CITY OF Grand Junction COLORADO

2020 Wastewater Treatment Facilities MASTER PLAN

FINAL | July 2021

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FINAL | July 2021

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Abbreviations

2003 WWTP Study	2003 Persigo Wastewater Treatment Plant Study
2008 WW Basin Update	2008 Comprehensive Wastewater Basin Study Update
2020 Comprehensive Plan	One Grand Junction 2020 Comprehensive Plan
2020 Master Plan	2020 Wastewater Treatment Facilities Master Plan
AACE	Advancement of Cost Engineering International
AADL	annual average daily load
ADAF	average daily annual flow
ADMM	average daily maximum month
ADMMF	average daily maximum month flow
AIRES	Aerometric Information Retrieval System
AIWA	America's Water Infrastructure Act
APEN	air pollution emissions notice
aSRT	aerobic solids retention time
ATAD	autothermal thermophilic aerobic digestion
AWWA	American Water Works Association
BESS	battery energy storage system
BFP	belt filter press
BLM	Bureau of Land Management
BOD_5	5-day biochemical oxygen demand
°C	degrees Celsius
Carollo	Carollo Engineers, Inc.
CCES	Carollo Cost Estimating System
CCTV	closed-circuit television
CDPHE	Colorado Department of Public Health and Environment
CEPT	chemically enhanced primary treatment
CFD	computational fluid dynamics
cfd	cubic feet per day
cf/lb VS	cubic feet per pound of volatile solids
cfm	cubic feet per minute
CFU/g	colony forming units per gram
CIP	capital improvement plan
City	City of Grand Junction
cm	centimeter
CMAR	Construction Manager at Risk
CMGC	Construction Manager/General Contractor
CNG	compressed natural gas
Comprehensive Plan	One Grand Junction Comprehensive Plan
County	Mesa County
cu ft	cubic feet
DAFT	dissolved air flotation thickening
DB	Design-Build

DBB	Design-Bid-Build
DO	dissolved oxygen
DOLA	Department of Local Affairs
DU	dwelling unit
DWF	dry weather flow
DWPCF	dry weather per capita flow
EPA	Environmental Protection Agency
EQ	equalization
°F	degrees Fahrenheit
FE	flow equalization
$FeCl_3$	ferric chloride
F:M	food to microorganism (ratio)
FOG	fats, oil, grease
FTE	full-time equivalents
ft/sec	feet per second
GGE	gasoline gallon equivalent
gpcd	gallons per capita per day
gpd	gallons per day
gpd/ft	gallons per day per foot
gpd/lf	gallons per day per linear foot
gpd/sq ft	gallons per day per square foot
gpm	gallons per minute
gpm/sq ft	gallons per minute per square foot
grease	fat, oils, and grease
HA	health advisory
HMI	human-machine interfaces
HMWMD	Hazardous Materials and Waste Management Division
hp	horsepower
HRT	hydraulic retention time
HVAC	heating, ventilation, and air conditioning
I&C	instrumentation and controls
IFAS	integrated fixed film activated sludge
I/I	inflow and infiltration
IGA	1998 Persigo Intergovernmental Agreement
kgal	kilogallon
kV	kilovolt
kW	kilowatt
kWh	kilowatt-hour
lb	pound
lbs BOD_5/d/lb MLVSS	pounds of 5-day biochemical oxygen demand per day per pound of mixed liquor volatile suspended solids
lbs TKN/d/lb MLVSS	pounds of total Kjeldahl nitrogen per day per pound of mixed liquor volatile suspended solids
lbs VS/cfd	volatile solids per cubic foot per day

MCC	motor control center
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
MG	million gallons
mgd	million gallons per day
mg/kg	milligrams per kilogram
mg/m^2	milligrams per square meter
mg/L	milligrams per liter
MHz	megahertz
mJ/cm^2	millijoules per square centimeter
mL	milliliter
mL/g	milliliters per gram
MLE	Modified Ludzack-Ettinger
MLR	mixed liquor recycle
MLSS	mixed liquor suspended solids
mm	millimeter
MOP	Manual of Practice
MPN/g	most probable number per gram
MWAT	maximum weekly average temperature
MWh	megawatt-hour
NACWA	National Association of Clean Water Agencies
NaOH	sodium hydroxide
NEG	net excess generation
NEPA	National Environmental Policy Act
ng/L	nanograms per liter
NH_4-N	ammonia
nm	nanometer
NORM	Naturally Occurring Radioactive Materials
NPV	net present value
NFPA	National Fire Protection Association
NREL	National Renewal Energy Laboratories
NWRI	National Water Research Institute
O&M	operation and maintenance
OSHA	Occupational Health and Safety Administration
PD	positive displacement
PDF	peak daily flow
PDR	Process Design Report
PEL	preliminary effluent limit
Persigo	Persigo Wastewater Sewer system
PFAS	per- and polyfluoroalkyl substances
PFBS	perfluorobutanesulfonic acid
PFD	process flow diagram
PFOA	perfluorooctanoic acid

PFOS	perfluorooctanyl sulfonate
PHF	peak hour flow
PID	proportional-integral-derivative
PLC	programmable logic controller
ppb	parts per billion
ppd	pounds per day
ppd/cu ft	pounds per day per cubic foot
ppd/sq ft	pounds per day per square foot
pph	pounds per hour
ppm	parts per million
ppt	parts per trillion
project team	City and Carollo's project team
PS	primary sludge
psi	pounds per square inch
PSRP	Processes to Significantly Reduce Pathogens
PV	photovoltaic
RAS	return activated sludge
RIN	renewable identification number
RNG	renewable natural gas
rpm	revolutions per minute
SAE	Society for Automotive Engineers
SCADA	supervisory control and data acquisition
scfd	standard cubic feet per day
scfm	standard cubic feet per minute
scfy	standard cubic feet per year
SLR	solids loading rate
SOR	surface overflow rate
SOUR	specific oxygen uptake rate
SPA	state point analysis
sq ft	square feet
SRT	solids retention time
SU	Standard Unit
SVI	sludge volume index
TCLP	toxicity characteristic leaching procedure
TDH	total dynamic head
TDS	total dissolved solids
TENORM	Technologically Enhanced Naturally Occurring Radioactive Materials
TIN	total inorganic nitrogen
TMDL	total maximum daily load
TN	total nitrogen
TOrC	trace organic contaminants
TP	total phosphorus
TPCE	total project cost estimate

TS	total solids
TSCA	Toxic Substances Control Act
TSS	total suspended solids
TWAS	thickened waste activated sludge
UDB	Urban Development Boundary
UV	ultraviolet
UVT	UV transmittance
V	volt
VAR	vector attraction reduction
VFD	variable frequency drive
VS	volatile solids
VSLR	volatile solids loading rate
VSR	volatile solids reduction
WAS	waste activated sludge
WEF	Water Environment Federation
WJE	Wiss Janney, Elstner Associates, Inc
WQBEL	water quality-based effluent limits
WQCD	Water Quality Control Division
WS-1	Warm Water Stream Tier 1
WSE	water surface elevation
WWTP	wastewater treatment plant
Xcel	Xcel Energy

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2020 Wastewater Treatment Facilities Master Plan

Executive Summary

The City of Grand Junction's (City) Utilities Department jointly owns and operates the Persigo Wastewater Treatment Plant (WWTP) with Mesa County. The City is responsible for operating this system, which includes all the regional wastewater collection and treatment facilities that serve the 201 Service Area.

As a recognized industry leader, the Persigo WWTP staff focuses on being fiscally responsible stewards of sustainability and environmental protection. The City initiated the *2020 Wastewater Treatment Facilities Master Plan* (2020 Master Plan) to address service area growth, aging infrastructure, and operational efficiencies.

Recommendations and facility improvements focus on three areas to organize the City's capital improvement plan (CIP):

- Capacity Improvements.
- Asset Revitalization Projects.
- Operational Improvements.

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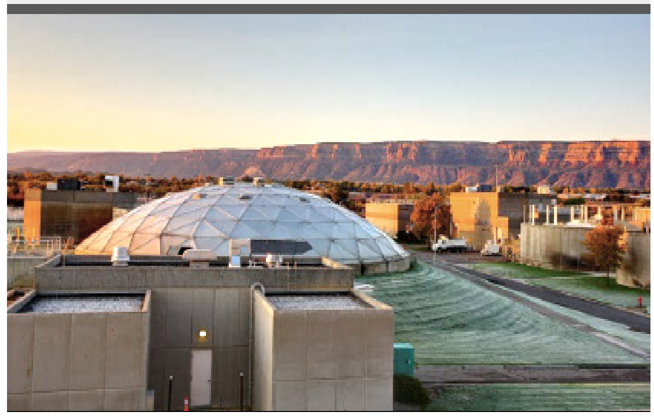
Wastewater Treatment Facilities At-A-Glance:

- 12.5 mgd treatment capacity.
- Commissioned in 1984.
- Serves population of approximately 100,000.



Persigo Wastewater Treatment Facility

Master Plan Goals

The 2020 Master Plan develops a roadmap for achieving operational resiliency and reliability to meet the wastewater needs of current and future users within the 201 Service Area. This roadmap incorporates the strategic visions and opportunities defined for the Persigo facilities, by the City and County, and as documented in the intergovernmental agreement (IGA). Figure ES.1 highlights the goals developed for the 2020 Master Plan.

Figure ES.1 2020 Master Plan Goals

Capacity Improvements

Population projections and the associated wastewater flow and loading conditions were developed using the City's approved 201 Service Area's boundary and urban development boundary (UDB), as shown in Figure ES.2, in conjunction with the City's *2020 Comprehensive Plan*.

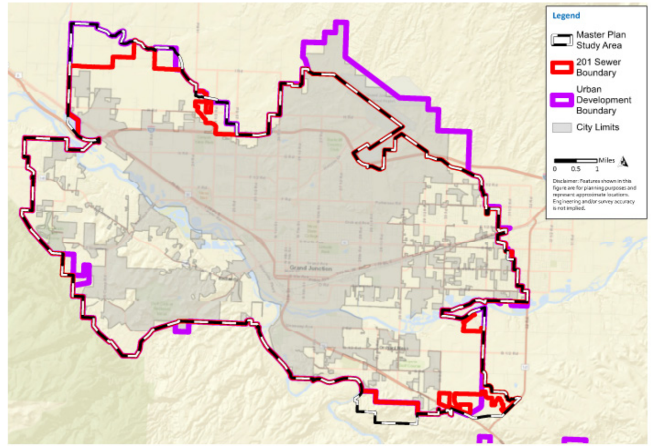


Figure ES.2 Master Plan Study Area Boundary

Population Growth

The City's projected population growth within the 201 Service Area matched projections from the City's *2020 Comprehensive Plan*. Figure ES.3 illustrates the projected annual growth rate of 1.1 percent for the 20-year planning period.

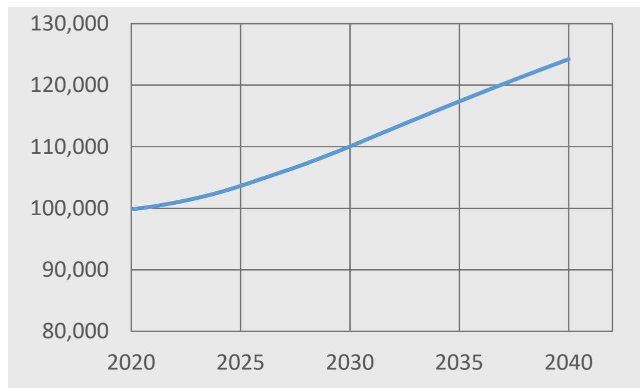
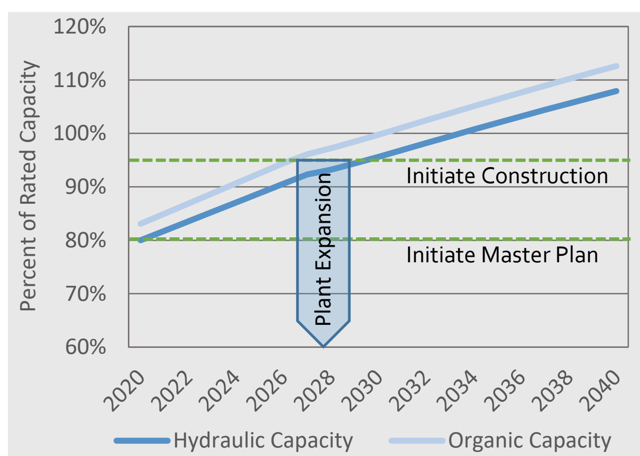


Figure ES.3 Service Area Population Growth

Permitted Capacity

The Persigo WWTP operates under the Colorado Department of Health and Environment (CDPHE) discharge permit (CO0040053), effective as of January 1, 2018. The facility has a permitted hydraulic capacity of 12.5 million gallons a day (mgd) and an organic capacity of 26,480 pounds per day of biological oxygen demand (ppd BOD_5) as shown in Figure ES.4. Based on CDPHE guidance, utilities are required to initiate master planning and construction activities at 80 percent and 95 percent of permitted capacity, respectively.



Hydraulic Capacity: 12.5 mgd Organic Capacity: 26,480 ppd

Figure ES.4 Capacity Expansion Driver

Unit Process Capacity Improvements

To meet the permitted capacity, each unit process needs to have the same or higher treatment capacity. Figure ES.5 shows a simplified facility schematic with the unit process improvements recommended to meet the current and future growth projections through the 2040 planning period. The capacity-related expenditures for the 20-year period equals $100 million. Of this, $25 million will need to be invested before 2028 to provide a minimum of 13.5 mgd capacity, which will be sufficient through 2040. The remaining $75 million would fund the next expansion project implemented after 2031 to provide an additional 6 mgd of treatment capacity, which should be sufficient to accommodate City growth through 2060.

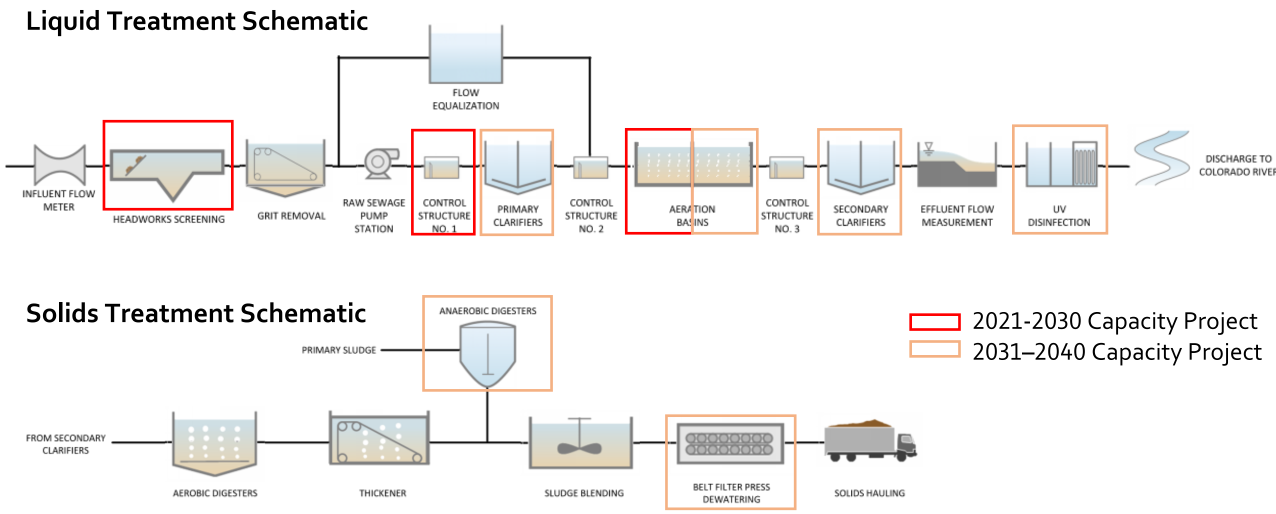


Figure ES.5 Recommended Unit Process Improvements Schematic

2008 Comprehensive Wastewater Basin Study Comparison

The 2020 Master Plan updated the City's *2008 Comprehensive Wastewater Basin Study* (2008 Study). The major differences between these reports includes:

- Future population growth decreased from 201,315 (2008 Study) to 124,000 (2020 Master Plan).
- Future capacity requirements decreased from 25 mgd to 13.5 mgd based on the revised population growth projections and water conservation efforts.
- Capacity related expenditures decreased from $125 million to $100 million for a 20-year planning period.
- The 2020 Master Plan evaluation included all Persigo WWTP facilities and not soley focused on wastewater treatment processes.

Asset Revitalization

Figure ES.6 shows the asset revitalization improvements identified for the Persigo WWTP within the next 10-year period. The City will average $6.5 million annually for asset renewal and replacement, as many of the processes and facilities are reaching the end of their useful life.

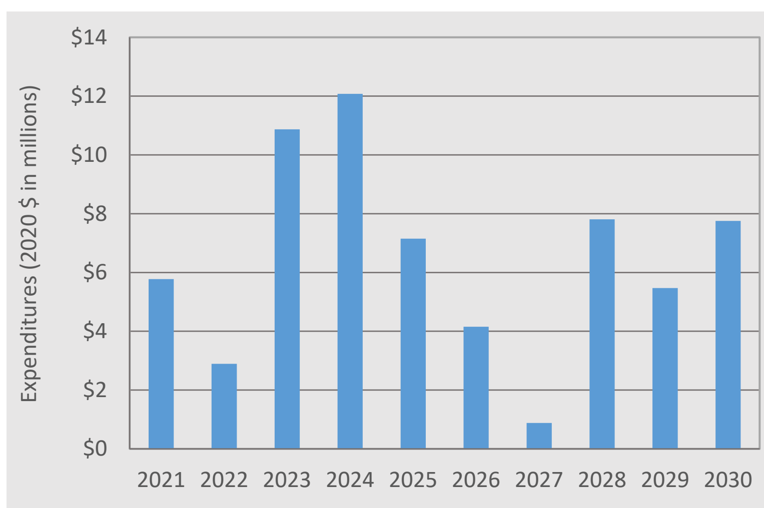


Figure ES.6 Persigo WWTP Asset Revitalization Annual Expenditures

Installing plant-wide fiber communications network and SCADA enhancements are examples of recommended operational improvements.

Operational Improvements

Operational improvements are recommended to address safety concerns and high maintenance activities, while increasing environmental benefits through resource recovery and innovation. These recommended projects improve overall operation efficiencies by reducing costs, increasing staff productivity, and improving staff safety.

Capital Implementation Plan – Persigo WWTP

The 2020 Master Plan evaluated over 20 treatment and unit process alternatives and prioritized these alternatives for implementation. The prioritization process used life-cycle financial comparisons and non-economic criteria. The implementation plan identified $200 million in infrastructure investments needs at the Persigo WWTP for the 2040 planning period. Figure ES.7 illustrates the allocation of infrastructure needs for the periods based on the three focus areas. Initially, the focus will be on asset revitalization projects. In the later years, the City will shift focus towards capacity-related projects.

10-Year Implementation Focus

Between 2021 and 2030, the 2020 Master Plan identified $124.7 million across all project categories in capital expenditure investments, which is an average of $12.5 million annually for the Persigo WWTP improvements as shown in Figure ES.8.

Table ES.1 shows the annual planned expenditures, sequence of prioritized projects, and project budgets. Figure ES.9 shows the location of each of the prioritized projects.

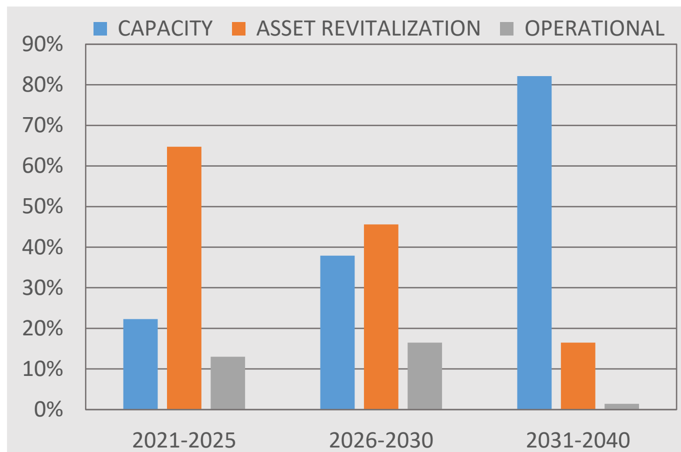


Figure ES.7 Persigo WWTP Funding Allocation

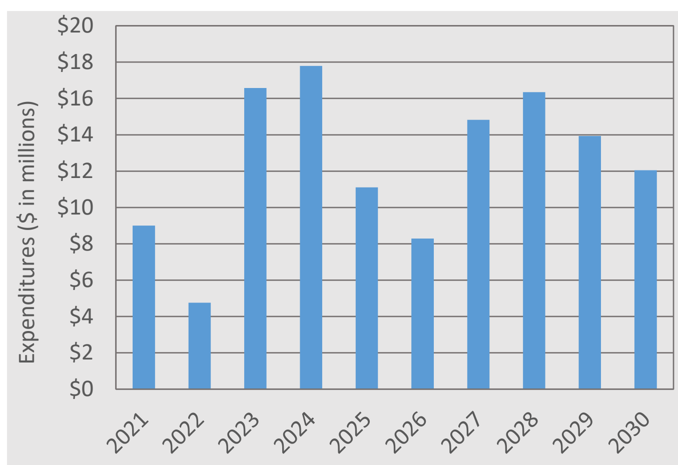


Figure ES.8 Persigo WWTP Annual Expenditures

Table ES.1 Persigo WWTP Implementation Projects for 2021-2030

Identified Project Groupings	10-Year Project Budget	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
WWTP Asset Replacements - 2020 and 2021 Projects	$5,732,179										
Odor Control Improvements	$2,345,000										
CNG Gas Storage / Enhanced Fueling Station	$1,080,000										
Persigo WWTP Master Plan	$164,660										
Flow Equalization Basin - Asset Revitalization	$584,000										
Aeration Basin Asset Revitalization and Blower Building	$16,209,000										
Disinfection Operational Improvements	$600,000										
New Dewatering Building and Solids Storage	$19,300,000										
Headworks Asset Replacements and Hydraulic Improvements	$6,287,000										
Admin Building Improvements and Electrical Distribution Loop	$11,840,000										
Anaerobic Digestion Conversion and Grease Building	$22,990,000										
Primary Clarifier Expansion and Asset Revitalization Projects	$13,278,000										
UV Disinfection Expansion	$9,551,000										
Biosolids Management - Class B Program	$756,000										
Raw Sewage Pump Station (RSPS) - Asset Revitalization	$5,149,000										
Secondary Clarifier - Asset Revitalization	$7,976,000										
Total Annual Capital Expenditures	**$124,696,000**	**$9,005,000**	**$4,755,000**	**$16,579,000**	**$17,792,000**	**$11,111,000**	**$8,292,000**	**$14,825,000**	**$16,345,000**	**$13,938,000**	**$12,054,000**
LEGEND: Project Development Phases	Study Phase	Design	Construction	Commissioning							

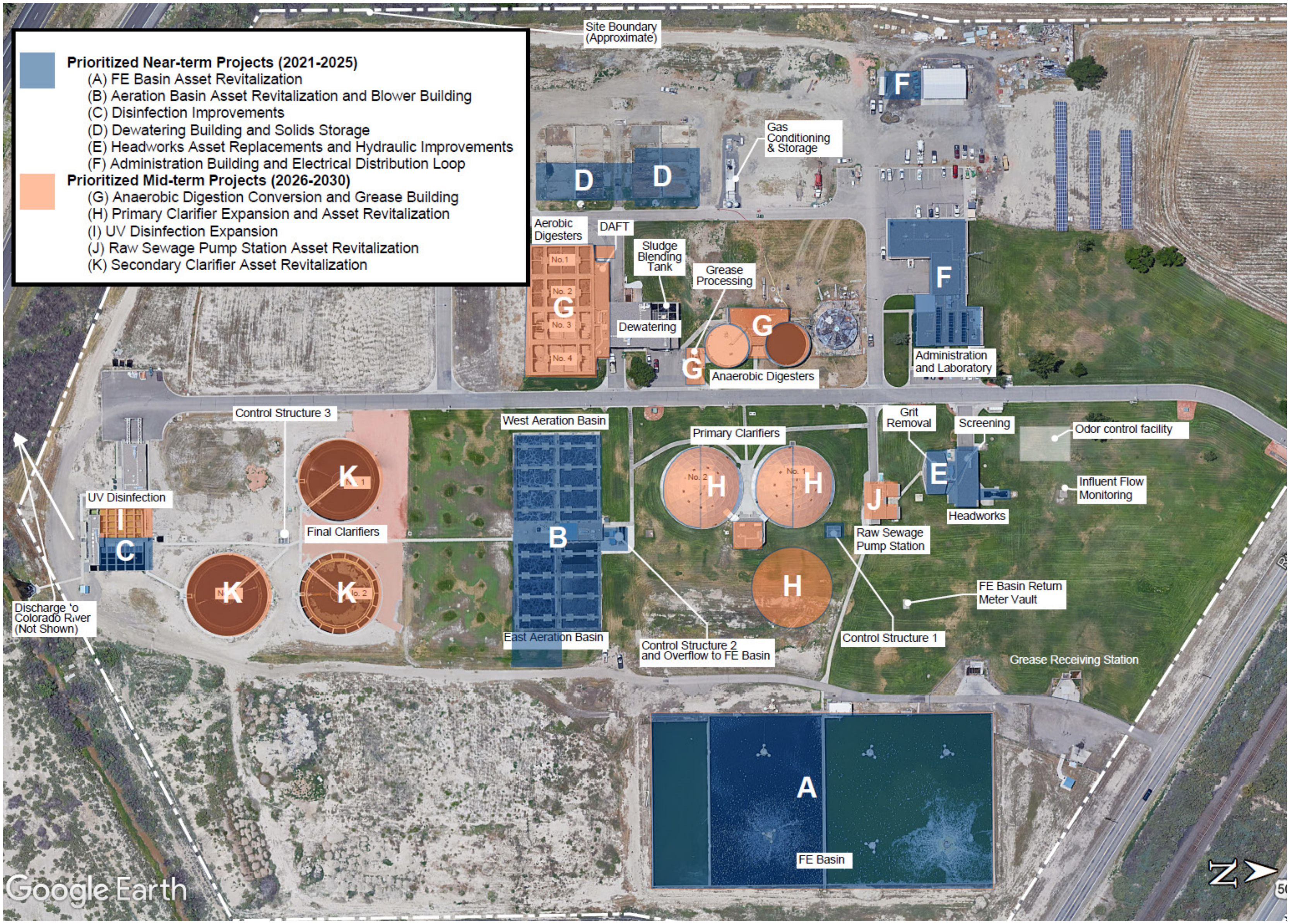


Figure ES.9 Aerial Image of Persigo WWTP Implementation Projects for 2021-2030

Combined Capital Implementation Plan

The City's combined CIP includes the Persigo WWTP and Collection System projects as identified in the 2020 Master Plan and 2020 Wastewater Basin Master Plan Update. Figure ES.10 and Table ES.2 show the capital expenditures for a 10-year period.

Table ES.2 Combined Expenditures for 2021-2030

Time Period	Collection System	Persigo WWTP	Total
2021-2025	$48.4	$59.2	$107.6
2026-2030	$41.5	$65.5	$106.9
Total	**$89.8**	**$124.7**	**$214.5**

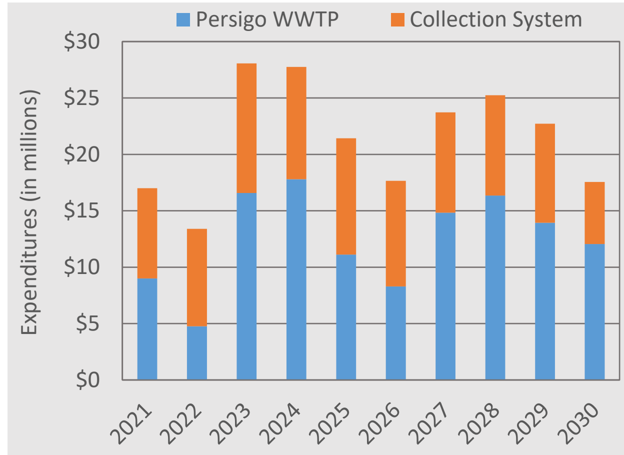


Figure ES.10 Combined Expenditures for 2021-2030

Organizational Impacts

Due to the magnitude of recommended capital improvements, the City will continue to assess if the existing staffing levels of 39.25 full-time equivalents can meet the management, operational, and construction related demands. The 2020 Master Plan recommends the City consider increasing staffing levels in the following areas to supplement the current staff:

- To support the delivery and execution of projects over the next 5 years, it is recommended that an additional project engineer, a project manager, and O&M construction liaison be added to the future staffing projections.
- As the City continues eliminating septic systems and creates new sewer improvement districts, it is recommended a Sewer Improvement District Coordinator be added.
- In 2027, the City will shift towards a Class B biosolids land application program and it is recommended a biosolids program manager be hired.

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Chapter 1

PROJECT BACKGROUND

1.1 Introduction

The City of Grand Junction (City) and Mesa County (County) jointly own and operate the Persigo Wastewater Treatment Plant (WWTP). The WWTP was commissioned in 1984 and has complied with its statutory and regulatory requirements along with meeting the policy guidance specified in the 1998 Persigo Intergovernmental Agreement (IGA) between the City and County.

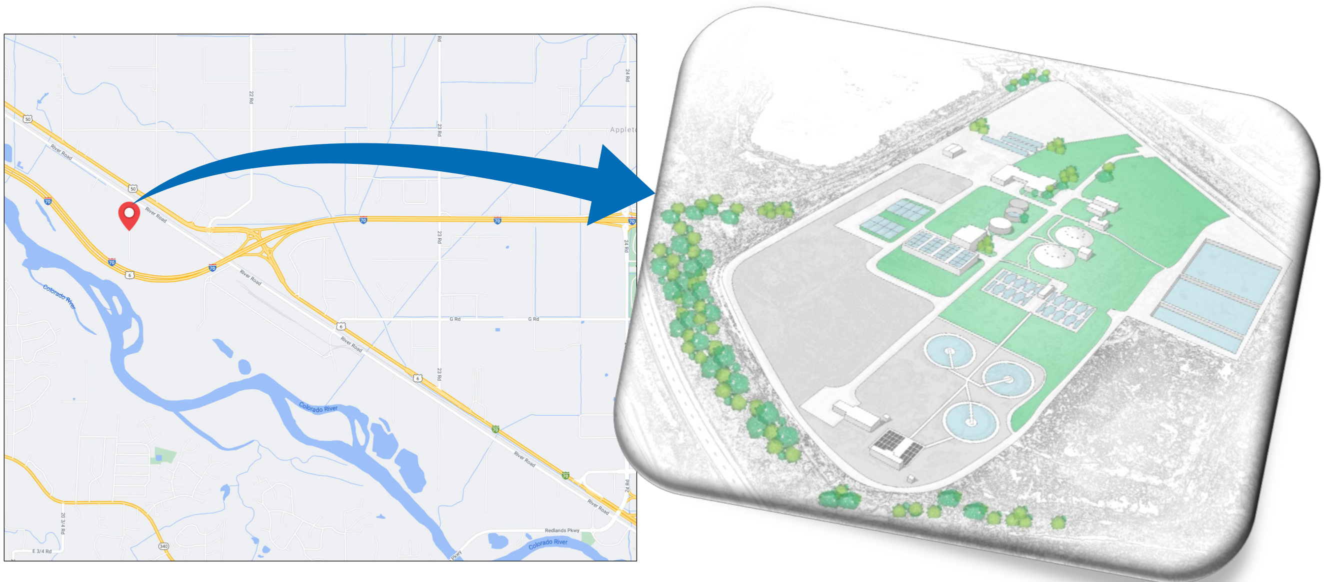

Figure 1.1 Vicinity Map and Aerial of Persigo WWTP

The City is committed to safeguarding the community's most vital resource, clean water. A team of 37 dedicated water professionals manage, operate, and maintain the wastewater treatment systems in a fiscally responsible manner that ensures the protection of public health and the environment. The Persigo Wastewater Sewer (Persigo) system provides reliable and efficient wastewater collection, conveyance, and treatment service to approximately 85,000 people in the City and surrounding Mesa County.

The Persigo system:

1. Provides conveyance and treatment services for the 201 Service Area which defines the service area boundaries, excluding current septic or other individual sewage disposal areas within the boundary.
2. Treats wastewater flows at the 12.5-million-gallon-per-day (mgd) WWTP, which is located at 2145 River Road (location shown in Figure 1.1). Effluent from the WWTP is discharged to the Colorado River.
3. Conveys wastewater flows to the WWTP through 600 miles of collection system piping, 14,000 manholes, 26 lift stations, and two siphon structures.

1.2 Previous Background

Previous master planning efforts include the following. These provide the basis for comparison and understanding previous infrastructure planning efforts.

- In 2014, the City completed the Persigo Wastewater Treatment Facilities Nutrient Study Report, which evaluated treatment processes to meet the Colorado Department of Public Health and Environment (CDPHE) Regulation 85, Regulation 37, and a diffuser outfall evaluation for discharging to the Colorado River.
- In 2011, the City completed the Process Design Report for the Aeration Basin Demonstration Study at the Persigo WWTP to evaluate and conduct full-scale aeration improvements to increase nitrification performance.
- In 2010, the City completed the Aerobic Digester Study, which evaluated alternatives to enhance the capacity of the aerobic digestion process. The recommendations provide included operational enhancements, modifications to existing infrastructure, and investment in new infrastructure and equipment.
- In 2008, The City completed the 2008 Comprehensive Wastewater Basin Study Update (2008 WW Basin Update), which updated the Comprehensive Wastewater Basin Studies in completed in 1997 and 1992. The 2008 WW Basin Update included the incorporation of two special districts into the wastewater service area boundary, replaced and upgrade lift stations, and aligned wastewater infrastructure planning with the City's overall 2008 Comprehensive Plan Update to reflect changes in the City's land use and development planning.
- In 2008, the City completed the Compressed Natural Gas Evaluation Study, which evaluated improvements to increase biogas and to evaluate conversion of a vehicle fleet to compressed natural gas operations.
- In 2006, the City completed a Nitrification/Denitrification Study to evaluate treatment improvements and associated compliance schedule requirements to meet the water quality stream standards at the Persigo Wash outfall.
- In 2006, the City completed a Digester Gas Utilization Study, which evaluated best-value use of the City's biogas.
- In 2003, the City completed the 2003 Persigo Wastewater Treatment Plant Study, which evaluated the operations and performance of the WWTP. The study evaluated six areas that included liquid stream process improvements, energy use, anaerobic biogas uses, facility instrumentation and controls, disinfection approach, and enhanced anaerobic digestion. This study built on the 2001 Secondary Treatment System Analysis and the 1999 Persigo Wash Wastewater Treatment Plant Capacity.
- In 1999, the City completed a capacity evaluation for the WWTP with recommended infrastructure improvements.

Recently, the City completed the following evaluations, which recommended improvements to be incorporated into the City's budgeting process. As a result, these improvements have been included in the capital improvement plan (CIP), as described in Chapter 8.

- Structural evaluations completed by Wiss, Janey, Elstner Associates, Inc. (WJE) in 2020. The evaluated focused on six areas: the raw sewage pump station, primary clarifiers, the aeration basins and blower room, the aerobic digesters, the sludge processing (dewatering) facilities, and the anaerobic digesters.

- An Odor Abatement Evaluation was completed in 2020 by Garver and Perkins Engineering Consultants to evaluate the odor impacts and mitigation strategies for the WWTP and the collection system.
- A structural evaluation of the Flow Equalization Basin Concrete Structure was completed in 2020 by WJE to recommend structural improvements to the existing structure.

1.3 Planning Objectives and Goals

This 2020 Wastewater Treatment Facilities Master Plan (2020 Master Plan) is intended to develop a roadmap for achieving operational resiliency and reliability to meet the wastewater needs of users within the 201 Service Area. The 2020 Master Plan will identify the wastewater infrastructure needed to serve the anticipated growth projections for future land uses identified in the 2020 Comprehensive Plan. Additionally, the 2020 Master Plan will ensure the facilities meet the current and future regulatory and statutory requirements while reinvesting in asset revitalization and replacement. Figure 1.2 highlights goals discussed further in this 2020 Master Plan.

Figure 1.2 2020 Master Plan Goals

Consistent with these overarching goals, the following additional objectives were established for the 2020 Master Plan project. The main objective of this 2020 Master Plan is to present a comprehensive review of the existing treatment processes and recommended improvements using a holistic approach that:

- Protects the health and safety of the community and City employees.
- Is protective of and provides benefit to all environmental media (water, air, land).
- Ensures infrastructure is in service to connect all existing properties and meet future development needs.
- Evaluates resource recovery opportunities.
- Manages risk and extends the life of existing assets through critical asset revitalization.
- Identifies operational and energy efficiencies.
- Demonstrates fiscal responsibility.
- Demonstrates leadership by providing innovative solutions for future management, operation, and maintenance of the wastewater system while addressing issues of regional importance.

To achieve these goals, the following guiding principles will be employed in developing the 2020 Master Plan:

- Provide an efficient alternatives analysis process that analyzes the efficacy of solutions.
- Ensure new processes are compatible with existing facilities and provide best value solutions.
- Anticipate unintended consequences for recommendations and identifying backup systems to minimize adverse impacts.
- Develop transparent and justifiable business case evaluation process, which includes defining the financial cost benefits and environmental benefits, as applicable.
- Develop budgetary cost estimates, including capital costs and ongoing operations and maintenance expenses.
- Define clear timing, including a 5-year implementation schedule and a longer-term (6- to 20-year) implementation forecast.

Subsequent chapters and the associated appendices demonstrate that these goals have been achieved.

1.4 Strategic Visions

In developing an infrastructure roadmap for the future, this 2020 Master Plan needs to understand and incorporate the strategic visions and opportunities as defined for the Persigo facilities, by the City and County, and as documented in the IGA.

1.4.1 Persigo WWTP Vision

Persigo Wastewater Treatment Facility

As a recognized industry leader in the Rocky Mountain region and nationally, the Persigo management and operations staff focuses on being dedicated stewards of sustainability and environmental protection.

This is demonstrated by the emphasis on safeguarding the community and Persigo staff while producing clean water that exceeds regulatory and statutory requirements. The Persigo staff meets these requirements in a fiscally responsible manner by providing some of the most affordable wastewater rates in the

State of Colorado. Achieving this requires an organization that concentrates on operational reliability by embracing asset revitalization and innovation in treatment infrastructure while exploring and developing regional solutions and partnerships.

The Persigo facilities and vision aligns with the strategic directions established by the City and County by providing reliable and cost-effective wastewater services for its' customers today and in the future.

1.4.2 City of Grand Junction Strategic Plan

The City's 2019 Strategic Plan was adopted by the City Council in November 2019. The 2019 Strategic Plan serves as a guide for the City staff, including Persigo staff, for planning and infrastructure investments. The Plan has four guiding principles and four strategic directives which include:

Guiding Principles

› Partnerships and Intergovernmental
› Fiscal Responsibility
› Communication
› Leadership
› Relations and Engagement

Strategic Directives

› Public Safety
› Diversification of Economic Base
› Connectedness through community building
› Planning and Infrastructure

In developing the 2020 Master Plan, these principles and directives will define the roadmap developed and infrastructure investments needed for the Persigo facilities.

1.4.3 City of Grand Junction One Grand Junction Comprehensive Plan

As part of the City's One Grand Junction Comprehensive Plan (Comprehensive Plan), community input was gathered over the course of the yearlong planning process to develop 11 planning principles as the cornerstone for future development within the community. The 11 principles are shown in Figure 1.3, indicating those principles that are most relevant for consideration during master planning for the Persigo wastewater system.

- Collective identity
- Resilient and diverse economy
- Responsible and managed growth
- Downtown and university districts
- Strong neighborhoods and housing choices
- Efficient and connected transportation
- Great places and recreation
- Resource stewardship
- Quality education and facilities
- Safe, healthy, and inclusive community
- Efficient and transparent government

- Responsible and managed growth
- Downtown and university districts
- Resource stewardship
- Safe, healthy, and inclusive community
- Efficient and transparent government

Figure 1.3 Planning Principles

1.4.4 Persigo Sewer System Intergovernmental Agreement

The Persigo Sewer System Intergovernmental Agreement provides the goals and values for the Persigo wastewater system, which include:

- Operating for the benefit of the current and future users in the 201 Service Area.
- Pursuit of health and water quality on behalf of all citizens.
- Providing a high standard of quality management, operation, and maintenance of the system.
- Encouraging all non-connected properties within the 201 Service Area of the system to connect to the Persigo system.

1.4.5 Utility of the Future Vision

As a leader and pioneer, the Persigo staff looks towards a future vision of wastewater utilities. The National Association of Clean Water Agencies (NACWA) defines a utility of the future as one that:

> *"... [Pioneers] innovative technologies and cutting-edge practices, with a focus on resource recovery, efficiency, and sustainability."*

NACWA recognizes utilities of the future as those that actively build and enhance organizational effectiveness through seven categories, as shown in Figure 1.4. In many of these categories, Persigo WWTP has been an industry leader.

Figure 1.4 NACWA's Seven Categories for the Utility of the Future

The City, County, and Persigo WWTP are committed to continuous improvement and investments in a responsible and defensible approach. Areas of focus for the Persigo WWTP in the future include:

- Recovering resources from wastewater (energy, water, digester gas, heat, nutrients, and others).
- Providing leadership for the full water cycle and considering the social, economic, and societal impacts to the community.
- Developing a culture of innovation and efficiency.
- Engaging in strategic partnerships to move the region forward.

1.5 General Planning Approach

As alternatives are identified for unit processes or for the overall treatment plant, an abbreviated business case evaluation was conducted to support recommendations provided as part of the 2020 Master Plan. The evaluation criteria shown below center on supporting the strategic visions and goals listed above. The Persigo staff have reviewed these evaluation criteria and agreed they are aligned with your community values and strategic goals. Thus, providing a common framework for implementation of future projects.

The analysis will compare economic and non-economic benefits and costs. The economic component includes an evaluation of capital costs and annual operating costs, resulting in a net present value (NPV) for comparison of an alternative. The non-economic analysis includes evaluation of performance, operations, implementation, and whole-plant integration.

The project team used the alternatives assessment pathways presented in Figure 1.5 to develop the justification and rational for the final recommendations.

The assessment phases are described in more detail below.

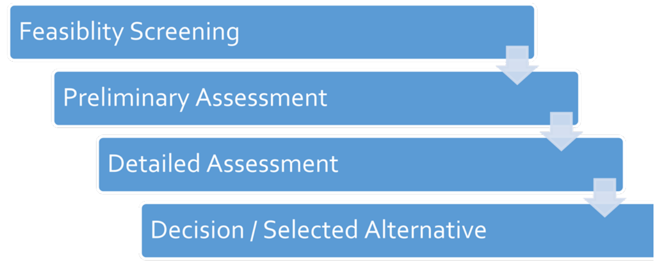

Figure 1.5 Alternatives Assessment Pathway Option

Feasibility Screening: In the first step the team conducted a feasibility screening of all alternatives and possibilities. This was accomplished through the scoping process and later validated during two meetings with Persigo staff. The Persigo staff indicated only alternatives that are practical and implementable within the framework of the City's and County's strategic visions should be considered.

Preliminary Assessment: The preliminary assessment of the alternatives uses comparative financial criteria (relative differences) and qualitative non-economic criteria. Alternatives that are fatally flawed, technically unproven, excessively expensive, or otherwise unworthy of detailed evaluation were eliminated.

Detailed Assessment: This more in-depth analysis includes development of the financial costs and benefits based on the cost criteria established shown in the next section, siting of infrastructure, and development of qualitative benefits and treatment plant impacts. The NPV opinions of cost (cost estimates) include capital and lifecycle costs for an alternative.

1.6 Cost Criteria

The economic analysis will include the following cost criteria:

- Capital (including direct and indirect construction costs),
- Operation and maintenance (O&M), and
- Payback period (if applicable).

The estimates will be prepared using pricing from similar projects, conceptual unit cost factors, available vendor quotes, equipment pricing, historic pricing databases, and knowledge of typical rates for local construction crew using the Carollo Cost Estimating System (CCES). The CCES is an estimating database that can be used for planning purposes to provide long-term budgeting estimates. It is important to realize that changes will alter the totals to some degree and that future changes in the cost of material, labor, and equipment can affect the total.

An NPV will be developed for each alternative to allow for a financial comparison.

1.6.1 Capital Estimating Assumptions

Cost estimates developed represent the Association for the Advancement of Cost Engineering (AACE) International criteria for a Class 5 Planning Level or Design Technical Feasibility Estimate. For this class, the accuracy is typically -30 to + 50 percent. Class 5 estimates are used to determine a project's feasibility and to compare and select alternatives.

Cost estimating will be conducted by identifying equipment and construction costs in 2020 dollars. The total project cost includes additional costs directly associated with the cost to construct City projects, including engineering, administrative and legal services, costs associated with bond sales, and interest on money borrowed during construction, if applicable.

Direct costs include subcontractor costs and costs for materials, labor, and construction equipment involved with installation. The indirect (non-distributable) costs consist of general conditions, contingency, general contractor's overhead and profit, escalation, sales tax, and bid market allowance. At this level of estimate, many of the contractor costs and other indirect costs are assumed to be a percentage of construction or equipment costs. Table 1.1 summarizes these assumptions. An example of a capital cost estimate is shown in Figure 1.6.

Table 1.1 Contractor Markups and Capital Project Allowances

Capital Cost Parameter	Assumption
Construction Cost Factors	
General Conditions	~10% of equipment cost
Equipment Installation	20% to 40% of equipment cost
Other Allowances (heating, ventilation, and air conditioning [HVAC], plumbing, structural, architectural, demolition, etc.)	Varies
Electrical, Instrumentation, Programming(1)	20% to 25% of equipment cost
General Contractor Overhead, Profit, and Risk	15% of construction cost
Contingency – Construction Contingency	30% of construction cost
City Taxes and Other Administrative Fees	4.5% of construction cost
Non-Construction Cost Factors	
Engineering, Legal, and Administrative Fees	20% of construction cost
Owner-Controlled Contingency (for Class 4 Estimate)	10% of total project cost

Notes:
(1) This allowance is used to replace non-quantifiable electrical infrastructure such as panels, conductors, conduits, etc. Major electrical equipment (such as motor control centers [MCC] are itemized out in the project cost estimates.

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT City of Grand Junction -
PROJECT: Asset Replacements - Baseline Condition (Chapter 4) — Estimate Basis (year) = 2021
Process Area: Headworks Facility - Asset Replacements — Mid point of Construction (year) = 2022

Class V Cost Estimate for replacement and rehabilitation of Headworks Building assets, which includes the screening facilities, washer compactor, and grit treatment and conveyance. These assets are assumed to have a 20 year useful life. Estimated project costs include odor control improvements identified by Garver.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Replace roofing membrane	1	LS	$ 75,000	$ 75,000
Replace and Rerate step screens	2	EA	$ 230,000	$ 460,000
Manual bar screen	1	LS	$ 45,000	$ 45,000
Replace screening conveyor	1	LS	$ 85,000	$ 85,000
Replace 1 screenings compactor / washer	1	LS	$ 150,000	$ 150,000
Replace grit pumps	2	EA	$ 35,000	$ 70,000
Replace grit washer/compactor	2	EA	$ 115,000	$ 230,000
Replace 2 dumpsters (screenings and grit)	2	EA	$ 5,000	$ 10,000
				$ -
MCC Replacments	1	LS	$ 85,000	$ 85,000
Replace HW Generator	0	LS	$ 500,000	$ -
PLC Replacement	1	LS	$ 75,000	$ 75,000
				$ -
Flow Monitoring Equipment	0	LS	$ 15,000	$ -
Covering for Bar Screen, conveyor, dumpster	400	FT2	$ 200	$ 80,000
Biofilter for Odor Control (Garver, 2020)	0	LS	$ 603,000	$ -
Persigo Wash Air Jumper (By Garver, 2020)	0	LS	$ 193,000	$ -
			BASE ASSET COST	**$ 1,365,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	10	%		$ 136,500
Structural / Architectural Allowance (Including Demolition)	10	%		$ 136,500
Coatings and Finishes	5	%		$ 68,250
Mechanical System Allowance (HVAC, Plumbing, etc)	10	%		$ 136,500
Electrical, IC, Programming Allowances	25	%		$ 341,250
Equipment installation	20	%		$ 273,000
Construction contingency	30	%		$ 737,000
			SUBTOTAL DIRECT COST	**$3,194,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 319,400
GC Overhead, Profit, Bonds, Mob	25	%		$ 799,000
City Taxes, other fees	4.5	%		$ 144,000
Cost Escalation to Mid-Point of Construction	3.0	%		
			TOTAL CONSTRUCTION COST	**$4,456,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 891,000
Owner maintained project contingency	10	%		$ 446,000
			TOTAL PROJECT COST (2021 $'s)	**$5,793,000**

Figure 1.6 Capital Cost Estimate Example

1.6.2 Lifecycle Costs

During the detailed assessment, lifecycle costs will be calculated to compare alternatives. Lifecycle costs include O&M costs as well as interest charges on capital expenditures. Estimated lifecycle costs developed assume linear increases in the cost of energy, labor, and materials throughout the planning period.

1.6.2.1 Net Present Value Cost Factors

All future costs are factored for inflation based on applying assumed annual escalation rates to the current costs for each year of the planning period. For the purposes of comparison, all costs will be calculated in terms of NPV for a 20-year planning analysis starting in 2020. Assumed NPV factors are listed in Table 1.2 and will be consistently applied to all alternatives. Equivalent annual costs express the total present worth of project or capital costs and the total present worth of O&M costs as a uniform annual amount. The total equivalent annual cost of each alternative will be used as an expression of the true economic burden.

Table 1.2 Net Present Value Assumptions

Net Present Value Parameter	Assumption
Annual Inflation/Escalation Rates (gas, power, chemicals, labor, equipment, and materials)	3% annual
Discount Rate (rate of return used to discount future cash flows back to present value)	3%
Duration of NPV, Project Lifecycle	20 years

1.6.2.2 Unit Costs

Using unit costs, O&M costs were developed for each alternative. Unit costs are based on historic or current pricing as provided by the City, as identified in Table 1.3.

Table 1.3 Unit Costs

Parameter	Value	Unit
Utility Cost Assumptions		
Electricity(1)	0.06	$/kilowatt-hour (kWh)
Natural Gas	$0.64	$/therms
Potable Water(2)	0.01	$/gallons
Chemical Cost Assumptions(3)		
Ferrous Chloride	$980	$/ton
Polymer	1.33	$/pound (lb)
Transportation Cost Assumptions		
Diesel Fuel Costs(4)	2.77	$/gallon
Compressed Natural Gas (CNG) Fuel Costs(5)	1.57	$/gallon
Biosolids Tipping Fees(6)	23.75	$/ton
Grit/Grease/Screening Tipping Fees(6)	33.00	$/ton
Tipping Fee Annual Increase(7)	5	%
Fuel Efficiency of Transport Trucks	5	miles/gallon
Roundtrip Distance to Mesa County Landfill	28	miles
CNG Revenue Assumption		
Renewable Identification Number (RIN) Value	1.25	$/RIN
Gallons of Gasoline Equivalent Value	1.25	$/gasoline gallon equivalent (GGE)
Labor Cost Assumptions		
Labor Average Hourly Rate	46.00	$/hour
Labor Average (O&M Staff)	0.5 to 1.0%	% of capital cost

Notes:
(1) Annual average calculated from 2018 and 2019 Xcel electricity bills.
(2) Annual average calculated from 2018 and 2019 Ute Water Bills for water line only, fire line = $75/month flat rate.
(3) 2020 Wastewater Budget Review with Mesa County (City provided PowerPoint presentation).
(4) Grit, grease, screenings use diesel use trucks to haul to landfill. Cost information based on 2019 diesel gallons used for landfill hauling and 2019 mileage (email correspondence April 4, 2020).
(5) Biosolids hauling uses CNG fueled vehicles. Cost information based on 2019 CNG gallons used for landfill hauling and 2019 mileage (email correspondence April 23, 2020).
(6) 2020 tipping fees (email correspondence April 23, 2020).
(7) Based on 2019 to 2020 average tipping fee increase.

1.7 Non-Monetary Criteria

Alternatives were evaluated using typical non-monetary criteria as reflected in your strategic goals and objectives. For the non-monetary component, five main criteria were identified.

Table 1.4 Non-Monetary Criteria

Criterion	Definition
1. Fiscal Responsibility	Measures each alternative's financial parameters to provide the best value solution. Fiscal responsibility does not always mean that the lowest capital cost option is the best solution. The subcriteria include O&M costs and calculation of the NPV for a 20-year period.
2. Operational Risk and Complexity	Measures how each alternative meets the operational requirements expressed as ease of operations, process and asset reliability, and proven nature of technology.
3. Flexibility/Adaptability for Future Uncertainties	Measures how one alternative meets future growth, regulatory, planning criteria, and provides level of treatment within existing fence line of the facility.
4. Community/Environmental Benefit + Resource Recovery	Measures the benefit of alternatives based on the energy consumption or conservation. Measure the beneficial reuse of natural resources.
5. Health and Safety	Evaluates how well each alternative meets the health and safety goals of the City. Measures the impact of exposure to raw wastewater, chemicals, traffic congestion, and exposure to harmful chemicals as relates to City staff and public.

1.8 Report Organization

This 2020 Master Plan is organized into the following chapters:

Executive Summary.

Chapter 1 – Introduction. This chapter summarizes the history of the Persigo WWTP planning at the treatment facility and identifies the direction and vision for the 2020 Master Plan. This chapter also summarizes the financial assumptions used to develop the capital and O&M costs.

Chapter 2 – Wastewater Planning Conditions. This chapter summarizes the wastewater planning conditions, including the population projections, flow and loading assumptions, and regulatory drivers.

Chapter 3 – Existing Facilities and Capacity Analysis. This chapter defines the existing hydraulic, organic, and nutrient capacities, as well as the existing unit processes for treatment.

Chapter 4 – Asset Revitalization Projects. This chapter summarizes the projects focused on rehabilitating and replacing aging infrastructure.

Chapter 5 – Persigo WWTP Alternatives Analysis. This chapter defines the alternatives evaluated, while developing the 2020 Master Plan.

Chapter 6 – Biosolids Management. This chapter summarizes the current and future biosolids management approaches.

Chapter 7 – Supporting Infrastructure and Personnel Facilities. This chapter summarizes the infrastructure improvements for other facilities unrelated to treatment. This includes the administration building, electrical equipment, water systems, and other ancillaries.

Chapter 8 – Implementation Plan. This chapter defines the capital improvement plan sequencing and illustrates the schedule for the various projects.

Chapter 2

PLANNING AREA CHARACTERISTICS

2.1 Service Area Overview

The Persigo WWTP and collection system service area is defined by the 201 Service Area boundary. As part of the City's 2020 Comprehensive Plan, the City proposed to modify the 201 boundary to include portions of the Urban Development Boundary (UDB). The primary modifications occurred in the northwest corner and in the southeast corner for the service area. This boundary was also coordinated with the Clifton Sanitation District to avoid extension of the boundary into Clifton's current or proposed service area.

These modifications were proposed for agency approval and formal adoption in early 2021. As of April 2021, the boundary modifications were pending final agency approval. Due to the timing of the proposed changes to the UDB and 201 Service Area boundaries, the study area was not modified to align with the revised boundaries in all locations. This boundary serves as the basis of the 2020 Master Plan for population, flow, and loading projections. The gross acreage included in the study area is 42,106 acres. The UDB, study area, and 201 Service Area boundary are illustrated in Figure 2.1.

2.2 Climate and Topography

The climate in Grand Junction is particularly mild and less variable than most of Colorado. Table 2.2 summarizes Grand Junction's monthly and annual average maximum and minimum temperatures and precipitation data for Grand Junction. The topography varies near Grand Junction as it is bisected by the Colorado River. Near the river the topography is fairly flat but slopes upwards to the mesas and mountains that are located outside of town. The Colorado River flows from east to west on the southerly side of Grand Junction. The confluence with the Gunnison River (running north-south) is in the southern portion of the City.

Table 2.1 City of Grand Junction Climate Summary

Month	Maximum Temperature, °F(2)	Minimum Temperature, °F(2)	Average Total Precipitation, inch(2)	Average Percent of Total Precipitation
January	36.6	15.9	0.59	7%
February	44.6	23.3	0.57	7%
March	55.2	31.2	0.81	9%
April	65.2	39.2	0.79	9%
May	75.6	48.2	0.79	9%
June	87.0	57.2	0.44	5%
July	92.9	64.1	0.62	7%
August	89.5	62.0	0.98	11%
September	80.7	53.0	0.95	11%
October	67.3	41.0	0.91	10%
November	51.2	28.3	0.63	7%
December	38.9	18.6	0.59	7%
Annual	65.4	40.2	8.67	-

Notes:
(1) Data obtained from Western Regional Climate Center website for the Walker Field weather station. https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?co3488
(2) Average based on data from 1/1/1900 through 6/9/2016.
°F degrees Fahrenheit

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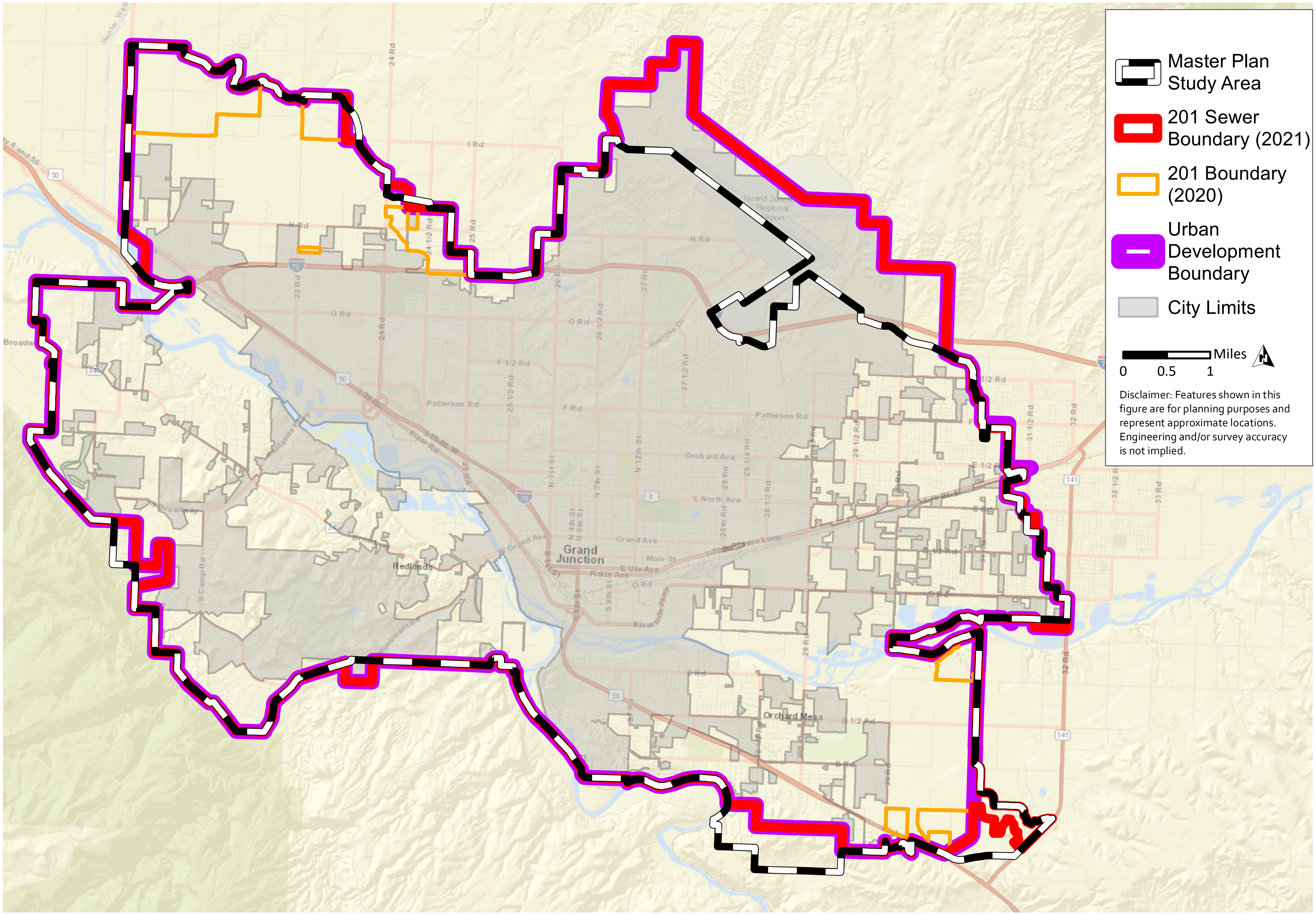

Figure 2.1 Study Area Boundary

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2.3 Population Estimates

The 2020 Comprehensive Plan estimated population projections for the Persigo WWTP 201 Service Area boundary through the year 2040. These projections were adopted for the 2020 Master Plan and used to calculate future flow and loading condition. Table 2.2 shows the projections and compares population growth to the 2008 Collection System Master Plan (2008 Master Plan).

As evident in Table 2.2, there are significant differences in projections between the 2008 Master Plan and the 2020 Master Plan. The 2008 Master Plan developed population equivalents based on the projected residential and employment population through the 2035 planning horizon. The projected total population equivalent developed was 247,223, with a projected residential population of 201,315. The 2008 projections are reported in the 2008 Master Plan as being consistent with the City's Comprehensive Plan, which was developed concurrently. Interim projections were not developed as part of the 2008 effort and additional detail on development of the 2008 projections is not provided in the 2008 Master Plan. It is unclear from the available information why the projects developed in the previous plan are higher than the current projections; however, there is some indication that the projections were developed assuming all available future land in the service area was "built-out". Wastewater flow for the service area was developed using a per capita unit flow of 85 gallons per capita per day (gpcd) (average daily annual flow [ADAF]).

Table 2.2 Service Area Population Projections

Year	2008 Master Plan Projected Population(1) (2)	2020 Comprehensive Plan Population	Percent Difference
2008	78,150(2)	-	-
2020	-	99,819	-
2025	-	103,623	-
2030	-	110,036	-
2035	201,315	117,360	41.7%
2040	-	124,220	-

Notes:
(1) Table TM3-1 and Table TM3-7, 2008 Master Plan (Black and Veatch).
(2) Value represents the existing population in 2008 in population equivalents Table TM3-1, 2008 Master Plan (Black and Veatch).

The 2020 Master Plan has been developed in collaboration with the 2020 Comprehensive Plan efforts, which calculated an average population increase of approximately 1.1 percent for the 20-year planning period. Information provided by the State of Colorado Demographers Office was used by the City to calculate population projections.

Additional scenarios for 1.5 percent annual growth and 2.0 percent annual growth have been developed to aid City staff in adjusting to changing growth scenarios. These growth scenarios are shown in Figure 2.2 and will be further discussed in Chapter 8 with regards to prioritized project timing recommendations.

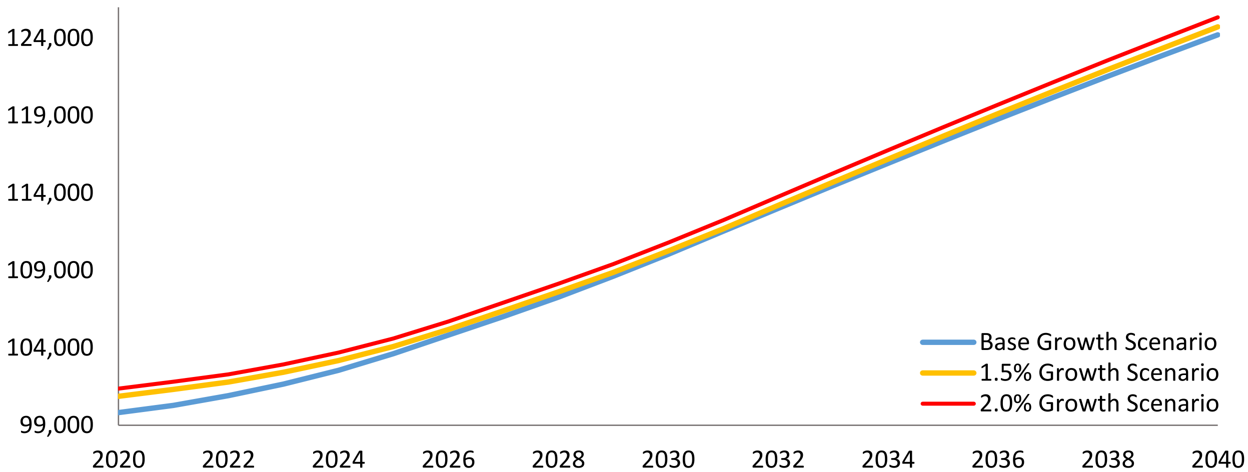

Figure 2.2 Population Growth Scenarios

2.3.1 Future Impacts of Commercial and Industrial Dischargers

The 2008 Master Plan documented large commercial and industrial water users within the service area as less than 6 percent of the total influent flow to the WWTP. Water use data associated with large users was not available for this Master Plan. The City has an Industrial Pretreatment Program with discharge limits for constituents of concerned as outlined in City of Grand Junction Municipal Code 13.04.370, which include 5-day biochemical oxygen demand (BOD_5), temperature, pH, petroleum, fat, oils, and grease; corrosive substances; radioactive substances; and others as specified or identified through the discharge permit application process. A reasonable expectation, based on discussions with operations and City staff, is that commercial and industrial customers in the service area will continue to grow at a rate proportional to the anticipated residential growth. Therefore, flow and loading calculations in this 2020 Master Plan were calculated on a per capita basis and comprise all existing flow sources, including domestic, commercial, and industrial wastewater. By multiplying the expected future population by combined per capita flows and loads, future commercial and industrial flows and loads are inherently reflected in the flow and load projections for the WWTP.

2.4 Influent Flow Projections

For master planning purposes, future projections were developed for the scenarios shown in Table 2.3.

Table 2.3 Summary of Projected Flow and Load Conditions

Condition	Projected Condition	Master Planning Purpose
ADAF	Flow and Loads	Relevant for demonstrating treatment capacity with units out of service now and in the future.
Average Daily Maximum Month Flow (ADMMF)	Flow and Loads	Relevant for CDPHE permitting and design treatment capacity purposes.
Peak Day Flow (PDF)	Flow	Relevant for demonstrating hydraulic treatment and equalization capacity now and in the future.
Peak Hour Flow (PHF)	Flow	Relevant for the CDPHE for permitted hydraulic treatment capacity purposes.

Results derived from the flow and load analyses, along with supporting documentation from previous studies and population projections, are summarized below. Historical data from January 2015 through December 2019 was used to determine future flow and loading projections.

