The Effect of Draining Lake Powell on Water Supply and Electricity Production

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Summary

The recent proposal to restore Glen Canyon by draining Lake Powell has caused public concern over the Colorado River's ability to provide water to the desert southwest, and sharp rebuke from public agencies and water users[1]. It is unlikely that the proposal's proponents and opponents will ever agree specifically whether draining Lake Powell would be in the public interest nor generally on a method to compare the benefits of a restored or preserved wilderness canyon with those of developed supplies of water and power. The purpose of this study is not to address these more complicated issues, but simply to estimate the impact of draining Lake Powell to water and hydropower users.

The impact to deliveries of water from the Colorado River to users in the United States and Mexico as a result of the proposal to drain Lake Powell, which would leave only Lake Mead as the lower river's principal storage facility, can be estimated by performing comparative simulations using computer-based hydrologic operations models. The Bureau of Reclamation's CRSSEZ model, coupled with its historical hydrologic records, is easily suited to the task. For the purpose of this study, CRSSEZ was run twice; first to model a "Current Operations" scenario, and second to model a "Drain Lake Powell" scenario. CRSSEZ not only projects deliveries to the Upper and Lower Basin States[2], but also flows to Mexico, reservoir evaporation and hydropower generation.

The delivery of water to the Upper Basin States does not change between the two scenarios. Average annual deliveries to the Lower Basin States are 91 thousand acre-feet (TAF) less under the *Drain Lake Powell* scenario than under the *Current Operations* scenario, or a little over 1% of the average annual delivery of 7926 TAF. That this difference is so small may not be surprising, as Lake Mead remains downstream, still providing 25 million acre-feet (MAF)[3] of storage on a river where the average annual inflow into the Lower Basin is less than 11 MAF.

Significantly larger projected average annual hydrologic differences include a reduction in losses due to evaporation of 445 TAF/year (37% of the total evaporation at Mead and Powell in the *Current Operations* scenario) and an average increase in flow of 444 TAF/year (21% of projected flows under the *Current Operations* scenario) to Mexico, either for consumptive use or for environmental flows to the usually dry Colorado River Delta. A summary of the average annual hydrologic differences between the two scenarios is shown in Figure 1.

The average reduction in hydroelectric power generation would be 4551 gigawatt-hours (GWh), approximately 3% of total electricity consumption in the four state area (Colorado, Utah, Arizona and New Mexico) where most of Glen Canyon's power is consumed.

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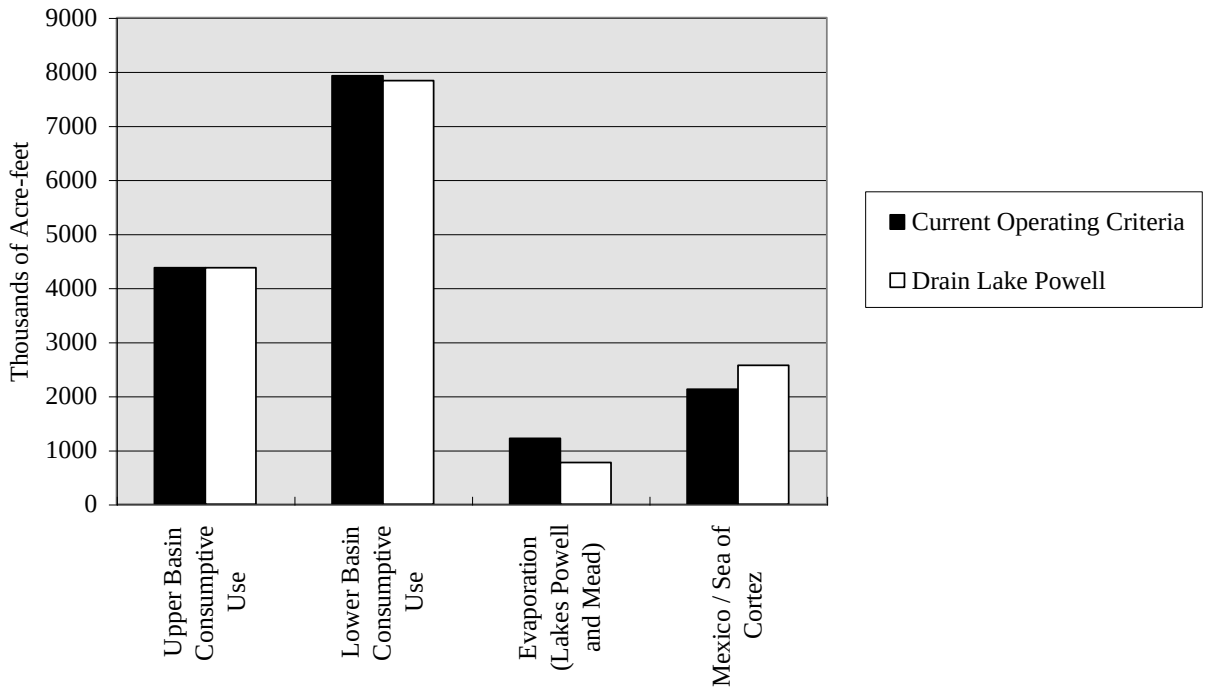
[1]" It's so foolish, with such incredible repercussions, that it's hard to take it seriously. " (Ted Stewart, Utah Department of Natural Resources). "The impact would be catastrophic." (Wayne Cook, Upper Colorado Basin Commission) (San Francisco Examiner, August 24, 1997)

[2] The Colorado River compact defines the Upper Basin as Colorado, New Mexico, Utah and Wyoming, and the Lower Basin as Arizona, California and Nevada.

