TC CONSULTING SERVICES

SYSTEM OPERATION AND MAINTENANCE

Cherry Creek Basin Water Quality Authority
% Chuck Reid
R.S. Wells LLC
8390 E. Crescent Parkway, Suite 500
Greenwood Village, Colorado 80111

February 17, 2010

Dear Messrs:

The Cherry Creek Basin Water Quality Authority (Authority) operates the destratification facilities located at the Cherry Creek Reservoir. These facilities serve to enhance the quality of the water contained in the reservoir.

The Authority retained TC Consulting Services to operate and maintain the facility and equipment during the calendar year 2009.

Please, find attached for your review the Cherry Creek Basin Water Quality Authority, Reservoir Destratification Facilities, Operation and Maintenance, Annual Report 2009.

Sincerely,

Terry Cunningham

CHERRY CREEK BASIN WATER QUALITY AUTHORITY

RESERVOIR DESTRATIFICATION FACILITIES

OPERATION AND MAINTENANCE ANNUAL REPORT 2009

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CHERRY CREEK BASIN WATER QUALITY AUTHORITY
RESERVOIR DESTRATIFICATION FACILITIES
OPERATION AND MAINTENANCE
ANNUAL REPORT
2009

February 17, 2010

INTRODUCTION:

TC Consulting Services was retained in 2009 to operate and maintain the Cherry Creek Reservoir Destratification Facilities. This was the second consecutive year that the facilities were operated continuously during the spring, summer and fall seasons.

START UP:

The compressor was started on February 7, 2009. The unit was started to provide aeration to the reservoir to prevent large sheets of floating ice that had melted from damaging the marina and shoreline protection improvements. The weather forecasts for this day and subsequent days were for high and strong south westerly winds. Marina docks and shoreline improvements had been damaged as a result of similar circumstances several years ago.

Terry Cunningham met Todd Brophy on this particular day in the late afternoon at the reservoir. The compressor was turned "ON" at 4:00 pm. The valve on the air header that provides air in and around the marina area was left "OPEN". Todd disconnected (2) two air headers from the air supply manifold in the access manholes. This provided a release of excess air to alleviate the compressor cycling. All other air header valves were turned "CLOSED".

Terry inspected the compressor later in the evening at approximately 10:00 pm to ensure that the compressor was operating and functioning appropriately. The unit was found to be operating properly.

Todd later during the week turned the other aeration header valves "OPEN" and reconnected the air header lines to the manifold that had been disconnected previously. The aeration pattern coverage on the surface of the reservoir appeared normal compared to the previous seasons after several days of operation. The unit operated continuously until April 18, 2009 when the first fault of the season occurred shutting down the system due to a snow storm that interrupted the electrical power.

The facilities were inspected a minimum of once each week during the season. Refer to **ATTACHMENT NO. 1 – 2009 AERATION EQUIPMENT LOG**.

EQUIPMENT SHUTDOWNS:

The compressor operated uninterrupted except for a number of shutdowns. The shutdowns are listed in **ATTACHMENT NO. 2 – 2009 SHUTDOWNS**. The shutdowns include times when the equipment was turned off for service or operating parameter changes. Most of the shutdowns that occurred were due to high equipment temperature.

EQUIPMENT MODIFICATIONS:

Several enhancements and modifications were installed to decrease and minimize the temperatures of the compressor and the building interior:

- Insulate the discharge duct
- Install additional "Backwash" panel
- Sliver the existing ceiling foam insulation board
- Relocate the blower unloader blow-off discharge air

DISCHARGE DUCT INSULATION

Hot air discharged from the heat exchanger is conveyed to the outside by a sheet metal duct having a large surface area. The large metal surface convects heat into the interior of the room. Foil laminated polyurethane sheets were installed on the exterior of the duct. After installing the insulation the external temperature of the duct is nearly the same as the ambient air temperature of the room. The temperature rise within the room appears to be (2) two degrees Fahrenheit above ambient with the insulation installed.

DISCHARGE DUCT INSULATION

BACKWASH PANEL ADDITION

It was observed after installing "blocking" panels last year that an amount of air discharged from the heat exchanger fans reenters the building. The stationary vanes of the existing louver located on the outside of the building direct the air that is discharged downward. This downward direction of the discharged air causes it to easily be swept into the building.

