Yakima River Basin Water Storage Feasibility Study, Washington

Preliminary Appraisal Assessment of Columbia River Water Availability for a Potential Black Rock Project

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The mission of the U.S. Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Preface

This appraisal assessment on Columbia River water availability is one of the preliminary components of the *Yakima River Basin Water Storage Feasibility Study* (Storage Study) which will examine the feasibility and acceptability of storage augmentation for the benefit of fish, irrigation, and municipal water supply within the Yakima River basin. This appraisal assessment is intended to provide Reclamation and others with preliminary information and guidance on the viability of diverting Columbia River water to a potential offstream Black Rock project for use in the Yakima River basin. It addresses the questions of if, when, and in what amount Columbia River water in excess of current instream requirements may be available for diversion.

As the Storage Study proceeds, Reclamation will investigate many other factors relevant to the feasibility and acceptability of storage augmentation within the Yakima River basin. This will include further investigations of matters associated with Columbia River water availability and may result in refining or modifying the findings of this preliminary appraisal assessment document.

Preliminary Appraisal Assessment of Columbia River Water Availability for a Potential Black Rock Project

Introduction and Findings

Basis For Determining Water Availability

The basis for determining water availability is a Bonneville Power Administration computer model which uses historic hydrologic flow conditions for the 50-year period of 1929-1978. This model simulates the most current Federal Columbia River Power System (FCRPS) operating requirements of each Federal and non-Federal project of the main stem Columbia River. Output includes monthly average flows at different points of the river system.

This assessment assumes that only water in excess of seasonal instream flow targets established in the December 2000 FCRPS Biological Opinion, plus flow objectives for nonlisted salmon downstream from Priest Rapids Dam at Vernita Bar, is available for diversion by a potential Black Rock project.

Potential Water Exchange Participants

The Roza and Sunnyside divisions of the Yakima Project are located such that a Columbia River water exchange may be feasible. At this time, conceptual water delivery plans indicate it is physically possible to meet all or most of their water rights from the Columbia River in lieu of the Yakima River. This does not imply that these divisions have agreed to a water exchange and its extent, but only their willingness to explore such possibilities.

This assessment assumes both the Roza and Sunnyside divisions will no longer divert from the Yakima River but will instead obtain all their water rights from a Black Rock project. If such an exchange could be consummated, diversions from the Yakima River could possibly decrease by up to 810,400 acre-feet annually (April - October) and 840,400 acre-feet annually with March flood flows.

Water Delivery Criteria

One of the purposes of the Storage Study is to improve the reliability of the Yakima Project water supply for proratable water rights in dry years. A water supply goal of providing no less than 70 percent of the proratable rights in dry years historically has been used in the Yakima River basin for planning purposes. This goal is also used in this assessment and is applicable to potential water exchange participants. A full water supply thus consists of the sum of all authorized nonproratable water and (a) 100 percent of the proratable water in wet and normal

water years, and (b) a minimum of 70 percent of proratable water in Yakima River basin dry years.

Water Availability Findings

The major findings of the appraisal assessment are as follows:

If, when, and in what amount Columbia River water in excess of instream flow targets may be available for diversion:

- Model simulations indicate the following average monthly water supplies in excess of instream flow targets may be available for diversion from the Columbia River in the vicinity of Priest Rapids Dam.

Average monthly water supply available for pumping

Period	50-Year Average (acre-feet)	# of years water is available
Oct	1,772,770	50
Nov	413,010	17
Dec	2,082,440	41
Jan	4,574,080	44
Feb	2,826,800	35
Mar	2,498,100	35
1-Apr	603,120	30
2-Apr	235,990	16
May	2,048,580	27
Jun	2,449,230	26
Jul	1,477,810	29
1-Aug	61,250	4
2-Aug	0	0
Sep	1,040,840	48
total	22,084,020	

- Columbia River water appears to be available for exchange with willing Yakima River basin water users contingent on obtaining State authorization in some form of water right approval.

- Instream flow targets at various points on the Columbia River downstream from Priest Rapids Dam limit diversions in every month except September, and the October flow target is relatively low.

- Water is available for diversion in October of every year of the 50-year model simulation period and in September 48 of the 50 years. Therefore, September and October are the primary pumping months.

- Four years (1931, 1937, 1945, and 1973) of the 50-year model simulation period have little water available for diversion.

Viability of direct delivery to water exchange participants without storage:

- Because of the timing of water availability in excess of instream flow targets and Columbia River water supply deficiencies in some dry years, direct delivery (without storage) during the irrigation season to the Roza and Sunnyside divisions is not viable.

- A Black Rock reservoir would be required in order to effect a water exchange with the Roza and Sunnyside divisions.

Pump and reservoir capacities which may be required for a water exchange:

- To meet water delivery criteria for a water exchange with the Roza and Sunnyside divisions, the following Black Rock reservoir and Columbia River pumping capacity configurations would be necessary:

Maximum Reservoir			Minimum Reservoir		
Active Reservoir Capacity	Pumping Capacities		Active Reservoir Capacity	Pumping Capacities	
1,300,000 acre-feet	Minimum	3,500 cfs [a]	800,000 acre-feet	Minimum	6,000 cfs [a]
	Maximum	9,000 cfs [b]		Maximum	15,500 cfs [b]

[a] Light load hour and heavy load hour pumping all year

[b] Light load hour only pumping all year

When pumping would have to occur to meet the water delivery criteria:

- Water diversion only during the peak Columbia River runoff period of April, May, and June with a 1,300,000-acre-foot active capacity reservoir and pumping capacity in excess of 10,000 cfs operating during both light load and heavy load hours could not meet the water delivery criteria over the 50-year period of analysis.

- Water diversion only during November through August with a 1,300,000-acre-foot active capacity reservoir and pumping capacity in excess of 8,000 cfs operating during both light load and heavy load hours could not meet the water delivery criteria over the 50-year period of analysis.

- Water diversion with a 1,300,000-acre-foot active capacity reservoir and a 9,000-cfs pumping capacity operating all year at light load hours only could meet the water delivery criteria over the 50-year period of analysis.

- Water diversion would have to occur throughout the year with a 1,300,000-acre-foot active capacity reservoir and a 3,500-cfs pumping capacity operating during both light load and heavy load hours to meet the water delivery criteria over an extended period.

- Water diversion throughout the year with an 800,000-acre-foot active capacity reservoir and a pumping capacity of about 15,500 cfs operating all year at light load hours only could meet the water delivery criteria over the 50-year period of analysis.

- Water diversion would have to occur throughout the year with an 800,000-acre-foot active capacity reservoir and pumping capacity at 6,000 cfs operating during both light load and heavy load hours to meet the water delivery criteria over an extended period.

- The primary pumping months to ensure refill of a Black Rock reservoir are September and October.

Estimated time for initial reservoir filling:

- Depending on Columbia River water supply conditions and assuming no deliveries during initial filling and that the inactive storage is already full, a 1,300,000-acre-foot Black Rock reservoir would require 6 to 30 months to fill, and an 800,000-acre-foot capacity reservoir 2 to 13 months.

The degree to which a reservoir could remain full:

- In 16 of 50 years, the 1,300,000-acre-foot active capacity reservoir would be full on June 1; and in 36 of 50 years, it would be more than half full by the end of August.

- In 19 of 50 years, the 800,000-acre-foot active capacity reservoir would be full on June 1; and in 31 of 50 years, it would be more than half full by the end of August.

Water availability appraisal assessment summary of a Black Rock project:

Data assumed or computed for this appraisal assessment:

	Maximum Reservoir	Minimum Reservoir
Active reservoir capacity	1,300,000 af	800,000 af
Water exchange April - October wet and average years	810,400 af	810,400 af
Water exchange April - October that meets water exchange delivery criteria in Yakima River basin dry years	662,000 af [a]	662,000 af [a]
Assumed seepage loss	15,000 af	15,000 af
Assumed evaporation loss	30,100 af	23,470 af
Months to fill	6 to 30 months	2 to 13 months
Average August end-of-month reservoir content	888,000 af	468,000 af
Average August reservoir percent full	68%	59%
Pump capacity that meets water exchange delivery criteria		
Round-the-clock pumping, all year	3,500 cfs	6,000 cfs
Light load hours only pumping, year round	9,000 cfs	15,500 cfs

[a] The water delivery criteria is the sum of all authorized nonproratable water and (a) 100 percent of the nonproratable water in wet and normal water years, and (b) a minimum of 70 percent of proratable water in Yakima River basin dry years.

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Objective

The Congress (Act of February 20, 2003; Public Law 108-7) directed the Bureau of Reclamation (Reclamation) "...to conduct a feasibility study of options for additional water storage in the Yakima River basin, Washington, with emphasis on the feasibility of storage of Columbia River water in the potential Black Rock reservoir..." Reclamation initiated the "Storage Study" in May 2003.

