LIMITING FLOWS FOR BEAR RIVER AT BORDER GAGING STATION FOR ALLOWANCE OF UPSTREAM STORAGE

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(Manuscript portion only)

LIMITING FLOWS FOR BEAR RIVER
AT BORDER GAGING STATION
FOR ALLOWANCE OF UPSTREAM STORAGE

The proposed draft of the Bear River Compact contains a provision, which in general states, new storage will be allowed above Bear Lake during the irrigation season, when the flow of Bear River at Border gaging station exceeds a certain amount and the resultant effect of such upstream storage will not be such as to reduce the flow at the Border gaging station below this amount.

The object of the limitation is to protect present direct flow irrigation rights below Bear Lake from encroachment, occasioned by the upstream diversion of natural flow water to storage. The determination of the limitation figure has been assigned by the Compact Commission to the Engineering Committee and this study has been prepared as basic information on which to make the determination.

Bear River basin covers a large area and has considerable variation in climatic and geophysical conditions. These affect the time and magnitude of runoff from different portions of the basin, and can only be expected that there will be some variation in the relation of the patterns of runoff in the portions of the basin above and below the Border gaging station. In general, the major portion of the runoff from the lower part in the basin occurs prior in time to that originating in the upper area and in many years much of the natural flow passing the Border gaging station is needed to fill natural flow rights below Bear Lake. The purpose of this study is to determine how much of the natural flow passing Border may be stored upstream without affecting downstream direct flow irrigation rights.

The basin below Border may be divided into four critical reaches, or critical places, and for each, the date determined when natural flow supplies

decrease to the point that cutting of natural flow rights become necessary. These are as follows:

Border
450 1. Border to Stewart Dam section

400 2. Last Chance Canals (primary right)

? 3. Riverdale and West Cache Canals

Approx - 600 4. Cutler Dam

Border to Stewart Dam Section

The natural flow supply for canals diverting between Border and Stewart Dam is that passing the Border gaging station plus inflow from Thomas Fork. → 1/37½ 618 x 75 → 46.4 Decreed rights for canals in this reach total 618 second-feet. About seventy-five percent of this amount is derived from natural flow passing the Border gaging station. The effect of upstream storage should therefore, not result in decreasing the flow at Border during the irrigation season below about 500 second-feet. About 450

Last Chance Canals

The natural flow supplies for the Last Chance Canal system would be practically the same as the natural flow passing the Bear River at Alexander gaging station. Decreed rights for the Last Chance Canal system total 650 second-feet, however, a review of past years of record indicate that about 528 in 1972 450 second-feet is the maximum diverted when a plentiful supply is available. The time when cutting of direct-flow irrigation rights begins can be taken as the day on which the natural flow at Alexander drops below 450 ? 440 incl. 1000 cfs for Green River second-feet. In some years the maximum diversion by the canal system is less than 450 second-feet and a lesser amount can be used. However, as can be noted in this study, the decrease in natural flow is very pronounced and it matters little which criteria is used, as the date is seldom changed more than one day. only 1 yr since 1943

only True Prior to ?1948

Storage arriving Cutler minus Bear at Collinston equals storage to canals:] Assumes all Natural flow to canals

