Lake Powell Pipeline Phase I - Preliminary Engineering and Environmental Studies

Task 5 - Develop and Analyze Alternatives

Technical Memorandum 5.13A
Review of Water Quality and Treatment Issues

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TM 5.13A REVIEW OF WATER QUALITY AND TREATMENT ISSUES

5.13A.1 OBJECTIVE

The proposed Lake Powell Pipeline (LPP) will provide a new water supply to Southern Utah communities including St. George, Kanab and Cedar City. The water will be pumped at a maximum flowrate of approximately 100 mgd (144 cfs) from a proposed Intake along the southwest shore of Lake Powell and conveyed in a 139-mile raw water pipeline. An intake pump station and booster pump stations, small regulating reservoirs (forebays) and hydropower stations are planned along the pipeline alignment. The terminus of the initial pipeline segment is proposed to be the existing Sand Hollow Reservoir near St. George. The approximate travel time in the pipeline from Lake Powell to Sand Hollow Reservoir is 1.54 days at the design/maximum flow rate.

Sand Hollow Reservoir (volume = 50,000 ac-ft and depth = 65 ft when full) currently is used as off-line storage for the Quail Creek Water Treatment Plant (WTP), for aquifer recharge, and for recreation. Surplus water from the Virgin River is diverted into Sand Hollow Reservoir during spring runoff and then water from Sand Hollow Reservoir flows back into Quail Creek Reservoir during the summer and fall during low river flow periods. Quail Creek Reservoir (volume = 40,325 ac-ft and depth = 135 ft when full) also is filled from the Virgin River and provides the raw water supply for the 40 mgd (80 mgd ultimate) Quail Creek WTP. Groundwater from wells adjacent to Sand Hollow Reservoir (20 mgd maximum ultimate capacity) is pumped to the transmission system downstream of the treated water storage reservoirs at the Quail Creek WTP. All of these facilities are owned and operated by the Washington County Water Conservancy District (WCWCD).

In order to deliver LPP water to the Central Iron County Water Conservancy District (CICWCD) in the Cedar Valley, LPP water may flow through Sand Hollow Reservoir and into an existing 60-inch diameter pipeline that connects Quail Creek Reservoir with Sand Hollow Reservoir. This existing pipeline would be tapped to serve as the water supply to the Cedar Valley Pipeline (CVP). The LPP water would be pumped from these existing facilities through the 30-inch diameter, 38-mile long CVP. There are proposed intermediate pumping stations and small regulating reservoirs (forebays) along the pipeline alignment to the Cedar Valley. The approximate travel time in the CVP from Sand Hollow Reservoir to the Cedar Valley is 0.42 day at the design/maximum flow rate.

Water delivered to the Kane County Water Conservancy District (KCWCD) would be diverted from the LPP approximately 70 miles from the intake (approximately 69 miles upstream of the Sand Hollow Reservoir) and conveyed by a 21-inch diameter, 10.2-mile long pipeline. The terminus of the KCWCD pipeline to the Kanab area is a proposed new reservoir and water treatment plant in Johnson Canyon. The approximate travel time in the pipeline from Lake Powell to the Kanab area is 0.78 day at the design/maximum flow rate.

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The proposed annual delivery volumes and instantaneous flow rates to each of the Districts are:

- KCWCD = 4,000 af/year; peak pipeline flow = 6 mgd+/- = 6 cfs
- WCWCD = 70,000 af/year; peak pipeline flow = 70 mgd+/- = 108 cfs
- CICWCD = 20,000 af/year; peak pipeline flow = 20 mgd+/- = 31 cfs

The quality issues and treatment requirements of Lake Powell water are presented in this Technical Memorandum (TM). The quality of Lake Powell water is compared to existing supplies currently used in each community. Alternative methods of treating and then integrating the Lake Powell water into each community's existing transmission and distribution systems are then introduced.

This TM presents a "high-level" overview of water quality, treatment and regulatory compliance issues to provide information relative to the planning and environmental impacts of the proposed project. If the LPP proceeds, further analysis (typical of a preliminary design scope of work) is required relative to the issues discussed herein. A detailed water quality sampling program, specific for the LPP, should also be initiated as well as a State-required sanitary survey (drinking water source assessment).

5.13A.2 OVERVIEW OF LAKE POWELL WATER QUALITY

The Colorado River is used as the primary potable water supply for many agencies and for millions of citizens throughout the southwestern United States. Las Vegas and southern California derive much of their water supply from Colorado River water stored in Lake Mead and Lake Havasu. Colorado River water is delivered to Phoenix and Tucson via the Central Arizona Project (CAP). Untreated Colorado River water is conveyed long distances in pipelines and aqueducts. In many cases, treated Colorado River water is blended with local supplies including treated surface water and groundwater.

Water from Lake Powell is currently used as the drinking water supply for Page, Arizona. The mineral quality of the upper reaches of the Colorado River, including Lake Powell, is slightly better (i.e., lower TDS concentrations) than from the lower River where most of the water is currently diverted for use in Las Vegas, southern California and Arizona. There have been no major regulatory compliance problems via use of the Colorado River as a drinking water supply. However, there are quality challenges, regulatory compliance concerns and other issues related to the use of Colorado River water that must be carefully considered for the Lake Powell Pipeline project.

Existing, available water quality data was provided by each participant, as well as available data collected from other sources, and was reviewed to provide a general understanding of the lake's water quality to determine treatment requirements and regulatory compliance issues, as well as to compare with the quality of each community's existing supplies. A detailed water quality sampling program was not completed as part of this effort. Appendix A includes a detailed review of current and proposed future drinking water regulations and their impact on treatment requirements for Lake Powell.

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In general, the water stored in Lake Powell provides a good water source with respect to drinking water quality. The water must be treated to meet all drinking water regulatory requirements (State and Federal). As described above, the Colorado River is successfully used as a potable water supply for millions of citizens throughout the southwestern United States. Most of the treated water is produced by conventional filtration plants, but membrane filtration (microfiltration or ultrafiltration) is also used at a number of locations. A very small amount of this water is also treated by softening (to remove dissolved calcium and magnesium) and by demineralization (to remove TDS). The City of Page, Arizona currently uses water from Lake Powell (via Glen Canyon Dam) as its drinking water source. Page has a 2 mgd conventional filtration plant (without softening or demineralization) and uses chlorine for disinfection.

Some of the Colorado River is treated and stored via aquifer recharge and recovery systems. The City of Tucson, Arizona has been using large-scale aquifer recharge program since 2000 using CAP water.

Based on limited historical data collected by ambient monitoring programs in the vicinity of the proposed LPP Intake location, there appear to be very low (or non-existent) levels of regulated inorganic compounds, organic compounds, and microbiological constituents. There is a moderate concentration of disinfection by-product (DBP) precursors as indicated by total trihalomethane (TTHM) and haloacetic acid (HAA5) concentrations in Page's water distribution system. Page uses free chlorine as its primary and secondary disinfectant. Other water systems which use Colorado River water and which use free chlorine see higher TTHM/HAA5 concentrations in larger distribution systems (longer contact times).

A review of issues and concerns related to the potential presence of quagga mussels in Lake Powell, with respect to the LPP project, is presented in TM 5.13.B. A brief summary of quagga mussel control issues as well as general biota transfer issues, with respect to water quality and treatment is presented in this TM.

5.13A.3 MINERAL QUALITY, INORGANICS AND GENERAL QUALITY PARAMETERS

The Colorado River quality is generally described as moderately mineralized (total dissolved solids or TDS) with moderate hardness (dissolved calcium and magnesium). The water in the upper reaches of the Colorado River basin (upstream of Lake Powell) is generally lower in TDS and hardness compared to the lower Colorado River basin. The TDS in Lake Powell has been reported in the range of 400 to 650 mg/L over the past 15 years.

TDS concentrations in Lake Powell vary seasonally (depending on inflow) and also vary with water depth and reservoir elevation. TDS is generally lower in the winter and spring when inflows are higher. TDS concentrations in the lake generally increase with depth and are higher when the reservoir elevations are low. The prolonged drought in the basin over the past decade has resulted in lower inflows and significantly lower reservoir levels, which have tended to increase the TDS and hardness of the water stored in the reservoirs compared to long-term historical concentrations.

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The TDS concentrations at the proposed Intake elevation of 3,540 feet varied from 380 to 520 mg/L during a sampling program conducted from 1994 to 1998. More recent sampling in the Wahweap Bay area indicates TDS concentrations in the range of 500 to 650 mg/L. The LPP project should plan for potential TDS concentrations in the range of 360 to 650 mg/L (or possibly higher depending on drought conditions). The TDS concentrations can be as low as 400 mg/L depending on time of year and precipitation and runoff in the Colorado River basin.

Note that Utah DEQ has a suggested (secondary) maximum TDS concentration of 500 mg/L for potable water supplies. 500 mg/L TDS is also the maximum concentration for a groundwater to be classified "pristine Class IA" per Utah guidelines. TDS is a secondary standard, therefore it is not a strict requirement and would not eliminate the use of Lake Powell as a water supply. The treated water from WCWCD's Quail Creek WTP routinely has TDS values in excess of 500 mg/L.

There is less available total hardness data for Lake Powell compared to TDS data. Recent data near Wahweap Bay indicates total hardness concentrations in the range of 220 to 320 mg/L as $CaCO_3$. It is likely that trends in hardness are similar to trends in TDS, with respect to inflows, reservoir elevation and water depth. The LPP project should plan for potential hardness concentrations in the range of 250 mg/L to 300 mg/L as $CaCO_3$.

Limited data for total alkalinity in Lake Powell indicate a range from 130 to 180 mg/L as $CaCO_3$. It is probable that alkalinity varies seasonally and similarly to variations in TDS and hardness.

Other anions and cations of interest in Lake Powell include sodium (ranges from 60 to 90 mg/L as Na), chloride (ranges from 50 to 80 mg/L as Cl), and sulfate (ranges from 200 to 280 mg/L as SO_4). Silica ranges from 7 to 9 mg/L as SiO_2. Very low concentrations of dissolved iron and manganese are expected.

The pH of Lake Powell water is generally between 7.5 and 8.5 pH units. The pH appears to have periods of depression during the winter and spring months of some years, likely impacted by snowmelt runoff, and reservoir inflows. The pH tends to be higher in the summer and fall months. The pH range in Sand Hollow Reservoir is similar, although higher pH values (up to 8.8) have been occasionally reported.

The mineral quality and chemical nature of LP water will change depending on blending with the Virgin River water stored in Sand Hollow Reservoir and/or Quail Creek Reservoir. The mineral quality of water delivered to the Cedar Valley will reflect the blending and also other attributes of the reservoir(s) that the LP water is stored in, including the effects of detention time and seasonal variations.

The Lake Powell water temperature varies seasonally, by inflow and by reservoir elevation, but is fairly consistent from year to year. The overall average water temperature is approximately 11° Celsius. The lowest temperatures occur during the winter months (averaging 5° to 7° Celsius) and the highest temperatures occur during the summer months (averaging 15° to 17° Celsius). Temperatures in the lower part of the ranges are expected at the proposed Intake elevation of 3,540 feet. It is likely that the water temperature will moderate and will change as it flows in the long pipeline to Sand Hollow Reservoir. The ground temperature along the pipeline alignment will have a large impact on the ultimate temperature of water delivered into Sand Hollow Reservoir.

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The temperature of water delivered to Cedar Valley will depend on the temperature conditions in Sand Hollow Reservoir and/or in Quail Creek Reservoir. Current summertime maximum water temperatures of the raw water entering Quail Creek WTP can be as high as 26° Celsius. Water temperatures in Sand Hollow Reservoir have been observed to range from 4° to 30° Celsius.

A limited review of regulated inorganic contaminants, including metals, in Lake Powell indicates that there may be occasional very low concentrations of some metals present in the raw water. These metals are detected at such low levels, however, that they would not generally be reportable to the regulatory agencies nor are they a concern from a drinking water quality regulatory compliance perspective. The same can be said of the Virgin River water currently stored in Sand Hollow Reservoir and Quail Creek Reservoir.

Colorado River water is generally described as “non-corrosive” and users are generally able to comply with the Lead and Copper Rule (LCR) due to elevated pH and alkalinity of the water supply. The LCR requires 90% of “at-the-tap”, first-flush samples from selected homes to be below 0.015 mg/L and 1.3 mg/L for copper and lead, respectively. Recent data from the City of Page distribution system indicate lead concentrations less than 0.005 mg/L and copper concentrations less than 1.0 mg/L. The treated water from the Quail Creek WTP is also in compliance with the LCR.

5.13A.3.1 Turbidity

There is limited reliable turbidity and total suspended solids (TSS) data available from Lake Powell. Turbidity and TSS reflect the presence of suspended solids in the water and can impact water treatment and disinfection requirements. If significant TSS is present at the proposed LP Intake, then the potential deposition and clogging of the long pipeline would be of concern. Based on discussions with the City of Page staff, the raw water turbidity entering their WTP rarely, if ever, exceeds 5 NTU and is usually 2 NTU or lower. Page’s raw water comes from an outlet at the Glen Canyon Dam.