2.4.1.1 Current Flow

Using influent flow data from 2015 through 2019 as the basis, the current ADAF was determined to equal 8.6 mgd. As a note, flow data from 2020 was not used in the analysis due to the impacts of COVID-19 and the stay-at-home order issued in 2020.

Figure 2.3 illustrates other critical flow values that are used to calculate the hydraulic peaking factors.

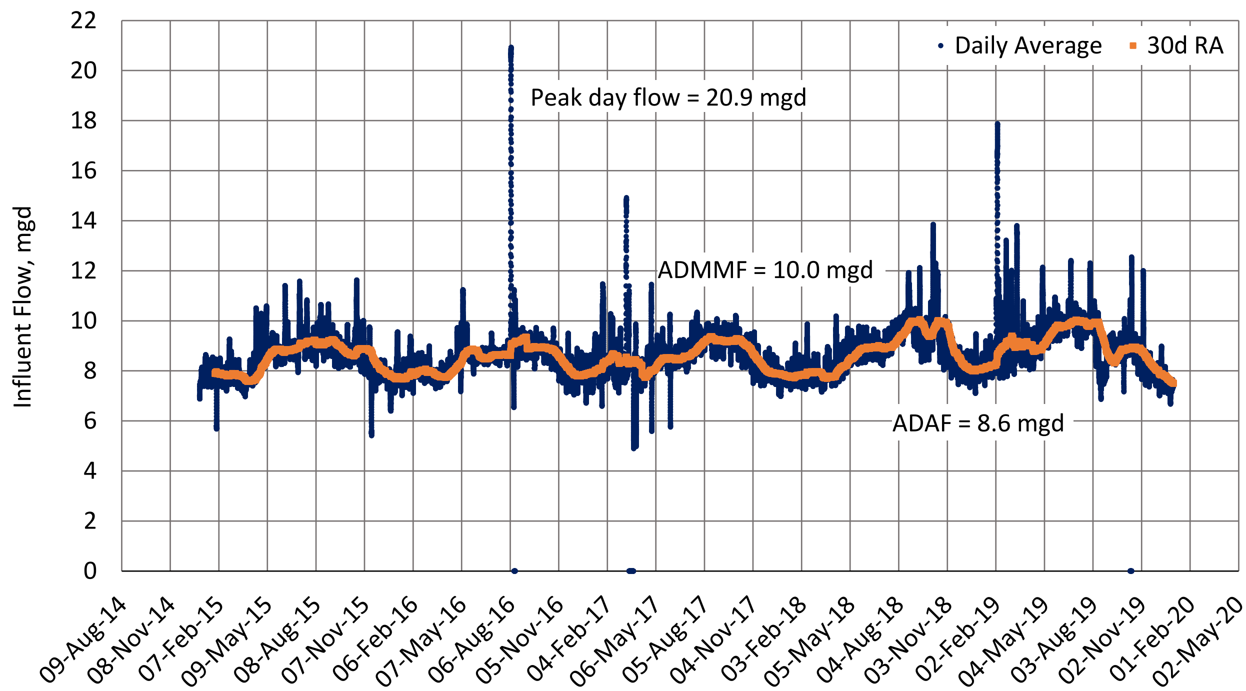

Figure 2.3 Average Day and 30-day Running Average Flows

The historic PHF was recorded as 42 mgd. Based on data analysis and feedback from Persigo staff, this appears to be an instrumentation limitation which reflects inaccurate flow metering. Therefore, PHFs were calculated, as shown in Table 2.4, using engineering best judgment, comparison to similar sized facilities, and previous master planning studies.

Table 2.4 Summary of Historical Flow Conditions and Peaking Factors

Condition	Current (mgd)	Condition	Peaking Factor
ADAF	8.6	ADAF/ADAF	1.0
ADMMF	10	ADMMF / ADAF	1.17
PDF	20.6	PDF / ADAF	2.4
PHF	23.2	PHF / ADAF	2.7

Operations staff also reported that influent flow is backed up in the collection system to maintain an influent flow below 20 mgd to the control structure upstream of the primary clarifiers (Control Structure No. 1). After a review of the historical data, shown in Figure 2.4, and review of previous studies, the project team recommends using a peak hour flow factor (PHF/ADAF) of 2.7.

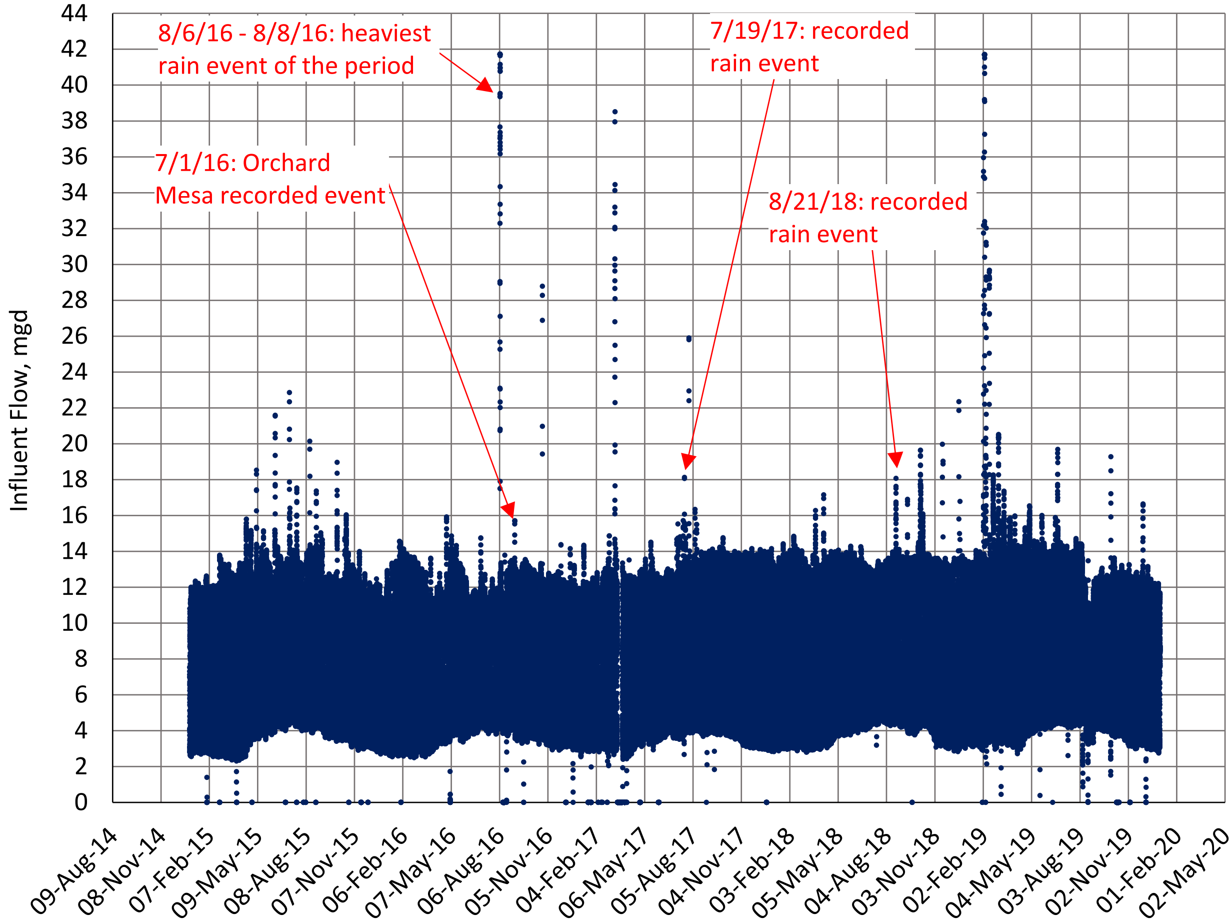

Figure 2.4 Peak Hour Flow 2015 through 2019 with Extreme Rainfall Events

2.4.1.2 Inflow and Infiltration Analysis

A specific inflow and infiltration (I/I) assessment of the collection system was not conducted as part of the 2020 Master Plan. The impacts of I/I are localized across older parts of the City's service area. With the collection system inspection program and annual rehabilitation efforts, it is expected the I/I impacts will decrease in the future. For planning purposes, the impacts of I/I have been included in the collection system modeling and projection of future flows for the treatment plant.

2.4.1.3 Unit Flow Rate Per Capita and Per EQU

Using the current population projections (shown in Table 2.2) and the influent ADAF flow shown in Table 2.4, a per capita flow of 90.5 gpcd will be used to project future influent flows. The ADMMF per EQU was calculated as 206 gallons per day (gpd) per EQU.

2.4.1.4 2040 Projected Flow Conditions

Using the population projections shown in Table 2.2, the calculated unit flow per capita value and the peaking factors shown in Table 2.4 future influent flow conditions were determined. Figure 2.5. shows the projected future flows conditions.

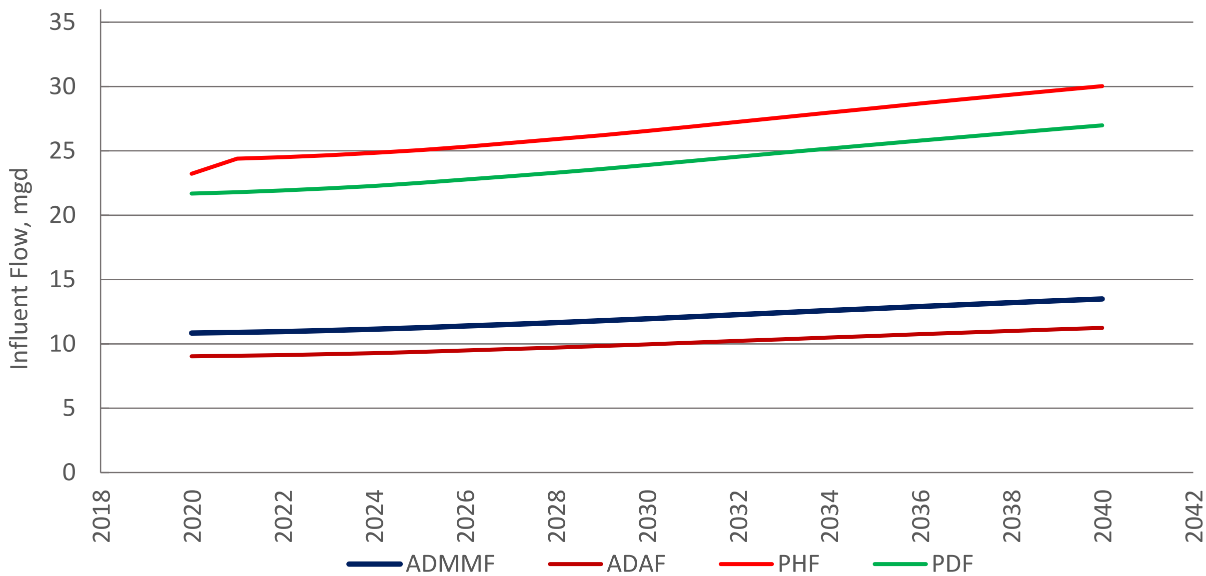

Figure 2.5 Flow Projections through 2040

Projections for the ADMMF condition through 2040 for the population growth scenarios presented in Figure 2.2 and are provided in Figure 2.6. The 2040 ADMMF condition ranges from 12 mgd for an annual population growth of 0.5 percent to 16.1 mgd for an annual population growth of 2.0 percent.

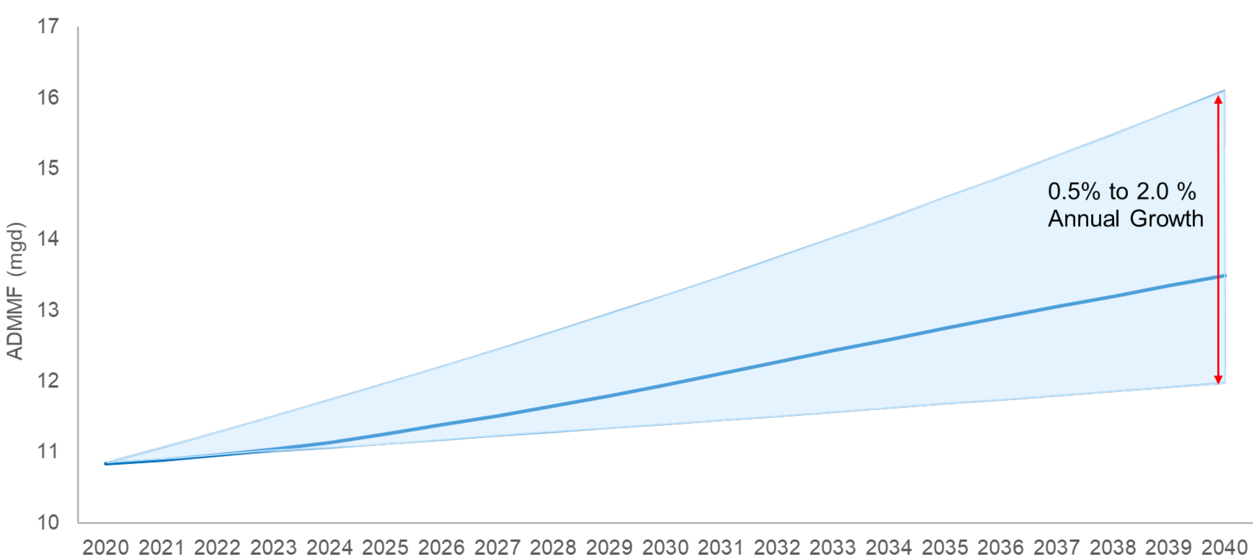

Figure 2.6 Flow Projections though 2040 at varying growth scenarios

2.4.1.5 Buildout Projections

The projected buildout flow was estimated using the 2020 Comprehensive Plan future land use designations which are illustrated in Figure 2.7 and summarized in Table 2.5. The buildout flow was determined assuming complete buildout of the future land use areas within the UDB.

Table 2.5 Future Land Use Summary

Land Use Category	Area, acre(1)	Percent of Total	Min DU/Acre(2)	Max DU/Acre(2)
Rural Residential	3,932	10%	0.2	0.2
Residential Low	12,113	32%	1	5.5
Residential Medium	5,927	16%	5.5	12
Residential High	737	2%	12	12
Mixed Use	1,276	3%	12	24
Commercial	3,201	8%	-	-
Airport	2,607	7%	-	-
Industrial	3,052	8%	-	-
Parks and Open Space	5,155	14%	-	-

Notes:
(1) Based on future land use classifications included in the 2020 Comprehensive Plan.
(2) Provided by City's Community Development staff.

The land use acreages were used to project the future number of dwelling units (DU) within the UDB. For the residential land use categories, the number of DUs per acre were developed from the conditions established within the 2020 Comprehensive Plan. DU data was not provided for non-residential land uses so only the residential categories were used. The buildout population was then calculated by assuming 2.2 people/DU which is consistent with the TAZ based population projections and provided City planning documents.

Average day annual flows were calculated by multiplying the calculated population by the per capita flow rate of 90.5 gpcd. It was determined that as residential growth occurs, non-residential growth occurs at the same pace based on historical data as discussed in Section 2.3.1. Thus, the per capita flow rate can be multiplied by the build-out population to estimate the buildout ADAF. Based on these calculations the projected population was calculated to be 250,615, which corresponds to an ADAF of 22.7 mgd. The corresponding ADMMF, or the hydraulic design capacity for the facility at buildout is 27.2 mgd. A summary of the DU, population, and flows are included in Table 2.6.

Table 2.6 Build-Out Population and Flow Projections

Land Use Category	Area, acres(1)	Projected DU/acre(2)	Projected DUs	Projected Population	Projected Flow, mgd(3)
Rural Residential	3,932	0.2	786	1,730	0.2
Residential Low	12,113	3.3	39,367	86,608	7.8
Residential Medium	5,927	7.1	41,950	92,290	8.4
Residential High	737	12	8,844	19,457	1.8
Mixed Use	1,276	18	22,968	50,530	4.6
Sub-Totals	23,985	-	113,916	250,615	22.7

Notes:
(1) Based on future land use classifications included in the 2020 Comprehensive Plan.
(2) Based on min/max DUs/acre.
(3) ADAF, projected ADMMF at buildout is 27.2 mgd.

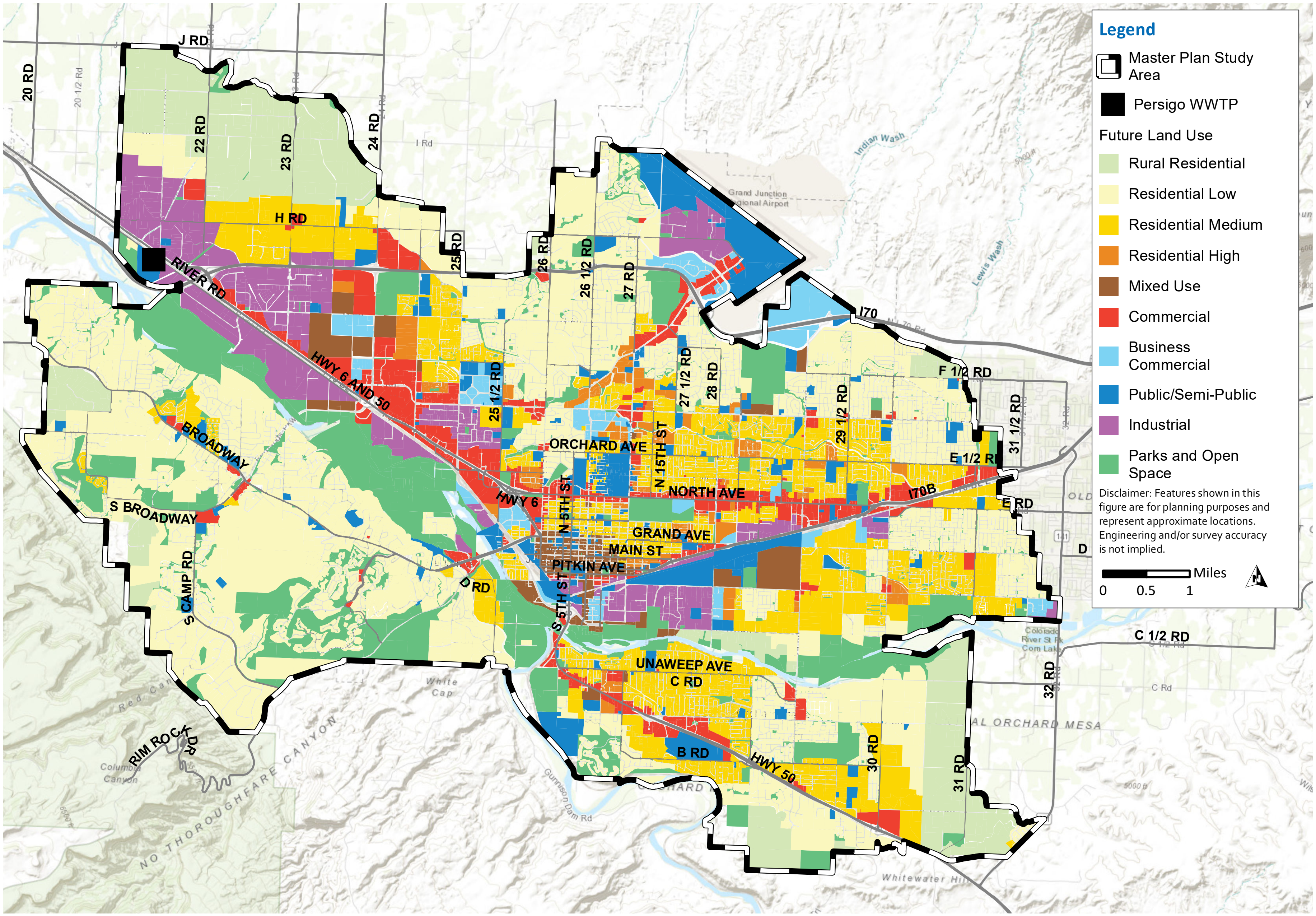

Figure 2.7 Future Land Use Overview

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2.4.2 Influent Load Projections

Influent loading conditions were determined for BOD_5, total suspended solids (TSS), and ammonia using historical influent data and the population and flow projections above.

2.4.3 Current Influent Loads

The City provide four years of influent wastewater loads and calculated design concentrations for BOD_5, TSS, and ammonia (NH_4-N) are summarized in Table 2.7.

Table 2.7 Influent Flows, Loads, and Design Concentrations [(1)]

Parameter	Influent Loading (ADMMF) (ppd)	Concentration (mg/L)
BOD_5, ppd	22,130	265
TSS, ppd	22,271	266
NH_4-N, ppd	2,619	31.3

Notes:
(1) Values are derived from data collected by plant operations staff, unless otherwise noted.
mg/L milligrams per liter

2.4.4 Per Capita and EQU Loading Rates

Based on the current 2020 loading conditions and the current population, Table 2.8 illustrates the calculated unit loading per capita rates that were used to compare the loading at the Persigo WWTP with industry standard loading.

When benchmarking these unit loading per capita rates against the Water Environment Federation's (WEF) "Design of Water Resource Recovery Facilities Manual of Practice (MOP) No. 8.", the City's wastewater loading appears to be in the typical range for other wastewater utilities.

Table 2.8 Current per Capita and EQU Loading Rates

Per Capita Loading Rates	Persigo WWTP (ADMMF)	WEF MOP 8
BOD_5, ppd per capita	0.22	0.11 - 0.20
BOD_5, ppd per EQU[(1)]	0.47	--
TSS, ppd per capita	0.22	0.13 - 0.33
Ammonia, ppd per capita	0.026	0.011 - 0.026

Notes:
(1) Per EQU loading is calculated based on 2019 data for number of EQUs and BOD_5 loading.

2.4.4.1 Influent Load Projections

Using the projected future flow and average daily maximum month (ADMM) concentrations based on historical data BOD_5, TSS, and NH4-N, loading projections were developed for the 20-year planning horizon. Table 2.9 illustrates the 2020 to 2040 ADMM loading values in 5-year increments.

Table 2.9 ADMM Loading Projections

Parameter	BOD_5, ppd	TSS, ppd	NH_4-N, ppd
2020	23,958	24,049	2,857
2025	24,871	24,965	2,966
2030	26,411	26,510	3,149
2035	26,168	28,275	3,359
2040	29,815	29,927	3,555

2.4.4.2 Comparison to Previous Studies

The 2003 Persigo Wastewater Treatment Plant Study (2003 WWTP Study) (Sear Brown, October 2003) and the 2008 Master Plan were reviewed in support of the flow and loading analysis to provide a basis of comparison between historical and current flows and loads and population and growth projections.

Table 2.10 shows a comparison of the flow and loading concentrations and peaking factors used to determine the future flow projections.

Table 2.10 Historical Master Planning Effort Flow and Load Projection Factor Comparison

	Units	2003	2008	2020
Flow				
Per Capita Flow	gpcd		85	90.5
ADMMF/ADAF		1.16	1.25	1.17
PDF/ADAF		1.38		2.4
PHF/ADAF		2.7		2.7
BOD_5	mg/L	228		265
TSS	mg/L	253		266
NH_4-N	mg/L	--		31.1

Notes:
(1) Projected loads for ammonia were not projected as part of the previous planning studies.

A summary of the 2003 WWTP Study ADMMF flow projections are provided in Figure 2.7. The 2008 Master Plan did not develop incremental flow projections, but the ADMMF for 2035 is shown for reference. Primary differences for the variation in flow projections appear to originate from the differences in population projections between the planning studies which was discussed in Section 2.3.

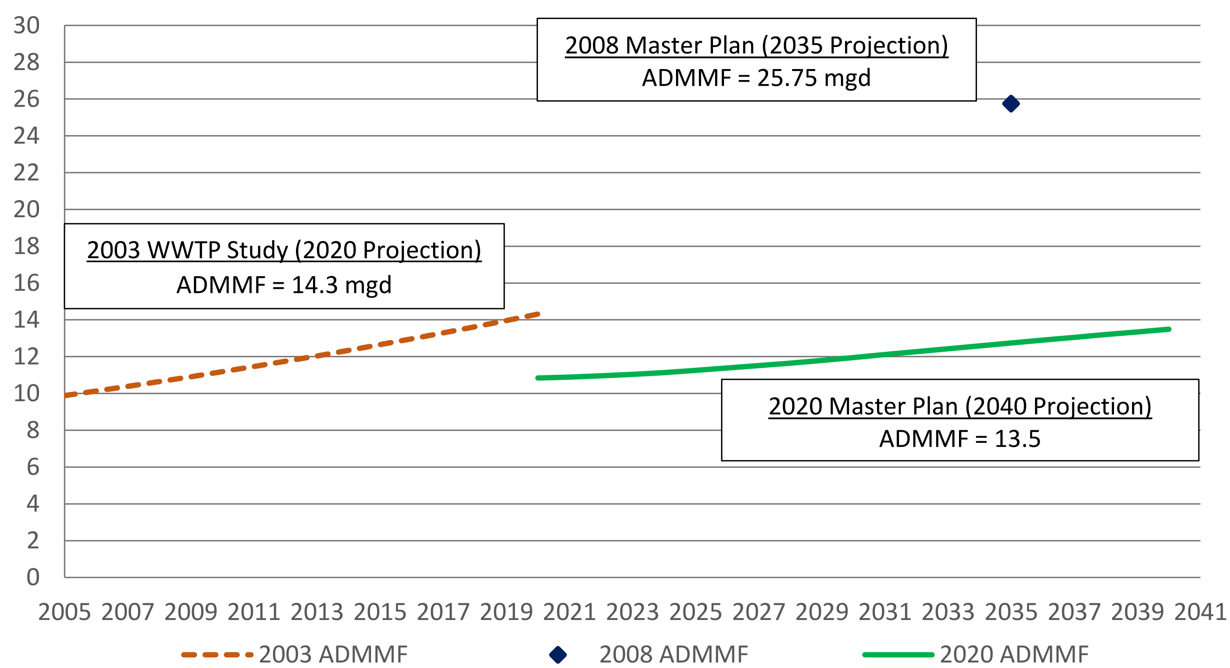

Figure 2.8 Master Planning Flow Projection Comparison

2.5 Summary of Hydraulic and Loading Projections

Based on the information presented above, Table 2.11 summarizes the 2040 influent conditions.

Table 2.11 Summary of Projected 2040 Flows and Loads

	ADAF	ADMMF	PDF	PHF
Influent Flow, mgd	11.3	13.5	27.0	30.4
Influent Loads			Not Analyzed	
BOD5, ppd	24,658	28,815		
TSS, ppd	24,565	29,927		
NH_4-N, ppd	2,927	3,555		

The projected buildout ADMMF is 27.2 mgd with a projected buildout population of 250,615 people.

2.5.1 Persigo WWTP Permitted Capacity

In the current discharge permit, the Persigo WWTP has a permitted hydraulic capacity equal to 12.5 mgd and an organic loading capacity, expressed as BOD_5, equal to 26,480 ppd. Based on the forecasted population growth for the City's service area, the permitted hydraulic capacity will be exceeded in 2034 and the permitted organic capacity will be exceeded in 2030.

Figure 2.9 shows the relative capacity trigger points which require utilities to initiate capacity planning and construction activities. Per Colorado Law, C.R.S. 25-8-501 (5d and 5e), wastewater discharge permitees are required to:

1. Initiate engineering and financial planning for expansion whenever the ADMMF throughput and treatment reaches 80 percent of design capacity, and
2. Commence construction of such expansion whenever ADMMF throughput reaches 95 percent of the design capacity.

Planning activities have begun in 2020 to address the 80 percent CDPHE capacity triggers. Chapter 3 includes a unit process capacity evaluation in relation to CDPHE WPC-DR-1, Design Criteria for Domestic Wastewater Treatment Works.

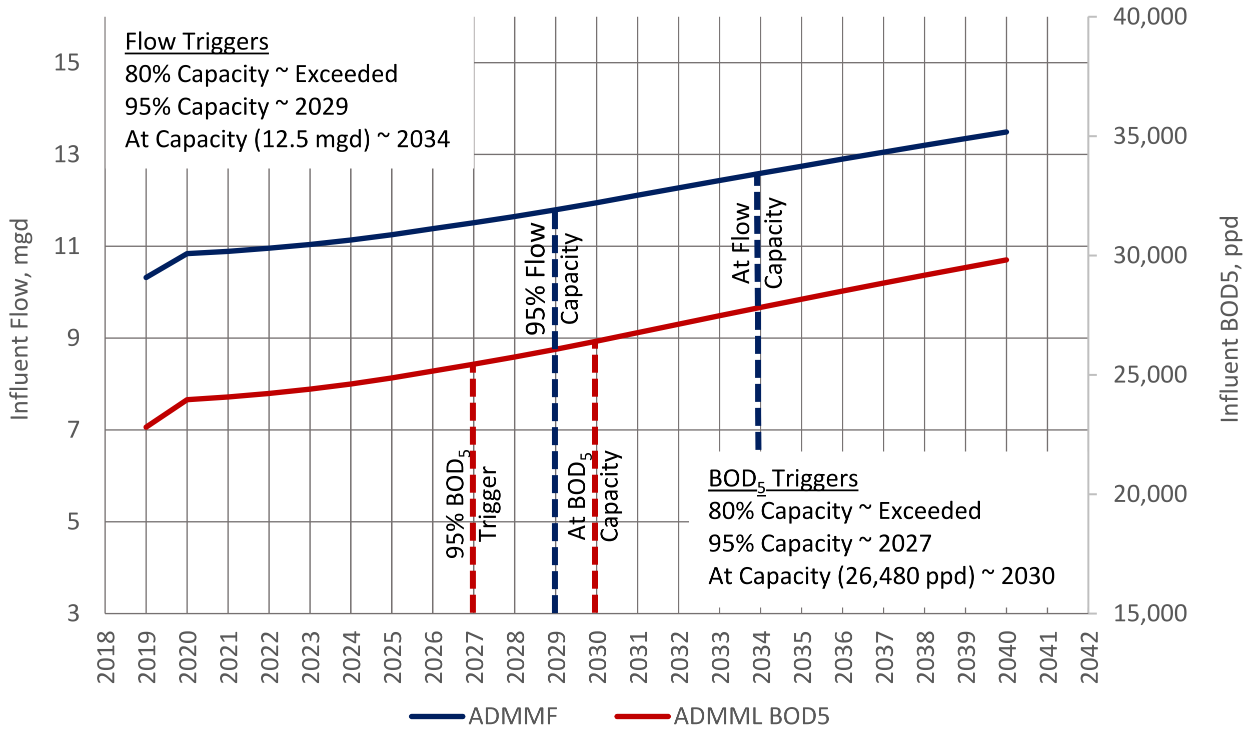

Figure 2.9 20-Year Planning Horizon Permitted Capacity Summary

2.6 Regulatory Framework

The Persigo WWTP treats domestic and industrial wastewater in compliance with state and federal regulations to protect human health and water quality-related classified uses in the Colorado River. The regulatory requirements are continuously changing through revisions of current regulations, new water quality standards, or the addition of new facilities that can alter existing assimilative capacity allocations. The following sections present current, future, and other potential water quality regulatory drivers that are expected to impact near and long-term treatment planning activities for the WWTP.

2.6.1 Current Discharge Permit

The Persigo WWTP is owned and operated by the City of Grand Junction and Mesa County, and is permitted under Discharge Permit No. CO0040053 that went into effect on January 1, 2018. The permit is valid for 5 years and will expire on December 31, 2022. The WWTP is located at the SE 1/4 of the NW 1/4 of S36, T1N, R10W; 2145 River Road, Grand Junction, CO 81505; at 39° 06'00" latitude North and 108° 36'00" longitude West. There are two outfall locations associated with the current permit, Persigo Wash (Outfall 001) and the Colorado River (Outfall 002). A third monitoring location is included in the discharge permit indicated as Outfall 003, which is described in the permit as "calculated from a combination of Outfalls 001A and 002A." The WWTP is no longer discharging to Persigo Wash/Outfall 001 and will complete a permit modification on the next permit cycle to have this outfall removed from the facility permit. Therefore, although effluent requirements are included for each outfall in the permit, only the discharge limits for Outfall 002 and the Colorado River stream segment water quality, are discussed in the following summary.

The WWTP is permitted for a hydraulic capacity of 12.5 mgd ADMMF and an organic loading of 26,480 ppd BOD_5. Table 2.11 summarizes the discharge limits. The current discharge permit does not set effluent limits for selenium, nonylphenol, total inorganic nitrogen (TIN) or total phosphorus (TP), but the City is required to monitor and report effluent concentrations for these constituents.

The facility has a compliance schedule for the Persigo Wash to meet total ammonia, TIN, and TP. The compliance schedule requires design developments by the end of 2021 and completion of related construction activities by June 30, 2022. To avoid any future compliance violations pertaining to the prescribed schedule, the City should move forward with a permit modification to remove this outfall and the associated compliance schedule as soon as possible.

Table 2.12 Current WWTP Discharge Permit Limitations for Outfall 002

Effluent Parameters	Units	Colorado River Effluent Limitations	
Effluent Flow	mgd	12.5	
E. coli	#/100 mL	2,000 (30-day average) 4,000 (7-day average) 1,056 (2-year average)	
Total Residual Chlorine	mg/L	0.17 (30-day average) 0.2 (daily maximum)	
BOD_5	mg/L	30 (30-day average) 45 (7-day average)	
TSS	mg/L	30 (30-day average) 45 (7-day average)	
pH	SU	6.5-9.0	
Oil and Grease	mg/L	10 (daily maximum)	
Selenium	µg/L	Report	
Nonylphenol	µg/L	Report	
		30-day Average	**Daily Maximum**
January	mg/L	19	65
February	mg/L	16	63
March	mg/L	17	62
April	mg/L	14	46
May	mg/L	16	49
June	mg/L	13	46
July	mg/L	13	47
August	mg/L	11	46
September	mg/L	12	47
October	mg/L	17	40
November	mg/L	17	51
December	mg/L	19	51

Notes:
(1) The Persigo WWTP also has monitoring and reporting requirements for the following parameters: TIN, TP, total dissolved solids (TDS), aluminum, arsenic, cadmium, chromium, copper, cyanide, iron, manganese, molybdenum, mercury, nickel, selenium, silver, zinc, and total phenols.
µg/L micrograms per liter
mL milliliter
SU Standard Unit

The WWTP is authorized to use the following chemicals on site: ferrous chloride for hydrogen sulfide control, and polymer for dewatering solids. Per the facility fact sheet, the use of magnesium hydroxide and calcium hypochlorite are also permitted at the WWTP.

2.6.1.1 Current Compliance Review

The Persigo WWTP has been consistently complying with effluent limits in recent years. The facility is meeting its ammonia effluent limits, but at times is short on alkalinity resulting in a decreased effluent pH.

The *E. coli* limits for discharge into the Colorado River are very high for 2-year, monthly, and 7-day average discharge. This provides potential opportunities to assess in this 2020 Master Plan whether to lower ultraviolet dosages for energy conservation or even bypass disinfection when secondary effluent pathogen limits are below the effluent discharge requirement (Figure 2.10).

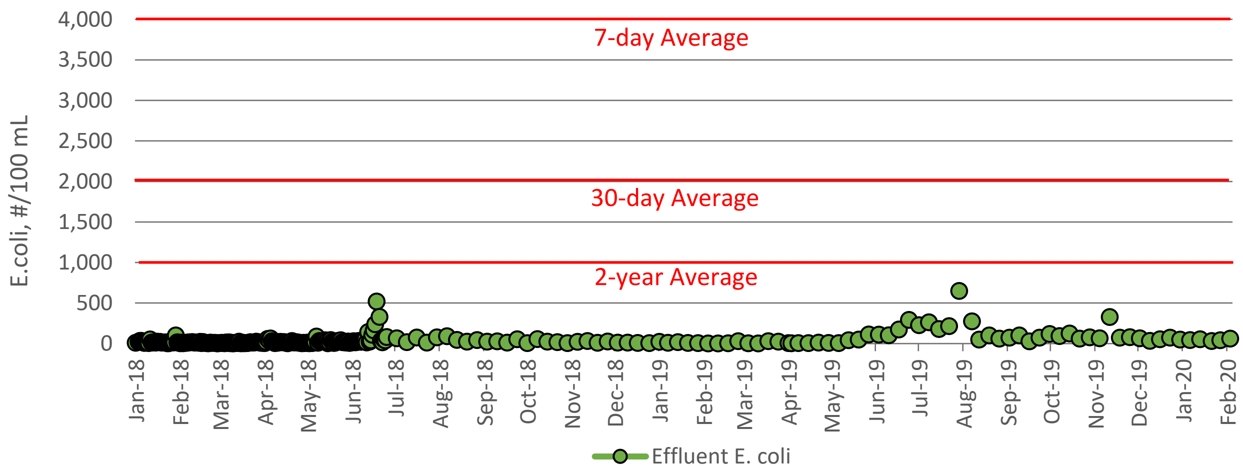

Figure 2.10 Effluent *E. coli* Persigo WWTP (2018-2020)

2.6.2 Water Quality of Receiving Water

This section provides a brief overview of water quality considerations in the Colorado River discharge Segment COLCLC03. Segment COLCLC03 in the Colorado River is designated as reviewable under the classification for Aquatic Life Warm 1, Recreation Class E, and Agriculture and requires an antidegradation review as a "reviewable" segment. The dilution ratio of the chronic low flow (30E3 – 30-day average low flow recurring in a 3-year interval) to the design flow of the Persigo WWTP (12.5 mgd) for discharge into the Colorado River is 57.

This segment contains threatened and endangered species, so the assimilative capacity for aquatic life-based standards is zero. This means that for aquatic life standards assessments on effluent limitations, CDPHE assumes that the upstream low flow is zero and no dilution credit is applied.

Ambient water quality in the Colorado River segment was not reported to exceed any of the chronic stream standards in the 2016 Water Quality Assessment. The stream segment is listed for selenium under the 303(d) listing in Regulation 93 and falls under a control regulation for salinity.

According to the Rationale for Classifications, Standards and Designations of the Colorado River, Segment COLCLC03 is not designated a water supply. For this reason, the nitrate standard of a daily maximum concentration of 10 mg/L, which is applied at the point of intake to a water supply, was not evaluated as part of the last Water Quality Assessment in 2016.

Tables 2.13 and 2.14 list the in-stream standards, ambient water quality and effluent quality for Segment COLCLC03 that are permit relevant today or in the future.

Table 2.13 CDPHE Chronic and Acute Water Quality-Based Effluent Limitations Developed for Colorado River

Effluent Limit	Units	Colorado River	
		30-day Maximum	Daily Maximum
Temperature MWAT March-November	°C	27.5	28.6
Temperature MWAT December-February	°C	13.8	14.3
E. coli	#100/mL	7,205	
Nitrate as N	mg/L		4,800
Nitrite as N	mg/L		2.4
Nitrate and Nitrate as N	mg/L		4,800
Total Residual Chlorine	mg/L	0.011	0.019
Al, total recoverable	µg/L	1,314	10,071
As, total recoverable	µg/L	438	340
Cd, dissolved	µg/L	0.73	9.1
Cr+3, dissolved	µg/L	134	1,773
Cr+6, dissolved	µg/L	11	16
Cu, dissolved	µg/L	17	50
CN, Free	µg/L		5
Fe, total recoverable	µg/L	1,000	
Pb, dissolved	µg/L	5.5	281
Mn, dissolved	µg/L	2,099	4,738
Mo, total recoverable	µg/L	12,103	
Hg, total(1)	µg/L	0.58	
Ni, dissolved (1)	µg/L	96	1,513
Se, dissolved	µg/L	4.6	18
Ag, dissolved	µg/L	1.1	22
Zn, dissolved	µg/L	230	467
Nonylphenol(1)	µg/L	6.6	28

Notes:
°C degrees Celsius
MWAT maximum weekly average temperature

2.6.3 Water Quality Parameters Potentially Relevant in Future Permit Renewal

2.6.3.1 Salinity

Salinity of the Colorado River is currently the biggest water-quality issue in the interstate watershed. For the Colorado River, Watershed Regulation 61.8(2)(1) sets requirements for salinity for any discharger. Specific to municipal "*discharges to any portion of the Colorado River stream system shall be allowed an incremental increase in salinity of 400 mg/L or less above the flow weighted averaged salinity of the intake water supply. The maximum incremental increase requirement, and the requisite demonstration that it is not practicable to meet the incremental increase requirement, may be waived in those cases where the salt load reaching the main stem of the Colorado River is less than one ton per day or 366 tons per year, whichever is more appropriate*."

Analysis for salinity may be either as TDS or by electrical conductivity where a satisfactory correlation with TDS has been established. The City currently has a monthly salinity monitoring and reporting requirement in their permit for TDS in a representative sample of the raw water supply and the Persigo WWTP effluent when discharging into the Colorado River.

According to the Persigo WWTP discharge permit, the total salinity loading from the WWTP exceeds allowable limits in Regulation No. 61. As a result, the City was required to submit a report addressing salinity by January 1, 2019.

Generally, most relevant sources of high salt concentrations in domestic effluent can include source water salinity (e.g., Grand Mesa source versus Gunnison River), chemical addition (e.g., alum or ferric for phosphorus removal), industrial discharges (e.g., meat processing), groundwater infiltration, and point of use household water filters. Salinity management is a topic that should be considered in this 2020 Master Plan.

2.6.3.2 Temperature

The City has received effluent temperature monitoring and reporting requirements in the past permit just as the City of Fruita and Clifton Sanitation District. The water quality-based effluent limits (WQBEL) analysis conducted by CDPHE in 2016 calculated a maximum month and maximum daily effluent temperature limit for summer and winter conditions. During the winter months (December to February), limits of 13.8 and 14.3°C for discharge into the Colorado River were developed. It is to be anticipated that these limits will be refined to define month-by-month limits by CDPHE in the next preliminary effluent limit (PEL) evaluation upon permit renewal in 2022 based on current data collected by the City in the stream and effluent. Regulation 37 defines instream temperature standards for Segment COLCLC03 for Warm Water Stream Tier 1 (WS-I) as 24.2°C and 29°C in March through November for MWAT and daily maximum temperature, respectively. For December through February, the standards are set to 12.1°C and 24.6°C for MWAT and daily maximum, respectively.

Given the annual wastewater temperature profile in the aeration basins, the City is unlikely to meet the monthly or daily maximum limits in the winter season (Figure 2.11). Therefore, this 2020 Master Plan should include a closer evaluation of temperature compliance risk along with regulatory, technical, and other options to prepare potential compliance strategies.

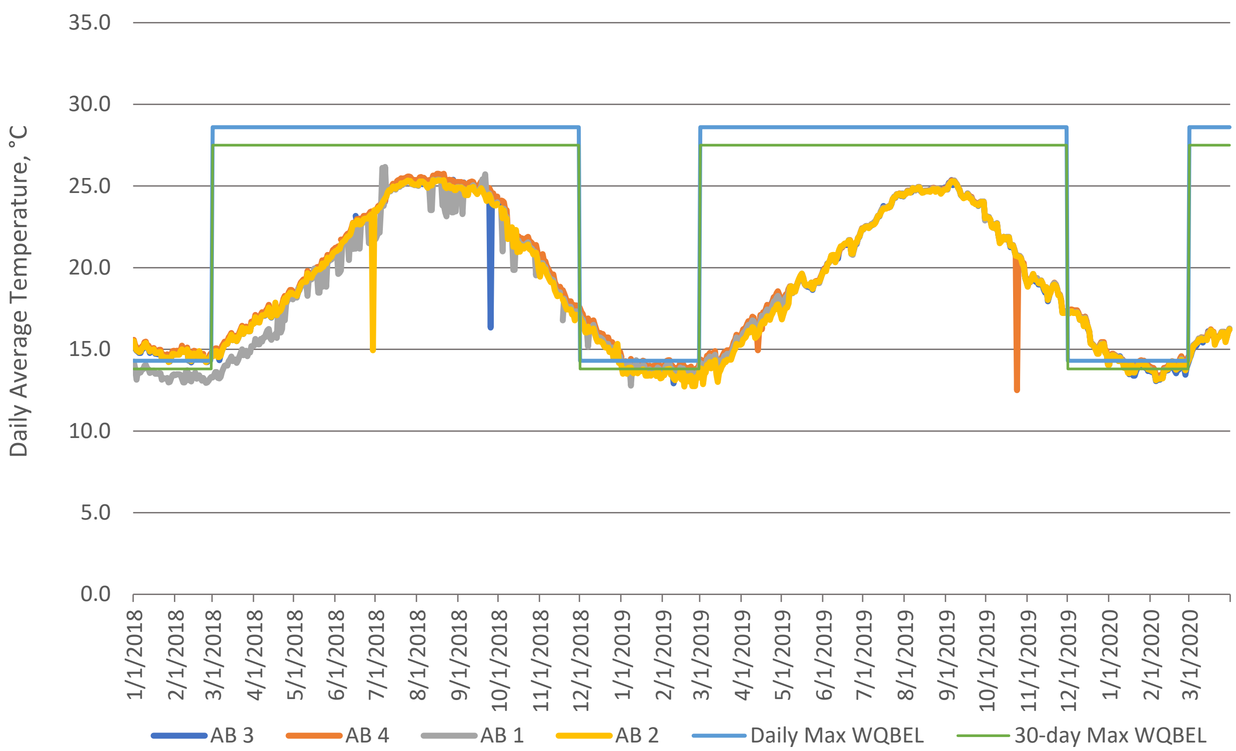

Figure 2.11 Aeration Basin Temperature for Persigo WWTP (2018-2020)

2.6.3.3 Nutrients

Total Nitrogen and Total Phosphorus

The high degree of dilution of the outfall into the Colorado River has the result that Regulation 31 limits for total nitrogen (TN) and TP Persigo WWTP are already met with current effluent quality by dilution. WQBELs for TN and TP were established by CDPHE in the fact sheet issued on November 30, 2017 as 192 mg/L and 16 mg/L, respectively, which are met easily by the current treatment process (Figure 2.12). The background concentrations upstream of the discharge point were assumed to be 4.8 mg/L TN and 0.21 mg/L TP in this calculation.

This means that the Persigo WWTP is not anticipated to receive TN or TP effluent limits until beyond 2030. This situation might change in case the minimum river flows change noticeably over the coming years, or in case the Environmental Protection Agency (EPA) lowers the preliminary in stream standards for TN and TP established by CDPHE in the future. The EPA has expressed that they consider the preliminary standards for TN and TP in streams and rivers as too high. It is currently uncertain what standards the EPA will set and this decision is not anticipated until about 2027. Carollo Engineers (Carollo) recommends that the City stays aware of these developments over the coming years.

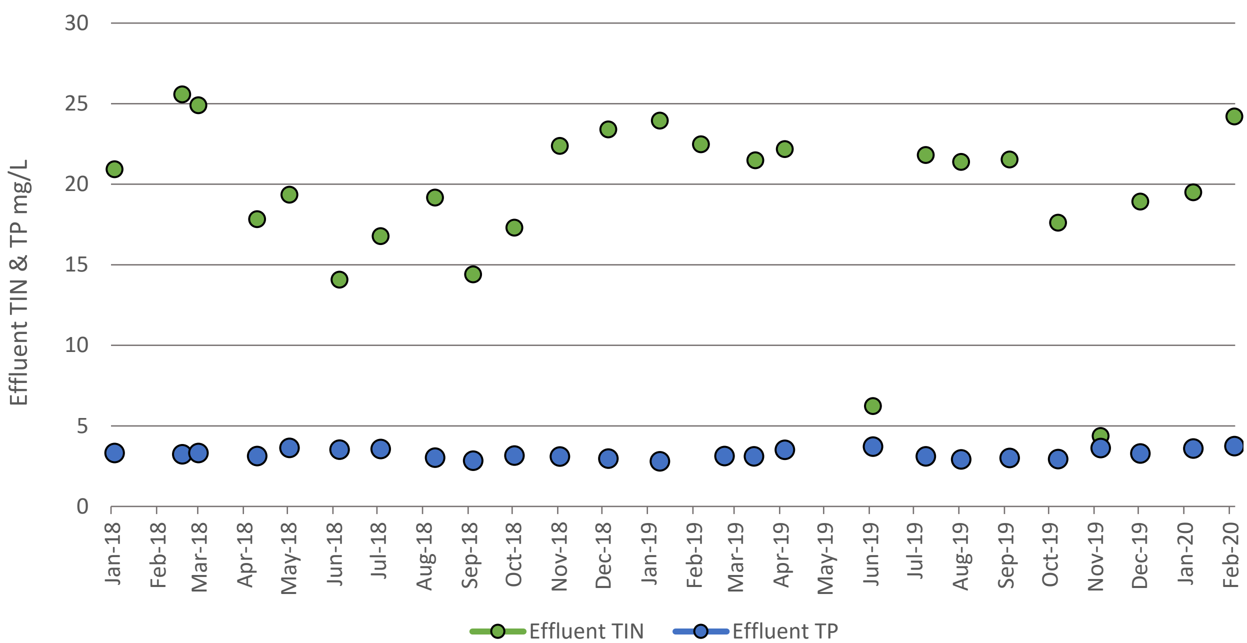

Figure 2.12 Effluent TIN and TP for the Persigo WWTP (2018-2020)

Chlorophyll-a

In 2022, the Water Quality Control Division (WQCD) will adopt proposed chlorophyll-*a* standards statewide for all river and stream segments. Chlorophyll-*a* measures the abundance of algae or periphyton and will be assessed during the summer from July 1 to September 30. Assessment is based on public responses to the level of "greenness" in a water, affecting the recreation use. One sample is required for assessment. The allowable exceedance frequency is once in 5 years.

The chlorophyll-*a* standard will not be implemented directly as a permit limit. If a waterbody is determined to be impaired for chlorophyll-*a*, a total maximum daily load (TMDL) must be developed to evaluate whether reductions of nutrient loading point sources could bring the segment back in attainment. It seems unlikely that Segment COLCLC03 in the Colorado River will not meet Chlorophyll-*a* standards; however, it is advisable that the City stays aware of these regulatory developments in the next few years.

The interim chlorophyll-a standard for warm water rivers in Colorado is set to 150 milligrams per square meter (mg/m^2) maximum attached algae in summer (July 1 to September 30) per Regulation 31. Monitoring data for Chlorophyll-*a* in the Colorado River near Grand Junction is not available at this time through CDPHE's database. Monitoring requirements for streams and rivers in Colorado are anticipated to be expanded after the standard is enforced and implemented into permits after 2022.

Upstream and Downstream Dischargers

The Town of Fruita's discharge permit is currently in public draft review. The new draft permit includes running annual median limits for TN and TP of 79 and 5.0 mg/L, respectively, although a compliance schedule was not determined to be necessary.

Clifton Sanitation District discharges upstream of the Persigo WWTP outfall prior to the confluence with the Gunnison River. The Clifton permit expired on March 31, 2020 and did not include nitrogen or phosphorus removal requirements. Carollo recommends that the City follow the status of Clifton's new wastewater quality assessment and PEL renewal process with CDPHE to see whether TIN and TP limits will be proposed and included.

2.6.3.4 Ammonia

Since the EPA published updated ammonia standards in 1999, the ammonia aquatic life criteria have been reevaluated on basis of recent evidence that freshwater mussel species may be more susceptible to ammonia than the aquatic organisms used for developing the 1999 criteria. The EPA published the revised ammonia criteria in 2013. CDPHE is currently assessing the presence of sensitive mussel species in Colorado streams and rivers. Alternate ammonia criteria may be developed for Colorado streams and rivers pending these results. CDPHE is scheduled to propose revised ammonia criteria in 2027. These criteria could tighten Persigo WWTP's effluent ammonia limits.

2.6.3.5 Metals

Several of the metals evaluated in the City's last PEL evaluation were flagged in the antidegradation review with an impact on in-stream quality (see Table 2.9). It is possible that the City receives permit limits for these metals in the future including TDS, aluminum, arsenic, cadmium, chromium, copper, cyanide, iron, manganese, molybdenum, mercury, nickel, selenium, silver, zinc, and total phenols.

The Town of Fruita's permit includes 30-day average and daily maximum limits for potentially dissolved cadmium and copper of 1.0 and 4.8 µg/L respectively. The monthly limit is higher than the WQBEL determined previously for Persigo WWTP's discharge into the Colorado River (see Table 2.9). Fruita's anticipated permit further contains new limits for chromium+6, cyanide, mercury, selenium, and silver. For most of these parameters the proposed effluent limits are the same or similar to the WQBELS developed by CDPHE for discharge into the Colorado River by the Persigo WWTP.

Therefore, it is recommended that the 2020 Master Plan evaluate current influent and effluent data for these metals in comparison to the PELs to assess whether current treatment performance is sufficient or may result in possible future compliance risk.

The City's current permit already contains a selenium limit that is based on the EPA's 304(a) criteria for selenium released in June 2016. CDPHE is currently collaborating with Colorado Parks and Wildlife and Colorado State University to evaluate and possibly revise the criteria in a 2027 rulemaking hearing.

2.6.4 Future Effluent Regulatory Considerations

2.6.4.1 Per- and Polyfluoroalkyl Substances in Effluent Discharges

Per- and polyfluoroalkyl substances (PFAS) are a large group of synthetic fluorinated organic chemicals that are soluble, mobile, and recalcitrant to chemical and biological processes. The two most dominant groups of PFAS consist of perfluorooctanyl sulfonate (PFOS) and perfluorooctanoic acid (PFOA).

PFAS are manmade chemicals that are heat, water, and lipid-resistant. Because of these qualities, they deter water, grease, and oil, and are therefore used in many industrial applications, ranging from flame-retardants to stain-resistant carpets to Teflon® pans. Due to decades of ubiquitous use of these chemicals, PFAS are now detected throughout the environment in soil, air, water, household dust, and humans.

Elevated exposure to PFAS compounds (primarily by way of ingestion of drinking water) have been associated with developmental effects during pregnancy such as low infant birth weights and skeletal variations, effects on the immune system such as changes in antibody production and immunity, liver effects including tissue damage, cancer, and thyroid hormone disruption. Even though PFAS compounds are not used in the wastewater treatment process, because they are so widely used in commercial and residential applications, they end up in wastewater. The largest source of PFAS compounds at WWTPs is from industrial dischargers. Thus, source control of industrial facilities using significant volumes of PFAS compounds is important because WWTP solids treatment processes do not destroy PFAS compounds. Under certain circumstances, PFAS can be created from precursors during the treatment process.

Most PFAS will partition to solids and end up in the biosolids stream. However, some treated effluents can contain concentrations that could be deemed problematic. What concentrations are "problematic" for discharge into streams and rivers is currently being defined by regulatory state agencies including CDPHE. The EPA has not regulated PFAS other than in drinking water, but it is in the process of developing standards for PFAS in biosolids and surface waters. As such, the EPA is following regulatory developments that individual state agencies are currently leading. Examples include:

- States that have already developed or are in the process of developing surface water quality standards for PFAS include Wisconsin, Minnesota, Colorado, New Hampshire, and Vermont. Michigan has set for non-drinkable sources a PFOS limit of 12 nanograms per liter (ng/L) and for PFOA 12,000 ng/L.
- States that have developed or are in the process of developing biosolids and or compost standards for PFAS include California and Massachusetts. Maine has set enforceable biosolids screening levels at 0.0025 milligrams per kilogram (mg/kg) for PFOA, 0.0052 mg/kg for PFOS, and 1.9 mg/kg for perfluorobutanesulfonic acid (PFBS).
- First states that require monitoring and reporting of PFAS concentrations in biosolids include California, Washington, Maine, New York, Massachusetts, and North Carolina.
- First states that have implemented requirements to monitor and report PFAS concentrations in treated effluents include Washington, and California.

In 2012, the European Union implemented a combined PFOS and PFOA limit of 100 micrograms per kilogram (µg/kg) that was adopted into composting and biosolids standards. This limit is generally not considered to be stringent enough by regulatory agencies in the United States.

CDPHE has initiated a public stakeholder group process in 2019 to accompany the development of water quality standards in Colorado for PFOS. The process is scheduled to be completed in summer 2020. CDPHE focuses on surface water standards first since the analytical methods for PFAS in wastewater matrices are further developed. CDPHE currently does not have a basis for developing PFAS limits for biosolids since occurrence data does not exist at this time and analytical methods for PFAS in biosolids are still under development. Regardless, it is anticipated that PFAS effluent limits may be implemented within the next 5 years in Colorado followed shortly by PFAS limits for biosolids.

2.6.4.2 Emerging Unregulated Contaminants

A number of trace organic contaminants (TOrC) can be detected in treated domestic wastewater effluents that have been demonstrated to negative effects aquatic and/or human health depending on occurrence concentrations. These contaminants originate differently in domestic, industrial, or stormwater sources including personal care products, food additives, pharmaceuticals, industrial chemicals, or disinfectant by-products. Concentrations in treated effluent can range from micro to nanograms. While some of the chemicals can be toxic or carcinogenic for humans, concentrations are typically too low and of more immediate concern for discharge locations can be the possible toxic effects of TOrC on aquatic life, specifically endocrine disruption in fish.

Because of the large amount of TOrCs and incomplete data on cause-effect relationships, the EPA has not yet regulated the large majority of these compounds. Instead, standards have been developed for individual compounds, such as nonylphenol and currently perfluorinated compounds (see section below). However, regulations regarding TOrCs discharge from wastewater treatment facilities have been anticipated in the coming one to two decades. Several years ago, other European countries already started to require and implement treatment requirements in form of the so-called fourth treatment step (post tertiary treatment for nutrient removal). The two most typical technologies that are implemented for TOrC removal are either activated carbon sorption or ozonation followed by biologically active filtration.

Two feasible regulatory pathways for TOrC in future years are:

1. Development of regulatory requirements for a small defined group of TOrCs that require treatment upgrades that will then also result in the effective removal of a broader group of TOrCs.
2. The EPA has also contemplated developing "group regulations" for TOrCs instead of proceeding with compound-by-compound regulations.

While timing and nature of these regulations are uncertain, utilities are advised to plan long-term in site layouts and finances for treatment upgrades that can accommodate TOrC removal.

2.6.4.3 Microplastics

Microplastics in wastewater and the environment have become a topic of research over the past years. Of general interest are particles less than 5 millimeters (mm) in size and particles are categorized into micro-, meso-, and nano plastics. Plastic particles are detected virtually ubiquitously and introduced in wastewater treatment plants through consumer products, stormwater, and other sources.

Microplastics cause possible concerns for aquatic life, but the science and cause-effect relationships are not yet well understood. Detection methods are still under development and not standardized. In the United States, research needs to be further developed before it is clear whether microplastics need to be regulated to mitigate exposure risks, and if that should be the case, for the EPA to develop the necessary data to develop standard methods and the necessary database to develop standards. For this reason, regulations in the United States from the EPA are not anticipated within the next 10 to 15 years.

2.6.4.4 Nanoparticles

Nanoparticles are a broad group of organic or inorganic particles in the size range of about 1 to 100 nanometers (nm) or larger. These particles originate various sources in wastewater influent including consumer products, industrial chemicals, clothing, electronics, or food. In August 2017, the EPA issued a requirement for information collection and reporting for nanomaterials under the Toxic Substances Control Act (TSCA). This is regarded as a first necessary step for the EPA to start collecting data on this group of chemicals to help with the assessment of whether regulations may be necessary.

Nanoparticles have a high surface area to volume ratio and are therefore often reactive. Few particles are known to be cancerogenous or toxic; for most particles, such information is not yet available. Toxicity endpoints are not well understood, occurrence data is difficult to analyze in environmental matrices, and toxicity data is insufficient. For this reason, regulations in the United States from the EPA are not anticipated within the next 10 to 15 years.

2.6.5 Anticipated Permitting Timeline

CDPHE reviews basin water quality every 5 years, which may impact Persigo's discharge permit. The summary below includes CDPHE's schedule to update the following water quality standards relevant for Persigo WWTP, which may affect the next permit limits include the following:

- 2019: Regulation 37 *Classifications and Numeric Standards for Lower Colorado River Basin*, rulemaking hearing.
- 2020: Review nutrient progress.
- 2022: Chlorophyll-α standard adopted for streams statewide.
  - Address non-point source controls and incentive program progress.
- 2025: Review nutrient progress.
- 2026: Release draft TN and TP criteria for streams.
- 2027: Implement ammonia, TN, and TP standards statewide.

Figure 2.13 summarizes anticipated milestones of potential relevance for the Persigo WWTP based on a 5-year permit renewal cycyle.

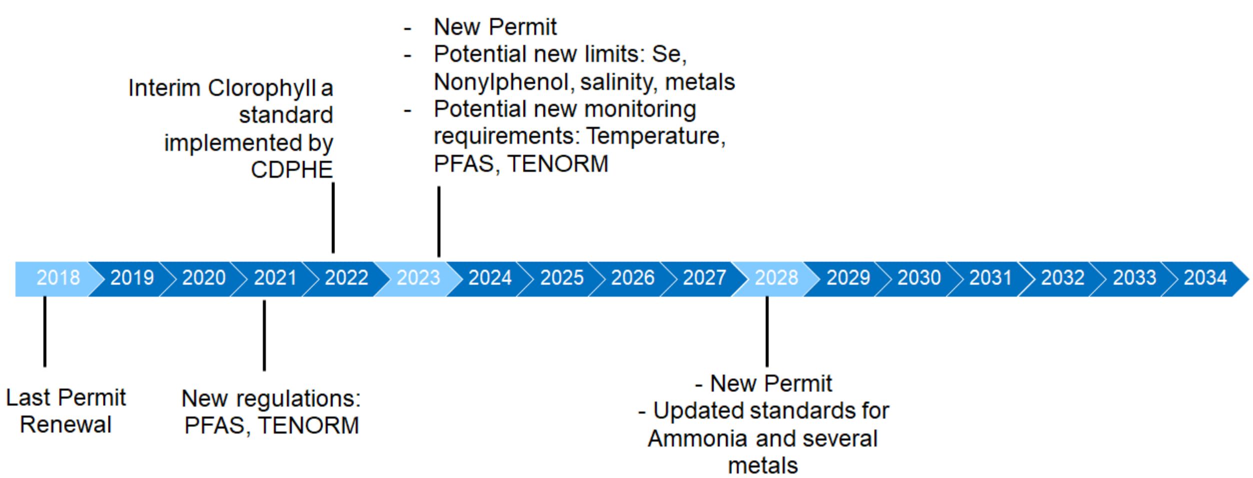

Figure 2.13 Anticipated 10-year Regulatory Timeline for Persigo WWTP

2.6.6 Current and Anticipated Regulatory Requirements for Biosolids

This section summarizes the current and future anticipated regulatory requirements for Class B biosolids production in Colorado.

Currently, the Persigo WWTP uses anaerobic digestion for primary sludge stabilization and aerobic digestion for waste activated sludge (WAS) stabilization. Following stabilization, sludge is dewatered and dewatered cake is hauled to the Mesa County Landfill for disposal. The City is interested in exploring opportunities for Class B biosolids land application in the future to promote resource stewardship and manage operating costs associated with hauling and tipping fees.

2.6.6.1 Mesa County Landfill Disposal Regulations (Current Operation)

Dewatered solids from the existing treatment process are hauled and disposed at the Mesa County Landfill. Regulatory requirements for disposal at the landfill include a paint filter test and toxicity characteristic leaching procedure (TCLP) analysis. The paint filter test is conducted on one load each month and a toxicity TCLP metals sample is tested once annually to comply with Mesa County Landfill dumping requirements. The loads are also tested for pH quarterly and standard metals annually. Testing costs amount to approximately $500 per year.

2.6.6.2 Regulation 64 Background

The WQCD adopted *Biosolids Regulation No. 64 (5 CCR 1002-64)* (Regulation 64) (CDPHE, 1993) in November 1993; the regulation was last amended June 2014. Regulation 64 "establishes requirements, prohibitions, standards, and concentration limitations on the use of biosolids as a fertilizer and/or organic soil amendment in a manner so as to protect the public health and prevent the discharge of pollutants into state waters."

Regulation 64 is based on EPA 40 CFR Part 503 Biosolids Rule, but it is a Colorado-specific rule that governs how biosolids are handled, treated, and applied to land or utilized for public use. The following discussion presents regulatory pathways for beneficial use of biosolids for land application (Class B).

Class A biosolids are a higher-quality product that must meet more stringent pathogen reduction requirements. As a result, these biosolids can be distributed for public use without further testing and monitoring. Class B biosolids must still meet certain pathogen reduction requirements, but the limits are lower than those for Class A biosolids. These biosolids cannot be distributed for public use, but they may be land-applied. However, sites that apply Class B biosolids are subject to certain access and food production restrictions.

2.6.6.3 Pathogen Reduction Requirements

Pathogens are disease-causing organisms present within the biosolids. Only biosolids that meet either Class A or Class B requirements for pathogen destruction can be land applied.

For Class B biosolids to be used or distributed for beneficial use, the biosolids pathogen destruction must be evaluated or treated by one of two alternatives, as shown in Table 2.14.

Table 2.14 Pathogen Reduction Alternatives (Class B)

Alternative	Description
1	Geometric mean of seven samples
2	Process to significantly reduce pathogens

Alternative 1 requires that the geometric mean of seven samples shows the density of fecal coliforms to be less than 2,000,000 most probable number per gram (MPN/g) of total solids on a dry weight basis or less than 2,000,000 colony forming units per gram (CFU/g) of total solids on a dry weight basis. No further treatment is required if the biosolids meet this criterion.

Alternative 2 requires processing the biosolids using one of six treatment processes known as "Processes to Significantly Reduce Pathogens" (PSRP). The possible PSRPs are shown in Table 2.15.

Table 2.15 Processes to Significantly Reduce Pathogens

Alternative	Process	Description
2a	Aerobic Digestion	Biosolids are agitated with air or oxygen to maintain aerobic conditions for a mean cell residence time at a temperature or temperatures within a time-temperature function having as end points 40 days at 20°C and no less than 60 days at 15°C.
2b	Air Drying	Biosolids are dried on beds or on paved or unpaved basins. The biosolids dries for a minimum of 3 months. During 2 of the 3 months, the ambient average daily temperature is above 0°C.
2c	Anaerobic Digestion	Biosolids are treated in the absence of air for a mean cell residence time at a temperature or temperatures within a time-temperature function having as end points 15 days at 35 to 55°C and no less than 60 days at 20°C.
2d	Composting	Using either the within-vessel, static aerated pile, or windrow composting methods, the temperature of the biosolids is raised to 40°C or higher and remains at 40°C or higher for 5 days. For 4 hours during the 5 days, the temperature in the compost pile exceeds 55°C.
2e	Lime Stabilization	Sufficient lime is added to the biosolids to raise the pH of the sewage sludge to 12 after 2 hours of contact.
3	Alternative EPA Approved	Any other method of biosolids treatment which is certified as a PSRP by the EPA, Region VIII, or, after assumption of delegation by the State, which is is certified as such by the WQCD.

2.6.6.4 Vector Attraction Requirements

In addition to pathogen destruction criteria, biosolids for use or distribution must also meet vector attraction reduction (VAR), also referred to as "biosolids stability." Vectors are disease-carrying organisms that are attracted to biosolids. VAR requirements must be met regardless of whether the biosolids are Class A or Class B. There are ten methods available to meet the VAR requirement; only one must be met for compliance with Regulation 64. The VAR alternatives are described in Table 2.16.