The potential for diverting water from the Columbia River was addressed in the May 2002 Washington Infrastructure Services (WIS) reconnaissance study titled *Yakima River Storage Enhancement Initiative - Black Rock Reservoir Study* commissioned by Benton County, Washington. The concept is to divert Columbia River water and deliver it to Yakima River basin entities susceptible to receiving their irrigation supply from this source and willing to exchange it for their present (entire or partial) diversions from the Yakima River. Such an exchange would improve the reliability of Yakima Project water supplies for fishery, irrigation, and other purposes.

It is recognized that State authorization in some form of water right approval will be required for such a diversion, and the conditions of the authorization (if allowed) may influence the sizing of a Black Rock project. Recent litigation over Columbia River water rights prompted the State of Washington to undertake a planning process which will result in a rewrite of current administrative rules for Columbia River water appropriation, management, and use. This process is termed the *Columbia River Initiative* (CRI). The target for completion of this process is spring of 2004. Rather than delay activities of the Storage Study until administrative rules are in place, Reclamation completed this preliminary assessment of water availability based on current Columbia River flow objectives as recognized by NOAA Fisheries, U.S. Fish and Wildlife Service, Bonneville Power Administration (BPA), and other Federal agencies. The findings of this assessment will be reviewed and evaluated once the CRI process is completed.

Purpose of Appraisal Assessment

As part of the Storage Study, this "appraisal level assessment" examines the hydrologic considerations concerning the potential diversion of Columbia River water to the Yakima River basin. It considers not only the construction of an offstream Black Rock reservoir that provides water to potential water exchange participants in the Yakima River basin, but also the viability of direct delivery to such participants without storage. Consequently, the term "Black Rock project" is used.

This assessment provides the following information and is intended to provide further guidance to Reclamation for the Storage Study:

- if, when, and in what amount Columbia River water in excess of instream flow targets may be available for diversion
- viability of direct delivery to water exchange participants without storage
- pump and reservoir capacities which may be required for a water exchange
- when pumping would have to occur to meet the water delivery criteria
- estimated time for initial reservoir filling
- the degree to which a reservoir could remain full.

The *Introduction and Findings* section at the front of this document contains a summary of the appraisal assessment. The *Assumptions Used for This Assessment* section at the end of this document lists the primary assumptions Reclamation used in its hydrology model and appraisal assessment of Columbia River water availability for a potential Black Rock project.

FCRPS Flow Regime for Operational Considerations

To assess the hydrology of a Black Rock project, it is necessary to first quantify the amount of water which may be available for diversion from the Columbia River in the vicinity of Priest Rapids Dam. Output data from BPA's computer model (Hyd-Sim) of the Federal Columbia River Power System (FCRPS) provides the necessary information. The BPA model includes all significant United States Federal and non-Federal dams and the major Canadian projects on the main stem Columbia River and its major tributaries (figure 1). It is accepted widely as accurately simulating current operation of the Columbia River system. BPA's latest applicable analysis is known as "FRIII_03SN6704."

Figure 1. Many of the significant dams in the Columbia River Power System

FRIII_03SN6704 uses the current FCRPS system operating requirements of each project and historic hydrologic flow conditions. It contains a data set of runoff from 1929-1978 to determine impacts to various resources and obligations (such as power, instream flow, contract obligations, authorizations, and biological opinions) from operating the FCRPS under different scenarios. The 1929-1978 data set is modified to the 1980 level of agricultural diversions.[1] Given a set of operating parameters of each project, BPA determines the Columbia River operation that best minimizes impacts on each project and optimizes use of water resources. Model output includes information such as inflow, outflow, end-of-month reservoir elevations, power generation at each project, and monthly average flows at different target points on the system. For the purposes of this assessment, it is assumed there is no change in the model discharge from the Yakima River which could affect flows downstream.

The Hyd-Sim model splits the average monthly flows for the months of April and August so the first 15 days are separate from the remaining days of those two months. This is because April and August are dynamic months in which flows can change dramatically. The April split represents the fact that flow targets start in mid-April. The August split represents the higher flows that typically occur during the first half of August and drop off during the last half of the month. Modeling the entire month of August without the split would likely result in the model never meeting August flow targets (and, thus, no August water available for a Black Rock project). Therefore, splitting the August water supply presents a more realistic hydrograph. The model considers the remaining months as ten single monthly averages for each year.

[1] Depletions Task Force. Columbia River Water Management Group. July 1983. 1980 Level Modified Streamflow 1928 – 1978. Columbia River and Coastal Basins.

Instream Flow Targets for the Main Stem Columbia River

Hanford Reach

The proposed water diversion for a Black Rock project is from the 52-mile-long "Hanford Reach," which is the last undammed, free-flowing reach of the Columbia River in the U.S. A Black Rock project primarily affects a 67-mile-long reach of the Columbia River extending from the mouth of the Yakima River (RM 330.0) to Priest Rapids Dam (RM 397.1). The lower 15 miles of this reach is backwatered by McNary Dam and is not considered free-flowing habitat. Vernita Bar, about 4 miles downstream from Priest Rapids Dam, is one of the largest spawning areas for fall Chinook salmon.

Four species of anadromous salmonids inhabit or migrate through the Hanford Reach: spring, summer, and fall Chinook salmon (*Oncorhynchus tshawyscha*); summer steelhead (*O. mykiss*); coho salmon (*O. kisutch*); and sockeye salmon (*O. nerka*). The Endangered Species Act lists the upper Columbia River spring Chinook salmon Evolutionarily Significant Unit (ESU) and the upper Columbia River steelhead ESU as endangered. Only fall Chinook salmon are known to spawn and rear in this reach. The other anadromous species migrate through as adults returning to upriver spawning areas, while smolts travel through the area on their downstream migration.

Seasonal Flow Targets

The National Oceanic and Atmospheric Administration, National Marine Fisheries Service, (NOAA Fisheries) FCRPS Biological Opinion (BIOP) of December 2000 establishes seasonal flow targets downstream from Priest Rapids, McNary, and Bonneville Dams. NOAA Fisheries is in constant negotiations with Reclamation and the U.S. Army Corps of Engineers in an attempt to balance refilling upstream reservoirs with meeting downstream flow targets. Water from the Columbia River cannot be stored unless there is enough water to first meet these flow targets. Target flows facilitate spawning, downstream passage of juveniles, and accommodate returning adult salmon and steelhead.

System operations include other flow objectives (not part of the BIOP) for nonlisted salmon downstream from Priest Rapids Dam at Vernita Bar. Table 1 and figure 2 summarize all seasonal instream flow targets downstream from Priest Rapids Dam. This assessment assumes that only water in excess of flow targets is available for diversion to a Black Rock project.

Table 1. Seasonal flow targets and planning dates for the main stem Columbia River

	Fall Through Spring Targets		Summer Targets	
Columbia River Location	Dates	Flow (cfs)	Dates	Flow (cfs)
at Priest Rapids Dam - transport target [(a)]	4/10 - 6/30	135,000	NA	NA
at Priest Rapids Dam - spawning target [(b)]	10/10 - 6/30	55,000	NA	NA
at McNary Dam - transport target[(a)]	4/10 - 6/30	220,000 - 260,000 [(c)]	7/01 - 8/31	200,000
at Bonneville Dam - spawning target [(a)]	11/1 through April	125,000 - 160,000 [(d)]	NA	NA

[(a)] as per 2000 FCRPS BIOP for listed species

[(b)] pertains to nonlisted species (Chinook salmon) as per Vernita Bar Agreement; would govern in October; after 4/10, the 135,000 cfs minimum governs

