Barfield, Dave

From: Barfield, Dave
Sent: Wednesday, August 21, 2002 3:08 PM
To: 'ableed@dnr.state.ne.us'; 'Knox Ken'; 'Allacher Dennis'; 'Swanda Marv'; 'Aycock Gordon'; 'Edward E Parker (E-mail)'
Cc: 'Dale Book (E-mail)'; Pope, David L.
Subject: RRCL Settlement - flood flows

HowMuchToRemove1993.xls

As we agreed last meeting, below and attached are my initial estimates of the volume of flood flows in 1993 that I believe should be deducted from the long-term allocations if a flood like 1993 occurred again.

I have not tried to determine how the change in storage accounting might impact these estimates. Perhaps we can discuss this tomorrow. For this example with our historic methods, all the flood waters appeared as VWS and allocations in 1993. With the revised storage accounting, flood waters are included when they are released which may not be in the same compact year.

Attached is a spreadsheet which provides my analysis. As you will see, I borrowed data from Ann and the Bureau.

Here my preliminary conclusions for discussion at our meeting.

1) I conclude there is on the order of 350,000 AF of flood waters at Hardy in calendar year 1993 that should not be included in the long-term allocations. This includes approx. 150,000 AF in July 1993 that originated in the reach below HC (this is approx. the difference in the Hardy flow for the month and the long term mean) and approx. 200,000 AF during September to December when HC was spilling. This is again the excess vs. the long-term monthly means for these months. I have not considered what to do about the spills in 1994.

2) This value generally agrees with excesses in VWS in the basin for 1993, the great majority of which occurred in the mainstem reach. For 1993, the mainstem VWS was 286% of average, 678,900 AF vs. 237,300 AF. This is an excess of 440,000 AF in the MS only. There may be some excess in Medicine Creek as well. I believe Medicine spilled and, if so, contributed to the HC spill. Prairie Dog VWS was higher than average but I do not believe Norton spilled. I don't see anything higher in the basin.

See many of you tomorrow.

David Barfield

RRCL Settlement **Draft** **Confidential**
Analysis to determine that amount of 1993 flood flows to remove from the compact computations
David Barfield August 2002

From Ann
Hardy Monthly.xls

Year	Month	Flow (cfs)	Monthly AF	2 month running, AF
1993	6	327	19,463	47,939
1993	7	3,210	197,428	216,891
1993	8	848	52,155	249,583
1993	9	1,173	69,817	121,972
1993	10	1,251	76,942	146,758
1993	11	1,308	77,852	154,794
1993	12	928	57,076	134,928
1994	1	474	29,153	86,229
1994	2	529	29,387	58,540
1994	3	1,133	69,684	99,071
1994	4	401	23,868	93,552
1994	5	357	21,957	45,824

From Bureau
Floodflows4.xls
HC releases

unused for irrigation AF	
0	
1,896	
9	32,562
10	59,566
11	59,504
12	35,334
189,545	Total
14,021	
19,705	
36,188	
1,888	
10,076	

David's first estimate of flood flows

Mean for month (AF)	Actual less monthly mean	Flood volume	
76,067	(56,604)		
51,356	146,072	146,072	<--- note high runoff in this month, 3201 v average of 835.
36,964	15,191		
27,260	42,557	42,557	<--- HC evacuating flood storage
19,866	57,076	57,076	<--- HC evacuating flood storage
16,189	61,663	61,663	<--- HC evacuating flood storage
15,068	42,007	42,007	<--- HC evacuating flood storage
14,945	14,207		<--- HC evacuating flood storage
22,387	7,000		<--- HC evacuating flood storage
33,581	36,103		<--- HC evacuating flood storage
33,153	(9,285)		
43,237	(21,280)		
	total	349,374	

RRC computations (see VWS page)

	VWS	% of avera	Average	excess	
1993 RR basin	1,035,820	167%	621,357	414,463	
1993 MS only	678,900	286%	237,298	441,602	MS 3×normal
1993 MS w/o stora	403100	168%			

Monthly means, Hardy (cfs), period of record
note: these means go back to 1904; a large part of the record are pre-development and un-controled.

	means, cfs	conversion AF	
Jan	243	61.504	14,945
Feb	403	55.552	22,387
Mar	546	61.504	33,581
Apr	557	59.52	33,153
May	703	61.504	43,237
Jun	1,278	59.52	76,067
Jul	835	61.504	51,356
Aug	601	61.504	36,964
Sep	458	59.52	27,260
Oct	323	61.504	19,866
Nov	272	59.52	16,189
Dec	245	61.504	15,068