Table 2.16 Vector Attraction Reduction Alternatives (Class A and Class B)

Alternative	Process	Description
1	Volatile Solids Reduction	Reduce the mass of volatile solids by a minimum of 38%.
2	Bench-Scale Digestion (Anaerobic)	Demonstrate vector attraction reduction with additional anaerobic digestion in a bench-scale unit.
3	Bench-Scale Digestion (Aerobic)	Demonstrate vector attraction reduction with additional aerobic digestion in a bench-scale unit.
4	Specific Oxygen Uptake Rate (SOUR)	Meet a specific oxygen uptake rate for aerobically treated biosolids.
5	Aerobic Processing Plus Raised Temperature	Use aerobic processes at greater than 40°C for 14 days or more.
6	Alkaline Addition	Add alkaline materials under specified conditions.
7	Percent Solids of Stabilized Biosolids	Reduce moisture content of biosolids.
8	Percent Solids of Unstabilized Biosolids	Reduce moisture content of unstabilized biosolids from primary treatment.
9 or 10	Application Method	Inject or incorporate biosolids under specified conditions.

The City has indicated that the existing biosolids stabilization process does not meet current regulations for stabilization with regards to time or temperature conditions.

2.6.6.5 Metals Concentration Limits in Biosolids

Section 64.12 of Regulation 64 lists the limits on metals concentrations in biosolids. Both Class A and Class B biosolids must be tested for metals and meet the same concentration limits. Biosolids with metals exceeding the ceiling concentrations in Table 2.17 are not allowed to be applied to land.

Table 2.17 Metals Ceiling Concentration Limits (Table 1 Quality)

Pollutant	Ceiling Concentration Limit (mg/kg, dry weight)
Arsenic	75
Cadmium	85
Copper	4,300
Lead	840
Mercury	57
Molybdenum	75
Nickel	420
Selenium	100
Zinc	7,500

Biosolids which meet the ceiling concentration limits listed in Table 2.17 are considered "Table 1 quality" biosolids and are subject to maximum cumulative loading limits on land application sites. Regulation 64 also specifies pollutant concentration limits under which biosolids are no longer subject to those maximum loading limits. If the average of at least seven daily composite samples in a calendar month is below the concentration listed in Table 2.18, the biosolids are considered "Table 3 quality" and are not subject to cumulative pollutant loading rates for land application sites. This means it may be easier to find and manage land application sites for "Table 3 quality" biosolids versus "Table 1 quality" biosolids.

Table 2.18 Metals Pollutant Concentration Limits (Table 3 Quality)

Pollutant	Ceiling Concentration Limit (mg/kg, dry weight)
Arsenic	41
Cadmium	39
Copper	1,500
Lead	300
Mercury	17
Molybdenum	N/A
Nickel	420
Selenium	100
Zinc	2,800

2.6.6.6 Biosolids Land Application Requirements

Before pursuing land application of biosolids, a "Letter of Intent" must be submitted to CDPHE. It includes general information regarding both the application site, the biosolids generation facility, and the biosolids applier. The soil must be tested for soil fertility, physical characteristics, and metals concentrations, both before application and on a set sampling frequency after application. These results are used to determine both the quantity and quality of acceptable biosolids application. The site also must meet several location-specific criteria to qualify as an acceptable location. These include proximity to surface water as well as several other physical characteristics.

The biosolids from the Persigo WWTP would need to be routinely sampled to confirm quality. Biosolids require sampling on a frequency determined by the total quantity of solids production and the total quantity being reused for land application purposes. In addition to the pathogen, vector reduction, and metals sampling requirements discussed above, there are general biosolids monitoring requirements that include testing for nutrients such as phosphorus and nitrogen. The results of this testing are factored into a calculation on cumulative metals and nutrient loading to the site. When a site has reached their allowable metals and nutrient limits (which are based on agronomic uptake rates), the site can no longer accept biosolids.

All collected data is summarized and reported annually in accordance with Regulation 64 Biosolids Annual Report – Section 1 Biosolids Land Application Report. This report form is also referred to as the "self-monitoring report." There are also notification letters required of both the biosolids preparer (WWTP) and applier (end user).

2.6.6.7 Anticipated Future Biosolids Requirements

It is anticipated that in the foreseeable future biosolids regulations in Colorado will be expanded to include provisions for PFAS limits and radionuclide requirements.

Per- and Polyfluoroalkyl Substances

As introduced in Section 2.6.3.6 PFAS regulations PFAS water quality standards are currently under development by CDPHE. Given that several states in the United States are already currently developing PFAS limits for biosolids and that this is a current priority focus by EPA as well, it is to be anticipated that CDPHE will also develop or adopt PFAS limits for biosolids in the near future. As a first step, monitoring and reporting of PFAS in biosolids may be required.

The concern with PFAS in biosolids is two-fold. In particular, in shallow groundwater areas, the land application of biosolids containing PFAS contamination has resulted in PFAS leaking into ground water resulting in drinking water source contamination. Second, PFAS may be taken up into plants and crops and thereby entering the human food chain.

On a national level, the EPA has set a health advisory (HA) for PFOA and PFOS in drinking water at 70 parts per trillion (ppt) and is currently evaluating the need for maximum contaminant levels. An HA limit provides information on contaminants that can cause human health effects and are set to offer a margin of protection for all humans (including the most vulnerable populations) throughout their life. The HA limits are non-regulatory and non-enforceable, regardless public attention and concern surrounding PFAS have required utilities and local regulators in many parts of the country to take immediate action.

To date, most biosolids land application sites where groundwater monitoring is conducted have not found levels of PFOA and PFOS above 70 ppt; however, there have been a few cases (e.g., in Maine, Alabama, and Michigan) where biosolids land application resulted in PFAS levels above the EPA drinking water HA in the groundwater tested. These cases were the result of high levels of PFAS discharged to WWTPs by a PFAS-using industry. In March 2019, in reaction to public outcry of a farm that received paper mill sludge and biosolids, Maine initiated a testing requirement for all land-applied biosolids. While this farm did receive biosolids, after further investigation, the source of the PFOS contamination (biosolids or other residuals) was inconclusive. As a precautionary measure, Maine established a limit for PFOA and PFOS in beneficially used biosolids. These limits are 2.5 parts per billion (ppb) and 5.2 ppb, respectively. Notably, these levels are lower than the concentration levels detected in most biosolids products tested to date.

Radionuclides

Geologic sources of radionuclides in groundwater in the Colorado River basin may enter the collection system via inflow/infiltration. Therefore, the City should anticipate that monitoring and reporting might be included in the upcoming permit renewal.

Regulation 64 does not include requirements for Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM) in biosolids at this time. However, plant staff have reported that radioactivity has been shown on the general screening at Mesa County Landfill during disposal. Under these conditions, the waste is not accepted and must be re-blended at the Persigo WWTP prior to hauling back to the landfill. From time to time, stakeholders discuss issues regarding the levels of TENORM due to the potential for TENORM to be present in discharges to domestic wastewater treatment facilities from some drinking water treatment facilities. A recent law was passed (Senate Bill-245) in Colorado that requires CDPHE to develop new Naturally Occurring Radioactive Materials (NORM) and TENORM regulations even without the EPA having adopted such rules first, following a stakeholder process. New rules are required to be adopted by December 31, 2020. A stakeholder process was initiated and began in July 2018.

2.6.7 Regulatory Requirements for Biogas

Regulatory requirements for biogas depend on the end use for biogas. For renewable natural gas quality used for vehicle fueling, the applicable standard is provided by the Society for Automotive Engineers (SAE) SAE-J1616 (https://www.sae.org/standards/content/j1616_199402/). Renewable natural gas quality must meet vehicle manufacturers' requirements and the Standard for Compressed Natural Gas Vehicle Fuel in accordance with this standard. In some cases, manufacturers' requirements may supersede SAE standards.

Biogas that is not used for vehicle fueling is currently flared in an existing waste gas burner. Destruction efficiency of the waste gas burner must meet all applicable requirements in the Persigo WWTP's air pollution emissions notice (APEN) requirements.

2.6.8 Air Permit

The Persigo WWTP operated under the Aerometric Information Retrieval System (AIRS) Identification/ Permit No. 077-0107-999 for emissions associated with the anaerobic digester flare (AIRES Point 007). The permitted annual level of digester gas is 84,313,919 standard cubic feet per year (scfy). The permitted emissions associated with this permit are shown in Table 2.19.

Table 2.19 Current APEN Emissions Factors (Based on 2017 Inspection Records)

Parameters	Emissions Limit, (tons per year)
PM	0.42
PM_{10}	0.42
$P_{2.5}$	0.42
CO	9.95
NOx	1.82
H_2S	0.57
VOC	0.58
SO_2	21.30

A compliance inspection of the WWTP was conducted by the CDPHE Air Pollution Control Division on January 24, 2017. The system was found to comply with the APEN during the inspection. Although there are not pending regulatory changes associated with the United States Clean Air Act or the CDPHE APEN permitting process, modifications to the anaerobic digestion system and biogas processes that expand the current capacities will need to consider these permitting requirements.

2.6.9 Air and Odor Control

The City conducted the *Persigo WWTP and Collection System Odor Abatement Evaluation* (January 2020) to evaluate odors for the Persigo facility and multiple locations throughout the collection system. The initial goal of this study was to evaluate locations where the City had received odor complaints and to prepare recommendations to support worker health and safety in the collection system and at the Persigo WWTP site. Historically, odor complaints have occurred most frequently in the collection system. The closest location to the Persigo WWTP with odor complaints is the Persigo Wash Siphon.

At the Persigo WWTP site, hydrogen sulfide, ammonia, mercaptan, and dimethyl sulfide concentrations were sampled at various locations. The general industry limit for worker exposed to H_2S from the Occupational Health and Safety Administration (OSHA) is a ceiling limit of 20 parts per million (ppm) with a peak limit of 50 ppm. However, most people report olfactory detection of this compound at 5 ppb. The typical wastewater odorants were summarized in the Persigo WWTP and Collection System Odor Abatement Evaluation with detection thresholds as summarized in Table 2.20.

Table 2.20 Typical Wastewater Odorants(1)

Parameters	Detection Threshold ppm (v/v)	Recognition Threshold ppm (v/v)	Odor Description
Dimethyl Sulfide	0.001	0.001	Decayed cabbage
Dimethyl Disulfide	0.001	--	Decayed vegetables
Ethyl Mercaptan	0.0003	0.001	Decayed cabbage
Hydrogen Sulfide	0.0005	0.0047	Rotten eggs
Indole	0.0001	--	Fecal, nauseating
Methyl Mercaptan	0.0005	0.001	Rotten cabbage
Propyl Mercaptan	0.0005	0.02	Unpleasant
Pyridine	0.66	0.74	Pungent, irritating
Skatole	0.001	0.05	Fecal, nauseating

Notes:
Persigo WWTP and Collection System Odor Abatement Evaluation (Garver, 2020)

Continued air and odor monitoring were recommended as part of the Persigo WWTP and Collection System Odor Abatement Evaluation (Garver, 2020) and modifications were recommended to address odor concerns at the Persigo WWTP. These recommends are discussed and implemented into the prioritized capital improvements plan in Chapter 8.

2.6.10 Stormwater

The Persigo WWTP does not have a stormwater permit associated with the facility as there is no stormwater discharge from the site. Staff reported that the site no longer has a stormwater discharge permit since drainage is held in an onsite pond and evaporates.

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Chapter 3

EXISTING FACILITIES AND CAPACITY ANALYSIS

3.1 Introduction

This chapter summarizes the desktop and process modeling capacity analysis conducted for the Persigo WWTP as part of the 2020 Master Plan. An evaluation of the current hydraulic and treatment capacity of existing liquid and solid stream unit processes under current effluent permit limits is presented. Influent flow and load assumptions for the capacity evaluation (Tables 3.1 and 3.2) were adopted from the analyses summarized in Chapter 2 for current and projected conditions. A detailed evaluation of future regulatory changes is summarized in Chapter 2, and a definition of various treatment alternatives considering future flows, loads, and regulatory requirements are presented in Chapter 5.

Table 3.1 Summary of Flows and Loads

	ADAF	ADMMF	PDF	PHF
Current Influent Flow, mgd	8.6	10.0 (80% of hydraulic design capacity)	20.6	23.3
Influent Flow Peaking Factor(1)	1.0	1.2	2.4	2.7
Influent Design Flow, mgd(2)	10.4	12.5	25.0	28.1
Influent Loads(3)			Not Analyzed	
Current BOD_5, ppd		22,100 (83% of hydraulic design capacity)		
Design @ 12.5 mgd ADMMF				
BOD_5, ppd	23,470	26,480 / 27,626(4)		
TSS, ppd	23,400	27,755		
Ammonia, ppd	2,820	3,264		

Notes:
(1) Influent peaking factors are derived assuming ADAF (e.g., 10.0 divided by 8.6 equals an estimated ADMMF peaking factor of approximately 1.2).
(2) Design flows, other than ADMMF, have been calculated based on the peaking factors established from influent flow data.
(3) Based on rated design capacity, 12.5 mgd ADMMF.
(4) 26,480 ppd BOD_5 is the design/rated organic capacity of the facility. Based on historical data the maximum month design BOD_5 concentration has increased from 254 mg/L during original design to 265 mg/L at present (about 4% increase). Therefore, the BOD_5 loading based on historical BOD concentrations at the 12.5 mgd hydraulic capacity is 27,626 ppd BOD_5.
ppd pounds per day

The Persigo WWTP operates currently at about 80 percent of its rated hydraulic capacity and about 83 percent of its rated organic loading capacity. According to its permit requirements, the City is therefore required to start the planning phase for a treatment expansion.

In Chapter 2, the projected flows and loading conditions for the Persigo WWTP service area, as shown in Table 3.2, were calculated for a 20-year planning period. The growth projections predict that the 90 percent flow threshold will be exceeded in about 2031. The 90 percent organic load threshold is predicted to be exceeded in 2028. Based on Carollo's experience, it is recommended that at the 90 percent threshold utilities should begin developing design documents for construction of the infrastructure improvements at the 95 percent threshold. Based on CDPHE guidance, utilities are required to start capacity expansion construction at the 95 percent threshold.

Table 3.2 Summary of Projected Flows and Loads for 2040 for the Persigo WWTP Service Area

	ADAF	ADMMF	PDF	PHF
Influent Flow, mgd	11.3	13.5	27.0	30.4
Influent Loads(1)			Not Analyzed	
BOD_5, ppd(1)	24,700	28,800		
TSS, ppd	24,600	29,900		
Ammonia, ppd	2,900	3,600		

Notes:
(1) Loadings are calculated based on the per capita annual average daily load (AADL) and average daily maximum month load (ADMML) values developed in Chapter 2.

3.1.1 Objectives of the Capacity Evaluation

The current capacity evaluation accomplished the following objectives:

1. Modeled the existing facility to assess the actual current hydraulic and organic treatment capacity at current wastewater influent strength and under current effluent permit requirements.
2. Summarized the required upgrades to expand the treatment capacity of the liquid and solids streams to meet near-term discharge permit limits.
3. Identified potential unit process limitations that may require improvements to expand treatment capacity through the 2040 planning horizon.

These objectives were met through a combination of analyses:

- Reviewed previous 2 years of available process performance data to develop appropriate criteria and assumptions for the capacity evaluation.
- Reviewed current unit process sizing and, where relevant, comparison with the State of Colorado Design Criteria for Domestic Wastewater Treatment Works (CDPHE, 2012) to support the plant's existing capacity rating.
- BioWin modeling and spreadsheet-based evaluations of the current treatment capacity under its current permitted hydraulic and organic loading.

3.1.2 Historical Design Records

Unit process design criteria were aggregated from the following design records as part of this capacity evaluation and supplemented by a field investigation conducted by Carollo staff in June 2020:

- 1980 Persigo Wash WWTP Basis of Design (summary file).
- 1981 Persigo Wash WWTP Design (drawings).
- 2001 Persigo WWTP Final Clarifier Addition (drawings).
- 2010 Persigo Wash WWTP UV Disinfection Improvements (drawings and design report).
- 2012 Persigo Wash WWTP Aeration Basin Improvements (drawings).
- 2016 Persigo WWTP Diffuser Outfall Improvements (drawings and design report).

This effort resulted in a single repository for liquid and solid stream unit process design criteria and mechanical equipment data summarized in this chapter that may be useful for the City in the future. The complete list of design criteria for the main unit processes is in Appendix A.

3.2 Existing Facility Description

The existing liquid stream treatment process consists of preliminary treatment with influent flow measurement and wastewater pumping; primary clarification; flow equalization of primary effluent, activated sludge secondary treatment operated in a two-train configuration; secondary clarification; and ultraviolet light disinfection with subsequent discharge to the Colorado River.

The solids treatment process consists of anaerobic digestion of primary sludge; aerobic digestion of WAS; dissolved air flotation thickening (DAFT) of aerobically digested WAS; blending of all digested solids; and dewatering belt filter presses. Approximately 80 percent of the biogas produced from the anaerobic digesters is captured for beneficial use in CNG fleet vehicles. The remainder is flared due to insufficient storage and capacity limitations of the biogas conditioning system. Dewatered solids are transported off-site for disposal at the Mesa County Landfill. Pressate from the dewatering process, subnatant from the DAFT, and supernatant from the anaerobic and aerobic digesters are returned to the headworks via an in-plant waste pump station.

The facility operates a grease handling system, which accepts fats, oils, and grease (grease) from businesses within the City of Grand Junction. Grease is transported to the site by third-party hauling companies, is thickened via a floatation and skimming process, and is ultimately disposed of in the regional landfill. Liquid separated from the grease is sent to the WWTP for treatment.

Simplified schematics of the existing liquid and solids stream treatment processes are shown in Figures 3.1 and 3.2, respectively, and a site plan is presented in Figure 3.3. Abbreviated summaries of existing liquid and solids stream capacities across the facility are summarized in the following sections.

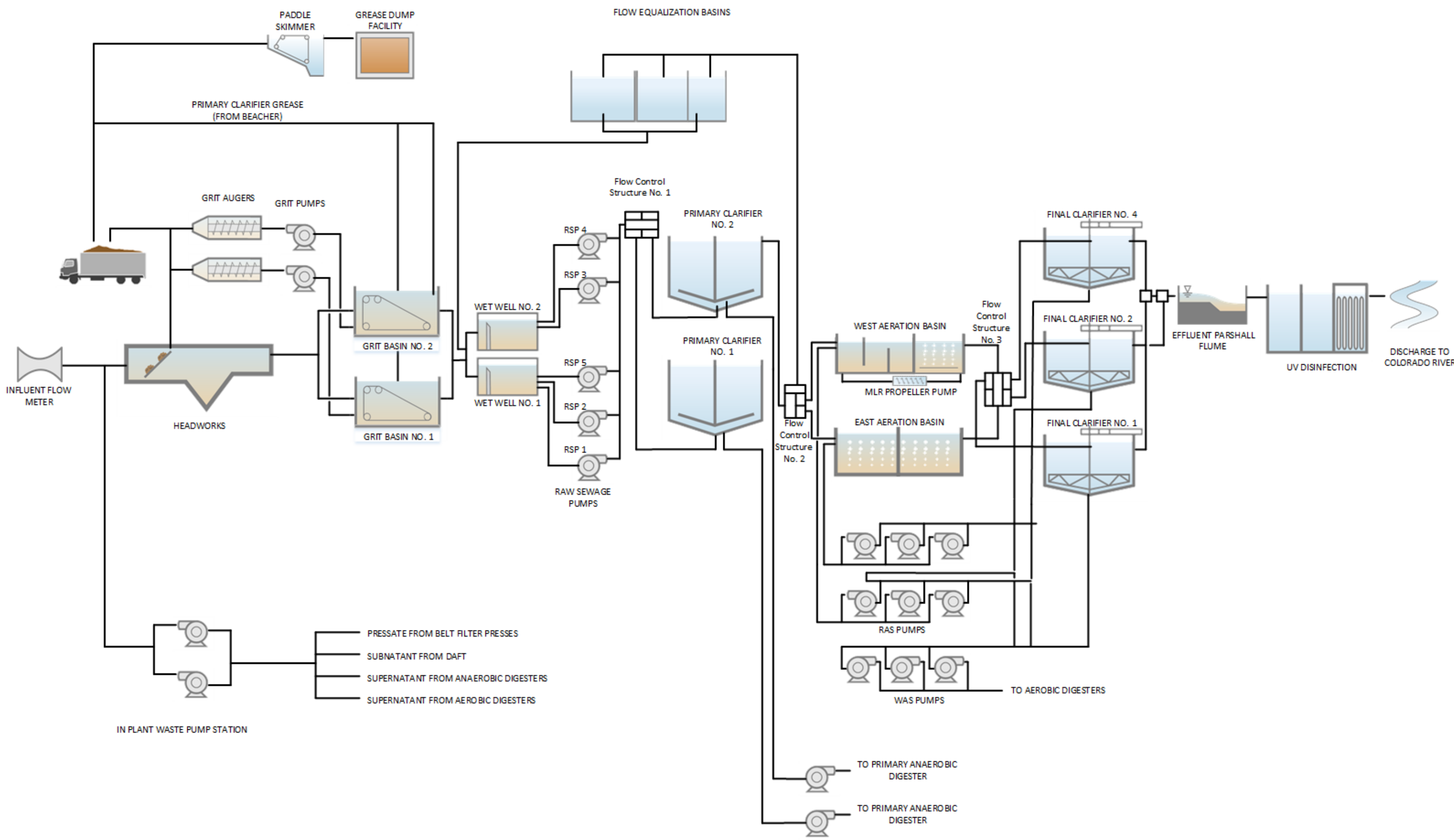

Figure 3.1 Simplified Schematic of Existing Liquid Stream Treatment Process

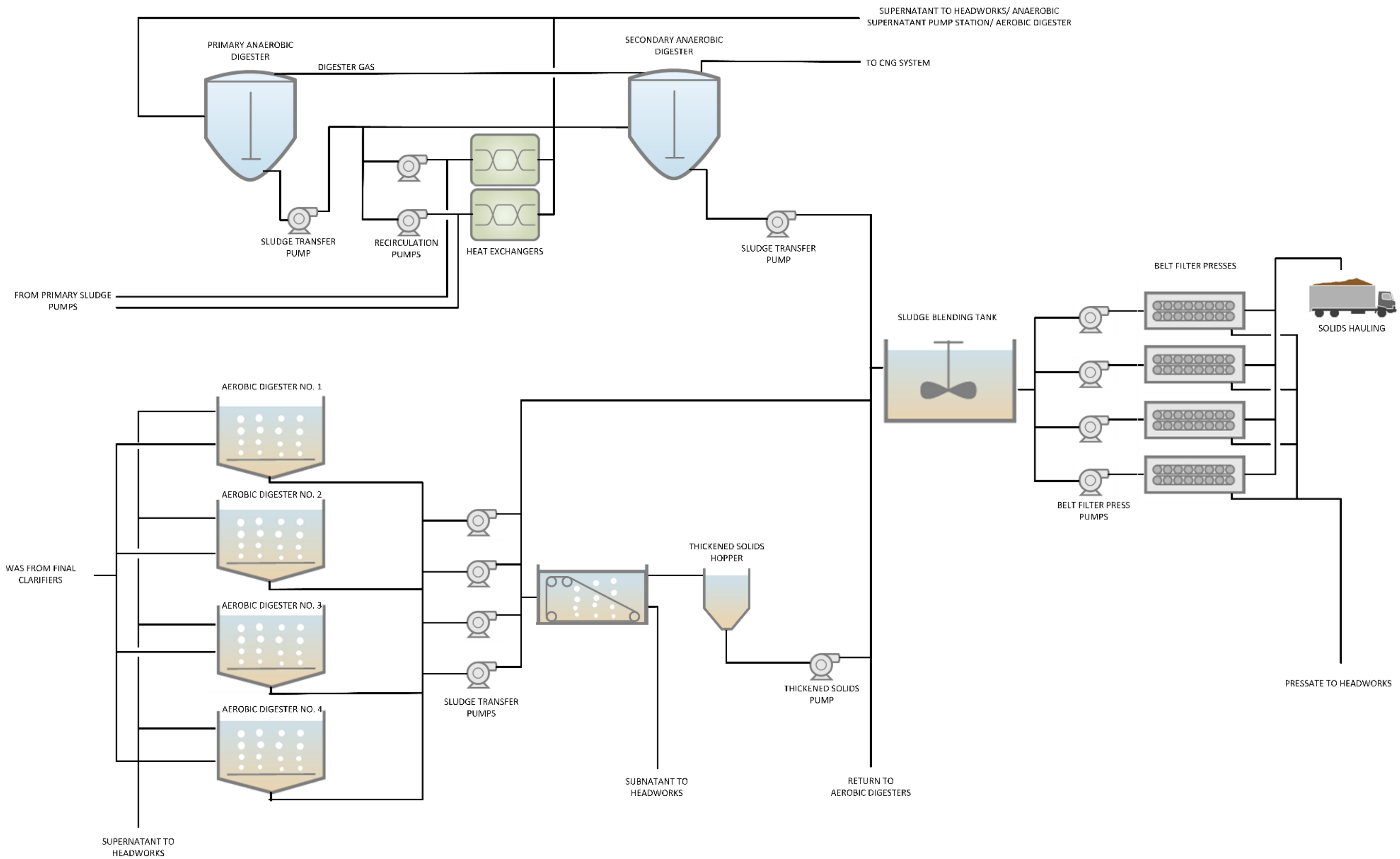

Figure 3.2 Simplified Schematic of Existing Solids Stream Treatment Process

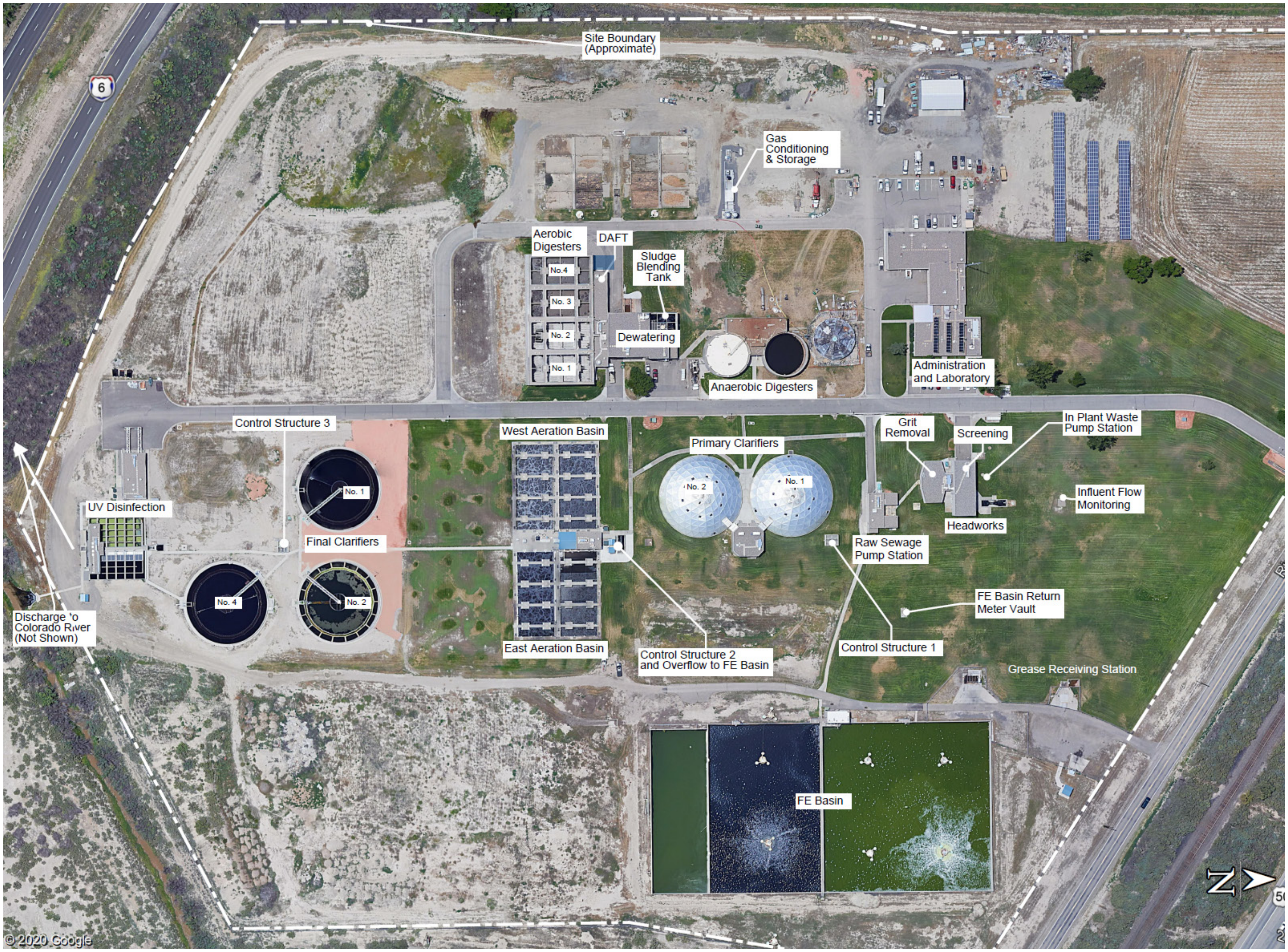

Figure 3.3 Persigo WWTP Site Plan

3.3 Hydraulic Capacity and Modeling

A hydraulic model of the existing Persigo WWTP was developed from upstream of the influent Parshall flume and extends through the outfall diffusers in the Colorado River. The following flow conditions were evaluated in the hydraulic model:

- PHF of 28.8 mgd, calculated based on a peaking factor of 2.7 from average day annual design flow.
- Current permitted ADMMF of 12.5 mgd.
- ADAF of 10.7 mgd.

The model was also run at the 2040 ADMMF of 13.5 mgd to confirm capacity and possible infrastructure limitations at this future flow condition.

3.3.1 *Hydraulix®* Model Construction

The hydraulic analysis was performed using Carollo's *Hydraulix®* modeling software. *Hydraulix®* is an in-house, spreadsheet-based, steady-state hydraulic model used to calculate the hydraulic and energy grade lines through treatment plants. The model estimates the water surface elevation (WSE) at a given point in the process stream and creates a hydraulic profile through the treatment facility.

The hydraulic profile is determined for the "critical" path (or path that results in the greatest headloss) through the plant. Key parameters for the hydraulic model are downstream control points, which dictate the hydraulic grade lines as the critical flow path is modeled through the facility. Typically, the location farthest downstream (i.e., effluent discharge location) is taken as the downstream control point.

3.3.2 Modeling Assumptions and Constraints

The following key assumptions were made in developing the hydraulic profile:

- Flow distribution between like unit processes (e.g., primary clarifiers, aeration basins, final clarifiers) is equal.
- All hydraulic components (basins, pipes, channels, etc.) are in service. The exception to this is the secondary clarifiers. Two of the three secondary clarifiers were modeled as in-service to match current single-sludge operation configurated in two parallel treatment trains.
- All flow above ADMMF is equalized at Control Structure No. 2.
- Friction losses in piping were determined using the Darcy-Weisbach/Colebrook formula.
- In open channels, the depth of flow and resultant headloss were determined using the Chezy-Manning's equation via an iterative analysis.

The three flow scenarios considered in developing the existing hydraulic profile are summarized in Table 3.3. For the purposes of this evaluation, equalization of all flows above ADMMF was assumed downstream of primary clarification. A hydraulic profile of the WWTP is presented in Figure 3.4. A bar chart representing water surface elevations in each structure under PHF conditions is presented in Figure 3.5.

Table 3.3 Hydraulic Profile Flow Conditions

	ADAF	ADMMF	PHF
Plant Influent Flow, mgd	10.7	12.5	28.8
Equalization Flow, mgd	0.0	0.0	16.3
Return Activated Sludge (RAS) Flow, mgd(1)	4.3	6.3	6.3
Mixed Liquor Recycle (MLR) Flow, mgd(2)	16.1	18.0	18.0
Flow through Aeration Basins, mgd	31.1	36.8	36.8

Notes:
(1) RAS flow is typically operated at 40% recycle rate. Model was run at 40% recycle rate for ADAF and 50% for ADMMF and equalized PHF.
(2) MLR flow is based on recycle rate of 150% for ADAF and nameplate capacity of 18 mgd for ADMMF and PHF.

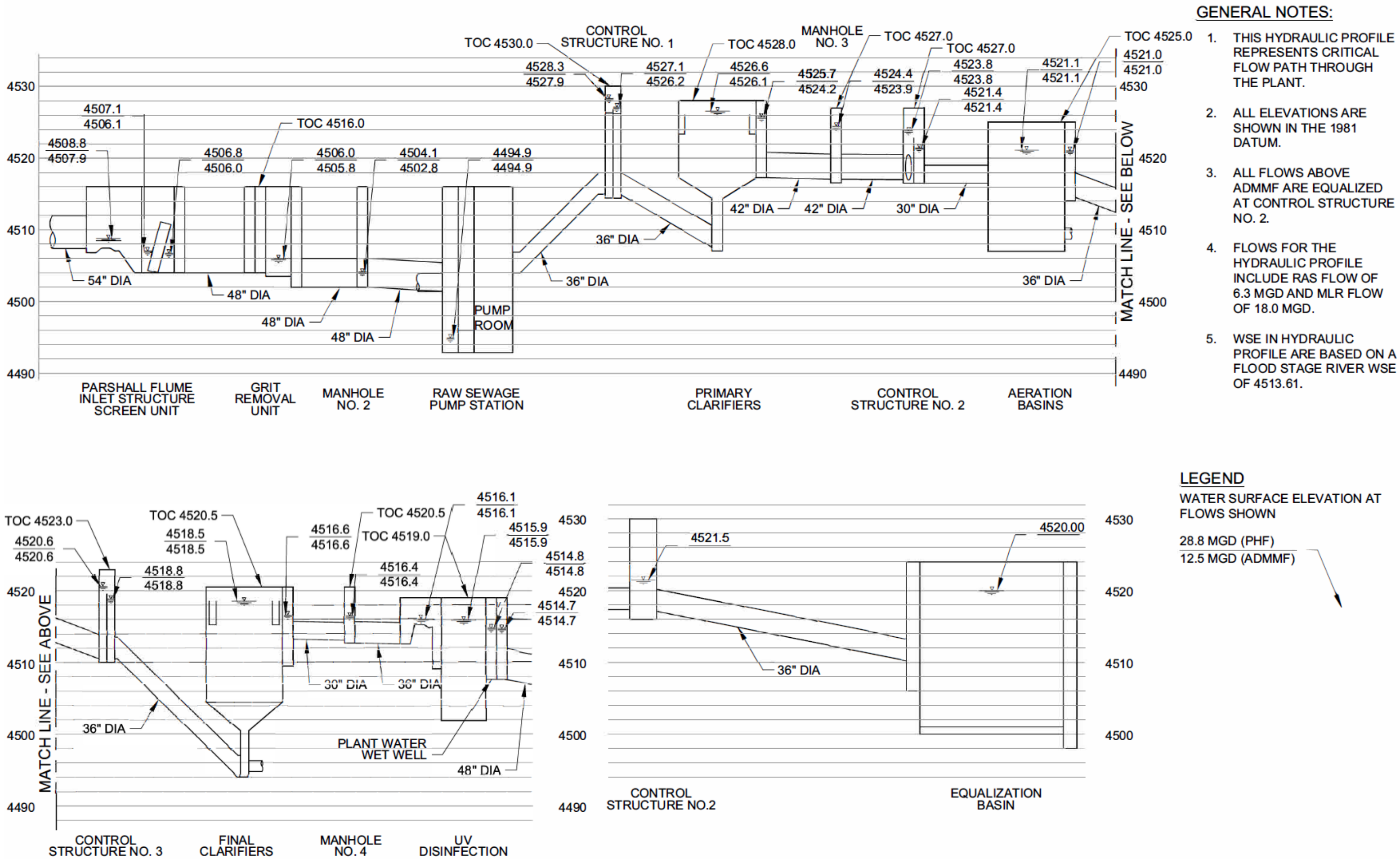

Figure 3.4 Persigo WWTP Hydraulic Profile

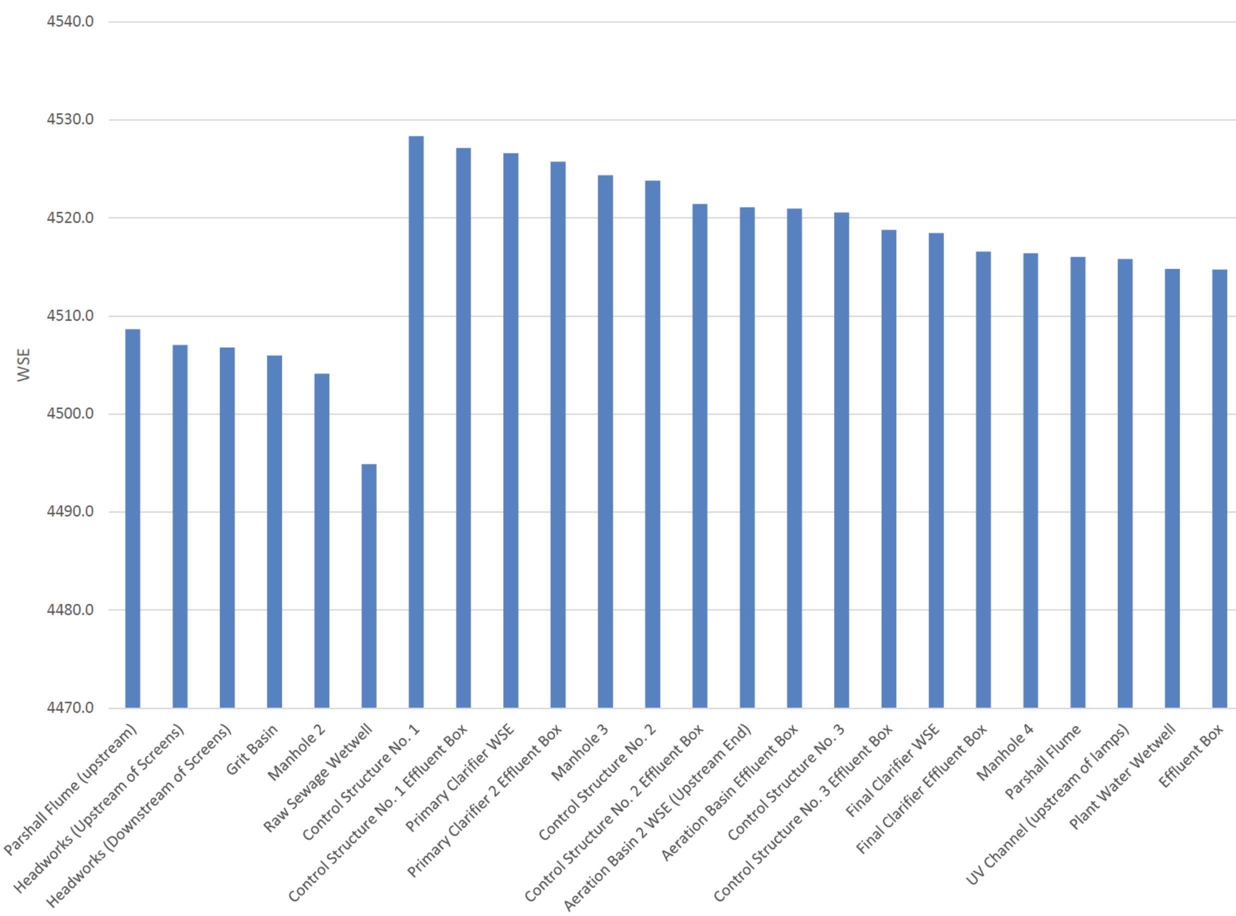

Figure 3.5 Modeled Water Surface Elevations at PHF

The information presented herein is based on the original datum used in the 1981 construction drawings. The datum in the 2016 drawings is 3.39 feet higher than the original datum. All elevations taken from these drawings were adjusted to the original datum.

The hydraulic profile through the facility was evaluated both at a normal river elevation of 4,501.6 feet and a 100-year flood elevation of 4,513.6 feet, based on the original datum.

3.3.3 Hydraulic Results and Discussion

The WWTP is able to hydraulically treat flows up to the PHF of 28.8 mgd through preliminary and primary treatment, and equalized flows up to the ADMMF of 12.5 mgd (and 2040 ADMMF of 13.5 mgd) through secondary treatment and disinfection assuming all unit processes in service. It is noteworthy that an analysis with individual unit processes out of service was not conducted. Flow equalization is critical to the facility and must be maintained in service whenever flows increase above approximately 13.5 to 14.5 mgd.

A summary of hydraulic bottlenecks identified by the model and plant staff observations include:

- Potential overtopping of Control Structure No. 1 (located between the raw sewage lift pump station and the primary clarifiers) at influent flows above 20 to 30 mgd. Within this window of raw sewage flow rates, plant staff have observed overtopping of the structure's walls due to the turbulent inlet conditions in the narrow inlet channel.
- Submergence of primary clarifier weirs at influent flows above approximately 20 mgd.

- Opening in Control Structure No. 3 (between the east and west trains) is normally closed and has not been used by plant staff in the past. If plant staff were interested in operating a combined sludge process, the 2-foot square opening in Control Structure No. 3 would be a hydraulic bottleneck and would need to be enlarged.
- Submergence of the Parshall flume at the upstream end of the UV system.

These items should be considered as part of the alternative evaluation, which will be detailed in Chapter 5. Additional hydraulic treatment capacity details are presented for each unit process in the sections below.

Following this 2020 Master Plan, it would be prudent to field verify weir elevations in Control Structure No. 2 to confirm both the equalization weir elevation as well as the elevation of the aeration basin influent weir.

3.4 Liquid Stream Treatment Capacity Analysis

3.4.1 Preliminary Treatment

Raw wastewater flows and loads from the service area enter the northeast side of the WWTP through a 54-inch gravity sewer interceptor. Influent flow measurement, mechanical screening, grit removal, and raw sewage pumping equipment are housed in and immediately adjacent to the headworks building on the north side of the plant. Relevant unit process design criteria and hydraulic capacities are summarized in Table 3.4. A detailed description of these systems is provided in the subsections below.

Table 3.4 Preliminary Treatment Design Criteria

Process/Equipment	Units	CDPHE Design Criteria(1)	Criteria / Capacity
Influent Flow Measurement			
Type	-	-	FLO-DAR® by HACH
Total Capacity	mgd	Able to function over the full range of expected design flows	0-20(3)
Mechanical Bar Screens			
Number	-	-	2
Channel Dimensions, (W x H)	feet	-	4 x 12
Bar Spacing	inch	0.25 - 1.75	0.25
Velocity through Screens	ft/sec	<3 through screen at PHF	3(2)
Capacity, each	mgd	-	12.5
Total Capacity	mgd	-	25
Firm Capacity	Mgd	Shall meet design PHF	12.5
Horizontal Flow Grit Basins			
Number	-	-	2
Dimensions, (L x W)	Feet	-	20 x 20
Water Depth	Feet	-	2
Capacity, each	Mgd	Horizontal flow velocity <1.3 ft/sec	33.6
Total Capacity	Mgd	Shall meet design PHF	67.2

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Process/Equipment	Units	CDPHE Design Criteria(1)	Criteria / Capacity
Grit Pumps			
Number	-	-	2
Capacity, each	gpm	-	150
Total Capacity	gpm	-	300
Grit Washers with Cyclones			
Number	-	-	2
Capacity, each	gpm	-	150-300 @ 5-12 psi
Total Capacity	gpm	-	300-600 @ 5-12 psi
Raw Sewage Lift Pumps			
Number	-	-	5 – Variable Speed
Capacity, each	mgd	-	10
Total Capacity	mgd	-	50
Firm Capacity	mgd	Shall maintain wet well water surface level below design maximum high level (alarm level)	40

Notes:
(1) State of Colorado Design Criteria for Domestic Wastewater Treatment Works (CDPHE, 2012).
(2) Original submittal with design criteria and calculations could not be located by the local Huber manufacturer representative. Huber was contacted by plant staff in August 2020 to calculate the velocity through the existing screens at the design capacity of 12.5 mgd. Per the manufacturer's calculations, the velocity through the screen at 12.5 mgd (each) and at 30 percent screen blinding is 3 ft/sec.
(3) Current hydraulic range for the FloDAR is set at a maximum flow of 20 mgd, as staff set maximum influent flow at 20 mgd. This range can be expanded to 42 mgd based on historical data.
ft/sec feet per second
psi pounds per square inch
gpm gallons per minute

3.4.1.1 Influent Flow Measurement

Historically, a Parshall flume (still existing) measured influent flows at the north side of the headworks building. The flume has a throat width of 4 feet and a reported flow metering range of 0.82 mgd to 44 mgd. It is not uncommon for influent flows to back-up into the Parshall flume during peak flow events and skew meter readings, as plant staff will intentionally restrict flow into the headworks via the bar screen influent gates and allow raw influent to temporarily back-up into the Parshall flume upstream of the headworks. Therefore, the Parshall flume was abandoned in place and a FLO-DAR® (HACH) sensor assembly was installed in a manhole immediately upstream of the flume. The sensor assembly is calibrated based on a level and pressure range of 6 to 48 inches and 0 to 48 inches, respectively, which are then converted to influent flow in the plant's supervisory control and data acquisition (SCADA) system. The FLO-DAR® is set for the existing manhole and interceptor pipe and programmed within SCADA to record a range of 0 to 20 mgd. Plant staff currently limit influent flow to the WWTP to 20 mgd by either allowing flow to back-up into the WWTP collection system interceptor or by diverting influent flow to the flow equalization (FE) basin upstream of the influent flow metering manhole. The FLO-DAR meter range can be adjusted to a maximum flow of 42 mgd based on an evaluation of historical plant data.

All in-plant waste flows are returned to the headworks building downstream of the FLO-DAR® sensor and are therefore not included in reported influent flows.

3.4.1.2 Screening

After influent flow measurement, raw wastewater and in-plant waste flows are conveyed into a slide gate chamber and then split between three isolatable screening channels. Two channels are outfitted with mechanical, self-cleaning step screens (0.25-inch clear openings by Huber) to remove plastics, rags, and other materials, while the third channel is reserved for future use (currently outfitted with an original 1983 mechanical bar screen with hand operated electrical controls). Screenings are collected and discharged onto a common screenings conveyor where they are pressed and transferred to a dedicated screenings dumpster for landfill disposal. Excess wash water and press water is returned to a common drain, which flows to the common flow channel following the step screen channels.

The existing screening equipment does not have sufficient treatment capacity through the 2040 planning horizon (PHF of 31.1 mgd) and does not meet the facility's current PHF of 28.8 mgd with one mechanical step screen out of service. This conclusion assumes no credit for the 1983 mechanical bar screen located in the third headworks channel, which anecdotally is inoperable per plant staff. The unit is no longer powered because during high flow events, the unit's 480-volt (V) motor can become submerged and poses a significant safety risk to plant staff. The unpowered unit was left in the channel to serve as a "manual" bar screen in case emergency bypass through the third channel was required. It should be noted that Huber was contacted to obtain the original design submittal to verify the flow capacity of the step screens, but the manufacturer was not able to locate the requested information. Therefore, the design team adopted the 12.5 mgd hydraulic capacity noted in the O&M manual, which indicates that the design was based on the plant rated capacity as opposed to the peak hour flow condition. Huber provided screen flow velocity calculations to operations staff via email in August 2020, which indicated a screening velocity of 3 ft/sec at a flow of 12.5 mgd and assumed screen blinding of 30 percent.

3.4.1.3 Grit Removal

Screened wastewater is de-gritted through two square shaped, horizontal flow grit basins. This type of grit basin has been used for nearly 80 years but is less common in new installations as compared to vortex-type and aerated grit chambers. Based on commonly reported design criteria and recommended CDPHE design guidelines for horizontal flow grit basins, each unit is sized to treat up to 33.6 mgd. Therefore, the combined capacity of 67.2 mgd is sufficient for treating flows through the current design capacity of the facility and the 2040 planning horizon. Note that this conclusion is not based on an investigation of particle size removal in the grit basins as a function of hydraulic throughput.

Settleable grit is conveyed by a rotating rake mechanism to a sump located at the side of each tank and then pumped to two cyclone separators and dewatering classifiers. Dewatered grit is discharged into a dedicated grit dumpster for landfill disposal.

3.4.1.4 Raw Sewage Pump Station

Screened and de-gritted wastewater is conveyed into two wet wells and then lifted approximately 26 feet by five drywell, vertical shaft, centrifugal pumps into Control Structure No. 1. Each pump is outfitted with a variable frequency drive (VFD) and has a design hydraulic capacity of 10 mgd at 35 feet total dynamic head (TDH). The common header of the raw sewage pump station discharges upstream of flow control weirs in Control Structure No. 1, which help to minimize the chance of reverse flow from preliminary treatment when individual pumps are not in service.

The firm capacity of the raw sewage pump station (40 mgd) is sufficient for the current design capacity and 2040 planning horizon. Note, however, that developing a system curve for this pump station was beyond the scope of the project and therefore the conclusion is based solely on the nameplate capacity of the pumps.

3.4.1.5 Preliminary Treatment Hydraulic Capacity

The hydraulic profile through preliminary treatment was modeled at a Raw Sewage Pump Station wet well elevation of 4,494.9 feet, which represents a side water depth of 12 feet. Per discussions with plant staff, this wet well is currently operated with a side water depth between 11 and 12 feet to improve suction head on the centrifugal raw sewage pumps. Before switching to this operation, plant staff historically maintained the wet well elevation at approximately 5 to 6 feet deep. There were no hydraulic bottlenecks identified in the preliminary treatment system (headworks and grit removal) at the PHF condition. All structures have sufficient freeboard.

3.4.2 Primary Treatment

From Control Structure No. 1, screened and de-gritted wastewater and return flows from the FE basins are designed to be distributed proportionally to two 115-foot diameter primary clarifiers. The clarifiers are center-feed, peripheral overflow type with 8-foot side water depth. Primary effluent from each unit flows by gravity through Manhole No. 3 and Control Structure No. 2 prior to distribution between the plant's two secondary treatment trains.

Primary sludge is collected independently from each clarifier via a rotating rake mechanism and centrally located sludge sump. The facility currently practices intermittent sludge pumping from each clarifier at relatively high solids concentration (historical average of 5.6 percent total solids) using two positive displacement, rotary lobe pumps. Two additional pumps (positive displacement plunger-type) are used to periodically pump scum, which is conveyed from the surface of each clarifier via a scum skimmer into a scum box. All primary sludge and scum pumps are interconnected for duplicate service and to provide redundancy. All primary sludge is pumped to the primary anaerobic digester for stabilization, while scum is pumped to a grease loading station for rendering.

Table 3.5 summarizes the existing capacity of the primary treatment process. The existing system has sufficient capacity through the 2040 planning horizon and can meet the facility's current design PHF of 31.1 mgd with all units in service based on the CDPHE design criteria of a maximum surface overflow rate (SOR) of 3,000 gallons per day per square foot (gpd/sq ft) at PHF. Assuming a maximum weir loading rate of 40,000 gallons per day per linear foot (gpd/lf) as recommended by CDPHE, the calculated PHF capacity of the primary clarifiers (24.7 mgd) is less than the design and projected PHF. This may require a site-specific deviation as part of a future site application process to align the PHF capacity with the maximum surface overflow rate, barring any limitations identified during hydraulic modeling.

If the primary clarifiers operate similarly into the future, the primary sludge pumps have sufficient hydraulic capacity (0.29 mgd) to meet the projected primary sludge flows through the current ADMMF design capacity of the plant (0.037 mgd presented with solids handling below). Thin sludge pumping was discussed with operations staff as a potential future opportunity for the WWTP to increase secondary treatment capacity. However, thin sludge pumping would require that the plant construct a gravity thickener (or similar) to thicken the primary sludge prior to anaerobic digestion. Upon further consideration by the project team, the group decided not to further evaluate this option because of the capital costs associated with constructing gravity thickeners.

Note that the side water depth of the existing units (8 feet at the clarifier edge) does not meet current CDPHE design recommendation of greater than 10 feet. For reference, CDPHE defines the side water depth as the water depth from the top of the cone in a cone bottom tank to the water surface or the water depth from 2 feet above the bottom of a flat bottom tank with a hydraulic sludge removal mechanism. Regardless, there is no consequence as the Persigo WWTP is grandfathered in since the facility was constructed after the CDPHE design criteria became effective in 2012.

Table 3.5 Primary Treatment Design Criteria

Process/Equipment	Units	CDPHE Design Criteria(1)	Criteria/Capacity
Primary Clarifiers			
Number	-	-	2
Diameter, each	feet	-	115
Surface Area, each	sq ft	-	10,387
Weir Length, each	feet	-	342
Side Water Depth	feet	>10	8 at clarifier edge 12.5 at clarifier center
ADMMF Capacity	mgd	800 to 1,200 gpd/sq ft SOR	24.9(2)
PHF Capacity	mgd	2,000 to 3,000 gpd/sq ft SOR	62.3(2)
	mgd	10,000 gpd/ft to 40,000 gpd/ft (weir loading) at PHF	24.7(3)
Primary Sludge Pumps			
Number	-	-	2
Capacity, each	gpm	-	100
Total Capacity	gpm	-	200
Primary Scum Pumps			
Number	-	-	2
Capacity, each	gpm	-	150
Total Capacity	gpm	-	300

Notes
(1) State of Colorado Design Criteria for Domestic Wastewater Treatment Works (CDPHE, 2012).
(2) Flow capacity calculated based on all primary clarifiers in service and assuming maximum SOR recommended by CDPHE.
(3) Flow capacity calculated based on all primary clarifiers in service and assuming maximum weir loading rate recommended by CDPHE.
sq ft square feet

Generally, the calculated TSS removal at the WWTP has ranged from about 55 percent to as high as 80 percent while BOD_5 removal has varied between approximately 25 percent and 55 percent (Figure 3.6). However, there is a discrepancy between primary sludge reported by the WWTP and calculated primary sludge based on primary influent and effluent water quality data (Figure 3.7). The reported primary sludge data (approximately 7,000 ppd to 13,000 ppd) is typically low as compared to the calculated primary sludge (approximately 8,000 ppd to 19,000 ppd). Based on discussions with operations staff during an onsite workshop on June 29, 2020, both the calculated primary clarifier percent removals and mass balance calculations may be unreliable for the following reasons:

- The primary effluent concentrations may be skewed during different periods of the day when equalized flow is either diverted to the FE basins or is returned back to the mainstream at the raw sewage pump station. Plant staff are concerned that the autosampler may be "double-counting" equalized flows, which would impact the reported daily composite concentration.
- The primary sludge data collected by plant staff is based on a grab sample and not diurnal composite data. While the grab is typically collected at the same time every day, the facility may be sampling during a time which represents lower diurnal loading into the WWTP than the true daily average condition.

- For those reasons, the project team agreed to adjust the primary clarifier percent removals in the calibrated BioWin model to achieve acceptable calibration with historical secondary treatment performance. The percent removals from the calibrated BioWin model would then be carried forward into the capacity evaluation and alternatives analyses.

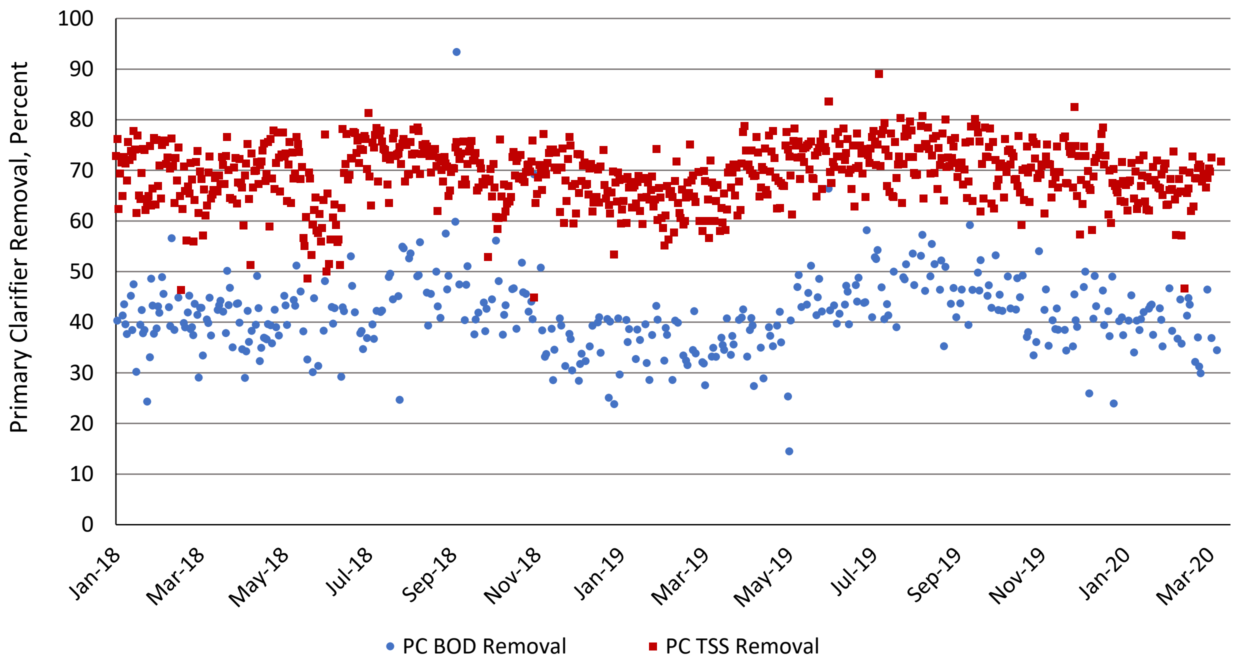

Figure 3.6 Historical BOD_5 and TSS Removal in Primary Clarifiers

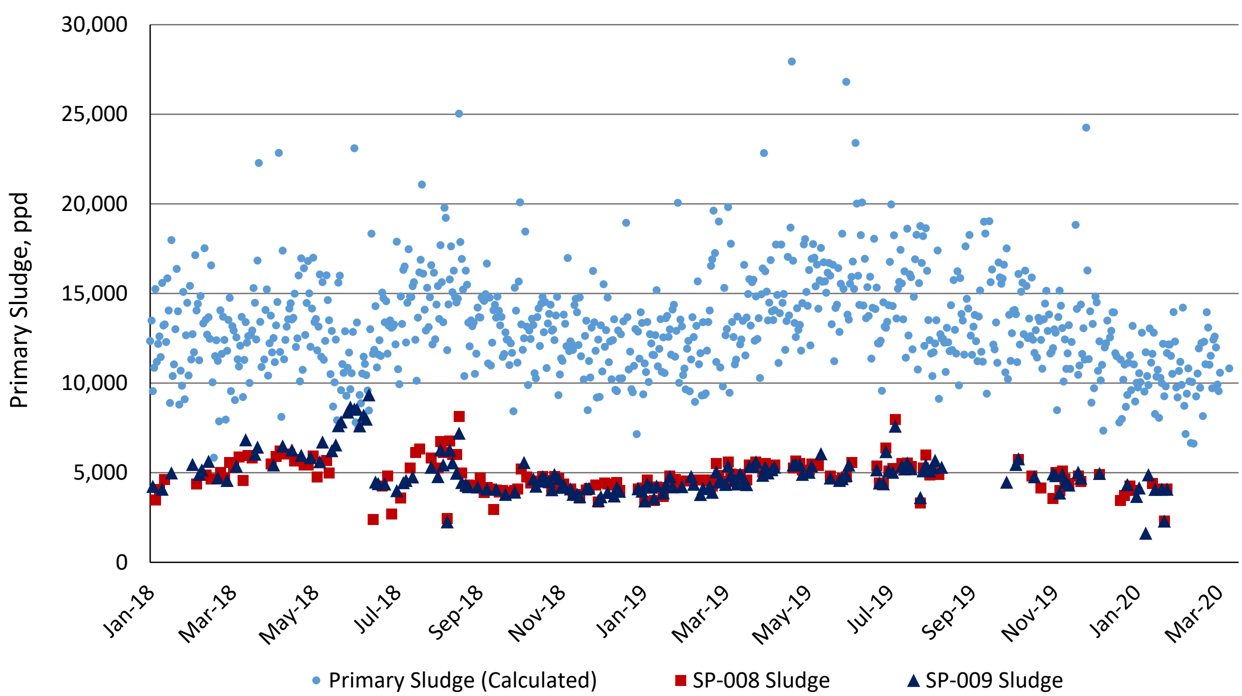

Figure 3.7 Historical BOD_5 and TSS Removal in the Primary Clarifiers

3.4.2.1 Primary Treatment Hydraulic Capacity

Plant staff has indicated that flow has historically overtopped the walls of Control Structure No. 1 above 20 to 30 mgd with two primary clarifiers in service. Based on the hydraulic model, there is just over 18 inches of freeboard upstream of the weirs in this control structure under PHF conditions. It is likely that the overtopping seen by plant staff is due to the turbulent inlet conditions in the narrow (4 feet wide) inlet channel. It is recommended that modifications to this structure be considered to increase the wall height to avoid unintended spills.

The primary clarifier effluent weir becomes submerged at influent flows above approximately 20 mgd. The downward opening weir gates in Control Structure No. 2 have an adjustable elevation but were set at 4,523.0 feet in the model to allow for equalization flow (above ADMMF) to pass over the 42-foot long fixed weir at elevation 4,523.63 feet. One option to alleviate this bottleneck would be to lower both the aeration basin influent and equalization weir. There is some capacity in the equalization system to accommodate lowering the weir elevation since the modeled capacity of the piping between Control Structure No. 2 and the flow equalization basin is higher than required to equalize PHF.

3.4.3 Flow Equalization

The WWTP currently uses 11 million gallons (MG) of repurposed aerated lagoon tankage to equalize primary effluent flow and to attenuate peak diurnal and seasonal wet weather flows upstream of secondary treatment and UV disinfection. The concrete FE basin is divided into three compartments, which are separated by concrete baffle walls and outfitted with drainage valves at the bottom and overflow weirs at the top. The north, middle, and south compartments have an approximate equalization volume of 5.4 MG, 3.7 MG, and 1.9 MG, respectively. The operating depth ranges from a minimum of 4 feet (due to the current surface aerator mixers) to a maximum of about 12 feet. Overflow gates to the aeration basins in Control Structure No. 2 are adjusted by plant staff to control the flow to the aeration basins by diverting excess primary effluent flow via gravity to the FE basins. When the plant influent flow falls below the desired plant flow set point, an automated valve in the yard opens and is modulated to allow flow from the FE basins to return to the raw sewage pump station wet well.

Based on recent Process Design Reports submitted to CDPHE for the UV disinfection system and diffuser outfall into the Colorado River, unit processes downstream of primary clarification are designed for an equalized flow of 12.5 mgd. Because plant staff currently limit influent flow to the WWTP to 20 mgd by backing-up flow into the collection system interceptor, the historical wet weather data likely does not arcuately reflect the true diurnal flow pattern into the plant. Therefore, Carollo could not accurately estimate the FE basin capacity at the 2040 planning horizon. We recommend that the FE basin capacity be re-evaluated once the hydraulic bottlenecks identified herein are corrected and representative wet weather diurnal profile data can be collected for analysis.

3.4.3.1 Equalization System Hydraulic Capacity

The hydraulic model included piping between Control Structure No. 2 and the equalization basin to confirm equalization capacity to maintain ADMMF through secondary treatment and disinfection under PHF conditions. This requires an equalization flow of 16.3 mgd at PHF of 28.8 mgd. Based on the model, it appears that there is sufficient capacity to equalize up to 20 mgd of flow through Control Structure No. 2 and the piping between that structure and the flow equalization basins, assuming a high-water level in the equalization basins of 4,520.0 feet.

3.4.4 Secondary Treatment

The secondary treatment process consists of four aeration basins and three secondary clarifiers. The aeration basins are designed to provide operational flexibility such that the basins can be loaded either as two independent, separate sludge treatment trains or as four plug flow reactors. Only Aeration Basin 3 has an anoxic zone, and therefore the process has been predominantly operated in a two-train configuration to allow for nitrate removal and alkalinity recovery (Figure 3.8). Aeration Basins 3 and 4 (east train) are operated in the Modified Ludzack-Ettinger (MLE) configuration, while Aeration Basins 1 and 2 (west train) are operated as two separate aerobic reactors. All aerobic zones are outfitted with 9-inch Sanitaire fine bubble ceramic diffusers.

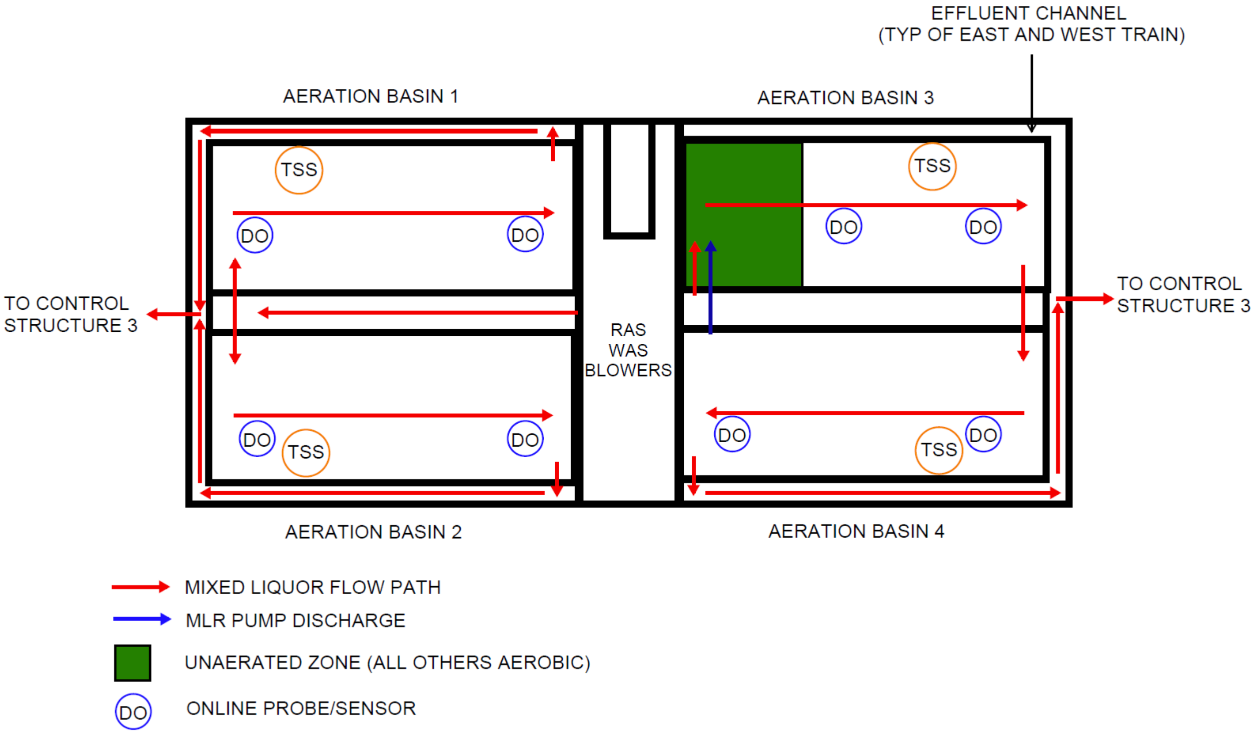

Figure 3.8 Simplified Schematic of Current Aeration Basin Flow Routing

Under typical operating conditions, RAS is mixed with primary effluent in a distribution channel at the head of each treatment train. From there, mixed liquor flows into and through the east and west treatment trains. The first half of Aeration Basin 3 is operated as an anoxic zone for denitrification, while all remaining basin volume is operated as aerobic. Nitrate is returned to the anoxic zone using a submersible wall pump (e.g., MLR pump) located at the end of Aeration Basin 4.