[(c)] objective varies according to water volume forecasts

[(d)] objective varies based on actual and forecasted water conditions

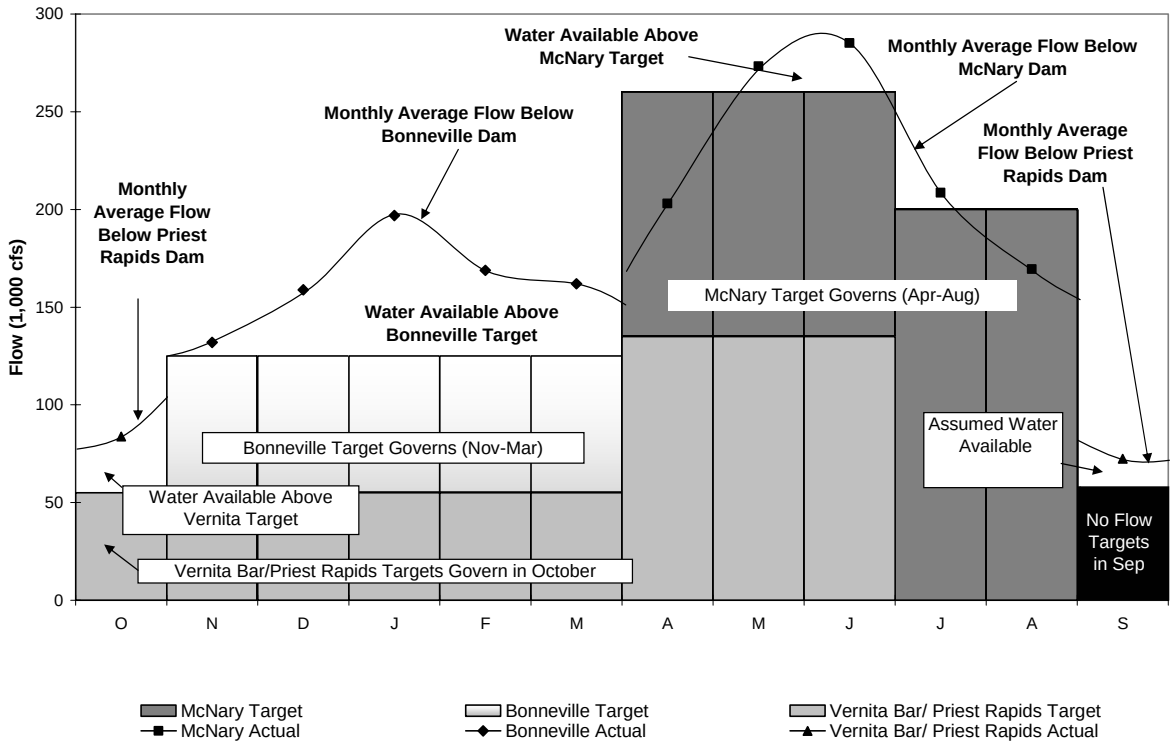

Figure 2. Flow targets on the Columbia River and water availability above flow targets

Priest Rapids Targets

The Priest Rapids transportation flow target for ESA-listed fish is 135,000 cfs from April 10 - June 30. To protect nonlisted Chinook salmon downstream from Priest Rapids Dam at Vernita

Bar, a minimum spawning flow target of 55,000 cfs at Priest Rapids is generally recognized during October, as shown on figure 2. Although the Vernita Bar targets generally govern in October, this minimum flow target rarely limits water availability because Northwest power demands generally exceed the 55,000-cfs threshold. For the purpose of this assessment, the Priest Rapids flow target is simulated at 135,000 cfs from April - June; but McNary flow targets will typically govern.

McNary Targets

The transportation flow targets at McNary Dam are high to maintain the health of the smolts by quickly moving them to the ocean. These high flow targets are, therefore, most restrictive as far as water availability for a Black Rock project. If McNary targets are being met, then the Priest Rapids and Vernita Bar flow targets are generally being met. Summer flow targets for July and August at McNary are 200,000 cfs. The variable McNary spring target ranges from 220,000 cfs to an optimum 260,000 cfs and is set each March based on the runoff forecast. It is unlikely NOAA Fisheries would accept the diversion of flows to a Black Rock project when McNary flows are less than 260,000 cfs. Therefore, for the purpose of this assessment, the spring McNary transport flow target is simulated at 260,000 cfs.

Bonneville Targets

Initially, a flow target for spawning chum salmon (*O. keta)* downstream from Bonneville Dam is set low in the fall to force the salmon to spawn in the lower stages of the river. Once the fish spawn in early November, the action agencies maintain the elevation higher to keep the spawning beds covered and protect the redds with their incubating eggs. The target is set each year to achieve a high probability of sustaining the flow target throughout the season and to reduce the likelihood of missing other objectives such as the April 10 flood control elevations and June 30 refill at Franklin D. Roosevelt Lake, Dworshak Reservoir, Lake Koocanusa (Libby Dam), and Hungry Horse Reservoir. Once the Bonneville tailwater is set, it remains throughout the remainder of the year. However, the actual Columbia River flow requirements vary daily because of the influence of ocean tides and backwater effects from the mouth of the Willamette River. Also, if meeting the Bonneville flow targets results in missing other targets, the Bonneville target is abandoned. For the purpose of this assessment, the Bonneville flow target is simulated at a constant 125,000 cfs from November - April.

Water Supply Available in Excess of Instream Flow Targets

While the BPA Hyd-Sim model uses a “power” water year that begins in August and ends in July each year, the hydrology model for this assessment uses a Reclamation “irrigation” water year that runs from October 1 through September 30.

1929-1978 Data

Table 2 simulates the average monthly volumes of water in the vicinity of Priest Rapids Dam after all the instream flow target assumptions are met downstream. These volumes may be available for diversion from the Columbia River under water supply conditions similar to those of the 1929-1978 period. The monthly average water supply for this appraisal assessment is assumed to be available for each day of the month.

Table 2. Average monthly water available in the vicinity of Priest Rapids Dam in excess of instream flow targets

(Flows above 125,000 cfs Bonnneville Dam Nov-Apr; 260,000 cfs McNary Dam Apr-Jun; 200,000 cfs McNary Dam Jul-Aug; 135,000 cfs Priest Rapids Dam Apr-Jun; 55,000 cfs at Priest Rapids Dam Sept-Oct)

(in 1,000 acre-feet)

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr2	May	Jun	Jul	Aug1	Aug2	Sep	Total
1929	1387	0	0	1286	0	0	0	0	0	0	0	0	0	640	3313
1930	1844	0	0	0	373	0	0	0	0	0	0	0	0	834	3050
1931	1587	0	0	0	0	0	0	0	0	0	0	0	0	1095	2683
1932	1666	0	0	0	0	2274	608	971	2552	234	216	0	0	801	9322
1933	1451	0	1537	5222	3289	0	0	0	0	5587	5137	0	0	1419	23643
1934	2858	2591	9752	13415	7578	4848	2808	927	757	0	0	0	0	729	46263
1935	1543	0	963	4611	4831	0	0	0	0	0	26	0	0	879	12853
1936	1667	0	0	0	0	123	0	0	3883	0	0	0	0	440	6114
1937	1662	0	0	0	0	0	0	0	0	0	0	0	0	530	2192
1938	1828	0	829	5977	920	3548	59	0	3644	0	0	0	0	860	17665
1939	1490	0	0	1903	0	347	0	0	0	0	0	0	0	509	4248
1940	1811	0	324	1010	177	3441	0	0	0	0	0	0	0	380	7143
1941	1470	0	1013	2094	0	0	0	0	0	0	0	0	0	637	5214
1942	1314	0	3706	5673	260	0	0	0	0	171	463	0	0	585	12174
1943	1632	0	1387	4996	3709	4074	1784	593	3516	1462	2075	0	0	512	25741
1944	1458	0	89	1731	0	0	0	0	0	0	0	0	0	734	4012
1945	1462	0	0	0	0	0	0	0	0	0	0	0	0	315	1777
1946	1690	0	231	3133	2148	4239	482	39	4457	0	857	0	0	904	18181
1947	1060	0	5174	5675	4199	4367	0	0	2363	0	236	0	0	737	23810
1948	3993	1699	2887	6072	1220	2026	81	0	4311	15620	2691	0	0	1927	42528
1949	1814	0	955	2297	1540	6525	0	695	3846	0	0	0	0	205	17877
1950	1490	0	156	3091	5026	7537	759	281	1790	7856	3747	0	0	1161	32895
1951	2294	2627	6406	9109	8943	5173	1000	1050	6410	0	1613	0	0	1416	46043
1952	3124	412	3340	4990	3232	2978	405	220	5279	0	0	0	0	513	24494
1953	1422	0	0	2958	4782	184	0	0	562	3934	1955	0	0	885	16682
1954	1747	81	2368	4107	4813	2541	685	0	3173	6281	3923	952	0	4452	35123
1955	2454	1170	2056	1044	0	0	0	0	0	7265	6264	0	0	1037	21289
1956	2271	1976	6450	10088	3284	6679	1409	2216	8067	7435	2711	0	0	875	53461
1957	1725	0	2704	3533	0	2546	1255	0	3918	5691	0	0	0	514	21885
1958	1373	0	398	3136	3955	2876	0	0	3131	1951	0	0	0	657	17477
1959	1394	1019	3747	8782	5011	2609	1175	0	1410	5052	3306	0	0	3984	37488
1960	4694	3082	4817	4475	1360	2090	2689	200	0	481	372	0	0	839	25100
1961	1623	553	964	3981	4979	3993	1372	0	389	8332	0	0	0	384	26570
1962	1401	0	59	3733	0	0	1484	626	0	0	0	0	0	517	7821
1963	1587	1047	3703	3899	2543	1211	0	0	0	0	41	0	0	1006	15038
1964	1240	0	375	3641	660	0	0	0	0	5979	4743	0	0	1657	18296
1965	2743	159	7388	10836	8165	5171	327	626	3835	1899	243	0	0	667	42059
1966	1579	223	1993	4767	0	92	683	0	0	0	698	0	0	589	10624
1967	1344	0	1184	5768	5984	650	842	0	0	7189	3661	0	0	1208	27830
1968	1593	220	2042	4925	4216	2446	0	0	0	896	2701	0	0	2291	21331
1969	2484	1528	2892	8023	4813	3118	2412	1086	6486	629	185	0	0	619	34276
1970	1454	0	530	5392	3648	497	0	0	0	1986	0	0	0	0	13506
1971	1185	0	452	7606	9358	4092	564	455	7128	4962	3308	0	0	792	39903
1972	1158	103	2025	6758	8114	13880	3228	0	6524	10616	4977	529	0	1421	59333
1973	1545	0	2564	5537	0	0	0	0	0	0	0	0	0	0	9646
1974	1300	0	4814	13853	9371	6685	1932	1477	6253	8111	7671	129	0	1513	63110
1975	1150	0	800	5056	2478	3927	0	0	2225	2737	5096	0	0	801	24270
1976	1888	2160	8488	8839	5041	3371	1637	335	4934	106	3843	1453	0	5103	47198
1977	1753	0	313	1936	0	0	0	0	0	0	0	0	0	431	4434
1978	938	0	2243	3743	1318	4746	473	0	1584	0	1131	0	0	1036	17213
Average	1773	413	2082	4574	2827	2498	603	236	2049	2449	1478	61	0	1041	22084

