FINAL REPORT

Conceptual Level Estimates of Probable Cost For the Dry Gulch & Snowball Water Treatment Facilities

March 30, 2009

BRILIAM ENGINEERING

301 N. Pagosa Blvd., Suite B-16 . P.O. Box 3238 . Pagosa Springs, Colorado 81147
Phone: (970) 731-9338 . Fax: (970) 731-8330
PAWS 5425

This page intentionally blank

Conceptual Level Opinion of Probable Cost for the
Dry Gulch and Snowball Water Treatment Facilities
Pagosa Area Water and Sanitation District
Pagosa Springs, Colorado

Table of Contents

Tables

Appendices

Appendix A	Site Layouts, Process Flow Diagrams, and Water Treatment Plant General Arrangements
Appendix B	Conceptual Cost Estimates

Acronyms

AACE	Association for the Advancement of Cost Engineering
AWWA	American Water Works Association
CDPHE	Colorado Department of Public Health and Environment
CIP	Clean-In-Place System
CMU	concrete masonry units
CPDWR	Colorado Primary Drinking Water Regulations
CT	Contact Time
EA	Environmental Assessment
EPA	Environmental Protection Agency
GFD	Gallons per Foot per Day
IBC	International Building Code
LRV	Log Removal Value
LT2ESWTR	Long Term 2 Enhanced Surface Water Treatment Rule
MF	Microfiltration System
MG	Million Gallons
MGD	Million Gallons per Day
PSI	Pounds per square inch
SUVA	Specific Ultraviolet Absorbance
TOC	Total Organic Carbon
UV	Ultraviolet Disinfection (UV) System
VFD	Variable Frequency Drive
CIF	Capital Investment Fee

Conceptual Level Opinion of Probable Cost for the
Dry Gulch and Snowball Water Treatment Facilities
Pagosa Area Water and Sanitation District
Pagosa Springs, Colorado

Executive Summary

This Report has been prepared for the Pagosa Area Water and Sanitation District (PAWSD) to assist in the evaluation of the existing Capital Investment Fee (CIF) specifically for the replacement of the existing Snowball Water Treatment Plant (WTP) either at the Dry Gulch site or at the existing Snowball WTP site. Each of the conceptually designed facilities has an initial capacity of 2 MGD, readily expandable to the ultimate design of 4 MGD.

The conceptual development of Snowball and Dry Gulch facilities are based upon the raw source water available. The conceptual construction costs associated with each facility layout are directly related to the raw water quality. Since the raw water qualities associated with each of these facilities are significantly different, the conceptual construction costs associated with the different facilities are different. The Snowball Water Treatment Facility will receive raw water from the West Fork of the San Juan River. The Dry Gulch Water Treatment Facility will receive raw water from the Main Stem of the San Juan River.

The cost estimates included in this Report are based upon the Level 4 Engineer's Conceptual Level Opinion's of Probable Construction Cost as developed by the Association for the Advancement of Cost Engineering (AACE) Cost Estimate Classification System. The purpose of a Level 4 Estimate is to provide a conceptual level effort that has an expected accuracy range from -30% to +50% and the inclusion of an appropriate contingency.

The conceptual nature of the design concepts and associated costs presented in this Report are based upon the very limited information available at this stage of the project. These cost estimates have been developed using a combination of experience with similar projects, current and foreseeable regulatory requirements, specific requirements of the PAWSD, and an understanding of the necessary project components, specifically raw water quality treatment requirements and handling by-products of the treatment processes. As the project progresses, the design and associated costs could vary significantly from the project components identified in this Report.

These cost estimates provided below will be used in the development of a revised Capital Investment Fee (CIF) specifically for the replacement of the existing Snowball Water Treatment Plant (WTP) either at the Dry Gulch site or at the existing Snowball WTP site. In addition to these two sites, for planning purposes an additional expansion or facility has been incorporated solely for the purpose of defining additional future treatment capacity requirements.

Pagosa Area Water and Sanitation District

Engineer's Conceptual Level 4 Estimate of Probable Cost

Dry Gulch Water Treatment Facility (San Juan River Main Stem or Reservoir Water Source)

Description	*2 MGD*	*4 MGD*	*Total Costs*
Site Work	$ 1,404,765		$ 1,404,765
Building Architectural & Structural Components	$ 6,921,990		$ 6,921,990
Treatment Process Systems	$ 3,813,500	$ 2,050,000	$ 5,863,500
Solids Handling Systems	$ 297,600		$ 297,600
Mechanical (HVAC/DWV) Systems	$ 372,000		$ 372,000
Electrical/Instrumentation & Controls Systems	$ 1,488,000	$ 500,000	$ 1,988,000
Mobilization & Bonds	$ 428,936	$ 76,500	$ 505,436
Subtotal Base Construction Costs	$ 14,726,791	$ 2,626,500	$ 17,353,291
Engineering Services Costs	$ 2,945,358	$ 525,300	$ 3,470,658
Subtotal Conceptual Level Project Costs	$ 17,672,149	$ 3,151,800	$ 20,823,949
Contingency	$ 3,534,430	$ 630,360	$ 4,164,790
Total Conceptual Level Project Costs for Construction & Engineering Services Costs	**$ 21,206,579**	**$ 3,782,160**	**$ 24,988,739**

Pagosa Area Water and Sanitation District

Engineer's Conceptual Level 4 Estimate of Probable Construction Cost

& Conceptual Estimate of Engineering and Construction Management Services Fees

Snowball Water Treatment Facility (West Fork San Juan River)