The aeration system is controlled based on dissolved oxygen (DO) setpoints tied to an individual DO probe in each aeration basin. Plant staff noted that DO control is challenging with the existing blower system and is particularly troublesome when the FE basin is out of service and secondary influent flows are not equalized. Carollo staff also observed air flow control valves that are likely oversized and that are located in pipe runs which do not provide lay lengths (both upstream and downstream) that meet industry standards for mechanical flow control. Plant staff indicated that the blower system should be replaced and moved from the lower levels of the aeration basin to a standalone blower building located adjacent to the existing aeration basins. Alternatives for aeration improvements are further discussed as part of the Alternatives Analysis in Chapter 4.

Treated mixed liquor is conveyed to the aeration basin effluent channels, where it is then distributed to two 115-foot diameter secondary clarifiers via Control Structure No. 3 (see Figure 3.9). The City currently only operates two of three secondary clarifiers in order to maintain single sludge operation through the east and west trains. The clarifiers are center-feed, peripheral overflow type with 14-foot side water depths. Secondary effluent flows by gravity to UV disinfection through Manhole No. 4 and Manhole No. EF-1.

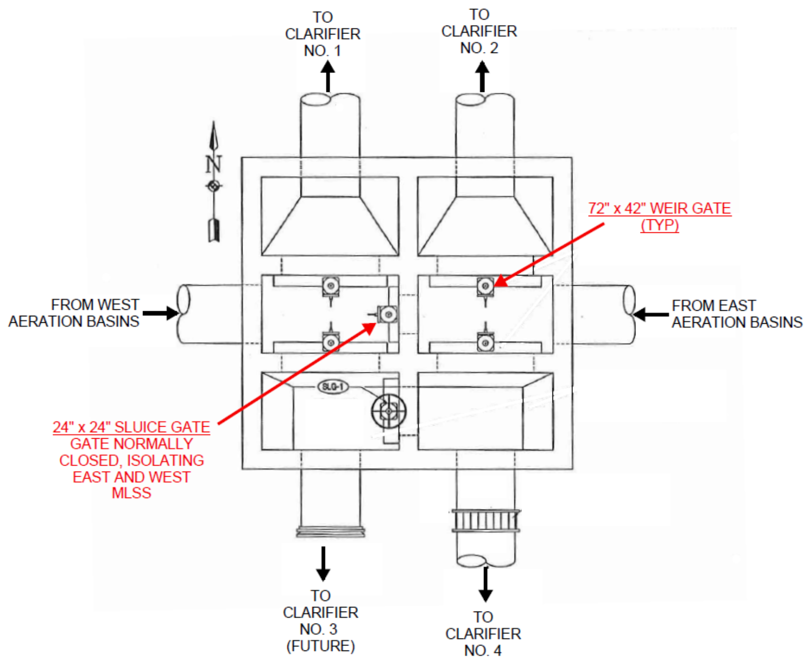

Figure 3.9 Simplified Schematic of Control Structure No. 3

Settled solids are collected independently from each clarifier via draft tube sludge collection headers (Clarifiers 1 and 2) and a Tow-Bro® sludge removal system (Clarifier 4). The sludge collection headers in each clarifier are connected to a center drive mechanism that rotates along the bottom of the clarifiers. RAS is conveyed to the aeration basins via six pumps, each with a capacity of 3.2 mgd. This represents a firm RAS pumping capacity of approximately 127 percent of the plant's 12.5 mgd ADMMF rated capacity (two RAS pumps per train with two out of service), which meets CDPHE guidance criteria. WAS is pumped from the RAS header (three pumps at 400 gpm) to the aerobic digesters for stabilization.

The design criteria for the secondary treatment unit processes and related equipment are summarized in Table 3.6. Modeled aeration basin and secondary clarifier performance is further discussed as part of the BioWin process modeling summary provided in subsequent sections. While the existing blower capacity is summarized herein, recommendations for improving aeration control are provided as part of the Liquid Stream Alternatives Evaluation in Chapter 5.

Table 3.6 Secondary Treatment Design Criteria

Process/Equipment	Units	CDPHE Design Criteria(1)	Criteria/Capacity(2)
Aeration Basins			
Number of Basins	-	-	4
Length, each	feet	-	120
Width, each	feet	-	60
Side Water Depth	feet	-	15
Total Basin Volume	cu ft	-	417,752
	MG	-	3.125
Total Size of Anoxic Zone (Aeration Basin 3)	MG	-	0.20
Total Size of Aerobic Volume	MG	-	2.925

Process/Equipment	Units	CDPHE Design Criteria(1)	Criteria/Capacity(2)
MLR Pumps			
Number of Pumps	-	-	1
Type of Pump		-	Submersible propeller
Capacity, each	mgd	-	18 mgd at 0.9 feet TDH(3)
Flow Capacity as % of Design ADMMF	%	Adequately sized to meet effluent quality objectives	290% of east train flow
Secondary Clarifiers			
Number of Clarifiers	-	Multiple independently operating units	3
Diameter	feet	-	115
Surface Area, each	sq ft	-	10,387
Total Surface Area	sq ft	-	31,161
Weir Length, each	feet	-	600
Side Water Depth	feet	13	14 at clarifier edge 18.7 at clarifier center
RAS Pumps			
Number of Pumps	-	-	6
Type	-	-	Centrifugal
Drive	-	-	Variable speed
Capacity, each	mgd	-	3.2
Total Firm Capacity/ Total Capacity	mgd	-	12.7 / 19.0
Total Firm RAS Flow Capacity as % of ADMMF Design Flow	%	100 to 150% of ADMMF	127
WAS Pumps			
Number of Pumps	-	-	3
Type	-	-	Centrifugal
Drive	-	-	Constant speed
Capacity, each	gpm	-	400
Total Capacity	gpm	-	1,200
Blowers			
Number of Blowers	-	-	3 @300 hp 1 @ 400 hp
Type	-	-	Centrifugal
Capacity, each	scfm	-	3 @ 3,100 scfm @ 10.6 psi discharge pressure 1 @ 4,500(4) scfm
Total Firm Capacity	scfm	Sufficient firm capacity to meet biological treatment needs	9,300
Total Capacity	scfm	-	13,800

Notes:
(1) State of Colorado Design Criteria for Domestic Wastewater Treatment Works (CDPHE, 2012).
(2) Unit process design criteria were obtained from the 1980 Persigo Wash WWTP Basis of Design file unless noted otherwise.
(3) Design information obtained from the 2012 Persigo Wash WWTP Aeration Basin Improvements drawings.
(4) SCFM value for three smaller blowers was calculated from a site specific ICFM value of 4,500 shown on the original Lamson blower curve.
cu ft cubic feet
hp horsepower
scfm standard cubic feet per minute

3.4.4.1 Secondary Treatment Capacity Evaluation Under Current Permit Limits

The analysis of the secondary treatment capacity is detailed in Appendix B along with the process modeling approach, assumptions, and results. Briefly, the following design were selected in coordination with operations staff for the capacity evaluation of the secondary treatment system under current permit limits. The WWTP is not required to fully remove ammonia or to denitrify the effluent.

- Design ADMMF = 12.5 mgd.
- Minimum aerobic solids retention time (aSRT) under winter temperature conditions = 8 days.
- All primary clarifiers in service; average BOD removal = 31 percent, average TSS removal = 50 percent.
- All aeration basins in service, operated in the two-train configuration.
- Two secondary clarifiers in service (for operation in the two-train configuration).
- Wastewater temperature = 15.7°C (60.3°F).
- Maximum mixed liquor suspended solids (MLSS) concentration = 3,500 mg/L based on verbal discussions with plant staff.
- Design sludge volume index (SVI) under ADMM conditions = 150 milliliters per gram (mL/g)

Results from the current capacity evaluation using the calibrated BioWin model are presented in Table 3.7.

Table 3.7 BioWin Model Output of Current Secondary Treatment Capacity at 8-day aSRT

Parameter	Unit	CDPHE Guidance Criteria(1)	Simulated ADMMF Condition in BioWin
Influent			
ADMMF	mgd	12.5 mgd (Permitted Capacity)	12.5
BOD_5	ppd	26,480 (Permitted Capacity)	27,653
TSS	ppd	-	26,188
TKN	ppd	-	4,944
Ammonia	ppd	-	3,263
Temperature	°C	-	15.7
Primary Clarifiers			
SOR	gpm/sq ft	800-1,200	667
TSS Removal	%	-	50
BOD_5 Removal	%	-	31
Aeration Basin Operation			
BOD_5 Loading	ppd/1,000 cu ft	5-20 (nitrification) 20-40	46
Food to Microorganism (F:M) Ratio	lbs BOD_5/d/lb MLVSS	0.1-0.25	0.26
TKN Loading	lbs TKN/d/lb MLVSS	0.02-0.15	0.063
Anoxic	hours	0.5-1.0	0.74(3)
Aerobic	hours	4-8	5.2 to 5.9(4)

Parameter	Unit	CDPHE Guidance Criteria(1)	Simulated ADMMF Condition in BioWin
aSRT	days	8-20	7.0 (East) 7.9 (West)
East Train MLSS	mg/L	2,000-3,500	3,512
East Train MLVSS			2,849
West Train MLSS	mg/L	2,000-3,500	3,521
West Train MLVSS	mg/L	2,000-3,500	2,859
Secondary Clarifier Operation(2)			
Solids Loading Rate (SLR)	ppd/sq ft	29	24.7
SOR	gpd/sq ft	600	600
RAS Recycle	%	50-150	60
Effluent Quality			
BOD_5	mg/L	-	4.2
TSS	mg/L	-	9.2
Ammonia	mg/L	-	0.1
Nitrate	mg/L	-	18.4

Notes
(1) State of Colorado Design Criteria for Domestic Wastewater Treatment Works (CDPHE, 2012).
(2) SOR and SLR are presented for the ADMMF condition only.
(3) Assumes a forward flow of approximately 6.3 mgd through the east treatment train.
(4) Aerobic hydraulic retention time (HRT) varies between the east and west treatment trains given the anoxic volume in the east train.
gpm/sq ft gallons per minute per square foot
lbs BOD_5/d/lb MLVSS pounds of 5-day biochemical oxygen demand per day per pound of mixed liquor volatile suspended solids
lbs TKN/d/lb MLVSS pounds of total Kjeldahl nitrogen per day per pound of mixed liquor volatile suspended solids
ppd/sq ft pounds per day per square foot

Under the current permitted ADMMF flow and organic load, steady state process modeling suggests that the WWTP has sufficient treatment capacity as currently permitted and complies with most design criteria recommended by CDPHE. The modeled BOD_5 loading to the aeration basins and the F:M ratio are above the CDPHE design recommendations for single-stage nitrification and exceed design values observed at other Colorado facilities. While CDPHE accepts site-specific variations for design criteria in cases where a utility can demonstrate reliable operation at these conditions, significant exceedances above the recommended criteria does indicate a capacity limitation. A state point analysis (SPA) conducted on the secondary clarifiers indicates adequate safety factor when the plant operates at equalized PHF conditions of 12.5 mgd as documented in several recent design studies (e.g., UV disinfection, effluent diffuser outfall) (Figure 3.10).

Additional clarification safety factor can be achieved (Figure 3.11) if the facility were to open center gate in Control Structure No. 3 to operate the aeration basins as a combined sludge system with three secondary clarifiers in service. This is particularly beneficial if the WWTP experiences an extended period of poor sludge settleability with SVI values exceeding 150 mL/g.

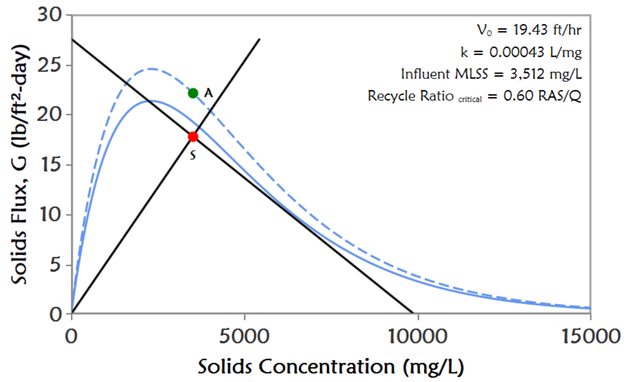

Figure 3.10 SPA with Two Clarifiers Online at 12.5 mgd Flow through Secondary Treatment

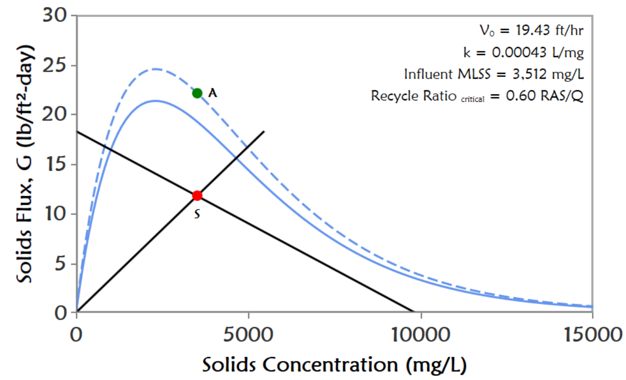

Figure 3.11 SPA with Three Clarifiers Online at 12.5 mgd Flow through Secondary Treatment

A detailed analysis of operational strategies and recommendations for increasing the permitted treatment capacity to meet or exceed the projected flow and load projections in 2040 are provided as part of the Liquid Stream Alternatives Evaluation in Chapter 4. That effort includes sensitivity analyses which investigate the impact of increasing or decreasing the safety factor applied to key criteria such as design wastewater temperature, aSRT, maximum MLSS concentration, and SVI. Special attention should be paid to the aeration basin BOD_5 and F:M ratio as the calculated values at current permitted capacity already exceed CDPHE design recommendations for single-stage nitrification.

3.4.4.2 Secondary Treatment Hydraulic Capacity

As noted, the secondary treatment process was modeled at ADMMF assuming that all flow above 12.5 mgd (and above 13.5 mgd for the 2040 condition) would be equalized. The aeration basins and secondary clarifiers were modeled as east and west trains, assuming that all flow from the east aeration basin is routed to a single clarifier, and all flow from the west aeration basin (which is operated as two parallel basins) is routed to a single clarifier. As such, the 2-foot square opening in Control Structure No. 3 (which would allow flow from the east and west trains to be combined) is normally closed and has not been used by plant staff in the past. If plant staff were interested in operating a combined sludge process, the 2-foot square opening in Control Structure No. 3 would be a hydraulic bottleneck and would need to be enlarged.

The ability to equalize flows above ADMMF is critical to passing flow through the secondary treatment process. If the equalization basins were off-line, the model indicates that the secondary clarifier weirs become submerged at an unequalized influent flow of approximately 20 mgd. However, the weir submergence predicted by the model may be due to an over prediction of headloss through the Parshall flume located upstream of the ultraviolet (UV) lamps.

To confirm actual field conditions upstream of the UV Parshall flume, plant staff performed a field test. They measured upstream and downstream water surface elevations at flows of 12.0 through 14.5 mgd. The results of this hydraulic test are shown in Table 3.8.

Table 3.8 Hydraulic Test of UV Parshall Flume

Flow Rate (mgd)	WSE Upstream of UV Parshall Flume (feet)	Headloss Across Flume (inches)
12.0	4,516.8	9.5
12.5	4,516.9	7.8
13.2	4,516.9	7.4
14.5	4,516.9	5.6

This field test confirms that the UV Parshall flume becomes increasingly submerged at higher flow rates. The reduction in headloss across the flume with increasing flows is due to the increasing submergence of the flume, i.e., a higher downstream water surface elevation. The field test also shows that the water surface elevation upstream of the flume does not increase significantly with increasing flow, meaning that the modeled secondary weir submergence at 20 mgd may not truly occur.

Based on this field test, it appears that flows of at least 14.5 mgd can be routed through the secondary treatment process without submerging weirs or resulting in freeboard violations. While the field test and modeling results confirmed that the secondary treatment system has the hydraulic capacity for flows up to 14.5 mgd, maintenance and operation of the equalization basin and associated infrastructure is critical to keep this system in service at all times.

3.4.5 Disinfection

Secondary effluent enters the north side of the UV disinfection structure from Manhole No. EF-1 and is measured through a single Parshall flume. The flume has a throat width of 3 feet and a reported flow metering capacity of up to 32.6 mgd (Persigo Wash WWTP Capacity Analysis, Carollo, 1999). Flow then passes through the east side of the decommissioned chlorine contact basin in a serpentine pattern before entering the single UV disinfection channel.

The existing Trojan UV3000Plus system (designed 2010) is comprised of three UV banks oriented in series (see Figure 3.12), each having seven UV modules containing lamps, quartz sleeves, and electronic ballasts. This configuration allows for two banks to be in service with one bank in standby. In total, the disinfection system includes 21 UV modules, each containing eight lamps for a total of 168 lamps. One system control center monitors and controls the UV system and is integrated into the WWTP SCADA system to allow remote monitoring of system functions and performance. The UV system was designed to meet disinfection requirements up to 12.5 mgd and to be expanded to a peak flow of 17 mgd by removing a two-module reduction baffle and adding two additional UV modules per bank. Based on conversations with City staff, the two-modules have already been added in the banks and there are no opportunities to add additional modules.

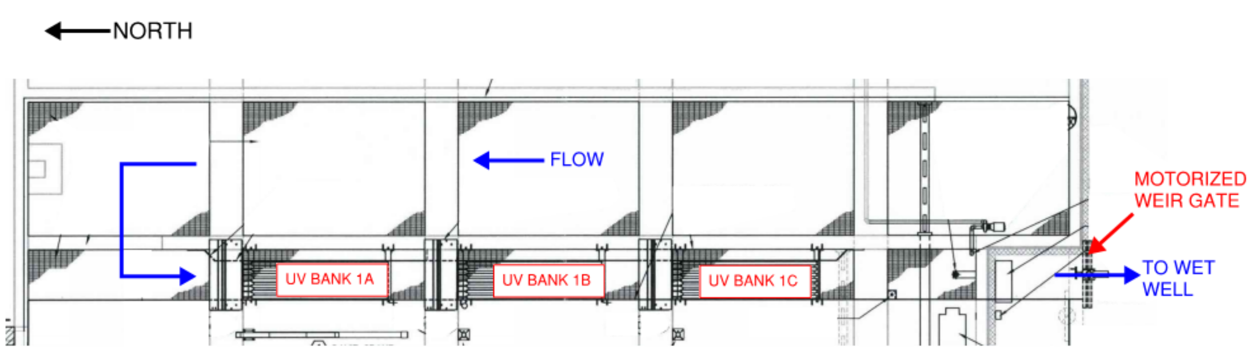

Figure 3.12 Simplified Schematic of the UV Disinfection System (Plan View)

A weir gate level controller is installed at the downstream end of the UV channel to control the water level across the UV modules independent of flow rate. A downward opening gate is automatically actuated based on a signal from an ultrasonic level sensor located downstream of the UV banks and upstream of the weir gate. Based on input from operations staff, the level in the UV channel is typically set between 30 and 33 inches. The design elevation per the submittal documents is 32 inches.

The original system design criteria are summarized in Table 3.9. The UV disinfection system was designed for a capacity of 12.5 mgd per the manufacturer's design submittal and assumes flow equalization occurs upstream of secondary treatment.

Table 3.9 Original UV Disinfection System Design Criteria and Capacity Rating

Process/Equipment	Units	CDPHE Design Criteria(1)	Criteria/Capacity
Number of Channels	-	-	1
Number of Banks per Channel	-	At least 2 banks in series per reactor channel	3
Design Capacity, total			
ADMMF	mgd	System shall be capable of disinfecting its proportionate share of the design maximum month flow with 1 bank out of service	12.5
PHF	mgd	Designed to treat PHF	12.5
Minimum UV Transmittance (UVT)	% per cm	65	55-65
Design Dose	mJ/cm2	30	30.74 at 65% UVT 19.76 at 55% UVT

Notes:
(1) State of Colorado Design Criteria for Domestic Wastewater Treatment Works (CDPHE, 2012).
cm centimeter
mJ/cm^2 millijoules per square centimeter

Based on the revised dose equations for the installed system updated dose levels for the conditions listed in Table 3.9 are 29.5 mJ/cm^2 at 65 percent UVT and 18.8 mJ/cm^2 at 55 percent. This revision decreases the installed dose by 4 and 5 percent, respectively.

The daily UVT data from September 2018 to August 2020 (April 2020 data was missing) was analyzed for this evaluation. According to the CDPHE design criteria, the design UVT shall be the lower 90th percentile value of site-specific data. The lower 90th percentile for the Persigo system is 52.0 percent and the average UVT is 59.5 percent. The historical daily UVT data was highly variable and should be closely scrutinized by operations staff moving forward to help identify the source(s) of variability. While the UVT can be impacted by secondary treatment performance and industrial discharges in the collection system, it is also important to periodically verify that the currently installed equipment is accurately recording plant conditions. The City should consider purchasing a portable UVT meter to confirm the plant readings on a weekly basis.

Using the above revised/current dose equation, the existing UV system with seven UV modules per bank has a flow capacity of 11.4 mgd to achieve a UV dose of 17.2 mJ/cm^2 specified in Stantec's Process Design Report at 52 percent UVT. If the UV system is expanded by adding two additional UV modules per bank, nine UV modules per bank total (as is currently installed per discussions with operations staff), then the flow capacity increases to 14.6 mgd to achieve the same dose at 52 percent UVT. Table 3.10 provides a summary of the updated capacity rating.

Table 3.10 UV Disinfection System Design Criteria and Capacity Rating

Process/Equipment	Units	CDPHE Design Criteria(1)	Criteria/Capacity
Number of Channels	-	-	1
Number of Banks per Channel	-	At least 2 banks in series per reactor channel	3
Design Capacity, total			
ADMMF	mgd	System shall be capable of disinfecting its proportionate share of the design maximum month flow with 1 bank out of service	14.6(2)
PHF	mgd	Designed to treat PHF	14.6(2)
Minimum UVT	% per cm	65	52
Design Dose	mJ/cm^2	30	31.46 at 65% UVT 17.2 at 52% UVT

Notes:
(1) State of Colorado Design Criteria for Domestic Wastewater Treatment Works (CDPHE, 2012)
(2) The Trojan UV3000Plus was re-validated in April 2014 based on the National Water Research Institute (NWRI) Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse (Third Edition, 2012) and the UV system's capacity is greatly reduced using the latest validation. The UV system's capacity will only be 11.7 mgd with nine modules per bank using the latest validation.

To increase the capacity of the installed UV system the plant must make efforts to improve the current design UVT. Improving the design UVT above 55 percent increases the UV system's capacity to 13.5 mgd. A UVT study at the plant could help identify the cause of the lower UVT.

The installed UV system can also be expanded to increase the capacity but that may complicate matters. Typically, when a UV system is expanded, CDPHE may require that the latest validation report be applied to the design. The Trojan UV3000Plus was re-validated in April 2014 based on the NWRI *Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse* (Third Edition, 2012) and the UV system's capacity is greatly reduced using the latest validation. The UV system's capacity will only be 11.7 mgd using the latest validation. Therefore, it is recommended that the plant try to improve the current design UVT, until then, the plant's equalization system must be able to trim the design PHF from 28.8 mgd to 11.4 mgd.

3.4.5.1 Ultraviolet Disinfection and River Outfall Hydraulic Capacity

Based on the hydraulic model, the Parshall flume upstream of the UV lamps is submerged under all flow conditions, which could impact the accuracy of the flow measurement. There are no other modeled hydraulic limitations in the UV disinfection system at ADMMF and equalized PHF under normal river WSE. The motorized downward opening weir gate immediately downstream of the UV lamps is submerged under all flow conditions but can modulate to achieve the target water surface elevation of 4,515.75 feet at the UV lamps (which represents 33-inch depth in the UV channel). The design water level for the Trojan UV300+ is 32 inches.

The hydraulic profile in the UV system is not impacted by the river outfall being at the 100-year flood elevation, as there is a free discharge over the plant water wet well (downstream of UV) weirs.

Parshall flume.

3.4.6 Summary of Liquid Stream Capacity Evaluation

As noted in Chapter 2, the ADMMF in the year 2040 (13.5 mgd) exceeds the facility's current permitted treatment capacity of 12.5 mgd. Therefore, while most unit processes are adequately sized to meet current permitted capacity (Figure 3.13), the facility will need to either expand or demonstrate that a higher capacity can be achieved. This demonstration would involve operating the facility outside of the historical boundary conditions so that a capacity re-rating with CDPHE can be justified.

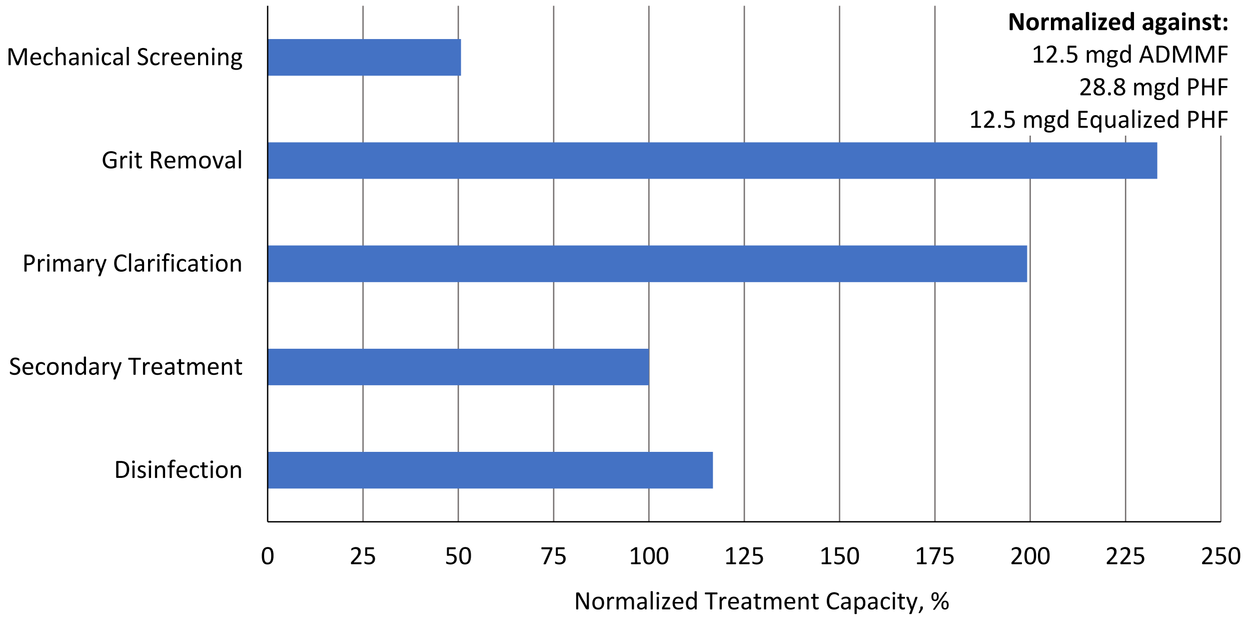

Figure 3.13 Simplified Summary of Current Liquid Stream Treatment Capacities

Steady state process modeling, coupled with a desktop review of existing hydraulic design capacities, revealed the following conclusions for consideration in this 2020 Master Plan (also shown in Figure 3.14):

- Hydraulic bottlenecks identified in the hydraulic model should be more closely investigated and corrected to eliminate the current practice of allowing raw influent to temporarily backup in the collection system upstream of the plant.
- The existing bar screens do not meet CDPHE criteria for PHF with one unit out of service. An additional mechanical bar screen should be added in the third channel and the existing equipment should be re-rated for additional capacity through Huber.
- The primary clarifiers do not meet CDPHE's maximum weir loading rate requirement 40,000 gallons per day per foot (gpd/ft) at current or future conditions. The City may request a site-specific deviation as part of a future site application process to align the PHF capacity with the maximum surface overflow rate, barring any limitations identified during hydraulic modeling.
- The City should begin improved data collection on primary effluent TSS and BOD_5 removals to increase data accuracy for a future capacity re-rating of the WWTP.

- The modeled BOD_5 loading to the aeration basins and the F:M ratio are above the CDPHE design recommendations for single-stage nitrification and exceed design values observed at other Colorado facilities. While this exceedance can indicate a capacity limitation, it is noteworthy that the facility does not need to fully nitrify based on the current effluent discharge permit, and therefore the capacity limitation as it relates to a single-stage nitrification system does not necessary apply.
- Plant staff have indicated that the existing blower system is challenging to control and does not maintain stable DO concentrations in the aeration basin.
- Using the latest UV validation for the installed system (NWRI *Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse* (Third Edition, 2012)) the system's capacity is reduced to only 11.7 mgd. Therefore, it is recommended that the plant try to improve the current design UVT, but until then, the plant's equalization system must be able to trim the current design PHF from 28.8 mgd down to 11.4 mgd.

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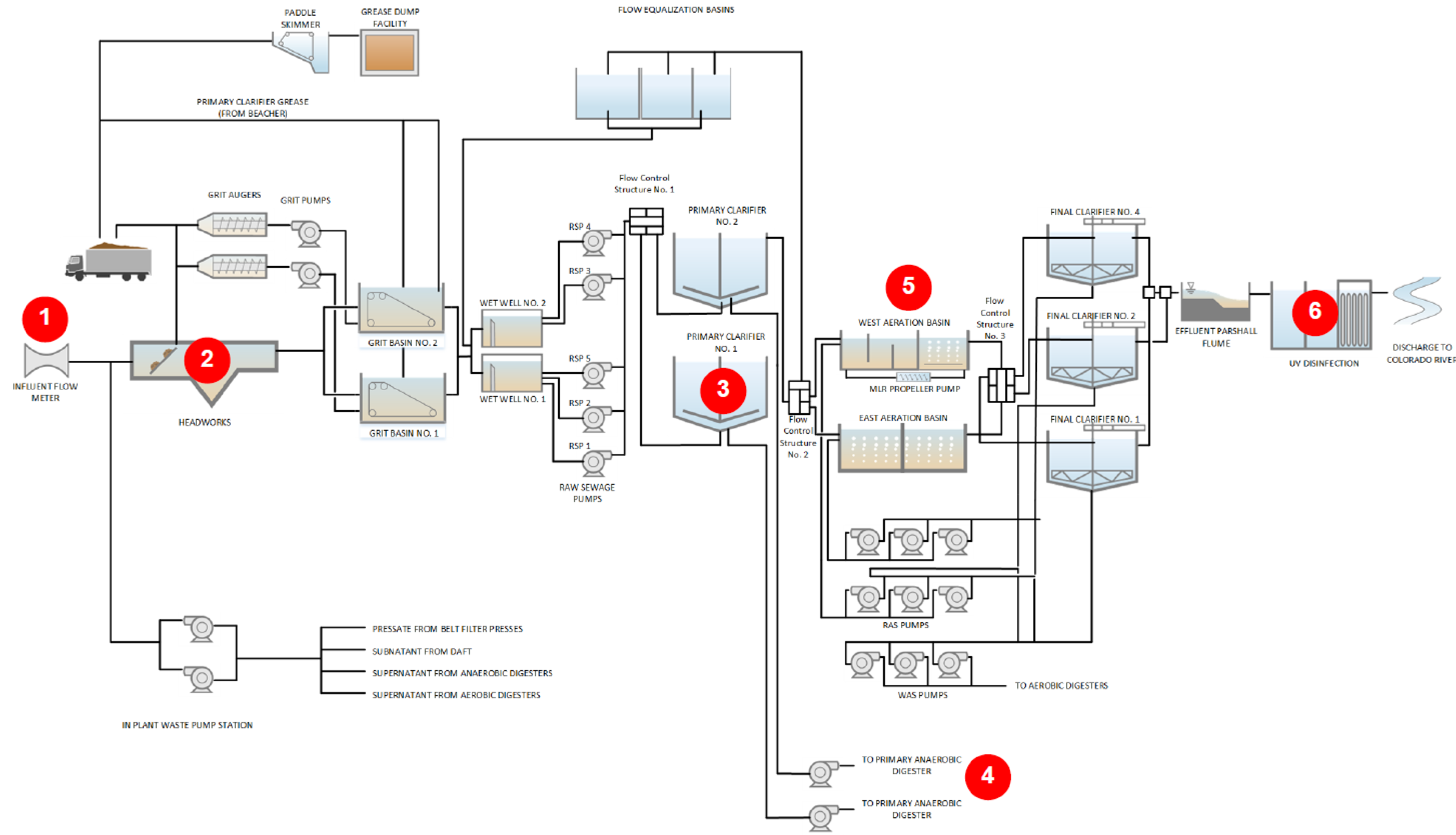

1. CORRECT HYDRAULIC BOTTLENECKS TO ELIMINATE CURRENT PRACTICE OF BACKING UP RAW INFLUENT INTO THE COLLECTION SYSTEM INTERCEPTOR

2. EXISTING BAR SCREENS DO NOT MEET CDPHE CRITERIA FOR FIRM PHF CAPACITY AT CURRENT OR FUTURE CONDITIONS. INSTALLATION OF AN ADDITIONAL MECHANICAL BAR SCREEN IS REQUIRED AND THE EXISTING EQUIPMENT SHOULD BE RE-RATED FOR ADDITIONAL CAPACITY.

3. EXISTING PRIMARY CLARIFIERS DO NOT MEET CDPHE CRITERIA FOR MAXIMUM WEIR LOADING RATE AT CURRENT OR FUTURE CONDITIONS. THE CITY MAY REQUEST A SITE-SPECIFIC DESIGN VARIANCE.

4. BEGIN IMPROVED DATA COLLECTION ON PRIMARY CLARIFIER TSS AND BOD CAPTURE TO INCREASE ACCURACY FOR A FUTURE SECONDARY TREATMENT CAPACITY RE-RATING.

5. MODELED F:M RATIO IS ABOVE CDPHE DESIGN RECOMMENDATIONS AND SHOULD BE MONITORED DURING PROCESS OPTIMIZATION FOR A FUTURE SECONDARY TREATMENT CAPACITY RE-RATING. EXISTING BLOWER SYSTEM CONTROLS ARE ALSO CHALLENGING UNDER CURRENT FLOWS AND LOADS.

6. EXISTING UV SYSTEM CAPACITY IS REDUCTED TO ONLY 11.7 MGD USING THE LATEST UV VALIDATION CRITERIA. PLANT SHOULD TRY TO IMPROVE CURRENT UVT AND MAXIMIZE FE BASIN OPERATIONAL CAPACITY.

Figure 3.14 Simplified Summary of Liquid Stream Treatment Considerations

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3.5 Solids Stream Treatment Capacity

Anticipated solids production (e.g., primary sludge and WAS) generated under future flows and loads were evaluated and are summarized in Table 3.11. The assessment assumed that primary and secondary clarifier performance remain relatively unchanged in the future, and that recycle streams are returned to the liquid process without additional sidestream treatment.

Table 3.11 Current and Projected Solids Production

Parameter	Unit	Current ADAF	Current ADMMF	2040 ADAF Condition	2040 ADMMF Condition	13.5 mgd ADMMF
Primary Solids Production(1)						
Flow	mgd	0.022	0.030	0.028	0.037	0.040
TS	ppd	9,800	13,900	12,700	17,300	18,700
VS	ppd	8,000	10,200	10,200	12,700	13,700
WAS Production(2)						
Flow	mgd	0.143	0.185	0.189	0.231	0.249
TS	ppd	7,800	9,600	11,200	11,900	12,900
VS	ppd	6,400	7,900	9,200	9,800	10,600
Thickened Aerobic Digester Sludge						
Flow	mgd	0.158	0.188	0.197	0.234	0.253
TS	ppd	8,300	10,200	10,300	12,700	13,700
VS	ppd	6,800	8,700	8,500	10,800	10,800
Belt Filter Press Feed						
Flow	mgd	0.055	0.078	0.069	0.098	0.106
TS	ppd	9,600	12,500	11,900	15,500	16,800
VS	ppd	6,800	8,700	8,500	10,800	11,700

Notes:
(1) Primary sludge total solids concentration has averaged approximately 5.6 percent since 2018.
(2) WAS total solids concentration has ranged between approximately 6,000 mg/L and 8,000 mg/L since 2018.
TS total solids
VS volatile solids

3.5.1 Anaerobic Digesters

The WWTP digests primary sludge in a two-stage anaerobic digester system. Primary sludge is first pumped from the primary clarifiers to a primary anaerobic digester for solids stabilization. Mixing is accomplished using a linear motion oscillating mixer and heating by external heat exchangers and dual fired (biogas/natural gas) boilers. The boilers currently operate on natural gas so that the biogas can preferentially be used for the production of renewable natural gas (RNG). Following primary anaerobic digestion, the biosolids are discharged to a secondary digester for storage and low-rate stabilization (i.e., mixed but not heated). The secondary digester is periodically decanted to minimize the volume of solids that require dewatering. Supernatant from the secondary digester can be returned to the front of the plant or pumped to the aerobic digesters to minimize the organic load returned to the head of the wastewater treatment plant. Anaerobically digested biosolids are pumped from the secondary digester to the sludge blending tank, where they are mixed with aerobically digested WAS.

The facility is projected to have sufficient anaerobic digestion capacity for primary sludge through the 12.5 mgd ADMMF rated capacity assuming both the primary and secondary digesters are online and with no redundancy (Figure 3.15). At the current rated treatment capacity of the plant, the projected HRT is approximately 15 days. This meets the CDPHE design guidance for anaerobic digestion processes, which is also 15 days. The VS loading rate at those same conditions is 0.16 ppd/cu ft. The WEF MOP 8 recommends a design sustained peak loading rate of 0.12 to 0.16 pounds of volatile solids per cubic foot per day (lbs VS/cfd) with an upper limit for short-term operation of 0.20 lbs VS/cfd. CDPHE design guidance recommends maintaining a loading rate below 0.2 ppd/cu ft. Operating at the lower- to mid-VS loading rate loading range under normal conditions is recommended to maintain stable anaerobic digester operation. While the existing infrastructure is sufficient for the WWTP's current rated capacity, it may make sense to construct a new digester tank in the future to allow for one unit out of service when the facility is operating closer to its design capacity. Additional tankage would also be required if the City chose to anaerobically digest both primary and secondary solids in the future.

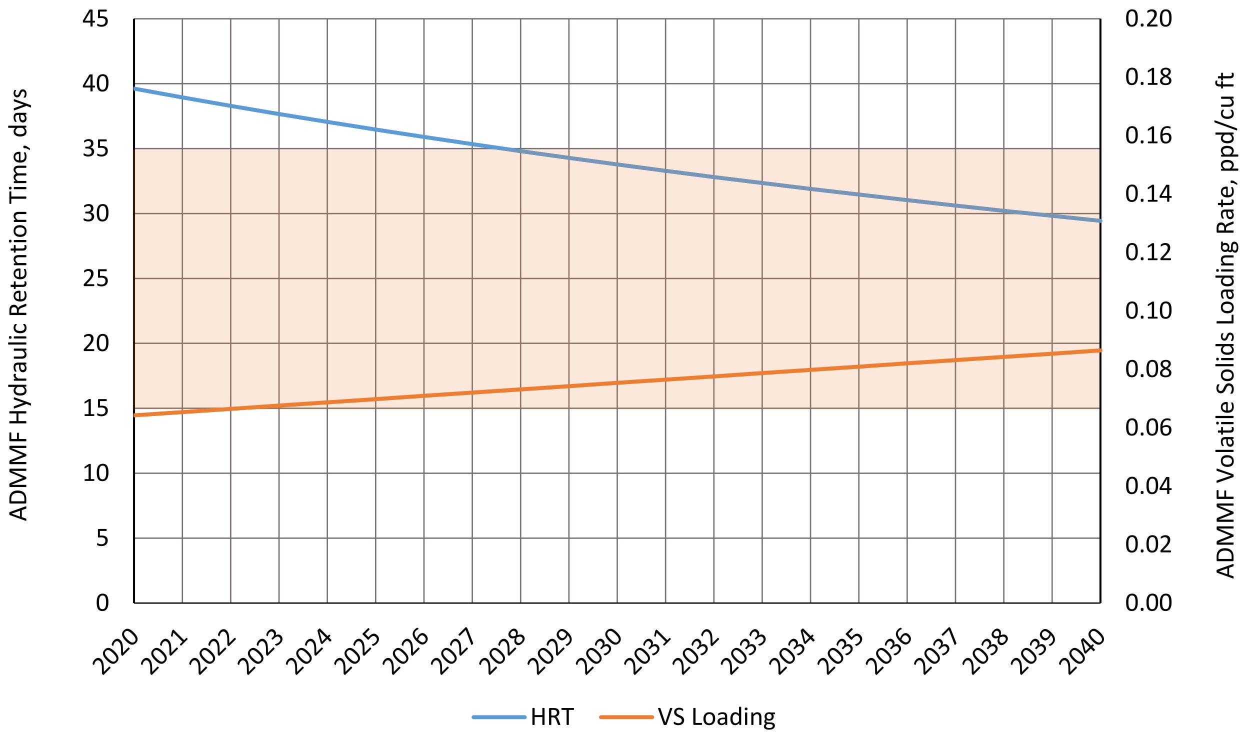

Figure 3.15 Projected HRT and VS Loading Rate for Two Anaerobic Digesters

3.5.2 Aerobic Digesters

WAS is pumped from the final clarifiers to the aerobic digesters. The four aerobic digester tanks are operated in series and were originally designed to provide an average SRT of approximately 15 days. The dilute WAS is periodically decanted to minimize the volume of solids that require final dewatering and to thicken the sludge in the digesters. The aerobically digested WAS is then pumped to the dissolved air floatation system for additional thickening, followed by blending with anaerobically digested primary sludge in the sludge blending tank.

As currently operated, the existing aerobic digesters do not meet CDPHE's recommended design criteria for aerobic solids stabilization (Figure 3.16). At the current rated treatment capacity of the plant (and not taking into account decanting), the projected HRT is approximately 7 days. This does not meet the CDPHE design guidance for aerobic digestion processes, which is 40 days at 20°C operating temperature. The VS loading rate at those same conditions is 0.042 ppd/cu ft, which is below the CDPHE design guidance range of 0.1 ppd/cu ft to 0.3 ppd/cu ft.

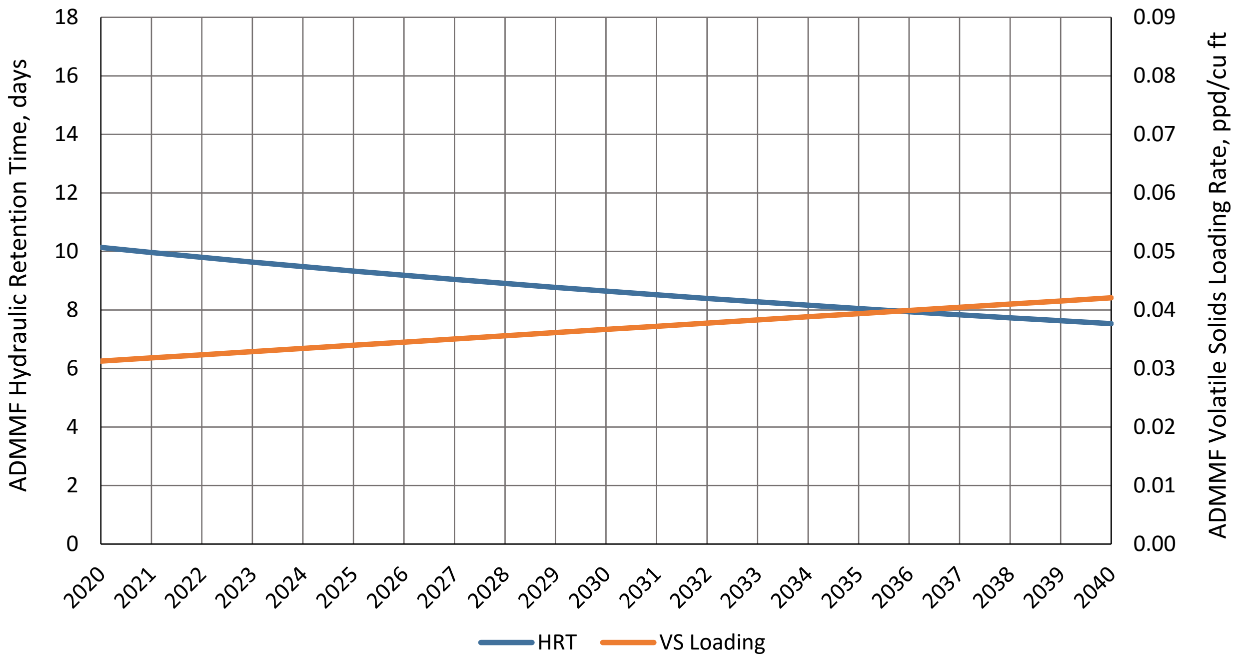

Figure 3.16 Projected HRT and VS Loading Rate of Four Aerobic Digesters

3.5.3 Dissolved Air Flotation Thickening

Dissolved air flotation thickening (DAFT) was installed at the WWTP to improve solids/water separation and to enhance the seasonal aerobic digestion of WAS. The DAFT system is supplied by World Water Works and is a proprietary system using cross-flow design and lamella plate to enhance solids removal. In addition, the DAFT uses a pump to entrain air as fine bubbles in recirculated flow from the unit. The packaged DAFT unit is installed within the existing sludge processing building and can be operated in one of the following two ways:

- Digested sludge is removed from the aerobic digesters for thickening and is returned back to the digesters to increase the SRT.
- Digested sludge is removed for the aerobic digesters for thickening and is then conveyed to the sludge blending tank before belt press dewatering.

The DAFT is designed as a high-rate system with a capacity to process 500 gpm of WAS at 7,000 mg/L TSS concentration and projected subnatant TSS concentration of less than 700 mg/L. The design thickened WAS concentration achievable with the DAFT is 5 percent (50,000 mg/L). Therefore, this thickening system has sufficient capacity to thicken WAS in the aerobic digesters through the 2040 planning horizon and 12.5 mgd ADMMF design capacity of the plant as the projected WAS flow is less than 175 gpm (252,000 gpm ADMMF).

3.5.4 Dewatering

Aerobic and anaerobic sludge is combined in a sludge blending tank, which uses a 50-hp motor to drive a vertical shaft mixer. The blend tank mixes and stores solids prior to polymer conditioning and dewatering using four belt filter presses. The belt presses are currently operated for approximately 4 hours per day at

90 gpm feed flow rate per unit with four units in service (design capacity range of approximately 120 to 160 gpm per the manufacturer's historical literature). During the late summer months, the belt press operation increases the feed flow rate per unit to between 100 and 110 gpm. At the 2040 projected belt filter press flow, four belt filter presses would need to operate for approximately 8 hours per day and 5 days per week assuming 130 gpm feed flow rate per unit.

3.6 Biogas Treatment and Storage Capacity

The WWTP produces and average of 90,330 cubic feet per day (cfd) of biogas, based on data from 2018 through 2020, in its two anaerobic digesters. Assuming influent solids concentrations remain relatively stable, the WWTP is projected to produce 117,000 cfd at design ADAF and the 2040 projected condition.

In 2014, the City installed a biogas conditioning system to clean and compress the biogas produced on-site. The biogas conditioning system consists of hydrogen sulfide removal, moisture removal, compression, siloxane and volatile organic compound removal, and separation of carbon dioxide via membranes. The resulting RNG is delivered via a 6-mile pipeline to a CNG fueling station for the City's fleet vehicles. The biogas conditioning system is designed to clean and compress up to 144,000 cfd (100 cubic feet per minute) of biogas. The City has minimal low-pressure storage on-site (via a gasholder floating cover) and approximately 1 day of storage off-site in the 6-mile pipeline between the WWTP and the CNG fueling station. Even with this available storage, due to diurnal fluctuations in biogas production and fluctuations in CNG demand, the City has reported that approximately 20 percent of the biogas produced on-site is flared while the biogas conditioning system is operating below its design capacity. Additional storage is recommended to allow the City to convert all biogas produced on-site to CNG.

3.7 Grease Handling System

Anticipated grease loads collected from the City's service area under future flows and loads were evaluated and are summarized in Table 3.12. The assessment assumed that grease system loading, and general performance remain relatively unchanged in the future.

Table 3.12 Current and Projected Solids Production

Parameter	Unit	Current ADAF	Current ADMMF	2040 ADAF Condition	2040 ADMMF Condition	13.5 mgd ADMMF
Grease Handling System						
Flow	gpd	4,500	10,100	5,700	12,600	13,600
TS	ppd	600	1,400	760	1,700	1,800
VS	ppd	510	1,200	640	1,400	1,600

3.7.1 Summary of Solid Stream Capacity Evaluation

The solids handling facilities, including anaerobic digestion, DAFT, and dewatering, are sized to meet the current ADMMF permitted treatment capacity of 12.5 mgd. Figure 3.17 presents a simplified summary of the currently installed solid stream treatment capacity normalized against the current ADMMF capacity of the facility (12.5 mgd). It is important to note that the capacities summarized in the graphic assume solids dewatering conducted 5 days per week at 8 hours per day, anaerobic digestion of primary sludge only and without redundancy, and aerobic digestion without WAS thickening. If WAS thickening is included with aerobic digestion, the aerobic digesters are sized to meet the current ADMMF permitted treatment capacity of 12.5 mgd without redundancy or storage.

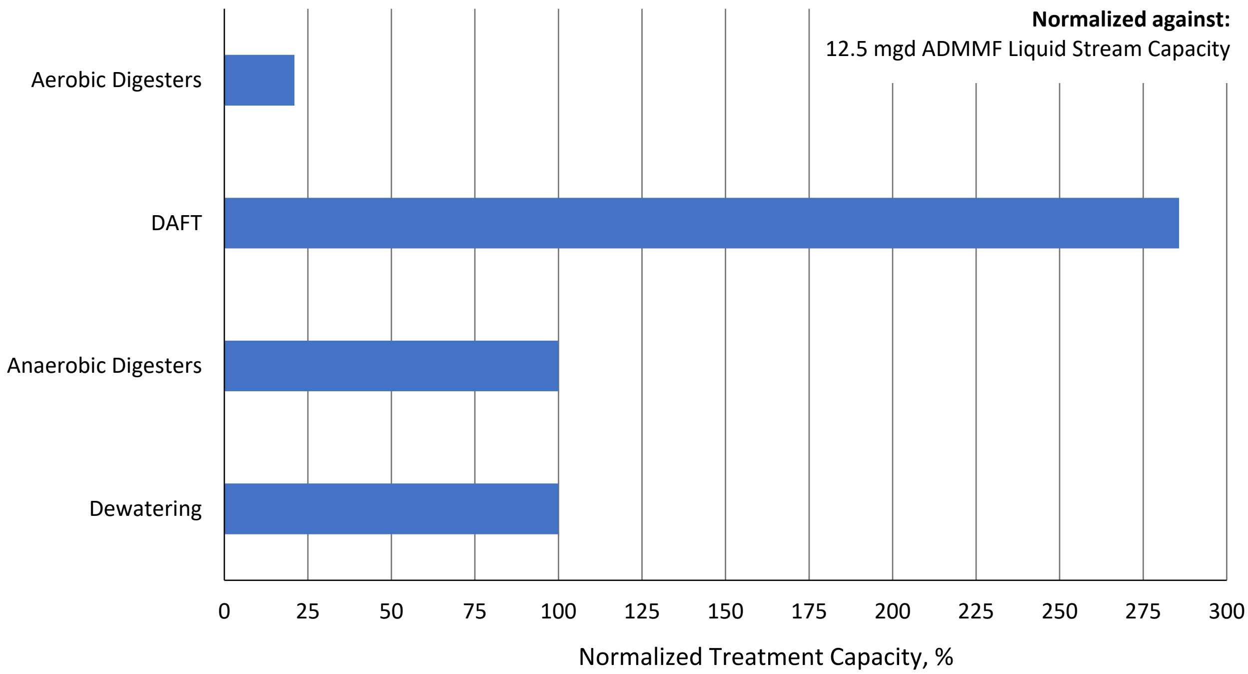

Figure 3.17 Simplified Summary of Current Solid Stream Treatment Capacities

The following items are noted for consideration as part of the alternative evaluation and apply to both the ADMMF permitted treatment capacity of 12.5 mgd and to an ADMMF of 13.5 mgd (also see Figure 3.18):

- While the existing digestion infrastructure is sufficient for the WWTP's current rated capacity, it may make sense to construct a new anaerobic and a new aerobic digester in the future to allow for one unit out of service when the facility is operating closer to its design capacity.
- Additional anaerobic digestion tankage would be required if the City chose to anaerobically digest both primary and secondary solids in the future.
- Additional digester gas storage is recommended to allow the City to convert all biogas produced on-site to CNG. This is being addressed as part of a separate project.

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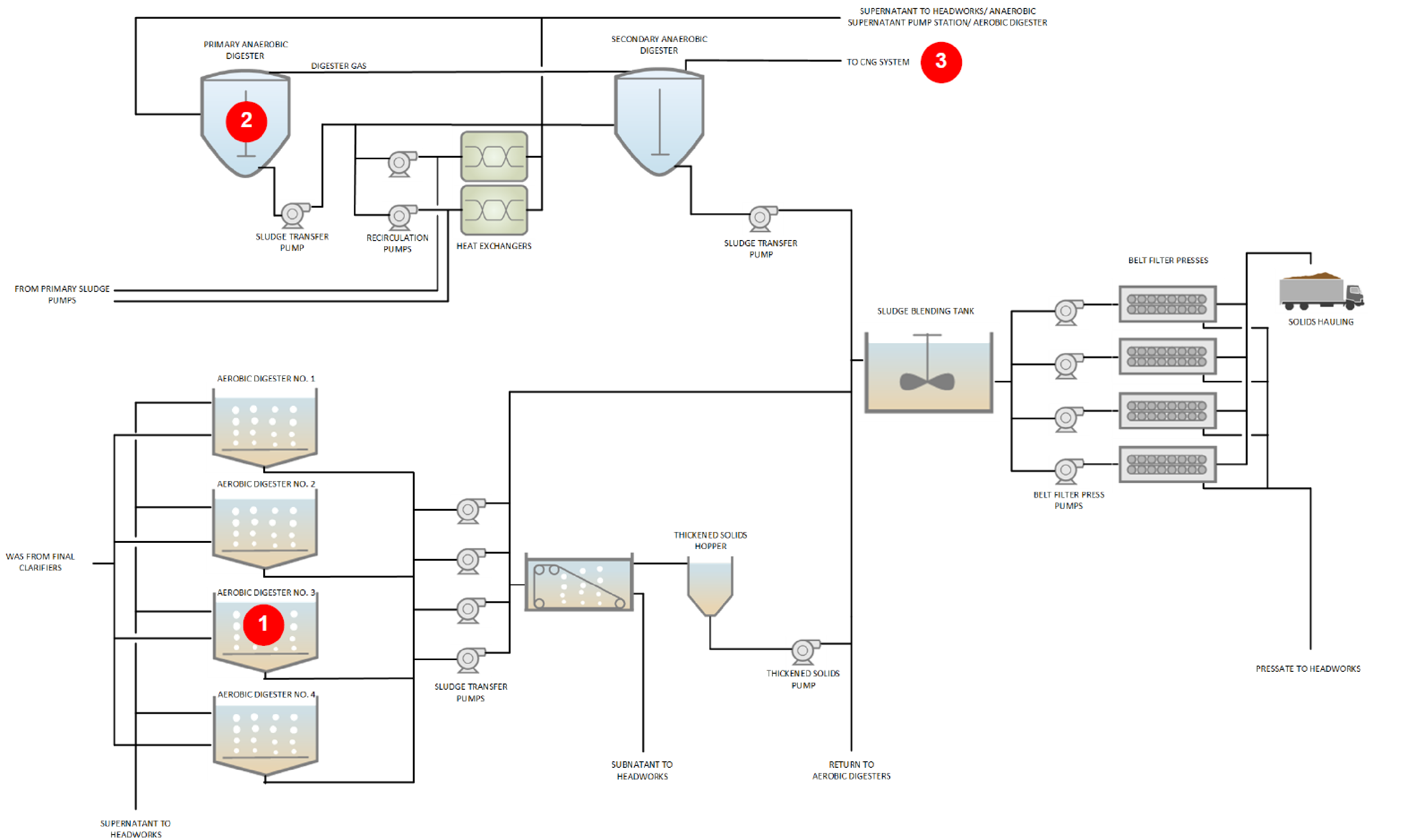

1. EXISTING DIGESTION SYSTEM INFRASTRUCTURE IS SUFFICIENT FOR CURRENT RATED CAPACITY. CONSIDER CONSTRUCTING NEW ANAEROBIC AND AEROBIC DIGESTER FOR OPERATIONAL REDUNDANCY.

2. ADDITIONAL ANAEROBIC DIGESTER CAPACITY IS REQUIRED IF THE CITY CHOOSES TO ANAEROBICALLY DIGEST BOTH PRIMARY SLUDGE AND WAS.

3. ADDITIONAL DIGESTER GAS STORAGE IS RECOMMENDED TO CONVERT ALL BIOGAS PRODUCED TO CNG.

Figure 3.18 Simplified Summary of Solid Stream Treatment Considerations

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Chapter 4

ASSET REVITALIZATION PROJECTS

The Persigo WWTP has been in service for over 37 years providing reliable and efficient wastewater service to its customers. A key element in providing these services is assuring the treatment infrastructure and assests are reliably operated, maintained, and upgraded as needed to meet the treatment goals. Asset revitalization includes replacing aging assets, such as equipment or building components, or rehabilitating assets to maintain the operational performance and overall treatment system reliability. The Persigo WWTP staff has been implementing asset replacement practices since the date of commissioning date and will continue into the future.

Recently, the City has invested resources into developing a system wide asset database system to monitor and predict asset revitalization needs into the future. This type of proactive monitoring and planning has become an industry best practice. The City's Lucity asset database includes asset records for the Persigo WWTP. The City's asset management team will continue to develop the database functionality, condition assessment information, and financial information to create a reliable tool for predicting asset replacement needs for the next 20 years.

In evaluating the asset replacement needs for the Persigo WWTP, site inspections and plant staff interviews were conducted. Additionally, these recommendations were validated against the City's Lucity database. This chapter lists capital improvement projects identified as asset revitalization projects for the Persigo WWTP. These projects will be combined with other process improvements discussed in Chapter 5 and prioritized as part of the implementation plan in Chapter 8.

4.1 City's Asset Management Database

In 2020, the City began implementation of an Asset Management Program for the Persigo WWTP assets. The City staff developed the program internally and selected Lucity as the asset database. The City's existing database included a thorough listing of the Persigo WWTP assets, which was used to validate the asset replacement recommendations below.

The asset information for the Persigo WWTP did not include asset installation dates, useful life information, or replacement costs. As a result, the following asset revitalization projects listed below include replacement of most assets once in a 20-year planning period. Figure 4.1 shows an excerpt from the Lucity database illustrating the asset hierarchy and naming convention. The subsequent findings aligns with the hierarchy used in Lucity.

Index	Plant ID	Process	Process ID	Process Sequence	Process Text
1	PWWTF	PRE-210	PRELIMINARY-210	210	PRELIMINARY
2	PWWTF	PRE-211	PRELIMINARY-211	211	WEST SIDE, CHEMICAL FEED STATION
3	PWWTF	PRE-212	PRELIMINARY-212	212	SEPTIC RECEIVING STATION
4	PWWTF	PRE-213	PRELIMINARY-213	213	INFLUENT CONTROL & INPLANT WASTE
5	PWWTF	PRE-214	PRELIMINARY-214	214	HW STEP SCREEN & WASH PRESS
6	PWWTF	PRE-215	PRELIMINARY-215	215	GRIT REMOVAL
7	PWWTF	PRE-216	PRELIMINARY-216	216	RAW SEWAGE PUMP STATION (RSPS)
8	PWWTF	PRI-220	PRIMARY-220	220	PRIMARY
9	PWWTF	PRI-221	PRIMARY-221	221	FLOW EQUILIZATION BASIN (FE)
10	PWWTF	PRI-222	PRIMARY-222	222	PRIMARY CLARIFIER (PC)
11	PWWTF	PRI-223	PRIMARY-223	223	PRIMARY SLUDGE (PS)
12	PWWTF	SEC-230	SECONDARY-230	230	SECONDARY
13	PWWTF	SEC-231	SECONDARY-231	231	CONTROL STRUCTURES #2
14	PWWTF	SEC-232	SECONDARY-232	232	AERATION SLUDGE BASIN (AS)
15	PWWTF	SEC-233	SECONDARY-233	233	RETURN ACTIVATED SLUDGE (RAS)
16	PWWTF	SEC-234	SECONDARY-234	234	WASTE ACTIVATED SLUDGE (WAS)
17	PWWTF	SEC-235	SECONDARY-235	235	AS AIR BLOWER (PA)
18	PWWTF	SEC-236	SECONDARY-236	236	CONTROL STRUCTURES #3
19	PWWTF	SEC-237	SECONDARY-237	237	FINAL CLARIFIER (FC)
20	PWWTF	DIS-240	DISINFECTION-240	240	DISINFECTION
21	PWWTF	DIS-241	DISINFECTION-241	241	ULTRAVIOLET (UV)
22	PWWTF	DIS-242	DISINFECTION-242	242	DI BASIN CONTROL GATES
23	PWWTF	DIS-243	DISINFECTION-243	243	PLANT WATER (PW)
24	PWWTF	DIS-244	DISINFECTION-244	244	DIFFUSER (DF)
25	PWWTF	DIG-250	DIGESTION-250	250	DIGESTION
26	PWWTF	DIG-251	DIGESTION-251	251	ANAEROBIC DIGESTER (AN)
27	PWWTF	DIG-252	DIGESTION-252	252	AN BOILER SYSTEM
28	PWWTF	DIG-253	DIGESTION-252	253	AEROBIC DIGESTER (AR)
29	PWWTF	DIG-254	DIGESTION-253	254	AR AIR BLOWER (PA)
30	PWWTF	DIG-255	DIGESTION-254	255	COMPRESSED NATURAL GAS (CNG)
31	PWWTF	DEW-260	DEWATERING -260	260	DEWATERING (SP)
32	PWWTF	DEW-261	DEWATERING-261	261	BELT PRESS (BP)
33	PWWTF	DEW-262	DEWATERING -262	262	SLUDGE PRESS POLYMER ADDITION
34	PWWTF	DEW-263	DEWATERING-263	263	DISOLVED AIR FLOTATION (DAF)
35	PWWTF	DEW-264	DEWATERING -264	264	BLEND TANK
36	PWWTF	CNTRL-270	CONTROL ROOM-270	270	PROCESS CONTROL ROOM (CNTRL RM)

Figure 4.1 Example of Persigo WWTP Assets Hierarchy and Naming Conventions Provided from the City's Lucity Database

4.2 Preliminary Treatment Asset Revitalization

Raw wastewater from the service area enters the northeast side of the Persigo WWTP through a 54-inch gravity sewer interceptor. Influent flow measurement, mechanical screening, grit removal, and raw sewage pumping equipment are housed in and immediately adjacent to the Headworks Building on the north side of the plant. Chapter 3 documents the preliminary treatment unit process design criteria and hydraulic capacities.

4.2.1 Influent Flow Measurement

The Persigo WWTP should plan for the following asset replacements and improvements:

1. Evaluate condition of existing influent piping and flow throttling valves.
2. Replacement of flow throttling valve.
3. Replacement of Flo-Dar instrumentation.
4. Installation of an odor mitigation system for the Persigo WWTP wash inverted siphon (Garver, 2020).

Replacement costs for the influent piping and other underground process pipes have not been included in this analysis as there is remaining useful life at the end of the 2040 planning period. However, this 2020 Master Plan does recommend an underground piping condition assessment project, which would identify and prioritize needed pipeline replacement projects for the future.

4.2.2 Headworks Facility

The existing Headworks Facility was originally commissioned in 1984 and renovated in 2001 with new process equipment. This equipment and ancillary facilities supporting the operations are approaching the end of their useful life.

Headworks Building exterior.

During site visits, Carollo evaluated the improvements to upgrade elements of the existing Headworks Building to improve operational efficiencies, improve building mechanical systems and revitalize existing assets.

The following replacement and rehabilitation improvements were identified for the Headworks Facility.

Equipment Replacements

- Replace the two bar screens, one screening conveyor, and one screening washer compactor.
- Replace the screenings and grit dumpsters (two total) with a wench system for off-loading.
- Upgrade and replace associated instrumentation for each of the unit processes.

Building Improvements

- Rehabilitate areas of concrete spalling including the stairs.
- The upper roof decking could be treated and painted to remove visible corrosion.
- The roofing membrane was recently upgraded and has about 10 years remaining.
- Building mechanical systems need to be updated, replaced, and sized accordingly for the designated space.
- As part of the City's *Persigo WWTP and Collection System Odor Abatement Evaluation* (Garver, 2020), it was recommended to construct a biofilter adjacent to the Headworks Facility to treat influent and mitigate hydrogen sulfide.

Electrical and Controls Improvements

- Electrical improvements include replacement of the MCCs and replacement throughout the building to meet current code requirements. Replace wiring and conduit significantly impacts by corrosion.
- Instrumentation and controls (I&C) improvements include replacement of the programmable logic controllers (PLC) and instrumentation for each of the processes.

4.2.3 Grit Removal

The following asset replacement projects have been identified. General building improvements were identified above.

- Replace the two grit washer compactors and associated electrical and controls systems.
- Collect grit samples for particle size analysis to evaluate removal efficiency of existing equipment. This test will provide understanding if higher efficiency grit removal equipment should be installed.

Grit washer compactor.

4.2.4 Raw Sewage Pump Station

Persigo WWTP staff indicated the raw sewage pump station has abnormal vibration which causes piping failures. Additionally, grease accumulation in the wet well is problematic. To address these concerns and replace aging assets, the following improvements are recommended:

- Perform a vibration/cavitation analysis to determine how to address the vibration issue.
- Recoat the raw sewage piping.
- Improve the grease removal capabilities and efficiencies.
- Evaluate the building mechanical systems and replace to improve cooling in the MCC room.
- Replace the roofing membrane to eliminate water draining in the MCC room.
- Replace the MCCs, VFDs, and standby generator and electrical systems to meet current code.
- Incorporate the structural modifications as documented in the *Persigo Wastewater Treatment Plant Structural Condition Assessment (WJE, 2020)*.
- Replace and upgrade the PLC.