Monthly Availability

Table 3 shows water availability by month for the simulated 50-year period used in the model.

Table 3. Average monthly water available for pumping
in the vicinity of Priest Rapids Dam in excess of instream flow targets

Period	50-Year Average (acre-feet)	# of Years Water Is Available
Oct	1,772,770	50
Nov	413,010	17
Dec	2,082,440	41
Jan	4,574,080	44
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2-Apr	235,990	16
May	2,048,580	27
Jun	2,449,230	26
Jul	1,477,810	29
1-Aug	61,250	4
2-Aug	0	0
Sep	1,040,840	48
total	22,084,020	

Potential Significance of Including Post-1978 Data

Ideally, this assessment would look at the data set from 1929 to present time. However, FRIII_03SN6704 only contains data from 1929-1978. (Post-1978 data have not yet been regulated to the 2000 BIOP.) The 1930s and 1940s are the controlling "dry years" of the Columbia River water supply. Water is available for pumping to a Black Rock project only in September and October in 1931, 1937, and 1945. As a part of the Storage Study, Reclamation will work with BPA to extend the hydrology analysis through the most current water year possible. This will include the 3-year dry period of 1992-1994. The additional years will not change the results appreciably.

Potential Water Exchange

Participants

The Roza and Sunnyside divisions of the Yakima Project are located, both from the perspective of service areas and major conveyance facilities, such that a Columbia River water exchange may be feasible. Following discussions with these two irrigation divisions concerning their willingness to consider water exchanges, Reclamation initiated activities early in September 2003 to develop conceptual plans for the delivery of Columbia River water.

At this time, conceptual plans indicate it may be feasible to meet all or most of those irrigation divisions' water rights from the Columbia River in lieu of the Yakima River. This does not imply that these divisions have agreed to a water exchange and its extent, but only their

willingness to explore such possibilities. However, for the purpose of this assessment, it is assumed both Roza and Sunnyside diversions will no longer divert water from the Yakima River, but will instead obtain all their water from a Black Rock project.

Water Right Entitlements

In considering the annual Columbia River diversion and facilities necessary to effect a water exchange, the Yakima River water rights (or entitlements) of the two divisions are used. Potential exchange facilities should have adequate capacity to deliver the peak water rights, about 2,500 cfs in June. Table 4 identifies the Roza and Sunnyside divisions' Yakima River water rights which represent monthly and annual water exchange deliveries in this appraisal assessment. Table 4 also includes "flood flow waters" (unregulated natural flow out of the river system) which each division is entitled to divert based on availability. For the purposes of this assessment, these waters are assumed to be diverted in March.

Table 4. Yakima River water rights = water exchange for Roza and Sunnyside divisions [1] [2]

Month	Roza	Sunnyside	Combined Total
	(acre-feet)		
March [3]	18,000 [4]	12,000 [5]	30,000
April	37,500	52,160	89,660
May	56,250	72,670	128,920
June	71,250	74,370	145,620
July	71,250	76,020	147,270
August	71,250	76,020	147,270
September	45,000	56,910	101,910
October	22,500	27,260	49,760
Maximum	71,250	76,020	147,270
Total water rights:			
April - October	375,000	435,400 [6]	810,400
March - October	393,000	447,400 [6]	840,400

[1] Data applies on the Yakima River at the Roza and Sunnyside Diversion Dams. Data sources are the Conditional Final Order in the Acquavella proceedings (adjudication) and the 1974 C.R. Lentz review.

[2] The acre-foot data represents a full supply. In years of Yakima Project shortage proration, all of Roza's April - October supply is proratable; for Sunnyside, 119,600 acre-feet is proratable.

[3] March "flood flow waters" which each division is entitled to divert based on availability.

[4] Roza's Conditional Final Order provides that 18,000 acre-feet may be diverted throughout the irrigation season from natural flows. An instantaneous rate is not specified.

[5] Sunnyside's Conditional Final Order provides for a maximum diversion of 12,000 acre-feet in March.

[6] The April - October original entitlement was 458,520 acre-feet. As the result of the 2003 mediated settlement and Conditional Final Order, the April - October entitlement is reduced to 435,400 acre-feet (rounded). The monthly distribution of the 435,400 acre-feet is calculated on the percentage distribution of the original entitlement, and the addition of the March "flood flow waters" results in a rounded total of 447,400 acre-feet. The mediated settlement also provides for a reduction down to 415,972 acre-feet by the year 2017 and a further reduction down to 399,472 acre-feet by some future date.

Wet, Normal, and Dry-Year Water Delivery Criteria

Under current Yakima Project operations when there is a deficiency in the available water supply, senior (nonproratable) water rights are served first and shortages are assessed against junior (proratable) water rights. One of the purposes of the Storage Study is to improve the reliability of the Yakima Project water supply for proratable water rights in dry years. A water supply goal of providing no less than 70 percent of the proratable rights in dry years historically has been used in the Yakima River basin for planning purposes. This goal is also used in this appraisal assessment and is applicable to potential water exchange participants. A full water supply thus consists of the sum of all authorized nonproratable water and (a) 100 percent of the proratable water in wet and normal water years, and (b) a minimum of 70 percent of proratable water in Yakima River basin dry years.

Table 5 shows the April - October Columbia River water supply that would be provided to these two divisions in a repeat of the 1994 and 2001 Yakima Project dry years. In 1994, and again in 2001, the proratable entitlements took a 63 percent "hit" (proration) on their entitlements. This resulted in the water supply they received amounting to 37 percent of their entitlements.

Table 5. Columbia River water deliveries in repeat of 1994 and 2001 Yakima Project dry years

	Division		
Item	Roza	Sunnyside	Total
	(acre-feet)		
Water rights (April - October)			
Nonproratable	0	315,800	315,800
Proratable	375,000	119,600	494,600
Total	375,000	435,400	810,400
1994 and 2001			
With Columbia River deliveries	262,500 [1]	399,500 [2]	662,000
Actual Yakima Project deliveries	138,700	360,000	498,700

[1] 375,000 acre-feet proratable x 70 percent = 262,500 acre-feet.

[2] 119,600 acre-feet proratable x 70 percent = 83,700 acre-feet + 315,800 nonproratable = 399,500 acre-feet (rounded).

To determine how often proration would occur in the Yakima Project, simulated diversion data for 1926-1994 was obtained from the 1999 *Yakima River Basin Water Enhancement Project, Washington, Final Programmatic Environmental Impact Statement (EIS).* These data also match data presented in the September 2001 *Keechelus Dam Safety of Dams Modification Final EIS.* The model used to calculate the percent of proratable water rights met each year is based on historic streamflow and the current reservoir and diversion configurations. Based on the EIS data, proratable water rights will receive less than their full entitlement in 12 years between 1929 - 1978.