[3] Lake Mead's total capacity in 2050, with expected sedimentation of 56 TAF per year, is estimated to be 24.797 MAF.

Figure 1

Comparative Average Annual Hydrologic Volumes



The CRSSEZ Model

A CRSSEZ simulation projects how the lower Colorado River system would be operated according to a particular set of rules, assumed future demand levels, and a repetition of historic hydrologic conditions. For the purposes of this study, the default set of rules provided by the Bureau of Reclamation was used, including a 54 year study period lasting from 1997 until 2050. This study uses the historic hydrologic runoff data from the 90 year period 1906-1995, which was provided by the Bureau along with the CRSSEZ model.

Each model run normally consists of several "traces". Each trace is modeled by projecting operations during the study period while assuming that a series of consecutive years of the hydrologic data is repeated. For this study, all available traces, beginning in each of the 90 years from 1906 until 1995, were used to simulate a 54 year period. Thus, each model run includes 4680 (90 times 54) years of simulation.

The Bureau's default assumptions include demands in the Upper and Lower Basins, as well as deliveries to Mexico. Demands in the Upper Basin increase from 3813 TAF in 1997 to 5238 TAF by 2050, and are equally met under both scenarios. Lower Basin demands are 7500 TAF in every year, although in many years either a surplus or a shortage occurs. An annual obligation of 1515 TAF for delivery to Mexico is assumed.

CRSSEZ models reservoir storage in three locations, (1) Upper Basin reservoirs, (2) Lake Powell, and (3) Lake Mead. Surplus flows from Lake Mead are released when the reservoir is nearly full. CRSSEZ shows these releases as more than 1515 TAF going to Mexico.

Evaporation at Lakes Powell and Mead increases with reservoir elevation. Even with no storage, Lake Powell is assumed to lose 81 TAF/year to "evaporation". Power generation at Glen Canyon and Hoover Dams depends on the product of release volume and reservoir head (the elevation of the water surface above the powerplant).

A summary of the criteria used for the simulations, in the form of CRSSEZ input screens, is provided in Appendix 1.

Two changes were made to the input data in CRSSEZ to model the effect of draining Lake Powell. First, the target and initial storage elevations for Lake Powell are set to 3370 feet, or the bottom of the Dam.

The only other change made to CRSSEZ's input files is the assumed extra sedimentation in Lake Mead (beyond that embedded in the model) as a result of draining Lake Powell, which reduces storage in Lake Mead by 2222 TAF. This amount reflects the accumulation of sediment over the 87 year period from 1963 until 2050 at the rate of 26 TAF/year. The total amount would be not realized until the end of the study period and only if no sediment was left behind in the Grand Canyon. The reservoir elevation and capacity data used to run each scenario are provided in Appendix 2.

Hydrologic Results

On average, the *Drain Lake Powell* scenario reduces deliveries to the Lower Basin by only 91 TAF/year, approximately 1.15% of all Lower Basin deliveries. The Colorado River's ability to meet Upper Basin obligations does not depend on whether Lake Powell is drained.

As a result of reduced evaporation and total system storage, flows to Mexico are projected to exceed annual volumes of 1515 TAF in 35% of all years if Lake Powell is drained compared to only 22% of all years under the *Current Operations* scenario. Presumably, some portion of these *excess* flows would be diverted for consumptive use within Mexico, and the rest would flow through the Colorado River Delta and into the Sea of Cortez.

Table 1 presents average annual summaries of deliveries for Upper and Lower Basin consumptive use, evaporation from Lakes Powell and Mead and flows to Mexico.[1]

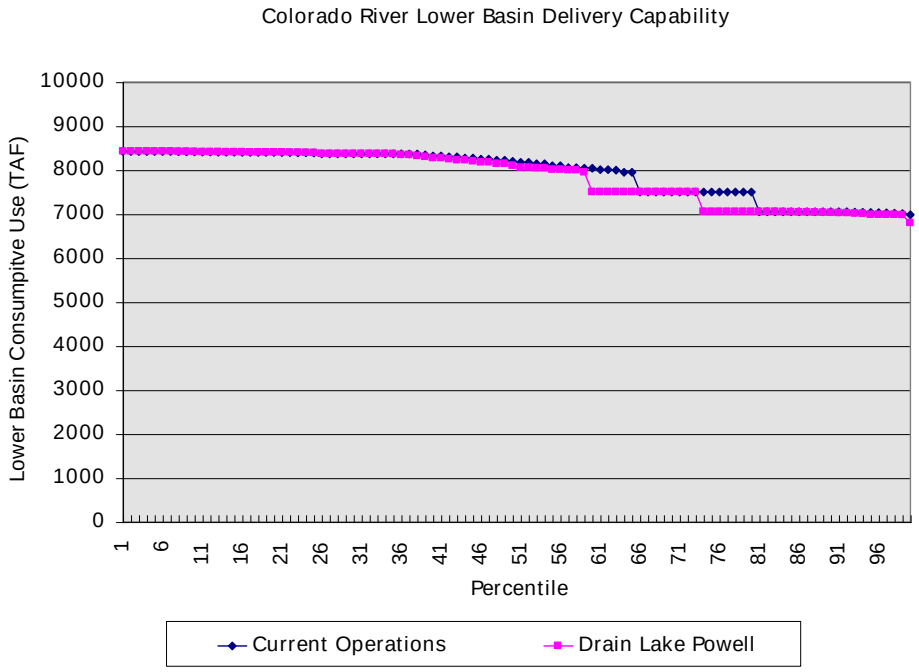
[1] The differences do not sum to zero, principally because the initial storage level in Lake Powell is set to zero under the Drain Lake Powell Scenario.

