

Utah Division of Water Quality

Statement of Basis

ADDENDUM

Wasteload Analysis and Antidegradation Level I Review - PRELIMINARY

Date: June 9, 2015

Facility: Castle Dale Wastewater Treatment Facility
Castle Valley Special Service District
UPDES No. UT0026663

Receiving water: Cottonwood Creek (2B, 3C, 4)

This addendum summarizes the wasteload analysis that was performed to determine water quality based effluent limits (WQBEL) for this discharge. Wasteload analyses are performed to determine point source effluent limitations necessary to maintain designated beneficial uses by evaluating projected effects of discharge concentrations on in-stream water quality. The wasteload analysis also takes into account downstream designated uses (UAC R317-2-8). Projected concentrations are compared to numeric water quality standards to determine acceptability. The numeric criteria in this wasteload analysis may be modified by narrative criteria and other conditions determined by staff of the Division of Water Quality.

Discharge

Outfall 001: Cottonwood Creek

The maximum daily design discharge is 0.95 MGD and the maximum monthly design discharge is 0.70 MGD for the facility.

Effluent parameters were characterized using data from monitoring site 4930900 Castle Dale Lagoons Outfall.

Receiving Water

The receiving water for Outfall 001 is Cottonwood Creek, which is tributary to Huntington Creek, which drains to the San Rafael River and the Colorado River.

Per UAC R317-2-13.1(b), the designated beneficial uses for Cottonwood Creek from confluence with Huntington Creek to Highway U-57 crossing are 2B, 3C and 4.

- *Class 2B - Protected for infrequent primary contact recreation. Also protected for secondary contact recreation where there is a low likelihood of ingestion of water or a low degree of bodily contact with the water. Examples include, but are not limited to, wading, hunting, and fishing.*
- *Class 3C - Protected for nongame fish and other aquatic life, including the necessary aquatic organisms in their food chain.*
- *Class 4 - Protected for agricultural uses including irrigation of crops and stock watering.*

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Typically, the critical flow for the wasteload analysis is considered the lowest stream flow for seven consecutive days with a ten year return frequency (7Q10). Due to a lack of flow records for Cottonwood Creek, the 20th percentile of flow measurements taken upstream of the outfall at the Highway U-10 crossing was calculated to estimate annual critical flow in the receiving water (Table 1).

Table 1: Annual critical low flow for Cottonwood Creek at U-10 crossing

Season	Flow (cfs)
Annual	1.1

Receiving water quality data were obtained from monitoring site 4930930 Cottonwood Creek at U-10 Crossing in Castle Dale. The average seasonal value was calculated for each constituent with available data in the receiving water.

Mixing Zone

The maximum allowable mixing zone is 15 minutes of travel time for acute conditions, not to exceed 50% of stream width, and 2,500 feet for chronic conditions, per UAC R317-2-5. Water quality standards must be met at the end of the mixing zone.

The actual length of the mixing zone was not determined; however, it was presumed to remain within the maximum allowable mixing zone dimensions. Acute limits were calculated using 50% of the seasonal critical low flow.

Parameters of Concern

The potential parameters of concern identified for the discharge/receiving water were total suspended solids (TSS), dissolved oxygen (DO), BOD₅, total phosphorus (TP), total nitrogen (TN), total ammonia (TAN), E. coli, pH, and total residual chlorine (TRC) as determined in consultation with the UPDES Permit Writer.

TMDL

Cottonwood Creek is listed as not impaired according to the 2010 303(d) list. The San Rafael River downstream of the confluence with Cottonwood Creek is listed as impaired for benthic macroinvertebrates.

Per UAC R317-2-14, Cottonwood Creek from the confluence with Huntington Creek to U-57 has a site specific criterion for TDS concentration of 3,500 mg/L that is based upon the EPA approved Total Maximum Daily Load (TMDL) *Price River, San Rafael River, and Muddy Creek TMDLs for Total Dissolved Solids, West Colorado Watershed Management Unit, Utah* (MFG Inc., 2004).