Operational Analyses

Direct Delivery Without Storage

This assessment includes an alternative of pumping directly from the Columbia River to irrigation canals serving the Roza and Sunnyside divisions. The maximum combined Sunnyside and Roza peak water right is about 2,500 cfs in June. Assuming a 2,500-cfs pumping capacity, the water supply shown in table 6 could be delivered.

Table 6. Direct delivery water supply based on 810,400-acre-foot April - October water rights

	Maximum	Average	Minimum
Amount delivered	736,800 acre-feet	437,200 acre-feet	142,600 acre-feet
Rights delivered	91 percent	54 percent	18 percent
Rights shortage	9 percent	46 percent	82 percent

Two factors make a direct delivery system not viable:

- the timing of availability of Columbia River water in excess of instream flow constraints
- the timing of water demand in the Yakima River.

In dry years, there is little Columbia River water available above flow targets to pump to Roza and Sunnyside divisions. Therefore, the water supply to these divisions must be met from the Yakima River in dry years. This impacts the viability of a potential Black Rock project.

Storage

Sizing Criteria

The water surface of a Black Rock reservoir would be between 1,200 and 1,300 feet higher than the Columbia River. Therefore, large pumps are necessary to get water up that distance. This assessment examines a Black Rock project configuration consisting of: 1) maximum active reservoir capacity with minimum pumping capacity, and 2) minimum active reservoir capacity with minimum pumping capacity, both of which meet the delivery criteria. The active capacity (figure 3) is above the reservoir outlet flow pipe intake and physically can be released and delivered to water exchange participants. The inactive capacity is unavailable to water exchange participants.

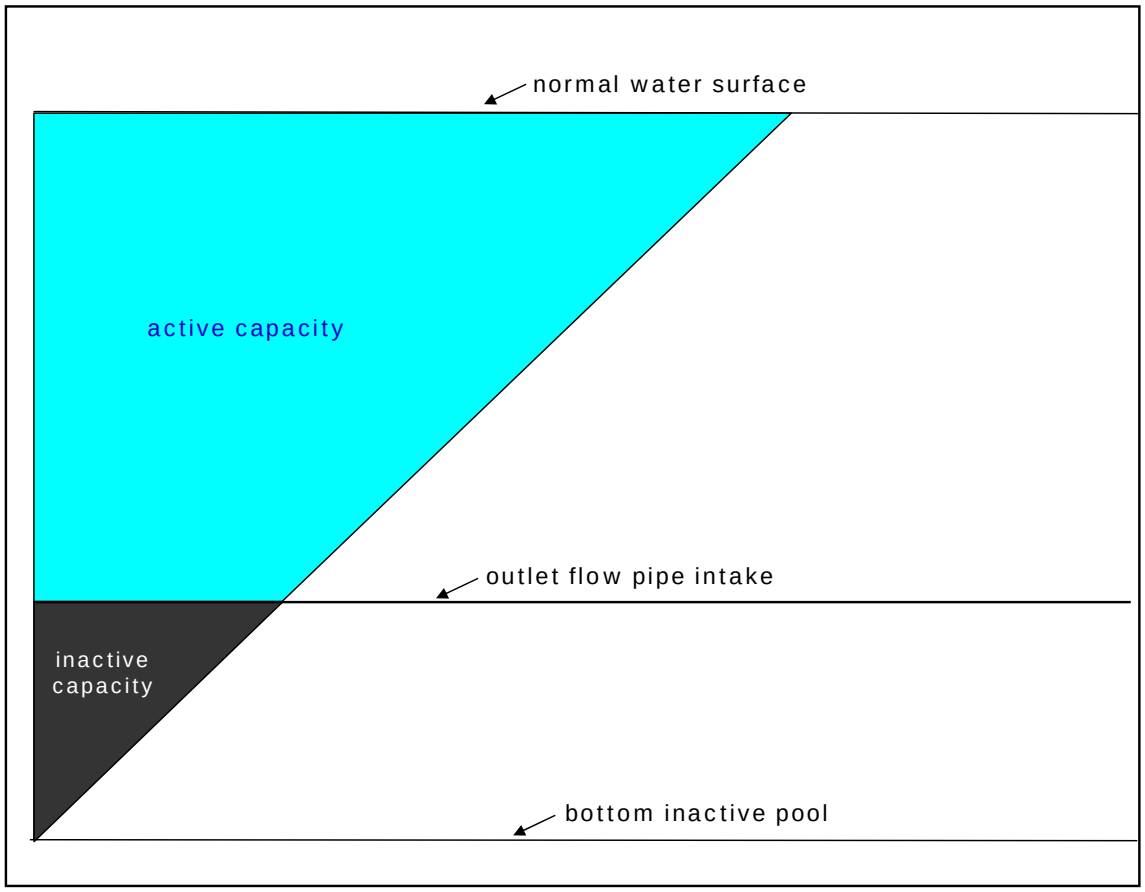

Figure 3. Active reservoir capacity for the Black Rock reservoir site

This assessment also examines two pump rate scenarios: light load hours only pumping and round-the-clock pumping. Light load hour (times of low electricity usage) pumping is assumed all day Sunday and from 10 p.m. to 6 a.m., Monday through Saturday. Pumping round the clock includes both light load and heavy load hours. Heavy load hour (times of highest electricity usage) pumping is assumed from 6 a.m. to 10 p.m., Monday through Saturday.

Maximum Active Reservoir Capacity with Minimum Pumping Capacity

Based on information contained in the WIS report, this assessment uses 1,300,000 acre-feet as the maximum active reservoir capacity. This storage capacity provides the basis for determining the lowest pump capacity required to meet the April - October, plus March flood flow, (840,400-acre-foot) water delivery criteria for the Roza and Sunnyside divisions.

This assessment examines pumping of various durations and during both heavy load and light load hours. One scenario includes water diversion during peak Columbia River runoff of April - June as assumed in the WIS report. Figure 4 shows the annual water supply of a 1,300,000-acre-

foot active capacity reservoir in relation to inflow pumping capacities. The bottom two lines indicate that with maximum pumping and diversion from the Columbia River during April - June only, the annual 840,400-acre-foot water delivery criteria (wet and normal water years) of the Roza and Sunnyside divisions cannot be met.

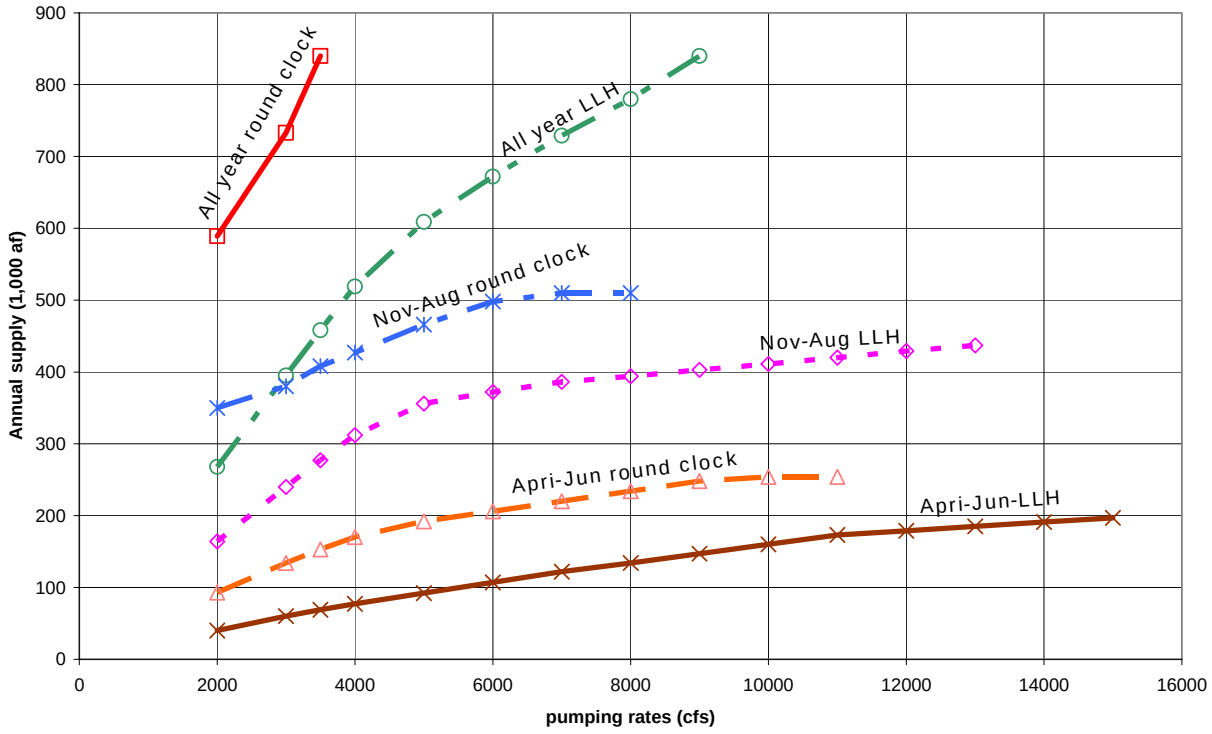

Figure 4. Annual water supply versus pumping scenarios for 1,300,000-acre-foot active capacity reservoir

Since the FCRPS power impact is likely less during November - August than for September – October[2], the November - August period for diversion was evaluated next. The middle two lines on figure 4 show the annual water supply also falls short of the delivery criteria.