Description	*2 MGD*	*4 MGD*	*Total Costs*
Site Layout, Yard Piping, & Storage Tanks	$ 1,404,765		$ 1,404,765
Architectural & Structural Components	$ 3,834,344		$ 3,834,344
Treatment Process Systems	$ 2,744,000	$ 2,050,000	$ 5,244,000
Solids Handling Systems	$ 93,000		$ 93,000
Mechanical (HVAC/DWV) Systems	$ 325,500		$ 325,500
Electrical/Instrumentation & Controls Systems	$ 1,488,000	$ 500,000	$ 1,988,000
Mobilization & Bonds	$ 296,688	$ 51,000	$ 347,688
Subtotal Base Construction Costs	$ 10,186,297	$ 2,601,000	$ 12,787,297
Engineering Services Costs	$ 2,037,259	$ 520,200	$ 2,557,459
Subtotal Conceptual Level Project Costs	$ 12,223,556	$ 3,121,200	$ 15,344,756
Contingency	$ 2,444,711	$ 624,240	$ 3,068,951
Total Estimated Conceptual Level Project Costs for Construction & Engineering Services Costs	**$ 14,668,267**	**$ 3,745,440**	**$ 18,413,707**

1.0 INTRODUCTION AND PURPOSE

1.1 Introduction

This Report has been prepared for the Pagosa Area Water and Sanitation District (PAWSD) to assist in the evaluation of the existing Capital Investment Fee (CIF) specifically for the replacement of the existing Snowball Water Treatment Plant (WTP) either at the proposed Dry Gulch site or at the existing Snowball WTP site. Each of the conceptually designed facilities has an initial capacity of 2 MGD, readily expandable to the ultimate design of 4 MGD.

In addition to these two sites, for planning purposes a supplemental facility or expansion to an existing facility has been included in the Report solely for the purpose of additional future treatment capacity requirements. This facility has been given a base cost equal to the Dry Gulch Facility. It should also be noted that a cursory investigation for expansions to a future ultimate build out of 8 MGD at either the Snowball or Dry Gulch site has been completed. Based upon that investigation, the site constraints associated with the Snowball Facility require placement of the current ultimate build out of 4 MGD so that any future layouts can be incorporated on to the site.

The conceptual development of Snowball and Dry Gulch facilities are based upon the raw source water available. The conceptual construction costs associated with each facility layout are directly related to the raw water quality. Since the raw water qualities associated with each of these facilities are significantly different, the conceptual construction costs associated with the different facilities are different. The Snowball Water Treatment Facility will receive raw water from the West Fork of the San Juan River. The Dry Gulch Water Treatment Facility will receive raw water from the Main Stem of the San Juan River.

The proposed Water Treatment Facility will be primarily used to supply drinking water to the Town of Pagosa Springs and outlying subdivisions along Highway 84. The existing Snowball WTP supplies water to the Snowball Storage Tank (0.25 MG), the Cemetery Storage Tank (1.0 MG) and the Reservoir Hill Storage Tank (0.5 MG) through a network of pipelines. The Snowball Storage Tank can also supply water north and south of Town. Water from the Cemetery Storage Tank and the Reservoir Hill Storage Tank supplies water to Town and to Putt Hill One and Putt Hill Two Booster Stations, which pump water to the Putt Hill Storage Tank (0.150 MG). The water from the Putt Hill Storage Tank then gravity feeds to the Pagosa Hills area. Another small tank within the distribution system is located at a high point in the Loma Linda Subdivision.

Due to the conceptual level nature of this analysis, many facets of the proposed facilities are based upon generally accepted conceptual design standards and practices, and a conceptual level understanding the proposed project sites. The proposed facilities are not based upon detailed alternative analysis or project feasibility. Site specific geotechnical components have not been used as a part of the Report. The following bullets identify many of those items that are relevant to the different project sites and further developed throughout the Report.

1) The conceptual level design was based upon the current and foreseeable regulations, specifically:
    - Stage 1 and Stage 2 Disinfectants and Disinfection By-Products Rules
    - Long Term 1 and Long Term 2 Enhanced Surface Water Treatment Rules
    - Lead and Copper Rule

- Colorado Department of Public Health and Environment (CDPHE) Design Criteria for Potable Water Systems, Revised March 31, 1997
- Colorado Primary Drinking Water Regulations (CPDWR), Effective September 30, 2008

2) The proposed drinking water treatment facilities will not be located within the floodplain.
3) The proposed drinking water treatment plant sites are free of historical and archeological resources, and are not known to be home to any endangered flora or fauna species. At this time, no Environmental Assessment (EA) Checklist has been completed to evaluate potential environmental impacts at the proposed sites.
4) The proposed drinking water treatment facilities do not address any treatment processes for the destruction of endocrine disrupting compounds.
5) The proposed drinking water treatment facilities do not address any of the potential impacts associated with the quagga mussels that appear to be infiltrating reservoirs within the Western United States.
6) The proposed drinking water treatment facilities estimates of probable costs are based upon direct intakes from the San Juan River without any significant reduction in suspended solids.
7) The building construction at either site will include a wall assembly that includes concrete masonry units (CMU), intermediate insulation, and brick exterior. The roof assemblies will include either concrete double tees or bar joists, parapets, in accordance with the IBC 2006 Codes.
8) The conceptual level estimates of probable cost are in 2008 dollars. No effort has been made to adjust the estimates due to the unknown time frame for the full build out of the project. Further discussion is included in Section 2.0 of this Report.

1.2 Purpose

The purpose of this Report is to develop an Engineer's Conceptual Level 4 Opinion of Probable Cost following the Association for the Advancement of Cost Engineering (AACE) Cost Estimate Classification System for each treatment facility. These costs will be analyzed in the development of a revised Capital Investment Fee (CIF) specifically for the replacement of the existing Snowball Water Treatment Plant (WTP) either at the Dry Gulch site or at the existing Snowball WTP site. In addition to these two sites, for planning purposes an additional expansion or facility has been incorporated solely for the purpose of defining additional future treatment capacity requirements. The conceptual water treatment facilities components include:

Dry Gulch Water Treatment Facility:

- Splitter Box (River Intake or Dam Intake)
- Yard Piping
- Pretreatment Systems
- Conventional Rapid Mix
- Conventional Flocculation (4 Stage)
- High Rate Sedimentation (Lamella Plate Setters)
- Microfiltration Systems
- Compressed Air System (MF System)
- Chemical Feed Systems
  - Chlorine Dioxide System (Pretreatment)
  - Coagulant System (Pretreatment)