4.2.5 Implementation Recommendations for Preliminary Treatment

The implementation recommendations for the preliminary treatment improvement projects are shown in Table 4.1. Appendix C includes an itemized Class 5 cost estimate for these improvements. The asset revitalization projects will be evaluated and included in the alternative analysis evaluations (refer to Chapter 5). Further prioritization will be completed as part of the implementation plan in Chapter 8.

Table 4.1 Recommended Preliminary Asset Revitalization Projects

Implementation Period	Identified Projects	Capital Costs (2021 $)
2021-2025	Screening and Headworks Building Asset Renewals Grit Removal Asset Renewals	$5.8 million
2026-2030	Raw Sewage Pump Station Renewals	$5.2 million
2031-2040	None identified	

4.3 Primary Treatment Processes

For the primary treatment process, the following asset replacement projects were identified for Control Structure 1 and the Primary Clarification Process. Chapter 5 identifies the improvements required to meet future design flow and loading conditions.

4.3.1 Control Structure No. 1

As noted in Chapter 3, plant staff has indicated that flow overtops the walls of the structure above 20 to 30 mgd with two primary clarifiers in service. Based on the hydraulic model, there is just over 18 inches of freeboard upstream of the weirs in this control structure under PHF conditions. It is therefore likely that the overtopping seen by plant staff is due to the turbulent inlet conditions in the narrow (4 feet wide) inlet channel. To address this problem, Carollo recommends increasing the height of the concrete walls of Control Structure No. 1 (18 inches was assumed for the purpose of cost estimating) to provide additional freeboard and minimize the potential for overtopping in the future.

4.3.2 Primary Clarifiers and Sludge Pumping

Asset replacement and enhancement projects for the primary clarifiers and sludge pumping include the following. Chapter 3 addresses capacity improvements.

- Rebuild or replace the clarifier drives.
- Replace the piston-type scum pumps.
- Replace the sludge pumps (progressive cavity pumps) and consider adding pressure protection on the pumps.
- Repair the corrosion with the primary clarifier mechanisms, launders, and concrete walls.
- Remove the existing primary clarifier covers and decommission the odor control ventilation system.
- Eliminate the air filter freezing issues experienced during the winter for the air handling units.
- Improvement maintainability of sludge pumping system by adding access points.
- Incorporate the structural modifications as documented in the *Persigo Wastewater Treatment Plant Structural Condition Assessment (WJE, 2020)*

4.3.3 Flow Equalization Basins

The following asset replacement projects for the FE basins have been identified:

- Repair of the structural walls in the FE basins will be initiated in 2021 as defined in the *Flow Equalization Basin Concrete Wall Repair Assessment (WJE, 2020).*
- Replacement of floating mixers.
- Replace the FE basin drain valves or if determined to be an infiltration issue, evaluate perimeter drainage system.
- Replace MCCs, VFDs, and electrical systems to meet current code requirements.
- Improve the I&C to monitor flowrate and levels in the FE basin.

4.3.4 Summary of Recommended Primary Improvements

The improvement projects shown in Table 4.2 indicate when the improvements identified above are recommended for implementation. Appendix C includes the detailed Class 5 cost estimate assumptions for the asset replacement projects. The asset revitalization projects will be evaluated and included in the alternative analysis evaluations, refer to Chapter 5. Further prioritization will be completed as part of the implementation plan in Chapter 8.

Table 4.2 Recommended Primary Asset Revitalization Projects

Implementation Period	Identified Projects	Capital Costs (2021 $)
2021-2025	Control Structure 1 Improvements: Replacement and rehabilitation of primary clarifier and primary sludge pumping assets	$3.9 million
2026-2030	FEB Basin Mixer Replacements	$1.3 million
2031-2040	None identified	

4.4 Secondary Treatment Asset Revitalization Projects

Secondary treatment asset revitalization projects include the aeration basins, RAS/WAS pumping, and secondary clarifiers. Chapter 5 identifies the improvements required to meet future design flow and loading conditions.

4.4.1 Aeration Basins

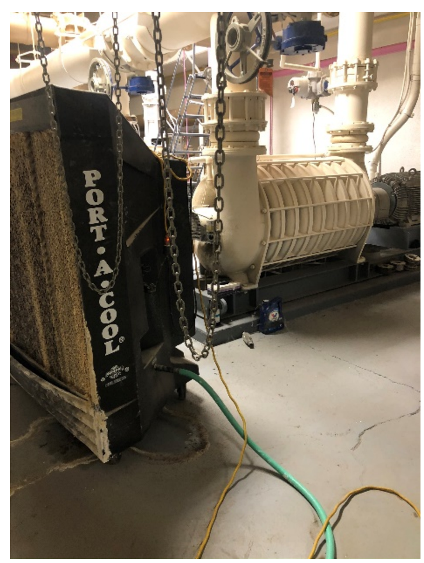
Asset replacement projects in the aeration basins include the following:

- Conduct diffuser cleaning and testing to measure the oxygen transfer efficiencies. According to plant staff, diffusers were replaced within last 10 years for all basins.
- Aeration control improvements needed with replacing air flow control valves and actuators.
- Replace the four mixed liquor pumps.
- Inspect and replace the corroded valve stems and gates.
- Replace existing instrumentation and add new instrumentation required for improved nitrification.
- Incorporate the structural modifications as documented in the *Persigo Wastewater Treatment Plant Structural Condition Assessment (WJE, 2020)*

Aeration basins.

4.4.2 Blower Building

The existing blowers are located in the basement adjacent to the aeration basins. This space has experienced flooding and several other operational, physical, and environmental challenges. As a result, a new Blower Building has been identified instead of rehabilitating the current location. Chapter 5 identifies replacement of the existing Blower Building and includes replacement of the existing blowers with new aeration systems and blowers.



Blower basement.

4.4.3 RAS and WAS Pumping

The RAS and WAS pumping systems are located in the basement adjacent to the aeration basins and share the space with the existing aeration blowers. The improvements identified include:

- Replacement of six RAS pumps.
- Replacement of three WAS pumps.
- Ventilation improvements following removal for the existing blowers from the basement location.

4.4.4 Secondary Clarifiers

The secondary clarifiers asset revitalization improvements include:

- Control Structure No. 3 improvements include structural modifications to improve the hydraulics and flow distribution and replacement of the existing gates.
- Replacement of two clarifier mechanisms.
- Rehabilitation of the Clarifier 4 mechanisms, walkway, motors, and scum.
- Add an allowance for rehabilitation of existing concrete structure and repair or coating of launders and weirs.

4.4.5 Summary of Recommended Secondary Treatment Improvements

The improvement projects shown in Table 4.3 indicate the implementation timing of the above-mentioned asset revitalization projects. Details on the capital cost information for each project is included in Appendix C. The asset revitalization projects will be evaluated and included in the alternative analysis evaluations, refer to Chapter 5. Further prioritization will be completed as part of the implementation plan in Chapter 8.

Table 4.3 Recommended Secondary Treatment Asset Revitalization Projects

Implementation Period	Identified Projects	Capital Costs (2021 $)
2021-2025	Aeration Basin Asset Revitalization	$2.4 million
2026-2030	Secondary Clarifier Asset Replacements	$4.5 million
2031-2040	Secondary Sludge Pumping Improvements (RAS and WAS)	$3.0 million

4.5 Disinfection and Outfall Asset Revitalization

The disinfection and outfall asset revitalization projects involve revitalizing the UV disinfection facilities, the non-potable water system, and the outfall. The UV facilities are about 10 years old and should be replaced and upgraded within the 20-year planning period.

The diffuser piping and system were constructed in 2017. It is assumed asset re-investments for this system will be beyond the 2040 planning horizon.

- Replacement of UV Disinfection approach.
- Rehabilitation and replacement of control gates and instrumentation for the disinfection systems.
- Replacement of plant water and irrigation pumping systems.

UV Channel

4.5.1 Summary of Recommended Disinfection and Outfall Improvements

The improvement projects shown in Table 4.4 indicate the implementation timing of the above-mentioned asset revitalization projects. Details on the capital cost information is included in Appendix C. The asset revitalization projects will be evaluated and included in the alternative analysis evaluations, refer to Chapter 5. Further prioritization will be completed as part of the implementation plan in Chapter 8.

Table 4.4 Recommended Disinfection and Outfall Asset Revitalization Projects

Implementation Period	Identified Projects	Capital Costs (2021 $)
2021-2025	None identified	
2026-2030	None identified	
2031-2040	Replacement and Rehabilitation of Existing UV System	$5.4 million

4.6 Digestion Processes

The digestion processes include the anaerobic digesters and heating systems, the aerobic digesters, thickening, and pumping systems.

4.6.1 Anaerobic Digesters

The following asset rehabilitation and replacement projects have been identified based on the site inspections. The cover for the primary anaerobic digester was replaced in 2016 and should be sufficient through the 2040 planning period.

- Replace digester cover for the secondary anaerobic digester.
- Rehabilitate or replace the existing heat exchanger and heating system.
- Rehabilitate or replace the two sludge transfer pumps and two recirculation pumps.
- Rehabilitate or replace the mixing systems for each digester.
- Replace the two boilers and vent piping which are showing significant signs of corrosion and can be replaced with high-efficiency boilers.
- Building mechanical improvements are needed to improve the ventilation systems.
- Replace the MCCs and associated electrical systems to meet current code and safety requirements and recommendations.
- Upgrade the existing PLCs and I&C.
- Incorporate the structural modifications as documented in the *Persigo Wastewater Treatment Plant Structural Condition Assessment (WJE, 2020).*

Anaerobic digesters.

4.6.2 Aerobic Digestion

Replacement of the aerobic digestion tanks should be evaluated in parallel with process improvements to the overall digestion system as it relates to migration to anaerobic digestion. The aerobic digestion process has the following asset replacement projects:

- Rehabilitate process the three blowers and motors.
- Replace the mixing systems and motors.
- Rehabilitate corroded concrete, and coatings to address corrosion impacts.
- Rehabilitate gates and metals experiencing corrosion.
- Building mechanical improvements are needed to improve the ventilation systems.

4.6.3 Dissolved Air Flotation and Sludge Blending Tank

The DAFT process was installed in 2012 and will require asset replacement and rehabilitation in the long term. Other asset rehabilitation and replacement needs include:

- Rehabilitate the dissolved air flotation unit (> 2025).
- Building mechanical improvements are needed to improve the ventilation systems.
- Mixing and coating improvements are recommended for the existing sludge blend tank.

4.6.4 Biogas Treatment System

The existing biogas treatment system will potentially require asset replacements and upgrades between 2035 and 2040. The timing of these asset replacement projects should be coordinated with potential capacity expansions of the biogas system. The assets to be replaced include the piping, mechanical components, electrical and controls panels.

4.6.5 Summary of Recommended Improvements

The improvement projects shown in Table 4.5 indicate the implementation timing of the above-mentioned asset revitalization projects. Details on the capital cost information is included in Appendix C. The asset revitalization projects will be evaluated and included in the alternative analysis evaluations, refer to Chapter 5. Further prioritization will be completed as part of the implementation plan in Chapter 8.

Table 4.5 Recommended Digestion Asset Revitalization Projects

Implementation Period	Identified Projects	Capital Costs (2021 $)
2021-2025	Anaerobic Digestion Asset Replacements	$7.4 million
2026-2030	Aerobic Digestion Improvements	$3.8 million
2031-2040	Dissolved Air Floatation Asset Replacements Biogas Asset Replacement	$2.0 million $2.0 million

4.7 Dewatering Treatment Processes

The dewatering facilities include the Belt Filter Press Building, the polymer feed systems, and the Cake Storage Facility.

4.7.1 Dewatering Facility Asset Revitalization Projects

The asset replacement projects associated with the Dewatering Treatment Process includes:

- Replace the belt filter presses.
- Replace the sludge feed pumps.
- Building mechanical improvements are needed to improve the ventilation systems.
- Replace the MCCs and associated electrical systems to meet current code and safety requirements and recommendations.
- Upgrade the existing PLCs and I&C.
- Incorporate the structural modifications include allowances in the *Persigo Wastewater Treatment Plant Structural Condition Assessment (WJE, 2020)*.

Dewatering Facility.

The long-term asset replacement project involves rehabilitating or replacing the three existing belt filter presses, three dewatering pumps, and three polymer pumps.

4.7.2 Polymer Feed Facilities

The existing polymer feed system mainly consists of peristaltic pumps and associated day tanks to deliver polymer and ferric for dewatering. The chemical systems do not have designated containment and could be made more permanent.

- Replace the existing polymer feed pumps.
- Provide chemical containment around the pumps and piping.
- Replace the MCCs and associated electrical systems to meet current code and safety requirements and recommendations.
- Upgrade the existing PLCs, instrumentation, and controls.
- Provide a designated working space for operations.

Polymer feed system

4.7.3 Cake Storage and Vehicle Off-Loading Facilities

The current cake storage hopper provides short-term solids storage before hauling to the landfill. The asset rehabilitation and replacement projects for this area include:

- Inspect the integrity of the existing hoppers and repair metals and concrete impacted by corrosion.
- Building mechanical improvements are needed to improve the ventilation systems to address adverse impacts during cold weather periods.

4.7.4 Solids Drying Beds

The existing solids drying beds could be re-purposed and used as a solar drying facility or as a temporary biosolids storage facility. Improvements related to these two types of uses will be covered in Chapters 5 and 6.

4.7.5 Summary of Recommended Dewatering Treatment Improvements

The improvement projects shown in Table 4.6 indicate the implementation timing of the above-mentioned asset revitalization projects. Details on the capital cost information is included in Appendix C. The asset revitalization projects will be evaluated and included in the alternative analysis evaluations, refer to Chapter 5. Further prioritization will be completed as part of the implementation plan in Chapter 8.

Table 4.6 Recommended Dewatering Asset Revitalization Projects

Implementation Period	Identified Projects	Capital Costs (2021 $)
2021-2025	Belt Filter Press Asset Replacements (includes polymer feed)	$10.1 million
2026-2030	Cake Storage and Vehicle Off-Loading Facilities	$0.5 million
2031-2040	Solids Blend Tank Asset Replacements	$1.2 million

4.8 Summary of Asset Revitalization Needs

Annually, the Persigo WWTP staff should review all the asset revitalization projects and prioritize those with other process improvements. Additionally, each asset replacement project should be evaluated to determine if in-house resources (engineering, construction) will be used to complete the work. The financial information presented in this chapter assumes that these asset replacement projects will be grouped together into larger projects and will require engineering and construction support. Appendix C includes detailed cost assumptions for these asset revitalization projects, which have been summarized in Table 4.7

The timing and financial information for these asset replacement projects will be balanced against projects identified in Chapters 5, 6, and 7. As a result, the timing and scope provided in Table 4.7 may not reflect the actual implementation plan as documented in Chapter 8. Chapter 8 includes the final implementation plan for asset revitalization projects and process improvements.

Table 4.7 Summary of Asset Revitalization Projects

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT: City of Grand Junction -
PROJECT : 2020 Persigo WWTP Master Plan
Process: All Rehab and Replacment Projects - Summary

Cost estimate for replacement of assets within the next 10 years. Costs are escalated for the midpoint of construction for each facility. Project sequencing and prioritization will be revised as part of Chapter 8 implementation plan.

		Year 1	*Year 2*	*Year 3*	*Year 4*	*Year 5*	*Year 6*	*Year 7*	*Year 8*	*Year 9*	*Year 10*	*Year 11*
Asset Area	**TOTAL**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**>2030**
Headworks	$5,967,000	$895,000	$5,072,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Raw Sewage PS	$6,435,000	$0	$0	$0	$0	$0	$0	$965,000	$5,470,000	$0	$0	$0
Primary Clarifiers	$4,406,000	$0	$0	$0	$661,000	$3,745,000	$0	$0	$0	$0	$0	$0
FEB- Basin	$1,540,000	$0	$0	$0	$0	$0	$231,000	$1,309,000	$0	$0	$0	$0
Abasins	$2,647,000	$0	$0	$397,000	$2,250,000	$0	$0	$0	$0	$0	$0	$0
RAS / WAS Pumping	$4,420,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$4,420,000
Secondary Clarifiers	$5,733,000	$0	$0	$0	$0	$0	$0	$0	$860,000	$4,873,000	$0	$0
Disinfection	$8,377,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$8,377,000
Anaerobic Digestion	$7,889,000	$0	$1,183,000	$6,706,000	$0	$0	$0	$0	$0	$0	$0	$0
Aerobic Digestion	$3,785,000	$0	$0	$0	$0	$0	$568,000	$3,217,000	$0	$0	$0	$0
DAFT Treatment	$2,802,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$2,802,000
Solids Blending Tank	$1,382,000	$0	$0	$0	$0	$0	$207,000	$1,175,000	$0	$0	$0	$0
Biogas Equipment	$2,963,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$2,963,000
Belt Filter Press Equipm	$11,378,000	$0	$0	$0	$1,707,000	$9,671,000	$0	$0	$0	$0	$0	$0
	$0											
Total	**$69,724,000**	**$895,000**	**$6,255,000**	**$7,103,000**	**$4,618,000**	**$13,416,000**	**$1,006,000**	**$6,666,000**	**$6,330,000**	**$4,873,000**	**$0**	**$18,562,000**

Chapter 5

PERSIGO WWTP ALTERNATIVE ANALYSIS

5.1 Introduction

Chapter 5 summarizes the results of the alternative evaluations conducted for the Persigo WWTP to meet the planning goals in Chapter 1. These goals included: 1) Existing and Future Service, 2) Resource Recovery, 3) Service Life, 4) Efficiency, 5) Fiscal Responsibility, 6) Innovation, 7) Environmental Protection, 8) Health and Safety as shown in Figure 5.1.

Figure 5.1 2020 Master Plan Goals

The following sections review previous planning recommendations and summarize the evaluation of each unit operation and process alternative identified by the City and Carollo's project team (project team). Where needed, baseline improvements are recommended to meet the current and future planning conditions as identified in Chapters 2 and 3, consisting of a combination of asset replacement needs and/or capacity improvements. A more detailed description of the asset replacement needs for each unit operation and process is provided in Chapter 4.

The alternatives described below include a short narrative and justification along with an estimate of relative capital and operating costs. Cost information presented in this chapter are based on comparative estimates developed to screen the alternatives. Where applicable, the analysis did include the estimated operating cost impacts over a 20-year planning period.

5.2 Background

The alternatives presented herein were identified to address the plan goals above and provide the cost-effective, efficient, and sustainable wastewater services for the City. In selecting and evaluating the alternatives, the project team screened several operation and process improvements. Selected alternatives that the project team considered implementable and feasible for the Persigo WWTP and meet the treatment objectives and goals. For each alternative, the project team validated and assessed the hydraulic and process capacity, completed process modeling, and performed a cost comparison. The alternative analysis results are presented below.

5.2.1 Key Planning Drivers

The key planning drivers through the 2040 planning period, as stated in Chapter 2, include:

- The rated flow capacity will be expanded from currently 12.5 mgd to 13.5 mgd ADMMF.
- The rated organic capacity will be expanded from currently 26,480 ppd BOD_5 to 28,800 ppd BOD_5.

Due to the flow and loading capacity expansion, the facility will require additional infrastructure to meet the 20-year planning projections as described in the following recommended baseline improvements and alternative evaluations.

Based on the future regulatory conditions presented in Chapter 2, there were no identifiable or immediate regulatory drivers in the next 10 years that impacted the development or selection of alternatives below.

5.2.2 Process and Capacity Validation

Process and hydraulic modeling was performed to inform the definition of required baseline improvements and alternatives. Chapter 3 includes further description and details on the hydraulic and process model calibrations and unit operation and process capacities.

The calibrated models were subsequently used to validate and calculate additional infrastructure needed to accommodate future capacity, to determine projected chemical dosing, solids production, and aeration requirements. These model simulations are the basis for the preliminary sizing of infrastructure and quantification of operating costs.

5.2.3 Capital and Operating Cost Estimates

Capital cost estimates were developed using the assumptions presented in Chapter 1 and cost summary sheets have been included as Appendix D. Chapter 1 presents a detailed breakdown of direct and indirect cost assumptions, financial terms, and operating assumptions used for developing the capital costs and NPV calculations below. Appendix E includes cost estimate summary sheets for the alternatives below, and Appendix D provides the financial summaries for the 20-year NPVs assessments.

Costing information presented in this chapter is expressed in 2020 dollars. These costs have not been escalated based on the anticipated timing of the recommended improvements. Capital cost adjustments based on project sequencing will be reflected in the implementation provided in Chapter 8.

5.2.4 Previous Planning Recommendations

For planning consistency, this section briefly revisits facility planning recommendations that have been documented in previously planning documents.

The 2008 WW Basin Update provided a brief summary of site expansion considerations for the Persigo WWTP, although its main emphasis was on the collection system. As discussed in Chapter 2, the 2035 projected flows assumed by the 2008 WW Basin Update were significantly higher (25.8 mgd ADMMF) than for this 2020 Master Plan (13.5 mgd). Additionally, in 2008, the Persigo Wash discharge location was the primary discharge location and nutrient limits were anticipated. On the basis of these assumptions, the 2008 WW Basin Update proposed the following improvements:

- Addition of Primary Clarifiers 3 and 4.
- Expanded aeration basin volume for biological nutrient removal.
- Consideration of integrated fixed film activated sludge process.
- Additional secondary clarifier capacity depending on nutrient removal approach.
- Phosphorus polishing to meet an effluent TP limit of 0.05 mg/L.
- Second-stage activated sludge denitrification/sludge reaeration.
- Conversion to UV disinfection.
- Transition to anaerobic digestion for primary and secondary sludge.
- Solids thickening improvements.
- Centrifuges for improved dewatering.

Of these recommendations, only the UV disinfection system has been implemented. The other improvements either have been delayed or eliminated for the following main reasons:

1. Change of discharge location in 2017 to the Colorado River.
2. Slower growth than expected in the Persigo WWTP service area.
3. Prioritization of infrastructure needs based on available capital budgeting resources.

The following sections will discuss certain recommendations from the 2008 WW Basin Update, which are still recommended today for the Persigo WWTP's next 20-year planning horizon.

5.3 Alternative Evaluations

For each unit operation and process up to two potential alternatives were selected and evaluated. The following describes the general framework for developing feasible alternatives.

1. **Baseline Condition:** This category represents recommended replacements or rehabilitations of the existing assets and infrastructure with the same type of equipment (in-kind replacements). The scope for recommended asset renewal and cost estimates are detailed in Chapter 4 and are summarized below.
2. **Capacity or Regulatory Improvements:** These alternatives address current or projected capacity or regulatory constraints.
3. **Efficiency Improvements:** These alternatives provide infrastructure or operating enhancements focused on increased efficiencies through optimization and innovation that lower capital and operating expenditures, enhance treatment capacity, lower energy consumption, and/or improve effluent quality.
4. **Operational Resiliency:** These alternatives increase the operational resiliency and reliability of the facility as a whole or individual unit operations or processes. As an example, this can be achieved by adding a redundant unit to increase the firm capacity and maintain reliable treatment performance when taking a unit out of service for maintenance or during construction.

5.4 Headworks Facility

Alternatives for the Headworks Facility focused on increasing the hydraulic capacity for PHF from the current 23.2 mgd to 30.4 mgd projected for 2040 (see Chapter 2) and improve the operation and resiliency of the screening and grit removal operations. Table 5.1 summarizes the upgrades that were evaluated.

Table 5.1 Headworks Facility Alternatives

Baseline Condition	Alternative 1 – Screening Capacity Expansion	Alternative 2 – Enhanced Grit Washing
• Replace and re-rate step screens, add third manual screen • Replace washer/compactor, and grit pumping and washing as in-kind	• Baseline Condition with following exception: – Addition of a mechanical third step screen and press unit	• Alternative 2 with following exception: – Addition of an enhanced grit removal and washing system

5.4.1 Baseline Condition

The Baseline Condition replaces and rehabilitates the existing assets as in-kind, which includes the step screens, screenings washer/compactor and the grit pumping and washing. The existing equipment is about 20 years old and while still functioning, it is anticipated to have limited remaining life. To meet the projected hydraulic screening capacity, Huber indicated that the existing units might be paper re-rated to 15.1 mgd each. Carollo recommends verifying this through field testing or hydraulic modeling. As a conservative assumption, Carollo recommends planning for a replacement and re-rating to treat 15.1 mgd per existing step screen.

Carollo further recommends adding a third manual bar screen and control gates to comply with the CDPHE's requirements per Policy WPC-DR-1 for screening capacity and redundancy during an emergency or equipment failure mode, namely that the "firm capacity of screening facilities shall meet design peak hour influent flow. A single mechanically cleaned screen and a bypass channel with a manually cleaned screen may be provided."

Figure 5.2 illustrates the recommended baseline improvements.

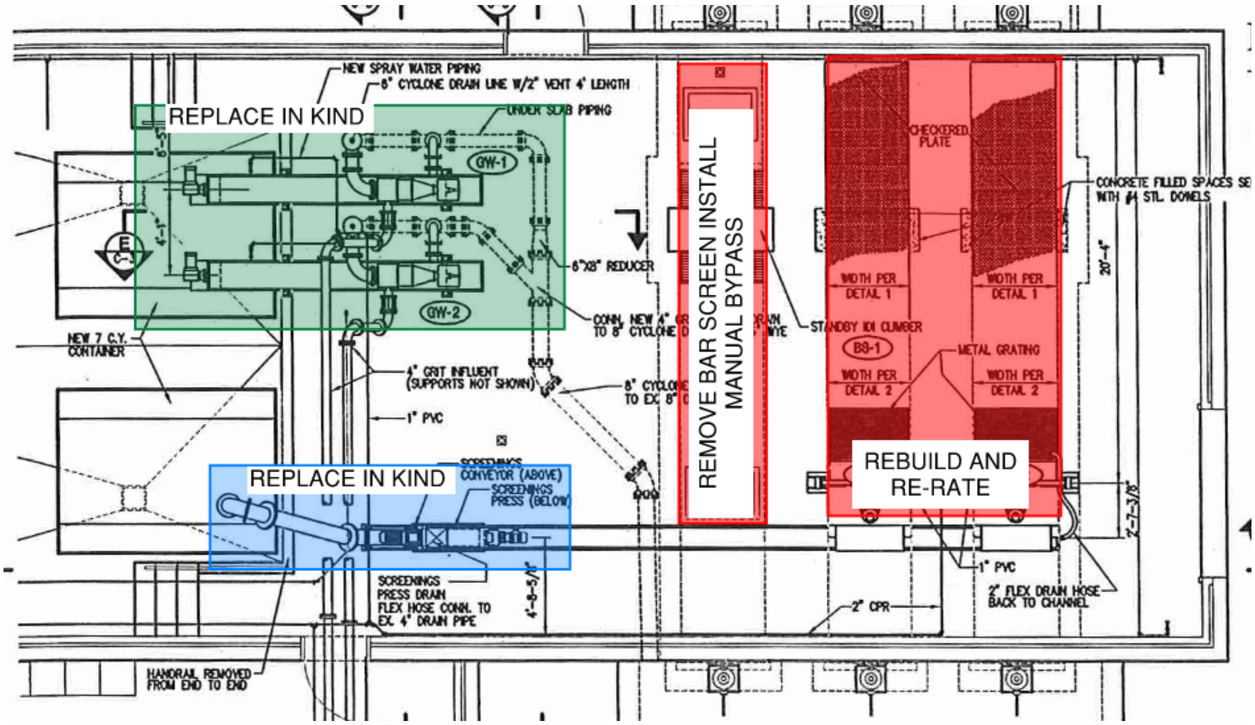


Figure 5.2 Preliminary Treatment – Recommended Baseline Improvements

5.4.2 Alternative 1 – Screening Capacity Expansion

This alternative increases the overall operational resilience and reliability of the headworks operations by adding a third mechanically cleaned step screen in place and a new manual bar screen included in the Baseline Condition. Three mechanical step screens provide full redundancy and firm capacity to meet the 2040 peak hour flow capacity.

Step screen.

The screening washing and compaction equipment has been identified by operations staff as a single point of failure. To increase the operational reliability and eliminate this single point of failure, it is recommended to add a second screenings washer/compactor and conveyance system to the existing single unit. To convey screenings from any of the three future step screens, a new sluiceway screening conveyance system would need to be provided. All other improvements associated with the baseline improvements would be included in this alternative, namely the in-kind replacement of the grit pumping and washing operation. Figure 5.3 illustrates the layout for this alternative.

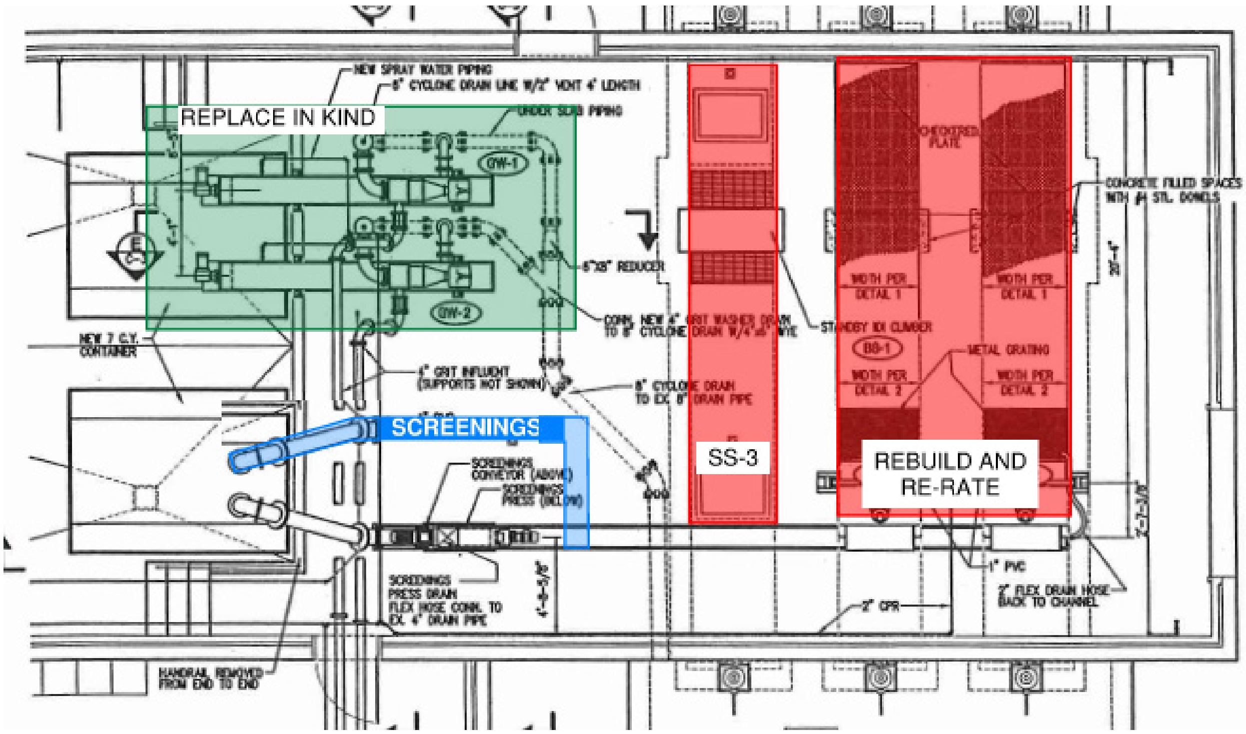


Figure 5.3 Preliminary Treatment – Redundancy Alternative Schematic

5.4.3 Alternative 2 – Enhanced Grit Washing

The second alternative addresses operational efficiency by enhancing grit washing and compaction system. Building on to Alternative 1, this alternative also provides a new grit washing and compaction equipment compared with the baseline assumption of replacing these assets with the same current system as in-kind.

As regulations continue to become stricter regarding landfill disposals, Carollo anticipates that the free liquid in waste will be strictly regulated. The volume of free liquid in a waste sample is measured with the so-called paint filter test. This has led many utilities to improve their grit handling systems to increase dryness and reduce odors. Enhanced grit washing and compacting technology, is now available, which combines grit classifying and washing into a single, small footprint step. One example of the single step washer classifier schematic is shown in Figure 5.4. Figure 5.5 shows the layout of this alternative.

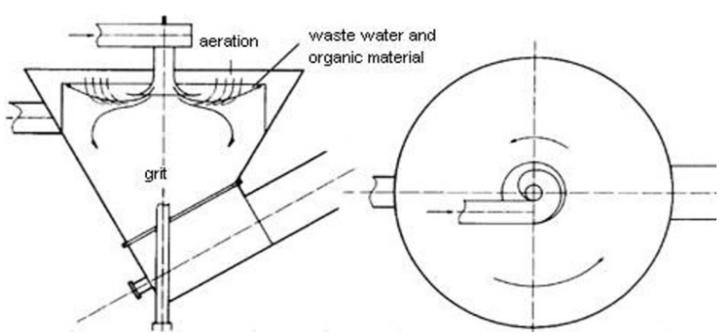


Figure 5.4 Example of Enhanced Grit Washing and Classification Technology

Carollo recommends conducting grit removal testing to determine if the existing grit removal system needs to be replaced with an enhanced system, for example with a vortex type or aerated type grit system to improve particle removal efficiency. This should be completed prior to selecting new grit washing equipment.

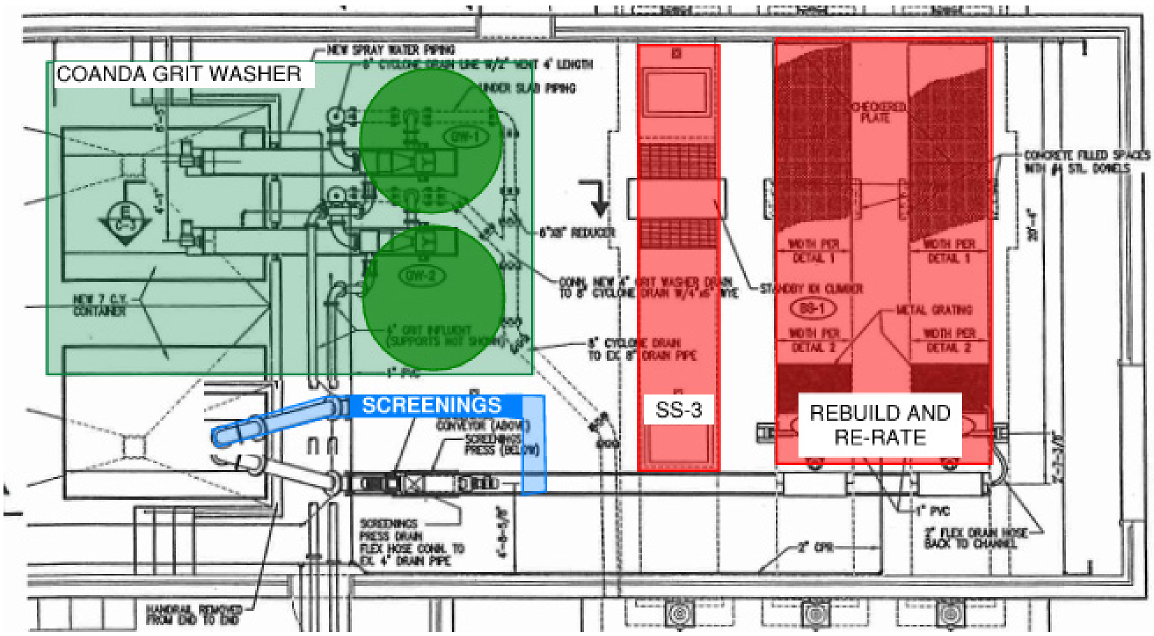


Figure 5.5 Preliminary Treatment – Operational Alternative Schematic

5.4.4 Financial Comparison of Headworks Alternatives

Capital costs for each of these alternatives is presented in Table 5.2. Detailed costing assumptions are included in Appendix E. Operating costs for the Headworks Alternatives were not developed as the difference between the alternatives are not significant.

Table 5.2 Capital Cost Comparison for Headworks Facility Alternatives

Baseline Condition	Alternative 1 – Screening Capacity Expansion	Alternative 2 – Enhanced Grit Washing
$5.8 million	$8.0 million	$8.8 million

Notes:
(1) Baseline cost estimate developed for asset revitalization program in Chapter 4.
(2) Alternative 1 cost estimate includes the Baseline Condition asset revitalization costs in addition to the third step screen, conveyance, and washer compactor.
(3) Alternative 2 cost estimate includes the asset renewals and replacement from the Alternative 1.
(4) Costs shown in 2021 dollars for comparative purposes.

5.4.5 Implementation Recommendations

In developing the Headworks Building implementation plan, Table 5.3 includes the recommended projects.

Table 5.3 Headworks Building Implementation Recommendations

Implementation Period	Identified Projects
2021-2025	1. Evaluate and test the grit removal system. Select grit washing technology. 2. Replace, upgrade, and rehabilitate step-screens and grit washing assets per Baseline Condition above (see Chapter 4 for further definition). 3. Construct the odor control biofilter from the *Odor Control Study* (Garver, 2020).
2025-2030	None identified.
2031-2040	1. Increase screening capacity and reliability with third mechanical step screen.

5.5 Primary Clarification and Carbon Management

Figure 5.6 illustrates the primary treatment alternatives that were considered for addressing three key drivers for primary clarifier improvements: 1) Carbon diversion for energy recovery via biogas production, 2) Increased secondary treatment capacity, and 3) Reduced secondary treatment aeration energy and cost.

Several alternatives and innovative primary treatment technologies were considered and discussed with City staff. These included primary filtration, biologically enhanced primary treatment (biosorption processes), and primary and secondary sludge co-settling. These technologies can help meet the City's key drivers for primary clarifier improvements and are at a technology development level ready for full-scale implementation. However, the associated capital costs for implementation are significantly greater than other viable alternatives considered in the following and were therefore not considered further at this time. The City is encouraged to revisit this assessment in future years as planning drivers may change over time.

Thin-sludge pumping was discussed as a viable option with plant staff, but it was ultimately removed from consideration because of the hydraulic impacts to solids handing. Thin sludge pumping increases BOD and TSS removal in the primary clarifiers but would require one or more gravity thickeners be constructed to re-thicken primary sludge (PS) that is typically pumped at or below 1 percent TS concentration before being stabilized in the anaerobic digesters, an alternative too costly at this time.

The following alternatives were carried forward for detailed evaluation:

- Baseline Condition – Critical asset renewals.
- Alternative 1: Chemically enhanced primary treatment (CEPT).
- Alternative 2: Conventional primary clarifier expansion.

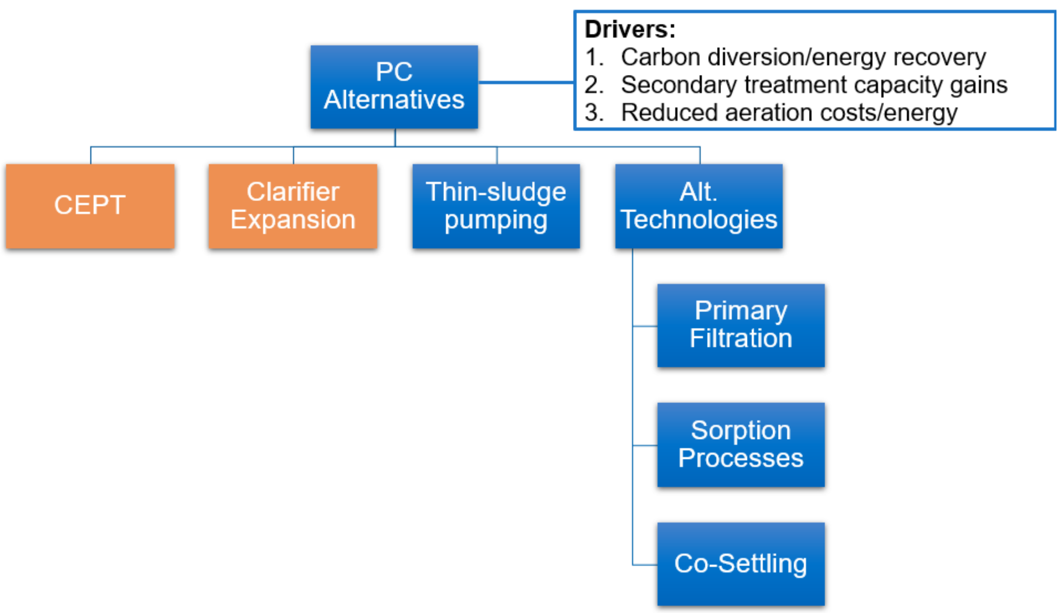


Figure 5.6 Overview of Primary Clarification Alternatives

5.5.1 Baseline Condition

The Baseline Condition included rehabilitation or replacement of the following items, as discussed further in Chapter 4:

- Primary clarifier mechanisms.
- PS and scum pumps.
- Removal of primary clarifier covers and odor control systems in PS pump station.
- Medium- and high-priority structural projects as identified in the 2020 WJE Assessment, including concrete repairs, installation of protective coating systems, and installation of new gasket materials between the doomed roof and concrete wall.
- Modifications to Control Structure No. 1 to resolve hydraulic limitations.

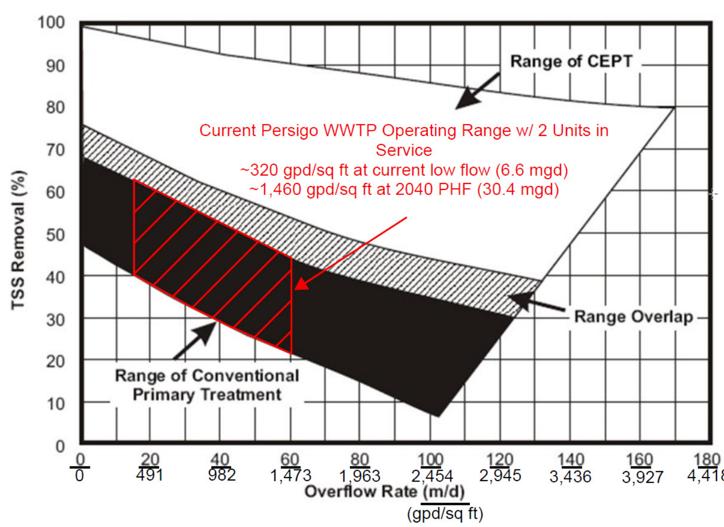
Scum pumps.

Based on the capacity evaluations presented in Chapter 3, the existing primary clarification process has sufficient hydraulic and process capacity to meet the 2040 planning conditions. Therefore, a third primary clarifier is not required under the Baseline Condition.

5.5.2 Alternative 1 – Chemically Enhanced Primary Treatment

CEPT involves chemical metal salt addition to screened and de-gritted wastewater prior to primary clarification. This alternative is simple and can be low in capital costs to enhance secondary treatment capacity. Chemical coagulants such as ferric chloride or alum provide metal salt cations that destabilize colloidal particles in the primary influent, while flocculent aids such as polymer accelerate the growth of flocs, and increase particle settling velocity. This destabilization and flocculation of colloidal particles increases the overall removal of BOD_5 and TSS in the primary clarifiers, which in turn reduces downstream organic and solids loading onto the secondary treatment process. PS contains increased organic carbon loads which are diverted to the anaerobic digesters for biogas production. Since biological nutrient removal is not necessary today or anticipated in the future, the City has leverage over diverting carbon from the liquid stream to solids handling. Just enough carbon should be provided to the secondary treatment to recover sufficient alkalinity for stable nitrification from denitrification.

CEPT further allows for higher SORs during peak flow events, while maintaining or increasing primary clarifier performance. Figure 5.7 compares the typical ranges of TSS removal for primary clarification against CEPT as a function of clarifier surface overflow rate. The removal efficiencies for TSS in conventional primary clarification typically ranges between 45 to 65 percent and with CEPT can increase to 60 to 85 percent. The figure also indicates that clarifiers can be operated at higher SORs at increased TSS removal rates.



Adapted from WEF MOP FD-8.

Figure 5.7 TSS Removal as Function of Overflow Rate for CEPT vs. Conventional Primary Treatment

Existing CEPT facilities typically employ metal salt doses in the range of 20 to 40 mg/L in combination with polymer addition (<1 mg/L), and include rapid mix and flocculation upstream of the primary clarifiers. While CEPT can be practiced by simply adding chemicals to grit tanks and primary clarifier influent channels, optimum performance depends on adequate coagulation prior to sedimentation. Jar testing is essential (and can readily be conducted) for determining the most appropriate chemical choice, dose-response relationships, and rapid mix and flocculation design parameters.

Adoption of this alternative would allow the Persigo WWTP to increase the performance of the existing two primary clarifiers and re-rate the flow and organic treatment capacity of the plant with minimal physical modifications to the existing process. A new, standalone chemical storage and feed facility with chemical dosing capabilities upstream of the primary treatment would be required. This alternative would result in long-term operational expenses related to continuous chemical addition. This might include alkalinity addition to offset the alkalinity consumed by coagulant addition depending on the chemical selection. Additional income may be generated from additional biogas production. Table 5.4 highlights the benefits and drawbacks of CEPT in-lieu of conventional primary clarifier operation.

Table 5.4 Benefits and Challenges of CEPT

Benefits	Challenges
• Increased removal of BOD_5, TSS, dissolved phosphorus, and metals. • Increases capacity of secondary treatment process. • Increased biogas production. • Improved ability to handle shock loadings/wet weather flows. • Can provide odor and corrosion control. • Enhances biological treatment performance.	• Requires chemical addition. • Increases TDS in the plant effluent and salt loads in the Colorado River. • Produces increased quantities of sludge. • Reduces alkalinity (chemical dependent). • Safety considerations related to chemical handling. • Sludge may not be as easy to dewater as conventional PS (chemical dependent). • Chemicals may have adverse impact on plant aesthetics (staining) and corrosion. • Coagulants may remove too much phosphorus making the primary effluent nutrient deficient.

5.5.2.1 Process Modeling Results

CEPT was modeled using the steady state process model in BioWin developed and calibrated for the capacity evaluation of the current facility (see Chapter 3). Table F.1 in Appendix F summarizes the model inputs and simulation results.

Under the projected 2040 ADMMF flow and organic load, steady state process modeling suggests that the WWTP has sufficient treatment capacity and can comply with effluent permit requirements and most design criteria recommended by CDPHE if primary clarifier BOD_5 and TSS removal can be increased through CEPT to at least 44 percent and 60 percent, respectively. (For comparison, the facility achieves currently approximately 31 and 50 percent BOD_5 and TSS removal in the primary clarifiers without chemical addition.) Carollo estimates that this performance can be achieved at a mainstream ferric chloride dose of about 40 mg/L. The resulting volumetric BOD_5 loading to the aeration basins with CEPT (40 ppd/1,000 cu ft) and the F:M ratio (0.26 lbs BOD_5/lb MLVSS) under 2040 ADMMF conditions are in line with CDPHE design recommendations for conventional activated sludge (20 to 40 lbs BOD_5/1,000 cu ft and F/M 0.2 to 0.4 lb BOD_5 applied/d/lb MLVSS) and therefore adequate to meet anticipated discharge requirements.

However, the parameters are above CDPHE's design parameters ranges for single stage nitrification facilities (5 to 20 ppd BOD_5/1,000 cu ft and F/M 0.1 to 0.25 lb BOD_5 applied/d/lb MLVSS) . The modeled MLSS in the aeration basins and the secondary clarifier SLR at 80 percent recycle rate are 3,750 mg/L and 22 ppd/sq ft, respectively, under 2040 ADMMF conditions. However, the projected operating parameters with CEPT at 2040 design conditions are similar to the plant rated treatment capacity as modeled in Chapter 3. Secondary treatment capacity might also be further increased by the City, should they choose to adopt CEPT in the future, by increasing the ferric dosage further above the estimated 40 mg/L upstream of the primary clarifiers. Dose-response relationships for metal salt addition and primary clarifier removal rates are ultimately most reliably determined through actual bench scale jar testing.

5.5.2.2 Chemical Dosing Requirements

Chemical dosages were estimated based on process modeling and Carollo's industry experience with operating CEPT facilities. Table 5.5 projects chemical demands through the planning horizon; these dosing rates are used in the financial analysis for CEPT as presented in Chapter 4. Due to the size and number of chemicals, a standalone chemical feed and storage facility will be required.

Table 5.5 Future Anticipated Chemical Demand for CEPT

Category	Current Conditions	13.5 mgd ADMMF Capacity
$FeCl_3$ Design Dosage, mg/L as $FeCl_3$	40	
Annual Average $FeCl_3$ Demand (gpd)[(1)]	640	860
Annual Polymer Demand (gpd)[(2)]	25	35
Annual Average NaOH Demand (gpd)[(3)]	300	400

Notes:
1) Assumes 38 percent Wt. ferric chloride.
2) Assumes active polyacrylamide concentration of 35 percent and dose of 1 mg/L.
3) Assumes 48 percent Wt. sodium hydroxide dosed to offset alkalinity consumption of ferric chloride dose.
$FeCl_3$ ferric chloride kgal kilogallon NaOH sodium hydroxide

5.5.2.3 Impact to Effluent Total Dissolved Solids

Chemical addition for CEPT adds TDS to the effluent. A 48 mg/L increase in effluent TDS should be expected under the dose assumptions stated in Table 5.5. As noted in Chapter 2, the City currently has a monthly salinity monitoring and reporting requirement in their permit for TDS. According to the current discharge permit, the total salinity loading from the WWTP already exceeds allowable limits in Regulation No. 61.

5.5.2.4 Impacts to Digestion Process

Ferric addition will increase solids loading to the digesters and dewatering system. An approximate 10 to 20 percent increase in current solids loading to the digesters may be observed based on the above assumptions, mainly in the form of chemical sludge (additional details provided in the solids handling sections below). Regardless, no additional solids handling capacity is required within the planning horizon. The increase in solids loading was accounted for in the financial analysis. Furthermore, ferric sludge in the anaerobic digesters will chemically bind hydrogen sulfide, thereby reducing corrosion potential in the digesters and dewatering equipment. The City may also observe improved solids capture and centrate quality from the dewatering process.

5.5.2.5 Carbon Redirection

The adoption of CEPT will increase the amount of influent carbon that is captured in the primaries and diverted to solids handling for anaerobic digestion. Under the dose assumptions stated in Table 5.5, Carollo estimates that the biogas production will increase by 0.006 scfm per pound of VA in the PS added to the anaerobic digesters at the 2040 planning horizon as compared to a Baseline Condition without CEPT has been included in the financial analysis.

The preliminary site layout for this alternative is shown in Figure 5.8. The site layout assumes a new slab on grade chemical storage (12,000 gallons $FeCl_3$ storage and 6,000 gallons NaOH storage for 14-day capacity) and feed facility with a building footprint of approximately 3,600 sq ft based on other similarly sized treatment facilities in Colorado. This location provides easy access for chemical deliveries and minimizes yard piping to the headworks building and primary clarifiers. Based on discussion with operations staff, the feed facility may be located in the empty lots immediately west or east of the location shown without impacting buried utilities and infrastructure. Site modifications anticipated include ancillary civil improvements and yard piping.

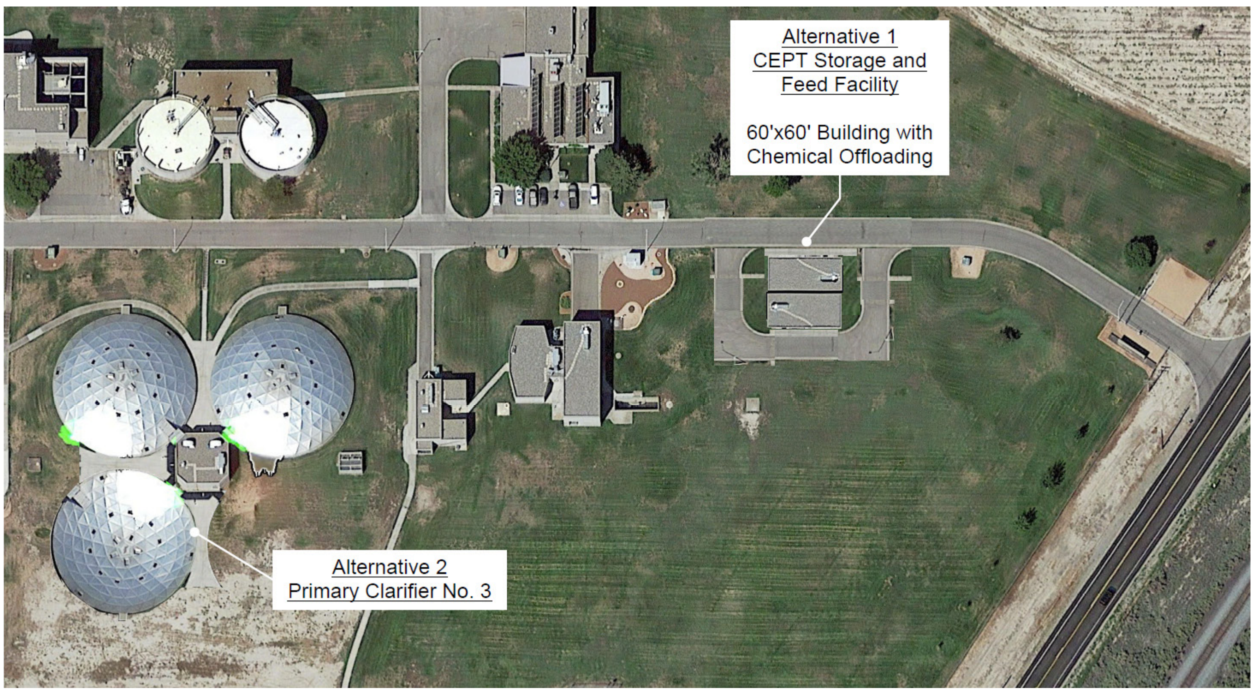
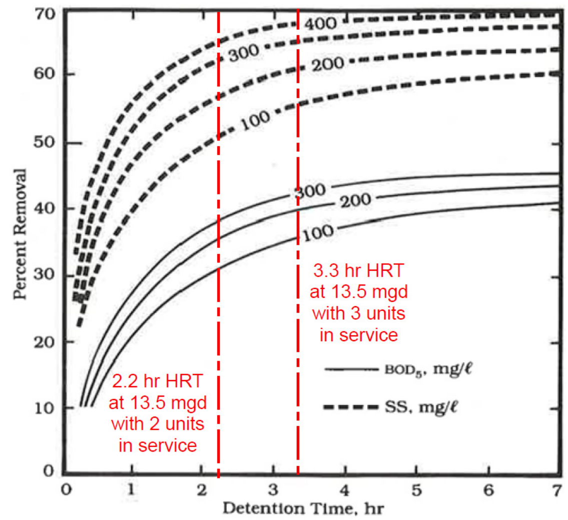


Figure 5.8 Site Layout of Primary Treatment Alternative 1 and Alternative 2

5.5.3 Alternative 2 – Primary Clarifier Expansion

Construction of a third primary clarifier was evaluated as a means for increasing the operational resiliency by providing a fully redundant treatment unit. While not required for hydraulic treatment capacity through the 2040 planning horizon as described in Chapter 3, operations staff expressed concerns about lack of redundancy with respect to operating for extended periods of time with only once clarifier in service. This alternative assumes an additional primary clarifier will be constructed and operated in the same configuration as the "Baseline Condition."

The third clarifier will improve operational redundancy and reliability and might improve BOD_5 and TSS removal performance. Adjusting the number of primary clarifiers in service increases the HRT through the online units. Figure 5.9 illustrates the typical relationship between TSS and BOD_5 removal versus HRT for conventional primary treatment, as published in literature (Reynolds/Richards, 1996). This illustration indicates that as the HRT increases, BOD_5 and TSS removal also increases. As removal efficiencies increase through the primary treatment process, additional secondary treatment capacity will be achieved. It is difficult to predict this theoretically as the clarifier settling performance depends on the fraction of slowly settleable and colloidal solids in the wastewater influent which are not directly measured. Modeling predictions can be verified again using bench scale settling tests.



(Source: Reynolds/Richards, 1996)

Figure 5.9 Typical TSS and BOD_5 Removal vs. HRT for Primary Treatment

5.5.3.1 Site Layout

The preliminary site layout for this alternative is shown in Figure 5.7. The site layout assumes a new primary clarifier construction immediately east of the existing units and tied into the current PS pump station complex. New primary influent piping would be installed in the yard from the existing pipe stub out located in Control Structure No. 1. New PS pumps would be installed in the basement of the existing pump station to serve the new clarifier unit.

5.5.4 Financial Comparison of Primary Clarifier Alternatives

The total project cost for each of the three alternatives are presented in Table 5.6 for a capacity of 13.5 mgd ADMMF. A detailed breakdown of cost estimating assumptions for each alternative can be reviewed in Appendix D.

Table 5.6 Capital Cost Comparison of Primary Treatment Alternatives(4)

Baseline Condition(1)	Alternative 1 – CEPT(2)	Alternative 2 – Conventional Clarifier Expansion(3)
$3.9 million	$11.9 million	$10.3 million

Notes:
(1) Baseline condition costs developed as part of Chapter 4 Asset Revitalization improvements for primary clarification.
(2) Alternative 1 cost estimate includes costs for the Baseline Condition and new chemical feed facility, which is estimated to equal $8.0 million.
(3) Alternative 2 cost estimate includes costs for the Baseline Condition and addition of a third primary clarifier.
(4) All dollars shown in 2021 values for comparison purposes. Escalation to future cost will be included as part of the implementation plan in Chapter 8.

A life-cycle cost analysis was completed for the CEPT system and is presented below as part of the Secondary Treatment Alternatives.

5.5.5 Implementation Recommendations

Based on the financial and non-economic evaluations, Carollo recommends including the Baseline Condition improvements into the City's future capital plan and adding the third clarifier as discussed under Alternative 2. The combined cost of this implementation recommendation is $10.3 million, as shown in Table 5.6.

Alternative 1, CEPT treatment, was eliminated by the City from consideration due to financial, safety, and operational concerns associated with the CEPT facility. Instead of a new facility, the City can use the existing Ferric Chloride Facility located in and feeding the collection system to test and monitor the impacts of chemical dosing on the primary clarifier removals. Carollo recommends that the City consider conducting jar testing to develop dose response curves for CEPT based on the City's raw influent wastewater composition and tests testing the removal rates as a function of HRT in the clarifiers. Alternatively, the City may consider increasing ferric addition in the collection system (already existing) and employing the system year-round to convert a portion of the influent colloidal BOD_5 to a particulate form that is better removed in the existing primary clarifiers.

In developing the primary clarifier implementation plan, recommended projects are listed in Table 5.7.

Table 5.7 Primary Clarifier Implementation Recommendations

Implementation Period	Identified Projects
2021-2025	1. Replace and rehabilitate assets per Baseline Condition defined in Chapter 4. 2. Conduct jar testing to determine dose response curves for ferric chloride addition using the ferric feed system in the collection system. 3. Test BOD_5 and TSS removal rates as a function of HRT in the primary clarifiers. 4. Construct the third primary clarifier for operational reliability and redundancy.
2025-2030	None identified.
2031-2040	None identified.

5.6 Flow Equalization Basin

The FE basin is a critical component to maintaining the plant's rated peak hour flow capacity and minimize the infrastructure requirements downstream of the primary clarifiers, as stated in Chapter 3. However, the existing mixing system and the controls for the FE basin are reaching the end of their useful life and require replacement. As part of the FE basin analysis, Carollo assessed how to increase the functional volume and operational flexibility of the FE basin. Figure 5.10 shows existing floating surface aerators and FE basin.

Figure 5.10 Floating Surface Aerators and FE Basin

5.6.1 Baseline Condition

The Baseline Condition assumed replacement of the existing floating mixers in-kind with the same number of units. The floating mixers gently draw water up from below using a high-volume axial pump (or similar) to generate an upward and a subsequent long-distance horizontal flow movement. The horizontal and vertical flow circulation pattern created prevents settling of solids and can promote some level of oxygen transfer to reduce the potential for odors and anaerobic conditions in the basin. The surface mixers can be electrically powered (to match existing) or supported by a solar array. The solar powered mixers can have their arrays mounted on the unit inside the basin or mounted on the shore.

Table 5.8 highlights the benefits and challenges of maintaining floating-type mixers in-lieu of an alternative mixing technology. A known limitation of the floating surface mixers is that they require a minimum of 3 to 4 feet of liquid volume in the FE basin at all times during normal operation, which accounts for 25 to 35 percent of the total equalization capacity. The City may unlock additional flow equalization capacity and operational flexibility by switching to a mixing technology that does not require a minimum operating water depth.

Table 5.8 Benefits and Challenges of Floating Surface Mixers in FE Basins

Benefits	Challenges
• Low energy technology (low hp to MG basin volume). • Low or no power consumption. • Can run dry without damaging the equipment. • Can output to SCADA, if desired. • Minimal maintenance required.	• May form dead zones below the mixer. • 4-foot minimum water depth required for mixing, which limits the usable FE basin volume. • Solar battery replacement every 7 to 10 years (if solar powered). • Excessive solids and rags may get trapped in mixers if raw influent is bypassed to the FE basin. • Electrical components are located inside the FE basin.

The Baseline Condition also addressed the electrical and controls improvements associated with the FE basin Building as identified in Chapter 4. The following alternative assesses a different type of mixing technology for the FE basin.

5.6.2 Alternative 1 – Large Bubble Compressed Gas Mixing System

Large bubble compressed gas mixing is a relatively new technology for mixing flow equalization basins and unaerated zones. First systems have been installed in Colorado in recent years. Large bubble mixing systems provide mixing through short bursts of compressed air intermittently fired in fractional second durations through engineered nozzles, simultaneously displacing and providing mixing to the surrounding liquid (Figure 5.11). The rapid upward velocity of the air through the water column, when combined with the relatively large bubble size, transfers an insignificant amount of oxygen to the wastewater.

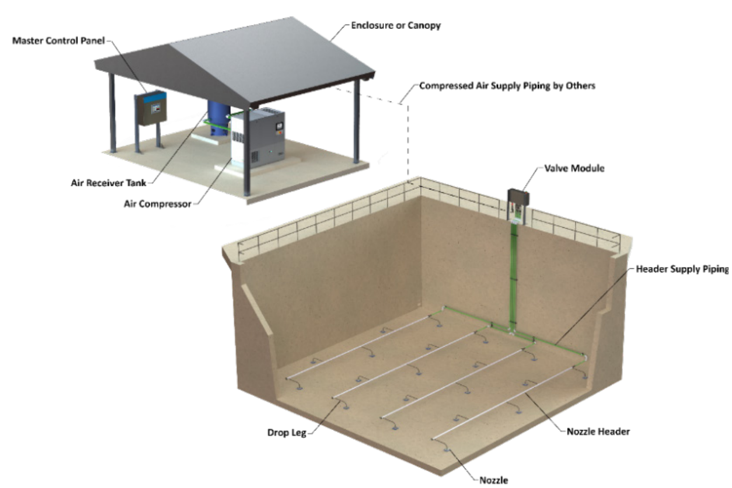


Figure 5.11 Subsurface Large Bubble Mixing System in FE Basins

The short bursts of air can be optimized to control firing pressure, sequence, frequency, and duration for each zone. The large bubble mixing system has no submerged mechanical components, providing easy maintenance on the system. Additionally, the maintenance is limited to the master control panel and air compressors, significantly fewer components than floating surface mixers. The main advantage of this alternative type of mixing system is that the City would gain an additional 3 to 4 feet of working volume in the FE basin, as there is no minimum working volume restriction. Based on a budgetary estimate obtained from EnviroMix, a vendor of this type of mixing technology in the United States, the general scope of supply for a large bubble compressed gas mixing system for Persigo WWTP would include; one master control panel, 10 valve modules, 1,392 mixing nozzles at the basin floor with associated stainless steel air piping, two 150-hp rotary screw compressors, and two vertical air receiver tanks.

Table 5.9 highlights the benefits and challenges of adopting large bubble compressed gas mixing in-lieu of an alternative mixing technology.

Table 5.9 Benefits and Challenges of Large Bubble Compressed Gas Mixing

Benefits	Challenges
• No minimum operating depth requirements. • No submerged mechanical systems or moving parts. • No electrical components in the water. • Higher degree of flexibility for control of mixing energy. • Fewer mechanical units/lower maintenance requirements. • Higher energy-efficiency compared to other mechanical mixers.	• Higher capital cost than floating surface mixers. • Potentially higher operating energy due to compressor operation at altitude. • More advanced controls required compared to floating surface mixers. • Permanent mounting of diffuser grids to the basin floor could limit ease of FE basin cleaning.

Other energy efficient mixing systems are available on the market such as top-mounted mechanical or hydraulic mixers (such as INVENT mixers). Top mounted mixers were not considered for the FE basin due to the very large span between the concrete walls.

5.6.3 Financial Comparison of FE Basin Alternatives

The capital costs for the two FE basin mixing alternatives are included in Table 5.10.

Table 5.10 Capital Cost Comparison of FE Basin Alternatives

Baseline Condition	Alternative 1 – New Mixing System
$1.3 million	$9.0 million

Notes:
(1) Baseline condition costs developed as part of Chapter 4 Asset Revitalization improvements for flow equalization basins.
(2) Alternative 1 cost estimate includes costs to install a new large bubble compressed gas mixing system.
(3) All dollars shown in 2021 values for comparison purposes. Escalation to future cost will be included as part of the implementation plan in Chapter 8.

Appendix D includes additional cost estimating assumptions and details.

5.6.4 Implementation Recommendations

Based on the magnitude of capital cost differences, uncertainties with peak flow measurement, and impacts of the existing hydraulic limitations in Control Structure No. 1, it is recommended the following implementation steps be completed, as shown in Table 5.11.

Table 5.11 Flow Equalization Basin Implementation Recommendations

Implementation Period	Identified Projects
2021-2025	1. Correct the Control Structure No. 1 hydraulic limitations, as described in Chapters 3 and 6. 2. Perform year-long data collection and assessment of peak flow conditions to assess actual peaking factors.
2025-2030	1. Implement asset revitalization recommendations for the Baseline Condition, as described in Chapter 4.
2031-2040	None identified.

It is not recommended at this time to include the large bubble compressed gas mixing system due to the significant difference in capital costs. However, this should be re-evaluated in the future prior to replacing the floating mixers to determine if additional equalization volume may be needed based on updated assessment of the peak flow conditions following correction of the hydraulic bottleneck in Control Structure No. 1.

5.7 Secondary Treatment Capacity-Driven Alternatives

Figure 5.11 illustrates the secondary treatment alternatives that were considered by the project team for addressing three key drivers for aeration basin improvements: 1) Increased secondary treatment capacity; 2) Opportunities to reduce energy consumption; and 3) Maintaining operational simplicity. While intensification technologies such as integrated fixed film activated sludge (IFAS), BioMag ballasted activated sludge, and sludge granulation can meet the City's key drivers for future improvements, the associated capital cost for implementation are greater than other viable alternatives in this evaluation and were therefore not considered further.