Table 1
Average Annual Hydrologic Volumes
(all values in TAF)

	Upper Basin Consumptive Use	Lower Basin Consumptive Use	Evaporation (Lakes Powell and Mead)	Mexico / Sea of Cortez
Current Operating Criteria	4374	7926	1218	2125
Drain Lake Powell	4374	7835	773	2568
Difference	0	91	445	-444

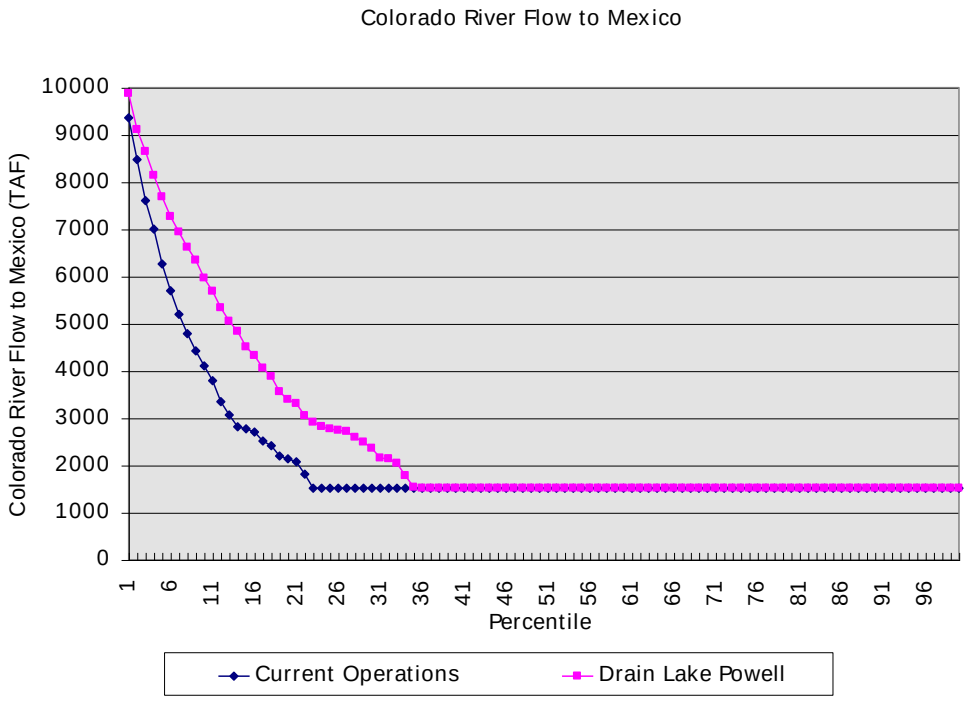
While Table 1 shows only a 1% effect on Lower Basin deliveries on average, in extreme cases the impact can be greater. CRSSEZ projects, in the *Current Operations* scenario, that shortages[1] in deliveries for Lower Basin consumptive use, averaging 459 TAF, occur in 20% of all years. In the *Drain Lake Powell* scenario, the frequency of shortage increases to 27%, and the average shortage to 498 TAF. In addition, while the *Drain Lake Powell* scenario projects higher average flows to Mexico, the obligation of 1515 TAF is not fully met in 19 of the 4680 years of simulation. Figures 2 and 3 show comparative cumulative frequency volumes for Lower Basin consumptive use and flows to Mexico respectively.

Figure 2



[1] A shortage in Lower Basin consumptive use is defined as the delivery o f less than 7.5 MAF.

Figure 3



A tabular summary of both scenarios is included as Appendix 3. A complete set of input and output files, including a spreadsheet summary in Excel format, is available on diskette from the Environmental Defense Fund upon request.

Hydropower Results

The total loss of hydropower generation as a result of draining Lake Powell is projected to be 4551 GWh/year, about 3% of the 166,249 GWh generated in the four state area (Colorado, Utah, Arizona and New Mexico) where most of Glen Canyon Dam's power is consumed.[1] The estimated annual cost to the federal treasury, using the federal "firm" power rate or $.0217/kWh, would be $M 98.7, or about 37 cents per person for each of the 268 million residents of the United States.[2]

Most power users in the southwest would not be affected by the loss of hydropower, because only selected regional utilities qualify as "preference" customers for federal hydropower. Because the hydropower generated at Glen Canyon Dam is sold at below-market rates, these preference customers may be forced to pay more for replacement power. Those customers whose electricity includes a high percentage of the low-cost Glen Canyon hydropower would bear the greatest financial burden.

[1] Energy Information Administration, Net Generation from U.S. Electric Utilities by Energy Source, Census Division, and State, 1995 and 1996.