    - Clean-in-Place System (MF System)
    - Neutralization System (MF System)
    - pH Adjustment (Corrosion Control)
    - Chlorine System (Residual Disinfectant)
    - Chlorine Scrubber System (Residual Disinfectant)
    - Polymer System (Dewatering System)
- Ultraviolet Disinfection System (Contact Disinfectant)
- High Service Pump System (Distribution System)
- Solids Handling System
- Water Storage Tank
- Office
- Laboratory
- Conference Room
- Electrical / MCC Room
- Bathroom
- Garage / Maintenance Room
- Storage Room

Snowball Water Treatment Facility:

- Yard Piping
- Pretreatment Systems
    - Conventional Rapid Mix
    - Coagulation Tanks
- Microfiltration Systems
- Compressed Air System (MF System)
- Chemical Feed Systems
    - Chlorine Dioxide System (Pretreatment)
    - Coagulant System (Pretreatment)
    - Clean-in-Place System (MF System)
    - Neutralization System (MF System)
    - pH Adjustment
    - Chlorine System (Residual Disinfectant)
    - Chlorine Scrubber System (Residual Disinfectant)
    - Polymer System (Dewatering System)
- Ultraviolet Disinfection System (Contact Disinfectant)
- High Service Pump System (Distribution System)
- Water Storage Tank
- Office
- Laboratory
- Conference Room
- Electrical / MCC Room
- Bathroom
- Garage / Maintenance Room
- Storage Room

2.0 COST ESTIMATE BASIS AND LIMITATIONS

2.1 Cost Estimate Basis

The cost estimates included in this Report are based upon the Level 4 Engineer's Conceptual Level Opinion's of Probable Construction Cost as developed by the Association for the Advancement of Cost Engineering (AACE) Cost Estimate Classification System. The purpose of a Level 4 Estimate is to provide a conceptual level effort that has an expected accuracy range from -30% to +50% and the inclusion of an appropriate contingency.

The conceptual level of the design concepts and associated costs presented in this Report are based upon the very limited information available at this stage of the project. These cost estimates have been developed using a combination of experience with similar projects, current and foreseeable regulatory requirements, specific requirements of the PAWSD, and an understanding of the necessary project components, specifically raw water quality treatment requirements and handling by-products of the treatment processes. The following list identifies several of the project component used for the development of the cost estimates:

- Conceptual Layouts
- Quantity Take Offs
- Project Components and Design Criteria
  - Treatment Processes
  - Ancillary Equipment and Facilities

For the purpose of developing a cost per gallon for the different water treatment facilities, the initial phase of the project has a capacity of 2 MGD with an ultimate full build out design of 4 MGD. The initial phase of construction has a higher cost per gallon because the facilities have been designed so that the ultimate design can be incorporated into the proposed facilities.

As the project progresses, the design and associated costs could vary significantly from the project components identified in this Report.

2.2 Cost Estimate Limitations

Engineer's opinions of probable Construction Cost are to be made on the basis of Engineer's experience and qualifications and represent Engineer's best judgment as an experienced and qualified professional generally familiar with the construction industry. However, since Engineer has no control over the cost of labor, materials, equipment, or services furnished by others, or over contractors' methods of determining prices, or over competitive bidding or market conditions, or other factors affecting construction costs. Engineer cannot and does not guarantee that proposals, bids, or actual Construction Cost will not vary significantly from Conceptual Level Opinions of Probable Construction Cost prepared by Engineer.

These Engineer's Conceptual Level Opinions of Probable Construction Cost estimates specifically address the capital costs associated with the construction of the water treatment facilities, including the building, treatment processes, ancillary equipments and facilities, and yard piping. The cost estimates do not include any utility extension costs, property acquisition or easement costs, or program/project level costs, including administrative, legal, and permitting.

2.3 Contingencies

The contingency used for this Report is 20 percent based upon the Base Construction Subtotal. The conceptual level of this Report requires this percentage allowance for construction contingencies to account for unforeseen site conditions, variations in the estimations in the construction costs, additional site specific information, and other unforeseen or unexpected costs that are not yet defined. As the project progresses, the contingency percentage will decrease as the specific project design is further developed.

3.0 PROJECT COMPONENT BASIS OF COST DOCUMENTS AND COST ESTIMATES

To maintain a level of consistency, each of the treatment facilities will include the following Process Equipment Components:

1) Microfiltration (MF) Systems as the primary filtration mechanism is designed on the basis of a "n + 1" approach, that includes a secondary recovery unit which will allow for increased water recovery from approximately 95% to 99% depending upon the raw water quality.
2) Neutralization System for Clean-In-Place waste from the MF system so that water discharged to either the sanitary sewer or backwash ponds will meet the Total Chlorine Residual limits required as identified in the Discharge Permit (Snowball WTP only).
3) Chemical Feed Systems including a preoxidant (chlorine dioxide) feed and storage, coagulant feed and storage, chlorine feed, storage, and future scrubber capability, and pH adjustment feed and storage.
4) Ultraviolet (UV) Disinfection Systems for contact disinfection in conjunction with chlorination as the residual disinfectant are also incorporated into each of the conceptual level estimates of probable cost.

3.1 Dry Gulch Water Treatment Facilities

The proposed Dry Gulch Water Treatment Facility Site is considered a "green field" site, meaning that there is no existing infrastructure on the property. Conceptual level drawings have been developed including a Site Layout, Process Flow Diagram, and Water Treatment Plant General Arrangement, that are included in Appendix A, Sheets 1, 2 and 3, respectively.

