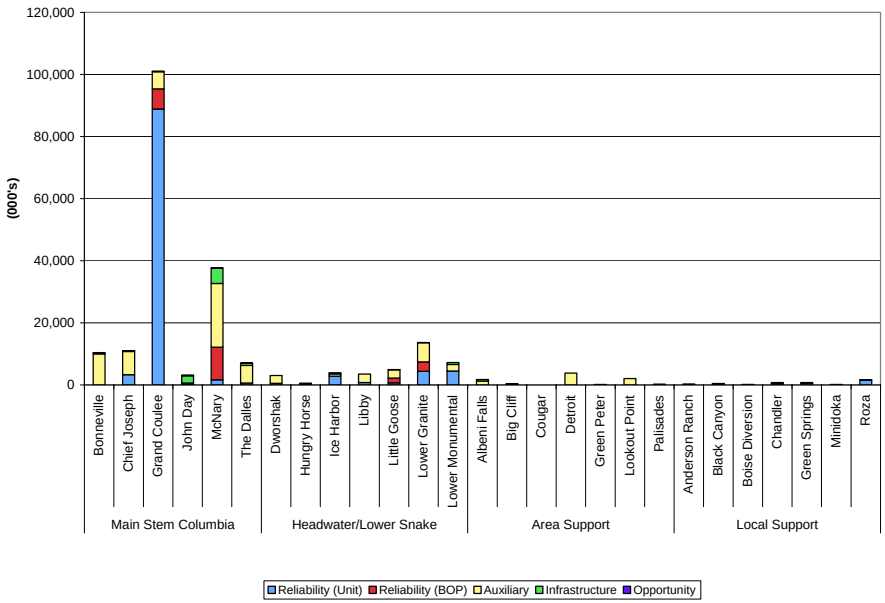
The proposed plan identifies $1.5 billion ($214 million per year) in Large Capital, and $220 million ($31 million per year) in Extraordinary Maintenance expense over the FY2009 – FY2015 period. Further breakdown of the plan by plant shows that Grand Coulee is a primary focus of investment, with nearly $400 million in Large Capital identified for the period. An additional $100 million in Extraordinary Maintenance expense is identified for work in Grand Coulee Third Powerplant.

$125 million in large capital is targeted for runner replacements at Chief Joseph, which will produce and additional 42 aMW of energy through improved efficiency.