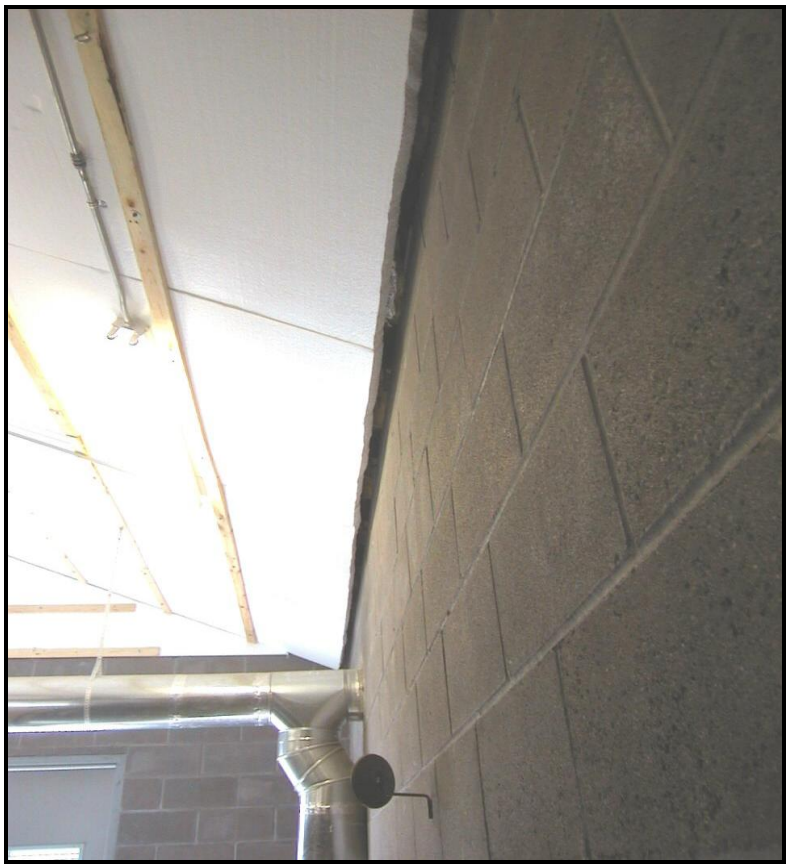
An additional (2') two vertical feet of polyurethane insulation board was installed below the discharge duct on the interior of the building. The polyurethane panels were installed in a frame fabricated from aluminum. The frame allows the pneumatic operated movable louver vanes to open and close without impinging on the movement.

BACKWASH PANEL

SLIVER CEILING FOAM

Polystyrene insulation foam was installed in the ceiling of the building interior shortly after the compressor began operation for the first time in 2008. The (2") two inch thick insulation was added to suppress the level of noise emanating from the building. This particular foam has good insulation properties (heat retention). Heat that rises from the equipment becomes trapped in the ceiling headspace.

A portion of the foam board was removed along the top of the wall. Approximately (4") four inches of foam was cut and removed around the interior perimeter of the block wall. This sliver allows some of the hot air to escape to the outside through the eve vents located just above the top of the wall.