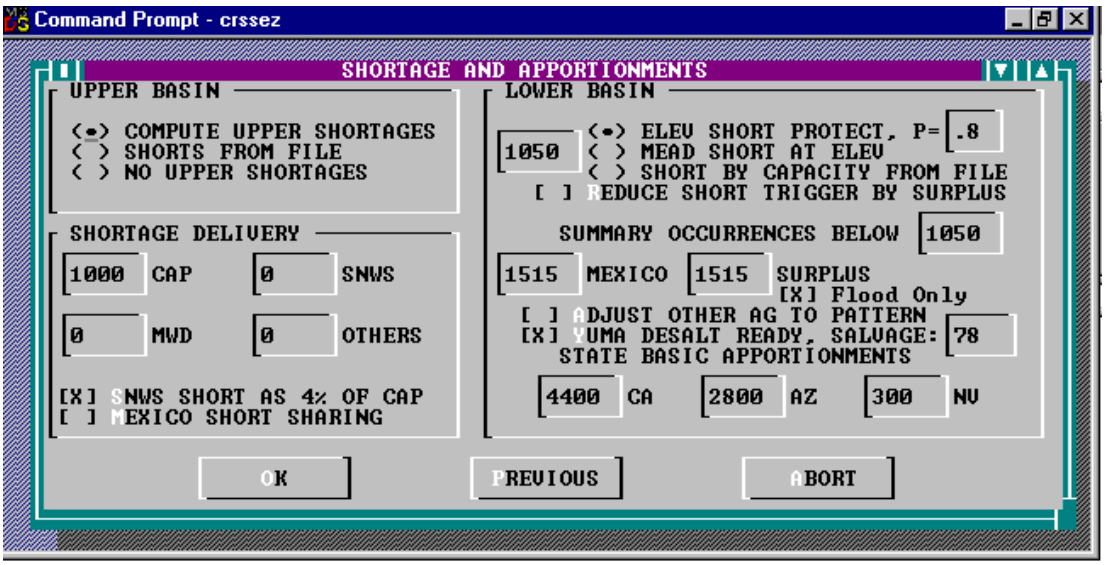
[2] Not all Glen Canyon hydropower is sold as "firm" , and the federal government purchases some of the firm power which it does sell rather than generate it at its hydroelectric facilities.

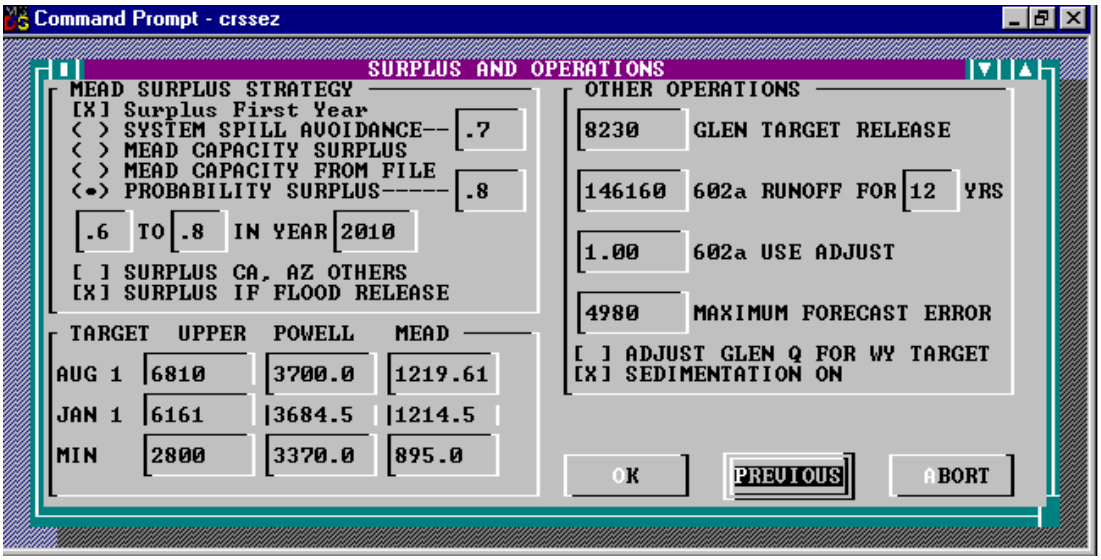
Likely, the power not generated at Glen Canyon would be replaced by power from a combination of sources, and would include an increase in the combustion of fossil fuels. Further analysis would be necessary to assess the environmental impacts from these additional sources.

Conclusion

While the analysis presented in this study is by no means comprehensive, it does suggest that draining Lake Powell would not result in unmanageable impacts to water deliveries or to hydropower. The Colorado River is the major source of water for many in the Southwest, but Glen Canyon Dam provides little incremental benefit to regional water supply reliability. While draining Lake Powell would significantly reduce the amount of hydropower produced at federal facilities on the Colorado River, this power is only a small part of the total production of electricity in the Southwest. A comprehensive study of the all of the effects of the proposal to drain Lake Powell, including those on water delivery and electricity production, is clearly warranted so the public and their elected representatives can best decide how to manage this section of the Colorado River.

Appendix 1
CRSSEZ Default Parameters


Command Prompt - crssez
SHORTAGE AND APPORTIONMENTS
UPPER BASIN
(•) COMPUTE UPPER SHORTAGES
( ) SHORTS FROM FILE
( ) NO UPPER SHORTAGES
SHORTAGE DELIVERY
1000 CAP
0 SNWS
0 MWD
0 OTHERS
[X] SNWS SHORT AS 4% OF CAP
[ ] MEXICO SHORT SHARING
LOWER BASIN
1050
(•) ELEV SHORT PROTECT, P= .8
( ) MEAD SHORT AT ELEV
( ) SHORT BY CAPACITY FROM FILE
[ ] REDUCE SHORT TRIGGER BY SURPLUS
SUMMARY OCCURRENCES BELOW 1050
1515 MEXICO 1515 SURPLUS
[X] Flood Only
[ ] ADJUST OTHER AG TO PATTERN
[X] YUMA DESALT READY, SALVAGE: 78
STATE BASIC APPORTIONMENTS
4400 CA 2800 AZ 300 NV
OK
PREVIOUS
ABORT