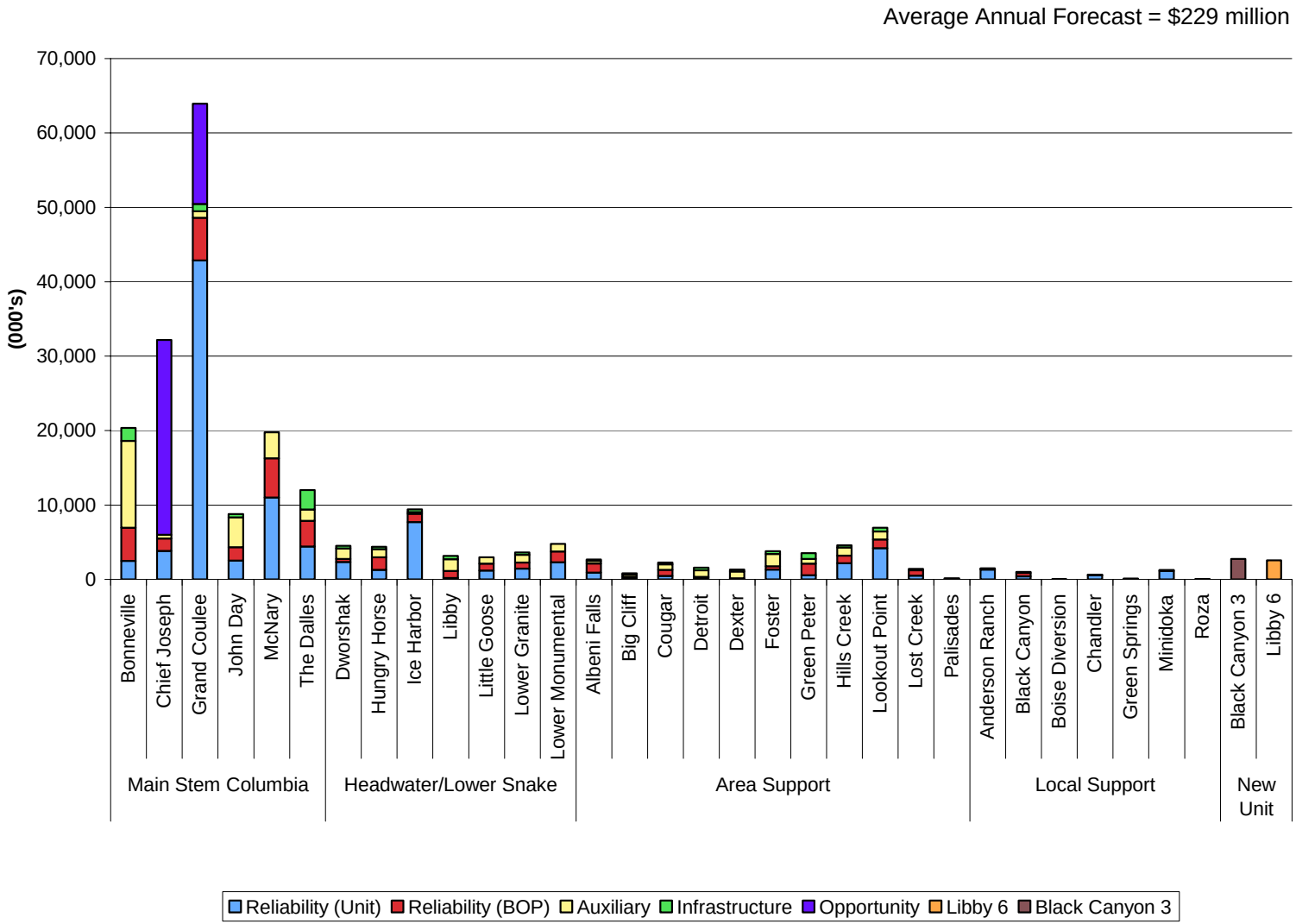
Proposed Large Capital w/ AFUDC by Plant FY2009 – FY2015