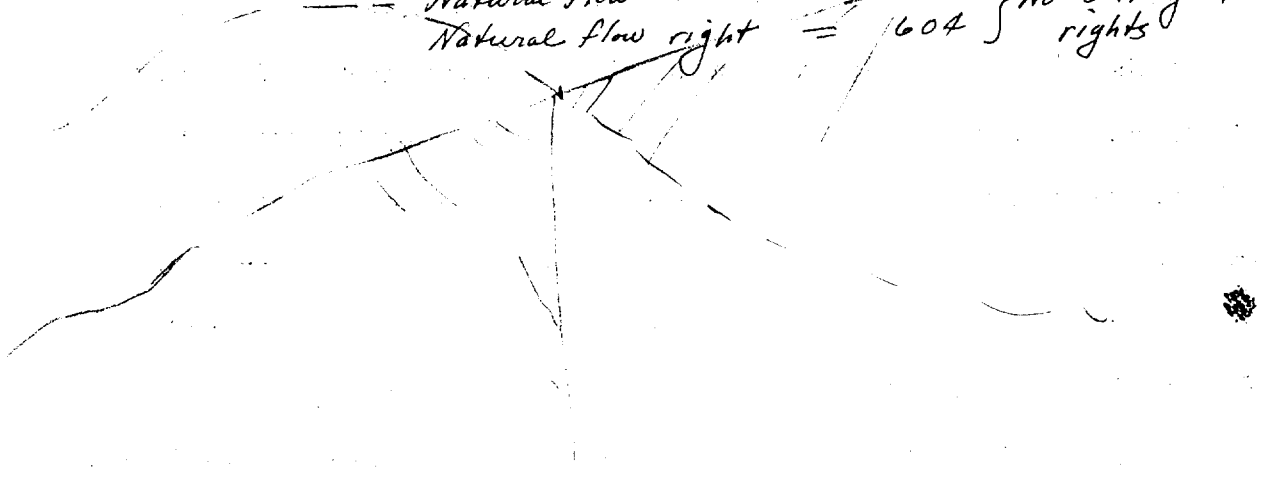
Total canal flow minus storage (above) equals natural flow
If below 604 rights have been cut.

Statement on opposite page not quite true
since storage water may be delivered to canals
before their natural flow right of 604 cfs is cut.

For Example:

Total storage release = 400
Flow passing Collinston = 300
Storage to canals = ~~100~~
Total flow in canals = 800

Natural flow in Canals = 200
Natural flow right = 604 } No Cutting of rights



Riverdale and West Cache Canals

This section is not believed to be a dry spot in the river. Difficulties in connection with determination of natural flow supplies for this group of canals are many and it is believed the critical flows based on the Last Chance Canals or Cutler Dam will be of earlier dates and greater magnitude. For these reasons this section will not be investigated.

Cutler Dam

The two canals diverting at Cutler Dam will carry about 900 second-feet. The effect of upstream temporary pondage and releases from Soda, Oneida, and Cutler reservoirs makes the determination of natural flow for these canals a problem, and the following rule has been formulated as a basis for determining the date on which cutting of rights would begin.

> "Cutting of irrigation rights begin at Cutler Dam on the day that the algebraic summation of storage being released from Bear Lake, Soda, Oneida, and Cutler Reservoirs, with due allowance for time interval, becomes greater than the flow passing the Bear River at Collinston gaging station."

In some years draft on Bear Lake begins before storage water is needed for irrigation, while in other years, storage is used from the temporary pondage reservoirs for irrigation before draft begins on Bear Lake. This definition takes these operations into account, as well as upstream storage releases which are retained in downstream pondage reservoirs.

Determination of Dates When Cutting of Rights Begin

On Plates 2 to 26 are shown the tabulations and computations used in determining dates when cutting of rights begin. The tabulation is arranged to allow for time interval to the nearest day of movement of water downstream.

The Bear River at Border gaging station was not established until 1938. In order to extend the records back to 1924, the Bear River at Harer gaging station can be utilized as there is a good correlation between daily flows at this station and the station at Border. The time interval for movement of water between the two stations is about twelve hours, but for all practical purposes flows at both stations on the same day can be used. The various columns on Plates 2 to 26 are obtained from records of discharge or computed as follows:

Column 2: Bear River above Sublette Creek. Station established in 1948 and records for 1947 are estimated.

Column 4: Bear River at Border. Station established in 1938.

Column 5: Bear River at Harer.

Column 7: Rainbow Inlet Canal at head.

Column 8: Dingle Inlet Canal near Dingle.

Column 9: Bear River below Stewart Dam.

Column 10: Column 7 plus Column 8.

Column 11: Natural flow actually ~~passing~~ reaching Bear Lake. Column 9 plus Column 15 minus Column 16, when Column 16 is greater than zero. Column 16 taken as zero when negative.

Column 13: Elevation of Bear Lake.

Column 14: Contents of Bear Lake.

Column 15: Bear Lake Outlet Canal near Paris.