Command Prompt - crssez
SURPLUS AND OPERATIONS
MEAD SURPLUS STRATEGY
[X] Surplus First Year
( ) SYSTEM SPILL AVOIDANCE-- .7
( ) MEAD CAPACITY SURPLUS
( ) MEAD CAPACITY FROM FILE
(•) PROBABILITY SURPLUS----- .8
.6 TO .8 IN YEAR 2010
[ ] SURPLUS CA, AZ OTHERS
[X] SURPLUS IF FLOOD RELEASE
TARGET UPPER POWELL MEAD
AUG 1 6810 3700.0 1219.61
JAN 1 6161 3684.5 1214.5
MIN 2800 3370.0 895.0
OTHER OPERATIONS
8230 GLEN TARGET RELEASE
146160 602a RUNOFF FOR 12 YRS
1.00 602a USE ADJUST
4980 MAXIMUM FORECAST ERROR
[ ] ADJUST GLEN Q FOR WY TARGET
[X] SEDIMENTATION ON
OK
PREVIOUS
ABORT


Command Prompt - crssez
RESERVOIR STARTING CONDITIONS
CONTENTS, KAF
382 OTHERS
53 TAYLOR PARK
183 FONTENELLE
583 BLUE MESA
3262 FLAMING GEORGE
1186 NAVAJO
ELEVATION, FEET
3674.83 POWELL
1194.06 MEAD
Jan1,1997 from 24mo Nov 15
Cap Table
OK
SAVE
PREVIOUS
ABORT

Appendix 2

Current Operations Scenario

ELEVATION CAPACITY AREA TABLE ADJUSTED FOR SEDIMENT

powell 1986 sed. table			mead 1984 sed. table		
3370	0	20.4	895	0	28.8
3370.1	2	20.5	895.1	3	28.9
3380	212.03	22.1	900	147	30.0
3390	442.95	24.08	910	458	32.3
3400	693.67	26.06	920	757	34.6
3410	964.24	28.05	930	1115	36.9
3420	1254.73	30.05	940	1465	39.1
3430	1566.82	32.37	950	1868	41.6
3440	1902.17	34.7	960	2297	44.2
3450	2263.32	37.53	970	2706	46.7
3460	2652.77	40.36	980	3185	49.1
3470	3071.17	43.32	990	3658	51.6
3480	3519.13	46.28	1000	4190	54.8
3490	3997.16	49.33	1010	4755	58.1
3500	4505.73	52.39	1020	5306	61.2
3510	5047.32	55.93	1030	5933	64.3
3520	5624.36	59.48	1040	6562	67.4
3530	6238.44	63.34	1050	7255	71.2
3540	6891.18	67.21	1060	7958	75.1
3550	7585.18	71.59	1070	8727	78.6
3560	8323.05	75.98	1080	9531	82.2
3570	9107.08	80.82	1090	10329	85.6
3580	9939.53	85.67	1100	11205	89.5
3590	10820.5	90.53	1110	12120	93.5
3600	11750.07	95.39	1120	13038	97.4
3610	12730.3	100.66	1130	14034	101.7
3620	13763.23	105.93	1140	15054	105.9
3630	14852.83	111.99	1150	16133	111.6
3640	16003.05	118.05	1160	17285	118.7
3650	17215.71	124.48	1170	18498	125.6
3660	18492.58	130.9	1180	19787	132.3
3670	19838.44	138.27	1190	21140	138.8
3680	21258.04	145.65	1200	22559	145.0
3690	22752.35	153.22	1210	24039	151.1
3700	24322.34	160.78	1220	25580	157.2
3710	25971.4	169.03	1229	27019	162.6

Appendix 2

Drain Lake Powell Scenario

ELEVATION CAPACITY AREA TABLE ADJUSTED FOR SEDIMENT

powell 1986 sed. table			mead 1984 sed. table		
3370	0	20.4	895	0	28.8
3370.1	2	20.5	895.1	3	28.9
3380	212.03	22.1	900	119	30.0
3390	442.95	24.08	910	372	32.3
3400	693.67	26.06	920	615	34.6
3410	964.24	28.05	930	905	36.9
3420	1254.73	30.05	940	1189	39.1
3430	1566.82	32.37	950	1517	41.6
3440	1902.17	34.7	960	2108	44.2
3450	2263.32	37.53	970	1865	46.7
3460	2652.77	40.36	980	2923	49.1
3470	3071.17	43.32	990	3357	51.6
3480	3519.13	46.28	1000	3845	54.8
3490	3997.16	49.33	1010	4364	58.1
3500	4505.73	52.39	1020	4870	61.2
3510	5047.32	55.93	1030	5445	64.3
3520	5624.36	59.48	1040	6022	67.4
3530	6238.44	63.34	1050	6658	71.2
3540	6891.18	67.21	1060	7304	75.1
3550	7585.18	71.59	1070	8009	78.6
3560	8323.05	75.98	1080	8747	82.2
3570	9107.08	80.82	1090	9480	85.6
3580	9939.53	85.67	1100	10284	89.5
3590	10820.5	90.53	1110	11123	93.5
3600	11750.07	95.39	1120	11966	97.4
3610	12730.3	100.66	1130	12880	101.7
3620	13763.23	105.93	1140	13816	105.9
3630	14852.83	111.99	1150	14806	111.6
3640	16003.05	118.05	1160	15864	118.7
3650	17215.71	124.48	1170	16977	125.6
3660	18492.58	130.9	1180	18160	132.3
3670	19838.44	138.27	1190	19401	138.8
3680	21258.04	145.65	1200	20704	145.0
3690	22752.35	153.22	1210	22062	151.1
3700	24322.34	160.78	1220	23476	157.2
3710	25971.4	169.03	1229	24797	162.6