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WET Limits

The percent of effluent in the receiving water in a fully mixed condition, and acute and chronic dilution in a not fully mixed condition are calculated in the WLA in order to generate WET limits. The LC₅₀ (lethal concentration, 50%) percent effluent for acute toxicity and the IC₂₅ (inhibition concentration, 25%) percent effluent for chronic toxicity, as determined by the WET test, needs to be below the WET limits, as determined by the WLA. The WET limit for LC₅₀ is typically 100% effluent and does not need to be determined by the WLA.

Table 2: WET Limits for IC₂₅

Season	Percent Effluent
Annual	50%

Effluent Limits

Effluent limits for conservative pollutants were determined using a mass balance mixing analysis (UDWQ 2012). The mass balance analysis is summarized in Appendix A.

The water quality standard for chronic ammonia toxicity is dependent on temperature and pH, and the water quality standard for acute ammonia toxicity is dependent on pH. The AMMTOX Model developed by University of Colorado and adapted by Utah DWQ and EPA Region VIII was used to determine ammonia effluent limits (Lewis et al. 2002). The analysis is summarized in Appendix B.

The effluent limits for DO and BOD₅ in order to meet minimum DO criteria in the receiving water was evaluated using the Utah River Model. The analysis is summarized in Appendix B.

The limits for total residual chlorine were determined assuming a decay rate of 20 /day (at 20 °C) and a travel time of 8.3 minutes in the outlet pipe prior to discharge to Cottonwood Creek (approximately 1000 linear feet at 0.5 feet per second velocity). The analysis for TRC is summarized in Appendix C.

Table 3: Water Quality Based Effluent Limits Summary

Effluent Constituent	Acute			Chronic		
	Standard	Limit	Averaging Period	Standard	Limit	Averaging Period
Flow (MGD)		0.95	1 day		0.70	30 days
Ammonia (mg/L)			1 hour			30 days
Summer (Jul-Sep)	6.1	9.5		2.2	6.8	
Fall (Oct-Dec)	6.1	9.1		2.7	8.3	
Winter (Jan-Mar)	6.1	9.3		2.8	6.3	
Spring (Apr-Jun)	6.1	9.1		2.6	8.8	
CBOD ₅ (mg/L)	N/A	35	7 days	N/A	25	30 days
Dissolved Oxygen (mg/L)	3.0	5.0	Minimum	5.0	5.0	30 days
Total Dissolved Solids (mg/L)	3,500	3,500	Maximum			
Total Residual Chlorine (mg/L)	0.019	0.03	1 hour	0.011	0.03	4 days

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Model and supporting documentation are available for review upon request.

Antidegradation Level I Review

The objective of the Level I ADR is to ensure the protection of existing uses, defined as the beneficial uses attained in the receiving water on or after November 28, 1975. No evidence is known that the existing uses deviate from the designated beneficial uses for the receiving water. Therefore, the beneficial uses will be protected if the discharge remains below the WQBELs presented in this wasteload.

A Level II Antidegradation Review (ADR) is not required for this discharge since the pollutant concentration and load is not increasing under this permit renewal.

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Documents:

WLA Document: *castledale_potw_wla_2015_final.docx*
Wasteload Analysis: *castledale_potw_utstreamdo_wla_2015.xlsm*

References:

Utah Division of Water Quality. 2012. *Utah Wasteload Analysis Procedures Version 1.0*.

Lewis, B., J. Saunders, and M. Murphy. 2002. *Ammonia Toxicity Model (AMMTOX, Version2): A Tool for Determining Effluent Ammonia Limits*. University of Colorado, Center for Limnology.

MFG Inc. 2004. *Price River, San Rafael River, and Muddy Creek TMDLs for Total Dissolved Solids, West Colorado Watershed Management Unit, Utah*. Utah Division of Water Quality.