The proposed property is adjacent to the proposed Dry Gulch Reservoir on the west side of Highway 160 approximately 2 miles northeast of the Town of Pagosa Springs. The Dry Gulch WTP intake would be located on the Main Stem of the San Juan River, and the raw water quality can vary from good to having seasonal very high solids component. This raw water quality directly impacts the costs associated with the design and construction of the facilities due to the additional treatment and solids handling that will be required at the facility. The typical raw water characteristics currently anticipated for this facility are defined below:

TABLE 3-1 RAW WATER QUALITY CHARACTERISTICS

Parameter	Quantity
TOC (mg/L)	2.0 to 6.0
Turbidity (NTU)	3.0 to 1,000
SUVA (L/mg-m)	1.9 to 2.5
Temperature (ºC)	4 to 20
pH	5.8 to 9.0
Total iron (mg/L)	0.21 to 0.5
Total manganese (mg/L)	0.1 to 1.5
Alkalinity (mg/L as CaCO3)	30 to 100
Hardness (mg/L as CaCO3)	140 to 160

3.1.1 Design Criteria for Conceptual Facilities and Equipment

The following design criteria tables were used for the development of the Conceptual Level Opinions of Probable Cost:

TABLE 3-2 PROPOSED FACILITIES AND EQUIPMENT

Facility or Equipment	Description
Splitter Box	Concrete Valve Vault for River Intake or Dam Intake, including valves, flow meters, pipes and fittings, and miscellaneous appurtenances.
Yard Piping	Standard Class Ductile Iron Pipe (typical) Raw Water Intake Piping Finished Water Conveyance Piping to Water Storage Tank Finished Water Conveyance Piping to High Service Pumps Miscellaneous Drain and Process Piping, Valves, Flow Meters, and Vaults
Pretreatment Systems	Conventional Rapid Mix Conventional Flocculation (4 Stage – Mechanical or Hydraulic) High Rate Sedimentation (Lamella Plate Setters)
Microfiltration Systems	Microfiltration Skids and Piping Racks, Valves, Flow Meters, Process Piping between Equipment Systems, Miscellaneous Instrumentation and Controls Compressed Air System Clean-in-Place Systems Neutralization System
Chemical Feed Systems	Chlorine Dioxide System (Pretreatment) Coagulant System (Pretreatment) pH Adjustment (Corrosion Control) Chlorine System (Residual Disinfectant) Chlorine Scrubber System (Residual Disinfectant)
Solids Handling System	Waste Storage Tank Solids Handling System Building Decant and Solids Conveyance Pumps Polymer System
Ultraviolet Disinfection System	Contact Disinfectant
High Service Pump System	Distribution System
Water Storage Tank	Chlorine Residual Contact Time SolarBee Mixing System (or equivalent) Distribution System Storage High Service Pump Feed System
Office	Facilities Operations
Laboratory	Facilities Operations
Conference Room	Facilities Operations
Electrical / MCC Room	Electrical Equipment and Material
Bathroom	Facilities Operations

Garage / Maintenance Room	Facilities Operations
Storage Room	Miscellaneous Space

TABLE 3-3 PRETREATMENT EQUIPMENT

Equipment	Preliminary Sizing / Description
Rapid Mix Chamber	30 seconds mixing time / Two Tanks
Coagulation Chamber	5 to 10 minutes mixing time / Two Tanks
Flocculation Basin	4 Stages (Mechanical or Hydraulic)
Sedimentation Basin	Lamella Plate Settlers

TABLE 3-4 PROCESS LOADING RATES FOR MICROFILTRATION SYSTEM

Design for Continuous and Intermittent Service	
Minimum MF flow rate	0.5 MGD
Full Capacity MF flow rate at 4ºC	2 MGD (readily expandable to 4 MGD)
Maximum filtrate turbidity	0.1 NTU
Transmembrane pressure (psi)	30
Minimum MF treatment system recovery	95%
Maximum Flux rate (gfd):	45
Log Removal Value (LRV)	4
Membrane Material	pvdf
Feed Water Pumps	Two (2) at 2 MGD per Pump
Minimum Number of Microfiltration Trains (Racks)	Two (2) at 2 MGD at 4ºC

TABLE 3-5 CHEMICAL FEED SYSTEMS

Equipment	Preliminary Sizing / Description
Chlorine Dioxide Feed System	0.3 to 1.5 mg/L
Coagulant Feed System	10 to 40 mg/L
Gaseous Chlorine Feed System	0.5 to 2.5 mg/L
pH Adjustment Feed System	0.5 to 15 mg/L

TABLE 3-6 MICROFILTRATION SYSTEM EQUIPMENT

Equipment	Preliminary Sizing / Description
Feed Pump System	Two (2) Pumps at 2 MGD per Pump Variable Frequency Drives (VFDs), and associated components to provide sufficient pressure to the MF treatment system for normal filtration and feed flush modes at design capacity and feed water characteristics
MF Unit Assembly	Two (2) Treatment Trains (Racks) at 2 MGD per Train at 4°C Membrane modules, piping assemblies, and structural steel support framework to produce the required quantity of filtrate
Compressed Air System	Two (2) Air Compressor (total redundancy) Duplex air compressors, a receiver and the related valves and instruments to provide compressed air for instrumentation and air scrub
Clean-In-Place (CIP) System	Two tanks with immersion heaters, bulkhead connections for all interconnect piping, chemical transfer pumps, instrumentation and controls sufficient to provide full automation of the chemically enhanced backwash and operator-initiated CIPs that are otherwise fully automated.
Neutralization System	One tank with a vent, overflow, and sample tap. The tank shall be plumbed to receive flows from the CIP drain, CIP acid transfer line, CIP caustic transfer line, and include a sodium bisulfite transfer system.
Backwash System	Backwash Pumps, Variable Frequency Drives (VFDs), and associated components to provide sufficient pressure to the MF treatment system for BW during the Air Scrub portion of Backwashing and any BW flushing (if used) included in the selectable controls system

Ultraviolet Disinfection (UV) System:

The primary goal of the UV disinfection system is to provide additional Cryptosporidium/Giardia log inactivation credit to meet the LT2ESWTR. The UV system would include an in-line system using high intensity medium pressure lamps oriented perpendicular to the water flow. Design criteria at a flow rate of 2.0 MGD per single reactor, four lamps per reactor, one intensity sensor per lamp, automated lamp cleaning system, and an automated transmission/lamp intensity optimization system. The system operation is controlled using an automatic dose-paced control system. The control system is capable of allowing lamps to be operated to maintain a target UV dose in regards to flow, lamp intensity, and water quality conditions.