Various reaches of the Colorado River can experience turbidities in excess of 1,000 NTU. However, the reservoirs provide significant settling of suspended solids and the turbidity in the outflows (released water) are generally very low except during extreme flood conditions. The turbidity at the proposed LP Intake location could be impacted by infrequent elevated turbidity events due to lake turnover and localized disturbance areas. The LPP project should plan for maximum turbidities in the range of 5 to 10 NTU, but normal turbidities should be 2 NTU or less.

The turbidity of LP water after it is stored in Sand Hollow Reservoir and/or Quail Creek Reservoir will be dependent on various conditions within each reservoir and also based on whether it is blended with Virgin River water. Maximum raw water turbidities currently treated by the Quail Creek WTP can be as high as 100 NTU. The turbidity of water delivered to the Cedar Valley will reflect the turbidity of water stored in the reservoir(s) and may be higher than LP water delivered into Sand Hollow Reservoir.

If 100 percent LP water is stored in Sand Hollow Reservoir, it is likely that the turbidity of the stored water will be less than current reservoir conditions when storing Virgin River. The Virgin River carries a higher suspended solids/turbidity load than is observed within Lake Powell. If silt deposition is a current cause for decline in aquifer recharge rates at Sand Hollow Reservoir, it is

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possible that storage of Lake Powell water would reduce this impact due to lower turbidity/TSS levels.

5.13A.3.2 Organic Compounds

There is limited reliable data regarding the presence of regulated organic compounds in Lake Powell. There have been infrequent very low levels of some organic compounds as reported by the City of Page in its Annual Consumer Confidence reports including:

- Atrazine (herbicide) = 1 ppb; regulated MCL = 3 ppb
- Simazine (herbicide) = 0.07 ppb; regulated MCL = 4 ppb
- Hexachlorocyclopentadiene (waste from chemical factories) = 2 ppb; regulated MCL = 50 ppb

The LPP project doesn't appear to need to plan for the presence of elevated levels of organic compounds. Virgin River water currently stored in Sand Hollow Reservoir and in Quail Creek Reservoir does not contain elevated levels of organic compounds (in excess of current MCLs) either.

5.13A.3.3 Radionuclides and Radon

Any detections of regulated radionuclides in Lake Powell have been at concentrations well below the MCLs. Radon is a dissolved gas sometimes found in groundwater, but is not present in Lake Powell. The same situation exists for Virgin River water stored in both WCWCD reservoirs.

5.13A.3.4 Disinfection By-Product Precursors (Total Organic Carbon)

There is limited reliable total organic carbon (TOC) data available from Lake Powell. TOC and other parameters (such as UV-254) are often used as indicators/surrogates of DBP (TTHM and HAA5) precursor compounds. The Colorado River is known to have TOC concentrations in the range of 2.0 to 4.0 mg/L, which is considered moderately-low compared to other US water supplies. The prolonged drought in the Colorado River basin has tended to increase TOC concentrations slightly compared to historic levels.

The Disinfection By-Product (DBP) Rule requires specific TOC removal percentages depending on TOC concentration and alkalinity. Based on the TOC concentration between 2 and 4 mg/L and alkalinity greater than 120 mg/L as $CaCO_3$ in Lake Powell water, a conventional water treatment plant will be required to remove at least 15% of the TOC, as determined on a monthly basis. The Page WTP has limited TOC data available (with raw water TOC between 2 and 3 mg/L), but appears to be able to meet the TOC removal requirement. The Quail Creek WTP is able to meet the TOC removal requirement while currently treating Virgin River water stored in Quail Creek Reservoir.

5.13A.3.5 Disinfection By-Products (DBPs)

Even though the TOC concentrations in Lake Powell water are considered to be moderately-low, various users of Colorado River water report maximum TTHM concentrations in the range of 80 to 120 ppb and maximum HAA5 concentrations in the range of 50 to 90 ppb when using free chlorine as the primary disinfectant. Regulated MCLs for TTHM and HAA5 are 80 ppb and 60 ppb, respectively, on a running annual average (RAA) basis. Even with the required TOC removal by a conventional water treatment plant as noted above, it is usually not possible to meet the TTHM

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and/or HAA5 MCLs when using free chlorine as the residual in the distribution system. The City of Page reported maximum TTHM and HAA5 concentrations of 66 ppb and 55 ppb, respectively, in 2006, and it has a relatively small (low contact time) distribution system.

The formation of DBPs in the distribution system is primarily dependent on water quality, disinfectant, and detention time. Water quality includes the presence of precursor material, water temperature, and treated water pH. The disinfectant type and dose, as well as the detention time in the distribution system, are also significant in the types of species and levels of DBPs formed. Peaks in individual samples may occur throughout the year, but the highest levels are often observed during low-demand periods and when DBP precursor (TOC) concentrations are elevated. Higher temperature source water will also contribute to elevated DBP concentrations.

Many utilities which use Colorado River as its primary supply use chloramines as the distribution system residual to minimize TTHM/HAA5 concentrations and to maintain a residual in large distribution systems. Many WTPs use ozonation as a DBP control process, as well as for T&O control. Some communities are able to blend Colorado River water with other sources, such as groundwater, to reduce DBP concentrations. The Page WTP does not use ozone nor does it use chloramines for DBP control. Its distribution system is relatively small and the detention time is therefore relatively short. The Quail Creek WTP produces low enough DBP concentrations to meet regulatory requirements while using free chlorine, but this is partly due to blending of the treatment plant effluent with other groundwater supplies which are lower in DBP concentrations.

No drinking water utilities in Utah currently use chloramines as a distribution system residual, including those in the St. George, Cedar City and Kanab areas. An evaluation of DBP control options for each user of LP water will be required as part of the preliminary design phase of the LPP.

5.13A.3.6 Microbiologicals

There is limited reliable data available from Lake Powell for several microbial constituents. The constituents of interest include fecal coliform and E.Coli, as potential indicators of human waste contamination, as well as the regulated protozoa Giardia and Cryptosporidium. Coliform levels are considered to be moderately low in Lake Powell, but can be relatively high within the Colorado River watershed. As with other constituents, settling and detention time in the reservoirs reduces microbial concentrations. Coliform concentrations can spike throughout the year, but the largest peaks are experienced during winter months, likely impacted by rainfall runoff and higher suspended solids concentrations.

Giardia and Cryptosporidium concentrations are believed to be relatively low in Lake Powell based on low concentrations observed in Lake Mead and Lake Havasu. It is believed that Lake Powell water would fall into Bin 1 in terms of Cryptosporidium concentrations (very low levels) per the Long-Term 2 Enhanced Surface Water Treatment Rule and therefore would not require enhanced disinfection. A site-specific sampling program at the proposed Intake location is required to confirm the regulatory and treatment requirements for microbial inactivation/removal. This would be part of the recommended source water assessment and water quality sampling program.

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The Quail Creek WTP using Virgin River water has been put into Bin 1 (very low Cryptosporidium levels) following its required 24-month sampling program. This needs to be verified with WCWCD.

5.13A.3.7 Tastes and Odors

There has been limited monitoring for taste and odor (T&O) compounds, such as geosmin and methylisoborneol (MIB), in Lake Powell. MIB and geosmin impart earthy/musty T&O which cause customer complaints when concentrations exceed 5 parts per trillion (ppt). The City of Page reports that it does not experience any significant T&O complaints from its customers. However, the presence of algae and T&O compounds is reported to be of some concern in lower Colorado River reservoirs (including Lake Mead and Lake Havasu), as well as in some Southern California storage reservoirs that receive Colorado River water. The continual lowering of reservoir levels due to drought conditions has enhanced concerns regarding higher temperatures, algae growth, and increased T&O problems.

Since LP water will be stored in Sand Hollow Reservoir and perhaps also in Quail Creek Reservoir, there is the strong possibility that T&O will be a routine concern for users of Lake Powell water in St. George and in the Cedar Valley. This is based on the fact that the Virgin River/Quail Creek supply has been experiencing severe T&O issues over the past few years (due to elevated concentrations of MIB and geosmin in the Spring, Summer and Fall), and is a primary reason why an ozone oxidation process is being added at the Quail Creek WTP.

If either Cedar Valley or Kanab use local surface water impoundments to store LPP water, then T&O will also probably be an issue from those impoundments also, due to the potential for warmer temperatures and algae growth.

5.13A.3.8 Summary of Lake Powell Water Quality Issues

Lake Powell is considered an acceptable source of drinking water supply. Water from the Colorado River basin has a relatively high concentration of dissolved minerals (TDS) and hardness (calcium and magnesium) which may differ from some supplies currently used in the St. George, Cedar City and Kanab areas. In order for Lake Powell to be used for potable/culinary purposes, it must be treated to meet the Long-Term 2 Enhanced Surface Water Treatment Rule to remove/inactivate particulates and microbial organisms. This treatment can be via a conventional filtration plant or via a membrane filtration plant. It may also be possible to recharge aquifer(s) with LP water and then use for potable purposes via extraction from wells. These potential uses are briefly introduced in this TM and are discussed in more detail in TM# 5.13-C.

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Table 5.13A.1 – Comparison of Water Quality with District's Supplies

Parameter	St. George Area									Cedar Valley Area					Kanab Area				
	Gunlock Wells	Snow Canyon Wells	Quail Creek WTP	Sand Hollow Res.	Sand Hollow Wells	Mill Creek Wells	Tollman Wells	City Creek Wells	Mountain Springs	West City Springs	CC Quichap a Well #7	CC Enoch North Well #3	Enoch Ravine Well	Enoch Ironwork s Well	CICWCD Derby Well #1	KCWCD Johnson Cnyn Well #2	Kanab City West Fork Well #3	Kanab City Well #15	Untreated Lake Powell Water
Ammonia (mg/L as N)				<0.04	<0.2						<0.05	<0.2	<0.2	<0.2	<0.2	< 0.2	<0.4	0.7	< 0.03
Arsenic (ug/L as As)				1.1 to 2.0															
Barium (mg/L as Ba)	0.1	0.083	0.073		0.3	0.042	0.025	0.016	0.005	0.013	0.053	0.12	0.082	0.087	0.013	0.48	0.18	0.071	
Boron (mg/L as B)					0.05						0.064	0.05		0.05	,0.05				
Calcium (mg/L as Ca)	91	22 to 40	70 to 115	63 to 78	30 to 35	49	78.7	129	18	66.2	33.4	47		44	51.3	34	15	45	60 to 80
CCPP (mg/L as CaCO3)	8	NC	-5	5	-100	-50	3	15	NC	NC	-30	-2	NC	-75	-50	-200	-345	-65	3
Chloride (mg/L)			20 to 45	45 to 80	10 to 20						11	14	12	12	7	5	2	7	50 to 80
Color (PCU)					1						1	< 5		5	0	ND	<5	5	
Conductivity (umhos/cm)				710 to 930	300 to 400						309	370		430	571	314			800 to 1100
Dissolved Oxygen (mg/L)			saturated	saturated															saturated
Fluoride (mg/L as F)	0.2	0.2	0.2	0.2 to 0.3	0.2	0.2	0.3	2.4	0.2	0.6	0.24	0.3	0.3	0.2	0.3	<0.1	<0.1	<0.1	
Langlier Saturation Index (LSI)	0.09	NC	-0.01	0.1	-0.4	-0.15	0.07	0.3	NC	NC	-0.13	-0.01	NC	-0.23	-0.14	-0.56	-0.98	-0.2	0.15
Magnesium (mg/L as Mg)	14	7.4 to 20	28 to 31	26 to 30	16 to 18	15	18.4	17.7	4.76	18.7	11.5	21		28	33.4	12.2	13	21	20 to 28
Nitrate (mg/L as N)	0.1	0.1	ND	0.3 to 0.4	1 to 3	0.3	0.5	0.2	0.2	0.7	0.25	0.8	1.1	0.9	0.4	1.6	1.9	1	< 0.6
pH	7.7?	7.0?	7.3 to 7.8	7.8 to 8.8	7.6 to 8.0	7.75?			7.7?		8.15?	7.8	7.15	7.6	7.4	7.2	7.6	7	7.8 to 8.2
Potassium (mg/L)	16	1.5 to 2.0	3.9	3.3 to 4.4	1.5 to 2.0	1.9	15.5	15.6	ND	9.4	1.6	5.9		3.7	2	1.4	2	2.4	2.5 to 4.0
Silica (mg/L as SiO2)				5 to 11	15 to 17						37.4	51		36	17.3				7 to 9
Sodium (mg/L)	16	5.6?	42.1	45 to 60	9 to 12	6.5	142	160	4.3	140	11.7	25	22	17	12.3	4.3	2.6	6.6	65 to 90
Sulfate (mg/L)	23	17?	240 to 380	120 to 160	12 to 16	88	380	410	2	290	23.8	24	27	26	148	9	3	<5	210 to 280
TDS (mg/L)	298	135?	525 to 625	440 to 570	200 to 260	272	776	940	44?	628	210	204	276	300	406	190	96??	236	360 to 680
Temperature (C)			7 to 26	4 to 30								19?					12		7 to 16
Total Alkalinity (mg/L as CaCO3)			130 to 170	130 to 200	115 to 125						118	180		200	180/140	120 to 160	82	209	135 to 180
Total Hardness (mg/L as CaCO3)	200 to 220	80 to 180	330 to 400	260 to 310	150 to 160	180	272	200	70 to 100	220 to 250	131	200		230	266	135	91	199	240 to 320
Total Organic Carbon (mg/L)			1.3 to 2.7																2.0 to 3.0?
Turbidity (NTU)	0.24	<0.02	<0.05		<0.5	0.04	4.3	0.5	0.26	0.02	0.52	6.1?	2.6?	2.4?	3.5?	0.16	0.93	<0.5	