Traditional aeration basin expansion was also discussed as a viable option with plant staff. This alternative does only need to be considered by the City in the long-term should other viable options discussed in the following, like improved SRT and aeration control, or chemical addition to the collection system (also termed CEPT in the following), fail to yield additional treatment capacity through the 2040 planning horizon.

The following process alternatives were ultimately carried forward for detailed evaluation:

- Baseline Condition with Aeration Basin expansion.
- Alternative 1: CEPT.
- Alternative 2: Improved SRT and Aeration Control Automation.

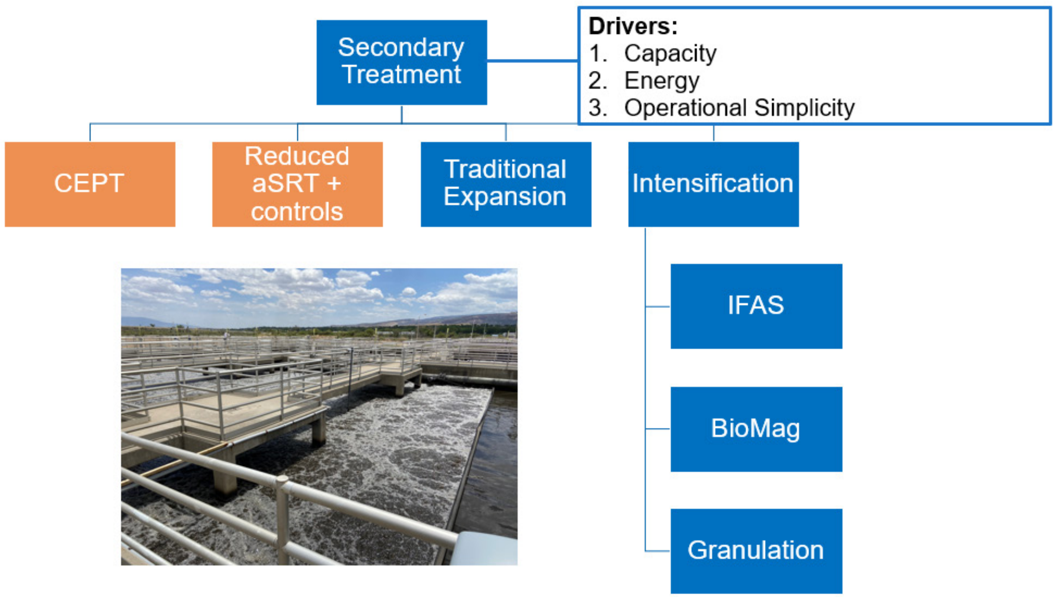


Figure 5.12 Overview of Secondary Treatment Alternatives

5.7.1 Baseline Condition

The Baseline Condition for secondary treatment generally consisted of a combination of asset replacement needs through the 2040 planning horizon as identified in Chapter 4. The following infrastructure improvements were identified as part of the recommended baseline upgrades:

- Testing and cleaning of the ceramic diffusers and diffuser replacements as needed in future.
- Aeration control improvements with upgrades to piping and valves.
- Replacement of mixers, submersible MLR pump, valve stems and gates, instrumentation.

The Baseline Condition includes a capital cost estimate for conventionally expanding either the east or west aeration basin treatment train to the south, as shown in the WWTP's record drawings, to achieve a secondary treatment capacity of 13.5 mgd. While operations staff did not raise concerns regarding aeration basin redundancy, Carollo recommends that the City develop contingency plans for taking an aeration basin out of service for routine maintenance and emergency repairs under current and future flows and loads. Historically, aeration basin MLSS concentration has varied seasonally between about 1,500 mg/L (summer) and 3,000 mg/L (winter) at aSRT values ranging from 6 to 8 days, respectively. These conditions suggest that the WWTP may already be capacity limited, at least seasonally, should a basin need to be taken offline for an extended period due to baffle wall repairs, diffuser repairs, or annual cleaning. The capacity limitation will become more critical, with shorter seasonal periods to take a unit out of service, as flows and loads increase through the planning horizon.

5.7.1.1 Site Layout

The preliminary site layout for the baseline alternative is shown in Figure 5.13. The site layout assumes a conventional expansion of either the east or west treatment train to meet a 13.5 mgd ADMMF treatment capacity in the future, should the WWTP be unable to successfully demonstrate adequate secondary treatment capacity, as a last resort. The site layout also shows the location for a fourth secondary clarifier for operational redundancy, as described further below.

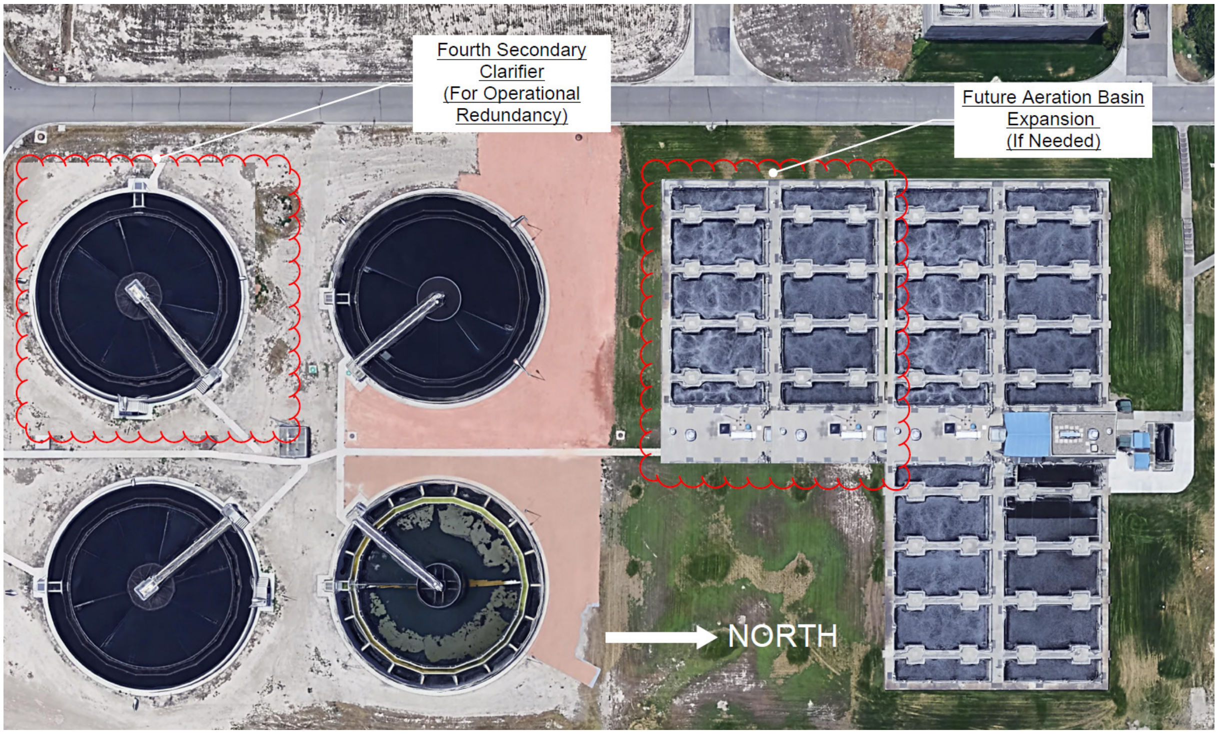


Figure 5.13 Site Layout of Secondary Treatment Baseline Alternatives

5.7.2 Alternative 1 – Chemically Enhanced Primary Treatment

As described in Section 5.5, the implementation of CEPT (through chemical addition into the collection system) is anticipated to increase the performance of the existing two primary clarifiers and provide an opportunity to re-rate the organic treatment capacity of the plant with minimal physical modifications to the secondary treatment process. As discussed, the direct addition of chemicals to the primary clarifiers was not recommended at this time due to high capital costs. The effectiveness of chemical addition to the collection system is recommended to be verified through field testing. The calibrated steady state process model indicated there is sufficient secondary treatment capacity if current BOD_5 and TSS removal efficiencies can be increased to at least 44 percent and 60 percent, respectively. The current removal efficiencies are 31 and 50 percent for BOD_5 and TSS, respectively. Additional information is included in Appendix F.

5.7.3 Alternative 2 – Enhanced SRT and Aeration Control

A growing number of facilities in Colorado and other states have started to implement real-time advanced process control systems. Specifically, two process areas stand out for promising return-of-investments:

1. Real-time solids inventory contollers (SRT controllers).
2. Advanced aeration control systems.

These control systems have resulted in capacity enhancements, energy savings, and easier process operation for facilities.

Typically, process changes for solids inventory control are made by operators on a daily or weekly basis. For example, SRT adjustments are made by operators through manual setpoint changes for wasting flows based on data received from samples collected hours or days earlier. Even though most operators believe they have a good handle on wasting as MLSS concentrations are relatively stable over time, Carollo and others have demonstrated that the operation is not efficient. At typically operated facilities, SRT values vary over time by about 20 to 30 percent around a given target SRT. Using real-time SRT controllers, Carollo and others have showed at several facilities that SRT variability can be reduced to less than a fraction of a day or about 5 percent variability. Controlling the SRT each hour of the day in the aeration basins has resulted in drastic, unexpected SVI improvements and filament reduction. Reducing the SRT variability also allowed for reducing the overall operating SRT while still allowing full nitrification. Facilities ended up with more capacity and better effluent quality.

A growing number of facilities have over the past years implemented alternative aeration control systems to conventional proportional-integral-derivative (PID)-based DO control. Advanced systems control aeration based on ammonia or ammonia and nitrate in addition to DO. Ammonia based aeration control adjusts DO concentrations to be just enough for full nitrification without overaerating. The influent diurnal flow and load patterns cause high variability throughout the day in terms of aeration demands and effluent nutrient concentrations. Process automation and controls can decrease the variability, stabilize the treatment performance, save energy, and improve the effluent quality. Improved alkalinity management in the aeration basins through improved denitrification could be a side benefit. First, new commercial aeration control systems combine ammonia-based aeration control with predictive control algorithms. These controllers achieve even higher energy savings and control accuracy.

Carollo recommends that the City implement real-time SRT and advanced aeration control systems near-term. There are several automated control system options available to the Persigo WWTP. A more detailed evaluation of the process control automation solutions and associated required online probes should be conducted when upgrading the existing aeration system and be completed in parallel with the Blower Building improvements.

5.7.3.1 Process Modeling Results

The capacity gains with real-time SRT control were evaluated in BioWin (see results included in Appendix E) using the steady state process model developed and calibrated for the capacity evaluation of the current facility (see Chapter 3). Steady state process modeling suggests that the WWTP has sufficient treatment capacity to meet the 2040 planning conditions if the design aSRT of 8 days (as demonstrated in Chapter 3) can be reduced to approximately 6.3 days. Note that the modeled BOD_5 loading to the aeration basins (50 ppd/1,000 cu ft) and the F:M ratio (0.31 lb BOD_5/lb MLVSS) are above the CDPHE design recommendations (5 to 20 ppd BOD_5/1,000 cu ft for single stage nitrification and 20 to 40 ppd BOD_5/1,000 cu ft for conventional activated sludge) and exceed design values observed at other Colorado facilities. Should the City select this alternative for demonstrating treatment capacity through the 2040 planning horizon, Carollo recommends the following:

- Evaluate automated aSRT control options and impacts of reducing the SRT safety factor to demonstrate additional secondary treatment capacity. This is particularly important given that projected BOD_5 loading to the aeration basins will exceed the criteria recommended by CDPHE, and a site-specific variance may be required.

- Operate the aeration basins and secondary clarifiers as a combined MLSS system, rather than a separate sludge system. Operating as a combined MLSS system allows all three secondary clarifiers to be in service with equal flow split, which helps to maintain SLR and SOR below CDPHE design criteria.
- Investigate the discrepancy between PS reported by the WWTP and calculated PS based on primary influent and effluent water quality data. As discussed in Chapter 3, the calculated primary clarifier percent removals and mass balance calculations may be unreliable for several reasons. Therefore, the project team agreed to adjust the primary clarifier percent removals in the calibrated BioWin model to achieve acceptable calibration with historical secondary treatment performance. This assumption has a direct impact on modeled treatment performance herein and therefore operations staff should investigate opportunities to close the mass balance and verify the assumptions adopted in this Master Plan. This information will be critical when pursuing a capacity re-rating through CDPHE.
- Install additional air flow monitoring for aeration, which includes flowrate, pressure, and temperature monitoring on the blower inlet and/or discharge to optimize blower sizing based on current conditions. At this time, the installed flow meters only report air flow in cubic feet per minute (cfm) at site conditions and there is no instrumentation currently installed to monitor both temperature and pressure in the system. Therefore, a conversion from cfm to scfm to accurately size aeration equipment during the 2020 Master Plan was not possible. Table 5.12 highlights the benefits and challenges of pursuing a secondary treatment capacity expansion under Alternative 1. Additional details regarding SRT control and aeration control automation are provided in subsequent sections.

Table 5.12 Benefits and Challenges of Enhanced SRT and Aeration Control

Benefits	Challenges
• Capacity improvements without physical expansion of the existing aeration basins. • Maximizes the use of existing assets over the 20-year planning horizon. • Improved controls can improve nitrate removal, thereby recovering additional alkalinity. • Improved controls can reduce energy demands associated with aeration.	• Additional probes and instrument maintenance required. • Aeration basin BOD_5 loading may exceed design values recommended by CDPHE. The WWTP may need to pursue a site-specific design variance. • The WWTP may need to operate with all three secondary clarifiers in service and as a combined MLSS system to demonstrate adequate secondary clarifier capacity.

5.7.3.2 Site Layout

There are no changes to the facility layout as part of this secondary treatment alternative.

5.7.4 Financial Comparison of Secondary Treatment Capacity Alternatives

The total project cost and 20-year operating costs for each alternative are presented in Table 5.13 for a capacity of 13.5 mgd ADMMF. A detailed breakdown of cost estimating assumptions for each alternative can be reviewed in Appendix D. Appendix F includes the operating assumptions and financial models for the calculated NPV values. Alternative 1 (CEPT) includes addition of chemicals upstream of the primary clarifiers and costs for a chemical feed facility.

Table 5.13 Financial Comparison of Secondary Treatment Capacity Alternatives(1)

Category	Baseline Condition(2)	Alternative 1 – CEPT(3)	Alternative 2 – Enhanced SRT and Aeration Control(4)
Project Cost	$15.0 million	$10.4 million	$15.6 million
O&M (20-year)	$--million	$10.3 million	($0.8 million)
Total NPV	**$15.0 million**	**$20.7 million**	**$14.8 million**

Notes:
(1) Costs shown in 2020 dollars. O&M costs shown are comparative to existing conditions for purposes alternative selection.
(2) The Baseline Condition cost estimate includes the $2.4 million for the baseline asset replacement needs as identified in Chapter 4 and capital costs for a 1.6-mgd aeration basin expansion.
(3) Alternative 1 cost estimate includes baseline asset replacement costs and $8.0 million for CEPT facility as estimated in Table 5.13.
(4) Alternative 2 cost estimate includes the Baseline Condition costs and the enhanced SRT and aeration control improvements.

5.7.5 Implementation Recommendations

Based on financial comparison and non-economic benefits for each alternative, the baseline improvements coupled with Alternative 2 – Enhanced SRT and Aeration Control are recommended for the implementation. plan. Note that the total project cost of $15.6 million for Alternative 2 includes the capital costs for the Baseline improvements. Table 5.14 includes a list of recommended projects.

Table 5.14 Secondary Treatment Capacity Recommendations

Implementation Period	Identified Projects
2021-2025	1. Complete the baseline asset replacement and renewals for aeration basins and implement aSRT controls (Alternative 2).
2025-2030	None identified.
2031-2040	1. Increase capacity of the activated sludge system to improve overall reliability and redundancy of activated sludge process. 2. Replace the existing diffusers, if needed based on performance testing and cleaning

Additional asset replacements and improvement projects for blowers, and clarifiers are shown below.

5.8 Secondary Process and Operational Improvements

In addition to capacity driven secondary treatment alternatives, the project team also investigated process alternatives that would improve the current operability and reliability of the existing system. These alternatives included:

- Construction of a new, standalone blower building sized for the 2040 planning horizon.
- Construction of a fourth secondary clarifier.
- Alkalinity addition or recovery.

5.8.1 New Blower Building

As previously noted, the WWTP struggles with DO control and maintaining the existing aeration blower system. Per discussions with operations staff, there is insufficient turn down and overlap in the existing blower system to maintain stable DO concentrations on a year-round basis. This has led to inconsistent biological treatment performance in the aeration basins, including periods of hindered nitrification and denitrification performance, and alkalinity recovery.

The blowers are also located in the basement of the aeration basin complex with the RAS and WAS pumps, which poses a risk to the City should a significant failure in one of these pumping systems occur and the basement become flooded. Climate control in the basement area was also noted as a challenge by operations staff during site visits by the project team; it is difficult to maintain air temperatures in the space to avoid overheating equipment, particularly during the summer months with multiple blowers are in service.

Lastly, the City is interested in installing more energy efficient blowers in the near future, which may be difficult to sequence into the existing space while maintaining the current blowers in service through construction. A new blower facility has been recommended and included in the implementation schedule, in Chapter 8, for this 2020 Master Plan.

5.8.1.1 Blower Technology Overview

Blower technologies that the City may consider as part of the blower replacement project include positive displacement (PD) blowers and centrifugal blowers (similar to what is currently installed). Table 5.15 lists the viable blower technologies and provides an abbreviated summary.

High speed turbo blowers can be utilized to reduce energy use and costs, which operate at a high rotational speed (up to 50,000 revolutions per minute [rpm]). These blowers require special bearings, air or magnetic, that theoretically do not wear and require no lubrication while the other blowers all use traditional film bearings and lubricating oil or grease. These blowers have been shown to reduce energy between 15 to 30 percent when compared to multi-stage centrifugal blowers.

PD blowers also offer reduced energy consumption as compared to multi-stage centrifugal blowers but operate on a different mechanical principle. For PD blowers, fixed volumes of air at the inlet are trapped between lobes or screws. As the lobes or screws rotate against each other, the volume where the air is trapped changes, compressing the air and then releasing it into the blower discharge in discrete packets of compressed air. This operating principal does not generate surge, and lobe and screw blower manufacturers do not need to specify a dead band at high-pressure conditions. This type of blower has gained increasing interest from small to medium sized facilities for secondary treatment aeration in recent years.

Table 5.15 Abbreviated Summary of Aeration Blower Technologies

Blower Type	Efficiency (%)	Capacity Range (scfm)	Turndown (%)	Bearing
PD				
Lobe Blower	45-60	100-3,500	30	Traditional - Oil
Low Pressure Screw	70-80	500-2,000	30	Traditional - Oil
Centrifugal				
Multistage	60-75	750-35,000	50	Traditional - Oil
Single Stage	70-80	2,000 - 80,000+	45	Traditional - Oil
High-Speed	70-80	500 - 8,000	50	High Speed - Air/Magnetic

At this level of planning, the equipment costs for the different blower technologies are not significantly different to urge a blower type selection for this 2020 Master Plan. Note, however, that newer blower technologies such as high-speed turbo and low-pressure screw blowers provide much higher energy efficiency (and thus lower operating costs) as compared to the existing multi-state centrifugal blowers. Carollo recommends that energy efficiency be closely evaluated by the facility as part of the future design project and final technology selection. As part of the conceptual design of the new Blower Facility, the City will conduct a detailed alternatives evaluation of the available blower technologies. That evaluation will evaluate in detail the current and projected air demands through the 2040 planning horizon. At this time, the installed flow meters only report air flow in cfm at site conditions and there is no instrumentation currently installed to monitor both temperature and pressure in the system to accurately convert the data to scfm. These recommended improvements were included in the secondary treatment baseline alternatives previously described.

5.8.1.2 Site Layout

The preliminary site layout for the new Blower Building is shown in Figure 5.14. The size of the new blower facility is based on a similarly sized and configured reference WWTP with a design capacity of 13 mgd ADMMF. The 70-foot by 30-foot building footprint includes space for up to five multi-stage centrifugal blowers paced approximately 9 feet on center. The footprint also includes space for a dedicated electrical and control room to support the new blower system.

Conservatively, multi-stage centrifugal blowers were used as the representative technology as they require the largest footprint. It is recommended the City complete a blower technology evaluation and to determine if facility footprint reductions can be achieved by reducing number of blowers or using more compact blower technology.

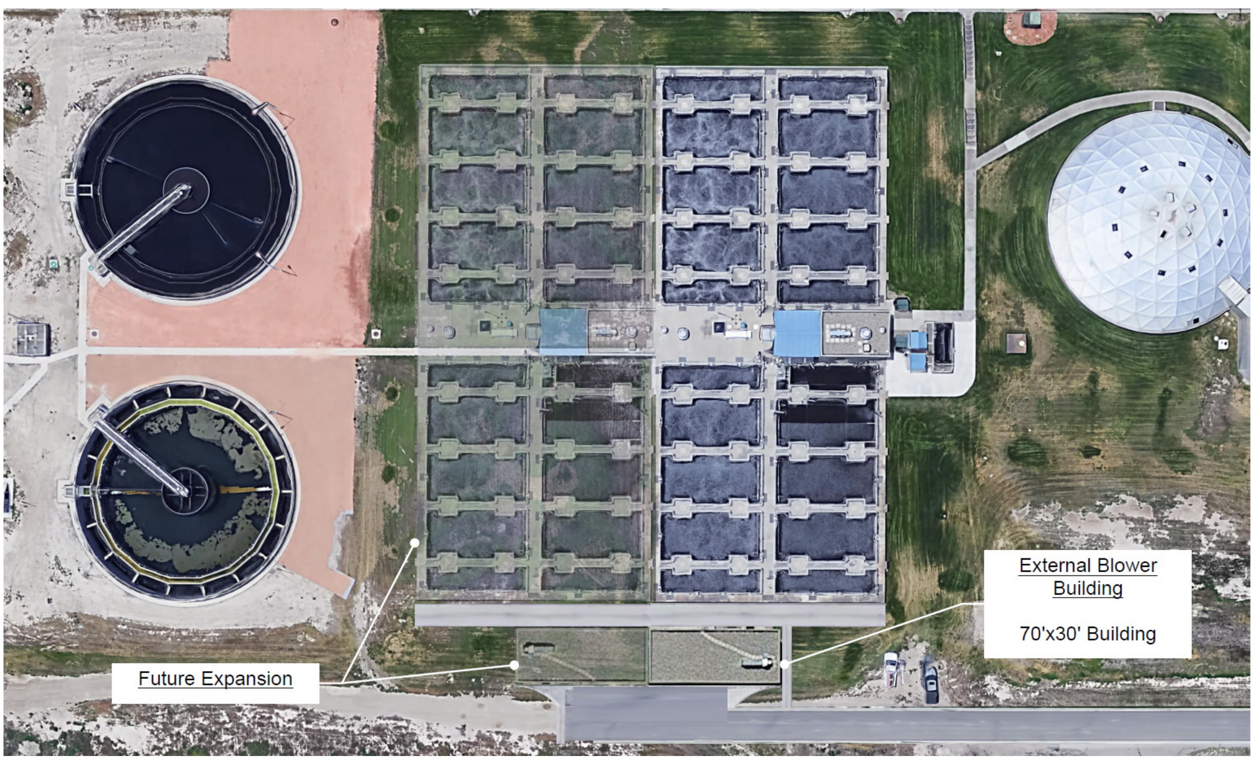


Figure 5.14 Site Layout of New Blower Building

5.8.2 Secondary Clarifier Improvements

As stated in Chapter 4, there are asset renewal projects for the secondary clarifiers, which mainly include clarifier mechanism replacements and pumping infrastructure replacements. There is adequate secondary clarification capacity to meet the 2040 planning conditions, as described in Chapter 3. To achieve the operational reliability and redundancy goals, staff set an operational goal to have a redundant clarifier available when three units are in service. As a result, a fourth secondary clarifier has been included as part of the implementation planning to increase process reliability and redundancy.

5.8.3 Alkalinity Improvements

As summarized in Section 5.6, alkalinity improvements will be addressed as part of the following secondary treatment alternatives:

1. **Alternative 1 – CEPT:** Chemical addition in the collection system or upstream of the primary clarifiers will include a chemical storage and feed system to, at a minimum, offset the alkalinity consumption associated with coagulant (e.g., ferric chloride) addition. This 2020 Master Plan assumes that caustic will be stored and dosed noting that there are other chemical alternatives. During preliminary design, the City may also consider increasing the alkalinity storage volume such that operations staff may also dose caustic in excess of the alkalinity demand noted above to offset seasonally low alkalinity levels in the influent to help stabilize final effluent pH.
2. **Alternative 2 -SRT and Aeration Control:** By optimizing the secondary treatment process through improved aeration control, alkalinity is anticipated to be recovered through improved denitrification performance. This is a lower cost solution to improving the overall alkalinity management in the secondary treatment process, as compared to long-term chemical addition.

5.8.4 Financial Comparison of Secondary Process and Operational Improvements

The total project cost for the secondary treatment process (i.e., aeration basins through the secondary clarifiers) and operational improvements are presented in Table 5.16 for a capacity of 13.5 mgd ADMMF. A detailed breakdown of cost estimating assumptions for each alternative can be reviewed in Appendix D.

Table 5.16 Financial Comparison of Secondary Treatment Process and Operational Improvements

Category	Capital Costs
Blower Building with new Switchgear	$12.4 million
Fourth 115-foot Diameter Secondary Clarifier	$6.5 million

Additional asset renewal projects for the clarifier mechanism replacements and for RAS/WAS pumping are included in Chapter 4.

5.8.5 Implementation Recommendations

Based on common improvements for the Secondary Treatment Facilities, Table 5.17 identifies the recommended timing of projects discussed above.

Table 5.17 Secondary Process and Operational Implementation Recommendations

Implementation Period	Identified Projects
2021-2025	1. Construct a new Blower Building.
2025-2030	1. Replace and rehabilitate secondary clarifier asset projects as identified in Chapter 4.
2031-2040	1. Build the fourth secondary clarifier. 2. Complete the RAS/WAS asset renewal projects as identified in Chapter 4.

5.9 UV Disinfection and Effluent Flow Monitoring

The main operational challenges associated with the UV system are centered around hydraulic limitations and operational redundancy and reliability. To address these challenges, the following alternatives were developed. Assuming the UVT is maintained at a minimum of approximately 60 percent, the existing UV system has sufficient capacity for the 2040 planning period.

5.9.1 Baseline Condition

The Baseline Condition addressed the immediate hydraulic limitations with the existing UV system configuration. The following solutions were identified and included as part of the Baseline Condition:

- Assess the viability of the hydraulic improvements with computational fluid dynamics (CFD) modeling. Distributing the flow and decreasing the velocity in front of the first UV bank is important to provide a consistent disinfection profile across the entire flow path. As seen exemplarily in Figure 5.14., CFD modeling demonstrated for another similar UV system that uniform flow can be achieved with the addition of a perforated baffle wall upstream of the first UV bank.
- Improving the hydraulic conditions prior to the first bank of UV bulbs could include smoothing the corner of the wall at the 180-degree turn, installation of a baffle plate upstream of the first bank, or a combination of the two.

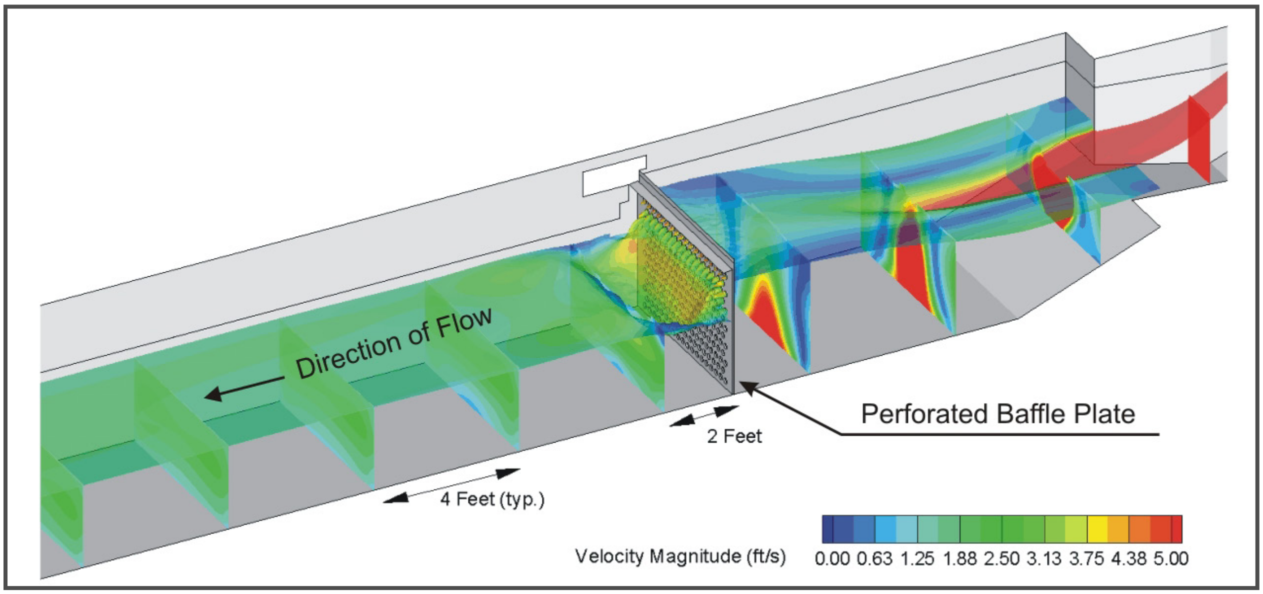


Figure 5.15 Example of CFD Modeling for UV Disinfection System

- Relocate the effluent flow measurement location to a manhole downstream of the UV system, as the existing Parshall flume is submerged during periods of high flow and does not provide accurate flow measurement. Figure 5.16 shows the proposed location to install a Flo-Dar type of measurement device.
- To address the redundancy and reliability challenges associated with the UV system, Carollo recommends that the City purchases nine UV modules as shelf spares. Maintaining a redundant set of modules to replace an entire bank will allow staff to switch the modules and minimize downtime. Additionally, the City is planning to install an emergency diesel generator, which will eliminate outages during a power failure.

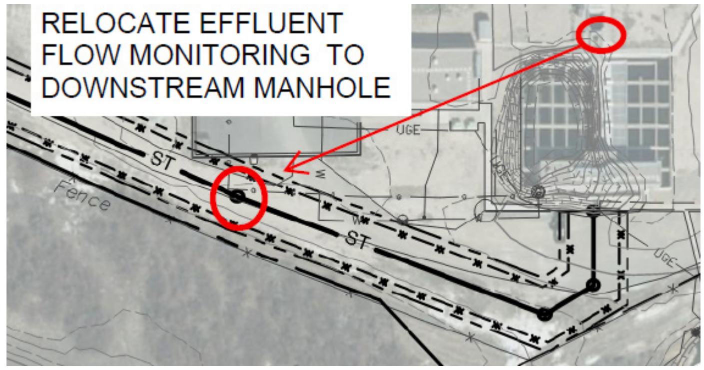


Figure 5.16 Relocated Effluent Flow Monitoring Location

- A bench UVT instrument is recommended to verify the UVT data recorded by the field instrument and future monitoring of the possible relationship between the UVT and SVI trends should be recorded to understand this relationship due to the significant impacts the decrease in UVT has on the system capacity rating as discussed in Chapter 3.
- The Baseline Condition also identified replacing the UV system with newer and more efficient technologies after the system has reached the end of its useful life. It is anticipated this would occur around the 2030 time period.

5.9.2 Alternative 1 – Operational Redundancy for UV System

Alternative 1 includes completing the improvements identified in the Baseline Condition and installing a redundant UV system on the opposite side of the contact basin. Figure 5.17 illustrates the proposed solution. The alternative eliminates the single point of failure associated with the existing downward opening slide gate and allows the City additional flexibility during construction sequencing to replace the existing UV banks as discussed in the Baseline Condition.

The new system would employ an alternative effluent level control strategy as compared to the existing gate configuration. The existing channel has suitable space and volume to install an effluent level control finger weir. Figure 5.18 shows an example of the type of weir. Using an effluent weir decreases the hydraulic losses during peak flows and more accurately maintains submergence across the UV lamps for optimal disinfection.

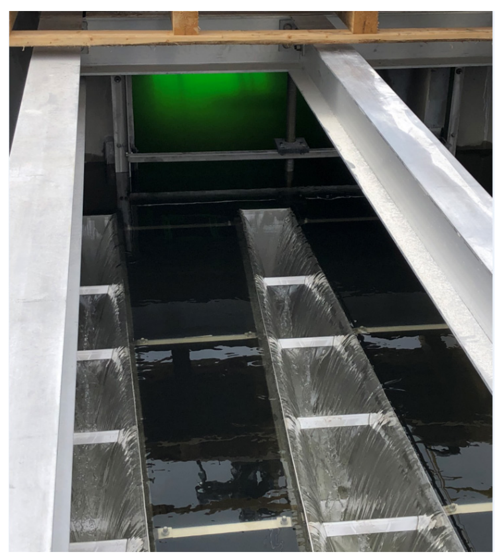


Figure 5.17 Example of Effluent Finger Weir Installed for Level Control

Installation of a redundant system in the recommended timeframe, has the advantage of deferring the replacement of the existing UV system and additional hydraulic improvements on the east of the basin after 2030 when the system has reached the end of its useful life.

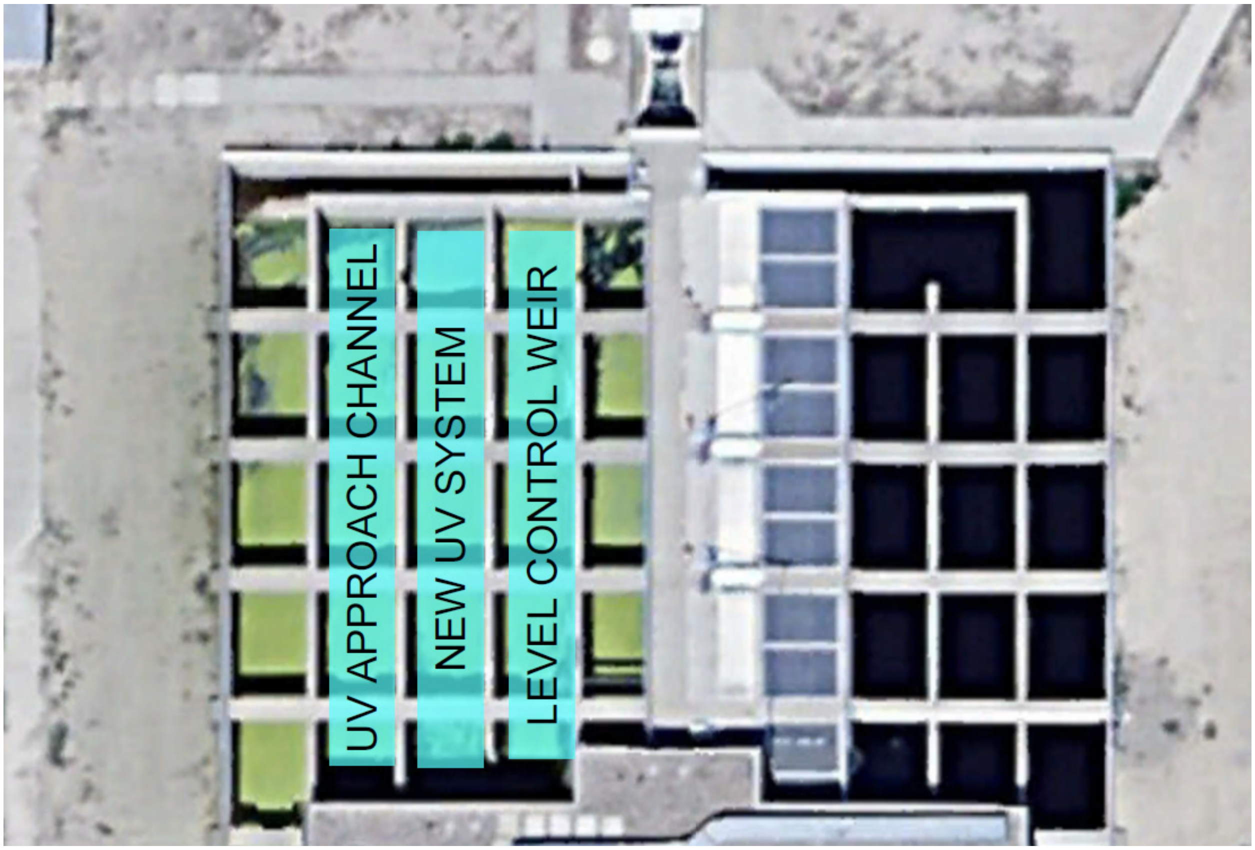


Figure 5.18 Capacity and Redundancy Alternative – New UV Bank

5.9.3 Financial Comparison of UV Alternatives

The capital costs for the UV disinfection alternatives are included in Table 5.18.

Table 5.18 Capital Costs for UV Disinfection Recommendations

Baseline Condition	Alternative 1 – UV Expansion and Hydraulic Improvements
$5.5 million	$13.2 million

Notes:
(1) Baseline condition costs developed as part of Chapter 4 Asset Revitalization improvements for UV system and associated plant water pumping infrastructure.
(2) Alternative 1 cost estimate includes costs to install a new UV system in the adjacent channels as shown in Figure 5.17 and replace the existing UV system.
(3) All dollars shown in 2021 values for comparison purposes. Escalation to future cost will be included as part of the implementation plan in Chapter 8.

These alternatives are not mutually exclusive and more closely represent an implementation plan to increase the operational reliability and efficiencies of the disinfection system. The costs for Alternative 1 include the replacement and hydraulic upgrades to the existing UV system. In the final configuration there will be two dedicated UV systems for redundancy. Although Alternative 1 requires additional capital investment, this option also provides necessary process redundancy for the facility's primary disinfection system.

Redundancy not only improves ease of operability and maintenance, but it also serves to reduce risk of a permit violation due to an equipment failure associated with the UV disinfection system.

5.9.4 Implementation Recommendations

Based on the 2040 planning conditions, Table 5.19 illustrates the phased approach to incorporating the recommended improvements for the UV Disinfection system.

Table 5.19 UV Disinfection Implementation Recommendations

Implementation Period	Identified Projects
2021-2025	1. Complete hydraulic improvements and purchase UV bulb shelf spares for redundancy(1).
2025-2030	1. Construct the new UV system as described in Alternative 1 above. 2. Complete the asset renewal projects for UV Disinfection and Plant Water system as identified in the Baseline Condition and described in Chapter 4.
2031-2040	None identified.

Notes:
(1) Identified project includes hydraulic modeling and improvements, relocation of effluent flow measurement, and purchase of UV bulbs as shelf spares. Additional allowances have been included for site civil and electrical. The estimated cost for this scope is $605,000.

For constructability purposes and to improve operational reliability and resiliency, it is recommended that installation of the new UV system as described in Alternative 1 be completed in the 2026 to 2030 timeframe.

5.10 Grease Receiving Station and Co-Digestion

5.10.1 Baseline

As mentioned above, grease is currently collected at the existing grease receiving station and hauled to landfill. This grease receiving station is old and not optimized for the beneficial use of the grease collected. Grease, along with other organic wastes, has the potential to increase biogas production if anaerobically digested. One option to consider for increasing biogas production is the addition of a new grease receiving station. This new grease receiving station would replace the existing grease receiving station and be designed to pump the hauled-in grease, as well as additional hauled organics if desired, to the anaerobic digesters. The new receiving station would also be designed to allow the City to pump grease to trucks for landfill disposal instead of to the anaerobic digesters.

It is important to note that injecting grease into the digesters that is hauled into the facility (i.e., not received through the collection system), may devalue all of the biogas produced from a D3 RIN to a D5 RIN. This is based on the EPA current interpretation of the Renewable Fuel Standard Program. Efforts have been made to allow for partitioning of the biogas, assigning a D3 value biogas produced from municipal solids (assuming municipal solids produces 15 standard cubic feet of biogas per pound of VS reduced), and assigning a D5 value to biogas from external grease or high strength waste.

Chapter 3 outlines the current and projected grease accepted at the Persigo WWTP. This grease could increase biogas production by 17,500 standard cubic feet per day (scfd) by 2040. Additionally, for some of the digestion alternatives considered, there is excess capacity in the digesters to accept additional organic feedstock. This would potentially increase biogas production further.

There are a number of organic waste types that could be processed at the Persigo WWTP. These organic wastes include grease; liquid food and beverage processing waste; the organic fraction of municipal solid waste (food waste); source separated commercial, institutional, or residential organic waste; and sludge from another municipal treatment plant. All of these organic wastes could impact the RIN credit eligibility, as noted above. Furthermore, City staff are not aware of another municipal treatment plant that would be interested in digesting their solids at the Persigo WWTP. The priority for the Persigo WWTP is to serve the 201 Service Area. Therefore, accepting municipal sludge from outside the 201 Service Area does not align with the vision and objective of the WWTP. Additionally, City staff have not received any requests from commercial, institutional, or industrial customers about processing organic wastes. Further study would be needed to determine if a market exists for this service.

As soon as the EPA allows partitioning of the biogas into D3 and D5 RINs, it is recommended that the grease already accepted from off-site be processed in a new grease receiving station and then sent directly to the existing anaerobic digesters for biogas production. This new grease receiving station would likely require heating, due to the weather at the Persigo WWTP.

5.10.1.1 Process Flow Diagram

A proposed process flow diagram (PFD) for a new grease receiving station is shown in Figure 5.19.

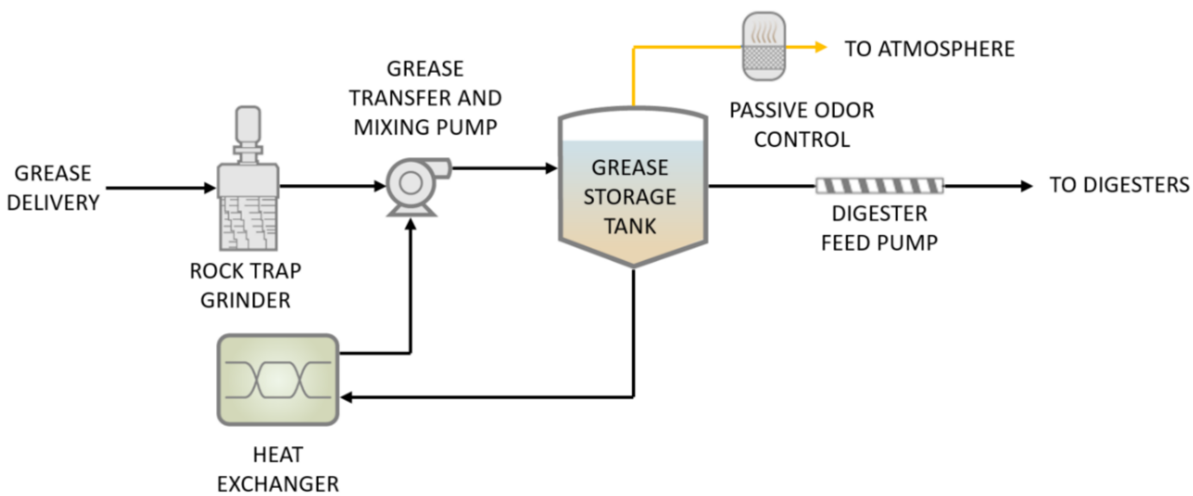


Figure 5.19 Proposed Grease Receiving Station PFD

5.10.1.2 Site Layout

Figure 5.20 illustrates the location for the new grease (fats, oil, grease [FOG]) receiving station located adjacent to the existing anaerobic digesters and the location of the existing grease receiving station.

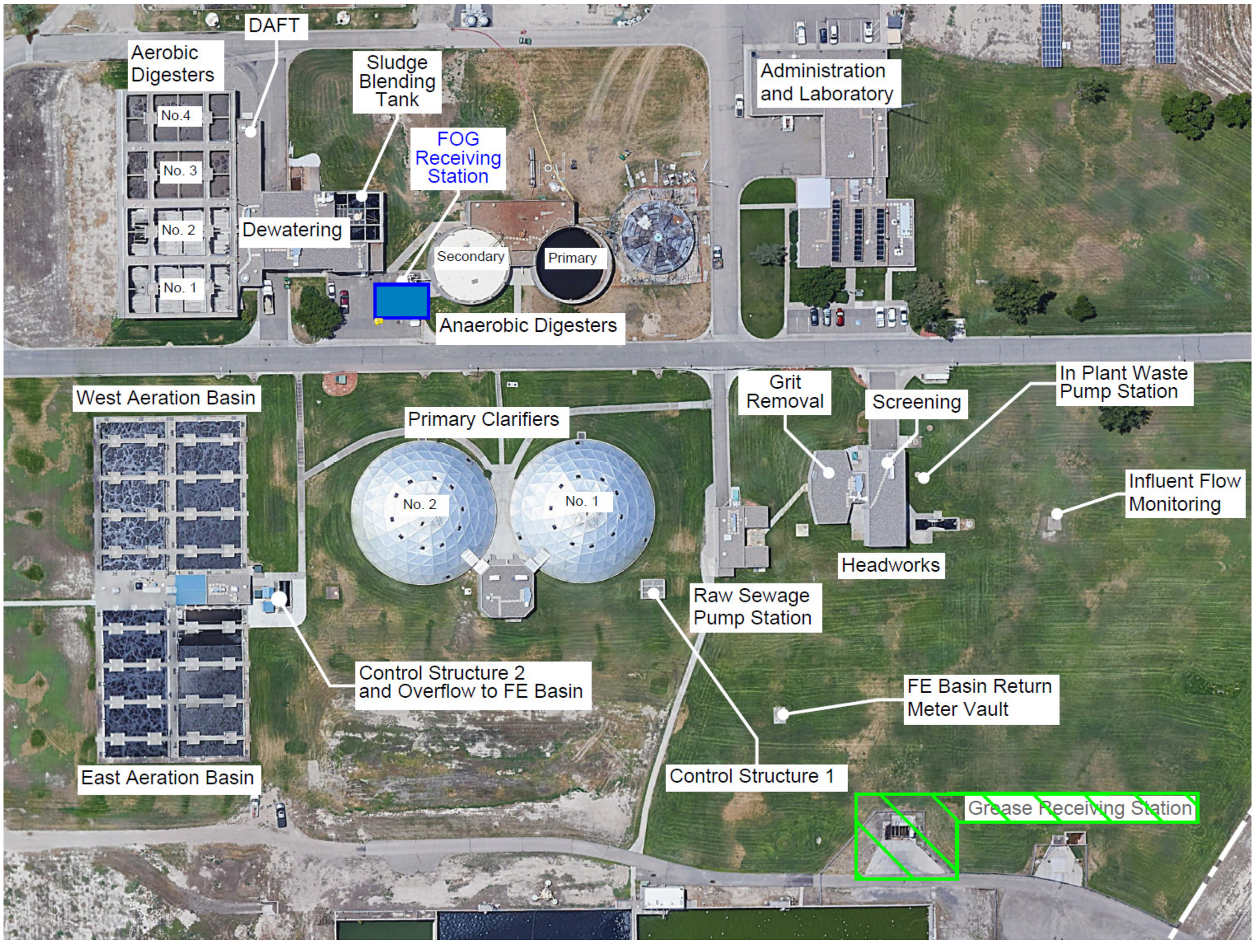


Figure 5.20 Proposed Grease Receiving Station Layout

5.10.2 Financial Comparison

Table 5.20 summarizes the financial information developed for the new grease receiving station. Additional information on the capital cost assumptions can be found in Appendix D.

Table 5.20 Grease Receiving Alternatives Summary of Costs

	Baseline	Alternative
Alternative Description	**Business as Usual: No Change to Existing System**	**Replace Existing System with New Grease Receiving Station**
Project Cost	Not Applicable	$4.8 million

5.10.3 Implementation Recommendations

It is recommended that the Persigo WWTP construct a new grease receiving station within the next 5 years (assuming the EPA has allowed for partitioning of biogas by that time) to reduce costs associated with operating and maintaining the existing grease receiving station, reduce costs associated with landfilling grease, and increase revenue from biogas production by co-digesting grease with PS.

5.11 Digestion Alternatives

Figure 5.21 illustrates the digestion alternatives that were considered by the project team for addressing key drivers: increased digestion performance, conversion to Class B biosolids, minimizing costs, and maximizing biogas production. While other technologies such as autothermal thermophilic aerobic digestion (ATAD), thermal hydrolysis, and acid phase digestion were considered, the associated costs and complexities for implementation in the next 10 years were not considered viable and therefore not considered further. This alternatives analysis focused on three digestion process alternatives:

1. **Baseline:** Maintain the existing digestion system as is and continue to landfill biosolids.
2. **Alternative 1 – Optimize the Existing System:** Aerobically digest WAS to Class B and anaerobically digest PS to Class B.
3. **Alternative 2 – Convert Entirely to Anaerobic Digestion:** anaerobically digest both PS and WAS to Class B.

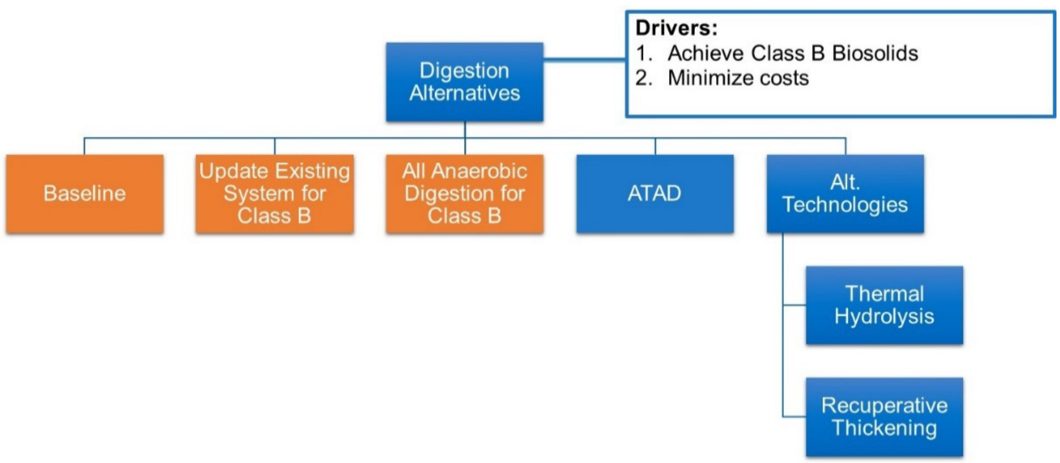


Figure 5.21 Overview of Digestion Alternatives

For each of these alternatives, the impacts on digestion capacity and biogas production were assessed for two additional conditions:

- Co-digestion with grease in the anaerobic digesters.
- Increased PS generation from use of CEPT in the primary clarifiers, with a target of 70 percent BOD removal.

The loading rates assumed for this analysis are summarized in Table 5.21.

Table 5.21 Assumed 2040 Solids Loading to Digestion

Parameter	PS + WAS	PS + WAS + Grease	PS (70% CEPT) + WAS	PS (70% CEPT) + WAS + Grease
ADMM PS, ppd	18,700	18,700	22,700	22,700
ADMM WAS, ppd	12,900	12,900	11,400	11,400
ADMM Grease, ppd	0	1,800	0	1,800
Total Solids Loading, ppd	**31,600**	**33,400**	**34,100**	**35,900**

5.11.1 Baseline Condition

For continued operation of the existing digestion process, asset renewals and replacements have been identified in Chapter 4. Specifically, for digestion, recommended improvements include projects for aerobic digestion, anaerobic digestion, DAFT, and sludge blending tank use. An overview of these asset replacements, expected timing, and their costs are included in the sections below.

5.11.1.1 Aerobic Digestion

Per Chapter 4, the following asset replacement projects include rehabilitation of the process blowers, mixing systems, concrete coatings and building mechanical improvements.

5.11.1.2 Anaerobic Digestion

Per Chapter 4, the following asset replacement projects include replace digester cover for the secondary anaerobic digester, replacement of heating systems, sludge pumping systems, digester mixing, boilers, and upgrades to the building mechanical, electrical, and controls infrastructure.

5.11.1.3 DAFT and Sludge Blending Tank

Per Chapter 4, the following asset replacement projects include rehabilitation of the dissolved air flotation unit and building mechanical systems.

5.11.2 Capacity Alternative 1 – Optimize the Existing System

To produce a Class B cake, aerobic digestion must be optimized to allow for sufficient hydraulic retention time. The sections below summarize the investments needed to accomplish this.

The City's existing aerobic digestion process does not currently meet the requirements to produce Class B biosolids. As required by the EPA's Standards for the Use or Disposal of Sewage Sludge (40 CFR Part 503) regulations to meet Class B, both the pathogen reduction and vector attraction reduction requirements must be met. For the pathogen reduction requirements, aerobic digestion requires 40 days solids retention time (SRT) at 20°C and 50 days SRT at 15°C. This SRT can be reduced to 20 to 42 days (at 20°C and 15°C, respectively) if the digestion is staged (as is the case at the Persigo WWTP). For the vector attraction reduction requirements, the most common way aerobic digestion meets the requirement is through either SOUR testing or by incorporating the biosolids produced into the soil within 6 hours of land application.

Chapter 3 determined that the SRT for the four aerobic digesters with no modifications by 2040 will be only 7 days. This is well below the required SRT for staged aerobic digestion. Specifically, for the Persigo WWTP, the required SRT for aerobic digestion is around 44 days based on historical temperature data collected in the aeration basins (minimum of 14°C, as shown in Figure 5.22). Given this 44-day SRT, a total of 17 to 21 aerobic digesters would be required to achieve Class B, depending on if grease is added and if CEPT is implemented. This is impractical, and thus not considered further.

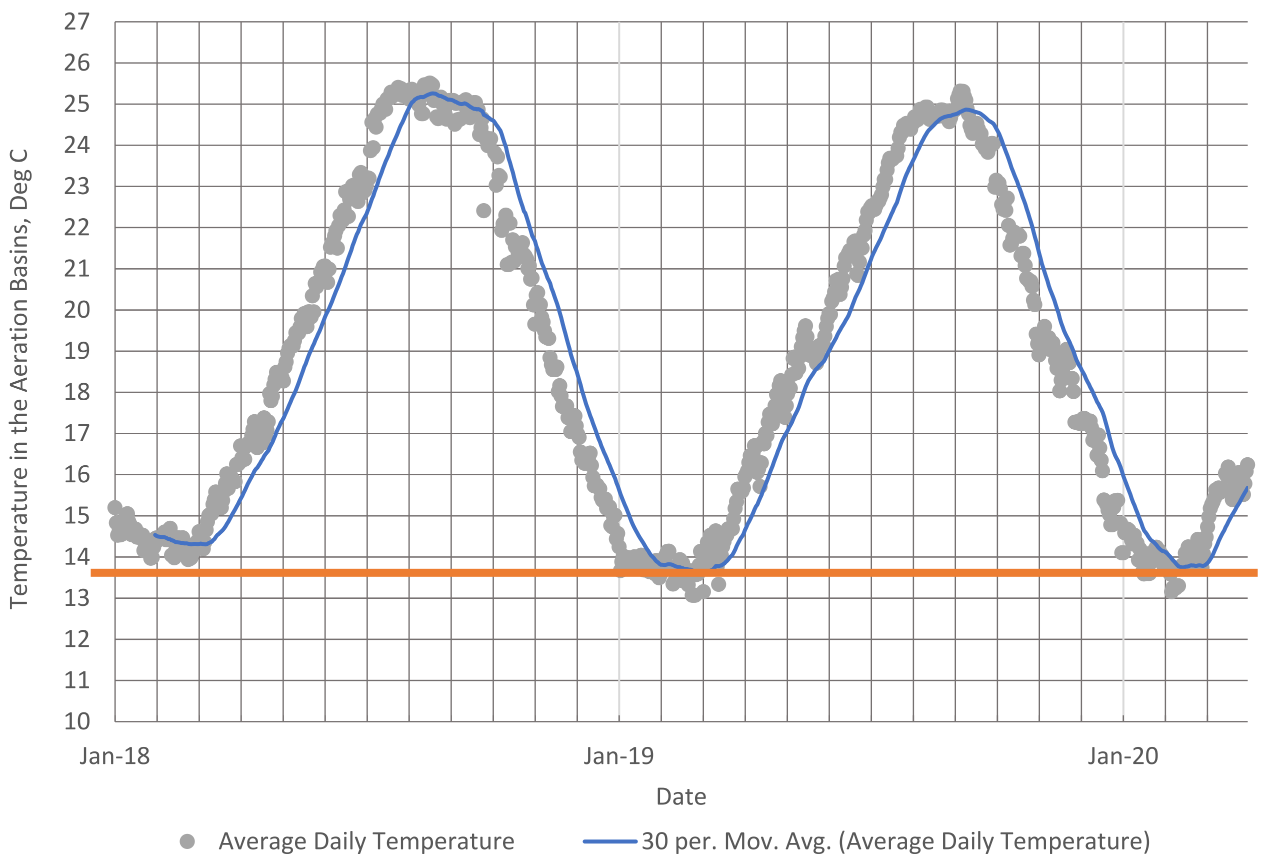


Figure 5.22 Historical Temperature Data in Aeration Basins

5.11.2.1 WAS Treatment

Instead of adding additional aerobic digestion basins, the City could pre-thicken or recuperatively thicken the WAS. Carollo recommends recuperative thickening because it allows for a more stable process temperature as compared to pre-thickening. Aerobic digestion is an exothermic process that can overheat the sludge in the summer and result in process failure or foaming. If temperatures are high enough, it can even damage aeration diffusers. With pre-thickening, there is less water to absorb the heat and the heated water remains in the basin. With recuperative thickening, the incoming WAS cools the digester and the thickening process removes the heated water from the digester. In addition, recuperative thickening allows a simpler operating configuration to keep the digester concentration below 2.5 to 3 percent TS. Most mechanical thickeners produce 5 to 6 percent solids, resulting in a higher than target percent solids concentration inside the tank.

The Persigo WWTP has an existing DAFT unit currently used for thickening the digested WAS. This system was originally intended to be used for recuperative thickening, but the aeration system inside the aerobic digesters is unable to effectively aerate or mix the solids if the concentration is above 0.8 percent TS. Carollo recommends reconfiguring the system for its originally intended purpose (with DAFT operated as the recuperative thickener) and replacing the aeration system as required to operate at a target concentration of 2.5 to 3 percent TS. Because WAS is currently wasted 24/7, the DAFT will also need to operate 24/7 unless WAS storage is provided. Carollo recommends adding a second DAFT unit for redundancy. Given space limitations in the existing Dewatering Building, it is recommended that the existing building be extended to accommodate an additional DAFT unit. See Figure 5.23 for a proposed layout of this extension.

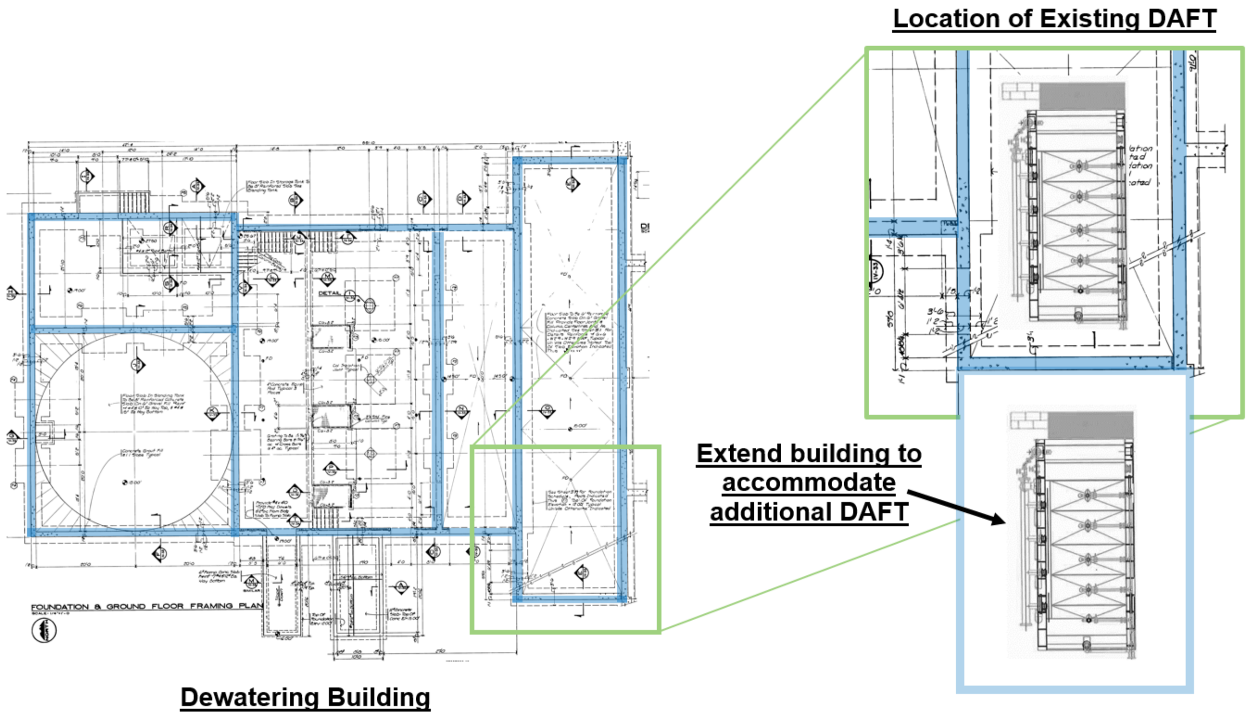


Figure 5.23 Proposed Expansion to Accommodate Additional DAFT

With this configuration, four aerobic digesters could successfully meet Class B pathogen reduction requirements through 2040. The City would still need to meet vector attraction reduction requirements. For aerobic digestion this is typically done either through SOUR testing or by incorporating the biosolids produced into the soil within 6 hours of land application. However, other methods are possible, including achieving a 38 percent VS reduction. See Table 5.22 for a summary of the aerobic digestion and DAFT operating parameters. As shown in the table, it is recommended that a fifth standby aerobic digester be constructed so that when one unit is out of service, the remaining aerobic digesters can still digest all the WAS generated. See the Pre-Dewatering Storage section below for additional uses for this fifth standby digester.

Table 5.22 2040 Operating Parameters for Aerobically Digesting WAS

Parameter	WAS
Aerobic Digesters (WAS Only)	
Duty / Standby, #	4 / 1
ADMM SRT, days	45 - 50(1)
DAFT (WAS Recuperative Thickening)	
Duty / Standby, #	1 / 1
ADMM Operating (hours / days / weeks)	24 / 7 /52
Portion of WAS Flow Sent to DAFT, %	92
ADMM Solids Loading each, pph	439 - 496(2)
ADMM Hydraulic Loading ea., gpm	31 - 38(2)

Notes:
(1) The lower value corresponds to the options without CEPT and the higher value corresponds to the options with CEPT.
(2) The lower value corresponds to the options with CEPT and the higher value corresponds to the options without CEPT.

5.11.2.2 Primary Sludge and Grease Treatment

Optimization of the existing digestion system also needs to consider how PS is currently stabilized and ensure there is sufficient capacity to continue operating in this manner. Upstream processes such as CEPT and/or grease addition will impact the capacity of the anaerobic digesters.

For anaerobic digestion to meet Class B requirements, a 15-day SRT is needed for pathogen reduction. Additionally, vector attraction reduction is typically met through confirming the volatile solids reduction (VSR) is greater than 38 percent. The digesters currently exceed this VSR. To maintain stable anaerobic digester operation, as discussed in Chapter 3, the WEF MOP 8 recommends a design sustained peak loading rate of 0.12 to 0.16 lbs VS/cfd with an upper limit for short-term operation of 0.20 lbs VS/cfd.

Figure 5.24 shows the expected maximum month SRT and volatile solids loading rate (VSLR) over time as PS flows increase with one anaerobic digester in service. As shown in this figure, a second digester will need to be brought online by 2035. It is recommended that at this time, a third anaerobic digester be constructed so that when one unit is out of service, the remaining digesters can still digest all the PS generated. This third digester can be used as a secondary digester under normal operation. If the City has a reliable alternate outlet for PS, such as hauling liquid PS, a third standby digester may not be required. The third digester may also be used for pre-dewatering storage, as noted below.

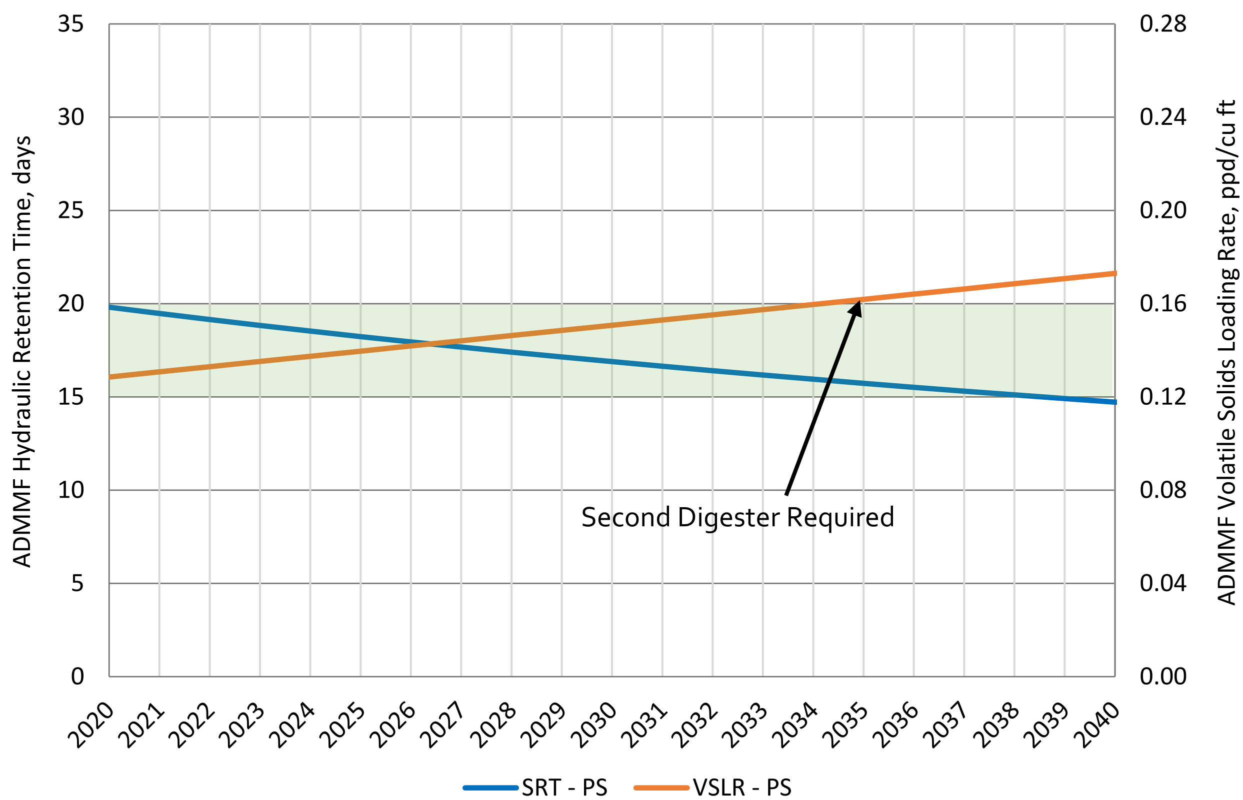


Figure 5.24 Capacity Analysis for PS Only with One Digester in Service

Figure 5.25 shows the expected maximum month SRT and VSLR over time if grease and if CEPT (with a target BOD removal of 70 percent) is implemented and directed to the anaerobic digesters. As shown in this figure, before a second digester comes online, a limited amount of grease could be added to the existing digester in service. Once a second digester comes online, all the grease generated could be added.