FOAM BOARD SLIVER

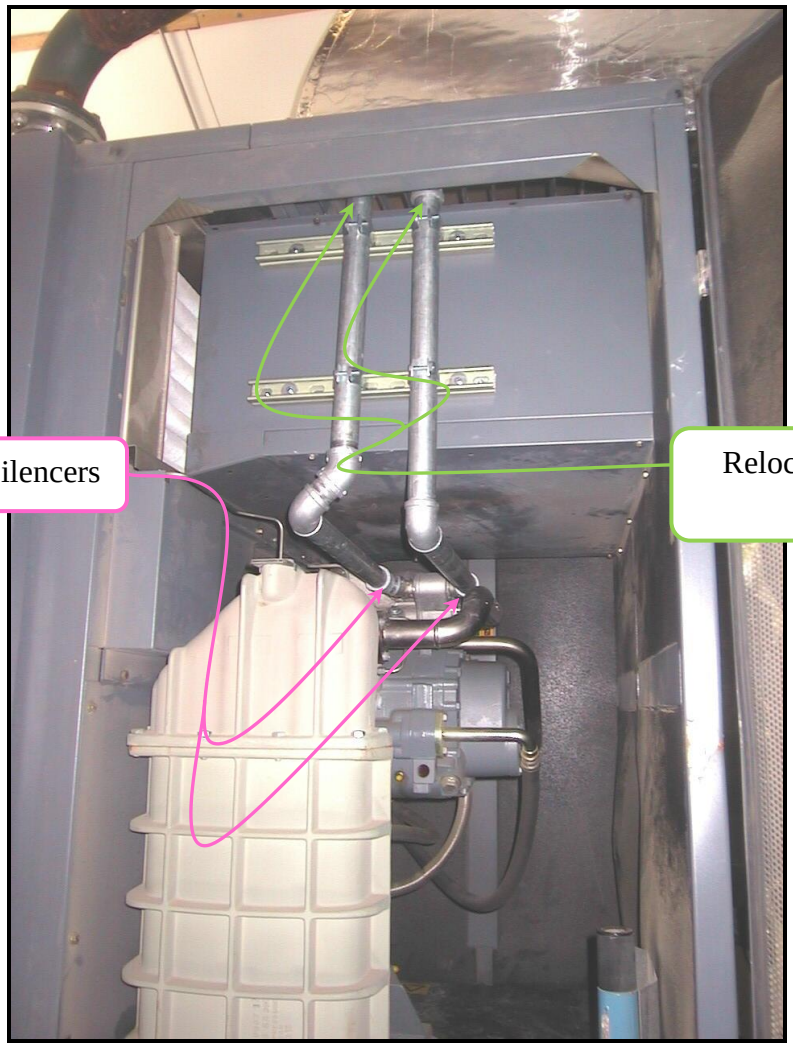
RELOCATION OF THE UNLOADER DISCHARGE

An integral component of the compressor is an Unloader Valve. This equipment feature allows the blower to operate without a load by closing the compressor inlet valve. Each time the inlet valve closes then opens a small amount of very high temperature air is relieved by the Unloader Valve. The very hot air is released into the cavity of the equipment enclosure. The release of air occurs an average of every (45) forty-five seconds. The temperature in close proximity of the unloader discharge is 450 ^{o} Fahrenheit.

It was suspected that the first Unloader Valve diaphragm failed due to heat prostration and fatigue. The Unloader Valve discharge was by design directed at the Unloader Valve housing. The silencer closest to the Unloader Valve was rotated "UP" as far as was practical prior to the 2009 operating season.

The surface temperature of the internals precluded performing this work until the unit was allowed to sufficiently cool. The modifications were effected after the equipment was shut down for the season. The full affect and benefit of this modification will not be recognized until the 2010 operating season.

The discharge piping was extended. The air discharged from the Unloader Valve is now released at a point within the discharge duct. The fan forced air utilized to cool the unit heat exchanger now sweeps the hot air released by the Unloader Valve to the outside.



RELOCATION OF THE UNLOADER VALVE DISCHARGE

EQUIPMENT PERFORMANCE:

SHORT CYCLING

It has been observed since the first season of operation that the aeration equipment "short cycles". The cycling is the result of the equipment "loading and unloading" to meet the demands of the system. The repetitive "On/ Off, Open/ Close" cycles have contributed to specific internal part failures.

The Cherry Creek Basin Water Quality Authority posed the following question, "How much significant reduction in the life of our compressor can we expect with it operating as it is presently in comparison to a smaller compressor more closely matched to the same airflow, or the same compressor with larger airflow?

Is there any increased chance of catastrophic loss of the compressor system in its current configuration due to the oversizing?" to the equipment manufacturer, Atlas Copco.

Atlas Copco responded that the extent of wear, damage and failure may only be discerned by disassembling the unit and inspecting the various machine parts. This inspection was arranged to coincide with the scheduled 8,000 hour service of the equipment. The 8,000 hour service includes inspection or replacement of most major internal component parts.