- TTHMs in Page, AZ Distribution System = 66 ppb in 2006 (per CCR)
- Barium in Page, AZ water = 0.12 mg/L in 2006 (per CCR)
- Sodium in Page, AZ water = 80 mg/L in 2006 (per CCR)
- Water Temperature in Page, AZ water ranged from 8 to 12 C in 2006 (per Ops Reports)
- HAA5 in Page, AZ Distribution System = 37 to 55 ppb in 2006 (per CCR)
- Fluoride in Page, AZ water = 0.29 mg/L in 2006 (per CCR)
- pH in Page, AZ treated water ranged from 7.3 to 7.8 in 2006 (per Ops Reports)
- TOC in Page, AZ treated water = 2.5 mg/L in sample taken on 3/22/04
- Page withdraws and treats water from Lake Powell via the Glen Canyon Dam outlet penstock - 2 mgd WTP
- LSI and CCPP are calculated values based on pH, Temperature, TDS, Calcium, and Alkalinity - the values presented in this table may be inaccurate due to the limited amount of data, potential inaccuracy and variability of the data for each supply

Major water quality concerns or regulatory issues with respect to Lake Powell include:

- Compatibility with local water supplies currently used in the St. George, Cedar City and Kanab areas especially mineral quality (TDS and hardness)
- Issues related to storing Lake Powell water in Sand Hollow Reservoir and/or in Quail Creek Reservoir, which may alter the LP quality (such as temperature, minerals, tastes and odors, and DBPs) and perhaps have different treatment requirements compared to 100 percent LP water
- Relatively-high formation potential for TTHMs and HAA5 when free chlorine is used as the residual
- Potential taste and odor problems
- Effects of the preferred quagga mussel control program on water quality and regulatory compliance
- Impacts of LP and associated quality issues on current and possible future aquifer recharge programs

5.13A.4 REVIEW OF KEY WATER QUALITY ISSUES FOR THE LPP PROJECT

5.13A.4.1 Compatibility With Existing Water Supplies (Mineral Quality)

As explained above, there are a number of water quality and related issues which must be carefully considered to ensure that the proposed LP supply is an acceptable water source for the participants. Most importantly, the new supply should be acceptable to the customers and end users while also meeting all drinking water regulations and delivered in a cost-effective manner.

Table 5.13A.1 presents a summary of water quality data for the existing water supplies used within each community as well as for the untreated Lake Powell water. In general, the quality of Lake Powell water is similar to the Virgin River supply used in the St. George area (and similar to some of the groundwater), but is significantly different compared to the groundwater supplies currently used in the Cedar Valley and in the Kanab area. The Lake Powell water has higher TDS and higher hardness than those groundwaters.

Table 5.13A.2 presents a generalized comparison of some of the key water quality parameters for various sources. The differences in water quality are common in locations which have historically used a single source of supply (such as when a new surface water supply is introduced to a historical groundwater system, or vice-versa), but they can be addressed and resolved in a number of different ways, and are not insurmountable. A review and discussion of each participant's issues and potential concerns are presented in the following paragraphs.

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Table 5.13A.2 – Comparison of Various Water Quality Parameters with District's Supplies

Parameter	Lake Powell	Sand Hollow Reservoir	Quail Creek WTP Effluent	Cedar Valley Groundwater	Kanab Groundwater
TDS (mg/L)	360-680	450-670	525-650	200-400	150-250
Hardness (mg/L as CaCO3)	240-320	260-310	330-400	130-260	100-200
pH	7.8-8.3	7.8-8.8	7.3-7.8	7.0-7.5??	7.0-7.5??
Temperature (C)	7-16?	4-30	7-26	10??	10??
Sodium (mg/L)	65-90	45-60	40-50	10-25	5-10
Chloride (mg/L)	50-80	45-80	20-45	10-15	5-10
Sulfate (mg/L)	210-280	120-160	240-380	20-30	5-10
Silica (mg/L as SiO2)	7-9	5-11	??	35-50	??

5.13A.4.1.1 St. George Area

The St. George area receives potable water from a number of sources including:

- Quail Creek WTP (40 mgd conventional plant, expandable to 80 mgd)
- Multiple groundwater wells located in different areas
- A few springs located in different areas
- A small (3 mgd) membrane filtration plant near the provider's water to Washington County is also used to treat Quail Creek/Virgin River water

The wells include those located adjacent to the Sand Hollow Reservoir which deliver chlorinated water to the Quail Creek WTP transmission pipeline downstream of the plant's clearwells. Currently, the Sand Hollow wells produce water quality representative of the Navajo Sandstone aquifer, but the on-going recharge program will alter the quality from these wells (higher TDS and hardness) over time.

Most customers within the area receive a blend of groundwater and Quail Creek water. Some of the groundwater has elevated levels of arsenic and blending with Quail Creek water helps achieve compliance with the 10 ppb MCL. The mineral quality (TDS and hardness) of the wells varies by location with a wide range of TDS and hardness as shown in **Table 5.13A.2**. Some of the wells have TDS values greater than that from Quail Creek WTP.

Lake Powell water has similar TDS and alkalinity compared to the Virgin River/Quail Creek WTP water currently being distributed within the St. George area. Quail Creek water has higher hardness and higher sulfate compared to Lake Powell and also compared to water stored in Sand Hollow Reservoir. The sodium and chloride concentrations in Lake Powell water are slightly higher compared to Quail Creek water.

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Based on a few discussions with WCWCD and St. George staff, there do not appear to be many complaints related to the mineralized nature of the water distributed, nor are there many complaints related to different quality between Quail Creek water and groundwater. There also do not appear to be any "dirty water" complaints which may arise from un-lined metallic pipes in older areas of the distribution systems. Over time, the older unlined metallic pipe will eventually be replaced with new pipe (lined or non-metallic).

The biggest customer complaint in the St. George area relates to the significant earthy/musty tastes and odors which come from the Quail Creek WTP. These tastes and odors are the result of significant concentrations of MIB and/or geosmin which are present in Quail Creek Reservoir on a seasonal basis due to excessive algae growth. The plant is adding an ozonation system to control T&O in the future.

The Quail Creek WTP, which includes chemical coagulation, PAC addition, DAF clarification and granular media filtration is suitable for treatment of Lake Powell water. The smaller membrane filtration plant near Hurricane should also be able to successfully treat Lake Powell water.

In summary, the Lake Powell water quality is similar in many ways to the existing Quail Creek WTP supply and it is not expected that it will present any significant treatment or quality problems for the St. George area. Its quality is also similar enough to the Virgin River quality that it should not have any major impacts on the aquifer recharge program at Sand Hollow Reservoir. As mentioned previously, the LP water should have a lower suspended solids/turbidity level compared to Virgin River water and may then improve recharge rates if siltation is a major reason for declining recharge rates. Refer to TM 5.13C for additional information regarding aquifer recharge of LP water.

5.13A.4.1.2 Cedar Valley Area

The Cedar Valley area is supplied potable water solely from groundwater from three suppliers:

- City of Cedar City
- City of Enoch
- Central Iron County Water Conservancy District (CICWCD)

Groundwater quality within the valley varies with the highest quality (lowest TDS) water being derived from wells closest to Quichipa Lake. The groundwater basin has been classified by Utah DEQ into three distinct areas including Class IA (pristine – TDS < 500 mg/L), Class II (TDS between 500 and 1500 mg/L), and Class II (TDS > 1500 mg/L).

Each supplier has multiple wells to meet demands. Water quality data from two wells from Cedar City, two from Enoch and one from CICWCD are presented in Table 1. All of the wells presented in **Table 5.13A.1** represent Class IA groundwater, but it should be noted that some of the wells have TDS concentrations as low as 200 mg/L and some have TDS as high as 400 mg/L.

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As shown in **Table 5.13A.2**, the mineral quality of LP water is significantly different than the current groundwater supplies:

- LP water as 2 to 3 times higher TDS
- LP water has 1.5 to 2 times higher hardness
- LP water has 3 to 5 times lower silica
- LP water has higher pH
- LP water has a wide temperature variation and much warmer water during summer

These water quality differences will be very noticeable to customers currently accustomed to local groundwater supplies. The harder water may result in increased use of water softeners in the community. The different water quality may also impact/disrupt existing distribution systems (especially those with un-lined metallic pipes). Less silica in the LP water may be a benefit to some users including industrial/commercial customers that require low-silica water for high purity uses and for boilers and HVAC systems.

The issues facing the Cedar Valley with respect to importing Lake Powell water are very similar to those which the City of Tucson, Arizona faced two decades ago when it decided to bring CAP water from Lake Havasu into its water system. The lessons learned from the Tucson experience are presented later in this TM. The challenging water quality issues facing the Cedar Valley can be resolved with careful analysis and planning with respect to water treatment and integration of the new supply into the distribution systems, along with a public education and involvement program.

One of the most-challenging decisions facing the Cedar Valley is whether to implement an expensive demineralization treatment process (such as Reverse Osmosis) to treat LP water such that the TDS is made to “match” the existing groundwater quality. Further discussion about this is presented later in this TM and also in TM 5.13.C.

5.13A.4.1.3 Kanab Area

The Kanab area is supplied potable water solely from groundwater from three suppliers:

- City of Kanab
- Kane County Water Conservancy District (KCWCD)

The groundwater quality in the area is generally good and with similar TDS and hardness (perhaps even lower) as the groundwater in the Cedar Valley. The Utah DEQ has not yet classified the groundwater basin in and near Kanab, but much of the basin would be expected to be classified Class IA (pristine – TDS < 500 mg/L). There are some localized areas with higher TDS.

Each supplier has multiple wells to meet demands. Water quality data from two wells from Kanab City and one from KCWCD are presented in **Table 5.13A.1**. All of the wells presented in **Table 5.13A.1** represent Class IA groundwater, but it should be noted that some of the wells have TDS concentrations around 200 mg/L.

Table 5.13A.2 presents a comparison of selected water quality parameters for Kanab, Lake Powell and Cedar Valley. The water quality and treatment issues facing Kanab are very similar to Cedar Valley's with respect to the proposed LP supply.

5.13A.4.2 DBP Control Options for Lake Powell Water

There are a number of potential approaches to resolving THM/HAA5 formation issues to allow Lake Powell users to meet the requirements of the D/DBP Rule. All of the water systems in each community currently use free chlorine for their water supplies and, as mentioned above, none use chloramines. It is assumed that chloramines are not desired for use by any of the participants, especially since chloramines are not used in any Utah drinking water systems. Therefore, it is assumed that free chlorine is desired to be used as the distribution system residual in all participants' water systems.

If the LP water is to be treated by a conventional water filtration plant, the plant should include ozonation as a process to reduce the DBP formation potential. Ozonation has proven to be an effective DBP control process in other plants treating Colorado River water. Ozonation will also provide other benefits including T&O control and enhanced disinfection. As mentioned previously, the Quail Creek WTP will be adding ozone to control T&O and for DBP control benefits.

Enhanced coagulation is not considered a cost-effective method to reduce DBP formation due to the extremely high coagulant and acid/base chemical addition requirements, in addition to significantly higher sludge handling and disposal requirements.

It may also be necessary to blend treated water with groundwater to allow full compliance with the D/DBP Rule, depending on the actual TTHM/HAA5 concentration produced by the LP treatment plant(s). Each community should be able to continue using local groundwater supplies after the LP supply is brought on-line.

If LP water is to be re-charged into an aquifer(s) for extraction by wells (such as is done with CAP water in Tucson), then the DBP formation potential of the extracted water may be significantly lower compared to the recharge water. This has been demonstrated to occur in Tucson's situation, such that no additional treatment of the extracted water is required besides chlorination and pH adjustment.

If the quagga mussel control approach forms DBPs (such as if chlorination of the source water at the intake is practiced), then these DBPs will be present in the stored water and in the recharge water unless they can be removed. This will be a challenging aspect of the LPP project to resolve.

5.13A.4.3 Taste and Odor Control Options for Lake Powell Water

Based on the experiences in Page, Arizona, the direct use of Lake Powell water is not expected to have a high level of tastes and odors. However, it should be assumed that LP water which is stored in Sand Hollow Reservoir and/or blended with Virgin River water in Quail Creek Reservoir will require treatment for T&O control due to recent T&O problems that have been experienced with these supplies. The 40 mgd Quail Creek WTP in St. George will be adding ozonation as a process to reduce/eliminate undesirable earthy/musty tastes and odors (from MIB and geosmin) caused by algal activity in Quail Creek Reservoir. Also, the 3 mgd membrane filtration Washington County WTP will be adding a post-filter GAC contact system to remove the T&O compounds since it also uses Quail Creek/Virgin River water as its raw water source.

If LP water is stored in a surface impoundment in the Cedar Valley and/or in Kanab, then T&O may also be a concern for those communities due to the potential for algal activity and MIB/geosmin formation.

Any new WTP for LP water should have either ozone or GAC or both to provide T&O control and other benefits.