Lastly, year-round diversion was considered. The top two lines on figure 4 show the results for a 1,300,000-acre-foot active capacity Black Rock reservoir. Diversion during light load hours only can meet the delivery needs with a 9,000-cfs pumping capacity. Diversion with round-the-clock pumping will require a 3,500-cfs inflow pumping capacity. A 3,500-cfs pumping capacity

[2] Because September has no flow targets and October has a low flow target, a large portion of Columbia River water can be delivered to a Black Rock reservoir during these 2 months. However, the typically low Columbia River flows during these 2 months, and adding a large power requirement for pumping during that time, could have significant power generation impacts.

and a 1,300,000-acre-foot active capacity Black Rock reservoir represents the maximum reservoir, minimum pumping capacity configuration of a Black Rock project.

While carryover storage plays a big part in this operation, pumping is required all year, round the clock when water is available from the Columbia River. Because a large reservoir can hold more unused water over the winter time, less pump capacity is necessary to meet the 840,400-acre-foot water delivery criteria.

After the inactive pool is filled, it would take 6 to 30 months to fill a 1,300,000-acre-foot active capacity reservoir with a 3,500-cfs pumping capacity. This is based on the following assumptions:

- no diversions from a Black Rock reservoir during initial fill
- Roza and Sunnyside divisions continue diverting from the Yakima River until after the first filling
- first filling uses light load hour and heavy load hour pumping round the clock when Columbia River flows are in excess of the flow targets
- seepage and evaporation losses are equal to those used in sizing the reservoir.

It is likely additional seepage losses will occur during the first fill and increase the time required to fill; however, seepage studies are incomplete at this time.

Minimum Active Reservoir Capacity with Minimum Pumping Capacity

The model output of combining various reservoir and pump capacities identifies a minimum reservoir capacity that eliminates all water delivery criteria shortages. The smaller the reservoir gets, the criteria becomes impossible to meet, regardless of pump size. This assessment identifies an 800,000-acre-foot (rounded) active capacity reservoir, as the smallest reservoir that provides sufficient carryover to meet the water delivery criteria in all 50 years based on the available Columbia River water supply.

Figure 5 shows the annual water supply of an 800,000-acre-foot active capacity reservoir in relation to inflow pumping capacities. The top line indicates that with 6,000 cfs, all year, and round-the-clock pumping, the annual 840,400-acre-foot water delivery criteria (wet and normal water years) of the Roza and Sunnyside divisions can be met. The bottom line indicates that with all year, light load hours only, pumping to an 800,000-acre-foot active capacity reservoir, the annual water supply can meet the delivery criteria with 15,500-cfs pumping capacity.

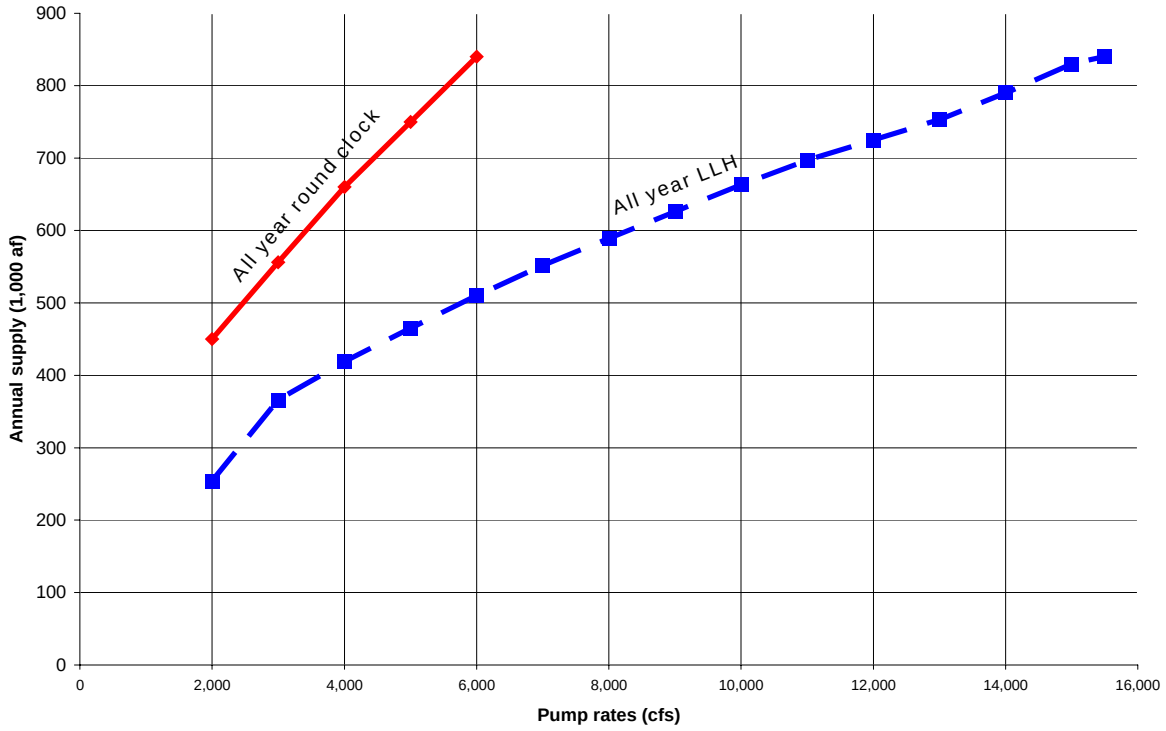

Figure 5. Annual water supply versus pumping scenarios for 800,000-acre-foot active capacity reservoir

By optimizing pumping requirements with minimum reservoir size, an 800,000-acre-foot active capacity reservoir will need year-round, 6,000-cfs pumping capacity and will take between 2 and 13 months to first fill.

Seepage and Evaporation Losses

Table 7 contains estimated evaporation and seepage losses representing uncontrolled losses from the reservoir; however, Reclamation will perform seepage studies as the Storage Study proceeds.

Table 7. Estimated seepage and evaporation losses assumed in all years

	Maximum Reservoir Capacity	Minimum Reservoir Capacity
Active reservoir capacity	1,300,000 acre-feet	800,000 acre-feet
Annual evaporation	30,100 acre-feet	23,470 acre-feet
Annual lake evaporation losses [1]	36.3 inches	36.3 inches
Annual seepage losses [2]	15,000 acre-feet	15,000 acre-feet
Total annual reservoir loss [3]	45,100 acre-feet	38,470 acre-feet

[1] Calculated from pan evaporation data from Western Regional Climate Center web page

[2] Seepage studies are incomplete at this time; therefore, Reclamation's groundwater hydrologist estimated 15,000 acre-feet for both reservoirs.

[3] Annual precipitation near the Black Rock reservoir site averages 8 inches and has no effect on pump sizes.

Supply Based on Yakima River Water Deliveries

This analysis assumes the water exchange for Roza and Sunnyside divisions is delivered entirely from a Black Rock project. The exchange is, therefore, dependent on the available Columbia River water supply. However, the proratable water delivery criteria are set based on water conditions in the Yakima River. Weather patterns vary geographically, and water supply conditions in the Yakima basin may be different from those in the Columbia Basin. While the Yakima River water supply may be plentiful, water supply conditions in the Columbia Basin, as a whole, may be below average and not always available for diversion to a Black Rock project.

Four years between 1929 - 1978 have little Columbia River water available for diversion to a Black Rock reservoir.

- In 1931, 1937, and 1945, water in excess of the flow targets is only available for diversion in September and October. In these 3 drought years, a Black Rock reservoir will need to provide carryover water for the months of April - August. Figure 6 shows actual runoff for 1945 compared to the flow targets on the Columbia River.

