



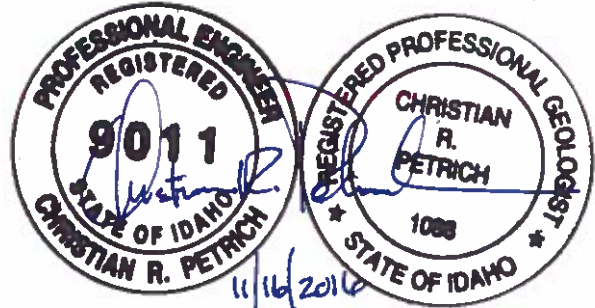
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NOV 18 2016

WATER RESOURCES
WESTERN REGION

MEMORANDUM

DATE: November 16, 2016
TO: Patrick Kelly, IDWR
FROM: Christian R. Petrich, Ph.D., P.E., P.G.
CC: Chris Bromley, McHugh-Bromley, PLLC
Brad Wilson, Bogus Basin
RE: Beneficial Use Field Report, Permit 65-13382



Permit 65-13382, listed under the name of Bogus Basin Recreational Association, Inc. (referred to hereinafter as "Bogus Basin") authorized the development of 0.34 cfs for snowmaking purposes (a commercial use) from November 1 through March 31 with a May 7, 1992 priority date. IDWR conducted a field exam to document the development of Permit 65-13382 on August 19, 2016. The Beneficial Use Field Report ("Field Report") recommends licensing the permit with a maximum instantaneous diversion rate of 0.34 cfs (approximately 153 gpm) and a maximum annual volume of 5.5 acre-feet (AF).

The purpose of this memorandum is to demonstrate that Bogus Basin

1. Developed the water-system infrastructure during the permit development period to divert an annual volume greater than 5.5 AF; and
2. Reasonably anticipates the need to divert a greater volume during low-snow years.

Infrastructure

Infrastructure available for snowmaking operations that Bogus Basin has purchased or constructed includes the following:

1. Five snowmaking machines with (according to the Field Report) the capacity to use between 0.15 and 1.65 cfs. The license recommendation of 0.34 cfs is consistent with the original application and subsequent permit.
2. Water for snowmaking operations can be accessed via an outlet and valve at the Bogus Creek culvert, the 250,000 gallon storage reservoir, or other points.
3. The culvert upstream of the direct-use connection, with a diameter of approximately 4 feet and a length of approximately 150 feet, has a capacity to store a volume of approximately 14,000 gallons (Table 1).

4. A settling pond located upstream of the pump house (and upstream of the direct-use connection), with a diameter of approximately 50 feet and a depth of 10 approximately feet, represents a storage volume of approximately 147,000 gallons (Table 1).
5. A 7,000-gallon "clear well" located near the sand filtration system.
6. A 12,000-gallon above-ground storage tank connected to the water system between the well and sand filtration system.
7. Combined, the culvert, settling pond, clear well, and 12,000-gallon above-ground tank represent a storage volume of 0.55 AF (Table 1).

Snowmaking Storage		
Storage	Volume ⁽¹⁾ (gal)	Volume (AF)
Culvert ⁽²⁾	14,000	0.043
Settling pond ⁽³⁾	147,000	0.451
Clear well ⁽⁴⁾	7,000	0.021
Lower storage tank ⁽⁴⁾	12,000	0.037
	180,000	0.55
Flow rate needed to fill storage in 24-hour period (cfs)		0.28
Notes (1) Values are rounded (2) Based on 48-inch diameter and approximate 150-foot length (3) Based on diameter of approximately 50 feet and assumed depth of 10 feet (4) As reported by Bogus Basin personnel		

Table 1. Snowmaking storage.

In addition, Bogus Basin uses a 250,000-gallon reservoir near the Pioneer Lodge for water storage. While a portion of this storage is dedicated for domestic uses, a portion is available for snowmaking purposes. Overall storage available for snowmaking,

depending on current or anticipated domestic uses from the storage reservoir, might be approximately 100,000 gallons (0.31 AF).¹

The Field Report for Permit 65-13381 lists an annual volume based on an assumed daily refill of a 10,000-gallon tank for 151 days. Using this same general approach for Permit 65-13382, a daily refill of 0.55 AF (Table 1) for 60 days (e.g., November and December) would result in an annual volume of 33 AF (Table 2). A volume of 32 AF would be consistent with the proposed annual volume under Permit 65-13466.