TABLE 3-7 UV REACTOR

Equipment	Description
In-Line UV Reactor	2 MGD UV transmittance of 80 to 92%, 2.0 log cryptosporidium removal, min dose 9 mJ/cm2 UV transmittance of 80 to 92%, 3.0 log cryptosporidium removal, min. dose 14.9 mJ/cm2

Treatment and Disinfection Log Inactivation / Removals

The treatment facilities approach to the inactivation/removal requirement includes the use of the chlorine dioxide feed system, microfiltration system, UV disinfection system, and the chlorination system in conjunction with the finished water storage prior to the distribution system.

Giardia Lamblia Cyst Inactivation (3-log) Removal Requirement

It is generally accepted that giardia lamblia cysts are typically larger than 1 micron in size. The microfiltration system membrane fibers have a 0.1 micron nominal pore size, and the filtration process removes solids larger than approximately 0.2 microns, therefore will provide a positive barrier for the a removal of giardia lamblia cysts. For the purposes of this Report, a generally accepted Log Reduction Value (LRV) is 4.0.

Per the LT2ESWTR requirements, at this time it appears that the raw water will be classified in Bin 2 ($\geq$ 0.075 and $<$ 1.0 oocysts/L). Therefore, an additional 1 to 1.5 Cryptosporidium/Giardia log treatment will be required.

Virus Inactivation (4-log) Removal Requirement

The viral inactivation's were developed using the Required CT Values (mg*min/L) 4-Log Inactivation of Virus by Free Chlorine, pH 6.0-9.0, and checked using the CDPHE Excel spreadsheet for Disinfection Profiling. The chlorination system will be used as the primary disinfectant for the viral inactivation requirement.

The disinfectant residual variations were provided to address seasonal variations in water quality. The average baffling condition presented is based upon the definition for the superior condition, which includes a perforated inlet (pipeline) with plug flow through the pipe to the clearwell tank, and intra-baffling the clearwell tank.

Water quality data used for Clearwell CT Calculations.

- pH: 7.0
- temperature: 0.5°C
- disinfectant residual: 1.0, 1.5, and 2.0 mg/L
- peak hourly flow rate: 4.0 MGD
- volume of water: 80,0000 gallon (min) pretreatment volume
  250,000 gallon (min) water storage tank
- baffling condition: 0.5 (efficient mechanical mixing)

Based upon this information, the following information was developed using both the CDPHE Excel spreadsheet for disinfection profiling and manually calculated using the EPA/AWWA CT Values for Inactivation Tables for Giardia lamblia cysts and viruses by free chlorine:

TABLE 3-8 DISINFECTION LOG REDUCTIONS FOR THE WATER STORAGE TANK

Residual Conc. (mg/L)	pH	Temp. (°C)	Peak Flow (GPM)	Vol. Min. (gal)	Vol. Eff. (gal)	CT Actual (mg*min/L)	Log-Reduction (Giardia)	Log-Reduction (viruses)
1.00	7.0	0.5	2,776	330,000	165,000	46.40	0.63	17.68
1.20	7.0	0.5	2,776	330,000	165,000	68.90	0.94	25.39
2.00	7.0	0.5	2,776	330,000	165,000	91.50	1.19	38.32

TABLE 3-9 SUMMARY OF LOG REMOVAL/INACTIVATION FOR THE TREATMENT FACILITY

Removal/Inactivation Technique	Log Reduction (1) (Giardia/Cryptosporidium)	Log Reduction (2) (Giardia/Cryptosporidium)	Log Reduction (Viruses)
Chlorine Dioxide	0.07	0.07	1.72
Microfiltration System	4.0	4.0	0.0
UV Disinfection System	2.0	3.0	0.5
Chlorination System / Water Storage Tank – CT	0.63 (worst case scenario)	0.63 (worst case scenario)	17.68 (worst case scenario)
Total Removal/Inactivation	6.70	7.70	19.90
Total Removal/Inactivation Required Between the Years 2010 to 2012	3.0 + 1.0 = 4.0 (min)* 3.0 + 1.5 = 4.5 (max)*	3.0 + 1.0 = 4.0 (min)* 3.0 + 1.5 = 4.5 (max)*	4.0

(1) UV transmittance of 80 to 92%, 2.0 log cryptosporidium removal, min dose 9 mJ/cm^2
(2) UV transmittance of 80 to 92%, 3.0 log cryptosporidium removal, min. dose 14.9 mJ/cm^2
* Actual Removal/Inactivation requirement will be dependent upon the LT2ESWTR results.

3.1.2 Assumptions

For the purposes of this report, the following assumptions were used for the development of the cost estimates:

1) The raw water quality entering the water treatment facility does not use a Ranney Collector Well for the collection of the raw water quality to the water treatment facility.
2) The conceptual level design was based upon the current and foreseeable regulations, specifically:
    - Stage 1 and Stage 2 Disinfectants and Disinfection By-Products Rules

- Long Term 1 and Long Term 2 Enhanced Surface Water Treatment Rules
- Lead and Copper Rule
- Colorado Department of Public Health and Environment (CDPHE) Design Criteria for Potable Water Systems, Revised March 31, 1997
- Colorado Primary Drinking Water Regulations (CPDWR), Effective September 30, 2008

3) The proposed drinking water treatment facilities will not be located within the floodplain.
4) The proposed drinking water treatment plant sites are free of historical and archeological resources, and are not known to be home to any endangered flora or fauna species. At this time, no Environmental Assessment (EA) Checklist has been completed to evaluate potential environmental impacts at the proposed sites.
5) The proposed drinking water treatment facilities do not address any treatment processes for the destruction of endocrine disrupting compounds.
6) The proposed drinking water treatment facilities do not address any of the potential impacts associated with the quagga mussels that appear to be infiltrating reservoirs within the Western United States.
7) The proposed drinking water treatment facilities estimates of probable costs are based upon direct intakes from the San Juan River without any significant reduction in suspended solids.
8) The building construction at either site will include a wall assembly that includes concrete masonry units (CMU), intermediate insulation, and brick exterior. The roof assemblies will include either concrete double tees or bar joists, parapets, in accordance with the IBC 2006 Codes.