Additionally, if CEPT is implemented, a second anaerobic digester would need to come online as soon as possible to accommodate the additional PS flow and load.

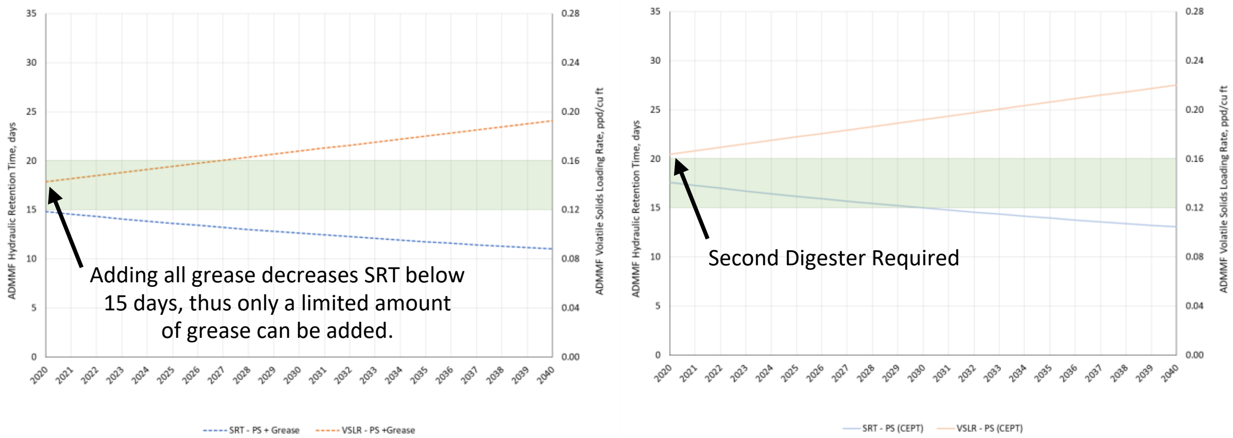


Figure 5.25 Capacity Analysis for PS + Grease (Left) and PS with CEPT (Right) with One Digester in Service

In any of the scenarios considered, by 2040, the City will need to operate with two anaerobic digesters online. See Table 5.23 for a summary of the operating parameters in 2040.

Table 5.23 2040 Operating Parameters for Anaerobically Digesting PS

Parameter	Value
Anaerobic Digesters (PS and Grease)	
Duty / Standby, #	2 / 1
ADMM VSLR, lbs VS/cfd	0.09 - 0.12(1)
ADMM SRT, days	20 - 29(2)

Notes:
(1) The lower value corresponds to the options without CEPT and grease and the higher value corresponds to the options with CEPT and grease.
(2) The lower value corresponds to the options with CEPT and grease and the higher value corresponds to the options without CEPT and grease.

5.11.2.3 Pre-Dewatering Storage

Currently, both aerobically digested WAS and anaerobically digested PS are sent to an existing sludge blending tank prior to dewatering. This tank has a storage capacity of around 500 gallons. Under current operations, the downstream dewatering facility only operates 4 hours per day, 5 days per week. When this facility is not in operation, digested thickened waste activated sludge (TWAS) and PS must be stored. Under the current operating scheme, 2 days of storage is needed. It is likely that this storage is currently accommodated in the existing sludge blending tank, the existing aerobic digesters, and the secondary anaerobic digester. In the future as flows increase and as the WWTP shifts to achieving Class B biosolids, storage in the existing digestion processes will be more limited.

Considering the anaerobic digestion process first, up until 2035, the existing secondary digester can operate as digested PS storage, as it does now. However, after 2035, a third digester should be constructed to act as both redundancy (as mentioned above) and for digested PS storage. Alternatively, a separate dedicated storage tank could be constructed at this time to avoid the construction of a third anaerobic digester if PS liquid hauling is pursued when a primary digester is offline. This would provide the needed storage capacity, but not the needed redundancy.

Considering the aerobic digestion process, the capacity analysis above indicates that if Class B is desired, all four aerobic digesters are needed for treatment. Thus, none of these digesters are available for digested WAS storage. It is recommended that a fifth aerobic digester be constructed to provide both redundancy for the treatment process and for digested WAS storage prior to dewatering. Alternatively, a separate dedicated storage tank could be constructed to avoid the need for a fifth aerobic digester if liquid WAS hauling is pursued when an aerobic digester is offline. This again would provide the needed storage capacity, but not the needed redundancy.

For this analysis, it was assumed that both a third anaerobic digester and fifth aerobic digester are added to accommodate both redundancy and storage capacity needs.

5.11.2.4 Process Flow Diagram

Combining both the aerobic digestion modifications and the anaerobic digestion modifications, a proposed PFD for optimizing the existing digestion system is shown in Figure 5.26.

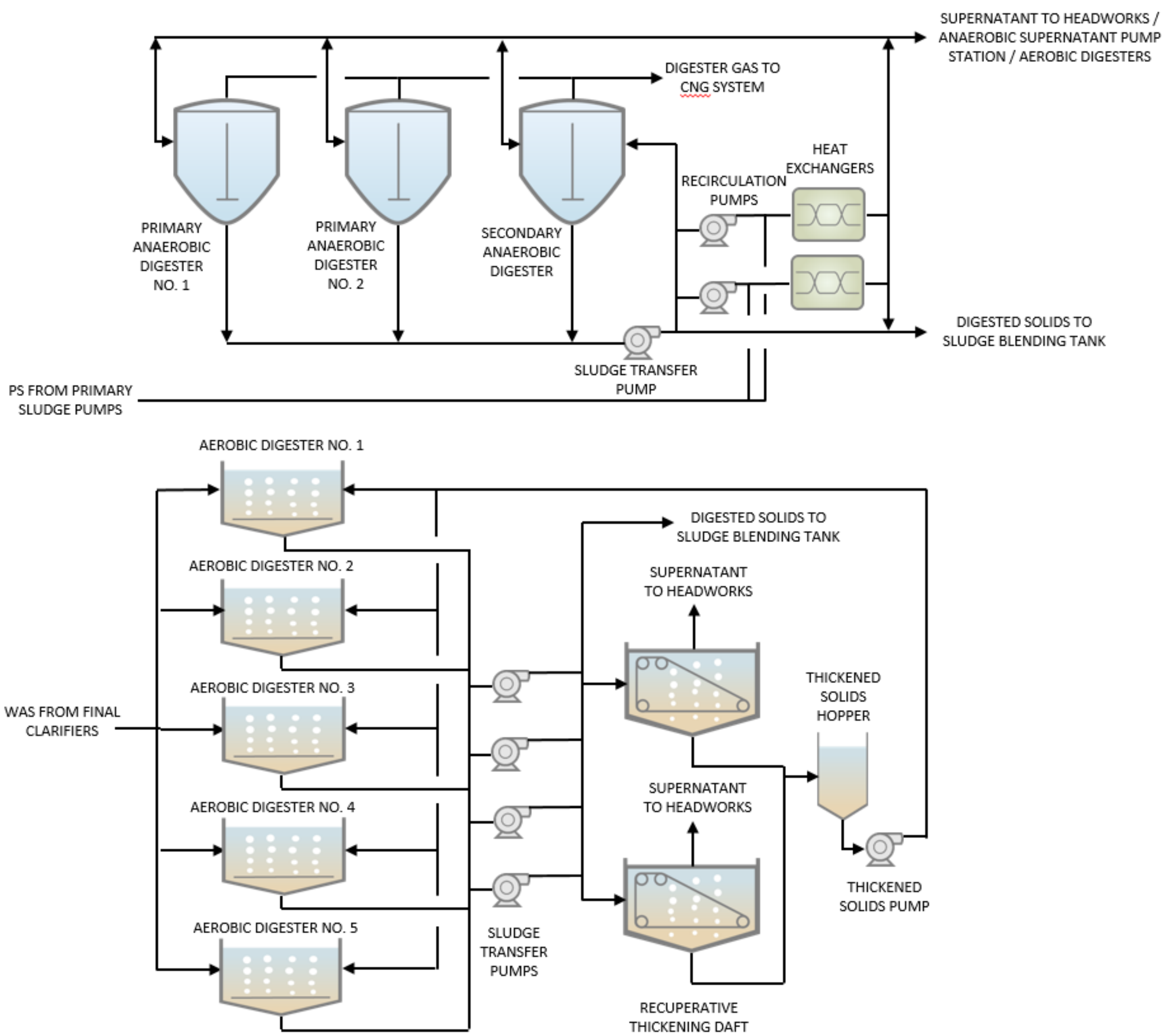


Figure 5.26 Proposed Aerobic + Anaerobic Digestion PFD

5.11.2.5 Site Layout

Figure 5.27 shows the proposed locations for the additional aerobic digester, DAFT and anaerobic digester recommended for Alternative 1.

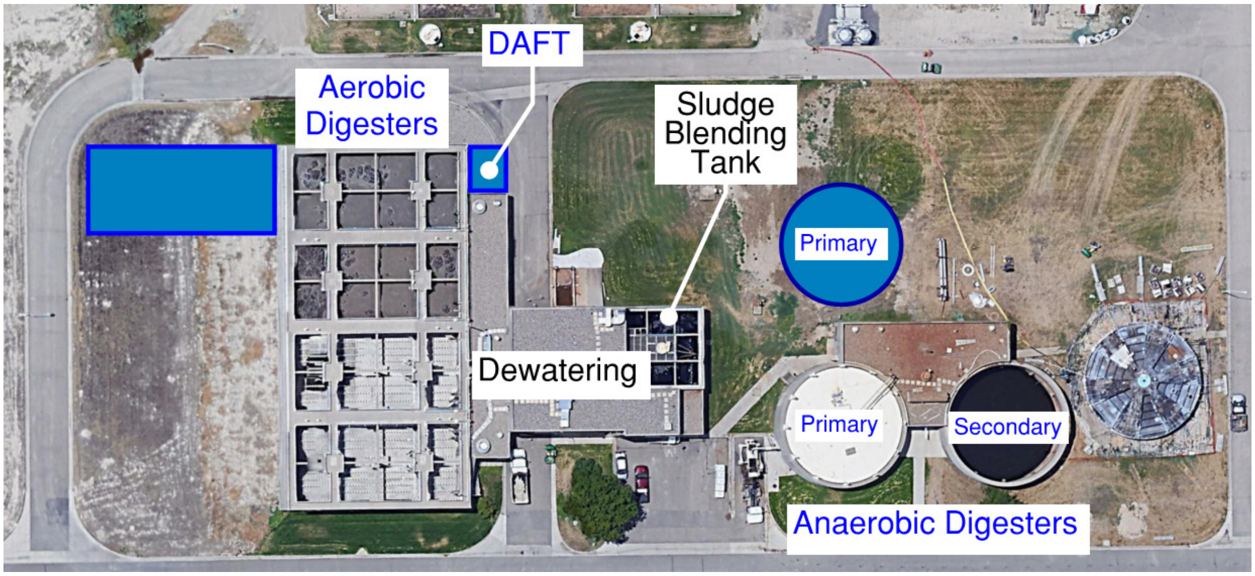


Figure 5.27 Proposed Aerobic + Anaerobic Digestion Layout

5.11.3 Capacity Alternative 2 – Anaerobic Digestion

The second digestion alternative considered was to anaerobically digest PS and WAS. This alternative would eliminate the aerobic digestion and repurpose those aerobic tanks for additional storage. Conversion to all anaerobic digestion will produce a Class B biosolids. Chapter 5 includes further discussion on options for the biosolids management and beneficial reuse of the Class B biosolids.

5.11.3.1 Primary Sludge, Grease, and WAS Treatment

Converting from aerobic to anaerobic digestion for the WAS requires thickening of the WAS. As a result, the existing DAFT unit would be reconfigured to thicken the WAS prior to anaerobic digestion. The same DAFT redundancy and operating parameters were assumed in this scenario as were assumed Alternative 1.

As described above, to meet Class B requirements and maintain stable digester operations, the SRT must be at least 15 days and the VSLR should not exceed a sustained peak of more than 0.16 lbs VS/cfd. With these design parameters, Figure 5.28 shows the expected maximum month SRT and VSLR over time as PS flows increase with one digester in service. As shown in this figure, the SRT will drop below 15 days and the VSLR will exceed 0.16 lbs VS/cfd. Thus, a second digester is needed. It is recommended that at this time, a third standby anaerobic digester be constructed so that when one unit is out of service, the remaining digesters can still digest all the TWAS and PS generated. However, if the City has a reliable alternative outlet for TWAS and PS, such as liquid hauling, this third standby digester may not be required.

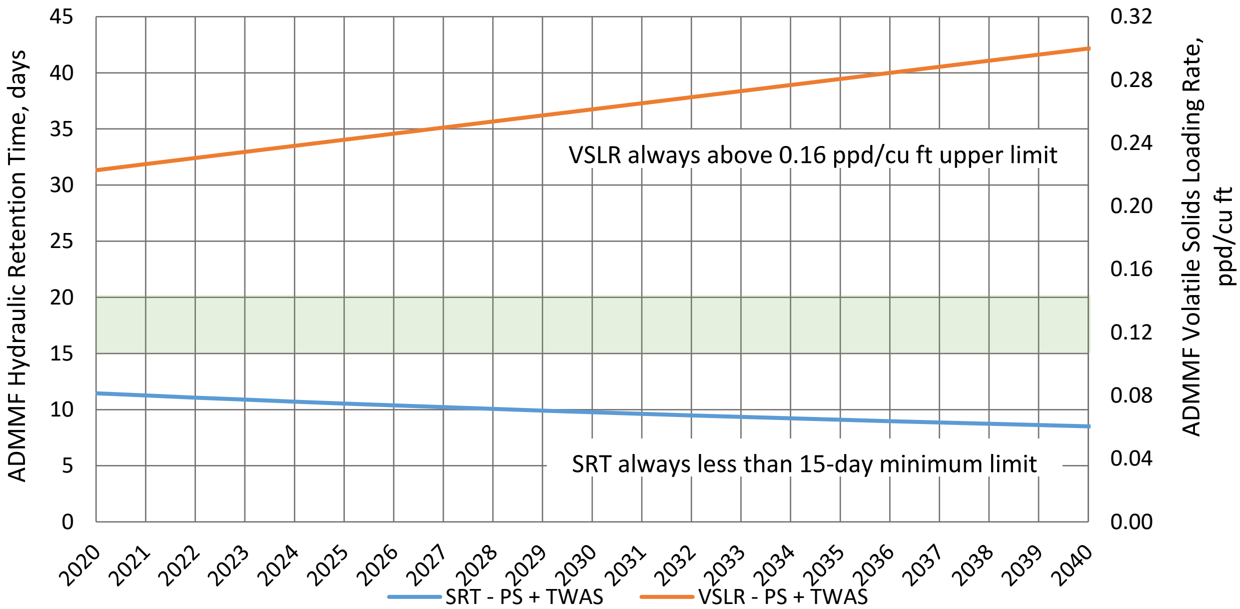


Figure 5.28 Capacity Analysis for PS + TWAS with One Digester in Service

Figure 5.29 shows the expected maximum month SRT and VSLR with two digesters in service. As shown in this figure, two digesters provide sufficient capacity through 2040. Figure 30 shows the expected maximum month SRT and VSLR over time assuming grease and CEPT is implemented. As shown in this figure, starting in 2036 grease addition would need to be limited to avoid triggering an additional digester. It is also relevant to note that CEPT does not greatly impact digester capacity. This is because, while PS production increases with CEPT, there is a roughly corresponding reduction in WAS production. Table 5.24 provides a summary of the operating parameters in 2040.

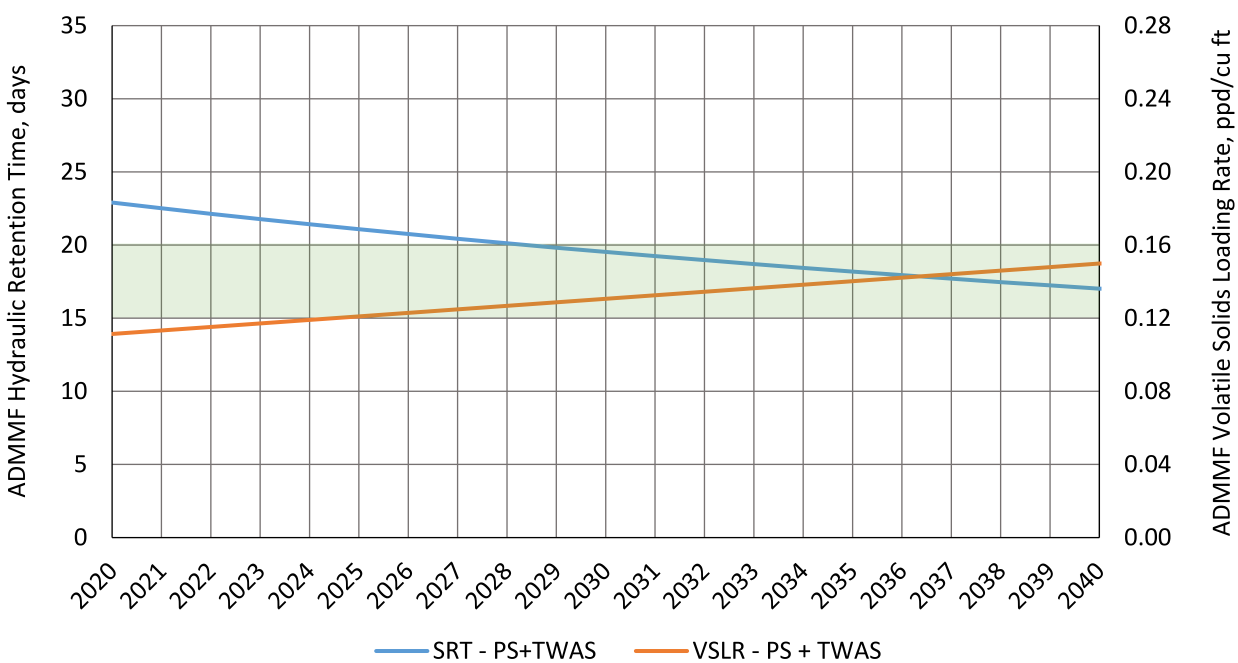


Figure 5.29 Capacity Analysis for PS + TWAS with Two Digesters in Service

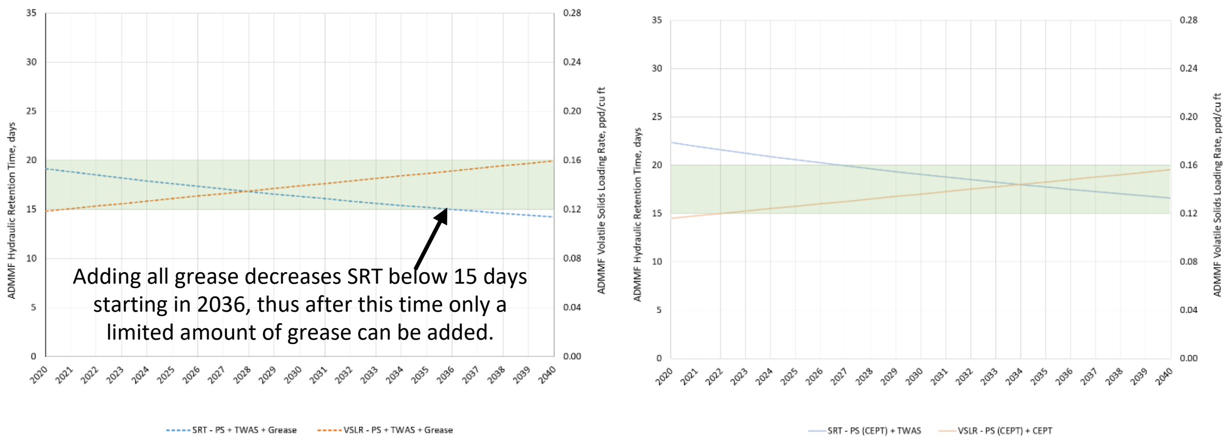


Figure 5.30 Capacity Analysis for PS + TWAS + Grease (Left) and PS w/CEPT + TWAS (Right) with Two Digesters in Service

Table 5.24 2040 Operating Parameters for Anaerobically Digesting PS and WAS

Parameter	Value
Anaerobic Digesters (PS, TWAS, and Grease)(1)	
Duty / Standby, #	2 / 1
ADMM VSLR, lbs VS/cfd	0.15 - 0.16(2)
ADMM SRT, days	15 - 17(3)
DAFT (WAS Pre-thickening)	
Duty / Standby, #	1 / 1
ADMM Operating (hours / days / weeks)	24 / 7 / 52
ADMM Solids Loading each, pph	475 - 537(2)
ADMM Hydraulic Loading each, gpm	154 - 173(2)

Notes:
(1) Grease flow and load to the digester is decreased starting in 2036 to avoid triggering a need for an additional digester.
(2) The lower value corresponds to the options without CEPT or grease and the higher value corresponds to the options with CEPT and limited grease.
(3) The lower value corresponds to the options with CEPT and grease limited grease and the higher value corresponds to the options without CEPT or grease.

5.11.3.2 Pre-Dewatering Storage

The existing sludge blending tank, as discussed under Alternative 1, has a limited capacity of 500 gallons which is insufficient to store all the digested PS and TWAS prior to dewatering for the required two days. By converting to all anaerobic digestion, the sludge storage capacity will need to be increased.

When the WWTP switches to all anaerobic digestion, the existing anaerobic digesters will need to be operating as primary digesters with gas storage covers. Therefore, the existing secondary anaerobic digester will no longer be available for post-digestion storage. However, the aerobic digesters could be repurposed to provide digested sludge storage prior to dewatering.

5.11.3.3 Process Flow Diagram

A proposed PFD for a Class B anaerobic digestion system is shown in Figure 5.31. It has been assumed that grease loading to the digesters will be limited by 2040 so a third primary digester is not needed.

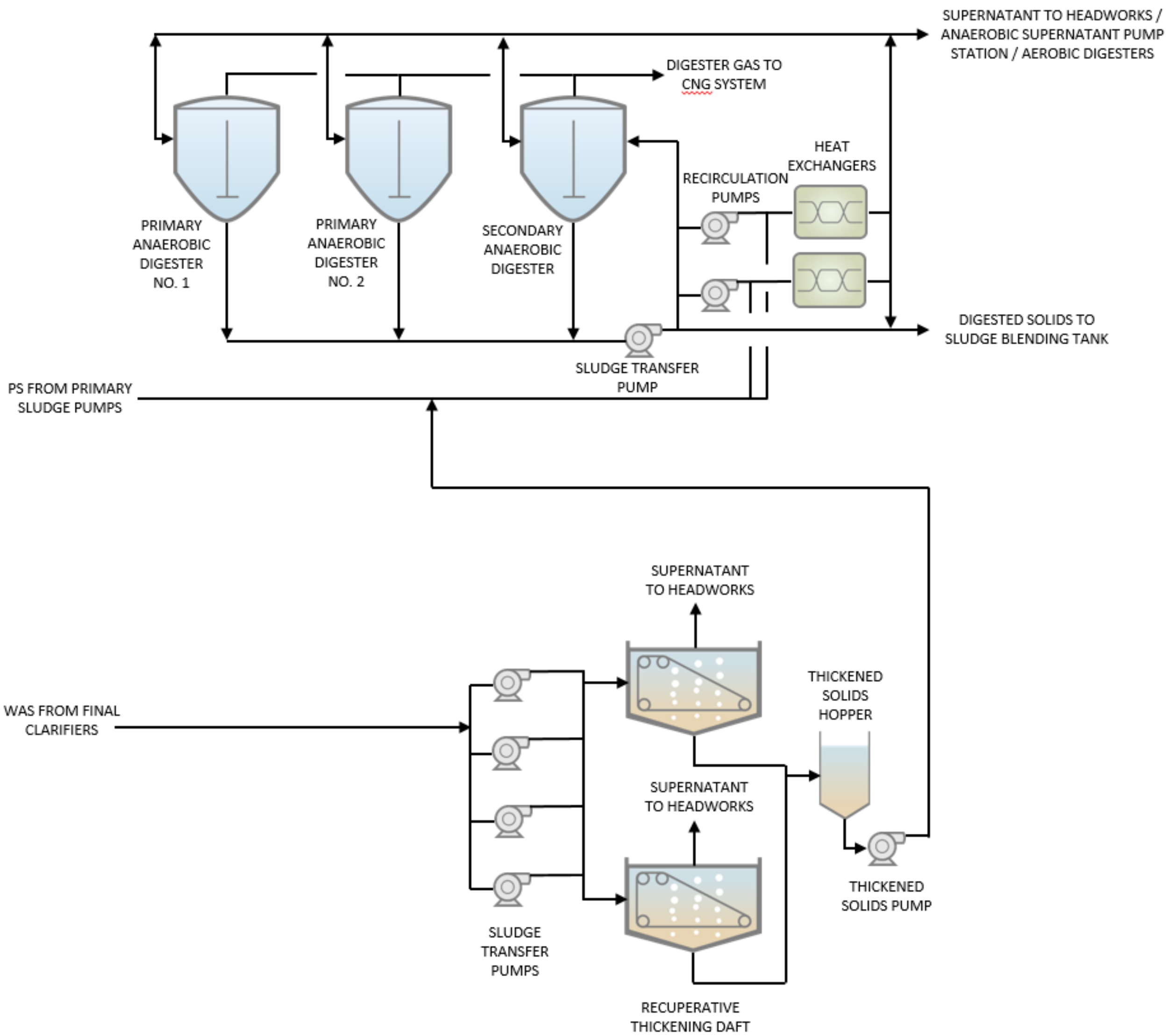


Figure 5.31 Proposed Anaerobic Digestion PFD

5.11.3.4 Site Layout

Figure 5.32 illustrates the infrastructure improvements required to convert to full anaerobic digestion, which include additional anerobic digester, re-purposing the aerobic digesters for pre-dewatered storage and additional DAFT for thickening.

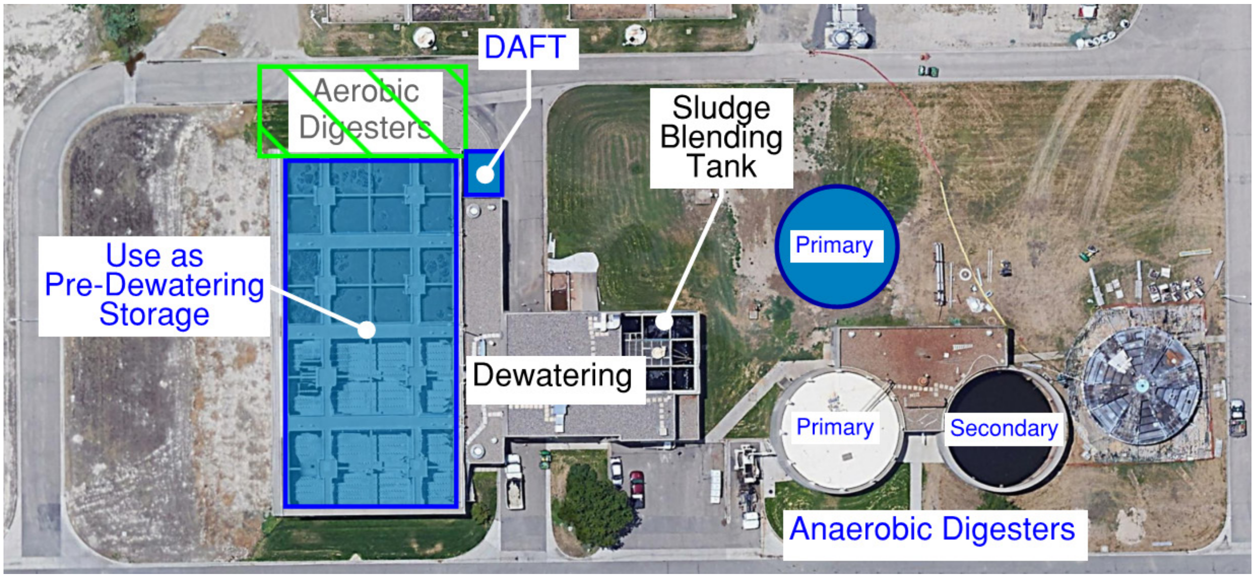


Figure 5.32 Proposed Anaerobic Digestion Layout

5.11.4 Financial Comparison of Digestion Alternatives

The total project costs and 20-year operating costs for each of the digestion alternatives are presented in Table 5.25 for a capacity of 13.5 ADMMF. A detailed breakdown of cost estimating assumptions for each alternative can be reviewed in Appendix D. Appendix F includes the operating assumptions and financial models for the calculated NPV values.

Table 5.25 Financial Comparison of Digestion Alternatives

	Baseline	Digestion Capacity Alternative 1	Digestion Capacity Alternative 2
Alternative Description	**Business as Usual (Landfill)**	**Aerobic + Anaerobic (Class B)**	**All Anaerobic (Class B)**
Project Costs	$3.8 million (aerobic dig) $7.4 million (anaerobic) Total = $11.2 million	$11.2 million (baseline asset replacement) $8.0 million (new aerobic dig & DAFT) Total = $19.2 million	$7.4 million (anaerobic baseline asset replacement) $6.9 million (aerobic mixing & new DAFT) Total = $14.3 million
O&M Costs - 20-year	NA	-$2.4 million	-$6.0 million
NPV	**$11.2 million**	**$16.8 million**	**$8.4 million**

Notes:
(1) O&M costs shown for 20-year period are comparative costs relative to current day options. As result, the Baseline Condition equals the 2020 operating costs. All capital and O&M costs shown are in 2021 dollars.
(2) Baseline asset revitalization projects have been identified in Chapter 4 with detailed cost estimate summaries. Assumes replacement of existing mechanical equipment and allowances for other building improvements.
(3) Digestion Capacity Alternative 1 includes costs from the Baseline Condition in addition to the new capital improvements for additional aerobic digestion capacity and dissolved air floatation process for redundancy and reliability.
(4) Digestion Capacity Alternative 2 includes costs from the anerobic asset revitalization Baseline Condition in Chapter 4, mixing improvements for the aerobic digester conversion to sludge mixing, and new DAFT system for redundancy.
(5) O&M cost reductions for Alternatives 1 and 2 account for decreases in biosolids transportation costs, biosolids tipping fees, energy, and chemical costs.
(6) O&M costs reductions for Alternative 2 includes benefits gained by increasing biogas production with anaerobic digestion.

The following infrastructure improvements are common to all three alternatives shown in Table 5.26 and were not included in the costs show in Table 5.25. These costs will be included in the Chapter 8 implementation plan.

Table 5.26 Financial Comparison of Common Digestion Improvements

Category	Capital Costs
Anaerobic Digester 3 (anticipated between 2030 and 2035)	$8.5 million
DAF asset revitalization projects included in Chapter 4	
Sludge blend tank asset revitalization and modifications included in Chapter 4	

Notes:
(1) All capital costs shown in 2021 dollars.

5.11.5 Implementation Recommendations

Based on the above evaluation and discussions with City staff, it is recommended that the Persigo WWTP transition to Class B anaerobic digestion (Alternative 2). Table 5.27 illustrates the projects proposed and the implementation schedule.

Table 5.27 Digestion Implementation Recommendations

Implementation Period	Identified Projects
2021-2025	1. Rehabilitation and replace Anaerobic Digestion asset renewals and convert to anerobic digestion. 2. Construct new DAFT facility. 3. Modifications to sludge blend tank.
2026-2030	1. Modify aerobic digesters to provide storage for digested solids.
2031-2040	1. Construction of the third Anaerobic Digester 2. Complete asset renewals for existing DAFT unit

5.12 Dewatering and Biosolids Storage Alternatives

Figure 5.33 illustrates the digestion and biosolids storage alternatives that were considered by the project team for addressing three key drivers – increased operational efficiencies, asset and facility reliability, and storage for biosolids solids management. While other dewatering options were considered such as onsite composting and thermal drying, the associated capital cost for implementation or benefits for achieving a higher quality biosolids were not warranted based on the current planning conditions. As a result, the three alternatives carried forward for further evaluations included:

1. **Baseline:** Maintain the existing dewatering system as is. Provide 7 days of solids storage.
2. **Screw Presses + Solar Drying:** Replace the belt filter presses (BFP) with screw press dewatering and construct a covered greenhouse-style solar drying facility.
3. **Centrifuges + Cake Storage**: replace the BFPs with centrifuge dewatering and construct a cake storage facility that provides 100 days of dewatered cake storage.

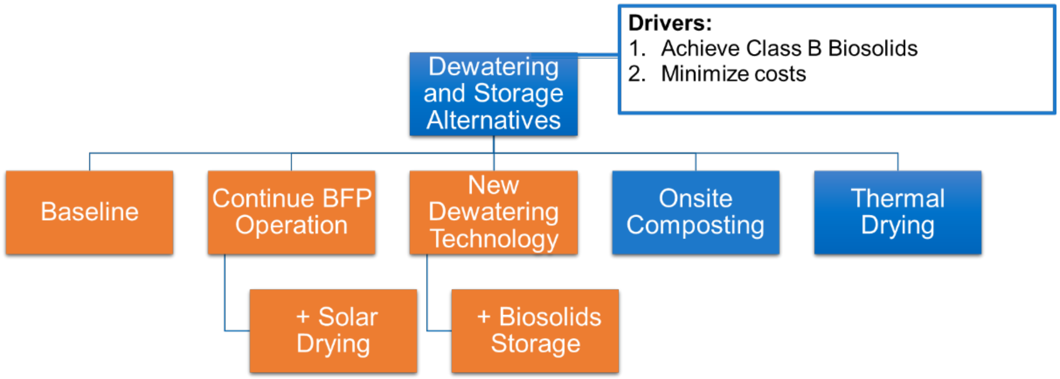


Figure 5.33 Overview of Dewatering and Biosolids Storage (On-Site) Alternatives

While each of these three alternatives are slightly impacted by the addition of CEPT and grease, neither of these factors are significant enough to impact infrastructure sizing. The dewatering and storage infrastructure sizing is dependent on the digestion process selection and the solids projections. It was assumed for the alternatives evaluation that the digestion process would continue to include aerobic and anaerobic treatment. Table 5.28 provides the assumed SLRs for the dewatering process alternatives.

Table 5.28 Assumed 2040 Solids Loading for the Dewatering and Storage Process Alternatives Considered

Parameter	Aerobic + Anaerobic Digestion			
	PS + WAS	PS + WAS + Grease	PS (70% CEPT) + WAS	PS (70% CEPT) + WAS + Grease
ADMM Digested Sludge Load, ppd	20,400	21,100	21,700	22,400
ADMM Digested Sludge Flow, mgd	0.08	0.10	0.08	0.10

5.12.1 Baseline Condition

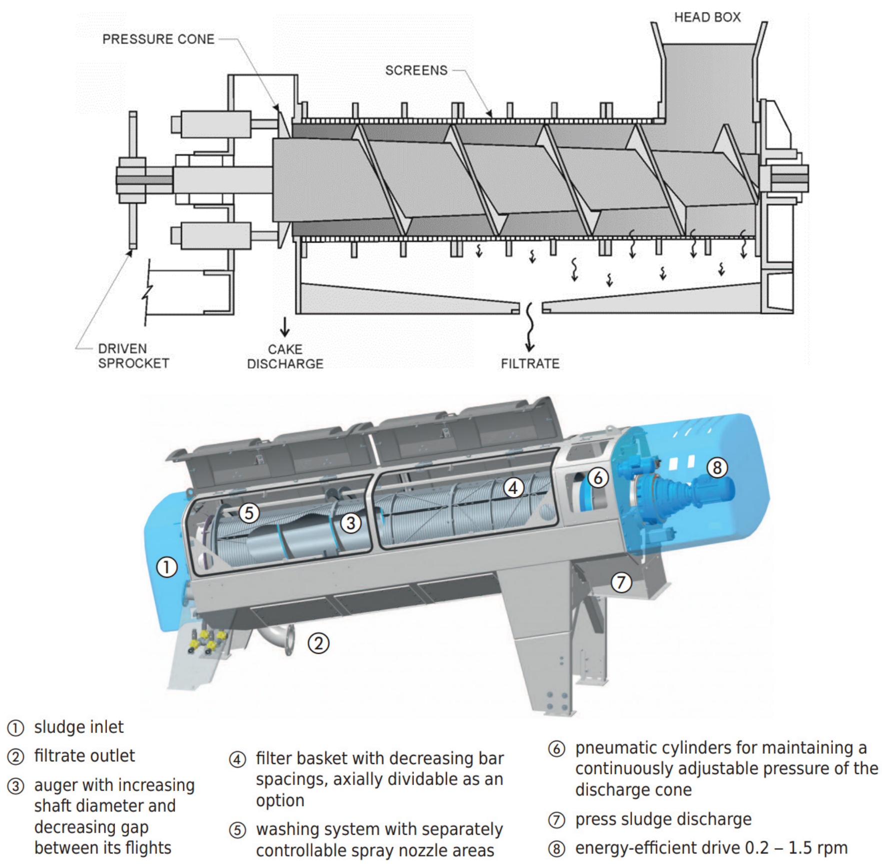
For continued operation of the existing dewatering process, several asset improvements have been identified in Chapter 4. Specifically, for dewatering and biosolids storage, recommended asset renewal projects address dewatering, polymer feed, cake storage, and vehicle off-loading facilities.

The baseline assumption assumes the existing BFPs will be replaced in-kind and remain in the current location. Additional storage for biosolids storage for this alternative was added at the request of staff in the event the landfill was closed due to inclement weather. Seven days of dewatered biosolids storage was assumed for the Baseline Condition. It should be noted that the existing BFPs produce a fairly low-quality cake, in the range of 10 percent TS. Plant staff expressed some concern with respect to the biosolids meeting the paint filter test at the landfill. Further evaluation and possibly pilot testing to determine how to increase the cake solids concentration would be recommended if the City elects to maintain current belt filter operation.

5.12.2 Alternative 1 – Screw Press and Solar Drying

This alternative improves the operational challenges associated with the existing BFPs by providing a new building with screw presses coupled with solar drying to further remove liquids from the biosolids.

Screw presses use a rotating screw to continuously dewater solids. Digested sludge is loaded into the screw press where a slow moving, shafted screw compacts the solids and increases the pressure along the length of the screw press, separating the solids from the liquid. The dewatered cake at the end of the machine forms a "plug" that provides additional dewatering pressure for the solids in the press. The separated water (pressate) flows through the screen and is collected and discharged at the bottom of the screw press while the dewatered cake is discharged at the end of the screw press. Screw presses are mechanically simple, slow moving, and quiet, but require consistent feed quality and polymer dosing to avoid losing the plug and reducing dewatering efficiency. The screw press technology is gaining popularity in municipal wastewater treatment plants due to its mechanical simplicity and ability for automated operation, which allows it to be operated with limited staffing. The units are often well suited for small plants with limited staff. Due to their enclosed configuration, screw presses contain odors better than BFPs. The expected polymer dosage required is similar to BFPs. There are two designs for screw presses: horizontal and inclined. Figure 5.35 shows the cross sections of both types of screw presses.



(Courtesy of FKC and Huber Technology, Respectively)

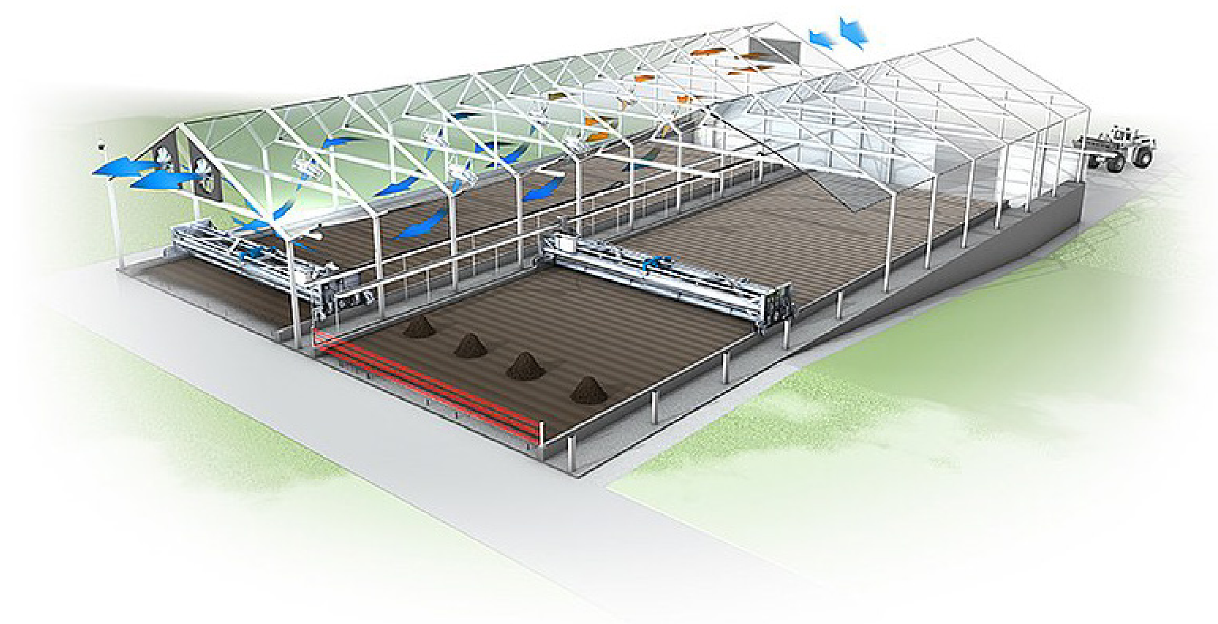
Figure 5.34 Screw Presses: Horizontal Unit (Top) and Inclined Unit (Bottom)

Based on conversations with City staff, it was assumed that infrastructure will be based on eight hours per day, five days per week operational schedule. With this operating scheme, five screw presses would be required. Fitting five screw presses into the existing dewatering building would be challenging and require significant structure improvements to an existing facility. Given the age of the existing dewatering building, a structural evaluation would be needed to confirm the ability of the building to support new equipment. It is likely that the existing building beams and columns would need to be strengthened, making the project more costly.

Transport of the dewatered cake to the solar drying facility also needs to be considered. In conversations with City staff, it was decided that trucking the dewatered cake from the dewatering building to the solar drying locations is not preferred. Given this, and the potential retrofit needs of the existing solids handling building, it is recommended that a new dewatering building be constructed adjacent to the new solar drying facility. Conveyors would be used to transport dewatered sludge to solar drying.

5.12.2.1 Solar Drying

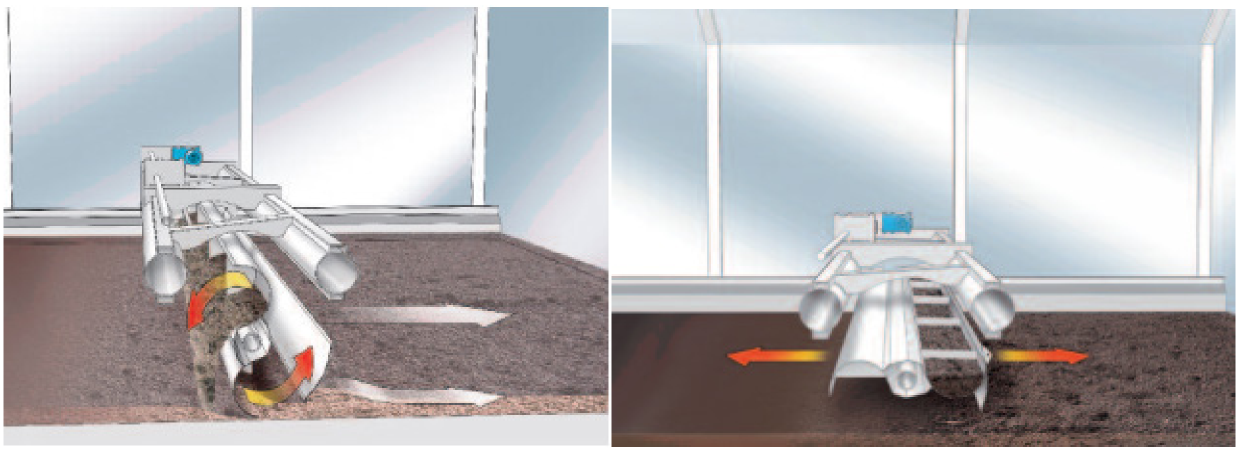
The solar drying evaluation is based on the Huber SRT system shown in Figure 5.35. This system uses incident solar radiation and artificially generated wind to dry dewatered sludge inside a greenhouse. In colder climates, such as Colorado, supplemental heating is also provided to ensure adequate drying in the colder months.



(Courtesy of Huber Technology)

Figure 5.35 Huber's SRT Solar Drying System

A sludge turning device that runs the width of each solar drying bed is used to transport and mix the sludge as it dries. Figure 5.36 shows an example of how this sludge turning device is operated. Additionally, sludge feeding to the solar drying beds can be either manual with a wheel loader or automatic through cake conveyors, as shown in Figure 5.37. Cake conveyors were assumed for the Persigo WWTP. These conveyors would drop cake into the sludge turning device for spreading. Manual removal of the dried product was assumed, which is usually by a front-end loader or skid-steer. Automated systems are available that discharge into a trench at the end of each drying bed where an in-ground conveyor transports the product out of the greenhouse. Typically, at the end of each drying bed, there is around 13 feet of extra floor space for storage of the dried product.



(Courtesy of Huber Technology)

Figure 5.36 Sludge Turning Device Operation

(Courtesy of Huber Technology)

Figure 5.37 Sludge Conveyance to Solar Drying Facility

For sizing the solar drying beds, it was assumed that the new screw presses could achieve 18 percent solids and that a 70 percent dried product was desired. With these assumptions 2.0 acres would be needed for solar drying. Table 5.29 shows the 2040 operating parameters of a screw press and solar drying facility.

Table 5.29 2040 Operating Parameters for Screw Press and Solar Drying

Parameter	Aerobic + Anaerobic Digestion
Screw Presses	
Duty / Standby, #	4 / 1
ADMM Operating (hours / days / weeks)	8 / 5 / 52
ADMM Solids Loading each, pph	890 - 980(1)
ADMM Hydraulic Loading each, gpm	60 - 70(1)
Solar Drying	
Duty / Standby, #	5 / 0
Greenhouse Dimensions, feet	200 by 450
Total Required area, acres	2.0

Notes:
(1) The lower value corresponds to the options without CEPT or grease and the higher value corresponds to the options with CEPT and limited grease.

5.12.2.2 Process Flow Diagram

A proposed PFD for screw presses and solar drying is shown in Figure 5.38.

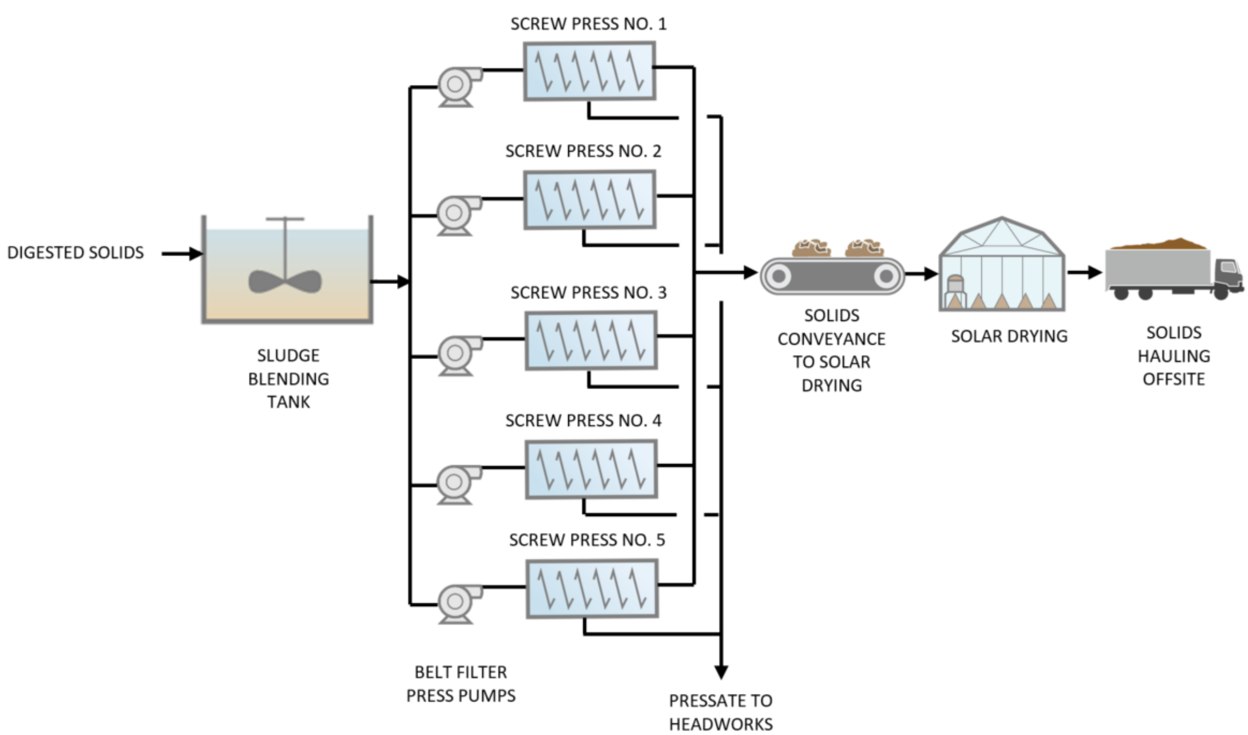


Figure 5.38 Proposed Screw Press + Solar Drying PFD

5.12.2.3 Site Layout

Figure 5.39 illustrates the location for the solar drying facilities and the new Screw Press Dewatering Building.

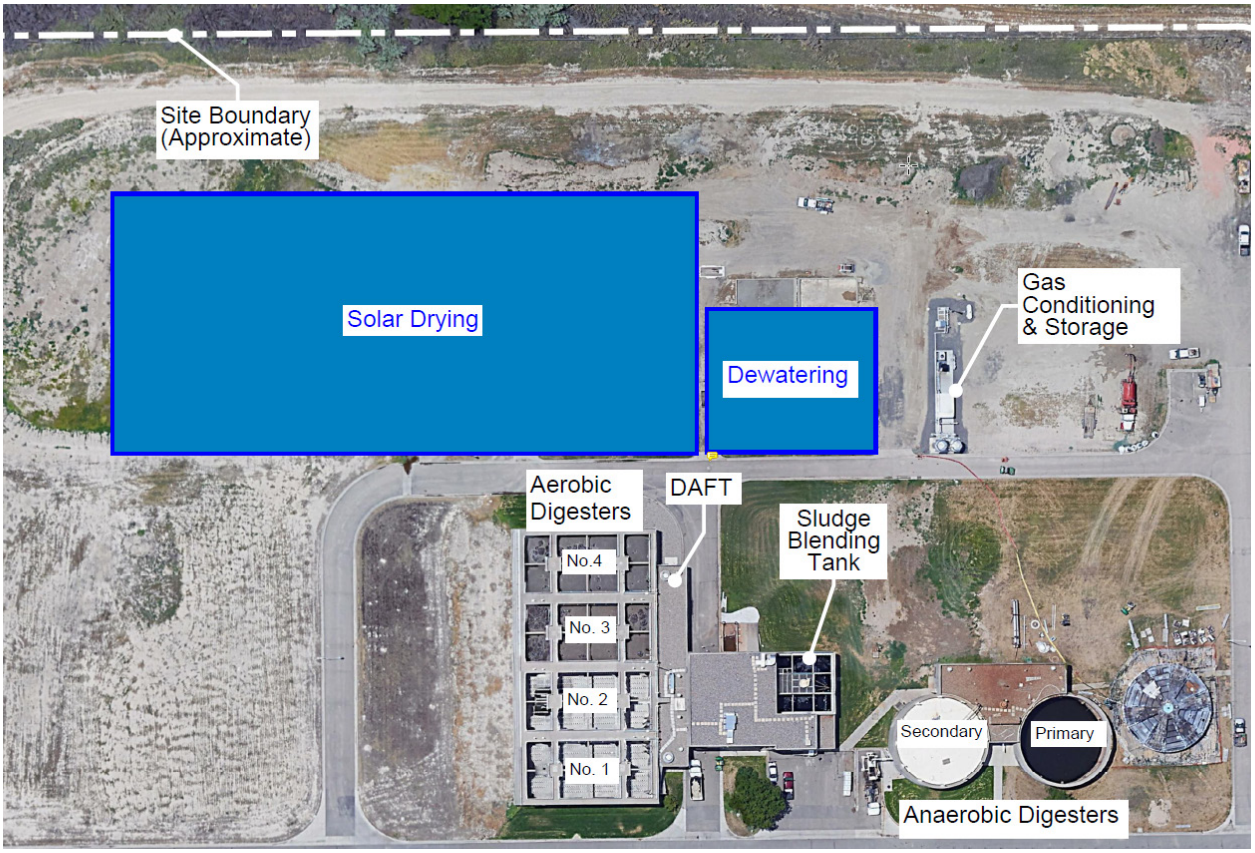


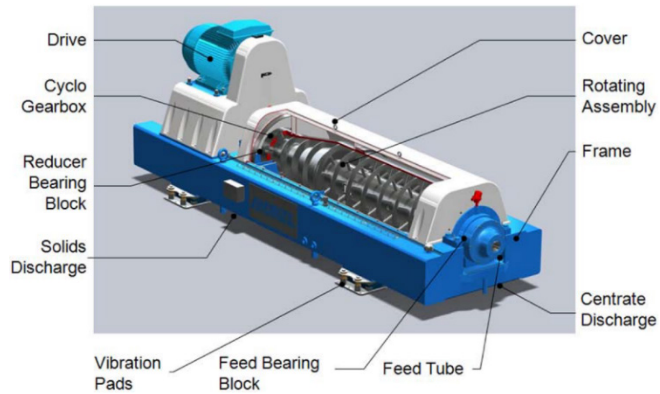
Figure 5.39 Proposed Screw Press + Solar Drying Layout

5.12.3 Alternative 2 – Centrifuge and Cake Storage Pad

Similar to Alternative 1, this alternative looked at improved technologies to increase the dewatering performance using centrifuges with 100 days of dewatered biosolids storage.

A centrifuge uses centrifugal force (up to 500 to 3,000 times the force of gravity) to separate solids from liquids in digestate. The centrifuge consists of a high-speed rotating bowl, a screw conveyor (scroll), a centrate port, and a dewatered cake port. The bowl and scroll operate at slightly different relative speeds, allowing the scroll to convey dewatered cake up the sloped "beach" to the solids discharge port. The liquid phase, or centrate, flows axially in the opposite direction from the solids and is released through centrate discharge ports. Solids are pumped into the feed tube and rotating assembly and exit the feed tube through ports into the bowl.

Centrifuges require more electrical power and maintenance than other thickening options. However, the additional electrical power and costs are typically not significant when compared to the increased solids concentrations and the reduction in transportation costs. Centrifuges do have higher polymer demand. However, like screw presses, they contain odors better than BFPs. Centrifuges also produce the driest cake and have the smallest footprint of mechanical dewatering options. The factors have been included in the financial analysis shown below. Figure 5.40 shows the major centrifuge components.



(Courtesy of Andritz)

Figure 5.40 Centrifuge Major Components

Similar to screw press dewatering, it was assumed that the units would be sized for operation 8 hours per day, 5 days per week. With this operating scheme, three centrifuges would be required. While three centrifuges would likely fit in the existing Dewatering Building, the same structural concerns with Alternative 1 apply to this alternative about the existing building. Thus, it is recommended that a new Dewatering Building be constructed with a new Biosolids Storage Facility. A conveyor will be used to transport dewatered sludge to the storage facility.

5.12.3.1 Dewatered Cake Storage

Dewatered cake storage facility with a capacity of 100 days of dewatered cake storage was included in the analysis. The 100 days was based as a worst-case storage solution, which was dependent on the different final uses of the biosolids, as discussed in Chapter 5. This maximum required on-site storage was used in event land application sites were not available for the winter months. Alternatively, if a third-party is used to manage the removal of dewatered biosolids, it was assumed quarterly visits to haul off-site.

The proposed Dewatered Cake Storage Facility would include concrete pony walls to provide a structure for containing the piles of dewatered biosolids and potentially supporting the structure's roof. It is assumed the building would consist of a concrete slab at grade with a metal canopy cover as shown in Figure 5.41. Depending on odor impacts, it is not expected that an odor control system or building heating will be required. However, electrical power will be needed for lighting and roof fans should be installed to force ventilation and stale air out of the space.

Figure 5.41 Examples of Metal Building Cake Storage Facility

To minimize odors, biosolids storage time should be minimized, especially during hot and humid weather. Thirty-foot buffers around the facility will be maintained. If odors are excessive, a biofilter could be installed. Biosolids could also be covered with compost or sawdust. If odors are due to a pH below 9.0 (indicating organic matter decomposition) lime could be added to the surface (EPA, 2000).

For sizing the cake storage facility, it was assumed that the centrifuges can achieve 22 percent solids. With this assumption, 0.5 acres would be needed for 100 days of cake storage. Table 5.30 shows the 2040 operating parameters of a centrifuge and cake storage facility for the options considered.

Table 5.30 2040 Operating Parameters for Centrifuge and Cake Storage

Parameter	Aerobic + Anaerobic Digestion
Centrifuges	
Duty / Standby, #	2 / 1
ADMM Operating (hours / days / weeks)	8 / 5/ 52
ADMM Solids Loading each, pph	1,790 - 1,960(1)
ADMM Hydraulic Loading each, gpm	120 - 140(1)
100 Days of Cake Storage	
Cake Pile Height, feet	10
Cake Storage Dimensions, feet	100 by 200
Total Required area, acres	0.5

Notes:
(1) The lower value corresponds to the options without CEPT or grease and the higher value corresponds to the options with CEPT and limited grease.

A proposed PFD for centrifuges and cake storage is shown in Figure 5.42 and a proposed layout is shown in Figure 5.43.

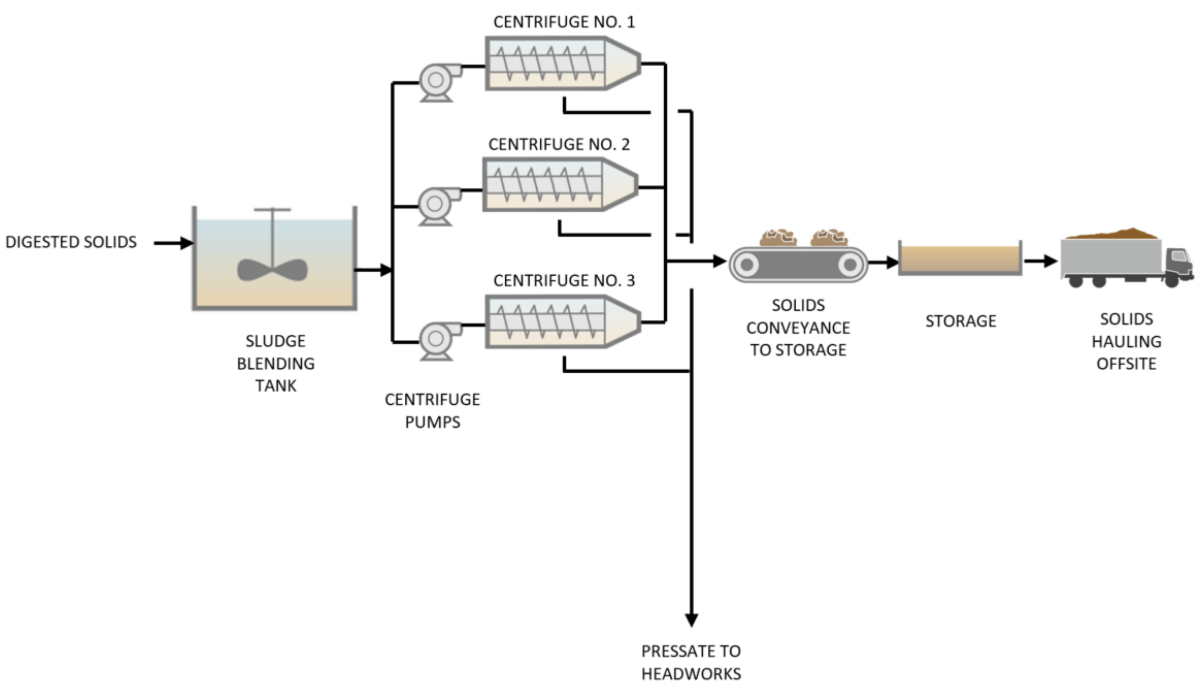


Figure 5.42 Proposed Centrifuge + Cake Storage PFD

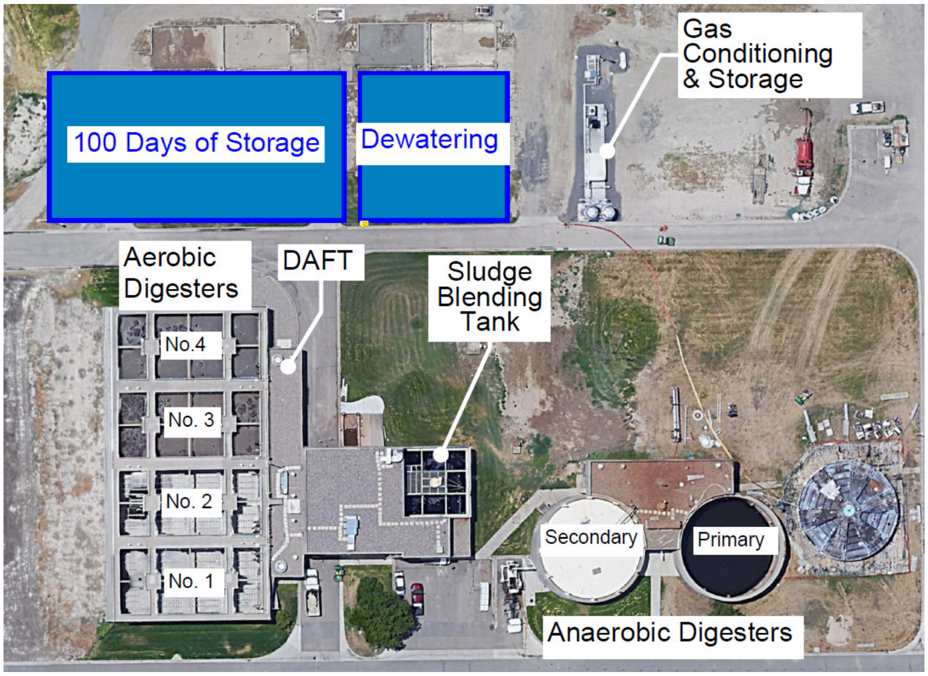


Figure 5.43 Proposed Centrifuge + Cake Storage Layout

5.12.4 Financial Comparison of the Dewatering Alternatives

The total project costs and 20-year operating costs for each of the dewatering alternatives are presented in Table 5.31 for a capacity of 13.5 mgd ADMMF. A detailed breakdown of cost estimating assumptions for each alternative can be reviewed in Appendix D. Appendix F includes the operating assumptions and financial models for the calculated NPV values.

Table 5.31 Dewatering and Storage Alternatives Summary of Costs

	Baseline	Dewatering Alternative 1	Dewatering Alternative 2
Alternative Description	**Business as Usual (BFPs)**	**Screw Press + Solar Drying**	**Centrifuges + Storage**
Dewatering Project Cost	$10.1 million	$16.6 million	$15.3 million
Storage Project Cost	$0.3 million 7 days storage	$16.3 million solar drying	$2.9 million 100 days storage
Total Project Costs	**$10.4 million**	**$32.9 million**	**$18.2 million**
O&M Costs - 20-year	NA(2)	- $7.1 million (3)(5)	- $3.7 M(4)(6)
NPV	**$10.4 million**	**$25.7 million**	**$14.5 million**

Notes:
(1) O&M costs shown for 20-year period are comparative costs relative to current day options. As result, the Baseline Condition equals the 2020 operating costs. All capital and O&M costs shown are in 2021 dollars.
(2) Baseline cost estimates developed and included in Chapter 4, shown here for comparison to dewatering alternatives.
(3) Alternative 1 costs include a new Dewatering Building with screw presses and new Solar Drying Facility, see detailed cost estimating sheets in Appendix C.
(4) Alternative 2 costs include a new dewatering building with centrifuges and 100 days of biosolids storage, see detailed cost estimating sheets in Appendix C.
(5) O&M cost reductions for Alternative 1 included the benefit of reduced hauling costs, and tipping fees. Included increased electricity, polymer use, and manpower.
(6) O&M cost reduction for Alternative 2 included the benefit of reduced hauling costs and tipping fees. Included increased electricity and additional polymer use.

5.12.5 Implementation Recommendations

Based on the benefits of improved dewatering and cake storage quality, updated facilities, and other considerations discussed with City staff, it is recommended that the Persigo WWTP transition to centrifuge dewatering and on-site cake storage. Of significant note, the improved cake quality (in terms of both consistency and overall percent TS) opens the City up to a wider variety of biosolids end use options, as discussed in Chapter 5. Some of these biosolids end use options may further reduce biosolids disposal costs, reducing the 20-year O&M costs. Table 5.32 lists the projects proposed and the implementation schedule.

Table 5.32 Dewatering and Biosolids Storage Implementation Recommendations

Implementation Period	Identified Projects
2021-2025	New Centrifuge Dewatering Building and storage.
2026-2030	None identified.
2031-2040	None identified. Could potentially defer some of the original biosolids storage costs to later period.

5.13 Biogas Process and Storage

As noted in Chapter 3, the City operates a biogas conditioning system to clean and compress the biogas produced on-site, which is delivered via a 6-mile pipeline to a CNG fueling station for the City's fleet vehicles.

While alternatives were not considered for biogas treatment and storage, a capacity expansion from the increased biogas production associated with the digestion alternatives was considered. A capacity expansion would only be needed if anaerobic digestion of all solids (PS and TWAS) is implemented. If the on-site biogas treatment system is expanded, additional storage may be required at the Fleet fueling station.

5.13.1 Baseline

Asset improvements were identified in Chapter 4 for continued operation of the existing biogas treatment system. As noted in Chapter 3, additional biogas storage is being installed as part of a separate project.