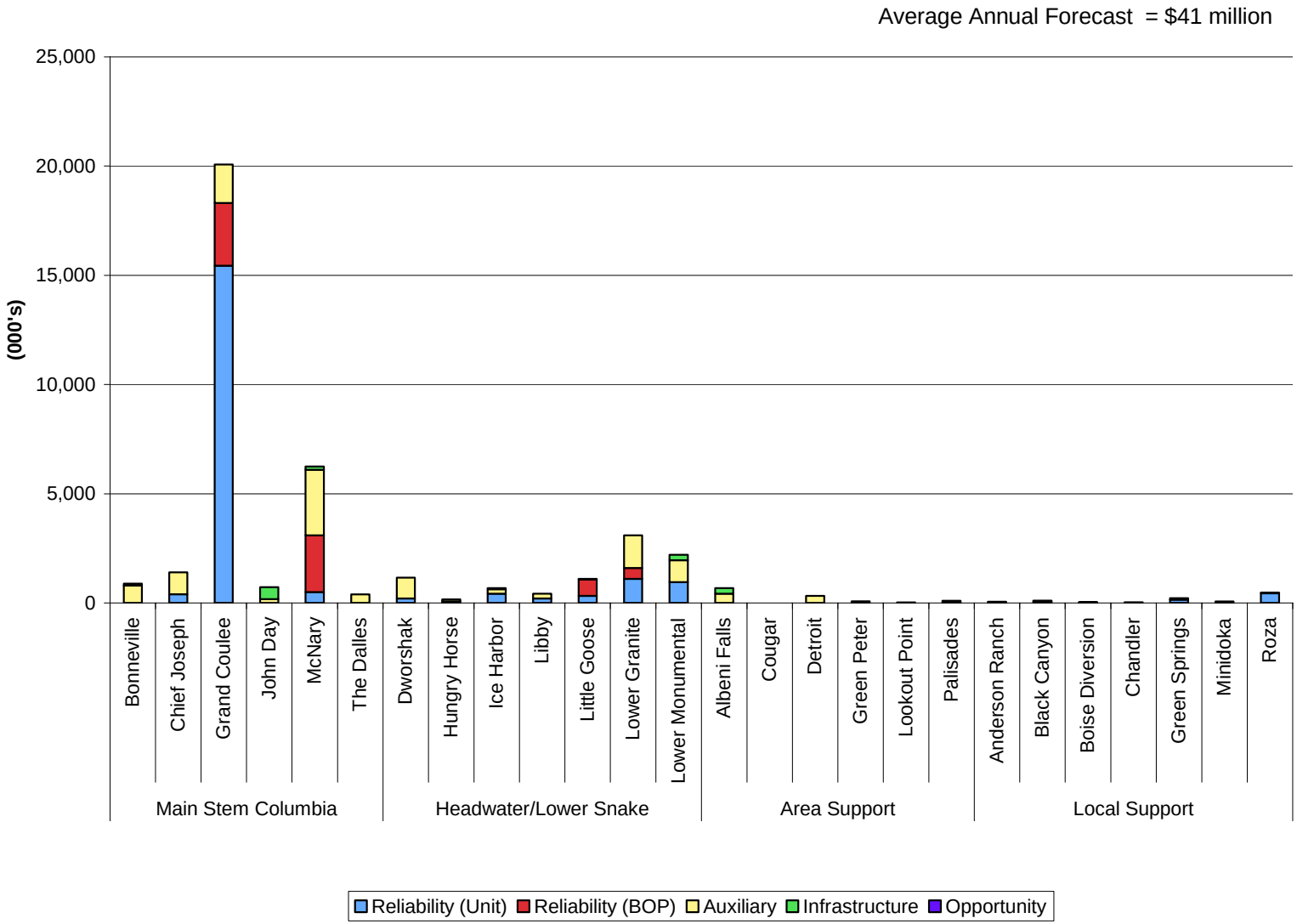
Proposed Extraordinary Maintenance Expense by Plant FY2009 – FY2015



Large Capital Forecast w/ AFUDC, Average Annual FY2010 – FY2013



Extraordinary Maintenance Expense Forecast, Average Annual FY2010 – FY2011



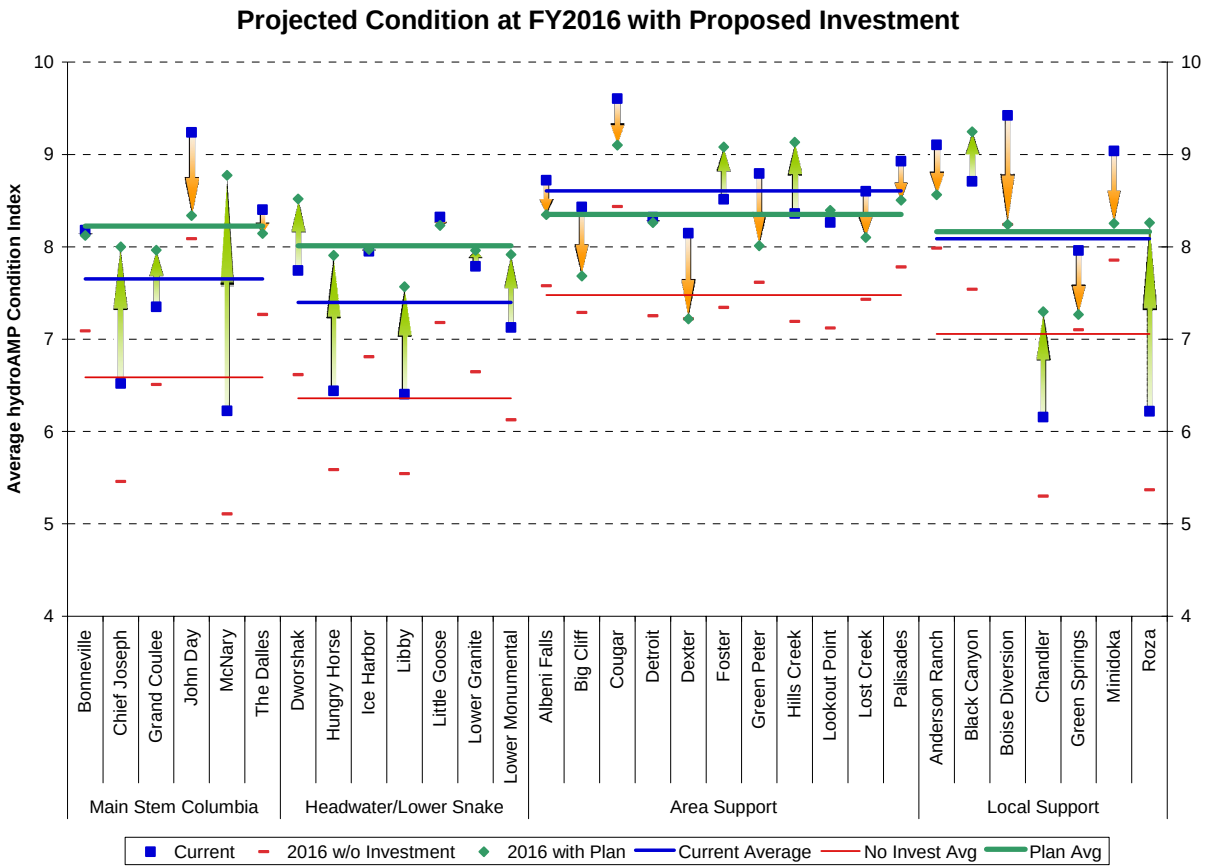
Proposed Long Term Plan – Average hydroAMP Index at 2016