Current Operations Scenario

YR	RUNOF	UBCU	USHRT	UPRES	P_IN	P_CON	P_EVP	P_REL	M_IN	M_CON	M_EVP	BGAIN	LBCU	MEX	G_GWH	H_GWH	P_ELEV	M_ELEV
1997	15040	3697	116	5828	10978	20539	562	10387	11244	21537	915	-366	7948	2196	4754	4873	3675	1193
1998	15040	3714	118	5841	11118	20302	559	10788	11645	21317	908	-366	7996	2578	4927	5080	3673	1191
1999	15040	3741	121	5816	11129	20035	555	10836	11692	21024	899	-366	8039	2670	4939	5129	3671	1189
2000	15040	3809	127	5791	11062	19770	550	10771	11628	20711	889	-366	8008	2667	4897	5073	3669	1186
2001	15040	3833	129	5756	11048	19440	544	10833	11689	20424	880	-366	8054	2665	4911	5071	3667	1184
2002	15040	3858	130	5709	11038	19135	538	10802	11658	20069	870	-366	8098	2672	4881	5073	3665	1182
2003	15040	3882	132	5671	11005	18847	532	10757	11614	19721	859	-366	8143	2585	4846	5022	3662	1179
2004	15040	3907	133	5632	10983	18592	527	10704	11561	19412	849	-366	8173	2473	4811	4960	3661	1177
2005	15040	3932	134	5599	10953	18306	522	10712	11569	19107	840	-366	8198	2460	4801	4951	3658	1174
2006	15040	3971	136	5571	10910	18034	517	10661	11517	18838	831	-366	8222	2355	4764	4894	3656	1172
2007	15040	4010	138	5540	10874	17743	511	10650	11507	18522	823	-366	8247	2377	4744	4905	3654	1170
2008	15040	4048	140	5508	10839	17459	506	10613	11469	18222	814	-366	8262	2318	4711	4866	3652	1167
2009	15040	4088	141	5470	10805	17171	500	10588	11445	17887	805	-365	8288	2315	4685	4861	3650	1164
2010	15040	4127	143	5440	10760	16886	495	10546	11403	17520	794	-364	8312	2294	4650	4844	3647	1161
2011	15040	4149	144	5402	10746	16602	489	10537	11393	17230	784	-363	8295	2231	4630	4786	3645	1159
2012	15040	4171	144	5367	10723	16339	484	10496	11353	16911	775	-360	8328	2201	4596	4767	3643	1156
2013	15040	4193	145	5333	10700	16112	479	10440	11297	16590	766	-360	8282	2201	4557	4728	3641	1153
2014	15040	4214	146	5309	10670	15911	475	10386	11243	16214	756	-360	8260	2239	4520	4718	3639	1150
2015	15040	4237	146	5275	10658	15720	471	10368	11224	15950	748	-357	8200	2172	4500	4636	3638	1147
2016	15040	4258	147	5250	10629	15571	468	10296	11153	15701	740	-352	8191	2107	4458	4578	3636	1145
2017	15040	4280	148	5219	10612	15416	465	10288	11145	15453	733	-350	8158	2139	4446	4564	3635	1143
2018	15040	4302	148	5200	10581	15284	463	10235	11092	15243	727	-347	8143	2071	4415	4504	3634	1140
2019	15040	4324	149	5167	10572	15197	461	10178	11035	15024	722	-346	8089	2085	4383	4440	3634	1138
2020	15040	4345	150	5148	10539	15140	460	10115	10972	14791	716	-342	8097	2038	4351	4300	3633	1136
2021	15040	4360	150	5133	10520	15089	459	10091	10948	14574	710	-339	8049	2054	4337	4236	3633	1134
2022	15040	4375	150	5119	10505	15054	459	10058	10915	14415	705	-333	8011	2008	4321	4076	3633	1133
2023	15040	4388	151	5104	10492	15027	459	10037	10894	14274	701	-327	7964	2024	4311	4088	3633	1131
2024	15040	4403	151	5085	10482	15034	459	9989	10846	14152	698	-319	7945	1987	4289	4012	3633	1130
2025	15040	4418	151	5074	10460	15034	460	9974	10831	14078	695	-315	7916	1957	4284	3974	3633	1129
2026	15040	4432	152	5066	10443	15034	460	9958	10814	13945	693	-314	7918	2004	4278	3960	3633	1128
2027	15040	4447	152	5056	10429	15042	461	9935	10791	13857	690	-312	7876	1980	4268	3883	3634	1127
2028	15040	4461	152	5046	10417	15063	462	9907	10764	13781	688	-310	7869	1950	4258	3824	3634	1126
2029	15040	4475	153	5037	10401	15082	462	9892	10749	13665	686	-308	7866	1985	4254	3767	3634	1125
2030	15040	4490	153	5032	10382	15104	463	9870	10717	13589	684	-308	7827	1954	4246	3764	3635	1124
2031	15040	4508	154	5022	10369	15146	465	9834	10680	13472	682	-307	7828	1962	4233	3766	3635	1123
2032	15040	4527	154	5014	10348	15169	466	9831	10678	13369	679	-306	7804	1973	4235	3754	3636	1122
2033	15040	4546	154	5005	10332	15215	467	9789	10635	13265	676	-305	7811	1928	4219	3692	3637	1121
2034	15040	4564	155	4998	10310	15244	468	9785	10631	13120	673	-304	7777	2006	4221	3675	3637	1119
2035	15040	4583	155	4991	10292	15312	470	9723	10570	12983	669	-302	7748	1971	4197	3568	3638	1118
2036	15040	4601	156	4989	10268	15386	472	9691	10537	12915	666	-301	7704	1913	4187	3443	3639	1117
2037	15040	4620	156	4991	10246	15434	474	9695	10541	12779	663	-301	7710	1987	4194	3492	3639	1115
2038	15040	4639	156	4995	10225	15465	475	9690	10537	12684	660	-300	7692	1961	4196	3466	3640	1113
2039	15040	4657	157	4996	10210	15519	476	9649	10495	12592	657	-299	7673	1940	4180	3443	3640	1112
2040	15040	4676	157	4996	10191	15579	478	9622	10469	12440	653	-297	7652	2004	4173	3428	3641	1110
2041	15040	4716	158	5001	10147	15638	480	9576	10423	12350	650	-296	7616	1932	4156	3376	3642	1109
2042	15040	4755	159	4995	10117	15650	481	9597	10443	12311	648	-295	7596	1921	4168	3325	3642	1108
2043	15040	4796	159	4982	10084	15717	483	9503	10350	12231	646	-294	7570	1901	4128	3265	3643	1107
2044	15040	4835	160	4966	10049	15762	484	9490	10337	12148	644	-293	7549	1914	4126	3260	3643	1106
2045	15040	4875	161	4949	10009	15779	485	9480	10326	12054	642	-290	7544	1927	4124	3263	3643	1105
2046	15040	4915	161	4930	9972	15781	486	9458	10305	11998	640	-289	7509	1901	4115	3195	3643	1104
2047	15040	4955	162	4905	9939	15786	487	9421	10268	11936	639	-289	7504	1879	4098	3214	3643	1104
2048	15040	4995	162	4880	9900	15756	487	9421	10267	11845	637	-288	7493	1921	4097	3193	3643	1103
2049	15040	5035	163	4854	9861	15713	486	9395	10242	11757	635	-288	7483	1907	4084	3212	3643	1102
2050	15040	5074	164	4826	9825	15642	485	9390	10237	11710	633	-288	7478	1864	4078	3182	3642	1102