Annual-Volume Scenarios	
Annual Volume	Volume per Season (AF)
One storage refill per day for 60 days	33.1
One storage refill per day for 30 days and 1/2 storage refill per day for 60 days	33.1
One snowmaker operating at a rate of 0.19 cfs for 60 days, 24 hours/day, or for 30 days at 24 hours/day and 60 days at 12 hours/day	22.6
Two snowmakers operating 90 days, 13 hours/day at a combined rate of 0.34 cfs	32.9

Table 2. Annual volume scenarios.

In practice, it is conceivable that snowmaking could occur on a continuous basis in November and early December (e.g., 6 weeks), and then occur on an as-needed basis in late December through February. A scenario like this (i.e., one storage refill per day for 30 days and half of a storage refill for 60 days) would also result in an annual volume of 33 AF.

Bogus Basin also has the capacity to use Bogus Creek water directly for snowmaking (i.e., without storage). In this case, one snowmaker operating continuously at a rate of

¹ The Field Report lists a pumping capacity of 0.08 cfs (~36 gpm) from the pumphouse to the upper reservoir. Bogus personnel report that the maximum flow rate from the pumphouse to the upper reservoir is approximately 50 gpm (0.11 cfs). Based on these two flow estimates, the daily refill in the upper reservoir ranges from approximately 52,000 to 72,000 gallons, or 0.16 to 0.22 AF. A portion of the flow rate and daily storage is dedicated to domestic uses.

0.19 cfs for 60 days (or for 30 days at 24 hours/day and 60 days at 12 hours/day) would represent an annual volume of 22.6 AF. Two snowmakers operating 90 days for 12 hours per day at a combined rate of 0.34 cfs would represent an annual volume of 30.3 AF. Five snowmakers operating on a consistent basis could use substantially more than 32 AF per year.

Each of these snowmaking scenarios are based on combined assumptions of poor snowpack, sufficiently low temperatures for snowmaking operations, and water availability. Given this combination of conditions, even if infrequent, it is conceivable that Bogus Basin could use up to approximately 33 AF during a winter season under water right 65-13382.

The second aspect of determining annual volume is one of need. Bogus Basin currently has the capacity to deliver artificial snow to approximately 45.1 acres (Field Report). The use of one acre-foot of water per ski-run acre is used as a general rule of thumb as the "duty" of water for snowmaking operations in the intermountain west (Attachment A). This application could represent multiple snowmaking events: snowmaking would be used to create an initial base, and then artificial snow would be added as the initial base is either skied off or partially melts during the day.

With this application rate, a 32-AF annual volume could easily be utilized on the 45.1-acre area on which Bogus Basin is able to make snow. Some of the authorized acres would receive less than one AF per acre; some areas with higher skier traffic may receive more than one AF per acre.

The level of snowmaking needed to use 32 AF may occur on a very infrequent basis. However, one year in which extensive snowmaking would have been required is 1977. The snow water equivalent (SWE) at Bogus Basin was 20% of normal January 5, 1977 (Table 3a and 3b). The SWE was 14% of normal at the end of January, and 23% of normal at the end of February. The snowpack has not been this low since 1977.

In summary, the need for snowmaking varies from year to year, as do conditions enabling the use of snowmaking equipment. Licensing a commercial right for snowmaking diversion and storage may be difficult because conditions requiring – and allowing – the full use of snowmaking equipment and infrastructure may be infrequent, and may not occur during a permit development period. However, Bogus Basin has constructed the infrastructure and storage to use 32 AF for snowmaking purposes under Permit 65-13382 (although use of this volume would occur under certain conditions, e.g. low snowpack, temperatures amenable to snowmaking, and sufficient water supply). Given the infrastructure that Bogus Basin has constructed for snowmaking purposes, I propose that Permit 65-13382 be licensed with a 32-AF volume limit (consistent with Permit 65-13466).