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WASTELOAD ANALYSIS [WLA]

Date: 6/9/2015

Appendix A: Mass Balance Mixing Analysis for Conservative Constituents

Discharging Facility: Castle Dale Lagoons
UPDES No: UT-0026663
Permit Flow [MGD]: 0.95 Annual Max. Daily
0.70 Annual Max. Monthly

Receiving Water: Cottonwood Creek
Stream Classification: 2B, 3C, 4
Stream Flows [cfs]: 1.1 All Seasons Critical Low Flow

Fully Mixed: NO
Acute River Width: 50%
Chronic River Width: 100%

Modeling Information

A simple mixing analysis was used to determine the effluent limits.

All model numerical inputs, intermediate calculations, outputs and graphs are available for discussion, inspection and copy at the Division of Water Quality.

Effluent Limitations

Current State water quality standards are required to be met under a variety of conditions including in-stream flows targeted to the 7-day, 10-year low flow (R317-2-9).

Other conditions used in the modeling effort reflect the environmental conditions expected at low stream flows.

Effluent Limitations for Protection of Recreation (Class 2B Waters)

No dilution in unnamed irrigation ditch.

Physical

Parameter	Maximum Concentration
pH Minimum	6.5
pH Maximum	9.0
Turbidity Increase (NTU)	10.0

Bacteriological

E. coli (30 Day Geometric Mean)	206 (#/100 mL)
E. coli (Maximum)	668 (#/100 mL)

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Effluent Limitations for Protection of Aquatic Wildlife (Assumed Class 3C Waters)

Inorganics	Chronic Standard (4 Day Average)		Acute Standard (1 Hour Average)
	Parameter	Standard	Standard
	Phenol (mg/L)		0.010
	Hydrogen Sulfide (Undissociated) [mg/L]		0.002

Metals-Total Recoverable

Parameter	Chronic (4-day ave)			Acute (1-hour ave)		
	Standard¹	Background	Limit	Standard¹	Background	Limit
Aluminum (µg/L)	N/A ³	20.4	N/A	750.0	20.4	1023.0
Arsenic (µg/L)	150.0	2.1	300.2	340.0	2.1	466.5
Cadmium (µg/L)	0.6	0.40	0.9	7.7	0.40	10.5
Chromium III (µg/L)	11.0	4.4	17.7	16.0	4.4	20.3
Chromium VI (µg/L)	230.7	4.4	460.5	1773.3	4.4	2435.3
Copper (µg/L)	29.3	5.0	53.9	49.6	5.0	66.3
Cyanide (µg/L) ²	5.2	3.5	6.9	22.0	3.5	28.9
Iron (µg/L)				1000.0	23.0	1365.6
Lead (µg/L)	10.9	0.9	21.1	280.8	0.9	385.6
Mercury (µg/L) ²	0.012	0.008	0.016	2.4	0.008	3.3
Nickel (µg/L)	168.0	5.4	333.2	1512.9	5.4	2077.1
Selenium (µg/L)	4.6	1.1	8.2	18.4	1.1	24.9
Silver (µg/L)				34.9	0.9	47.6
Tributyltin (µg/L) ²	0.072	0.048	0.096	0.46	0.048	0.61
Zinc (µg/L)	382.4	17.9	752.7	379.3	17.9	514.5

1: Based upon a hardness of 400 mg/l as CaCO₃

2: Background concentration assumed 67% of chronic standard

3: Where the pH is equal to or greater than 7.0 and the hardness is equal to or greater than 50 ppm as CaCO₃ in the receiving water after mixing, the 87 ug/L chronic criterion (expressed as total recoverable) will not apply, and aluminum will be regulated based on compliance with the 750 ug/L acute aluminum criterion (expressed as total recoverable).