The condition of the Main Stem class will improve from its current level under the proposed plan. The substantial investment that is proposed for Grand Coulee, Chief Joseph, and McNary will improve the condition of these facilities, though Grand Coulee and Chief Joseph still will be rated as Fair. The proposed plan will lead to additional condition improvements at Grand Coulee and Chief Joseph for work that will underway but not completed prior to 2016. The condition of Bonneville and The Dalles will be sustained. Condition of John Day will decrease but will remain in Good condition overall.

The condition of the Headwater/Lower Snake class will improve under the proposed plan. Hungry Horse and Libby will see the greatest improvement in hydroAMP ratings. The condition of other facilities will be sustained.

The condition of the Area Support class will decrease under the proposed plan but will remain in Good condition overall.

The condition of the Local Support class will remain constant. The proposed investment in Chandler and Roza, currently 4th quartile overall, will improve their conditions to Fair and Good, respectively. The condition of most other plants in this class will decrease but still remain Good.



Proposed Long Term Plan – Risk Profile at 2016

At 2016, the system risk profile is reduced significantly from that in 2008. This chart show that the proposed plan has the following effects:

- The proposed plan essentially eliminates risks to non-power train components.
- The number of high risk power train components will be significantly decreased by FY2016.
- In addition, some proposed work programs at Chief Joseph and Grand Coulee still will be underway in FY2016. This incomplete work is not reflected in the charts. As a result, the proposed plan will lead to additional reductions in risk in subsequent years.