Historical Snow Water Equivalents (Part 1: 1944-1980)												
Water Year	Jan 1st Half				Feb 1st Half				Mar 1st Half			
	Date	Snow Depth (in)	Snow Water Equivalent (in)	Percent of Normal (1981-2010)	Date	Snow Depth (in)	Snow Water Equivalent (in)	Percent of Normal (1981-2010)	Date	Snow Depth (in)	Snow Water Equivalent (in)	Percent of Normal (1981-2010)
1944	30-Dec	18	4.7	55%	31-Jan	24	4.8	29%	28-Feb	44	115	54%
1945	2-Jan	32	6.7	78%	29-Jan	33	8.7	53%	26-Feb	59	18	85%
1946	4-Jan	57	16	166%	4-Feb	78	25.2	154%	5-Mar	93	32	150%
1947	8-Jan	40	12.7	148%	2-Feb	56	16	98%	28-Feb	52	18.5	87%
1948	7-Jan	37	9.7	103%	3-Feb	38	10	61%	3-Mar	55	14.7	68%
1949	31-Dec	51	15	174%	31-Jan	51	17.3	105%	1-Mar	84	29.5	139%
1950	31-Dec	26	6.3	73%	2-Feb	52	13.3	81%	27-Feb	57	17.5	82%
1951	29-Dec	32	8	93%	29-Jan	61	18.3	112%	3-Mar	72	25	117%
1952	28-Dec	63	17.1	199%	1-Feb	81	25.7	157%	29-Feb	88	30	141%
1953	30-Dec	32	8.7	101%	31-Jan	55	215	131%	27-Feb	65	22.2	104%
1954	30-Dec	32	8.2	95%	30-Jan	53	16	98%	28-Feb	57	20.8	98%
1955	1-Jan	31	5.2	60%	29-Jan	33	8.3	51%	26-Feb	45	113	53%
1956	30-Dec	38	12.2	142%	2-Feb	68	19.2	117%	1-Mar	89	24.5	115%
1957	28-Dec	29	8.8	102%	1-Feb	62	15.3	93%	1-Mar	66	215	101%
1958	30-Dec	49	13.7	159%	2-Feb	67	20	122%	26-Feb	68	23.7	111%
1959	2-Jan	20	4.2	49%	30-Jan	37	9.7	59%	28-Feb	48	14.8	68%
1960	30-Dec	20	3.8	44%	31-Jan	37	9.8	60%	28-Feb	56	17.3	81%
1961	30-Dec	26	7.3	85%	1-Feb	31	7.8	48%	3-Mar	47	13.8	65%
1962	3-Jan	44	13.5	157%	31-Jan	53	16.5	101%	2-Mar	72	215	101%
1963	31-Dec	10	2.5	29%	4-Feb	24	8.2	50%	1-Mar	28	9.5	45%
1964	31-Dec	29	7	81%	2-Feb	60	13.7	84%	28-Feb	51	17.2	81%
1965	31-Dec	55	14.2	165%	30-Jan	85	28.2	172%	4-Mar	77	27.5	129%
1966	31-Dec	28	5	58%	1-Feb	38	112	68%	2-Mar	51	14.3	67%
1967	28-Dec	29	7.7	90%	2-Feb	57	18.2	111%	1-Mar	64	20.2	95%
1968	2-Jan	19	3.3	38%	2-Feb	33	7.8	48%	1-Mar	32	10.8	51%
1969	6-Jan	41	13.5	157%	4-Feb	83	27.5	168%	4-Mar	84	29.5	139%
1970	2-Jan	31	8.5	99%	30-Jan	65	23	140%	27-Feb	69	26.3	123%
1971	28-Dec	54	15.7	183%	1-Feb	70	26.3	160%	1-Mar	91	29.5	139%
1972	30-Dec	65	19	221%	28-Jan	93	31.3	191%	29-Feb	87	34.2	161%
1973	2-Jan	26	7.5	87%	31-Jan	40	117	71%	2-Mar	48	15.2	71%
1974	3-Jan	58	16.8	219%	1-Feb	68	217	132%	28-Feb	74	27.5	129%
1975	6-Jan	42	11.3	131%	30-Jan	48	17.2	105%	4-Mar	67	22	103%
1976	30-Dec	30	7.5	87%	29-Jan	54	16.3	99%	3-Mar	65	217	102%
1977	5-Jan	14	17	20%	28-Jan	11	2.3	14%	28-Feb	23	4.8	23%
1978	29-Dec	26	7.5	87%	30-Jan	55	18.3	99%	27-Feb	73	25.3	119%
1979	28-Dec	20	5.2	60%	29-Jan	40	10	61%	27-Feb	61	17.5	82%
1980	28-Dec	33	8.3	97%	2-Feb	50	15.8	96%	28-Feb	62	22.2	104%

Table 3a. Snow water equivalents (Part 1: 1944-1980).