3.1.3 Unlisted Items

The unlisted items allowance was eliminated in the final revision of the Report based upon the contingency allowance. This list includes emergency standby power and automatic transfer switches, Highway 160 improvements (acceleration/deceleration lanes), extensive landscaping and site improvements, potential architectural features required by Archuleta County Planning, and utility extensions.

3.1.4 Additional Considerations

Future regulatory impacts cannot be addressed at this time, but may impact future expansions of the water treatment facility.

3.1.5 Opinion of Probable Cost

The Conceptual Level Engineer's Opinion of Probable Cost for the proposed Dry Gulch Water Treatment Facility for the 2 MGD facility is $21,206,579 and for the 4 MGD facility $24,988,739.

3.2 Snowball Water Treatment Facilities

Currently, the existing Snowball WTP receives raw source water via a gravity intake from the West Fork of the San Juan River that is conveyed through a pipeline to a pre-sedimentation pond. The water then goes to the Snowball WTP that is currently rated at 1.5 million gallons per day (MGD).

The existing Snowball WTP was constructed in 1969, and upgraded in 1985. The upgraded facilities have exceeded their expected design life, and functionally have seasonal difficultly in meeting the Colorado Department of Public Health and Environment (CDPHE) regulations. The property is located approximately 3 miles north of the Town of Pagosa Springs on Snowball Road.

Due to the raw water quality of the West Fork of the San Juan, the proposed Snowball WTP facility does not require a robust pretreatment facility or a solids handling facility identified with the Dry Gulch Water Treatment Facilities. It is anticipated that the conventional backwash pond will meet the needs of the proposed facility.

Conceptual level sheets are attached in Appendix A, including a Site Layout, Process Flow Diagram, and a Water Treatment Plant General Arrangement Drawings, Sheet 4, 5, 6, and 7 respectively. These sheets identify the conceptual location of the proposed water treatment facility, the replacement of the existing 250,000 gallon water storage tank with a one million gallon tank, and the decommissioning and demolition of the existing water treatment facility. The anticipated raw water quality characteristics are defined below:

TABLE 3-10 RAW WATER QUALITY CHARACTERISTICS

Parameter	Quantity
TOC (mg/L)	2.0 to 4.0
Turbidity (NTU)	0.5 to 30
SUVA (L/mg-m)	1.9 to 2.5
Temperature (ºC)	4 to 20
pH	5.8 to 9.0
Total iron (mg/L)	0.2 to 0.3
Total manganese (mg/L)	0.1 to 1.0
Alkalinity (mg/L as CaCO3)	30 to 100
Hardness (mg/L as CaCO3)	140 to 160

3.2.1 Design Criteria for Conceptual Facilities and Equipment

TABLE 3-11 PROPOSED FACILITIES AND EQUIPMENT

Facility or Equipment	Description
Yard Piping	Standard Class Ductile Iron Pipe (typical) Raw Water Intake Piping Finished Water Conveyance Piping to Water Storage Tank Finished Water Conveyance Piping to High Service Pumps Miscellaneous Drain and Process Piping, Valves, Flow Meters, and Vaults
Pretreatment Systems	Splitter Box Conventional Rapid Mix Tanks Conventional Mechanical Coagulation Tanks
Microfiltration Systems	Microfiltration Skids and Piping Racks, Valves, Flow Meters, Process Piping between Equipment Systems, Miscellaneous Instrumentation and Controls Compressed Air System Clean-in-Place Systems Neutralization System
Chemical Feed Systems	Chlorine Dioxide System (Pretreatment) Coagulant System (Pretreatment) pH Adjustment (Corrosion Control) Chlorine System (Residual Disinfectant) Chlorine Scrubber System (Residual Disinfectant)
Backwash Pond System	Solids from Pretreatment and MF System
Ultraviolet Disinfection System	Contact Disinfectant
High Service Pump System	Distribution System
Water Storage Tank	Chlorine Residual Contact Time Solarbee Mixing System (or equivalent) Distribution System Storage High Service Pump Feed System
Office	Facilities Operations
Laboratory	Facilities Operations
Conference Room	Facilities Operations
Electrical / MCC Room	Electrical Equipment and Material
Bathroom	Facilities Operations
Garage / Maintenance Room	Facilities Operations
Storage Room	Miscellaneous Space

TABLE 3-12 PRETREATMENT EQUIPMENT

Equipment	Preliminary Sizing / Description
Splitter Box	Flow Splitting between Trains 1 and 2
Rapid Mix Chamber	30 seconds mixing time / Two Tanks
Coagulation Chamber	5 to 10 minutes mixing time / Two Tanks

TABLE 3-13 PROCESS LOADING RATES FOR MICROFILTRATION SYSTEM

Design for Continuous and Intermittent Service	
Minimum MF flow rate	0.5 MGD
Full Capacity MF flow rate at 4ºC	2 MGD (readily expandable to 4 MGD)
Maximum filtrate turbidity	0.1 NTU
Transmembrane pressure (psi)	30
Minimum MF treatment system recovery	95% to 99%
Maximum Flux rate (gfd):	45
Log Removal Value (LRV)	4
Membrane Material	pvdf
Feed Water Pumps	Two (2) at 2 MGD per Pump
Minimum Number of Microfiltration Trains (Racks)	Two (2) at 2 MGD at 4ºC

TABLE 3-14 MICROFILTRATION SYSTEM EQUIPMENT

Equipment	Preliminary Sizing / Description
Feed Pump System	Two (2) Pumps @ 2 MGD per Pump Variable Frequency Drives (VFDs), and associated components to provide sufficient pressure to the MF treatment system for normal filtration and feed flush modes at design capacity and feed water characteristics
MF Unit Assembly	Two (2) Treatment Trains (Racks) at 2 MGD per Train at 4°C Membrane modules, piping assemblies, and structural steel support framework to produce the required quantity of filtrate
Compressed Air System	Two (2) Air Compressor (total redundancy) Duplex air compressors, a receiver and the related valves and instruments to provide compressed air for instrumentation and air scrub
Clean-In-Place (CIP) System	Two tanks with immersion heaters, bulkhead connections for all interconnect piping, chemical transfer pumps, instrumentation and controls sufficient to provide full automation of the chemically enhanced backwash and operator-initiated CIPs that are otherwise fully automated.