Projected Risk Map at FY2016 with Proposed Investment

Likelihood	Insignificant (< $ 10K)	Minor ($ 10K to $ 100K)	Moderate ($ 100K to $ 1 M)	Major ($ 1 M to $ 10 M)	Extreme (> $ 10 M)	hydroAMP Index	
Almost Certain	6 Exciter	3 Exciter	13 Exciter			0 to 0.9 1 to 1.9	Poor
Likely			3 Exciter 1 Generator Rotor 2 Governor 2 Turbine	1 Exciter 7 Turbine		2 to 2.9 3 to 3.9	Poor Marginal
Possible		3 Generator Stator	8 Generator Rotor 2 Generator Stator 5 Transformer 11 Turbine 16 Unit Breaker	7 Generator Stator 8 Transformer 7 Turbine	4 Transformer	4 to 4.9 5 to 5.9	Marginal
Unlikely	2 Generator Rotor 2 Turbine	22 Exciter 11 Generator Rotor 3 Governor 7 Turbine 6 Unit Breaker	8 Exciter 62 Generator Rotor 20 Generator Stator 1 Governor 4 Transformer 32 Turbine 23 Unit Breaker	13 Exciter 6 Generator Rotor 35 Generator Stator 47 Transformer 5 Turbine	2 Transformer	6 to 6.9 7 to 7.9	Fair
Rare	2 Exciter 5 Governor 2 Unit Breaker 1 Non-Power Train	12 Exciter 26 Generator Rotor 4 Generator Stator 85 Governor 2 Turbine 28 Unit Breaker 83 Non-Power Train	122 Exciter 97 Generator Rotor 27 Generator Stator 110 Governor 95 Turbine 114 Unit Breaker 150 Non-Power Train	9 Exciter 1 Generator Rotor 111 Generator Stator 7 Governor 134 Transformer 44 Turbine 17 Unit Breaker 91 Non-Power Train	5 Generator Stator 29 Transformer 49 Non-Power Train	8 to 8.9 9 to 10	Fair Good

Consequence

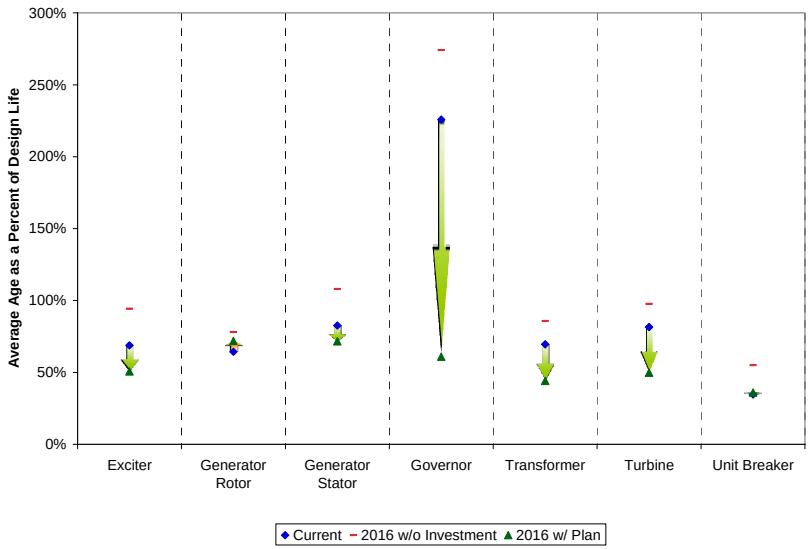
Risk Level	Low	Medium	Medium High	High

Proposed Long Term Plan – Age of hydroAMP Rated Equipment

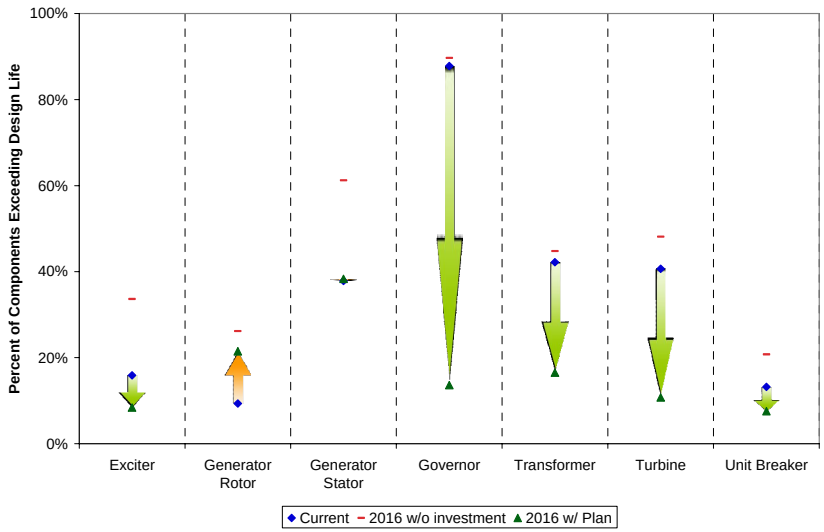
The average age of most hydroAMP rated equipment will decrease through the proposed plan. The most significant reduction in age profile will be for governors, which is the component type currently at the highest percentage of components exceeding design life. At FY2016, generator rotors, generator stators, and transformers will have the greatest percentage of components exceeding design life, each in excess of 20 percent of the asset base.