Organics [Pesticides]

Parameter	Chronic (4-day ave)		Acute (1-hour ave)	
	Standard	Limit	Standard	Limit
Aldrin (µg/L)			1.5	1.5
Chlordane (µg/L)	0.0043	0.0043	1.2	1.2
DDT, DDE (µg/L)	0.001	0.001	0.55	0.55
Diazinon (µg/L)	0.17	0.17	0.17	0.17
Dieldrin (µg/L)	0.0056	0.0056	0.24	0.24
Endosulfan, a & b (µg/L)	0.056	0.056	0.11	0.11
Endrin (µg/L)	0.036	0.036	0.086	0.086
Heptachlor & H. epoxide (µg/L)	0.0038	0.0038	0.26	0.26
Lindane (µg/L)	0.08	0.08	1.0	1.0
Methoxychlor (µg/L)			0.03	0.03
Mirex (µg/L)			0.001	0.001
Nonylphenol (µg/L)	6.6	6.6	28.0	28.0
Parathion (µg/L)	0.0130	0.0130	0.066	0.066
PCB's (µg/L)	0.014	0.014		
Pentachlorophenol (µg/L)	15.0	15.0	19.0	19.0
Toxephene (µg/L)	0.0002	0.0002	0.73	0.73

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Radiological

Parameter	Maximum Concentration Standard
Gross Alpha (pCi/L)	15

Effluent Limitation for Protection of Agriculture (Class 4 Waters)

Parameter	Maximum Concentration			
	Standard	Background	Limit	
Total Dissolved Solids (mg/L)	3500	3500	3500	Site specific standard
Boron (µg/L)	750	127.6	1382	
Arsenic, Dissolved (µg/L)	100	2.1	199	
Cadmium, Dissolved (µg/L)	10	0.4	20	
Chromium, Dissolved (µg/L)	100	4.4	197	
Copper, Dissolved (µg/L)	200	5.0	398	
Lead, Dissolved (µg/L)	100	0.9	201	
Selenium, Dissolved (µg/L)	50	1.1	100	
Gross Alpha (pCi/L)	15	0.0	30	

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Appendix B: Utah Stream DO and AMMTOX Models

Discharging Facility: Castle Dale Lagoons
 UPDES No: UT-0026663
 Permit Flow [MGD]: 0.70 Annual Max. Daily
 0.95 Annual Max. Monthly

Receiving Water: Cottonwood Creek
 Stream Classification: 2B, 3C, 4
 Stream Flows [cfs]: 1.1 All Seasons Critical Low Flow

Fully Mixed: NO
 Acute River Width: 50%
 Chronic River Width: 100%

Modeling Information

The modeling approach used in this analysis included a combination of the following models.

(1) The Utah River Model, Utah Division of Water Quality, 1992. Based upon STREAMDO IV (Region VIII) and Supplemental Ammonia Toxicity Models; EPA Region VIII, Sept. 1990 and QUAL2E (EPA, Athens, GA).

(2) AMMTOX Model, University of Colorado, Center of Limnology, and EPA Region 8

Coefficients used in the model were based, in part, upon the following references:

(1) Rates, Constants, and Kinetics Formulations in Surface Water Quality Modeling. Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Athens Georgia. EPA/600/3-85/040 June 1985.

(2) Principles of Surface Water Quality Modeling and Control. Robert V. Thomann, et.al. Harper Collins Publisher, Inc. 1987, pp. 644.

All model numerical inputs, intermediate calculations, outputs and graphs are available for review and comment at the Division of Water Quality.

Model Input

Current Upstream Information

Season	Critical Low		Temp. Deg. C	pH Ave	pH Max	NH3 mg/L as N	BOD5 mg/l	DO mg/l
	Flow cfs							
Summer	1.1		20.5	8.14	8.30	0.05	3.50	5.96
Fall	1.1		7.8	8.16	8.30	0.05	3.50	9.22
Winter	1.1		3.2	8.07	8.30	0.05	3.50	7.59
Spring	1.1		15.2	8.20	8.30	0.05	3.50	7.15
	Org N		NO3					
	mg/L as N		mg/L as N					
Summer	0.20		0.45					
Fall	0.20		0.45					
Winter	0.20		0.45					
Spring	0.20		0.45					