Drain Glen Canyon Scenario

YR	RUNOF	UBCU	USHRT	UPRES	P_IN	P_CON	P_EVP	P_REL	M_IN	M_CON	M_EVP	BGAIN	LBCU	MEX	G_GWH	H_GWH	P_ELEV	M_ELEV
1997	15040	3697	116	5900	10909	0	81	10828	11685	18889	899	-366	7948	3570	0	5591	3370	1185
1998	15040	3714	118	5902	11129	0	81	11048	11905	18237	869	-366	7996	3340	0	5430	3370	1179
1999	15040	3741	121	5910	11095	0	81	11014	11871	17520	845	-366	8039	3354	0	5409	3370	1172
2000	15040	3809	127	5908	11037	0	81	10956	11813	16995	825	-366	8002	3149	0	5217	3370	1167
2001	15040	3833	129	5907	11012	0	81	10931	11788	16572	809	-365	8023	3012	0	5079	3370	1163
2002	15040	3858	130	5904	10989	0	81	10908	11764	16023	793	-362	8053	3112	0	5107	3370	1158
2003	15040	3882	132	5895	10971	0	81	10890	11747	15546	777	-360	8047	3043	0	5028	3370	1153
2004	15040	3907	133	5887	10945	0	81	10865	11721	15193	764	-354	8068	2882	0	4921	3370	1149
2005	15040	3932	134	5880	10920	0	81	10840	11696	14940	754	-351	8040	2793	0	4877	3370	1147
2006	15040	3971	136	5872	10882	0	81	10801	11658	14724	747	-347	8008	2758	0	4760	3370	1144
2007	15040	4010	138	5863	10843	0	81	10762	11619	14476	740	-344	8022	2750	0	4752	3370	1142
2008	15040	4048	140	5855	10805	0	81	10724	11581	14272	732	-339	8012	2687	0	4666	3370	1140
2009	15040	4088	141	5846	10766	0	81	10685	11542	14005	725	-334	8018	2722	0	4673	3370	1138
2010	15040	4127	143	5837	10727	0	81	10646	11503	13797	718	-329	8007	2643	0	4506	3370	1135
2011	15040	4149	144	5829	10704	0	81	10623	11480	13632	712	-327	8010	2579	0	4382	3370	1134
2012	15040	4171	144	5821	10682	0	81	10602	11458	13437	706	-326	8009	2598	0	4351	3370	1132
2013	15040	4193	145	5813	10660	0	81	10580	11436	13243	701	-324	7996	2595	0	4360	3370	1129
2014	15040	4214	146	5805	10639	0	81	10558	11415	13036	694	-324	7964	2627	0	4226	3370	1127
2015	15040	4237	146	5798	10617	0	81	10536	11392	12925	690	-322	7954	2517	0	4087	3370	1126
2016	15040	4258	147	5790	10595	0	81	10515	11371	12778	686	-319	7956	2541	0	4016	3370	1125
2017	15040	4280	148	5782	10574	0	81	10493	11350	12621	682	-314	7939	2557	0	4008	3370	1123
2018	15040	4302	148	5774	10552	0	81	10472	11328	12575	679	-311	7908	2453	0	3931	3370	1122
2019	15040	4324	149	5766	10530	0	81	10449	11306	12458	676	-308	7908	2512	0	3896	3370	1121
2020	15040	4345	150	5759	10508	0	81	10428	11284	12342	673	-307	7936	2466	0	3809	3370	1120
2021	15040	4360	150	5751	10494	0	81	10413	11269	12199	669	-305	7913	2508	0	3889	3370	1118
2022	15040	4375	150	5744	10479	0	81	10399	11255	12083	666	-305	7901	2482	0	3761	3370	1117
2023	15040	4388	151	5737	10464	0	81	10384	11240	12019	663	-303	7894	2422	0	3754	3370	1116
2024	15040	4403	151	5731	10451	0	81	10370	11226	11968	662	-301	7891	2402	0	3703	3370	1116
2025	15040	4418	151	5724	10436	0	81	10355	11212	11875	660	-299	7873	2455	0	3717	3370	1114
2026	15040	4432	152	5717	10421	0	81	10341	11197	11763	657	-298	7875	2460	0	3715	3370	1113
2027	15040	4447	152	5710	10407	0	81	10326	11183	11707	655	-297	7842	2424	0	3647	3370	1112