As a general assessment, for most plants the proposed plan will not have a significant impact on overall age profiles at FY2016. Consequently, the level of investment proposed (and as based on condition and risk needs) appears to be consistent with long-range funding required for age-based replacements, under an overall assumption that the age profile of the asset base should not worsen with time.

Projected Average Age of Power Train Components as a Percent of Design Life



Projected Percentage of Power Train Components Exceeding Design Life



Proposed Long Term Plan – System Cost of Production

Long-term pro forma statements have been created to demonstrate the financial impacts of the proposed plan on the FCRPS' cost of production and program net benefit. The analysis includes:

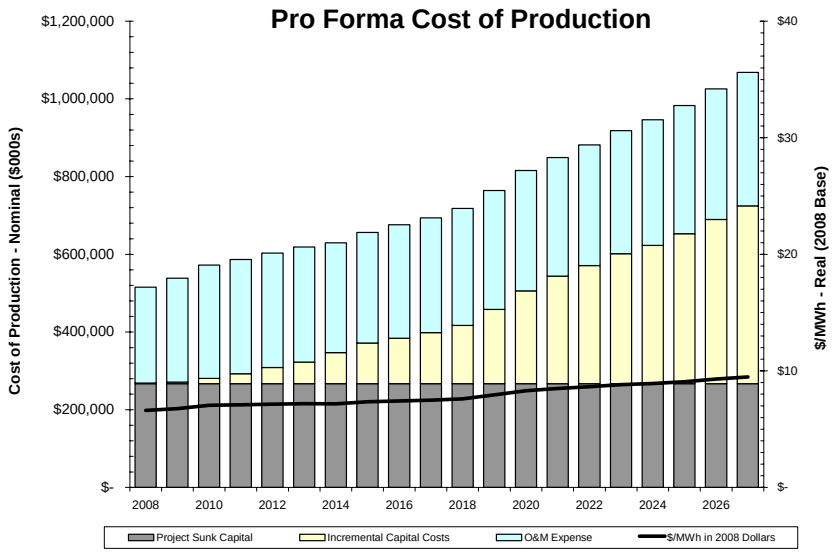
- O&M costs as proposed and forecasted for subsequent years;
- The impacts of proposed capital spending for condition/risk-driven projects and forecasted age-based replacements on finance charges and depreciation, and
- The 'sunk' finance charges and depreciation based on past investment.

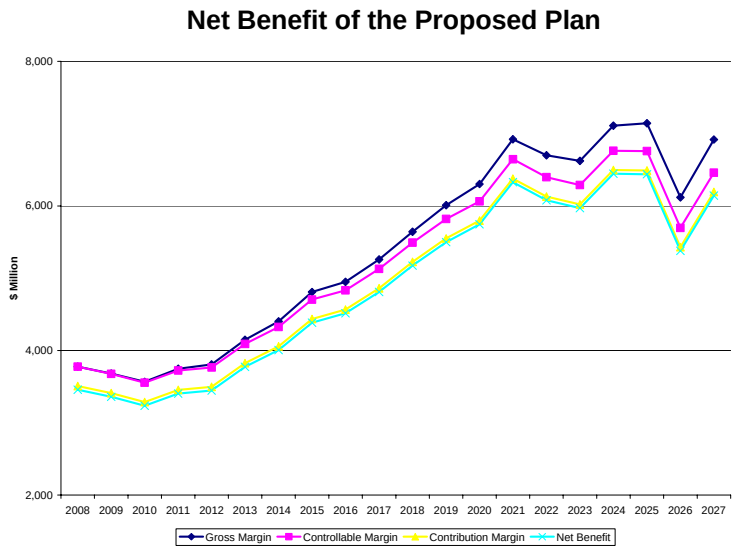
The analysis does not include any allocation of costs not directly attributable to Direct Funding programs. In addition:

- The cost of production chart calculates the unit cost of energy over time, shown in constant 2008 dollars, and
- The net benefit chart assumes energy from each plan is valued at long range forward energy price forecasts (Levelized $56/MWh in 2008$).