The fate of T&O compounds in the aquifer(s) needs to be evaluated if aquifer recharge is the preferred integration approach. It is not currently known if MIB and geosmin will be removed/reduced in the aquifer similar to how TOC may be removed.

5.13A.4.4 Demineralization of Lake Powell Water

Due to the high concentrations of TDS and hardness in Lake Powell water compared to the existing groundwater supplies in the Cedar Valley and in Kanab, it is possible that advanced treatment (demineralization) of the water supply may be required or desired to make the new water supply more acceptable to those customers. Demineralization could be part of the initial LPP program, or it could be deferred until a later date, depending on a number of issues. Demineralization is an expensive treatment process to build and to operate, and it also requires careful planning related to the handling and disposal of its waste residuals (concentrated brine). The St. George area should not have to consider demineralization based on its existing use of Virgin River water which has similar mineral quality as LP water.

The most-common demineralization approach would be a reverse osmosis (RO) system which uses special membrane systems, operating at relatively high pressures, to remove almost all dissolved minerals from the water. Another approach which could be considered is softening to remove dissolved calcium and magnesium, but this treatment would not be able to remove smaller dissolved mineral molecules such as sodium, chloride and sulfate. Typical softening approaches include the use of nanofiltration (NF) membrane systems (also referred to as membrane softening) and ion exchange (IX) using porous resin beads which exchange calcium and magnesium with sodium ions. All of these processes produce a concentrated waste stream (brine) which must be handled and disposed.

In order to treat a surface water with RO, NF or IX, it is first required to remove all suspended particles from the water. Particulate removal is achieved via a conventional (coagulation, flocculation, clarification, filtration) plant or via a membrane filtration plant. Low-pressure membrane filtration systems (microfiltration or ultrafiltration) are commonly used as pretreatment for RO or NF systems.

In order to achieve a TDS similar to that of the existing groundwater supplies in Cedar Valley and in Kanab, a fraction of the LPP water (50% to 75%) would need to be demineralized and then blended with untreated LPP water. Depending on the approach used to integrate the new supply in each community, an RO process could be used at the following locations:

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- Immediately downstream of a conventional (or membrane) filtration plant prior to transmission/distribution
- Immediately downstream of a conventional (or membrane) filtration plant prior to aquifer recharge
- Downstream of aquifer extraction wells and probably without pre-filtration (if untreated LPP water is recharged to the aquifer)

The first two demineralization options would likely be incorporated as part of the initial LPP program if the suppliers and customers decide that this would provide multiple benefits to the community. However, use of demineralized water is not a strict requirement of the LPP program since many communities throughout the southwestern United States successfully use Colorado River water without this costly treatment process.

If aquifer recharge of untreated LP water is selected for use in the Cedar Valley and/or in the Kanab area, then the extracted water will likely have a relatively low TDS/hardness initially and demineralization would not be immediately required. However, as the TDS/hardness of the extracted water slowly increases over time to match the LP water being recharged, the addition of a demineralization process may be desired or required to maintain customer satisfaction and/or to meet other users' requirements. This is a similar situation to the use of CAP water for aquifer recharge near Tucson, Arizona.

5.13A.5 REVIEW OF TUCSON'S EXPERIENCES WITH COLORADO RIVER WATER

The City of Tucson, Arizona has been using imported Colorado River via the Central Arizona Project (CAP) for almost a decade. The historical and recent experiences of Tucson present many similarities to the Cedar Valley and Kanab areas as those two communities begin to plan for the use of Lake Powell water. Prior to the importation of CAP water, the Tucson area derived 100% of its potable water from local groundwater in a basin that was experiencing declining water levels. Tucson's historical groundwater quality was generally similar to the quality in the Cedar Valley and Kanab areas from a mineral quality perspective.

The CAP project was initially completed for use of Colorado River water by Tucson in the early 1990's. The original design included a conventional filtration plant to treat the CAP water. Immediately upon startup of the filtration plant and introduction of the new supply into Tucson's distribution system, numerous customer complaints evolved, most of which were "dirty, smelly" water coming from households faucets and other fixtures. The complaints became so numerous that the decision was made to shutdown the new WTP until the cause(s) of the problems could be determined. Numerous lawsuits were later filed against the City by various customers and consumer advocacy groups to try to keep the new WTP from being re-activated.

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It was later determined that multiple water quality and distribution system issues caused the problems described above, including:

- Different pH of the treated water versus the groundwater
- Different chlorine concentrations
- Different water temperatures
- Different dissolved oxygen concentrations
- Different mineral quality (TDS and hardness)
- Changes in flow direction within the distribution system
- Significant buildup of corrosion by-products within sections of old, un-lined metallic pipe (steel, cast iron, galvanized steel) in use within large parts of Tucson's distribution system which were released in significant amounts when the new supply was introduced.

Eventually, it was concluded that the new system's planners and designers could have avoided most of the problems and complaints if more attention had been paid to the following primary factors:

1. Better understanding of the condition of the existing pipeline interiors
2. Better planning as to how to transmit, distribute and integrate the new supply into the existing distribution system
3. More attention paid to the finished water pH, corrosion potential, and chlorine residual of the water from the new WTP
4. Slowly introducing the new supply during low demand periods
5. Implementing an aggressive system flushing program before and during the introduction of the new supply
6. Better education and involvement of the general public and key customers

However, for various reasons, it was decided to not use the new WTP anymore (it was "mothballed") and to implement a new aquifer recharge program as a means to allow Tucson to use its allotment of CAP water. In the late 1990's, Tucson began recharging a large aquifer to the west of Tucson (Avra Valley) with untreated CAP water via a series of infiltration basins. A series of groundwater extraction wells were constructed near the recharge area and the collected groundwater was piped to the WTP site for chlorination and pH adjustment, and then introduced into the distribution system. In 2001, Tucson began the full-time use of this new groundwater source and the results since then have been very positive. The recharge program had the support of the state agency in charge of groundwater quality protection and considered recharge with CAP water to be a "beneficial use".

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The major benefits of Tucson's CAP recharge program include:

- The TDS and hardness of the extracted groundwater was initially very similar to the "native" groundwater (and therefore more acceptable to the customers)
- The only treatment requirements include low-cost chlorination and pH adjustment
- The DBP formation potential of the extracted groundwater is very low and does not create regulatory compliance problems (the TOC is reduced within the aquifer via blending and degradation)
- The wellfield operation is similar to existing wells historically used throughout the City and does not require specialized WTP operations expertise

To date, the recharge rate does not appear to have significantly declined. However, the TDS and hardness of the extracted groundwater has been slowly increasing since startup. The TDS is now greater than 300 mg/L and is expected to reach 400 mg/L in the next 5 to 10 years. Tucson is now in the preliminary stages of planning a centralized demineralization process to treat the extracted groundwater when the TDS reaches 450 mg/L. Tucson officials believe that keeping the TDS of the water less than 500 mg/L is an important community goal. However, not all of the ratepayers and citizens are fully aware (yet) of the high costs of adding a demineralization process.

Tucson's experiences with the use of CAP water, which has similar water quality to Lake Powell, provide valuable insights into the planned introduction of LP water into the Cedar Valley and Kanab, as well as the St. George, areas. It will be very important for these communities to carefully analyze the different approaches which can be used to integrate the new supply into their existing distribution systems, with respect to water quality, costs, ease of implementation/operations and other factors.

5.13A.6 ALTERNATIVE USES OF LAKE POWELL WATER AND TREATMENT APPROACHES

There are a number of potential uses for Lake Powell water within each of the District's service areas including:

- M&I (culinary/potable) supply
- Secondary supply only (as part of the M&I component)
- Other non-potable uses such as agricultural irrigation

The treatment and regulatory requirements for use of LP water for potable/culinary purposes will be different than if LP water is used solely for non-potable purposes. If the LP water is to be used for potable/culinary purposes, it can be treated directly from the pipeline (without raw water storage) and then transmitted into the various distribution systems. Alternatively, the raw water can be stored in local impoundment(s) and then treated/transmitted. If the primary use of LP water in a community is to be for secondary/non-potable water supply, then local storage of LP water would be required to take full advantage of the annual water rights allocations. The use of secondary/non-potable water is typically limited to the period from April to October each year when outdoor water use is high.

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As explained previously, LP water is proposed to be received and stored in Sand Hollow Reservoir and/or Quail Creek Reservoir for the benefit of WCWCD and CICWCD. The need for storage in the Cedar Valley has not been yet determined, and is the subject of further discussion herein. KCWCD has also been planning to receive and store LP water in a surface water impoundment.

As introduced above, there are various methods for receiving and using the LP supply in KCWCD and CICWCD which currently only use groundwater. Some of methods depend on whether the LP supply will be used for potable/culinary purposes or solely for non-potable purposes. These different methods include:

1. Storage in a surface impoundment and then treatment for potable purposes
2. Treatment for potable purposes directly from the LP pipeline and then storage of excess treated water via ASR wells
3. Direct infiltration to recharge an aquifer(s) and then extraction via wells for potable and/or non-potable purposes
4. Discharge to an existing water body (stream, creek or lake) for irrigation purposes and for aquifer recharge and then extraction via wells for potable and/or non-potable purposes
5. Storage in a surface impoundment, and then treatment for non-potable (irrigation) purposes
6. Delivery of treated water (from St. George to Cedar Valley only)

These alternatives are discussed further in TM# 5.13-C. If aquifer recharge of LP water can be demonstrated to be acceptable from a hydrogeological perspective, and acceptable to regulatory agencies, this approach for potable supply enhancement will have a low implementation cost as well as the best chance of minimizing the water quality impacts to each community. If the LP water is used solely for non-potable purposes, then the water quality impacts will be further minimized with respect to drinking water quality issues.

5.13A.7 RAW WATER PIPELINE FLUSHING AND BIOFILM CONTROL

The LPP will deliver untreated Lake Powell water to the Sand Hollow Reservoir almost 140 miles in a pipeline. A smaller pipeline will deliver water to Kanab upstream of Sand Hollow Reservoir. A separate pipeline would deliver untreated water from either Sand Hollow Reservoir or Quail Creek Reservoir to Cedar Valley. All of these pipelines are long and present potential operational and maintenance challenges since they will be carrying untreated (raw) water.

Lake Powell acts as a large settling basin and removes a high percentage of settleable suspended solids, including sediment, grit and other turbidity-causing particles. The larger particles consist of small and medium-sized sands, large colloidal material, clays and silts entrained in the mainstem of the Colorado River. Hence, the water pumped from Lake Powell at the proposed LPP Intake will normally have very low concentrations of suspended solids and turbidity. If larger particles, including sand and grit, were to enter the LPP from the Intake, it could cause significant damage to pumps and equipment, as well as deposit in the pipeline itself.

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It is anticipated that infrequent pipeline flushing (and perhaps draining) may be required to remove the smaller particles which enter the Intake and manage to settle in the pipeline. Flushing would be accomplished by increasing the pipeline flow to near-maximum rates to re-suspend particles that may have settled in the pipeline at lower flows. Flushing should only be required when pipeline flows are low enough for long periods of time to allow particles to settle.

The pipeline will be designed to be drained/dewatered at a few locations along its alignment, if this is ever necessary for maintenance purposes. The pipeline should also be designed to allow pigging of various segments of the pipeline for cleaning purposes, especially the pipeline from St. George to Cedar Valley (due to the issues currently being experienced in the raw water pipeline from Quail Creek Reservoir to the WTP).

Flushing water would be handled similar to normal pipeline operations at higher flows. Any dislodged material would be carried down the pipeline and will eventually enter Sand Hollow Reservoir (or at forebays at intermediate pump stations/energy recovery stations) and the Kanab receiving location. Based on long-term experiences with delivering Colorado River long distances in southern California and Arizona, the anticipated frequency and duration of flushing of the LPP upstream of Sand Hollow Reservoir is low.

The pipeline segment carrying untreated water to the Cedar Valley will also require provisions for flushing and draining. The turbidity and suspended solids coming from Sand Hollow Reservoir and/or Quail Creek Reservoir could be significantly higher than from Lake Powell and the need for flushing could therefore be more frequent than in the pipeline from Lake Powell. This pipeline segment should also include provisions for "pigging" due to the experiences of WCWCD at the Quail Creek WTP. The raw water pipeline to the WTP needs to be cleaned/pigged once or twice per year due to the buildup of an organic/inorganic slime that decreases carrying capacity. WCWCD is not completely sure of all the reasons why this fouling occurs, but it is believed that microbial organisms are forming a matrix with organic and inorganic materials to form a significant slime layer. If LP water is not stored in Quail Creek Reservoir and/or mixed with Virgin River water, then the slime formation potential in the pipeline to Cedar City may be lower. Chlorination or another disinfecting chemical might be beneficial in preventing or minimizing the slime buildup.

Provisions should also be made along the pipeline segments to allow periodic chlorination for biofilm control. It is possible that biofilm control may be required once or twice per year (probably simultaneous to a flushing event) to ensure that the pipeline does not become fouled by attached microbial growth on the pipe walls. The quagga mussel control program will also provide significant biofilm control.

5.13A.8 QUAGGA MUSSEL CONTROL

The need for permanent and/or continuous chlorination facilities (or other chemicals) at the LP Intake, at the beginning of the pipeline to Cedar Valley, and perhaps at other locations along the pipeline segments will be greatly influenced by the selected method of controlling or preventing the infestation and transport of quagga mussels. Due to the resilience of these mussels, it may be necessary to apply continuous or "semi-continuous" chemical applications (for up to 3 or 4

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consecutive weeks at a time) to ensure that the mussels can not grow and/or reproduce within the pipeline.