Monthly Streamflow Statistics for Kansas

From USGS NWIS — USGS 06853500 REPUBLICAN R NR HARDY, NE

YEAR	Monthly mean streamflow, in ft^3/s											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1904							1,658	472	181	514	523	
1905				1,060	1,927	2,950	5,734	3,084	725	479		
1906					1,613	466	664	553	253	371	610	
1907				518	590	699	435	123	78	122	240	
1908			460	287	337	1,615	812	878	203	609	565	
1909			803	651	555	1,680	1,254	238	690	201	358	
1910				359	388	264	116	1,121	496	201	239	
1911		459	463	273	285	150	1,079	5,850	708	424	300	
1912			2,079	1,457	826	818	349	1,080	320	360	426	409
1913				697	1,067	323	144	11	15	33	45	324
1914	420	509	577	385	799	2,296	1,057	243	173	76	177	
1915			893	803	1,038	9,629	3,597	5,400	1,317			
1931					1,124	966	222	566	102			
1932		1,456	817	591	484	2,044	353	440	390	76	147	300
1933	425	405	609	1,111	1,351	263	236	900	1,797	400	360	553
1934	530	485	623	494	207	1,120	110	18	320	94	238	248
1935	311	548	524	518	1,807	10,390	1,028	1,213	1,750	383	454	513
1936	307	261	733	561	2,020	1,221	118	35	166	61	183	286
1937	162	702	696	393	415	1,739	886	765	465	139	151	211
1938	414	456	581	540	1,458	1,684	924	829	839	123	185	255
1939	285	275	667	853	613	2,350	696	432	32	20	69	134
1940	102	205	754	439	496	1,298	620	537	238	274	261	301
1941	433	608	561	809	1,055	5,709	1,936	1,041	1,577	757	573	495
1942	449	790	1,184	1,885	1,290	3,590	869	1,179	1,963	504	563	493
1943	467	926	637	1,437	464	1,784	386	83	128	42	150	195
1944	354	507	781	1,748	1,933	2,270	3,136	1,588	398	259	372	361
1945	542	656	596	863	1,302	2,450	1,472	390	158	358	296	221
1946	401	689	622	414	637	920	1,555	398	1,471	4,194	1,375	864
1947	553	578	960	953	876	5,927	1,468	372	150	106	273	352
1948	496	868	1,494	590	400	2,682	1,224	545	196	106	314	358
1949	224	1,128	1,697	1,242	3,161	4,171	822	615	582	516	447	346
1950	273	641	781	541	1,014	532	2,362	2,270	1,193	572	337	334
1951	358	529	642	650	2,024	4,548	4,884	1,630	3,805	797	667	558
1952	628	998	1,148	1,366	1,580	539	1,159	191	80	60	158	138
1953	278	659	171	126	114	360	115	97	162	89	120	124
1954	65	126	95	90	295	113	57	161	76	72	73	90
1955	82	163	144	84	88	744	105	91	476	116	93	76
1956	80	103	129	88	48	183	275	98	81	55	63	67
1957	52	103	105	124	370	2,522	2,474	437	245	81	143	243
1958	248	354	851	1,442	615	720	648	1,135	748	396	225	373
1959	445	658	553	663	1,117	658	398	136	181	164	119	125
1960	92	177	664	2,415	2,523	2,031	1,005	180	114	114	117	116
1961	97	121	127	119	723	1,964	673	169	196	136	145	105
1962	218	291	292	586	368	1,618	2,795	1,800	977	440	211	190
1963	157	534	1,079	680	213	115	88	340	732	400	302	226
1964	219	326	172	133	78	171	93	239	467	105	112	106
1965	144	236	277	211	638	1,115	1,575	195	616	1,970	1,303	668
1966	636	968	967	674	272	218	563	194	255	163	144	219
1967	207	534	520	357	202	1,979	2,107	369	270	114	146	127
1968	101	336	344	642	287	184	133	242	186	137	124	92
1969	102	671	724	392	925	793	604	369	450	197	373	448
1970	295	540	632	750	283	148	71	101	99	142	172	134
1971	103	209	263	176	173	365	135	97	83	43	146	148
1972	118	135	130	128	158	113	196	218	144	112	182	161
1973	230	198	312	397	614	379	237	179	1,455	1,272	433	310
1974	378	780	723	627	531	191	72	199	76	121	154	152
1975	162	198	248	171	136	1,113	417	170	90	107	143	175
1976	155	170	154	364	169	165	152	99	65	52	46	78
1977	73	174	122	108	126	167	147	337	801	169	155	127
1978	97	99	550	241	157	73	132	281	397	108	131	110
1979	76	402	941	298	346	150	243	304	91	122	223	156
1980	132	183	312	535	182	182	86	139	61	93	98	115
1981	115	107	115	49	371	131	379	295	161	121	147	207
1982	101	426	261	171	1,360	529	687	295	206	212	161	147
1983	186	347	641	630	673	1,190	318	214	740	1,081	266	225
1984	500	439	406	1,093	1,500	761	184	143	91	55	122	299
1985	152	256	205	183	704	194	254	687	247	249	201	186
1986	240	210	195	298	230	222	194	264	392	375	176	196
1987	179	160	797	998	613	230	341	336	134	130	165	194
1988	189	258	193	153	110	56	519	235	70	54	105	115
1989	120	145	139	91	34	74	484	174	62	88	106	85
1990	126	96	87	135	144	297	186	486	72	35	36	35
1991	64	150	67	39	104	220	54	59	15	17	22	26
1992	34	27	78	57	30	47	930	243	140	122	127	121
1993	115	516	1,584	543	463	327	3,210	848	1,173	1,251	1,308	928
1994	474	529	1,133	401	357	135	273	142	140	111	138	153
1995	115	131	162	169	1,151	1,157	309	234	107	106	163	151
1996	140	129	157	145	400	341	591	968	1,283	1,137	898	331
1997	316	298	228	836	472	296	197	180	107	80	246	297
1998	260	266	292	778	483	122	261	205	77	146	197	200
1999	254	199	179	256	717	325	158	170	58	94	122	141
2000	148	143	76	241	93	131	506	93	39	29	42	24
2001	41	51	541	218	785	394	293	147	108			
Mean of monthly streamflows	243	403	546	557	703	1,278	835	601	458	323	272	245
1993 as a percent of mean	195%	131%	208%				384%	141%	256%	387%	481%	379%