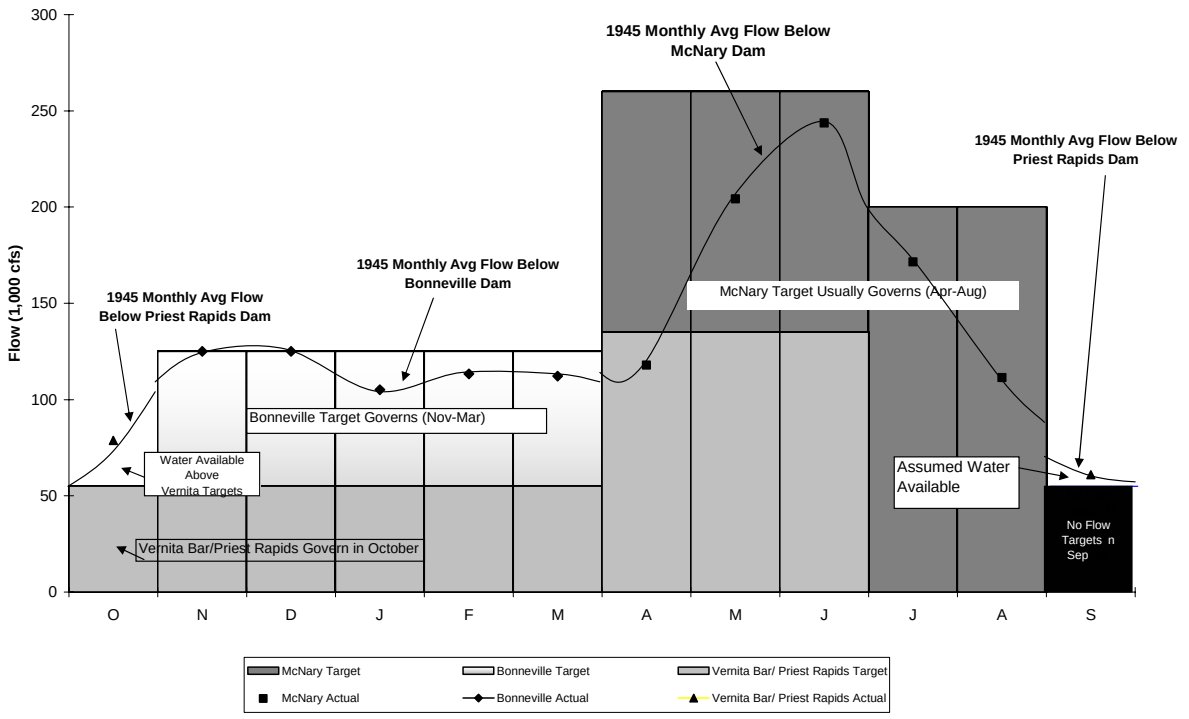

Figure 6. Actual runoff for 1945 compared to the flow targets on the Columbia River

- While the Columbia River had drought years in 1937 and 1945, these same 2 years were not drought years on the Yakima River. Since the proratable water delivery criteria are set based on the Yakima River water conditions, 100 percent of the proratable water rights from the Columbia River is required in 1937 and 1945. For assessment and modeling purposes, these 2 drought years of providing 100 percent of the criteria are the critical Columbia River water supply years.

- While 1973 has Columbia River water available for pumping for 3 months (November - January), no water is available for pumping after January, and no water is available in September. Black Rock reservoir carryover will need to supply the full water delivery criteria in April - September of 1973.

Recent droughts of concern for the Yakima River basin are 1992 - 1994 and 2001. In these years, the proratable water supply received less than 70 percent[3]. A Black Rock reservoir will provide a 70 percent proratable supply in a repeat of the foregoing years. Based on this analysis, water is available for pumping to a Black Rock reservoir in October of each year (1929 - 1978) and in September for 48 of the 50 years. Columbia River water conditions in 1992 and 1994 indicate that, at a minimum, water likely would be available during September and October both years for diversion to a Black Rock reservoir. As 1993 was not considered a drought year on the Columbia River, water likely would be available for pumping to a Black Rock reservoir after October.

[3] The 1992 proratable water supply received 58 percent; in 1993, it received 67 percent; and 37 percent in 1994 and 2001.

Carryover of Active Capacity

Pumping capacities influence the amount of critical carryover storage. A larger reservoir, with smaller pumping capacity, requires more carryover to eliminate shortages than the smaller reservoir with larger pumping capability.

Typically, reservoir water storage is highest during the winter when water is being stored. As water is released during the irrigation season, the storage decreases and the water surface lowers (table 8). Columbia River water is available for diversion to a Black Rock reservoir in September and October and often in December - March. As releases from a Black Rock reservoir will occur from April - October during the irrigation season, the storage and water surface typically will be lowest at the end of August. After the end of August, a Black Rock reservoir will start to refill.

Table 8. End-of-month reservoir contents based on meeting the water delivery criteria (1,000 acre-feet)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1,300,000-acre-foot active capacity reservoir												
Max storage	1300	1300	1300	1300	1300	1300	1300	1300	1300	1300	1223	1300
Min storage	286	284	448	446	444	626	614	480	329	175	21	123
Average storage	1103	1109	1166	1210	1224	1230	1182	1141	1081	1031	888	983
Average percent full	85	85	90	93	94	95	91	88	83	79	68	76
800,000-acre-foot active capacity reservoir												
Max storage	800	800	800	800	800	800	800	800	800	800	723	800
Min storage	393	391	677	675	673	681	591	461	316	167	20	71
Average storage	769	768	792	793	795	787	736	695	653	610	468	647
Average percent full	96	96	99	99	99	98	92	87	82	76	59	81

In 16 of 50 years, the 1,300,000-acre-foot active capacity reservoir would be full on June 1; and in 36 of 50 years, it would be more than half full by the end of August. In 19 of 50 years, the 800,000-acre-foot active capacity reservoir would be full on June 1; and in 31 of 50 years, it would be more than half full by the end of August.

Although the average annual water available is sufficient to meet the water delivery criteria, the limited pumping capacity makes it necessary in some years to use carryover Black Rock storage to meet the water delivery criteria. The Columbia Basin experienced droughts in water years 1931, 1937, and 1945, and during these years, water for diversion to a Black Rock reservoir is available only in September and October. In 1973, no water is available for a Black Rock

reservoir between January and the following October. (This is an issue only with the 800,000-acre-foot active capacity reservoir.) Tables 9 and 10 depict reservoir operations and carryover during these drought years.

Table 9. Dry year carryover based on a 1,300,000-acre-foot active capacity reservoir and 3,500-cfs pumping capacity

Period	Pumped	Released	Seepage Evaporation Losses	End-of-Month Reservoir Content
	(acre-feet)			
Aug 1930	0	119,600	5,800	475,400
Sept 1930	208,300	83,700	4,300	595,700
Oct 1930	215,200	40,800	2,900	767,200
Nov 1930 - Aug 1931	0	567,500	37,800	161,900
Sept 1931	208,300	83,700	4,300	282,200
Aug 1936	0	147,300	5,800	483,500
Sept 1936	208,300	101,900	4,300	585,600
Oct 1936	215,200	49,800	2,900	748,100
Nov 1936 - Aug 1937	0	688,700	37,800	21,600
Sept 1937	208,300	101,900	4,300	123,700
Aug 1944	0	134,400	5,800	635,400
Sept 1944	208,300	93,400	4,300	746,000
Oct 1944	215,200	45,600	2,900	912,700
Nov 1944 - Aug 1945	0	668,500	37,800	206,400
Sept 1945	208,300	98,900	4,300	311,500
Aug 1972	0	147,300	5,800	1,223,500
Sept 1972	182,700	101,900	4,300	1,300,000
Oct 1972	52,700	49,800	2,900	1,300,000
Nov 1972 - Aug 1973	5,300	607,900	37,800	659,600
Sept 1973	0	89,900	4,300	564,400

Despite 1,300,000 acre-feet of active capacity, the reservoir drafts as low as 161,900 acre-feet in August 1931, 21,600 acre-feet in August 1937, 206,400 acre-feet in August 1945, and 564,400 acre-feet in September 1973.

Table 10. Dry year carryover based on an 800,000-acre-foot active capacity reservoir and 6,000-cfs pumping capacity

Period	Pumped	Released	Seepage Evaporation Losses	End-of-Month Reservoir Content
	(acre-feet)			
Aug 1930	0	119,600	4,800	207,100
Sept 1930	357,000	83,700	3,600	476,800
Oct 1930	366,600	40,800	2,600	800,000
Nov 1930 - Aug 1931	0	567,500	32,300	200,200
Sept 1931	357,000	83,700	3,600	469,900
Aug 1936	0	147,300	4,800	344,600
Sept 1936	357,000	101,900	3,600	596,100
Oct 1936	256,300	49,800	2,600	800,000
Nov 1936 - Aug 1937	0	688,700	32,300	79,000
Sept 1937	357,000	101,900	3,600	330,500
Aug 1944	0	134,400	4,800	140,600
Sept 1944	357,000	93,400	3,600	400,600
Oct 1944	368,900	45,600	2,600	721,300
Nov 1944 - Aug 1945	0	668,500	32,300	20,500
Sept 1945	315,400	98,900	3,600	232,700
Aug 1972	79,900	147,300	4,800	724,000
Sept 1972	181,500	101,900	3,600	800,000
Oct 1972	52,400	49,800	2,600	800,000
Nov 1972 - Aug 1973	5,000	607,900	32,300	164,800
Sept 1973	0	89,900	3,600	71,300

Despite 800,000 acre-feet of active capacity, the reservoir drafts to 200,200 acre-feet in August 1931, 79,000 acre-feet in August 1937, 20,500 acre-feet in August 1945, and 71,300 acre-feet in September 1973.