TM 5.13.B present a detailed review of quagga mussel issues and control options. It is recommended that chemical systems be included at the LPP Intake and at the Cedar Valley Pump Station to control larvae settlement and adult attachment within the pipeline and system components. There are water quality issues related to the proposed mussel control program, including DBP formation and chemical additions, which must be addressed and resolved. Regulatory compliance, water quality degradation and general environmental impacts are significant issues.

5.13A.9 SUMMARY AND RECOMMENDATIONS

Lake Powell is an acceptable source of water for the participants in each community who expect to receive this new supply. The water quality differences between LP water and existing St. George area supplies (especially the Virgin River) are relatively minor and are not anticipated to create significant issues for current customers or for regulatory compliance. The existing Quail Creek WTP in St. George is capable of successfully treating Lake Powell water, especially with the upcoming addition of ozonation for T&O Control and DBP Control.

However, the LP water is more mineralized and harder than existing groundwater supplies in the Cedar Valley and in the Kanab area. These differences may create customer complaints and distribution system problems without careful analysis, planning and implementation. The best integration solutions for use of LP water in these communities appears to be:

1. aquifer recharge, or
2. use for non-potable and irrigation purposes

This would minimize the impacts of introducing a higher TDS/harder water into the distribution systems. These approaches, if determined to be technically feasible and acceptable to regulatory agencies, would have the highest water quality benefits and offer the lowest initial cost solutions, compared to constructing a new filtration plant to treat LP water. Further analysis and comparison of integration options in each community is presented in TM 5.13.

The potential need for demineralization of the LP water in the Cedar Valley and in the Kanab area should be included in long-range planning efforts since it may eventually be needed, if not provided initially. This topic should be discussed with suppliers and customers in each community, as part of a Public Education and Involvement process.

From a water quality perspective, it appears to be better for Cedar Valley recipients if the LP water is not stored in Quail Creek Reservoir. This reservoir appears to add minerals, including calcium and sulfate, based in part on its geologic nature. Minimizing the detention time of LP water in surface water impoundments, if possible, will also reduce evaporation losses and resultant increases in TDS.

The recommended approach for quagga mussel control is to continuously add chemicals (chloramines or chlorine) at the LPP intake and at the Cedar Valley Pumping Station. The impacts of the preferred treatment approach on the water quality in receiving reservoirs and other water bodies,

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as well as on planned or current aquifer recharge programs, requires careful analysis and discussion with regulatory agencies.

The impacts of introducing higher-TDS LP water into each community should also consider secondary impacts including:

- Wastewater quality including treatment and disposal impacts
- Impacts to the general groundwater basin and aquifer(s) due to land application and non-potable uses

All of these issues require more-detailed evaluations as part of the "next steps" in the Lake Powell Pipeline implementation program, including those typically included in a "preliminary design" scope of work. Implementation of a long-term water quality sampling program at Lake Powell, with special attention paid to drinking water quality and regulations should also be implemented in the near future. The sampling program should be designed to meet the "Drinking Water Source Assessment and Protection Program as explained in Appendix A.

It may be possible to jointly-fund this sampling program with current and potential users of Lake Powell water. On-going monitoring for quagga and zebra mussels within Lake Powell should also be initiated with multiple interested/affected parties.

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APPENDIX A
REVIEW OF CURRENT AND FUTURE
DRINKING WATER REGULATIONS

This Appendix provides background information regarding current and anticipated future drinking water regulations as they relate to the use of Lake Powell water for a potable supply source.

1.0 REVIEW OF CURRENT DRINKING WATER REGULATIONS

The most significant drinking water quality regulations are shown in Table A-1. Attachment B contains a summary Table B-1 of each of the contaminants currently regulated in drinking water by the USEPA and DEQ. Table A-1 identifies the regulation and the MCL or the TT associated with each of the contaminants listed. The following discussion provides some historical background and a general discussion of the requirements of those regulations.

Table A.1 – Summary of Major Federal and State Drinking Water Quality Regulations

Regulation	Year of Promulgation	Number of Contaminants	s
National Interim Primary Drinking Water Regulations (NIPDWR)	1975-1981	7	Trihalomethanes, Arsenic, Radiologicals
Phase I Standards	1987	8	VOCs
Phase II Standards	1991	36	VOCs, SOCs, and IOCs
Phase V Standards	1992	23	VOCs, SOCs, and IOCs
Surface Water Treatment Rule (SWTR)	1989	5	Microbiological and Turbidity
Total Coliform Rule (TCR)	1989	2	Microbiological
Lead and Copper Rule (LCR)	1991/2003	2	Lead and Copper
Drinking Water Source Assessment and Protection Program	1996	-	Source Water Protection
Stage 1 Disinfectants/Disinfection By-Products (D/DBP) Rule	1998	14	D/DBPs and Precursors
Interim Enhanced Surface Water Treatment Rule (ESWTR)	1998	2	Microbiological and Turbidity, Systems >10,000
Radionuclides Rule	2000	4	Radionuclides
Arsenic Rule	2001	1	Arsenic
Filter Backwash Recycling Rule	2001	-	Microbiological and Turbidity

1.1 National Primary Drinking Water Regulations (NIPDWR)

Prior to the establishment of the USEPA, the US Public Health Service had established 22 drinking water standards. These standards were adopted by the USEPA as National Primary Drinking Water Regulations (NPDWR) by the SDWA. These contaminants have been updated or replaced by subsequent regulations.

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1.2 Phase I Regulations

The Phase I Regulations were finalized in July 1987 and compliance was required by January 1989. The Phase I Regulations included MCLs for eight VOCs and required utilities to collect quarterly samples from each source water supply for one year. After one year, utilities could qualify for reduced monitoring based on the first year monitoring results (one sample every three years). The Phase I Regulations also included monitoring requirements for unregulated contaminants. All systems were required to monitor for a minimum of 34 unregulated volatile organic contaminants; 2 additional contaminants if the system is determined vulnerable; and 15 additional contaminants at the State's discretion.

1.3 Phase II Regulations

The Phase II Regulations were proposed in May 1989 and finalized in July 1991. Monitoring under the Phase II Regulations was required to begin in January 1993. The Phase II Regulations established MCLs for 38 contaminants (7 inorganic constituents (IOCs), 10 volatile organic compounds (VOCs), and 19 synthetic organic compounds (SOCs), plus nitrate, nitrite, and total nitrate and nitrite) and TT requirements for two additional treatment additives (polymers). In order to simplify the increasing number of monitoring requirements, the Standardized Monitoring Framework (SMF) was developed. The SMF is based on a 9-year cycle divided into three, three-year monitoring periods. Under the new monitoring schedule, initial monitoring, baseline monitoring, reduced monitoring, and increased monitoring requirements were established.

1.4 Phase V Regulations

The Phase V Regulations were proposed in July 1990 and finalized in July 1992. The SMF was incorporated into the Phase V Regulations with the first compliance period for large utilities beginning January 1994. Phase V established regulations for 23 contaminants including 22 from the original list of 83 included in the 1986 SDWA Amendments (originally included a proposal for sulfate that was not included in the final Phase V regulations). The 23 Phase V contaminants include 5 IOCs, 3 VOCs, and 15 SOCs. The US Court of Appeals (District of Columbia Circuit) remanded the MCL for nickel (0.1 mg/L) in February 1995. The USEPA is required to reconsider the nickel MCLG and MCL, but no action has yet been taken.

1.5 Surface Water Treatment Rule (SWTR)

The SWTR was promulgated to control the levels of turbidity, Giardia lamblia, viruses, Legionella, and heterotrophic plate count bacteria in U.S. drinking waters. Some of the detailed requirements of this regulation have been enhanced or superceded by the Interim and Long Term 2 Enhanced Surface Water Treatment Rules described later.

The State of Utah DEQ requires all utilities utilizing a surface water supply or a groundwater supply under the influence of a surface water supply, to provide adequate disinfection and, under most conditions, to provide filtration. Exemptions from filtration of surface water supplies are provided on rare occasions where the source water supply meets extremely rigid requirements for water quality and the utility possesses control of the watershed. The Lake Powell water source does not meet these stringent requirements for an exemption from filtration.

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General Requirements

The SWTR includes the following general requirements to minimize human exposure to microbial contaminants in drinking water.

Utilities are required to achieve at least 99.9 percent removal and/or inactivation (3-log removal) of Giardia lamblia cysts and a minimum 99.99 percent removal and/or inactivation (4-log removal) of viruses. The required level of removal / inactivation must occur between the point where the raw water ceases to be influenced by surface water runoff to the point at which the first customer is served.

- The disinfectant residual entering the distribution system must not fall below 0.2 mg/L for more than 4 hours during any 24-hour period.
- A disinfectant residual must be detectable in 95 percent of distribution system samples. A heterotrophic plate count (HPC) concentration of less than 500 colonies/mL can serve as a detectable residual if no residual is measured.
- Each utility must perform a watershed sanitary survey at least every five years.

Removal Credit

The maximum level of removal credit granted by the SWTR to a plant for both Giardia lamblia and viruses is determined by the type of treatment process used, namely:

- For a conventional filtration WTP:
    - 2.5-log removal credit for Giardia lamblia
    - 2.0-log removal credit for viruses.
- For a direct filtration WTP:
    - 2.0-log removal credit for Giardia lamblia
    - 1.0-log removal credit for viruses.

Alternative treatment technologies are awarded removal credit from the Utah DEQ based on performance tests discussed below.

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Disinfection Credit

The remainder of the log-removal / inactivation credit to comply with the SWTR must be obtained from primary disinfection, with minimum log inactivations as follows:

- For a conventional filtration WTP,
  - 0.5-log inactivation credit for Giardia lamblia
  - 2.0-log inactivation credit for viruses.
- For a direct filtration WTP:
  - 1.0-log inactivation credit for Giardia lamblia
  - 3.0-log inactivation credit for viruses.

To determine the inactivation credit of Giardia lamblia and viruses achieved at a treatment plant, the SWTR established the concept of disinfection concentration (C) and contact time (T). CT is the product of the concentration of disinfectant remaining at the end of a treatment process ("C" in mg/L) and the contact time ("T" in minutes) which is based upon the time that 10 percent of the water (T10) passes through the treatment process. The contact time in which 10 percent of the water travels through a unit process can be conservatively estimated from DEQ guidelines or more accurately determined by conducting a on-site tracer study. The USEPA Guidance Manual to the SWTR includes tables that identify the log removal of both Giardia lamblia and viruses achieved for a calculated CT value based on the type of disinfectant, water temperature, and pH.

1.6 Total Coliform Rule (TCR)

The TCR was promulgated by the USEPA in June 1989 with compliance required eighteen months after promulgation (January 1991). Under the TCR, utilities were to submit a monitoring plan to the DEQ for approval. The plan must provide for representative sampling of the distribution system (including all pressure zones and reservoir areas), describe any sample rotations proposed and include a statement that the sample collector has been trained. The total number of samples and frequency of sampling required is dependent on the population served by the utility. For all but the smallest utilities, weekly sampling is required. If any sample is coliform-positive, two actions must be taken within 24 hours of notification of the positive result, namely:

- A set of repeat samples must be collected. The location of the repeat samples must include the tap that tested positive, and one upstream and downstream location, both of which must be within five service connections of the positive sample location. If one or more of the repeat samples tests positive for the presence of coliforms, an additional set of repeat samples must be taken. This process continues until all of the samples are total coliform-negative or an MCL has been violated.
- The sample must be analyzed for the presence of fecal coliform or E. Coli.

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The previous coliform standard was a density-based standard. This was replaced by a presence / absence type standard. There are three potential scenarios in which an MCL is violated. These scenarios consist of the following:

- For utilities that analyze less than 40 samples per month, no more than 1 monthly sample may be coliform-positive (this includes repeat samples). If more than 1 monthly sample is coliform-positive than an MCL has been violated. For >40 samples per month collected, an MCL has been violated if more than 5.0% are positive.
- Utilities are in violation of an MCL if an original sample is fecal coliform/E. Coli-positive and any repeat sample is total, fecal, or E. Coli-positive.
- Utilities are in violation of an MCL if an original sample is total coliform-positive and any repeat sample is fecal coliform/E. Coli-positive.

Furthermore, there are two conditions that result in a "Significant Rise in Bacterial Count" classification. This condition is not considered a violation of an MCL; however, it does require notification to DEQ. The two conditions that result in this classification are listed below:

- An initial sample that is total coliform-positive is determined to be either fecal coliform or E. Coli.-positive, as well.
- At least two repeat samples are total coliform-positive but neither sample is fecal coliform or E. Coli-positive.

Best Available Technology

The TCR includes a list of four preventative measures a utility can institute to minimize the presence of coliforms in the distribution system. These four items include the following:

- Ensure proper well protection for groundwater supplies.
- Maintain of a minimum 0.2 mg/L disinfectant residual through the entire distribution system.
- Institute a distribution system maintenance program including:
  - Appropriate pipe replacement and repair procedures,
  - Flushing program,
  - Proper operation and maintenance of distribution system reservoirs, and
  - Maintenance of a positive water pressure throughout system.
- Provide adequate filtration and disinfection treatment processes.