1,278

TABULATON OF WATER COMPUTATIONS
REPUBLICAN RIVER COMPACT ADMINISTRATION
SUBMITTED TO THE SPECIAL MASTER IN KANSAS V. NEBRASKA AND COLORADO, NO. 126 ORIGINAL

PREPARED BY THE STATES OF COLORADO, KANSAS, AND NEBRASKA

May 10, 2001

TABLE 1. COMPUTATIONS OF VIRGIN WATER SUPPLY (TOTAL AND BY SUB-BASIN)

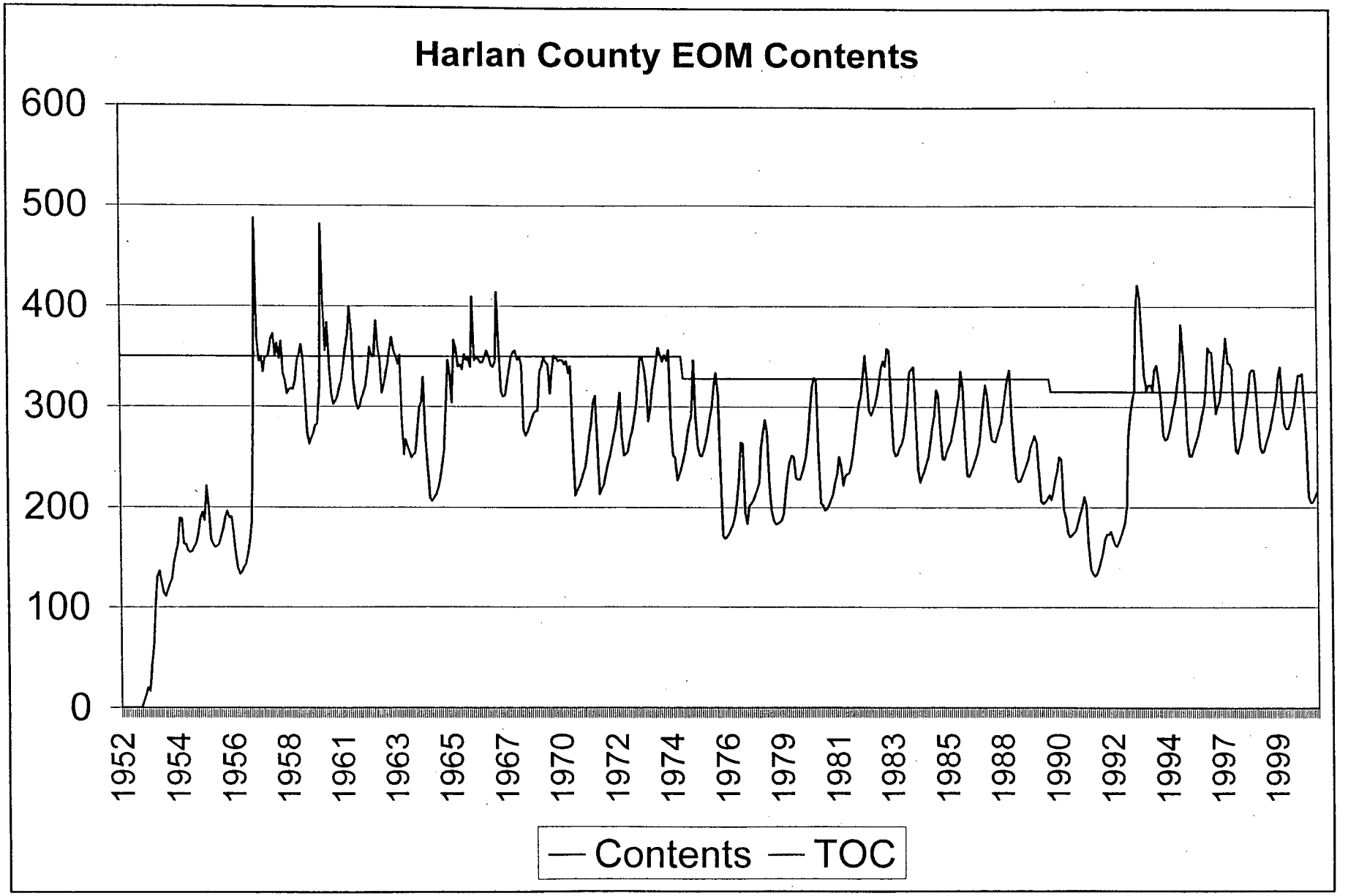
All values are in acre-feet for a water year (ending in September of the year indicated).