Power Service performed the 8,000 hour compressor service on 6/25/09. The items that were specifically requested by Atlas Copco were completed at the same time. It was concluded after inspection that no major equipment problems were noted or observed due to short cycling.

A Cherry Creek Reservoir Destratification Equipment Operating Cost Analysis report dated February 28, 2009 was prepared by TC Consulting Services to identify the costs of different operating schemes.

It has been determined at this time that the most economical operation of the equipment is replacing the few items subject to failure that are associated with short cycling. Historically, these items include the Unloader Valve Diaphragm, Unloader Valve Solenoid and (2) two gaskets. It appears that the frequency of replacement is once each year.

HIGH TEMPERATURE SHUT DOWN

The unit shut down a number of times later in the season due to "High Element Temperature". It is believed that the oil and the air heat exchanger cooling fins have fouled from dirt accumulations. The results of an inspection were included in the Cherry Creek Reservoir Destratification Equipment Element High Temperature Shut Down report dated September 14, 2009.

Cleaning of these elements was not accomplished in 2009 due to the prevailing weather conditions. Heavy equipment was necessary to transport water and a high pressure washer to the site. The soil along the access to the site became wet and saturated. The equipment would have caused ruts from the truck tires.

Monies to clean the elements have been appropriated in the 2010 budget and the work is scheduled to be performed prior to start up in 2010.

EQUIPMENT PARAMETER CHECKS

At the direction of Atlas Copco, Power Service performed a Shock Pulse Method (SPM) measurement of equipment vibration. As this was the first recorded measurement of the equipment it will provide a baseline for comparison in the future. An SPM measurement is a gauge of rotating machine balance. As parts wear especially bearings, the balance or vibration changes. SPM's will be performed with each service to determine if the equipment is wearing.

Additionally, the voltage and amperage draw of the motor is being checked and recorded. These monitoring checks have been performed at least once each month beginning in April. These measurements can provide a basis for diagnostic performance relating to the amount of electrical work required by the unit. These measurements are listed in **ATTACHMENT NO. 3 – 2009 ELECTRICAL MONITORING.**

FAULT MONITORING:

An alarm dialer was purchased and installed to continuously monitor the operation of the equipment. The dialer is remotely monitored by satellite communications by contract with a service company. Any time the equipment is turned off or shut down an alarm is initiated. The service company in turn contacts and notifies those who are identified on the "call" list. The alarm and notification system became fully operational on August 1, 2009.

OPERATION SUMMARY:

The equipment operated with few interruptions and no internal part failures during 2009. A summary of the annual statistics are listed in **TABLE NO. 1 – 2009 ANNUAL OPERATION SUMMARY** below:

2009 ANNUAL OPERATION SUMMARY											
	KWHR	RUN (HOURS)	LOAD (HOURS)	LOAD RELAY COUNT	UNIT STARTS	TEMPERATURE: DEGREES FAHRENHIET (° F)					OUTLET PRESSURE (PSI)
						OUTSIDE	AMBIENT	OUTLET	ELEMENT	OIL	
TOTAL	**7,823**	**6,384**	**3,147**	**571,525**	**90**						
MINIMUM						22	31	46	52	50	0.2
MAXIMUM						94	109	292	510	159	54.4
AVERAGE						65	73	97	445	124	50.3

RECOMMENDATIONS:

The following recommendations are provided for consideration to minimize repetition that leads to equipment fatigue:

- Operate the unit at the lowest discharge pressure that provides sufficient reservoir aeration
- Set the "Load" and "Unload" pressure settings to provide the greatest possible range between setpoints
- Install a meter to ascertain the volume and rate of air flow
- Install a pressure switch in the discharge pipeline that will initiate an alarm when pressure decreases to a minimum