The TCR only applies to the direct users and operators of distribution systems, and not to wholesale water providers. However, the water provided by wholesalers needs to meet minimum standards to allow the customers to be able to meet the TCR.

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1.7 Lead and Copper Rule (LCR)

The LCR was promulgated by the USEPA on June 7, 1991. The objective of the LCR is to minimize the corrosion of lead and copper-containing plumbing materials in public water systems (PWS) by requiring utilities to optimize treatment for corrosion control. The LCR establishes “action levels” in lieu of MCLs for regulating the levels of both lead and copper in drinking water. The action level for lead was established at 0.015 mg/L while the action level for copper was set at 1.3 mg/L. An action level is exceeded when greater than 10 percent of samples collected from the sampling pool contain lead levels above 0.015 mg/L or copper levels above 1.3 mg/L. Unlike an MCL, a utility is not out of compliance with the LCR when an action level is exceeded. Exceedance of an action level requires a utility to take additional steps to reduce lead and copper corrosion in the distribution system. There is also a secondary standard, of 1.0 mg/L, for copper.

In October 1999, USEPA made minor revisions to the LCR to clarify the original rule, streamline implementation, promote consistent national implementation, and reduce the reporting requirements. The revisions do not include any changes to the action levels for lead and copper. The revisions include requiring monitoring for public water systems with optimized corrosion control, which was inadvertently left out of the original LCR. The revisions also include changing the definition of the word “control” in the LCR to only require public water systems to replace lines that it owns or has authority to replace to protect the water quality. The revisions allow systems with low lead and copper tap levels to reduce the number and frequency of sample collection sooner. Finally, there are numerous modifications to the system reporting requirements to minimize the reporting burden.

As with the TCR, wholesale water providers are not directly responsible for compliance with the LCR; only owners/operators of distribution systems are responsible for compliance. However, the wholesale water needs to meet minimum water quality levels, including pH, to allow the customers to be able to meet the LCR.

1.8 Drinking Water Source Assessment and Protection Program (DWSAP Program)

The 1996 SDWA Amendments included a requirement for States to develop a program to assess sources of drinking water and encourage States to establish protection programs.

Once an original assessment is performed for a source water, the assessment must be reviewed and updated as necessary every five (5) years. It is also expected that a completed assessment will be required to obtain and continue to obtain chemical monitoring waivers for source waters.

There are eight components which are typically required as part of a DWSAP Program.

- **Source Identification:** Systems must locate the source using Global Positioning System.
- **Delineation of the Watershed and the Near Intake Zones:** Surface water systems must delineate the watershed contributing to the source and may, optionally, identify the near intake zones which are close to the point of diversion where contaminant activities may have a greater influence.

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- **Evaluation of the Physical Barrier Effectiveness:** Surface water systems must complete the forms developed by the State to determine the effectiveness of the natural physical barriers for preventing contaminants from entering the source.
- **Identification of Potential Contaminating Activities (PCAs):** Surface water systems must develop an inventory of PCAs within the near intake zone or the entire watershed. The PCAs on the inventory must then be ranked for risk using the table from the DWSAP guidance.
- **Perform a Vulnerability Assessment:** Systems must perform a vulnerability assessment for each PCA identified. This assessment is based on the risk ranking, location, and the physical barrier effectiveness. After assessment, the PCAs will be prioritized.
- **Develop an Assessment Map:** Systems must develop an assessment map, at a minimum using USGS quad maps 7.5 minute series. The map must show the location of the source, the watershed or recharge area, the near intake zones, and the location of the PCAs.
- **Prepare a Drinking Water Source Assessment Report:** Systems must prepare a report on the assessment to submit to the State for review. The report must include the assessment map, the methods used to locate the source, the recharge area delineation calculations, the physical barrier effectiveness forms, the potential contaminating activity forms, and the vulnerability assessment forms.
- **Include a Summary of the Report in the Annual Consumer Confidence Report:** Systems must prepare a summary of the assessment to include in the annual Consumer Confidence Report. The report must also be available to the public for review.

1.9 Stage 1 Disinfectants and Disinfection By-Products Rule (Stage 1 D/DBP Rule)

The purpose of the Stage 1 D/DBP Rule is "..to minimize risks from disinfection by-products and still maintain adequate control over microbial contamination."

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Maximum Residual Disinfectant Level Goals

The USEPA set maximum residual disinfectant level goals (MRDLGs) for chlorine, chloramines, and chlorine dioxide. These are shown in Table A-2.

Table A.2 – Maximum Residual Disinfectant Level Goals

Disinfectant	Goal
Chlorine	4 mg/L as Cl2
Chloramines	4 mg/L as Cl2
Chlorine Dioxide	0.8 mg/L as ClO2

The MRDLGs are set at levels for which no known or anticipated adverse health effects occur. These goals are non-enforceable health goals based only on health effects and exposure information.

Maximum Residual Disinfectant Levels

The Stage 1 D/DBP Rule established maximum residual disinfectant levels (MRDLs) for chlorine, chloramines, and chlorine dioxide. These are shown in Table A-3.

Table A.3 – Maximum Residual Disinfectant Levels

Disinfectant	MRDL
Chlorine	4.0 mg/L as Cl2
Chloramines	4.0 mg/L as Cl2
Chlorine Dioxide	0.8 mg/L as ClO2

Chlorine and Chloramines

The residual disinfectant level must be monitored at the same points in the distribution system and at the same time as when sampling for total coliforms. Compliance with the MRDL will be based on the running annual average of the monthly average of all samples, computed quarterly. Operators may increase the residual chlorine level in the distribution system above the MRDL if necessary to protect public health from acute microbiological contamination problems including; distribution line breaks, storm runoff events, source water contamination, or cross-connections.

Currently, there are no public water systems in Utah which use chloramines as the residual disinfectant.

Chlorine Dioxide

Systems that use chlorine dioxide must measure the residual disinfectant level at the entrance to the distribution system on a daily basis. Non-compliance with the MRDL can result in acute or non-acute violations. If the daily sample at the entrance exceeds the MRDL, then the system is required to take three additional samples in the distribution system on the next day as described below. If any samples collected the second day in the distribution system exceed the MRDL, or if the distribution system samples were not collected, the system will be in acute violation of the MRDL. If only the sample collected at the entrance to the distribution system exceeds the MRDL on the second day, or if the entrance sample was not collected, the system will be in a non-acute violation of the MRDL.

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Follow up monitoring in the distribution system will be governed by the type of residual disinfectant used. Systems using chlorine as a residual disinfectant and operating booster stations after the entrance to the distribution system must take three samples in the distribution system; one close to the first customer, one at an average residence time, and one at the maximum residence time. Systems using chlorine dioxide or chloramines as a residual disinfectant or chlorine without operating booster stations after the entrance to the distribution system must take three samples in the distribution system as close as possible to the first customer at intervals of not less than six hours. Operators may not increase the residual chlorine dioxide level in the distribution system above the MRDL under any circumstances.

Currently, there are no public water systems in Utah which use chlorine dioxide as the residual disinfectant, or as a pre-oxidant.

Maximum Contaminant Level Goals (MCLGs) for TTHMs, HAA5, Chlorite, and Bromate

The USEPA has set MCLGs for four trihalomethanes, two haloacetic acids, chlorite, and bromate. These are shown in Table A-4.

Table A.4 – Maximum Contaminant Level Goals for DBPs

Disinfection By-Product	MCLG
Bromodichloromethane	0 µg/L
Dibromochloromethane	60 µg/L
Bromoform	0 µg/L
Dichloroacetic Acid	0 µg/L
Trichloroacetic Acid	30 µg/L
Bromate	0 µg/L
Chlorite	0.8 mg/L

The MCLGs are set at levels for which no known or anticipated adverse health effects occur. These goals are non-enforceable health goals based only on health effects and exposure information.

- Maximum Contaminant Levels (MCLs) for TTHMs, HAA5, Chlorite, and Bromate
- The Stage 1 D/DBP Rule set MCLs for TTHM, HAA5, chlorite, and bromate as shown in Table A-5.

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Table A.5 – Maximum Contaminant Levels for DBPs

Contaminant	MCL
TTHM[1]	80 µg/L
HAA5[2]	60 µg/L
Bromate	10 µg/L
Chlorite	1.0 mg/L

[1]TTHM includes chloroform, bromodichloromethane, dibromochloromethane, bromoform.
[2] HAA5 includes mono, di and tri-chloroacetic acids and mono and di-bromoacetic acids.

Total Trihalomethanes and Haloacetic Acids

TTHMs and HAA5 are formed when disinfectants react with naturally-occurring organic matter in water. All systems must monitor the distribution system for TTHMs and HAA5. Compliance for surface water, GWUDIS and groundwater systems with population greater than 10,000 is based on the running annual average of quarterly averages of all samples taken in the distribution system, computed quarterly.

Bromate: Bromate is produced when ozone oxidizes naturally-occurring bromide. Systems using ozone for disinfection are required to conduct sampling for bromate. Systems must collect one sample per month at the entrance to the distribution system while the ozonation system is operating under normal conditions. Compliance with the MCL is based on a running annual average, computed quarterly, of monthly samples. Low to moderate levels of bromide (usually < 0.02 mg/l) have been measured in the Colorado River basin. The possible production of bromate from an ozone oxidation process needs to be carefully evaluated.

Chlorite: Chlorite (ClO_2^-) and chlorate (ClO_3^-) are both anions produced as natural byproducts in the formation of chlorine dioxide (ClO_2) for disinfection and when chlorine dioxide oxidizes other compounds (typically organics in the water). As a general rule, chlorite to chlorine dioxide ratios of about 0.6:1 are common. Systems using chlorine dioxide for disinfection are required to conduct sampling for chlorite. Systems are required to monitor chlorite on a daily basis at the point of entry to the distribution system. If chlorite is detected at levels greater than 1.0 mg/L at the entrance to the distribution system, then additional distribution system monitoring is required the following day. Systems must monitor three locations in the distribution system (i.e. close to the first customer, site representative of average residence time, and a site representative of maximum residence time) at the same time and on a monthly basis.

Treatment Technique for Disinfection By-Product Precursors

The USEPA requires systems that have surface water or groundwater under the direct influence of surface water (GWUDIS) as a supply, and that use conventional filtration treatment, to remove specific amounts of organic material by implementing a treatment technique, either by enhanced coagulation or enhanced softening. Direct filtration treatment (without clarification) does not have specific TOC removal requirements. The percent of TOC removal required for conventional plants

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depends on source water TOC and alkalinity. Table A-6 provides a summary of the removal requirements.

Table A.6 – TOC Removal Requirements for Conventional Treatment Plants (Percent)

	Alkalinity (mg/L as CaCO3)		
TOC, mg/L	0 – 60	> 60 – 120	> 120
> 2.0 - 4.0	35	25	15
> 4.0 - 8.0	45	35	25
> 8.0	50	40	30

Compliance with this treatment technique must be calculated on a quarterly basis, once 12 months of data are available. Each month, the system must calculate percent actual TOC removal, determine the percent required TOC removal (from above), and then calculate the removal ratio (must be greater than 1.0).

Systems with conventional treatment plants have the opportunity to be granted a 1.0 for the monthly removal ratio under the four following conditions, regardless of the calculated removal ratio:

- Remove greater than or equal to 10 mg/L of magnesium hardness (as CaCO3),
- Raw water TOC is less than 2.0 mg/L,
- Raw water or treated water specific UV absorbance (SUVA) is less than or equal to 2.0 L/mg-m, or
- Treated water alkalinity is less than 60 mg/L (only for systems practicing enhanced softening).

The USEPA has also provided alternative compliance criteria from the treatment technique requirements. Utilities will not be required to achieve the specified TOC removals provided one of the following conditions are met:

- Source water TOC is less than 2.0 mg/L,
- Treated water TOC is less than 2.0 mg/L,
- Source water TOC is less than 4.0 mg/L, source water alkalinity is greater than 60 mg/L, and distribution system TTHM is less than 0.04 mg/L and HAA5 is less than 0.03 mg/L,
- Distribution system TTHM is less than 0.04 mg/L and HAA5 is less than 0.03 mg/L, and only chlorine is used for primary disinfection and distribution system residual,
- Source water SUVA, prior to any treatment, is less than or equal to 2.0 L/mg-m, or
- Treated water SUVA is less than or equal to 2.0 L/mg-m.
- As noted above, a direct filtration plant is not required to meet specified TOC removals

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1.10 Interim Enhanced Surface Water Treatment Rule (IESWTR)

The IESWTR applies to public water systems (PWSs) that use surface water or GWUDIS and serve more than 10,000 population. The purpose of this regulation is "..to improve control of microbial pathogens, including specifically Cryptosporidium, in drinking water; and address risk trade-offs with disinfection by-products."

Cryptosporidium

The rule set an MCLG for the protozoan genus Cryptosporidium of zero (0). Since there was not a reliable means for monitoring this constituent in the drinking water at the time of promulgation, a treatment technique requirement was established in lieu of setting an MCL. The treatment technique requires a 2.0-log (99 percent) Cryptosporidium removal or control for PWSs that are currently required to filter under the existing SWTR. This removal must be achieved between the raw water intake and the first customer.