Historical Snow Water Equivalents (Part 2: 1981-2016)												
Water Year	Jan 1st Half				Feb 1st Half				Mar 1st Half			
	Date	Snow Depth (in)	Snow Water Equivalent (in)	Percent of Normal (1981-2010)	Date	Snow Depth (in)	Snow Water Equivalent (in)	Percent of Normal (1981-2010)	Date	Snow Depth (in)	Snow Water Equivalent (in)	Percent of Normal (1981-2010)
1981	29-Dec	18	5	58%	3-Feb	29	8	49%	2-Mar	29	9.3	44%
1982	29-Dec	36	8.5	99%	29-Jan	66	19.7	120%	1-Mar	61	22.5	106%
1983	29-Dec	57	15.8	184%	27-Jan	66	22	134%	28-Feb	90	31	146%
1984	30-Dec	61	18.5	215%	30-Jan	59	20.3	124%	1-Mar	75	26.3	123%
1985	27-Dec	48	14.8	172%	27-Jan	49	16.8	102%	28-Feb	62	22	103%
1986	30-Dec	30	8.7	101%	29-Jan	37	12.2	74%	3-Mar	61	24	113%
1987	30-Dec	16	3.5	41%	29-Jan	28	6.2	38%	26-Feb	41	11.7	55%
1988	28-Dec	13	3.5	41%	2-Feb	44	11.2	68%	1-Mar	38	12.8	60%
1989	29-Dec	50	13.2	153%	1-Feb	63	20.2	123%	2-Mar	78	25.3	119%
1990	27-Dec	9	2	23%	31-Jan	34	7.3	45%	1-Mar	47	14	66%
1991	28-Dec	27	5.2	60%	31-Jan	31	9.2	58%	27-Feb	31	10.5	49%
1992	31-Dec	23	5.3	62%	31-Jan	29	8.2	50%	27-Feb	40	10.8	51%
1993	31-Dec	47	12.2	142%	1-Feb	60	18	110%	1-Mar	68	22.8	107%
1994	30-Dec	24	6.5	76%	2-Feb	37	12.7	77%	1-Mar	62	20.3	95%
1995	2-Jan	45	15	174%	2-Feb	47	18	110%	1-Mar	52	20.6	97%
1996	2-Jan	17	4.8	56%	31-Jan	63	18.1	98%	2-Mar	48	17.1	80%
1997	4-Jan	64	22.2	258%	30-Jan	85	27.1	165%	1-Mar	78	29.1	137%
1998	6-Jan	27	7.2	84%	2-Feb	62	18.7	114%	1-May		25.9	122%
1999	31-Dec	45	13.2	153%	3-Feb	74	22.3	136%	1-Mar	101	33.7	158%
2000	31-Dec	23	6.8	79%	3-Feb	53	18.7	114%	3-Mar	77	24.7	118%
2001	3-Jan	42	11.6	135%	2-Feb	49	15.7	96%	1-May		17	80%
2002	27-Dec	55	18.2	212%	4-Feb	64	22.5	137%	26-Feb	68	24.7	116%
2003	28-Dec	31	7.5	87%	1-Feb	32	12.2	74%	2-Mar	46	16	75%
2004	31-Dec	50	12	140%	5-Feb	70	23	140%	26-Feb	78	26.3	123%
2005	31-Dec	33	9.8	114%	31-Jan	34	9.8	58%	2-Mar	44	13.8	65%
2006	31-Dec	32	10	116%	31-Jan	64	21	128%	26-Feb	61	22	103%
2007	1-Jan	32	8.5	99%	31-Jan	38	12.2	74%	1-Mar	69	17	80%
2008	31-Dec	36	7.7	90%	2-Feb	65	18.7	102%	26-Feb	68	23	108%
2009	31-Dec	40	9.8	114%	1-Feb	40	13.5	82%	26-Feb	45	15	70%
2010	29-Dec	26	5.8	67%	30-Jan	50	13.7	84%	25-Feb	58	17.2	81%
2011	2-Jan	53	14	163%	1-Feb		15.7	96%	28-Feb	51	17	80%
2012	31-Dec	11	3	35%	29-Jan	45	11	67%	1-Mar	55	15.3	72%
2013	31-Dec	19	4.3	50%	29-Jan	32	8.2	50%	28-Feb	40	10.8	51%
2014	31-Dec	19	4.7	55%	31-Jan	27	6.5	40%	28-Feb	42	13.7	64%
2015	31-Dec	38	10	116%	30-Jan	35	11.7	71%	26-Feb	33	12.8	60%
2016	3-Jan	47	13.7	159%	31-Jan	59	17.5	107%	29-Feb	55	20.2	95%

(NRCS data collected from Bogus Basin SNOTEL site).

Table 3b. Snow water equivalents (Part 2: 1981-2016).

Attachment A:

**Letter from Joseph VanderKelen (SMI SnowMakers, Inc.)
to Brad Wilson (Bogus Basin)
dated October 31, 2016**