Column 16: Bear Lake storage release. Column 15 minus Column 10. When Column 16 is minus Bear River water is being diverted to storage in Bear Lake.

Column 18: Elevation of Soda Reservoir.

Column 19: Contents of Soda Reservoir.

Column 20: Soda Reservoir release in acre-feet.

True because not flow going into storage is included in this column. (i.e. col. 9)

Why not Dingle + Rainbow + Stewart 7+8+9 or 9+10

9 + 15 - (15 - 10) = 9 + 10

'a' - How do we know that Last Chance isn't buying storage before this date - (See my report on Baird)

"Without affecting downstream irrig. rights"

Actually Last Chance is buying storage before this date due to Oneida Power right.

Column 21. Soda Reservoir release in second-feet.

Column 22: Summation of Columns 16 and 21. This is storage water passing Bear River at Alexander gaging station. When minus, natural flow is being stored upstream.

Column 23: Natural flow passing Alexander, or which would pass the Alexander gaging station if there were no water being placed in storage upstream. Column 24 minus Column 22.

Column 24: Bear River at Alexander.

Column 25: Last Chance Canal.

Column 26: Tanner Canal.

Column 27: Bench "B" Canal.

Column 28: Total Last Chance Canal system, Column 25, plus Column 26, plus Column 27.

Column 30: Elevation of Oneida Reservoir.

Column 31: Contents of Oneida Reservoir.

Column 32: Oneida Reservoir release in acre-feet.

Column 33: Oneida Reservoir release in second-feet.

Column 36: Cutler Reservoir contents.

Column 37: Cutler Reservoir release in acre-feet.

Column 38: Cutler Reservoir release in second-feet.

Column 39: Algebraic summation of Columns 16, 21, 33, and 38.

Column 40: Bear River near Collinston.

The heavy horizontal lines extending across each plate indicate when rights are cut at Cutler Dam. The heavy horizontal lines extending about two thirds across the plates indicate when rights are cut on Last Chance Canals. The short heavy horizontal lines indicate when storage draft began on Bear Lake.

In the tabulation on Page 7 are summarized the dates that cutting of rights began at different places and discharges at the Harer and Border gaging stations on an earlier date corresponding to time interval for movement of water between these gaging stations and the designated places of use. It is to be noted in this tabulation and on Plates 2 to 26 that Cutler Dam is the dry spot in the reach of the river below Bear Lake and in almost all years cutting of rights at Cutler Dam precede the cutting of rights on the Last Chance Canals.

On Plate 1 are plotted the critical flows at Harer, when rights were cut at Cutler Dam, on the Last Chance Canals, and storage release began from Bear Lake. The extreme range in values are well illustrated. The years of 1935 and 1941 were abnormal, as can be noted by the extreme high critical flows at Harer. In these two years, almost drought conditions existed at the beginning of the irrigation seasons. When the irrigation seasons were well along, heavy storms occurred and runoff from these storms caused high flows to occur at the Harer station after the effects of the storms had already passed in the lower basin. Because of such abnormal condition, these two years should be excluded when studying the critical flows at Harer. No special reason for the high critical flow figure is known for 1947, but it is felt that this year should also be eliminated from consideration. Except for these erratic years, the critical flows at Harer on the basis of Cutler Dam, are fairly well grouped between 600 and 900 second-feet and on the basis of the Last Chance Canals, between 400 and 600 second-feet.