The rule provides that systems with conventional or direct filtration water treatment plants will be granted the 2.0-log removal credit, provided turbidity requirements are met for the existing SWTR (1.0/5.0 NTU) and the combined filter effluent requirements for this rule (0.3/1.0 NTU).

For systems applying to use an "alternative filtration technology", the system must show that the treatment, in combination with disinfection, consistently achieves 99.9 percent removal/inactivation of Giardia, 99.99 percent removal/inactivation of viruses, and 99 percent removal of Cryptosporidium.

Turbidity

For surface water and GWUDIS systems that are required to filter their source water under the existing SWTR, that employ conventional or direct filtration for treatment, the combined filter effluent turbidity requirements have been tightened. For alternative filtration technologies, the State will set turbidity performance requirements at a level that, in combination with disinfection, will consistently achieve 99.9 percent removal/inactivation of Giardia, 99.99 percent removal/inactivation of viruses, and 99 percent removal of Cryptosporidium.

The combined filter effluent turbidity must be less than 0.3 NTU in 95 percent of measurements and may never exceed 1 NTU (based on four hour measurements). The combined filter effluent turbidity shall not exceed 1.0 NTU for more than eight hours (based on 15-minute measurements). Combined filter effluent and individual filter effluent continuous turbidity monitoring shall be recorded every 15 minutes. Monthly reports must show total number of measurements taken and have two options for value reporting:

- Report 15-minute measurements and show the 50th, 90th, 95th, 98th, and 99th percentiles and report all measurements greater than 1 NTU.
- Report 4 hour measurements and show all results greater than 0.3 NTU (based on 15 minute measurements) and percent of measurements less than or equal to 0.3 NTU (based on 15-minute measurements).

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The rule requires continuous, on-line measurement of turbidity for each individual filter. These data must be recorded every 15 minutes. Systems with two or fewer filters may conduct continuous monitoring of the combined filter effluent turbidity in lieu of individual monitoring. Individual filter effluent turbidity monitoring shall be less than 0.3 NTU within 60 minutes after return to service.

There are several other additions to the rule which some States have adopted including:

- All filters shall be visually inspected once per year as part of the operations plan based on DEQ guidance.
- Raw water shall be sampled for total coliform and either fecal coliform or E. Coli at least once per month.
- Chlorine residual shall be confirmed in 95 percent of distribution samples every month.
- On-line turbidimeters shall be manually verified once per month for combined filter effluent and once per month for individual filter effluent.
- Turbidity shall be recorded and reported for sedimentation effluent at least once per day.
- Flow rate and turbidity shall be recorded and reported for recycled backwash water at least once per day.
- System must report turbidity data to the State within 10 days after the end of each month.

Disinfection Profiling and Benchmarking

The purpose of disinfection profiling and benchmarking is to develop a process to assure that there is no significant reduction in microbial protection as a result of significant disinfection process modifications to meet the new MCLs for TTHMs and HAA5 from the Stage 1 D/DBP Rule.

Profiling will be required for surface water systems that have either TTHM levels greater than or equal to 80 percent (0.064 mg/L) of the new MCL or HAA5 levels greater than or equal to 80 percent (0.048 mg/L) of the new MCL. The District's objective is to have TTHM and HAA5 always below these levels.

The disinfection profile is developed using a minimum of one year of weekly Giardia lamblia log inactivation. The month with the lowest average log inactivation will be identified as the critical period or benchmark. When only one year of data is used, the benchmark inactivation shall be the same as the critical period. When multiple years of data are used, the benchmark inactivation shall be the average of the critical period from each year.

After the profiling and benchmarking is complete, a utility must submit it to the State as part of the sanitary survey. If a utility decides to make changes to the disinfection practices, then the utility must consult with the State to ensure that microbial protection is not compromised. Changes that would require a benchmark analysis include; changes in the point of disinfection, the type of disinfectant, the disinfection process, or any other modification identified by the State.

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Finished Water Reservoirs

Under this rule, surface water and GWUDIS systems must cover all new treated water reservoirs, holding tanks, and other storage facilities.

Sanitary Surveys

Primacy states, such as Utah, must now conduct sanitary surveys for all surface water and GWUDIS systems, regardless of size. These surveys must be conducted every three years for community water systems (CWS) and every five years for non-community water systems (NCWS). DEQ may grant a waiver to water utilities to perform the sanitary survey every five years if the system has outstanding performance based on previous sanitary surveys. DEQ must determine how outstanding performance will be evaluated to allow for the reduced frequency of the sanitary survey.

The sanitary surveys must meet the eight components of the 1995 USEPA/State Guidance. These components include: source assessment, treatment, distribution system, finished water storage, pumps, pumping facilities and controls, monitoring and reporting, data verification, system management and operation, operator compliance with state requirements, and disinfection profiling (if required).

1.11 Radionuclides

The USEPA published the Final Radionuclides Rule on December 8, 2000. The Rule applies to all CWSs. It included several new standards including:

- Set the Gross Alpha, Gross Beta and Photon, Combined Radium (226/228), and Uranium MCLGs at zero.
- Set the Gross Alpha MCL at 15 pCi/L.
- Set the Gross Beta and Photon MCL at 4mrem/yr.
- Set the Combined Radium MCL at 5 pCi/L.
- Set the Uranium MCL at 30 ug/L.

The Rule requires all initial monitoring to be collected at the entry point to the distribution system (EPDS). It also clarified that Gross Beta and Photon are only required to be monitored by vulnerable systems. The frequency of repeat monitoring is determined by initial monitoring results.

- Sample results less than the detection limit for reporting (DLR), then 1 sample every 9 years.
- Sample results less than half the MCL, then 1 sample every 6 years.
- Sample results less than the MCL, then 1 sample every 3 years.

1.12 Arsenic Rule

The Final Arsenic Rule was promulgated by the USEPA on January 22, 2001. The Rule sets an MCLG of 0 mg/L and an MCL of 0.010 mg/L (10 ug/L) for arsenic.

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Surface water systems are required to collect an annual sample. If sample results are greater than the MCL, then quarterly sampling is triggered. Waivers are available with three rounds of monitoring with results less than the MCL. With a waiver, sampling can be reduced to once every nine years.

1.13 Filter Backwash Recycling Rule

The final Filter Backwash Recycling Rule applies to all PWSs that use surface water and employ conventional or direct filtration and recycle water within the treatment plant.

This Rule requires all recycle streams to pass through all treatment processes, and therefore all streams need to be returned prior to chemical addition and coagulation. Also, each system must notify DEQ in writing that they practice recycling. This notification must include a plant schematic that shows the type and location of recycle streams, typical recycle flow data, highest plant flow in the previous year, design flow of the plant, and DEQ approved operating capacity.

The Rule is unclear as to whether Filter-to-Waste (FTW) water is considered a recycle steam, and whether such water can be returned to the filter influent channel or not. This decision is often made between the utility and State DEQ office on an individual plant basis.

Each system must collect and maintain the following information for compliance with the Rule:

- Copy of recycle notice to DEQ.
- List of all recycle flows and frequency.
- Average and maximum backwash flow rate and duration.
- Typical filter run length and how determined.
- Type of recycle treatment, and data on recycle treatment facilities

2.0 ANTICIPATED FUTURE DRINKING WATER REGULATIONS

The USEPA and DEQ are developing new drinking water regulations. The major anticipated future regulations that will impact surface water supplies are shown in Table A-7 and those regulations are discussed below.

Table A.7 – Summary of Anticipated Major Federal Drinking Water Quality Regulations for Surface Water Supplies

Regulation	Year Final Expected	Number of Contaminants	Targeted Contaminants
Stage 2 D/DBP Rule	2006	9	DBPs
Long Term 2 ESWTR	2006	1	Cryptosporidium
Drinking Water Candidate Contaminant List/ Unregulated Contaminant Monitoring Rule	2007	-	Unknown at this Time
Distribution System Rule/Revised Total Coliform Rule	2008	-	Microbiological
Atrazine	2010	1	Atrazine
Perchlorate	2010	1	Perchlorate

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2.1 Stage 2 Disinfectants and Disinfection By-Products Rule (Stage 2 D/DBP Rule)

The Proposed Stage 2 D/DBP Rule was published in August 2003 and the Final Stage 2 D/DBP Rule was published in the Federal Register in January, 2006. The Rule applies to all PWSs, non-transient non-community water systems (NTNCWSs), and transient non-community water systems (TNCWSs). The major provisions of the proposed rule include the following:

- MCLGs for several disinfection by-products have been proposed, see Table A-8.

Table A.8 – Proposed Maximum Contaminant Level Goals for DBPs

Disinfection By-Product	MCLG
Chloroform	70 μg/L
Monochloroacetic Acid	30 μg/L
Trichloroacetic Acid	20 μg/L

- Compliance with MCLs for distribution system TTHM and HAA5 levels may occur in two phases. Stage 2A would require compliance with MCLs of 80 and 60 ug/L based on a running annual average (RAA) of all distribution system locations, and MCLs of 120 and 100 ug/L based on locational running annual average (LRAA) for each sampling location. This would use current monitoring locations (Subpart L locations). Stage 2B would require compliance with MCLs of 80 and 60 ug/L based on LRAA for each sampling location. This would use monitoring locations finalized based on the results of the Initial Distribution System Evaluation (IDSE).
- Systems must perform an Initial Distribution System Evaluation (IDSE) to confirm location of the new monitoring locations. This monitoring will be conducted in addition to Subpart L TTHM and HAA5 distribution system monitoring conducted under the Stage 1 D/DBP Rule. For surface water systems serving greater than 10,000 population, the IDSE will include eight distribution system locations monitored for TTHM and HAA5 every 60 days. Samples shall be collected as follows:
  - One (1) at entry point to the distribution system,
  - Two (2) at average residence time,
  - Three (3) at highest TTHM level locations, and
  - Two (2) at highest HAA5 level locations.
- If all DBP data for a system are less than ½ the MCL (40 and 30 ug/L for TTHM and HAA5, respectively) for the previous two years, then a system can apply to the State for a waiver from the IDSE. Also, systems may conduct specific study in lieu of the standard monitoring program. Systems serving less than 10,000 population, including all those served by the DVWTP, will have to take 4 DBP samples per quarter if the population served is >3,301 or 2 DBP sample per quarter if the population served is between 500 and 3,300.

- A consecutive system is defined as one that receives water from a wholesaler more than 60 days per year. Each point of entry to the consecutive system is considered a water treatment plant for the consecutive system (regardless of source). Consecutive systems may apply to the State to treat multiple entry points to the consecutive system from the same source as a single water treatment plant. In a consecutive system, the compliance schedule is based on the system with the earliest date for compliance in the entire combined distribution system. Both the wholesale and consecutive systems will need to complete the IDSE. The requirement of the IDSE will be based on the individual system size.
- Concurrent with the Stage 2B monitoring, systems must document occurrences of peak DBP levels, termed significant excursions. Each State will develop criteria for determining whether a system has a significant excursion, based on guidance from USEPA. If a significant excursion occurs, a system must evaluate distribution system operational practices to identify opportunities to reduce DBP concentrations in the distribution system, prepare a written report of the evaluation, and review it with the State prior to the next sanitary survey for the system.

For systems serving less than 10,000 people, the IDSE Plan is due on April 1, 2008 and the IDSE Report is due on July 1, 2010. Compliance is to begin in October of 2013.

2.2 Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR)

The LT2ESWTR was proposed in August 2003 and the final rule was published in the Federal Register in January 2006. This Rule applies to all PWSs that use surface water or GWUDIS. Two additional years are available for capital improvement projects. The major provisions of the proposed rule include the following:

- Require source water monitoring for Cryptosporidium, E. Coli and turbidity for large systems (>10,000 population) and E.Coli for small systems (<10,000 population) for 24 months. Systems can choose between monthly or bi-weekly sampling. Small systems that exceed designated E.Coli trigger levels must then conduct 12 months of Cryptosporidium monitoring.
- Compliance for monthly sampling will be based on the maximum running annual average. Compliance for bi-weekly sampling will be based on the mean of all samples collected.
- Additional action for Cryptosporidium (beyond 3.0-log reduction) will be based on source water concentrations of the protozoa. No action is required if the average is less than 0.075 oocysts/L. 1-log action required if average between 0.075 and 1.0 oocysts/L. 2-log action required if average between 1.0 and 3.0 oocysts/L. 2.5-log action required if average is greater than 3.0 oocysts/L.
- Action credit can be granted in a variety of ways that will be displayed in a "Microbial Toolbox". This may include pretreatment actions such as a watershed control program (0.5 log) and bank filtration (1.0 log if > 50 feet from source). Treatment alternatives include superior treated water turbidity (0.5 log for <0.15

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NTU in 95 percent of samples collected every four hours or 1.0 log for <0.15 NTU in 95% of samples collected every 15 minutes), membranes (as proven in challenge tests,), secondary filtration (0.5 log for GAC, rapid sand or dual media), ultraviolet light (log achieved), and ozone (log achieved).

- Systems will have to conduct a second round of source water monitoring for Cryptosporidium six years after the initial bin classification is completed.
- All systems required to monitor for Cryptosporidium will be required to conduct disinfection profiling/ benchmarking. Same method as under Interim ESWTR.
- All uncovered treated water reservoirs must be covered or distribution from them must achieve 4-log virus inactivation.