Sincerely,

Terry Cunningham

ATTACHMENT NO. 1

2009 AERATION EQUIPMENT LOG

CHERRY CREEK BASIN WATER QUALITY AUTHORITY
RESERVOIR DESTRATIFICATION FACILITIES
2009 AERATION EQUIPMENT LOG

DATE	DAY OF WEEK	TIME OF DAY	UNIT HOURS	ELAPSED HOURS	UNIT STARTS	TEMPERATURE: DEGREES FAHRENHIET (° F)					OUTLET PRESSURE (PSI)
						OUTSIDE	AMBIENT	OUTLET	ELEMENT	OIL	
02/07/09	SAT	4:00 PM	5,476		127	54	53	55	52	50	54.4
02/07/09	SAT	10:00 PM	5,482	6	141	51	49	61	352	97	51.9
02/13/09	FRI	12:09 PM	5,616	134	172	30	50	65	355	100	54.2
02/20/09	FRI	12:20 PM	5,784	168	172	57	71	86	456	111	54.2
02/27/09	FRI	12:00 PM	5,951	167	172	39	63	80	445	105	54.3
03/02/09	MON	8:25 AM	6,020	69	172	44	59	75	433	103	54.3
03/06/09	FRI	11:51 AM	6,119	99	172	49	69	87	455	110	54.0
03/13/09	FRI	12:47 PM	6,287	168	172	44	63	80	445	107	54.0
03/20/09	FRI	12:02 PM	6,455	168	172	65	76	93	463	116	54.0
03/27/09	FRI	12:05 PM	6,623	168	172	22	44	59	420	100	50.4
04/03/09	FRI	12:35 PM	6,791	168	172	58	76	96	471	117	54.3
04/10/09	FRI	1:00 PM	6,960	169	172	58	75	91	469	113	54.2
04/17/09	FRI	12:23 PM	7,127	167	172	33	54	71	433	101	54.2
04/23/09	THU	3:12 PM	7,149	22	173	72	73	78	463	102	54.2
04/24/09	FRI	3:33 PM	7,172	23	176	73	79	107	462	127	52.7
04/30/09	THU	4:11 PM	7,317	145	176	66	78	109	445	127	52.7
05/01/09	FRI	11:18 AM	7,336	19	176	40	49	69	401	101	52.8
05/08/09	FRI	3:00 PM	7,508	172	176	66	81	96	467	122	53.7
05/15/09	FRI	3:41 PM	7,676	168	176	68	89	103	478	127	53.7
05/22/09	FRI	5:00 PM	7,846	170	176	71	77	97	461	122	53.4
05/29/09	FRI	12:32 PM	8,009	163	176	76	84	105	468	129	53.6
06/05/09	FRI	9:00 PM	8,186	177	176	68	75	97	460	124	53.6
06/12/09	FRI	3:00 PM	8,348	162	176	72	82	104	470	131	53.6
06/19/09	FRI	12:10 PM	8,513	165	176	72	80	103	468	133	53.2
06/21/09	MON	9:00 AM	8,582	69	176	72	76	98	463	128	53.7
06/25/09	THU	8:46 PM	8,666	84	176	62	72	96	456	126	53.5
06/27/09	SAT	4:00 PM	8,690	24	177	82	89	114	487	145	53.6
06/29/09	MON	12:15 PM	8,734	44	177	84	91	114	488	145	53.7
07/02/09	THU	12:26 PM	8,806	72	181	78	81	105	477	138	53.6
07/08/09	WED	3:43 PM	8,835	29	182	94	94	108	501	140	51.8
07/10/09	FRI	2:42 PM	8,882	47	182	91	95	117	504	150	51.6
07/17/09	FRI	12:00 PM	9,047	165	182	81	88	113	491	144	51.7
07/22/09	WED	4:30 PM	9,171	124	186	80	89	113	498	147	51.7
07/23/09	THU	6:39 PM	9,192	21	196	91	91	102	485	128	51.7