SUMMARY TABULATION OF CRITICAL FLOWS

	LAST CHANCE CANALS			CUTLER DAM			Storage Release Started at Bear Lake		
Year	Date First Nat. flow rights cut	Harer 2 days earlier c.f.s.	Border 2 days earlier c.f.s.	Date First Nat. flow rights cut	Harer 4 days earlier c.f.s.	Border 4 days earlier c.f.s.	Date	Harer 1 day earlier	Border 1 day earlier
1924	June 19	558		June 18	730		May 26	1,620	
1925	July 21	524		June 29	718		June 13	853	
1926	June 6	646		May 28	619		Apr. 30	746	
1927	July 28	356		July 9	794		July 5	746	
1928	July 18	366		June 30	626		June 27	626	
1929	July 26	412		July 5	901		July 6	772	
1930	June 28	565		June 8	970		[illegible] 22	708	
1931	-	-		-	-		-	-	
1932	July 22	530		July 19	678		July 23	472	
1933	June 29	642		June 28	790		June 28	642	
1934	-	-		-	-		-	-	
1935	June 30	644		June 26	1,270		June 24	1,000	
1936	June 26	648		June 23	758		June 22	686	
1937	June 20	530		June 22	530		June 18	582	
1938	July 23	380	268	July 15	579	451	July 13	543	405
1939	May 26	634	497	May 27	658	518	May 23	698	560
1940	-	-	-	-	-	-	-	-	-
1941	June 30	593	561	June 23	1,380	1,210	June 23	934	876
1942	June 24	515	439	June 16	812	812	June 7	824	784
1943	July 28	406	350	July 8	746	666	June 26	926	832
1944	July 17	402	348	July 3	850	824	July 9	719	614
1945	July 27	392	304	July 8	941	658	July 6	870	622
1946	June 29	442	383	June 26	572	495	June 12	820	758
1947	July 23	506	388	July 7	1,150	966	July 8	890	717
1948	July 8	508	308	July 6	538	373	June 14	1,120	768

Hydrographs of Discharge for Bear River at Harer and at Border

On Plates 27 to 53 are shown the hydrographs of Bear River at Harer for the years 1924 to 1950. Hydrographs of Bear River at Border are shown for the years 1938 to 1950. On each plate a heavy vertical line is drawn, indicating the date on which cutting of rights began at Cutler Dam and a small circle on the hydrographs shows discharge at Border four days earlier.

Conclusions and Recommendations

It is apparent from the computations on Plates 2 to 26 and the summary tabulation on Page 7, that Cutler Dam is the dry spot in the lower basin. If the abnormally high Harer critical flow values for 1935, 1941, and 1947 were eliminated and an arithemtic average taken of the remaining Harer figures on Page 7, the average for 19 years would be 722 second-feet. During the period that records are available at Border, the Harer average is 712 second-feet and the Border average 600 second-feet, providing the figures for 1941 and 1947 are disregarded. If an average critical flow figure is to be used for Border, the compact provision should specify that upstream storage will be allowed only when the flow at Border is greater than 600 second-feet.

However, if the condition that downstream rights should never or rarely be violated is necessary, then a critical flow figure of about 900 second-feet at Harer must be used. The equivalent flow at Border would be about 750 second-feet. A study of the hydrographs on Plates 27 to 51 using a limitation of this magnitude shows that upstream storage would only have been possible in about 12 of the 25 years investigated. Such a limitation would make upstream storage unfeasible.

It should be kept in mind the critical values as determined are those which occur during the period of flow recession following high water. Prior to this recession period, considerable amounts could be stored upstream, even

though the flow at Border were reduced below those indicated, without any effect on downstream natural flow irrigation rights. Upstream storage is not at all feasible unless water can be stored in practically all years except possibly in the extreme drought years.

If a definite limitation must be used at Border, it may be advisable to adopt a lower figure than indicated. This figure should not be below that necessary to supply the requirements of the canals in the Border to Stewart Dam section. About 500 second-feet is needed at Border to supply these canals, and the Harer equivalent flow is about 600 second-feet. This lower limitation will provide upstream storage in practically all years, except drought years. On Plates 27 to 53, this critical flow is indicated as a solid line for Harer and as a long dash line for Border. An examination of the hydrographs shows that in most years there will be only a few days difference in time between the ceasing of upstream storage operations if the lower critical flow value is used, than would occur if the average value based on Cutler Dam were used.