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Projected Discharge Information

Season	Flow (MGD)		Temp.	pH	pH	Org N	NO3
	Max Daily	Ave Monthly	Deg. C	Ave	Max	mg/L as N	mg/L as N
Summer	1.0	0.7	16.5	7.30	8.10	1.00	1.00
Fall	1.0	0.7	11.4	7.33	8.10	1.00	1.00
Winter	1.0	0.7	8.6	7.63	8.10	1.00	1.00
Spring	1.0	0.7	12.4	7.26	8.10	1.00	1.00

Effluent Limitations

Current State water quality standards are required to be met under a variety of conditions including in-stream flows targeted to the 7-day, 10-year low flow (R317-2-9).

Other conditions used in the modeling effort reflect the environmental conditions expected at low stream flows.

Effluent Limitations for Protection of Aquatic Wildlife (Assumed Class 3C Waters)

Temperature (deg C)	Maximum
Instantaneous	27.0
Change	4.0

pH	Concentration
Minimum	6.5
Maximum	9.0

Dissolved Oxygen (mg/L)	Standard	Limit
Instantaneous Minimum	3.0	5.0
30-day Average Minimum	5.0	5.0

CBOD5 (mg/L)	Standard	Limit
Daily Maximum	N/A	35.0
30-day Average	N/A	25.0

Ammonia-Total (mg/L)	Chronic (30-day ave)			Acute (1-hour ave)		
	Standard	Background	Limit	Standard	Background	Limit
Summer	2.2	0.05	6.8	6.1	0.05	9.5
Fall	2.7	0.05	8.3	6.1	0.05	9.1
Winter	2.8	0.05	6.3	6.1	0.05	9.3
Spring	2.6	0.05	8.8	6.1	0.05	9.1

Model Rate Parameters and Coefficients

CBOD	CBOD	REAER.	REAER.	NBOD	NBOD		
Kd(20)	Kd(T)	Ka(20)	Ka(T)	Kn(20)	Kn(T)		
/day	/day	/day	/day	/day	/day		
1.00	0.93	20.0	19.3	1.00	0.89		
NH3	NH3	NO3	NO3	BENTHIC	BENTHIC		
LOSS	LOSS	LOSS	LOSS	DEMAND	DEMAND		
K5(20)	K5(T)	K6(20)	K6(T)	SOD(20)	SOD(T)		
/day	/day	/day	/day	gm/m2/day	gm/m2/day		
3.00	2.80	0.25	0.23	1.00	0.91		
Kd	Ka	Kn	K4	K5	K6	KCI	SOD
CBOD	Reaer.	NH3	Open	NH3 Loss	NO2+3	TRC	Benthic
{theta}	{theta}	{theta}	{theta}	{theta}	{theta}	{theta}	{theta}
1.047	1.024	1.08	1	1.047	1.045	1.06	1.065

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Appendix C: Total Residual Chlorine

Discharging Facility: Castle Dale Lagoons
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CHRONIC

	Season	Receiving Water	Standard	Total Effluent	Mixing Zone Boundary	Effluent Limit Without Decay	Temperature (°C)	Decay Rate (/day)		Travel Time (min)	Decay Coefficient	Effluent Limit
								@ 20 deg C	@ T deg C			
Discharge (cfs)	Annual	1.1		1.1	2.2							
TRC (mg/L)	Annual	0.000	0.011			0.022	20.0	20	20.0	8.333333	0.89	0.025

ACUTE

	Season	Receiving Water	Standard	Total Effluent	Mixing Zone Boundary	Effluent Limit Without Decay	Temperature (°C)	Decay Rate (/day)		Travel Time (min)	Decay Coefficient	Effluent Limit
								@ 20 °C	@ T °C			
Discharge (cfs)	Annual	0.6		1.5	2.0							
TRC (mg/L)	Annual	0.000	0.019			0.026	20.0	20	20.0	8.333333	0.89	0.029