CHERRY CREEK BASIN WATER QUALITY AUTHORITY
RESERVOIR DESTRATIFICATION FACILITIES
2009 AERATION EQUIPMENT LOG

DATE	DAY OF WEEK	TIME OF DAY	UNIT HOURS	ELAPSED HOURS	UNIT STARTS	TEMPERATURE: DEGREES FAHRENHIET (° F)					OUTLET PRESSURE (PSI)
						OUTSIDE	AMBIENT	OUTLET	ELEMENT	OIL	
07/24/09	FRI	3:00 PM	9,212	20	196	94	97	126	501	159	51.7
07/31/09	FRI	3:07 PM	9,338	126	197	69	72	91	463	120	51.7
08/01/09	SAT	7:00 PM	9,367	29	198	81	73	103	468	135	51.7
08/04/09	TUE	3:28 PM	9,434	67	198	92	93	118	491	152	51.8
08/06/09	THU	5:50 PM	9,481	47	199	69	76	94	476	122	51.7
08/07/09	FRI	12:25 PM	9,500	19	199	85	91	119	494	152	51.7
08/14/09	FRI	11:30 PM	9,667	167	199	73	77	108	471	141	51.7
08/17/09	MON	7:20 AM	9,735	68	199	51	54	86	435	119	51.8
08/21/09	FRI	12:00 PM	9,835	100	199	77	82	111	473	145	51.6
08/28/09	FRI	11:53 AM	10,003	168	199	77	81	111	472	144	51.7
09/04/09	FRI	1:35 PM	10,173	170	199	83	92	123	492	157	51.9
09/11/09	FRI	12:12 PM	10,266	93	202	67	73	108	457	141	51.2
09/12/09	SAT	9:20 PM	10,299	33	202	87	53	87	429	120	51.3
09/16/09	WED	5:50 PM	10,392	93	202	72	73	108	456	142	51.3
09/18/09	FRI	12:20 PM	10,434	42	202	71	78	110	461	145	51.3
09/26/09	SAT	4:22 PM	10,631	197	202	80	87	112	510	147	51.1
09/28/09	MON	12:00 PM	10,631	0	203	60	61	70	434	85	51.3
09/30/09	WED	4:08 PM	10,678	47	204	80	79	85	443	114	51.2
10/02/09	FRI	1:35 PM	10,724	46	204	59	63	87	477	124	51.2
10/09/09	FRI	11:30 AM	10,890	166	204	52	56	87	449	124	51.2
10/10/19	SAT	7:06 PM	10,922	32	204	30	31	47	295	97	0.2
10/11/09	SUN	4:40 PM	10,922	0	205	35	36	46	403	73	51.2
10/15/09	THU	11:36 AM	11,015	93	205	65	76	110	466	147	51.3
10/23/09	FRI	2:38 PM	11,208	193	205	56	69	91	341	128	8.2
10/30/09	FRI	2:04 PM	11,375	167	205	38	53	80	374	117	52.5
11/06/09	FRI	3:40 PM	11,545	170	208	74	109	292	292	143	4.6
11/13/09	FRI	1:50 PM	11,572	27	217	51	54	70	452	94	52.6
11/20/09	FRI	1:20 PM	11,739	167	217	59	61	98	479	135	52.7
11/25/09	WED	2:13 PM	11,860	121	217	46	59	95	468	133	52.7

ATTACHMENT NO. 2

2009 SHUTDOWNS

CHERRY CREEK BASIN WATER QUALITY AUTHORITY
RESERVOIR DESTRATIFICATION FACILITIES
2009 SHUTDOWNS

DATE	DAY OF WEEK	TIME OF DAY	SHUTDOWN DESCRIPTION
04/18/09	SAT	9:42 AM	Snow Storm Caused Electrical Feed Fault
06/25/09	FRI	9:00 AM	8,000 Hour Service (performed by Power Service)
07/02/09	THU	12:26 PM	Replaced Air Filter (performed by Power Service)
07/08/09	WED	3:43 PM	Change Pressure Setpoints (51.5 Load, 45.0 Unload performed by Bob McGregor)
07/22/09	WED	4:41 PM	Change "Load" Pressure Setpoint from 45.0 to 46.5 PSIG
07/23/09	THU	2:00 PM	Terminated Wiring for Autodialer. Compressor Had to be Restarted at 6:00 PM Due to Heat
07/31/09	FRI	3:07 PM	Compressor Was Found "OFF"? No Faults Indicated.
08/01/09	SAT	7:00 PM	Terminated Wiring for "Alarm" to Autodialer
08/06/09	THU	5:30 PM	Alarm Call, Unit "OFF", Possibly Due to Electrical Storm Activity in the Area.
09/07/09	MON (Holiday)	3:20 PM	Fault, "High Element Temperature", 510° F, Reset Alarm and Restarted Unit
09/08/09	TUE	1:49 PM	Fault, "High Element Temperature", 510° F, Reset Alarm and Restarted Unit
09/10/09	THU	2:42 PM	Fault, "High Element Temperature", 510° F, Lowered "Unload" Pressure 51.5 → 51.0 PSIG
09/11/09	FRI	12:12 PM	Fault, "High Element Temperature", 510° F, Reset Alarm and Restarted Unit
09/26/09	SAT	4:22 PM	Fault, "High Element Temperature", 510° F, Reset Alarm and Restarted Unit
09/30/09	WED	4:08 PM	Fault, "Fan Overload", Reset Alarm and Restarted Unit.
10/10/09	SAT	7:06 PM	Fault, "Fan Overload", Reset Alarm and Restarted Unit.
11/06/09	FRI	3:00 PM	Fault, "High Element Temperature", 510° F, Reset Alarm, Unit Did Not Immediately Restart. Unit Was Restarted at 3:40 pm after cooling..
11/12/09	THU	1:40 PM	Fault, "High Element Temperature", 510° F, Reset Alarm and Restarted Unit
11/25/09	WED	2:13 PM	Shutdown for the Season