2028	15040	4461	152	5703	10393	0	81	10312	11169	11645	653	-296	7844	2417	0	3671	3370	1111
2029	15040	4475	153	5697	10378	0	81	10298	11154	11553	652	-295	7812	2467	0	3580	3370	1111
2030	15040	4490	153	5690	10364	0	81	10283	11130	11461	649	-295	7826	2434	0	3495	3370	1110
2031	15040	4508	154	5683	10346	0	81	10265	11111	11378	647	-294	7769	2466	0	3552	3370	1109
2032	15040	4527	154	5676	10327	0	81	10246	11093	11320	645	-294	7777	2413	0	3527	3370	1109
2033	15040	4546	154	5669	10309	0	81	10228	11075	11320	645	-294	7770	2341	0	3450	3370	1109
2034	15040	4564	155	5662	10290	0	81	10210	11056	11233	645	-293	7746	2441	0	3489	3370	1109
2035	15040	4583	155	5654	10272	0	81	10191	11038	11231	644	-291	7686	2395	0	3432	3370	1109
2036	15040	4601	156	5647	10254	0	81	10173	11019	11282	645	-290	7683	2323	0	3436	3370	1110
2037	15040	4620	156	5640	10235	0	81	10154	11001	11206	646	-290	7687	2433	0	3495	3370	1109
2038	15040	4639	156	5632	10217	0	81	10136	10982	11209	645	-290	7653	2366	0	3449	3370	1109
2039	15040	4657	157	5625	10198	0	81	10117	10964	11224	647	-289	7641	2347	0	3433	3370	1110
2040	15040	4676	157	5617	10180	0	81	10099	10946	11187	647	-288	7639	2386	0	3420	3370	1110
2041	15040	4716	158	5607	10142	0	81	10061	10908	11188	647	-288	7634	2313	0	3412	3370	1110
2042	15040	4755	159	5597	10103	0	81	10022	10869	11139	647	-288	7601	2361	0	3393	3370	1109
2043	15040	4796	159	5587	10063	0	81	9983	10829	11162	647	-288	7590	2255	0	3295	3370	1109
2044	15040	4835	160	5577	10024	0	81	9943	10790	11092	647	-288	7577	2329	0	3397	3370	1109
2045	15040	4875	161	5566	9984	0	81	9904	10750	10985	644	-288	7545	2362	0	3366	3370	1107
2046	15040	4915	161	5555	9945	0	81	9864	10711	10904	642	-288	7521	2322	0	3258	3370	1107
2047	15040	4955	162	5544	9906	0	81	9825	10672	10847	640	-288	7504	2277	0	3296	3370	1106
2048	15040	4995	162	5533	9866	0	81	9786	10632	10721	637	-288	7540	2277	0	3277	3370	1104
2049	15040	5035	163	5521	9827	0	81	9746	10593	10574	633	-288	7499	2306	0	3301	3370	1102
2050	15040	5074	164	5510	9788	0	81	9707	10553	10461	628	-288	7482	2253	0	3227	3370	1100

RUNOF = Upper basin undepleted unregulated runoff above Powell
UBCU = Upper basin consumptive use w/o upper reservoir evaporation
USHRT = Upper basin shortage caused by hydrology
UPRES = Contents of reservoirs above Powell= F.George+B.Mesa+Navajo+Font+Tay+Morr+Crys
P_IN = Depleted & regulated inflow to Powell
P_CON = Lake Powell contents
P_EVP = Lake Powell evaporation
P_REL = Lake Powell release
M_IN = Lake Mead inflow, Powell release plus gains above Mead minus system uses
M_CON = Lake Mead contents
M_EVP = Lake Mead evaporation
BGAIN = Gains below Hoover minus system use for evap & prheatophytes & bypass
LBCU = Lower basin consumptive use
MEX   = Flow to Mexico w/o bypass
G_GWH = Glen generation as gigawatt*hours/year
H_GWH = Hoover generation as gigawatt*hours/year
P_ELV = Lake Powell elevation
M_ELV = Lake Mead elevation