These charts show that the proposed plan has the following primary effects:

- The unit cost of production will increase slightly in real terms over the plan period (FY2009 – FY2015).
- Long range forecasts for the unit cost of production will continue to increase in real terms based on anticipated age-based replacements in FY2016 and beyond.
- The FCRPS will continue to provide positive and increasing net benefit, provided that investment plans successfully maintain or improve reliability and sustain the economic value of generating assets. The plan has a net present value of $30 billion over 20 years.





Proposed Long Term Plan – Risk and Uncertainties

The following are considered key risks and uncertainties that may materially affect this plan:

Ability to Execute – Resources from across FCRPS agencies will be responsible for the implementation of this plan. Activities include project management, design, contract development, scheduling, and supervision of contractors. Many rehabilitation/replacement work activities also are executed directly by FCRPS trades.

The proposed plan represents a substantial increase in workload over current levels. Discussions have started between FCRPS partners to ensure resource needs are understood and can be addressed.

Skill deficits due to labor force demographics and increasing skill requirements related to technological change in the industry could result in a decreased ability to accomplish maintenance and efficiency improvement projects.

Competing priorities with non-power missions among partner agencies could result in delays in meeting power-related goals.

Availability of Outages – Many proposed activities will require extended outages of generating equipment. Detailed analysis of outage requirements has not yet been undertaken. The sequencing of some projects could be affected as actual outage plans are developed.

Uncertainty of Cost Estimates – Detailed cost estimates have not yet been developed for many projects, particularly those in later years of the plan. This has the potential to affect year-over-year funding needs.

Suppliers – A limited number of suppliers for certain types of equipment could result in increased lead times, cost of equipment, and chances of supply chain disruptions.

Catastrophic Events – Unforeseen, low probability, high consequence events could require a refocus of priorities which could preclude completing items identified in this plan.

Corps Direct Funded Expense

$ in Thousands	Actuals		SOY	Rate Case Average	Rate Case	IPR	IPR	IPR
	FY 2006	FY 2007	FY 2008	FY 2007-09	FY 2009	FY 2009	FY 2010	FY 2011
Program Level Spending	146,700	158,400	165,700	164,833	170,400	179,500	193,000	197,900
Increase/Decrease *		11,700	7,300		4,700	9,100	13,500	4,900

* for FY 2006-2008, Rate Case FY 2009, IPR FY 2010 and FY 2011, change is from the prior year. For IPR FY 2009 Forecast, change is calculated from "Rate Case".

Program Background:
BPA works with U.S. Army Corps of Engineers and the Bureau of Reclamation to implement funding for operations and maintenance activities at 31 hydro electric facilities throughout the Northwest.

Drivers of Change:
WECC/NERC compliance requirements - $3 million per year
Corps hydro facility drawings - $1 million per year
Non-routine extraordinary maintenance needs - $3 million in FY 2009, $10 million per year in FY 2010 and FY 2011
Bi-Op requirements, including $2 million per year for Willamette Bi-Op expenses
Proposal is for O&M spending to rise at roughly the rate of inflation, (except for the costs described above)

Forecast Risk:
Increasing forced outages (particularly 3rd Powerplant units at Grand Coulee)
Material cost increases and availability of material (world markets)
Increasing risk to generating capacity
Non-compliance risk reliability standards
Ability to resource and execute (staffing, contracts, engineering and design, construction management, etc.)
Increasing Bi-Op requirements

Opportunities for Improvement:
Costs may be less due to resourcing limitations
Prioritization and further analysis of work activities and risks
Ability to take units off system is limited (especially once work begins on Grand Coulee 3rd Powerplant)

Reclamation Direct Funded Expense

$ in Thousands	Actuals		SOY	Rate Case Average	Rate Case	IPR	IPR	IPR
	FY 2006	FY 2007	FY 2008	FY 2007-09	FY 2009	FY 2009	FY 2010	FY 2011
Program Level Spending	62,600	67,300	74,800	73,300	77,800	82,100	87,700	98,500
Increase/Decrease *		4,700	7,500		3,000	4,300	5,600	10,800

* for FY 2006-2008, Rate Case FY 2009, IPR FY 2010 and FY 2011, change is from the prior year. For IPR FY 2009 Forecast, change is calculated from "Rate Case".