Neutralization System	One tank with a vent, overflow, and sample tap. The tank shall be plumbed to receive flows from the CIP drain, CIP acid transfer line, CIP caustic transfer line, and include a sodium bisulfite transfer system.
Backwash System	Backwash Pumps, Variable Frequency Drives (VFDs), and associated components to provide sufficient pressure to the MF treatment system for BW during the Air Scrub portion of Backwashing and any BW flushing (if used) included in the selectable controls system

TABLE 3-15 CHEMICAL FEED SYSTEMS

Equipment	Preliminary Sizing / Description
Chlorine Dioxide Feed System	0.3 to 1.5 mg/L
Coagulant Feed System	10 to 40 mg/L
Gaseous Chlorine Feed System	0.5 to 2.5 mg/L
Sodium Hydroxide Feed System	0.5 to 15 mg/L

Ultraviolet Disinfection (UV) System:

The primary goal of the UV disinfection system is to provide additional Cryptosporidium/Giardia log inactivation credit to meet the LT2ESWTR. The UV system will be an in-line system using high intensity medium pressure lamps oriented perpendicular to the water flow. Design criteria at a flow rate of 2.0 MGD include the use of a single reactor, four lamps per reactor, one intensity sensor per lamp, automated lamp cleaning system, and an automated transmission/lamp intensity optimization system. The system operation is controlled using an automatic dose-paced control system. The control system is capable of allowing lamps to be operated to maintain a target UV dose in regards to flow, lamp intensity, and water quality conditions.

TABLE 3-16 UV REACTOR

Equipment	Description
In-Line UV Reactor	2 MGD UV transmittance of 80 to 92%, 2.0 log cryptosporidium removal, min dose 9 mJ/cm2 UV transmittance of 80 to 92%, 3.0 log cryptosporidium removal, min. dose 14.9 mJ/cm2

Treatment and Disinfection Log Removals

The treatment facilities approach to the inactivation/removal requirement include the use of the chlorine dioxide feed system, microfiltration system, UV disinfection system, and the chlorination system in conjunction with the finished water clearwell and pipeline to the distribution system.

Giardia Lamblia Cyst Inactivation (3-log) Removal Requirement

It is generally accepted that giardia lamblia cysts are typically larger than 1 micron in size. The microfiltration system membrane fibers have a 0.1 micron nominal pore size, and the filtration process removes solids larger than approximately 0.2 microns, therefore will provide a positive barrier for the a removal of giardia lamblia cysts. For the purposes of this Report, a generally accepted Log Reduction Value (LRV) is 4.0.

Per the LT2ESWTR requirements, at this time it appears that the raw water will be classified in Bin 2 (≥ 0.075 and < 1.0 oocysts/L). Therefore, an additional 1 to 1.5 Cryptosporidium/Giardia log treatment will be required.

Virus Inactivation (4-log) Removal Requirement

The viral inactivations were developed using the Required CT Values (mg*min/L) 4-Log Inactivation of Virus by Free Chlorine, pH 6.0-9.0, and checked using the CDPHE Excel spreadsheet for Disinfection Profiling. The existing chlorination system is the primary disinfectant for the viral inactivation requirement.

The disinfectant residual variations were provided to address seasonal variations in water quality. The superior baffling condition presented is based upon the definition for the superior condition, which includes a perforated inlet (pipeline) with plug flow through the pipe to the clearwell tank, and intra-baffling the clearwell tank.

Water quality data used for Clearwell CT Calculations.

- pH: 7.0
- temperature: 0.5°C
- disinfectant residual: 1.0, 1.5, and 2.0 mg/L
- peak hourly flow rate: 4.0 MGD
- volume of water: 80,0000 gallon (min) pretreatment volume
  250,000 gallon (min) water storage tank

Based upon this information, the following information was developed using both the CDPHE Excel spreadsheet for disinfection profiling and manually calculated using the EPA/AWWA CT Values for Inactivation Tables for giardia lamblia cysts and viruses by free chlorine:

TABLE 3-17 DISINFECTION LOG REDUCTIONS FOR THE WATER STORAGE TANK

Residual Conc. (mg/L)	pH	Temp. (°C)	Peak Flow (GPM)	Vol. Min. (gal)	Vol. Eff. (gal)	CT Actual (mg*min/L)	Log-Reduction (Giardia)	Log-Reduction (viruses)
1.00	7.0	0.5	2,776	330,000	165,000	46.40	0.63	17.68
1.20	7.0	0.5	2,776	330,000	165,000	68.90	0.94	25.39
2.00	7.0	0.5	2,776	330,000	165,000	91.50	1.19	38.32

TABLE 3-18 SUMMARY OF LOG REMOVAL/INACTIVATION FOR THE TREATMENT FACILITY

Removal/Inactivation Technique	Log Reduction (1) (Giardia/Crypto-sporidium)	Log Reduction (2) (Giardia/Crypto-sporidium)	Log Reduction (Viruses)
Chlorine Dioxide	0.07	0.07	1.72
Microfiltration System	4.0	4.0	0.0
UV Disinfection System	2.0	3.0	0.5
Chlorination System / Water Storage Tank – CT	0.63 (worst case scenario)	0.63 (worst case scenario)	17.68 (worst case scenario)
Total Removal/Inactivation	6.70	7.70	19.90

(1) UV transmittance of 80 to 92%, 2.0 log cryptosporidium removal, min dose 9 mJ/cm^2

(2) UV transmittance of 80 to 92%, 3.0 log cryptosporidium removal, min. dose 14.9 mJ/cm^2

* Actual Removal/Inactivation requirement will be dependent upon the final LT2ESWTR results.