ATTACHMENT NO. 3

2009 ELECTRICAL MONITORING

CHERRY CREEK BASIN WATER QUALITY AUTHORITY
RESERVOIR DESTRATIFICATION FACILITIES
2009 ELECTRICAL MONITORING

DATE	DAY OF WEEK	TIME OF DAY	MOTOR VOLTAGE		MOTOR AMPERAGE			UNIT OPERATION DURATION (SEC)		TIME	
			PHASE	VAC	PHASE	LOADED	UNLOADED	LOAD	UNLOAD	ON	OFF
04/23/09	SAT	3:13 PM	$L_1 - L_2$	498	L_1	74.2	40.5	23	30	43 %	57 %
			$L_1 - L_3$	496	L_2	73.5	41.9				
			$L_2 - L_3$	500	L_3	68.2	37.4				
07/10/09	FRI	3:12 PM	$L_1 - L_2$	480	L_1	110.7	57.4	23	30	43 %	57 %
			$L_1 - L_3$	480	L_2	122.0	67.5				
			$L_2 - L_3$	480	L_3	115.5	64.7				
07/17/09	FRI	12:00 PM	$L_1 - L_2$	479	L_1	111.2	58.5	23	30	43 %	57 %
			$L_1 - L_3$	479	L_2	122.5	69.4				
			$L_2 - L_3$	483	L_3	116.3	64.7				
07/22/09	WED	4:41 PM	$L_1 - L_2$	480	L_1	109.8	56.6	24	30	44 %	56 %
			$L_1 - L_3$	480	L_2	122.0	67.1				
			$L_2 - L_3$	480	L_3	117.1	66.5				
07/31/09	FRI	3:26 PM	$L_1 - L_2$	482	L_1	116.8	61.6	46.5 PSI 17	21	45 %	55 %
			$L_1 - L_3$	482	L_2	123.0	68.1				
			$L_2 - L_3$	484	L_3	117.4	65.2				
08/14/09	FRI	11:30 PM	$L_1 - L_2$	486	L_1	114.4	59.9	16	20	44 %	56 %
			$L_1 - L_3$	487	L_2	121.4	67.4				
			$L_2 - L_3$	490	L_3	115.2	64.1				
09/04/09	FRI	1:40 PM	$L_1 - L_2$	478	L_1	111.9	57.6	16	22	42 %	58 %
			$L_1 - L_3$	479	L_2	121.2	66.9				
			$L_2 - L_3$	482	L_3	115.0	63.6				
10/09/09	FRI	11:30 AM	$L_1 - L_2$	480	L_1	115.9	61.1	16	18	47 %	53 %
			$L_1 - L_3$	480	L_2	123.3	71.0				
			$L_2 - L_3$	482	L_3	114.3	63.8				
11/20/09	FRI	1:20 PM	$L_1 - L_2$	481	L_1	115.7	60.3	45.0 PSI 28	52.5 PSI 38	42 %	58 %
			$L_1 - L_3$	481	L_2	124.1	70.2				
			$L_2 - L_3$	491	L_3	115.6	63.9				