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HYDSIM Use in Analysis of Removing 115% TDG Forebay Gauge Requirements
BPA Report to the Adaptive Management Team – May 2008

Objective

The Adaptive Management Team (AMT) was tasked with assessing the biological effects of a proposal to remove the requirement to maintain total dissolved gas (TDG) levels below 115% saturation levels at forebay monitors. The Corps of Engineers' (COE) SYSTDG model is not capable of identifying the extent spill must occur due to lack of markets since it does not incorporate a load-resource balancing function. SYSTDG is also very difficult to use for a large number of flow conditions since it is an hourly model. HYDSIM is a monthly model, capable of analyzing 70 flow conditions and does identify all the types of spill that can occur, including the amounts of spill expected due to lack of market. The NOAAF COMPASS model is useful in estimating changes in biological effects of alternative scenarios but also does not have the capability to identify spill due to lack of market. COMPASS has been used recently to assess the most recent Biological Opinion effects using project outflows and total spills provided from BPA's HYDSIM model. It was decided by the federal agencies that the best approach for aiding the AMT in their consideration was to link the uses of the SYSTDG, HYDSIM and COMPASS models, using the strengths of each model. SYSTDG analysis provided spill caps for each project for two scenarios (with and without the 115% TDG forebay requirement in effect) which were then used as input to HYDSIM which in turn produced project outflows and total spills for use in the COMPASS analysis of biological effects. This paper will describe more of the details of HYDSIM'S part in the process.

HYDSIM Overview

The HYDSIM model is used to evaluate how the region's system of hydro electric projects operates (within parameters established by the user) for each month of 70 years of historical inflow data. It analyzes the operation of approximately 70 hydroelectric projects one month at a time starting with the projects farthest from the ocean (the headwaters of the river system) and working the project outflows through all projects downstream, meeting all requirements (power and non-power) at each according to priorities established by the user. Non-power operating requirements include obligations for such things as International Treaties, flood control, navigation, irrigation, recreation, water quality, fish and wildlife, etc. Physical operating characteristics of all the projects are also observed in the model. After all projects' non-power requirements have been met each month, the energy produced by the projects is summed and compared to the system energy requirement (load) the user has specified for the month. When system energy production is less than or equal to the system load, the model moves on to the analysis of the next month. When it is greater than system load, the total system energy production is compared to the sum of the system load and the maximum expected secondary market established by the user. If energy production is less than or equal to that sum, the model moves on to the analysis of the next month. If it exceeds the sum, energy production at some of the projects is reduced by converting some of the flow at the project/s to additional spill until system energy production just matches that sum.

Again, the projects that implement this additional spill due to lack of markets (over-generation spill) are designated by the user.

Process

Total project outflows and juvenile passage spill criteria input to HYDSIM were the same in both scenarios. The only input modeling difference between scenarios were the TDG spill caps so that resulting HYDSIM changes in project operations could only be attributed to those changes.

In real-time operations, the combination of spill due to lack of turbine capacity and juvenile passage spill are not allowed to exceed TDG caps established by the COE using their SYSTDG model. In order to simulate real-time operations as closely as possible, HYDSIM was provided month average TDG spill caps for each scenario that varied by modeling period and low, medium or high flow condition as established by SYSTDG modeling of representative recent historical years.

The low, medium or high flow TDG caps were assigned to each of the 70 water conditions on the basis of the April-August average regulated flow at The Dalles in HYDSIM. Years with average flow less than 209 kcfs were low (23 years), above 263 kcfs high (23 years) and those in between medium (24 years).

HYDSIM identified month average outflow and total spill quantities from each scenario for each project. Total spill is the sum of forced spill (due to lack of turbine capacity), spill in accordance with juvenile passage spill criteria and over-generation spill (due to lack of markets for power). The month average project outflows and total spills were shaped into daily time increments for use as input to the NOAA Fisheries COMPASS model by a modulation routine provided by a BPA contractor, Charlie Paulsen. The modulation process was based on historical daily shape data from a recent year.

Conclusions

As expected, relieving the 115% TDG requirement in the forebays resulted in additional spill in some conditions. This was most noticeable at Bonneville and Lower Monumental because they operate with spill at the gas cap as their juvenile passage objective. Spill increases were not as frequent or as large as some anticipated due to the inclusion of the spill due to lack of market in the analysis. Removing the 115% TDG forebay limit during times when the hydro system was already spilling due to lack of market did not result in an increase in total spill because the system was already spilling above those caps for another purpose.