Pump Sizing Analysis

All year, round-the-clock pumping during both heavy load hours and light load hours at rates between 3,500 cfs (1,300,000 acre-foot active capacity reservoir) and 6,000 cfs (800,000-acre-foot active capacity reservoir) will provide enough water to meet the water delivery criteria. Table 11 illustrates the Columbia River flow in excess of instream flow targets that is available on an annual basis. It also identifies the annual volume of water that 3,500-cfs and 6,000-cfs pumping capacities can lift to a Black Rock reservoir based on timing of Columbia River water availability. Over the 50-year period, on average about 870,000 acre-feet of Columbia River water is required for pumping to both a 1,300,000-acre-foot and an 800,000-acre-foot active capacity Black Rock reservoir.

Table 11. Annual water available versus pump capacities

Year	Annual Columbia River flow available in excess of nonpower flow targets	Annual volume of water this pumping capacity can lift to a Black Rock reservoir based on timing of Columbia River water availability	
		3,500-cfs pump	6,000-cfs pump
	(acre-feet)	(acre-feet)	(acre-feet)
1929	3,313,140	638,677	1,094,875
1930	3,050,270	621,322	1,065,123
1931	2,682,710	423,471	725,950
1932	9,322,470	1,485,619	2,270,974
1933	23,642,840	1,475,206	2,528,924
1934	46,263,410	1,898,677	3,254,874
1935	12,852,750	1,077,806	1,829,045
1936	6,113,930	762,144	1,218,342
1937	2,191,970	423,471	725,950
1938	17,665,410	1,541,236	2,599,913
1939	4,247,990	853,884	1,441,727
1940	7,143,300	1,246,460	1,965,395
1941	5,213,940	853,884	1,463,801
1942	12,173,530	1,438,075	2,264,231
1943	25,741,140	2,113,883	3,623,800
1944	4,012,070	727,650	1,183,848
1945	1,777,420	423,471	725,950
1946	18,180,670	1,840,730	2,948,244
1947	23,809,800	1,697,354	2,776,568
1948	42,527,780	2,194,868	3,704,785
1949	17,876,560	1,586,280	2,719,337
1950	32,895,410	2,051,463	3,258,901
1951	46,043,130	2,113,883	3,623,800
1952	24,493,620	1,898,677	3,254,874
1953	16,681,890	1,658,931	2,712,649
1954	35,123,390	2,090,617	3,526,153
1955	21,289,230	1,381,493	2,368,269
1956	53,461,460	2,322,148	3,980,824
1957	21,885,400	1,596,693	2,737,189
1958	17,477,270	1,690,412	2,897,850
1959	37,488,180	2,218,015	3,802,312
1960	25,100,320	2,106,941	3,611,899
1961	26,570,130	2,002,809	3,433,387
1962	7,820,920	906,339	1,511,297
1963	15,037,560	1,516,218	2,569,936
1964	18,295,550	1,475,206	2,528,924
1965	42,059,270	2,272,878	3,657,053
1966	10,624,300	1,473,288	2,326,537
1967	27,829,880	1,794,544	3,076,362
1968	21,331,250	1,898,677	3,118,312
1969	34,275,740	2,291,711	3,796,669
1970	13,506,170	1,475,206	2,528,924
1971	39,903,440	1,905,619	3,266,775
1972	59,333,340	2,112,515	3,548,051
1973	9,646,170	958,016	1,642,313
1974	63,109,870	1,905,619	3,266,775
1975	24,269,530	2,009,751	3,395,929
1976	47,198,410	2,219,622	3,729,538
1977	4,434,250	958,016	1,586,544
1978	17,212,700	1,801,487	3,088,263

Table 12 shows that September and October pumping can provide a large volume of water for a Black Rock project. However, reservoir losses in the form of diversions, seepage, and evaporation, can prevent filling the reservoir in those 2 months. The net benefit from pumping is 261,200 acre-feet with a 3,500-cfs pumping capacity and 562,100 acre-feet with a 6,000-cfs pumping capacity. In 3 of 50 years, no water is available the rest of the year. Refill is at risk without September - October pumping.

Table 12. Maximum September - October pumping capability

	Maximum Reservoir - Minimum Pumping Capacity	Minimum Reservoir - Minimum Pumping Capacity
Pump capacity	3,500 cfs	6,000 cfs
Daily capability	7,000 acre-feet	12,000 acre-feet
Monthly (30-day) capability	210,000 acre-feet	360,000 acre-feet
September - October capability	420,000 acre-feet	720,000 acre-feet
Seepage and evaporation September - October	7,100 acre-feet	6,200 acre-feet
Reservoir releases September - October	151,670 acre-feet	151,670 acre-feet
Storable water for following year	261,200 acre-feet	562,100 acre-feet

Further Investigations

As the storage study proceeds, Reclamation will further investigate factors related to the availability of Columbia River water for pumping to a proposed Black Rock reservoir and the potential effects of such withdrawal on other uses and water users. These investigations will include, but are not limited to:

- Effects of hydroelectric generation at Priest Rapids Dam and at other Columbia River hydroelectric generating facilities.
- Opportunities for including pump generation as a project element to offset operating costs.
- Operational measures which may potentially benefit fishery flow regimes in the Hanford Reach.
- Recognition of the need to acquire State authorization to appropriate Columbia River water and to evaluate the conditions of such authorization which may result from the findings of the Columbia River Initiative.

Assumptions Used for this Assessment

The following list identifies the primary assumptions Reclamation used in its hydrology model and appraisal assessment of Columbia River water availability for a potential Black Rock project.

- The only water available for diversion by a potential Black Rock project is in excess of seasonal instream flow targets established in the December 2000 FCRPS BIOP and flow objectives for nonlisted salmon downstream from Priest Rapids Dam at Vernita Bar.
- Governing flow targets are:
  October; 55,000 cfs at Priest Rapids Dam at Vernita Bar
  November - April; 125,000 cfs at Bonneville Dam
  April 10 - June 30; 135,000 cfs at Priest Rapids Dam
  April - June; 260,000 cfs at McNary Dam
  July - August; 200,000 cfs at McNary Dam
  September; although technically no requirement, assumed 55,000 cfs at Priest Rapids Dam at Vernita Bar.
- A Reclamation "irrigation" water year runs from October 1 through September 30.
- The monthly average water supply is available for each day of the month.
- The 1930s and 1940s are the controlling "dry years" of the Columbia River water supply.
- The Roza and Sunnyside water exchange is delivered entirely from a Black Rock project.
- Potential exchange facilities should have adequate capacity to deliver the peak water rights.
- The water rights include flood flow waters which each division is entitled to divert based on availability. These waters are diverted in March.
- The Yakima River water right entitlements of the Roza and Sunnyside divisions (shown in table 4) represent monthly and annual water exchange deliveries to meet the annual Columbia River diversion and to effect a water exchange.
- A full water supply consists of the sum of all authorized nonproratable water and (a) 100 percent of the proratable water in wet and normal water years, and (b) a minimum of 70 percent of proratable water in dry years.
- The maximum peak water right used in this assessment is approximately 2,500 cfs in June.
- Light load hour pumping is assumed all day Sunday and from 10 p.m. to 6 a.m., Monday through Saturday.
- Pumping round the clock includes both light load and heavy load hours.
- Heavy load hour pumping is assumed from 6 a.m. to 10 p.m., Monday through Saturday.
- No diversions from a Black Rock reservoir occur during initial fill.
- Roza and Sunnyside divisions continue diverting from the Yakima River until after the first filling.
- First filling uses light load hour and heavy load hour pumping round the clock when Columbia River flows are in excess of the flow targets.
- Seepage and evaporation losses during first fill are equal to those used in sizing the reservoir.

- Seepage and evaporation losses are the same in all years.
- Seepage studies are incomplete at this time; therefore, Reclamation's groundwater hydrologist estimated a 15,000-acre-foot seepage loss from both reservoir capacities.
- When water was available for pumping, and when Black Rock reservoir was less than full, pumps will operate to capacity to refill the reservoir.