Year	Total	% of normal	North Fork[1]	Arikaree	Buffalo	Rock	South Fork	Frenchman	Driftwood	Red Willow	Medicine	Beaver	Sappa	Prairie Dog	Mainstem[1,2,3]
1959	510,670	82%	61,480	10,800	6,060	10,970	43,330	116,550	2,610	27,230	45,520	16,640	18,700	15,040	135,740
1960	**901,790**	**145%**	57,250	24,480	6,540	10,540	44,650	151,450	16,500	47,610	80,440	50,970	51,970	41,860	317,530
1961	550,750	89%	58,970	10,120	5,920	10,090	36,470	103,770	560	27,230	42,620	21,840	31,040	30,740	171,380
1962	**824,470**	**133%**	53,390	28,930	6,980	10,890	51,550	143,870	11,090	38,180	102,810	42,710	37,740	35,250	261,080
1963	584,260	94%	47,380	11,170	5,030	9,750	40,220	130,680	2,090	19,110	64,600	31,120	37,290	28,580	157,240
1964	487,920	79%	47,130	10,620	4,950	10,320	33,670	119,130	3,110	15,730	50,410	26,230	31,930	16,190	118,500
1965	546,570	88%	47,300	16,850	5,670	11,590	53,220	118,800	8,350	17,380	32,250	51,160	62,180	50,120	71,700
1966	791,540	127%	48,980	13,150	6,210	10,940	45,130	129,210	2,110	28,640	55,300	46,520	119,940	53,680	231,730
1967	742,540	120%	45,820	13,180	5,900	10,500	40,080	137,750	1,980	35,280	70,370	20,380	52,590	30,910	277,800
1968	502,170	81%	45,700	8,080	5,050	9,720	30,830	127,130	4,290	24,460	51,580	15,630	29,380	17,920	132,400
1969	568,480	91%	43,550	12,430	5,440	10,570	37,970	113,340	2,260	22,150	61,390	19,690	31,180	24,430	184,080
1970	514,590	83%	44,150	7,240	5,450	10,160	33,540	122,720	1,880	23,470	47,800	15,400	25,520	17,130	160,130
1971	498,750	80%	42,950	7,350	5,480	10,190	30,910	117,470	2,170	23,170	44,550	16,060	20,830	16,770	160,850
1972	518,300	83%	44,510	18,740	4,940	9,930	41,800	122,780	6,010	26,740	44,470	17,170	21,090	20,620	139,500
1973	653,810	105%	46,910	19,470	5,800	10,310	44,220	120,900	5,230	29,930	41,910	16,440	21,040	16,030	275,620
1974	724,740	117%	43,910	14,960	5,530	9,750	35,770	133,550	7,500	25,800	45,880	20,840	25,820	26,540	328,890
1975	681,450	110%	42,910	11,930	5,540	9,550	46,010	124,820	4,080	26,960	49,460	28,930	31,690	30,480	269,090
1976	551,260	89%	39,700	8,900	5,010	8,870	26,150	123,060	3,650	24,400	48,590	29,400	25,010	16,780	191,740
1977	642,690	103%	41,620	12,850	5,420	9,550	31,630	119,720	7,000	26,500	47,600	24,760	26,540	32,440	257,060
1978	636,370	102%	41,230	7,240	5,080	9,180	30,820	125,310	3,600	25,380	58,770	34,350	28,010	24,250	243,150
1979	603,910	97%	37,210	11,600	4,530	8,490	43,310	100,540	3,100	24,590	53,220	17,730	20,660	19,150	259,780
1980	567,780	91%	45,650	16,070	5,030	9,300	42,720	98,560	3,020	24,310	50,400	20,400	24,960	17,240	210,120
1981	518,900	84%	41,660	19,010	5,930	9,200	48,000	92,720	2,510	24,010	47,590	14,500	11,570	16,220	185,980