Compliance with the LT2ESWTR is to begin in October of 2013.

2.3 Drinking Water Candidate Contaminant List/ Unregulated Contaminant

Monitoring Rule

The 1996 Amendments provided a list of chemical and microbial contaminants for possible future regulation. Every five years, the USEPA is required to update the list, select at least five constituents for evaluation, and determine to regulate. The regulations will be determined based on risk assessment and cost-benefit considerations and on minimizing overall risk.

The USEPA selected constituents to evaluate as part of the first listing in 1998 and determined in 2003 not to regulate any of those selected. The USEPA has opted to use the remaining constituents from the first listing as the second list for evaluation. From this list of 51 constituents, 42 chemical and 9 microbial, the USEPA will select at least five to determine to regulate, expected to begin in 2006, but may be deferred.

The Unregulated Contaminant Monitoring Rule (UCMR) requires CWSs to conduct "treated" water monitoring of specified unregulated constituents. The purpose is to assist the USEPA to collect information about contaminants present in drinking water supplies that are currently unregulated. In agreement with the Candidate Contaminant List, the second UCMR, expected to be published in 2006, will be revised to reflect the constituents that USEPA believes they need more data to determine to regulate.

Once a contaminant is determined to need regulation, the standard shall be promulgated within 18 months of the determination. The regulations will be determined based on risk assessment and cost-benefit considerations and on minimizing overall risk. Regulations must be based on best available, peer-reviewed science and data from best available methods. The standard will take effect three years later. For each new regulation, the USEPA is required to identify affordable technologies that will achieve compliance for small systems.

2.4 Distribution System Rule / Revised Total Coliform Rule

The USEPA conducted a review of 69 existing drinking water regulations in April 2002. The USEPA determined only the Total Coliform Rule (TCR) was a candidate for revision. The USEPA

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conducted two experts meetings to identify the major distribution system issues. From these meetings, nine white papers were developed on the most critical subjects including:

- Cross connection control
- Aging infrastructure and corrosion
- Permeation and leaching
- Nitrification
- Biofilms/Growths
- Covered storage
- Decay in water quality over time
- New/Repaired Water Mains

The USEPA plans to publish a revised TCR by 2006 and a final rule by 2008. Without knowing the exact details of proposed changes, it is difficult to predict how an updated TCR would affect the users of LP water.

2.5 Atrazine

USEPA is planning to develop a primary MCL for atrazine in drinking water. Although the possible MCL is currently unknown, promulgation may occur as early as 2010. Atrazine has been detected in vey low levels in Lake Powell in the past.

2.6 Perchlorate

USEPA is planning to develop a primary MCL for perchlorate in drinking water. Some states, such as California, currently have a notification level for perchlorate of 6 ug/L. As part of the MCL development process, the Office of Environmental Health Hazard Assessment (OEHHA) published a final public health goal (PHG) for perchlorate of 6 ug/L in March 2004. A perchlorate MCL of 6 ug/L might be promulgated as early as 2010. There is no available data regarding perchlorate concentrations in Lake Powell.

3.0 TREATED WATER QUALITY GOALS

When planning water treatment facilities, it is necessary to identify goals and objectives for the treated water quality to guide process selection, design of facilities, and development of an operations plan. Typical treated water quality goals are presented below based on other recent WTP planning projects that MWH has recently completed in Utah. These goals would need to be reviewed/confirmed as part of a preliminary design effort in future phase(s) of the LPP project.

3.1 General

- Treated water shall be potable and at a minimum shall meet all Federal and State drinking water standards.
- Achieve the Phase IV turbidity goals established by the EPA's Partnership for Safe Water Program.

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3.2 Turbidity

- Settled water turbidity, if conventional treatment is implemented, shall be less than 2 NTU in 95 percent of samples.
- Recycled water turbidity, if in-plant recycling is practiced, shall be less than 2 NTU (on average) and shall be limited to less than ten percent of maximum plant flow. When the plant is operating at less than maximum flow, the recycle rate should ideally be limited to less than ten percent of actual flow.
- Combined filter effluent turbidity shall be less than 0.10 NTU at all times.
- Individual filters shall not discharge filtered water to the clearwell with a turbidity greater than 0.10 NTU.
- Individual filter effluent turbidity shall be less than 0.15 NTU after a backwash and filter-to-waste cycle, and less than 0.10 NTU within 30 minutes of bringing the filter on-line after a backwash.
- Individual filter effluent particle counts shall be less than 50 p/ml in the 2 to 400 micron size range as measured by Hiac Royko Model HRLD 400 particle counter.

3.3 Microbial

- Water treatment facilities shall be designed to achieve appropriate microbial treatment, including a minimum of 3-log reduction of Giardia, 4-log reduction of virus, and 2-log reduction of Cryptosporidium through physical removal and chemical inactivation.
- Plan and initiate a sampling program to monitor for Giardia and Cryptosporidium over a 24-month period to comply with the LT2ESWTR. Also include monitoring for E. Coli as another microbial surrogate parameter. Once the monitoring is completed, the determine what “bin” the water source falls within to determine the future treatment requirements it must comply with.
- Monitor and maintain chlorine residual at the entry to the distribution system and at distribution system extremities to meet Total Coliform Rule.

3.4 Disinfection By-Products

- Achieve at least 25% TOC removal if conventional treatment is implemented. These are estimates to achieve the desired DBP concentrations based on existing conditions.
- Achieve TTHMs < 64 ppb (80 percent of 80 µg/l MCL) as a running annual average at individual distribution system sampling locations.
- Achieve HAA5 < 48 ppb (80 percent of 60 µg/l MCL) as a running annual average at individual distribution system sampling locations.

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Taste and Odor

- Provide finished water with a TON < 2.0
- Reduce geosmin/MIB concentrations to < 5 ppb during seasonal events

3.6 Corrosion Control

- Maintain similar pH and alkalinity in finished water compared to existing supplies in each community:
  - pH = 7.6 to 8.0
  - Alkalinity > 120 mg/l as $CaCO_3$
  - Langlier Saturation Index (LSI) no less than –0.2

3.7 Fluoridation

Fluoridation of the finished water is not desired by any of the participants.

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ATTACHMENT B

Table B.1 – Summary of Contaminants Currently Regulated by USEPA and UDEQ

CLASSIFICATION	CONTAMINANT	REGULATION	MCL (MG/L)
Inorganics (Section 64432)	Aluminum	UDEQ	0.05
	Antimony	Phase V	0.006
	Arsenic	Arsenic Rule	0.01
	Barium	UDEQ	2.0
	Beryllium	Phase V	0.004
	Cadmium	Phase II	0.005
	Copper	LCR	1.3 1,2
	Cyanide	Phase V	0.15
	Fluoride	UDEQ	4.0
	Lead	LCR	0.015 1,2
	Mercury	Phase II	0.002
	Nickel	Phase V	0.1 3
	Selenium	Phase II	0.05
	Thalium	Phase V	0.002
Nitrate, Nitrite (Section 64432.1)	Nitrate	Phase II	10 as N (45 as NO3)
	Nitrite	Phase II	1 as N
	Nitrate + Nitrite	Phase II	10 (sum as N)
Asbestos (Section 64432.2)	Asbestos	Phase II	7 MFL (>10um)
Secondary Stnds (Section 64449, Table 64449-A)	Aluminum	UDEQ	0.2
	Color	UDEQ	15 Units
	Copper	UDEQ	1.3
	Iron	UDEQ	0.3
	Manganese	UDEQ	0.05
	Methyl-tert-butyl-ether (MTBE)	UDEQ	0.005
	Odor-Threshold	UDEQ	3 Units
	Silver	UDEQ	0.1
	Zinc	UDEQ	5
Secondary Stnds (Section 64449, Table 64449-B)	Total Dissolved Solids	UDEQ	500
	Specific Conductance	UDEQ	N.R.
	Chloride	UDEQ	250
	Sulfate	UDEQ	250
General Mineral (Section 64449 (c) (2))	Bicarbonate	UDEQ	MO
	Carbonate	UDEQ	MO
	Alkalinity	UDEQ	MO
	pH	UDEQ	MO
	Calcium	UDEQ	MO
	Magnesium	UDEQ	MO
	Sodium	UDEQ	MO
	Hardness	UDEQ	MO

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CLASSIFICATION	CONTAMINANT	REGULATION	MCL (MG/L)
(Volatile) Organic Chemicals (Section 64444, Table 64444-A (a))	Benzene	UDEQ	0.005
	Carbon Tetrachloride	UDEQ	0.005
	o-Dichlorobenzene	Phase II	0.6
	Dichloromethane (Methylene chloride)	Phase V	0.005
	1,2-Dichloropropane	Phase II	0.005
	Ethylbenzene	Phase II	0.3
	Styrene	Phase II	0.1
	Tetrachloroethylene	Phase II	0.005
	1,2,4-Trichlorobenzene	Phase V	0.005
	1,1,1-Trichloroethane	Phase I	0.2
	1,1,2-Trichloroethane	Phase V	0.005
	Trichloroethylene	Phase I	0.005
(Non-Volatile Synthetic) Organic Chemicals (Section 64444, Table 64444-A (b))	Acrylamide	Phase II	TT (PAP)
	Alachlor	Phase II	0.002
	Atrazine	Phase II	0.001
	Benzo(a)pyrene	Phase V	0.0002
	2,4,-D	Phase II	0.07
	Dalapon	Phase V	0.2
	Dibromochloropropane	Phase II	0.0002
	Di (2-ethylhexyl) Adipate	Phase V	0.4
	Dinoseb	Phase V	0.007
	Diquat	Phase V	0.02
	Endothall	Phase V	0.1
	Endrin	Phase V	0.002
	Epichlorohydrin	Phase II	TT (PAP)
	Ethylene Dibromide	Phase II	0.00005
	Glyphosate	Phase V	0.7
	Hexachlorobenzene	Phase V	0.001
	Hexachlorocyclopentadiene	Phase V	0.05
	Lindane	Phase II	0.0002
	Methoxychlor	Phase II	0.03
	Oxamyl	Phase V	0.05
	Pentachlorophenol	Phase II	0.001
	Picloram	Phase V	0.5
	PCBs	Phase II	0.0005
	Simazine	Phase V	0.004
	Toxaphene	Phase II	0.003
	2,3,7,8-TCDD (Dioxin)	Phase V	3.00E-08
	2,4,5-TP (Silvex)	Phase II	0.05
Unregulated (Volatile) Organic Chemicals (Section 64450, Table 64450-A)	Perchlorate	UDEQ	N.R.

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CLASSIFICATION	CONTAMINANT	REGULATION	MCL (MG/L)
Natural Radioactivity (Section 64441)	Gross Alpha Particle Activity	NPDWR	15 pCi/L
	Combined Radium 226 & 228	NPDWR	5 pCi/L
Man-Made Radioactivity (Section 64443)	Gross Beta Particle Activity	NPDWR	50 pCi/L
Disinfection By-Products	Total Trihalomethanes (Chloroform, Bromoform, Chlorodibromomethane, Bromodichloromethane)	Stage 2 D/DBP Rule	0.08
	Haloacetic Acids 5 (Mono, di, and tri-chloroacetic acid, mono and di-bromoacetic acid)	Stage 2 D/DBP Rule	0.06
	Chlorite	Stage 2 D/DBP Rule	1.0
	Bromate	Stage 2 D/DBP Rule	0.01
Disinfection By-Product Precursors	Total Organic Carbon	Stage 1 D/DBP Rule	TT (% Removal)
Disinfectant Residuals	Chlorine (as Cl2)	Stage 1 D/DBP Rule	4.0 5
	Chloramines (as Cl2)	Stage 1 D/DBP Rule	4.0 5
	Chlorine Dioxide (as ClO2)	Stage 1 D/DBP Rule	0.8 5
Microbial	Giardia Lamblia	SWTR	TT (3-log Reduction/Inactiv.)
	Legionella	SWTR	TT
	Viruses	SWTR	TT (4-log Reduction/Inactiv.)
	Disinfectant Residual	SWTR	TT(detectable)
	Fecal Coliform	TCR	TT (positive sample)
	E. Coli	TCR	TT (positive sample)
	Total Coliform	TCR	TT(<5% mo. samples pos., if >40 samples per month)
	Turbidity	IESWTR	TT (<0.3 in 95% CFE samples, <1 in 100% CFE)
	Cryptosporidium	LT2ESWTR	TT (2-log Reduction/Inactiv.)

1 - Action Level
2 - Based on 90th Percentile of Tap Water Samples
3 -
4 -
5 - Maximum Residual Disinfectant Level (MRDL)
Acronyms:
USEPA - US Environmental Protection Agency
UDEQ - Utah Department of Environmental Quality
MCL - Maximum Contaminant Level
NPDWR - National Primary Drinking Water Regulation
LCR - Lead and Copper Rule
MO – Monitored Only

TT - Treatment Technology

PAP - Polymer Addition Practices
D/DBP - Disinfectants and Disinfection By-Products
SWTR - Surface Water Treatment Rule
TCR - Total Coliform Rule
IESWTR - Interim Enhanced Surface Water Treatment Rule
LT2ESWTR - Long Term 2 Enhanced Surface Water Treatment Rule
CFE - Combined Filter Effluent