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Results

70-Year Average Spill Changes due to Removal of 115% TDG Caps in Forebays - KAF

(HYDSIM Forced + Bypass + Overgeneration spills)

	AP1	AP2	MAY	JUNE	JUL	AU1	AU2	Total
LWG	-1	-8	0	0	0	0	0	-9
LGS	-5	23	0	37	14	0	0	69
LMN	167	317	284	37	0	0	0	806
IHR	0	-10	-12	-1	0	0	0	-23
MCN	-9	-17	0	-15	-1	-4	0	-46
JDA	-11	-20	21	-23	-1	-3	-3	-39
TDA	-4	26	142	13	-17	0	0	160
BON	0	55	130	89	515	191	69	1,049
Total	138	365	565	138	511	184	66	1,966

70-Year Average Spill Changes due to Removal of 115% TDG Caps in Forebays - CFS

(HYDSIM Forced + Bypass + Overgeneration spills)

	AP1	AP2	MAY	JUNE	JUL	AU1	AU2
LWG	0	0	0	0	0	0	0
LGS	-175	955	0	1,518	416	0	0
LMN	5,850	10,651	5,275	1,205	0	0	0
IHR	0	0	0	0	0	0	0
MCN	0	0	0	0	0	0	0
JDA	0	-440	2,970	3,188	726	0	0
TDA	0	2,173	2,302	1,236	0	0	0
BON	0	1,836	2,109	1,692	9,421	6,420	2,161

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Example of data:

120 only minus 115&120 caps

TOTAL SPILLS (FORCED + BYPASS + OVERGEN) **KAF**

BON	15	15	31	30	31	15	16	
	AP1	AP2	MAY	JUNE	JUL	AU1	AU2	Total
1929	0	0	123	169	933	76	0	1301
1930	0	0	123	169	933	135	0	1360
1931	0	0	123	169	933	135	0	1360
1932	0	0	0	0	665	135	0	800
1933	0	234	900	0	0	372	385	1892
1934	0	0	307	107	665	127	0	1206
1935	0	0	123	169	933	135	0	1360
1936	0	0	123	35	933	135	0	1226
1937	0	0	123	169	933	135	0	1360
1938	0	0	0	107	665	115	0	886
1939	0	0	123	169	933	135	0	1360
1940	0	0	123	169	349	0	0	642
1941	0	0	123	169	933	135	0	1360
1942	0	60	307	0	665	135	0	1167
1943	0	0	0	0	652	372	0	1024
1944	0	0	123	169	706	80	0	1077
1945	0	0	123	169	933	135	0	1360
1946	0	0	0	107	665	135	0	906
1947	0	60	0	107	665	135	0	966
1948	0	234	0	0	0	372	385	992
1949	0	0	0	0	665	135	0	800
1950	0	234	0	0	652	372	200	1459
1951	0	0	0	498	0	372	0	870
1952	0	0	0	1064	652	372	0	2088
1953	0	60	128	0	0	135	0	322
1954	0	234	0	0	0	372	385	992
1955	0	60	307	0	0	135	56	558
1956	0	0	0	0	0	372	20	392
1957	0	234	0	0	652	282	0	1169
1958	0	0	0	0	665	135	0	800
1959	0	234	0	0	652	372	0	1259
1960	0	60	307	0	665	135	0	1167
1961	0	60	293	0	665	135	0	1152
1962	0	0	307	0	665	135	0	1107
1963	0	60	307	107	665	135	0	1273
1964	0	234	900	0	0	372	0	1507
1965	0	0	0	0	652	372	385	1410
1966	0	0	123	169	933	135	0	1360
1967	0	60	307	0	0	135	0	502
1968	0	0	123	35	933	135	101	1327
1969	0	0	0	0	652	372	0	1024
1970	0	60	307	0	665	57	0	1089
1971	0	234	0	0	0	372	385	992
1972	0	234	0	0	0	372	385	992
1973	0	0	123	169	933	0	0	1225
1974	0	0	0	0	0	372	385	758
1975	0	234	0	0	0	372	0	606
1976	0	0	0	0	0	372	385	758
1977	0	0	123	169	0	135	0	427
1978	0	60	0	107	665	135	0	966
1979	0	0	123	169	933	0	0	1225
1980	0	60	0	107	665	0	0	831
1981	0	60	307	0	0	135	56	558
1982	0	234	0	0	652	372	385	1644
1983	0	234	0	0	0	372	385	992
1984	0	0	32	0	-276	372	0	127
1985	0	0	123	169	829	0	0	1121
1986	0	60	307	107	665	135	0	1273
1987	0	0	123	169	933	0	0	1225
1988	0	0	123	169	933	135	0	1360
1989	0	0	123	169	497	0	0	789
1990	0	60	307	0	665	135	0	1167
1991	0	60	307	107	0	135	56	665
1992	0	0	123	169	933	0	0	1225
1993	0	0	123	169	933	135	0	1360
1994	0	0	123	169	933	135	0	1360
1995	0	60	307	107	665	135	0	1273
1996	0	0	0	0	0	372	69	441
1997	0	0	0	0	0	372	385	758
1998	0	60	0	0	0	0	0	60
Ave.	0	55	130	89	515	191	69	1049