1982	676,300	109%	46,370	14,890	5,290	8,950	38,080	97,230	6,270	23,280	45,880	15,860	23,470	11,740	338,990
1983	672,570	108%	43,200	12,850	5,000	8,250	37,170	105,100	5,220	23,120	43,320	38,270	23,520	23,110	304,440
1984	799,450	129%	43,190	13,550	5,060	8,580	42,070	106,630	4,060	22,990	53,180	19,680	29,240	20,820	430,400
1985	605,300	97%	41,980	12,880	5,570	8,190	35,980	101,180	6,220	21,830	48,210	15,750	23,890	22,480	261,140
1986	585,180	94%	40,660	12,140	5,620	8,650	32,680	92,250	2,710	21,180	47,680	19,640	33,380	24,280	244,310
1987	717,680	116%	38,920	10,070	5,720	8,460	34,810	93,080	4,210	23,230	42,140	21,580	31,680	29,400	374,380
1988	525,720	85%	36,560	13,120	4,840	8,450	27,730	93,380	5,600	25,400	48,320	18,490	27,530	30,530	185,770
1989	506,930	82%	35,320	9,470	4,460	7,860	38,310	93,100	6,180	22,680	43,640	20,620	31,240	21,380	172,670
1990	520,198	84%	34,630	10,940	4,690	7,780	34,540	95,250	3,600	20,508	45,590	20,050	27,220	20,450	194,950
1991	421,300	68%	37,120	11,890	4,710	8,030	39,910	83,820	4,190	17,820	36,110	20,170	28,020	19,020	110,490
1992	514,650	83%	34,660	14,870	5,050	7,790	39,490	94,500	6,060	21,540	36,260	13,970	20,490	19,940	200,030
1993	**1,035,820**	**167%**	35,430	15,300	4,710	8,020	39,080	86,570	3,780	26,530	71,410	9,520	24,600	31,970	**678,900**
1994	664,049	107%	36,170	19,112	4,770	7,420	33,417	94,960	2,430	21,510	50,980	19,300	43,330	25,480	305,170
average	621,357		43,710	13,507	5,361	9,355	38,480	111,969	4,590	24,997	51,396	23,660	32,064	24,971	237,298
1983-92 average	586,898		38,624	12,178	5,072	8,204	36,269	95,829	4,805	22,030	44,445	20,822	27,621	23,141	247,858
1993 % of average	167%		81%	113%	88%	86%	102%	77%	82%	106%	139%	40%	77%	128%	**286%**
1993 % of 83-92 avera	176%		92%	126%	93%	98%	108%	90%	79%	120%	161%	46%	89%	138%	274%

1. The mainstem includes the North Fork of the Republican River in Nebraska and the mainstem of the Republican River between the junction of the North Fork and the Arikaree River and the lowest crossing of the river at the Nebraska-Kansas state line and the small tributaries thereof, including Blackwood Creek.

2. Corrected values for 1959-1963 for a) the North Fork of the Republican River and b) the mainstem of the Republican River including Blackwood Creek sub-basis were taken from the 4th Annual Report, Exhibit B.

3. Corrected values for 1976 for the mainstem sub-basin taken from the note on page 17 of the 18th Annual Report.


Harlan County EOM Contents
600
500
400
300
200
100
0
1952
1954
1956
1958
1961
1963
1965
1967
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1972
1974
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