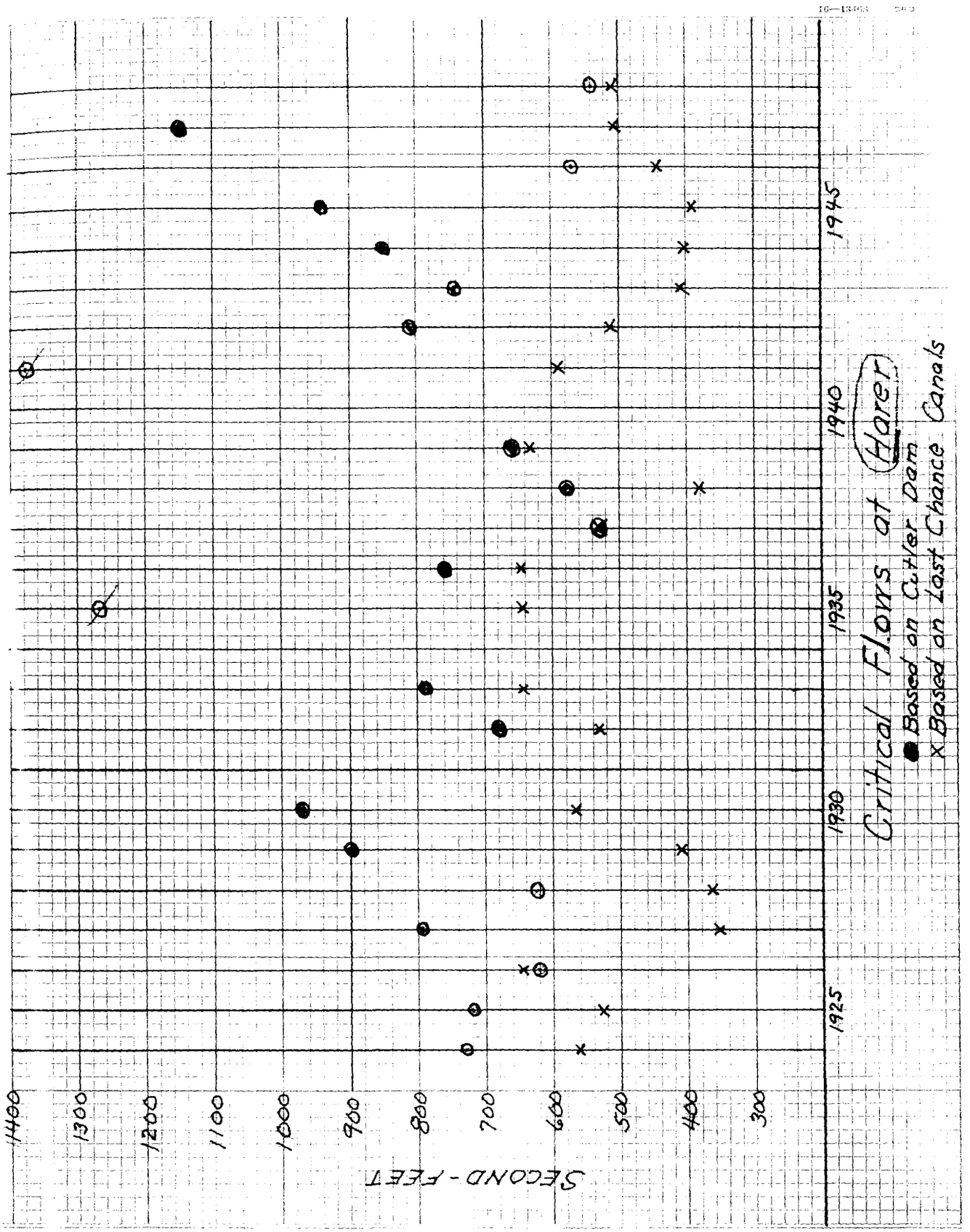
The release and use of upstream storage would begin during the period of flow recession and would result in more sustained flows at Border during the recession period. It is believed such sustained flow at Border would be quite beneficial to downstream water users and should more than compensate for any effect caused by using a lower critical flow at Border.

If upstream storage is to be allowed during the irrigation season, it is recommended that it be allowed to take place only when the flow at Border is greater than 500 second-feet and that the effect of upstream storage operations will not be such as to reduce the flow at Border below 500 second-feet.

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES BRANCH

File Number { Washington ..... District .....

PLATE 1



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