Program Background:
BPA works with U.S. Army Corps of Engineers and the Bureau of Reclamation to implement funding for operations and maintenance activities at 31 hydro electric facilities throughout the Northwest.

Drivers of Change:
WECC/NERC compliance requirements - $1 million per year
Non-routine extraordinary maintenance needs, including $4.9 million in FY 2010 and $12 million in FY 2011 for rehabilitation at Grand Coulee. This rehabilitation has been scheduled to allow for condenser work at CGS.
Bi-Op requirements, including $8 million for Leavenworth Hatchery Complex work
Proposal is for O&M spending to rise at roughly the rate of inflation, (except for costs described above)

Forecast Risk:
Increasing forced outages (particularly 3rd Powerplant units at Grand Coulee)
Material cost increases and availability of material (world markets)
Increasing risk to generating capacity
Non-compliance risk reliability standards
Ability to resource and execute (staffing, contracts, engineering and design, construction management, etc.)
Increasing Bi-Op requirements

Opportunities for Improvement:
Costs may be less due to resourcing limitations
Prioritization and further analysis of work activities and risks
Ability to take units off system is limited (especially once work begins on Grand Coulee 3rd Powerplant)

Corps/Reclamation Direct Funded Capital

$ in Thousands	Actuals*		SOY	Rate Case Average	Forecasted				
Description	**FY06**	**FY07**	**FY08**	**FY08-09****	**FY09**	**FY10**	**FY11**	**FY12**	**FY13**
Corps/Reclamation	120,561	108,351	150,488	150,301	142,950	173,000	189,000	197,000	210,000
AFUDC	7,580	12,358	12,000	12,000	12,000	10,200	10,200	11,200	10,200
Total Increase/Decrease From Prior Year						28,250	16,000	9,000	12,000

* Reflects accounting according to the Bonneville Enterprise System, which includes a September through August accumulative total.
** Average FY 2008 – 2009 Rate Case level.

Strategic Objective(s): This program is driven by BPA's strategic direction to insure that hydro projects' " … performance and expansion meet availability, adequacy, reliability and cost-effectiveness standards. " BPA works with the U.S. Army Corps of Engineers and the Bureau of Reclamation to ensure implementation of all regionally cost-effective system refurbishments and enhancements to federal hydro projects.

Drivers of Change: The proposed investment program increases significantly from past expenditure levels to address the condition and risk of hydro equipment. The investment program addresses trusted stewardship goals, including safety, environmental, and other non-power risks; however, the proposed increase in spending is primarily the result of the following factors related to FCRPS' goals of low cost power and power reliability:

1. Equipment condition is deteriorating at critical plants, which poses significant risk of increased power costs due to lost hydro generation. Of particular note are Grand Coulee, Chief Joseph, and McNary, which provide significant power production and transmission system support.
2. Continued investment is needed to capture economic opportunities for turbine runner efficiency improvements at Grand Coulee and Chief Joseph.
3. Funding is identified for a new generating unit at Libby to support flows for sturgeon habitat.

Forecast Risk: Increasing forced outages, equipment cost increases, increasing demand for equipment from a limited number of worldwide suppliers, increasing risk to generating capability, increasing environmental and fishery requirements, risk of non-compliance to reliability standards, ability to resource and execute the program, and catastrophic events causing a refocus of investment priorities.

Opportunities for Improvement: While these are not improvements per se, near-term program cost reductions may occur as a result of resource limitations, or the inability to schedule units out of service for rehabilitation; these may increase long-term costs.

Discussion of Significant Cost Drivers

WECC/NERC Reliability Compliance

Corps As-Built Drawings

Biological Opinions

Grand Coulee Third Powerplant Unit Overhauls

Libby Unit 6