3.2.2 Assumptions

For the purposes of this report, the following assumptions were used for the development of the cost estimates:

1) The conceptual level design was based upon the current and foreseeable regulations, specifically:
    - Stage 1 and Stage 2 Disinfectants and Disinfection By-Products Rules
    - Long Term 1 and Long Term 2 Enhanced Surface Water Treatment Rules
    - Lead and Copper Rule
    - Colorado Department of Public Health and Environment (CDPHE) Design Criteria for Potable Water Systems, Revised March 31, 1997
    - Colorado Primary Drinking Water Regulations (CPDWR), Effective September 30, 2008
2) The proposed drinking water treatment facilities will not be located within the floodplain.
3) The proposed drinking water treatment plant sites are free of historical and archeological resources, and are not known to be home to any endangered flora or fauna species. At this time, no Environmental Assessment (EA) Checklist has been completed to evaluate potential environmental impacts at the proposed sites.
4) The proposed drinking water treatment facilities do not address any treatment processes for the destruction of endocrine disrupting compounds.
5) The proposed drinking water treatment facilities estimates of probable costs are based upon direct intakes from the West Fork of the San Juan River.
6) The building construction at either site will include a wall assembly that includes concrete masonry units (CMU), intermediate insulation, and brick exterior. The roof assemblies will include either concrete double tees or bar joists, parapets, in accordance with the IBC 2006 Codes.

3.2.3 Unlisted Items

The unlisted items allowance was eliminated in the final revision of the Report based upon the contingency allowance. This list includes emergency standby power and automatic transfer switches, extensive landscaping and site improvements, and any potential architectural features required.

3.2.4 Opinion of Probable Cost

The Conceptual Level Engineer's Opinion of Probable Cost for the Snowball Water Treatment Facility for the 2 MGD facility is $14,668,267 and for the 4 MGD facility $18,413,707.

3.3 Future Water Treatment Facility / Expansion

In addition to these two sites, for planning purposes an additional cost estimate has been provided solely for the purpose of additional future treatment capacity requirements.

4.0 ENGINEER'S OPINION OF PROBABLE COST SUMMARY

4.1 Dry Gulch Water Treatment Facility

TABLE 4-1 CONCEPTUAL COST DRY GULCH WTP

Pagosa Area Water and Sanitation District

Engineer's Conceptual Level 4 Estimate of Probable Cost

Dry Gulch Water Treatment Facility (San Juan River Main Stem or Reservoir Water Source)

Description	2 MGD	4 MGD	Total Costs
Site Work	$ 1,404,765		$ 1,404,765
Building Architectural & Structural Components	$ 6,921,990		$ 6,921,990
Treatment Process Systems			
Pretreatment Systems	$ 1,292,700		$ 1,292,700
Filtration Systems	$ 2,000,000	$ 2,000,000	$ 4,000,000
Process Conveyance Equipment	$ 213,900		$ 213,900
Chemical Feed Systems	$ 306,900	$ 50,000	$ 356,900
Solids Handling Systems	$ 297,600		$ 297,600
Mechanical (HVAC/DWV) Systems	$ 372,000		$ 372,000
Electrical/Instrumentation & Controls Systems	$ 1,488,000	$ 500,000	$ 1,988,000
Mobilization & Bonds	$ 428,936	$ 76,500	$ 505,436
Subtotal Base Construction Costs	$ 14,726,791	$ 2,626,500	$ 17,353,291
Engineering Services Costs	$ 2,945,358	$ 525,300	$ 3,470,658
Subtotal Conceptual Level Project Costs	$ 17,672,149	$ 3,151,800	$ 20,823,949
Contingency	$ 3,534,430	$ 630,360	$ 4,164,790
Total Conceptual Level Project Costs for Construction & Engineering Services Costs	**$ 21,206,579**	**$ 3,782,160**	**$ 24,988,739**

4.2 Snowball Water Treatment Facility

TABLE 4-2 CONCEPTUAL COST SNOWBALL WTP

Pagosa Area Water and Sanitation District

Engineer's Conceptual Level 4 Estimate of Probable Construction Cost

& Conceptual Estimate of Engineering and Construction Management Services Fees

Snowball Water Treatment Facility (West Fork San Juan River)

Description	2 MGD	4 MGD	Total Costs
Site Layout, Yard Piping, & Storage Tanks	$ 1,404,765		$ 1,404,765
Architectural & Structural Components	$ 3,834,344		$ 3,834,344
Treatment Process Systems			
Pretreatment Systems	$ 106,950		$ 106,950
Filtration Systems	$ 2,000,000	$ 2,000,000	$ 4,000,000
Process Conveyance Equipment	$ 353,400		$ 353,400
Chemical Feed Systems	$ 283,650	$ 50,000	$ 333,650
Solids Handling Systems	$ 93,000		$ 93,000
Mechanical (HVAC/DWV) Systems	$ 325,500		$ 325,500
Electrical/Instrumentation & Controls Systems	$ 1,488,000	$ 500,000	$ 1,988,000
Mobilization & Bonds	$ 296,688	$ 51,000	$ 347,688
Subtotal Base Construction Costs	$ 10,186,297	$ 2,601,000	$ 12,787,297
Engineering Services Costs	$ 2,037,259	$ 520,200	$ 2,557,459
Subtotal Conceptual Level Project Costs	$ 12,223,556	$ 3,121,200	$ 15,344,756
Contingency	$ 2,444,711	$ 624,240	$ 3,068,951
Total Estimated Conceptual Level Project Costs for Construction & Engineering Services Costs	**$ 14,668,267**	**$ 3,745,440**	**$ 18,413,707**

4.3 Future Water Treatment Facility / Expansion

For planning purposes, the future water treatment facility or expansion is equal to the Dry Gulch Facility Conceptual Opinion of Probable Cost.