5.13.2 Biogas Treatment Capacity Expansion

Currently, the WWTP produces an average of around 60 scfm of biogas and has a biogas conditioning system designed to clean and compress up to 100 scfm. Table 5.33 summarizes the projected biogas production in 2040 for each of the digestion scenarios considered herein. The values shown in Table 5.33 assume a specific gas production of 15 cubic feet per pound of volatile solids (cf/lb VS) destroyed. The values shown represent maximum month condition.

Table 5.33 Biogas Production in 2040 for Scenarios Considered

Parameter	Aerobic + Anaerobic Digestion				Anaerobic Digestion			
	PS + WAS	PS + WAS + Grease	PS (70% CEPT) + WAS	PS (70% CEPT) + WAS + Grease	PS + WAS	PS + WAS + Grease	PS (70% CEPT) + WAS	PS (70% CEPT) + WAS + Grease
ADMM Biogas production, scfm	78	91	100	112	136	148	142	154

As shown in Table 5.33, the existing biogas conditioning system should have sufficient capacity through 2040 if the WWTP continues to both aerobically and anaerobically treat their solids. However, if the City switches to all anaerobic digestion, additional biogas treatment capacity would be needed to condition all of the biogas produced. Based on conversations with City staff, an additional 100 scfm treatment unit is recommended to maintain consistency with existing. The additional biogas conditioning capacity would be needed sometime after 2030 depending on the solids and grease treatment prior to the digestion process.

5.13.2.1 Process Flow Diagram

A proposed PFD for biogas conditioning is shown in Figure 5.44.

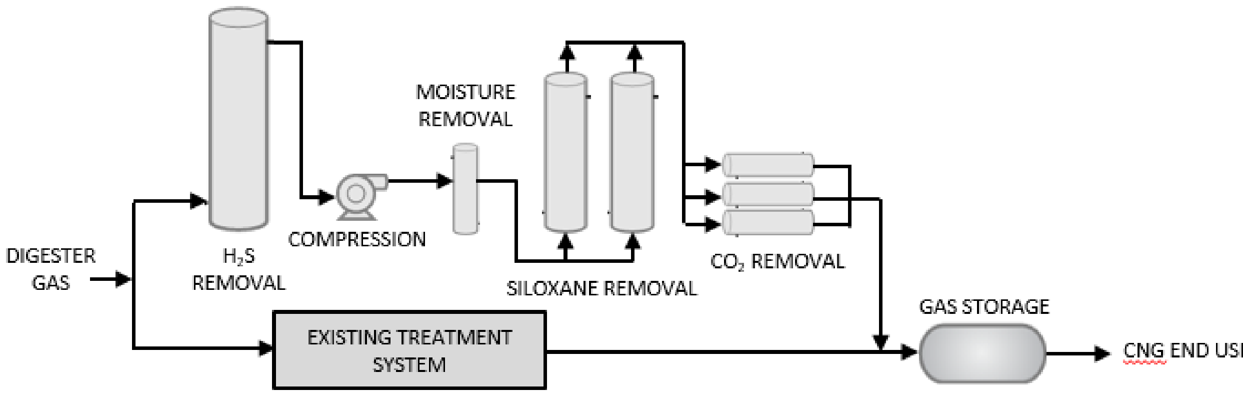


Figure 5.44 Proposed Biogas Conditioning PFD

5.13.2.2 Site Layout

Figure 5.45 illustrates the location for the new biogas treatment system, located adjacent to the existing gas conditioning and storage.

Figure 5.45 Proposed Biogas Conditioning Layout

5.13.3 Financial Comparison

Table 5.34 summarizes the financial information developed for the additional gas conditioning system. Additional information on the capital cost assumptions can be found in Appendix D. The additional RIN revenue associated with the increased biogas production of transitioning to all anaerobic digestion is included in the O&M costs for Digestion Capacity Alternative 2.

Table 5.34 Grease Receiving Alternatives Summary of Costs

	Baseline Condition	Expansion Alternative
Alternative Description	**Business as Usual: No Capacity Change, Rehabilitate Existing(1)**	**Increase Biogas Treatment Capacity(2)**
Project Cost	$2.0 million	$7.8 million

Notes:
(1) Asset renewal assumptions and costs included 40% of capital cost for a new biogas treatment system.
(2) The cost for the expansion alternative includes the costs for the Baseline Condition.

5.13.4 Implementation Recommendations

Depending on the digestion alternative selected, Table 5.35 illustrates the recommended infrastructure improvements to address the biogas asset renewals and capacity constraints in the 2040 planning horizon. Grant funding may be available from the Department of Local Affairs (DOLA) to reduce the payback period of additional conditioning equipment.

Table 5.35 Dewatering and Biosolids Storage Implementation Recommendations

Implementation Period	Identified Projects
2021-2025	None identified.
2026-2030	None identified.
2031-2040	1. Rehabilitate the existing biogas treatment system. 2. Expand the current biogas treatment capacity.

Chapter 6

BIOSOLIDS MANAGEMENT

6.1 Introduction

This chapter covers regulatory requirements, infrastructure improvements, and beneficial use outlets for developing a Class B biosolids land application program. Achieving Class B pathogen reduction limits would allow the plant to beneficially reuse wastewater biosolids, providing a sustainability benefit to the community.

6.2 Current Biosolids Management Operation

The Persigo WWTP's existing solids handling process is described in Chapter 3. Anaerobically digested solids and aerobically digested biosolids are blended and dewatered with belt filter presses. The dewatered biosolids are loaded into 12-cubic-yard side-dump trucks and hauled to the Mesa County Landfill, which is approximately 14 miles from the WWTP for disposal. Table 6.1 shows the annual biosolids quantities hauled to the landfill since 2015 based on records provided by the WWTP. Over the last 5 years, the WWTP has disposed on average 12,300 wet tons of biosolids per year. Though the annual quantities have remained relatively consistent since 2015, the disposal cost has risen substantially from $13 per wet ton to $23.74 per wet ton.

Table 6.1 Historical Biosolids Quantities

Year	Total Volume of Biosolids Disposed (wet tons)	Cost per Wet Ton	Total Disposal Cost
January-May 2020	5,800	$23.74	$138,000
2019	12,600	$22.75	$287,000
2018	12,700	$22.00	$279,000
2017	11,800	$17.09	$202,000
2016	12,200	$13.00	$159,000
June-December 2015	6,400	$13.00	$83,000

A paint filter test is conducted on one load each month and a TCLP metals sample is tested once annually to comply with Mesa County Landfill dumping requirements. The loads are also tested for pH quarterly and standard metals annually. Testing costs amount to approximately $500 per year.

Mesa County and Persigo WWTP staff assume the tipping fees will continue to increase in the future. Additionally, Mesa County will be reaching landfill capacity based on their current projections near the end of the 2040 planning horizon. It is assumed the future landfill site would be located in close proximity to the existing landfill.

6.3 Developing a Class B Biosolids Management Program

As a steward of resources and sustainable practices, the Persigo WWTP is evaluating the opportunities and costs to develop a Class B Biosolids Management Program. Pursuing such a program could decrease operating costs and increase beneficial reuse of resources through land application of biosolids. Land application of biosolids increases sustainable practices in agriculture since the nitrogen and phosphorus in the land-applied biosolids improve the soil conditions, offsetting the use of chemically applied fertilizers.

6.3.1 Class B Regulatory Requirements

As discussed in Chapter 2, wastewater biosolids must meet certain pathogen reduction, VAR, and metals concentration requirements to be certified as Class B. CDPHE Regulation 64 specifies five PSRPs – aerobic digestion, air drying, anaerobic digestion, composting, and lime stabilization.

Wastewater treatment plants can also apply for an alternative PSRP method for approval, or they may forego further treatment and use sampling to prove that the biosolids meet the Class B pathogen levels specified in Regulation 64. As noted in Chapter 3, the Persigo WWTP uses anaerobic digestion for primary sludge and aerobic digestion for WAS stabilization. However, Class B biosolids are not produced in the aerobic digester due to an insufficient detention time. As discussed in Chapter 5, it is recommended that the City expand and improve the solids digestion and dewatering processes for sludge stabilization to achieve Class B biosolids, specifically, through anaerobic digestion of both the primary solids and WAS.

Implementing a Class B program requires a permit from the CDPHE WQCD for the use and distribution of biosolids as discussed in Chapter 2.

6.3.2 Options for Beneficial Use of Class B Biosolids

This section summarizes several outlet options for Class B biosolids, including the following:

- City-Owned Land Application Sites.
- County-Owned Land Application Sites.
- Privately-Owned Agricultural Sites.
- Federal Land Application Sites.
- Mine Reclamation Sites.
- Third-Party Management.
- Alternative Daily Landfill Cover.

The most common outlet for land application of biosolids is agricultural land. Class B land application sites need to meet the criteria specified in Section 64.15 of Regulation 64. There are limits on a land application site's proximity to surface water, the depth to groundwater in the vicinity of the site, topography (slope), its soil quality, and what crops are grown on the site. Furthermore, Class B biosolids cannot be applied to sites where animals are actively grazing or where the public has continual access, which may impact City-owned properties.

The total area of land required for biosolids application varies substantially based on the nitrogen content of the biosolids and the nitrogen uptake rate of the crops or vegetation on the site. Based on feedback from the CDPHE Biosolids Coordinator and Veris Environmental, the biosolids loading rates for dryland and irrigated sites are as follows:

- Dryland biosolids application rates range from 2 to 3 dry tons/acre.
- Irrigated application rates range from 7 to 10 dry tons/acre.

The Persigo WWTP currently generates approximately 1,650 dry tons of biosolids per year. This is projected to increase to 2,060 dry tons of biosolids per year in 2040 as shown in Table 6.2.

Table 6.2 Biosolids Production Projections

Biosolids Production	Wet Tons per Day	Wet Tons per Year	Dry Tons per Year
2020	36.5	13,300	1,650
2025	38.0	13,800	1,710
2030	40.2	14,700	1,820
2035	42.9	15,700	1,950
2040	45.4	16,600	2,060

Notes:
(1) The calculated dry tons per year is based on the current solids concentration of 12.4 percent in 2020 using the existing belt filter press for dewatering.

Using the application rate estimates provided above, the WWTP would need to identify up to 830 acres for land application on dry land and 230 acres for application on irrigated land assuming just one crop cycle application per year. In 2040, this would increase to 1,030 acres for land application on dry land and 300 acres for land application on irrigated land. These estimates are summarized in Table 6.3. However, as stated above, this total area required could change substantially based on biosolids metals and nutrient concentrations, site characteristics, soil testing, type of crop, and the number of applications per year.

Table 6.3 Land Application Rates

Description	Rate	Annual Acreage Required, Current(1)	Annual Acreage Required, 2040(1)
Dryland Application	2-3 dry tons/acre	830 acres	1,030 acres
Irrigated Application	7-10 dry tons/acre	230 acres	300 acres

Notes:
(1) Actual land application acreage required will vary substantially based biosolids quality, soil quality, agronomic uptake rates, and other environmental factors.

To effectively administer and report biosolids land application to all Class B land application sites in accordance with Regulation 64, the City would need to transport its own spreading equipment and land apply the biosolids. These capital and O&M costs have been included in the financial analysis below. Depending on the dewatering technology implemented at the Persigo WWTP, as identified in Chapter 5, the total solids concentration for the Class B biosolids could range from 12 percent up to 25 percent total solids concentration. The total solids concentration assumptions will change the type of land application and the equipment used.

6.3.2.1 City-Owned Land Application Sites

Figures 6.1 and 6.2 identify properties owned by the City within 10 and 20 miles of the Persigo WWTP, respectively. Class B biosolids could be used as ground cover or fertilizer for City-owned properties. Applying to City-owned properties could reduce much of the administrative burden associated with land application at privately owned sites. However, the criteria in Regulation 64.15 could limit the site options, particularly near the City center. Public access to land application sites must be restricted for at least 30 days after the Class B biosolids application, which eliminates parks and recreation areas as viable outlets. Furthermore, applying biosolids to sites near populated areas could cause odor issues and complaints.

As shown on Figure 6.1, the City owns substantial areas of open space 15 to 20 miles southeast of the city limits. These properties could be good candidates for Class B biosolids land application, provided that the actual application site is at least 50 feet from the streams that run through this area and that the other restrictions in Regulation 64, Section 64.15 are met. These areas are large enough that the City could permit just one or two application sites, which would substantially reduce the sampling and reporting needs to run the Class B biosolids program.

6.3.2.2 County-Owned Land Application Sites

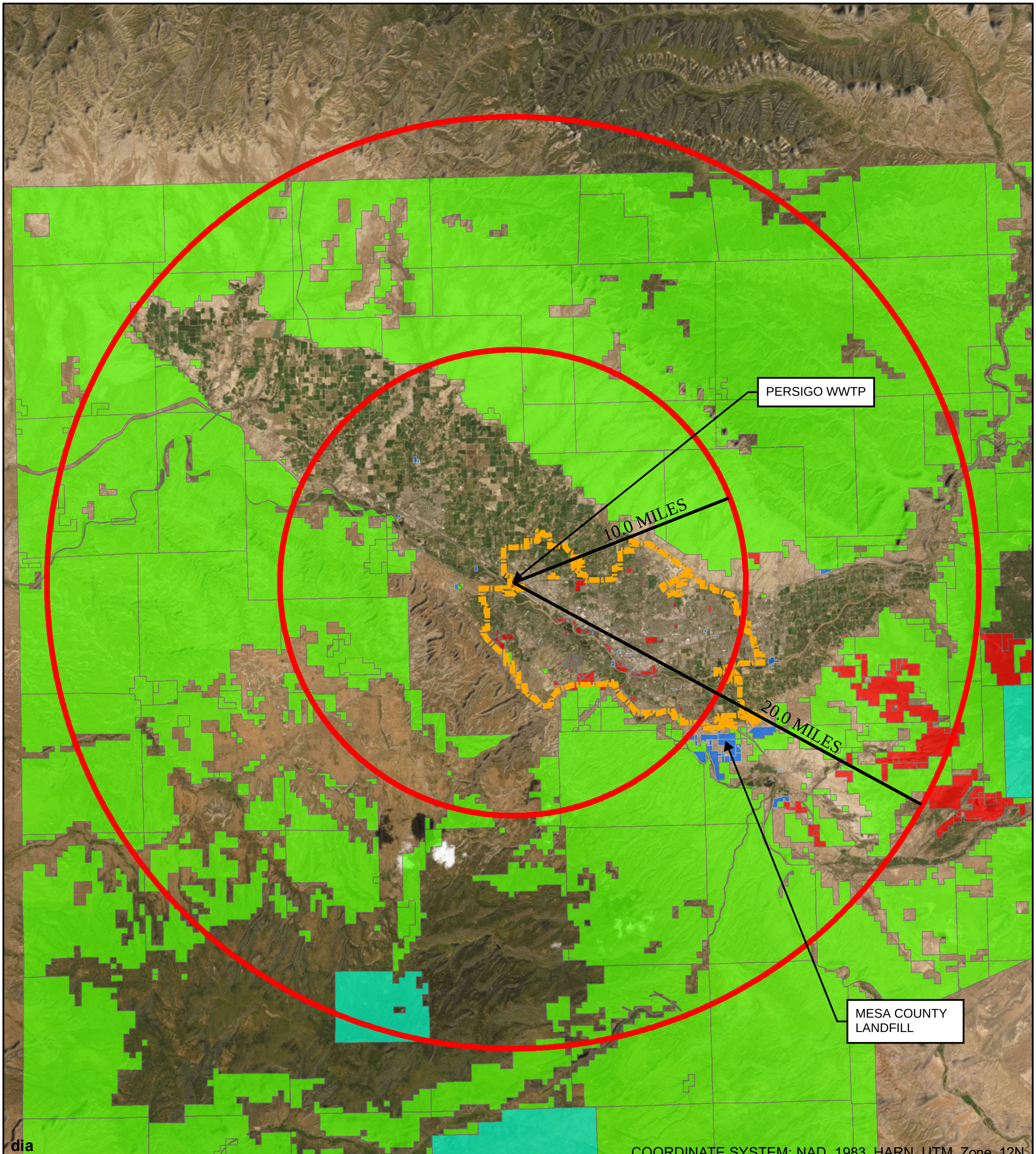
The administrative benefit of land applying at a County-owned site is similar to that of a City-owned site. As shown on Figures 6.1 and 6.2, Mesa County owns minimal land in the vicinity of Grand Junction. The County does own several large parcels of undeveloped land near the Mesa County landfill, approximately 10 miles southeast of the Persigo WWTP. However, according to representatives of the Mesa County Landfill, because the landfill is already prone to odor complaints from the nearby residential areas, biosolids application on these undeveloped parcels may face some opposition.

6.3.2.3 Privately-Owned Agricultural Sites

Privately-owned farms, ranches, and other agricultural sites could use Class B biosolids as nutrient-rich fertilizer. Figure 6.3 shows farms in the vicinity of the Persigo WWTP that are farther than 50 feet from surface water (one of the requirements in Regulation 64, Section 64.15). Grand Junction has large agricultural areas to northwest and east of the city limits including in Fruita and Palisade, but Regulation 64 crop restrictions may limit the number of acceptable sites. The crop restrictions for biosolids land application sites per Regulation 64 are as follows:

- Food crops with harvested parts that may touch the biosolids/soil mixture and which grow above the soil surface shall not be harvested for 14 months after application of biosolids.
- Food crops with harvested parts which grow below the soil surface shall not be harvested for 20 months after application of biosolids when the biosolids remain on the soil surface for 4 months or longer prior to incorporation into the soil.
- Food crops with harvested parts which grow below the soil surface shall not be harvested for 38 months after application of biosolids when the biosolids remain on the soil surface for less than 4 months prior to incorporation into the soil.
- Food crops for human consumption, feed crops for livestock consumption, and non-food crops shall not be harvested for 30 days after application of biosolids.

Animals also are not allowed to graze on biosolids application sites for 30 days after application. This option would require significant up-front work identifying acceptable sites, establishing agreements with the landowners, fencing restricted areas, and permitting the sites for Class B biosolids application. It would also require ongoing coordination with landowners to schedule the biosolids applications depending on planting and harvesting cycles, as well as ongoing soil sampling and reporting requirements.



LAND APPLICATION BOUNDARY
201 BOUNDARY
PERSIGO WWTF
CITY OF GRAND JUNCTION
MESA COUNTY
BUREAU OF LAND MANAGEMENT
FOREST SERVICE
NATIONAL FOREST

0 2.75 5.5 11 MILES

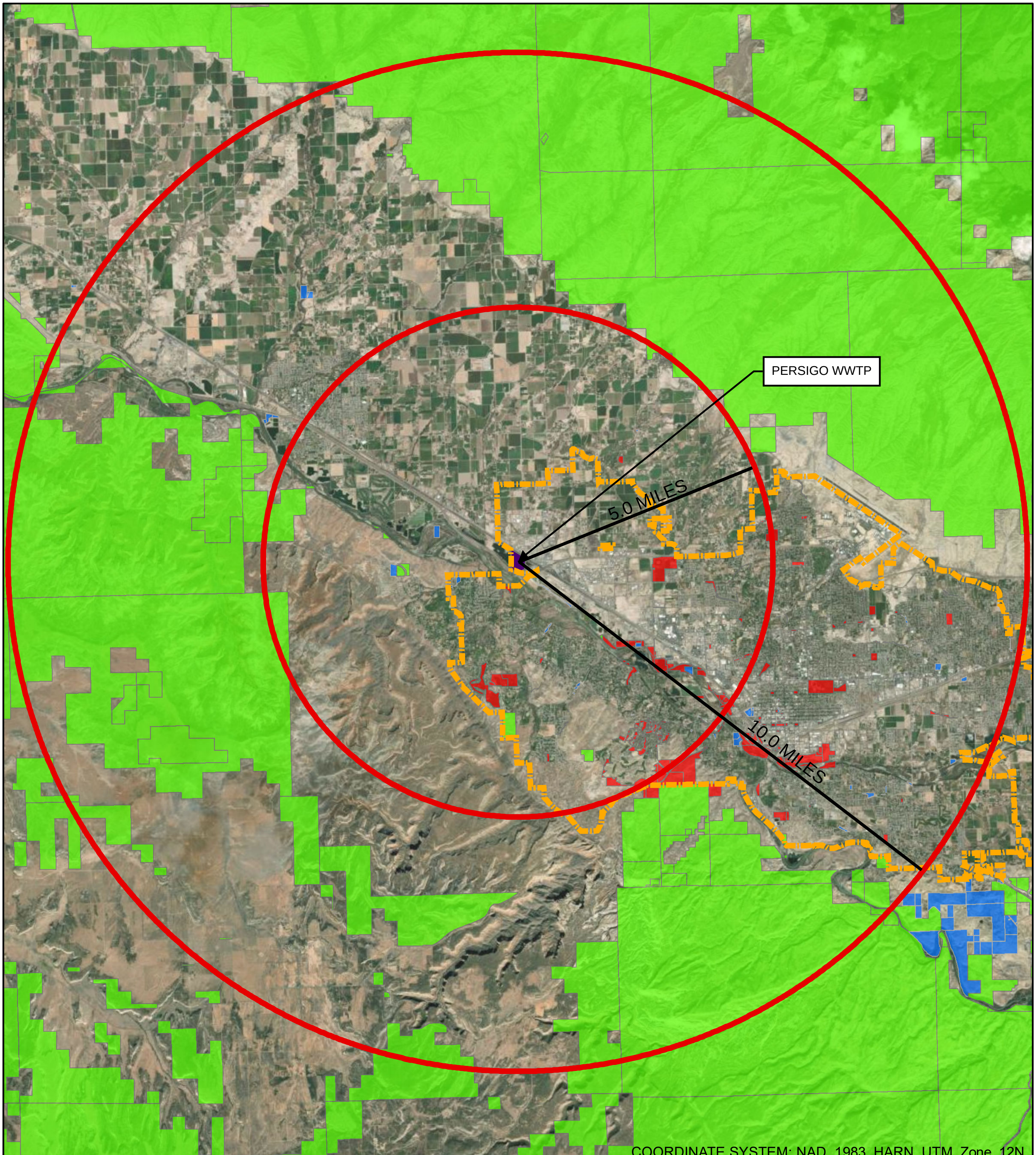
1 INCH = 5.5 MILES

FIGURE 6.1 - POTENTIAL NON-PRIVATE LAND APPLICATIONS FOR BIOSOLIDS (10- AND 20- MILE RADIUS)

GRAND JUNCTION PERSIGO WWTP
JVA JOB # - 1086e
JULY 2020

JVA, Inc.
1319 Spruce Street
Boulder, CO 80302
303.444.1951
www.jvajva.com
Boulder • Fort Collins • Winter Park
Glenwood Springs • Denver

CONSULTING ENGINEERS



LAND APPLICATION BOUNDARY
201 BOUNDARY
PERSIGO WWTP
CITY OF GRAND JUNCTION
MESA COUNTY
BUREAU OF LAND MANAGEMENT
FOREST SERVICE
NATIONAL FOREST

0 1.25 2.5 5 MILES

1 INCH = 2.5 MILES

FIGURE 6.2 - POTENTIAL NON-PRIVATE LAND APPLICATIONS FOR BIOSOLIDS (5- AND 10- MILE RADIUS)

GRAND JUNCTION PERSIGO WWTP
JVA JOB # - 1086e
JULY 2020

JVA, Inc.
1319 Spruce Street
Boulder, CO 80302
303.444.1951
www.jvajva.com
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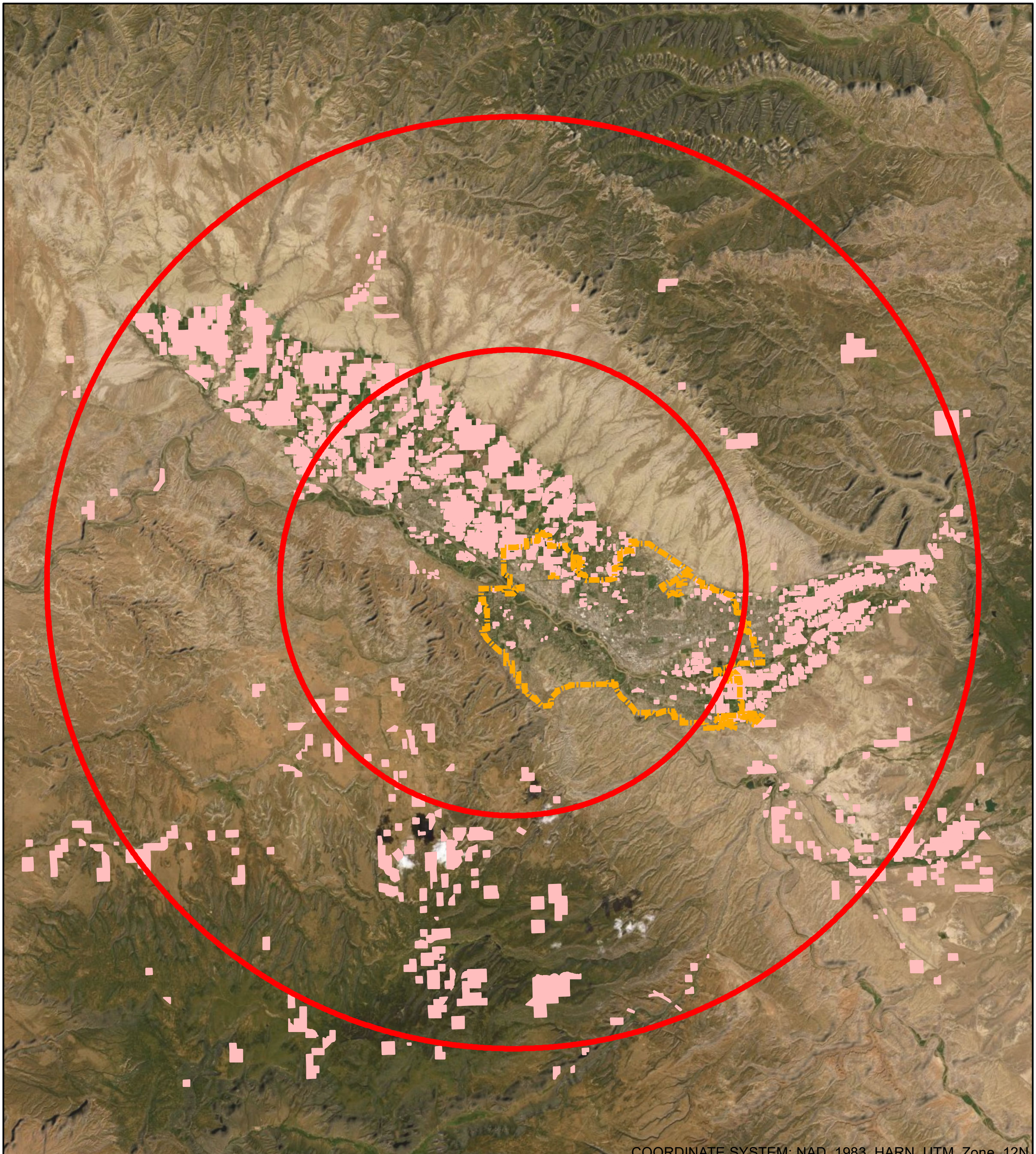

LAND APPLICATION BOUNDARY
201 BOUNDARY
PRIVATE PROPERTY AGRICULTURAL SITES

0 2.75 5.5 11 MILES
1 INCH = 5.5 MILES

FIGURE 6.3 - POTENTIAL PRIVATE LAND OUTLETS FOR BIOSOLIDS

GRAND JUNCTION PERSIGO WWTP
GRAND JUNCTION, COLORADO
JVA JOB # - 1086e

JULY 2020

JVA, Inc.
1319 Spruce Street
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303.444.1951
www.jvajva.com
Boulder • Fort Collins • Winter Park
Glenwood Springs • Denver

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6.3.2.4 Federal Land Application Sites

Other land application sites could include Bureau of Land Management (BLM) land or United States Forest Service land. There is a significant amount of BLM land in the vicinity of the WWTP, as shown on Figures 6.1 and 6.2. However, applying biosolids to federal land would likely require substantial permitting, including conducting a full environmental assessment in accordance with the National Environmental Policy Act (NEPA).

6.3.2.5 Mine Reclamation Sites

Wastewater biosolids have been used at mine reclamation sites to regenerate the soil layer, establish sustainable vegetation, and reduce the bioavailability of toxic substances. This outlet would require a partnership with the Colorado Division of Reclamation, Mining, and Safety. No mine reclamation sites have been identified in the Grand Junction area, and this option was eliminated from further consideration.

6.3.2.6 Third-Party Management

The Persigo WWTP could forego both hauling and land applying the biosolids by contracting with a third-party biosolids management company, such as Veris Environmental or McDonald Farms. In this scenario, the Persigo WWTP would still be responsible for treating the biosolids to Class B criteria, sampling the biosolids, and storing them. The biosolids management contractor would manage hauling and land applying the biosolids, including identifying appropriate land application sites and conducting the required soils sampling. A management company would likely haul biosolids from the plant three to four times per year. This option eliminates the administrative burden for the Persigo WWTP for site permitting, coordination, site soil sampling, and reporting. However, Persigo would need to construct storage infrastructure to store the biosolids to allow for cropping cycles and inclement weather conditions that prohibit land application. The cost for this on-site storage has been accounted for in Chapter 5.

6.3.2.7 Alternative Daily Landfill Cover

Class B biosolids could be used as an alternative daily landfill cover at the Mesa County Landfill or Monument Waste Landfill. This option would require a trial period and approval from CDPHE. A representative of Mesa County Landfill stated that the landfill existing cover material – a waste latex paint slurry – is financially and operationally advantageous and that the landfill does not need additional cover material at this time. Using Class B biosolids as an alternative daily cover at the Mesa County Landfill could be an option to consider in the future if the demand and potential financial benefits improve. When developing the future Class B program, the City should also investigate the potential of cover application at the Monument Waste Landfill as another alternative.

6.3.2.8 Summary of Options for Beneficial Use of Class B Biosolids

Table 6.4 summarizes the advantages and disadvantages of the alternatives considered for beneficial use of Class B Biosolids.

Table 6.4 Options for Beneficial Use of Class B Biosolids

Potential Class B Outlet	Advantages	Challenges
City-Owned Land Applications	• Less administrative burden to identify and manage application sites.	• Fewer site options. • Land application sites subject to access restrictions. • Requires crops or grasses.
County-Owned Land Application Sites	• Less administrative burden to identify and manage application sites.	• Fewest site options. • Land application sites subject to access restrictions. • Requires crops or grasses. • Potential odors from storage. • Requires purchase of biosolids spreading equipment.
Privately-Owned Agricultural Sites	• Many site options in the vicinity of Grand Junction. • Public relations/community benefit. • Opportunity for contracting with a private hauler.	• Substantial coordination and administrative needs for permitting and monitoring sites. • Continued efforts to find additional sites and coordination with farmers.
Federal Sites such as Bureau of Land Management and United States Forest Service	• Substantial land area available.	• Would require negotiation with federal agencies. • Substantial permitting requirements including a NEPA environmental assessment.
Third-Party Management	• Significantly reduces the administrative burden to identify and manage application sites. • Does not require purchase of biosolids spreading equipment.	• Potentially higher cost as compared to City-managed Biosolids Management Program.
Alternative Daily Landfill Cover	• Similar to existing practice. • Does not require purchase of biosolids spreading equipment.	• Landfill currently uses latex paint mixed with commercial spray slurry and is not interested in changing their current operation practices.

6.3.3 Persigo WWTP Infrastructure Improvements to Achieve Class B Program

On-site improvements to achieve Class B biosolids are addressed in Chapter 5. The recommended infrastructure improvement to achieve the Class B pathogen reduction requirements is conversion to full anaerobic digestion of primary solids and WAS.

As noted in Chapter 5, the WWTP would need to construct on-site biosolids storage to accommodate land application. No additional permitting is required to temporarily store biosolids on-site. Other on-site improvements include a loading station where the biosolids are loaded onto a transfer truck for transporting to the land application site.

6.3.4 Operational Considerations for Class B Program

Persigo WWTP would need to obtain separate permits for each land application site and would need to prepare the annual biosolids report required as part of the Class B land application permit. Additionally, a sampling program would be developed to comply with the WQCD permit. For land application, the Class B biosolids program would require the following sampling:

- Seven individual samples of biosolids would be collected and tested for pathogens at least quarterly.
- Composite biosolids samples would be collected and tested for total and volatile solids, pH, nutrients, and metals at least quarterly.
- Soils at all land application sites would be sampled prior to the initial biosolids application and once per application or cropping cycle thereafter. Soil samples would be tested for pH, conductivity, and nutrients.

At the 2020 biosolids production rate – around 1,650 dry tons per year – Regulation 64 requires biosolids sampling once every 2 months. More frequent sampling could protect the Persigo WWTP against non-compliance penalties. For example, if the WWTP samples its biosolids but continues to land apply before it receives the results and the results reveal an exceedance, the WWTP would be penalized for all biosolids applied after the sample was taken. As part of the NPV evaluation, it has been assumed the sampling costs will be escalated with inflation and the relative increase in biosolids production for the 2040 planning period. However, the assumption of six sampling periods per year remained constant.

6.3.5 Contingency Plans for Class B Biosolids Program

Contingency plans are a critical part of a Class B biosolids management program, whether it be due to inclement weather or the inability to meet the Class B regulatory criteria. These contingency plans include having agreements in place for the following options:

1. Transport biosolids to the Mesa County Landfill and dispose.
2. Store the biosolids on-site.
3. Store the biosolids off-site at the land application sites. This could be used if the weather prohibits spreading of the biosolids and on-site storage is full.

Storage infrastructure is included in the capital costs below to reflect these contingency plans. Chapter 5 includes capital costs for on-site storage.

6.3.6 Off-Site Infrastructure for Class B Biosolids for Land Application

Persigo WWTP could use its existing hauling vehicles to transport the biosolids to the land application sites, where the biosolids would then be transferred to the biosolids application equipment. Depending on the location of the land application site, an off-site short-term storage pad may be beneficial.

If the biosolids are applied to City-, County-, or privately-owned sites, Persigo WWTP will need to invest in application equipment. Biosolids with a high solids content (20 percent or greater) can be applied using a flail or beater-type spreader. Based on the recommendation made in Chapter 5, centrifuge dewatering would achieve greater than 20 percent total solids.

6.3.7 Class B Biosolids Management Program Costs

Tables 6.5 and 6.6 summarize the costs associated with Persigo WWTP's current biosolids management strategy compared with land application or working with a third-party biosolids contractor.

Table 6.5 Class B Program Capital Costs

	Existing System (Haul/Dump Biosolids at Landfill)	Class B Biosolids Land Application to City/County Sites	Class B Biosolids Land Application to Farms	Third-Party Biosolids Management
Anaerobic Digestion	$0	Included in Chapter 5	Included in Chapter 5	Included in Chapter 5
Hauling Trucks	$0	$0	$0	$0
Front End Loader	$0	$150,000	$150,000	$0
Spreaders	$0	$300,000	$300,000	$0
Trailers	$0	$100,000	$100,000	$0
Storage of Biosolids (# of days)	7 days	30 days	100 days	100 days
Storage Pad(s)	$200,000	$1 million	$3.1 million	$3.1 million
Storage Engineering Controls	$0	$50,000	$25,000	$50,000
Total Near-Term Capital Cost	**$200,000**	**$1,756,000**	**$3,722,000**	**$3,306,000**

Notes:
(1) Anaerobic Digestion costs are recommended for implementation as part of Chapter 5, independent of biosolids management approach.
(2) Costs for biosolids storage provided in Chapter 5, assumed covered storage for biosolids.

This capital cost estimates use the following assumptions:

- Persigo WWTP will use existing hauling trucks for landfill disposal or land application. No additional capital cost was allocated for hauling vehicles.
- Increased volatile solids destruction and dewatering of the biosolids resulting from the anaerobic digestion improvements are not taken into account, as this analysis is comparative based on current conditions.
- Persigo WWTP would invest in its own spreading equipment, which includes a front-end loader, two spreaders, and a trailer.
- Any Class B biosolids program requires dewatered biosolids storage infrastructure, which ranges from 7 to 100 days of biosolids storage. The costs shown were developed in Chapter 5 and assume concrete pad at grade with covered storage to protect dewatered biosolids from environmental conditions.

Table 6.6 compares the anticipated annual operating expenditures against the baseline condition of disposing biosolids at the Mesa County landfill.

Table 6.6 Class B Program Ongoing O&M Costs

	Existing System (Haul/Dump Biosolids at Landfill)	Class B Biosolids Land Application to City/County Sites	Class B Biosolids Land Application to Farms	Third-Party Biosolids Management
Sampling and Testing of Biosolids and Specific Sites	$500	$4,000	$11,000	$3,000
Hauling Costs	$104,500	$204,000	$312,000	$0
Spreading Costs	$0	$138,000	$138,000	$0
Tipping Fees	$316,000	$0	$0	$0
Program Administration	$0	$24,000	$96,000	$0
Third-Party Fees	$0	$0	$0	$533,000
Annual Total O&M	**$421,000**	**$370,000**	**$557,000**	**$536,000**

The O&M costs include the following assumptions:

- A Class B biosolids program requires two to three additional employees to spread the biosolids, regardless of whether the site was owned by the City, County, or a private landowner.
- The spreader maintenance cost is based the annual replacement cost for two spreaders with 30-year lifetimes, plus an additional $2,000 for site maintenance.
- Land applying on private agricultural sites would require much more hauling because of the possible distance between each farm if multiple loads were dropped off in 1 day. Site sampling costs are substantially higher because each site would need to be sampled twice per year. Due to the number of sites and the complexity of coordinating between the plant and private landowners, an additional full-time employee is included for program administration.
- Using a third-party management company like Veris Environmental would cost approximately $40 per wet ton of biosolids. Persigo WWTP would still need to conduct its own biosolids sampling and testing to confirm the biosolids meet Class B requirements.

Using the capital and O&M costs detailed in Tables 6.5 and 6.6, with an inflation rate of 3 percent and a discount rate of 4 percent, the 20-year lifetime costs associated with the biosolids management options were calculated and summarized in Table 6.7. These costs were calculated assuming annual biosolids produced increase from 13,300 wet tons/year in 2020 to 16,600 wet tons/year in 2040 (assuming a solids concentration of 12 percent.

The 20-year costs of hauling and dumping to the Mesa County Landfill also include a 5 percent annual increase in landfill tipping fees from $23.75 per wet ton in 2020 to $63.02 per wet ton in 2040. Based on this annual increase, the annual tipping fees exceed the annual O&M costs for the Class B land application programs listed between 2028 and 2030. Therefore, this suggests the City should initiate the Class B land application program between 2026 to 2030.

Table 6.7 Biosolids Management Options Lifetime Costs

	Existing System (Haul/Dump Biosolids at Landfill)	Class B Biosolids Land Application to City/County Sites	Class B Biosolids Land Application to Farms	Third-Party Biosolids Management
Capital Cost	$200,000	$1,756,000	$3,722,000	$3,306,000
Biosolids Handling 20-Year Lifetime Costs	$13,430,000	$7,319,000	$10,889,000	$11,317,000
Total 20-Year NPV	**$13,630,000**	**$9,075,000**	**$14,611,000**	**$14,623,000**

6.3.8 Recommendation for Implementing Class B Biosolids Management Program

The NPV costs shown in Table 6.7 suggest that implementing a Class B biosolids management program at the Persigo WWTP would be financially beneficial in the long term assuming the implementation of anaerobic digestion.

6.4 Future Drivers to Develop Class A Biosolids Management Program

There are facilities across the United States that face increased pressure to beneficially use their biosolids beyond land application. These pressures include:

- More stringent biosolids regulations.
- Increased public scrutiny over Class B land application programs.
- New revenue sources for higher quality biosolids product.

These drivers would require the Persigo WWTP to evaluate the implications of moving to a Class A type of biosolids management program, which would require significant capital expenditure at the Persigo WWTP. However, there is little regulatory driver for land application of Class A biosolids in Colorado. As such, developing Class A biosolids is not recommended at this time.

The capital infrastructure improvements to develop a Class A program include composting, heat and solar drying, heat treatment, thermal aerobic digestion, beta ray irradiation, gamma ray irradiation, pasteurization, or other methods demonstrated and approved by the EPA.

Currently, the Persigo WWTP is conducting a solar drying pilot project to determine the efficacy and operational approaches to developing a drier biosolids product which, in addition, may meet the pathogen destruction criteria to achieve a Class A product.

6.4.1 Class A Composting Opportunities

Composting is a common strategy for beneficial reuse of biosolids in Colorado. This could be a good option at the Persigo WWTP due to the availability of space and limited neighbors which would be impacted by potential odors generated.

There are three methods of composting biosolids – aerated static pile, windrow, and in-vessel composting, as shown in the Figures 6.4, 6.5, and 6.6. Although more land intensive, the windrow method requires the least infrastructure and largely consists of placing the biosolids in rows and periodically turning them using a bulldozer or other piece of earth-moving equipment.

Figure 6.4 Aerated Static Pile Composting

Figure 6.5 Windrow Composting

Figure 6.6 In-Vessel Composting

If local regulatory drivers develop that result in evaluating a Class A biosolids program, the following options could include:

1. Composting at the Persigo WWTP using traditional composting methods.
2. Composting at a City- or County-owned facility outside of the treatment facility. This option would require permitting under the CDPHE's Hazardous Materials and Waste Management Division (HMWMD), which is a different and more intensive process than permitting a biosolids composting program through WQCD.
3. Solar drying, as described in Chapter 5. Based on the EPA biosolids regulations and input from the manufacturer, the solar drying operations would need to achieve a total solids concentration of 90 percent for a Class A biosolids. This would require an expansion to the recommended solar drying process described in Chapter 5.

These options should be further verified and evaluated as the drivers for a Class A biosolids program increase. A Class A biosolids composting program requires a permit from the WQCD and regular sampling. Class A biosolids require less ongoing soils testing, permitting, and oversight and have a much wider variety of end use options compared to Class B.

6.5 Biosolids Management Recommendations

A Class B land application or third-party management programs at the Persigo WWTP will be financially beneficial as compared to the current operations of landfilling biosolids starting after 2028. Based on recommendations from Chapter 5, it is assumed the Persigo WWTP will convert their current digestion operations to complete anaerobic digestion before 2028. It is recommended that the City initiate a future biosolids management and Class B program development study. This study will further evaluate and refine the potential Class B land application sites and further refine the financial assumptions used. This 2020 Master Plan recommends in the 2028 to 2030 timeframe, the City should pursue implementation of a Class B biosolids management program.

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Chapter 7

SUPPORTING INFRASTRUCTURE AND PERSONNEL FACILITIES

For safe and reliable facility operation, it is critical to maintain the condition of the support utilities, such as electrical systems, control systems, natural gas supply, and potable water systems. Doing so promotes staff health and safety and provides the ability to reliably meet effluent goals and regulatory requirements.

This chapter provides information and recommendations for the support systems, developed from site investigations and discussions with Grand Junction staff.

7.1 Electrical Systems

7.1.1 Main Utility Feeds and Primary Switchgear

The Persigo WWTP has two primary electric utility feeds to a pad mount medium voltage switch maintained by Xcel Energy (Xcel). The pad mount equipment can automatically transfer between sources during power interruptions to either source. From the Xcel-owned pad mount equipment, a single medium voltage feed continues to the City-owned outdoor primary switchgear, which utilize fused switches to power a medium voltage loop.

The medium voltage loop continues through the site duct bank system to distribute power to step down transformers for various facilities. A diagram of the electrical connections and basic routing of the loop is shown in Figure 7.1.

7.1.1.1 Outdoor Primary Switchgear

The outdoor primary switchgear consists of fused switches to provide loop power for the facility. The outdoor gear was replaced in the last 5 years and appears to be in good condition. Because the equipment is new, it is not recommended for replacement. The gear is vulnerable to weather and wildlife and because of the fuses, there is limited coordination with downstream overcurrent devices. In the future, when the gear is considered for replacement, Carollo recommends evaluating an electrical room and switchgear that uses a circuit breaker and relays for overcurrent protection, a remote-control panel so facility staff does not have to be near electrical hazards, remote racking mechanism, and arc flash detection relays.

Primary switchgear.

During the site investigation, it was noted that the electrical staff does not have current training or capabilities to work on the medium voltage equipment. To handle emergencies and general maintenance of the medium voltage electrical system, it is recommended to either:

1. Invest in the training and equipment needed to safely work on the medium voltage system.
2. Develop an on-call contract with a third-party company to maintain and respond to emergencies in the medium voltage system.

Additionally, it is not known what the current fuse sizes are withing the gear. This should be I investigated, and spare fuses of each size be kept and stored for future use.

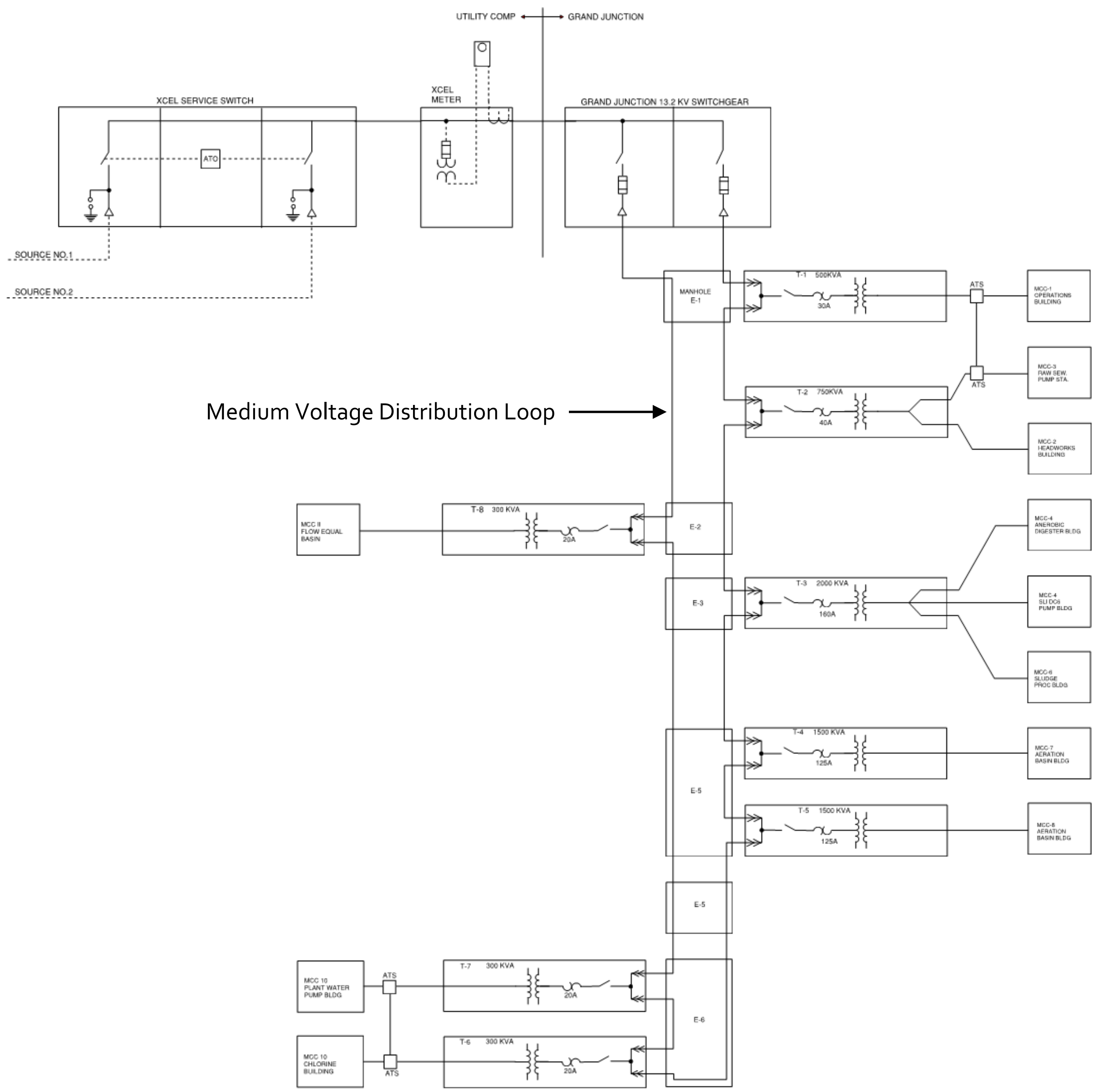

Figure 7.1 Existing Electrical One-Line Diagram

7.1.1.2 Loop Power Distribution

The outdoor primary switchgear provides power to the primary medium voltage loop. The loop routes through the plant's duct bank system to step-down transformers at various points in the facility. A diagram of the routing including the manholes it passes through is shown in Figure 7.1.

The cables for the medium voltage loop were part of the original installation in 1981 and reported to be submerged under groundwater throughout the year. No failures have been reported or recorded to this point. One consideration for the loop conductors is that both ends of the loop route through the same duct bank, and through the same manholes. This is not ideal because a single failure in a manhole or duct bank (fault condition, accidently damaged while digging, etc.) can cause a complete outage of the facility.

Considering the age of the conductors and the reliability concerns of the routing, planning for replacement of the medium voltage loop conductors is recommended. As part of the replacement, the design criteria should include a new path for the conductors that will ensure that the loops are not in a single point of failure (common manhole or common duct bank). Additionally, the loop system would provide an opportunity to have spare conduits to accommodate a fiber backbone ring for the facility's communications system discussed more in Section 7.2.

Installation of the new medium voltage power distribution loop requires coordination between on-going projects and operations to ensure sequencing does not cause service interruptions and ultimately discharge permit violations. Installing the new power distribution loop requires redundant duct banks and assumes the existing electrical distribution system would be maintained. Figure 7.2 illustrates a proposed routing for the new electrical duct bank, which would include both electrical cabling and fiber to provide a networked facility. A capital cost estimate has been provided in Appendix G.

7.1.2 Standby Generation

As described above, the facility has two electric utility sources that power the main facilities on-site through a medium voltage loop. In addition to dual utility sources, there are stationary diesel back-up generators dedicated to Raw Water Pumping and Headworks. In the event that both utility sources are lost, water can still be pumped through the plant. Plant staff noted that the raw water generator can support up to two Raw Water Pumps concurrently (of the five installed).

Staff noted that the generators are in reasonably good condition with no major concerns. Currently, the generators are operated weekly, but there is no regular load testing performed. To bring the generators up to operating temperature, and for the overall health of the machine, the manufacturers and National Fire Protection Association (NFPA) 110 recommend operating the generators under load at least twice a year. This can be done by using plant loads if available, or by load bank testing. It is recommended that the facility develop a regular load testing schedule for the generators.

7.1.2.1 Additional Standby Generator Needs

Facility staff indicated that the current electrical system is adequately reliable with the redundant feeders to the facility site. However, on-site generation would be beneficial at the disinfection building, which supports the UV system. Providing on-site generation will allow the staff to maintain disinfection during extended outages, which is critical to discharge permit compliance and maintaining service.

7.1.3 Medium Voltage Transformers

Throughout the facility, step-down transformers are present to reduce the voltage from 13.2 kilovolts (kV) to 480 V). As the existing electrical one-line diagram in Figure 7.1 shows, each building or process area can be fed from either side of the medium voltage loop. In total, there are eight transformers as shown on Figure 7.1.

Over the years, the staff has proactively replacement and maintained the pad mount transformers on site. As part of the current maintenance procedures, the transformer oil is tested regularly. Carollo recommends that the staff continue to test the transformer oil and trend for transformer replacements, especially on the transformers that have not been replaced.

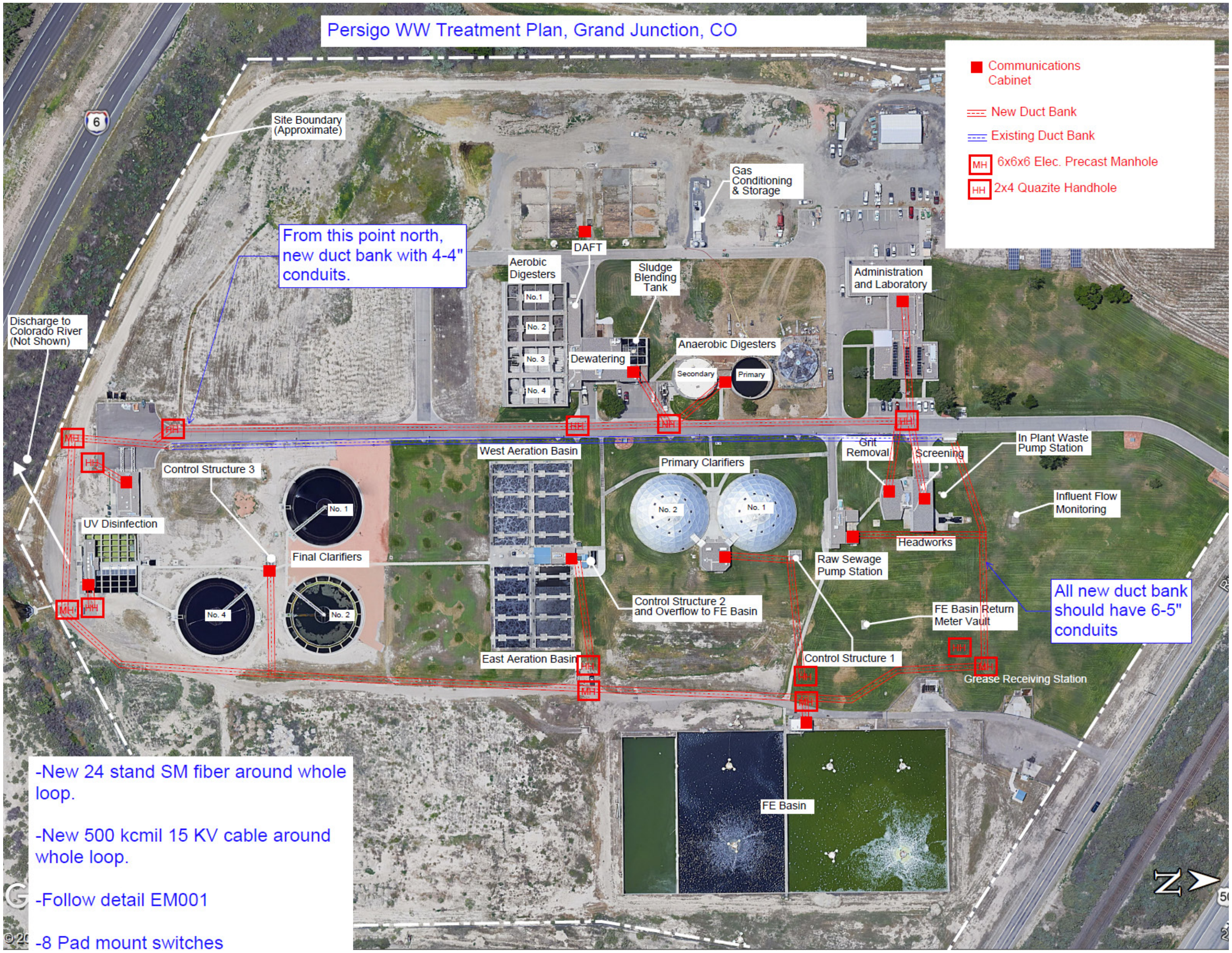

Figure 7.2 Proposed Routing for New Electrical Duct Bank

During the facility site visit, the transformer at the Administration Building was observed to be original equipment and may be leaking oil as shown in Figure 7.3. This transformer should be considered for replacement in the near-term and may be combined with the Administration Building upgrades or Medium Voltage distribution loop Projects.

When asked, the staff confirmed that many of the transformers on site have internal fusing. However, there are no records of which transformers have the internal fusing, nor the replacement fuse sizes. The existing fuse sizes for each transformer should be identified and spare fuses of each size should be kept on site for quick replacement. Additionally, the City should consider an on-call contract with a company that can help replace the fuses or invest in the proper training and equipment for staff to be able to replace fuses.

Figure 7.3 Administration Building Transformer

7.1.4 Low Voltage Distribution and Equipment

7.1.4.1 Motor Control Centers

There have been a number of MCC replacements over the years. However, there are still a few original MCCs on-site that are past their recommended useful life, and other MCCs that are installed in harsh environments and are recommended to be replaced even though they are newer. MCCs that are recommended for replacement include:

- Flow Equalization (EQ) Building.
- Headworks.
- Administration Building.
- Primary Clarifier Building.
- Blower Building.
  Replacement of the existing MCCs in the Blower Building is recommended. However, this 2020 Master Plan also recommends a complete replacement of the Blower Building for equipment and process reasons. As such, the replacement or upgrades to the existing Blower Building MCC needs to be evaluated to maintain secondary sludge (RAS and WAS pumping) operations in the basement of the existing Blower Building. Additionally, the controls upgrades/replacement should be coordinated and sequenced with the replacement of the Blower Building.
- Old Chlorine Building.

In addition to the MCC replacement, it is important to consider environmental improvements as well. If the City is going to invest in the replacement of the MCC, it makes sense to also invest in improvements to the environmental conditions to ensure longevity of the equipment. Some considerations noted from the site investigation include:

1. Headworks Electrical Room:
   a. Ventilation is poor and the room is located adjacent to classified spaces. Conduct NFPA 820 evaluation and modify the electrical room accordingly. Implement heating, ventilation, and air conditioning (HVAC) improvements to increase air flow and consider isolation from classified air spaces to increase MCC life expectancy.

2. Primary Clarifier Electrical Room:
   a. Ventilation is poor and room is located adjacent to classified spaces. Conduct NFPA 820 evaluation and modify the electrical room accordingly. Implement HVAC improvements to increase air flow and consider isolation from classified air spaces to increase MCC life expectancy.
   b. There appear to be potential roof leaks above the MCC as well. The building roof should be inspected and repaired as necessary to improve protection for the MCC.
3. Administration Building:
   a. The MCC is located in the walkway of the Administration Building. Recommend relocating and isolating so that staff are not exposed to the electrical hazards of 480 VAC electrical equipment.
4. Old Chlorine Building:
   a. The building's purpose has changed over the last several years. Consider replacement with equipment that is less expensive and adequate for the new purpose of the building.
5. Flow EQ Building:
   a. The future floating mixer replacement project identified as an asset replacement project in Chapter 4 could have an impact on electrical improvements if alternative technologies are used.
   b. Significant corrosion was also identified on the EQ Return Vault electrical infrastructure. This should also be considered for replacement after the future EQ basin plans have been finalized.

When considering building upgrades and equipment replacement, also consider access and space around the equipment. One concern is that currently, many facilities utilize the space around electrical equipment for storage. This is a violation of National Electric Code requirements and alternate storage methods and locations should be considered for the electrical spaces. In Chapter 8, it is recommended a storage and personnel space allocation and programming evaluation be completed to address these storage concerns.

Another consideration is trying to limit unqualified staff from having to interact or be around the power distribution equipment. There are design concepts such as separating the PLC controls by placing them in a different room from the power distribution equipment that can reduce interactions with unqualified staff to improve safety on site.

In addition to the environmental considerations, it is also important to note that today's MCCs are available with many different features, including but not limited to:

- Power metering.
- Networked or "intelligent" motor starters.
- Arc flash preventative equipment.
- Absence of voltage measurements.
- Remote controls, etc.

The City should review available features and consider defining standards to be implemented at all City facilities when replacing major electrical equipment such as the MCCs. These features are always evolving, and it is ideal to be consistent with replacements to the extent possible.

7.1.4.2 Ancillary Electrical Equipment

Corrosion concerns are common among many wastewater plant processes. The gas vapors associated with wastewater coupled with poor ventilation can create a harsh environment for electrical equipment, conductors, lighting, etc. Several facilities visited are seeing visual corrosion, as well as frequent failures due to the environmental conditions. It is recommended that while conducting the MCC replacements noted above, the conductors, conduits, lighting, and other miscellaneous boxes and components be evaluated and replaced as well.

While it is ideal to replace all the electrical in a building or process at one time, it can also be costly. To prioritize investments, it is recommended to start with replacing critical equipment, like the MCCs, and main feeders, then budget for other electrical improvements for future CIP projects.

7.1.4.3 Raw Water Pump Station Electrical Room

Currently, the raw water pump station Electrical Room houses the MCC, a switchboard distribution panel, and a control enclosure, which has the PLC as well as the raw water pump VFDs. Failures have occurred within the switchboard, and the VFD cabinet is experiencing issues with overheating.

To address the corrosive atmosphere and failures noted above, the following steps are recommended:

- Remove the switchboard.
- Separate the VFDs from the PLC enclosure.
- Install new PLC cabinet.
- Redesign HVAC system for the Electrical Room.

Completing these equipment replacements and implementing a properly designed HVAC system will increase the reliability and the life expectancy of the equipment in one of the most critical areas of the plant.

Additionally, the power meter installed in the existing MCC appears to be metering negative values. The meter should be investigated and verified that the polarity is correct on the current transformers.

7.1.4.4 Blower Building General Upgrades

The staff have identified several concerns with the aging electrical equipment in the Blower Building. The age coupled with the many modifications to date (see photo of modified control panel in Figure 7.4), equipment overheating, power quality issues below, and performance concerns of the process, replacements to the electrical and control systems are recommended. However, a complete Blower Building replacement is identified in this 2020 Master Plan. As such, replacement of the electrical system should be completed as part of the Blower Building replacement project.

7.1.4.5 Plant Variable Frequency Drives

Power quality concerns have been identified by the staff during blower operation. It is primarily noticed when the VFD for the 400-hp blower is operational. Upon starting and operating, lights are noted to flicker during VFD operation. Additionally, the large drives for the BFP process are on 6-pulse VFDs without any filtering.

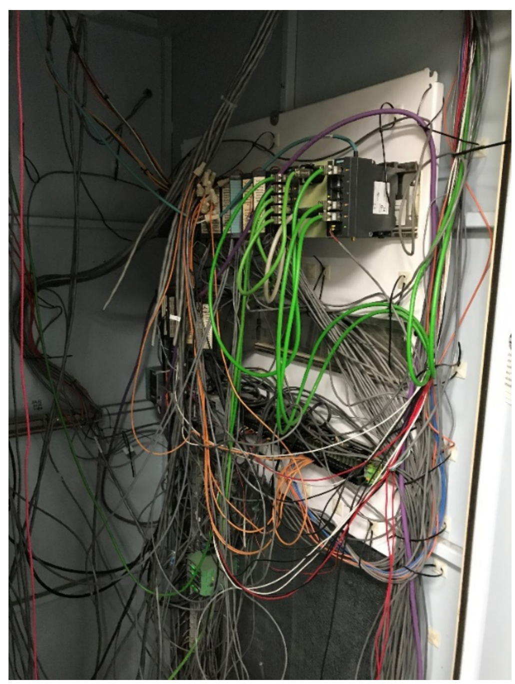

Figure 7.4 Blower Building Control Panel

VFDs generate electrical noise on the electrical system called harmonics. When severe enough, they can cause issues with lighting, extra heating in electrical components, and even equipment failures. When there are a large number of VFDs on an electrical system or high hp rated VFDs, harmonic mitigation is needed to maintain the stability of the electrical system. To address the current power quality concerns and future issues in the electrical system, addition of harmonic filtering to the Blower Building replacement project is recommended. A harmonic analysis is also recommended to determine other locations in the plant where harmonic mitigation is warranted.

7.1.5 Lift Stations

The City Owns and operates 26 lift stations throughout the collection system. The lift station design varies between three different layouts:

- Above ground.
- Partially above and partially below ground.
- Below ground.

The City is steadily replacing the below ground lift stations as these are older and have confined space concerns.

The newer lift stations have been installed with electrical labeling and have design drawings available for troubleshooting. However, many of the existing pump stations are missing labeling and have no record documentation. Additionally, many of the lift stations do not appear to properly address NFPA 820 which has specific continuous ventilation requirements to handle classified spaces as well as specific equipment ratings for classified areas. It is recommended that the lift stations be evaluated for conformance to current NFPA 820 requirements and the City maintain or develop record documents for all lift stations.

The lift stations currently communicate over a license-free, spread spectrum, 900 megahertz (MHz) radio system. The existing radio system is obsolete, becoming unsupported, thus it is not reliable and requires constant maintenance/attention. The City started investigating different options for cellular communications. The remote facilities should be connected to a secured cellular network. This cellular approach could be managed by the City or using a third-party provider.

For cellular communication, the City staff has been working with manufacturers to price and determine opportunities to connect the remote assets and provide real-time data and dashboards through a cloud service for City use. This would provide immediate resolution and connection to the remote facilities. Using a third party would also likely result in the lowest near-term costs; however, there are likely to be long-term management and annual fees associated with the third-party approach.

7.1.6 Recommended Capital Improvement Projects

Table 7.1 shows the recommended capital improvement projects to address the electrical infrastructure. Project costs are shown in 2021 dollars. Some of these projects have been captured in Chapter 4 Asset Replacement Projects. As a result, most of these identified projects will not be included as stand-alone projects in the implementation plan.

Table 7.1 Recommended Electrical System Improvements

Implementation Period	Identified Projects	Capital Costs (2021 $)
2021-2025	1. Medium voltage loop and fiber ring installation.	$7.1 million
	2. MCC replacements (for the six identified above) and associated electrical equipment replacement.	$350,000 per MCC $2,100,000 total
	3. Administration Building transformer replacement.	$500,000
	4. Headworks Electrical Room improvements.	Costs included in Chapter 4 Asset Revitalization Projects
	5. Raw Water Pump Station Electrical Room improvements.	
	6. Primary Clarifier Electrical Room improvements.	
	7. Flow EQ basin and return vault electrical replacement.	
	8. Generator addition to UV Building.	
	9. Harmonic study and plant VFD upgrades/replacement.	
2026-2030	1. Electrical system studies.	$100,000
	2. Miscellaneous electrical improvement projects for unit process areas and site electrical.	Included as allowance with identified projects
2031-2040	1. MCC replacements (future – assume 5).	$350,000 per MCC $1,750,000 total
	2. Electrical system studies.	$150,000
	3. Transformer and switchgear replacements (future allowance).	$1,500,000 every 5 years

7.2 Instrumentation and Controls

The Persigo WWTP focuses on providing the appropriate level of instrumentation for the right application. As treatment processes and instrumentation evolve, the organization will confirm that implemented new technologies make sense financially and are appropriate for the facility staffing requirements. To date, the facility's design philosophy has been and should continue to be focused on using the best available technologies to provide more precise, robust, reliable control and require less operator intervention in process control.

The existing Siemens SCADA system is maintained with in-house SCADA technicians. There is local support in the greater Grand Junction area by Siemens and other integrators to support the Persigo WWTP staff with troubleshooting and implementing software upgrades.

7.2.1 Organizational I&C Vision

In order to understand the future direction, a visioning exercise was completed through a series of facilitated discussions with Persigo WWTP and City staff. In developing and understanding the existing SCADA and business networks, a network architectural diagram was created. Figure 7.5 illustrates Carollo's understanding of the current network configurations at the Persigo WWTP.

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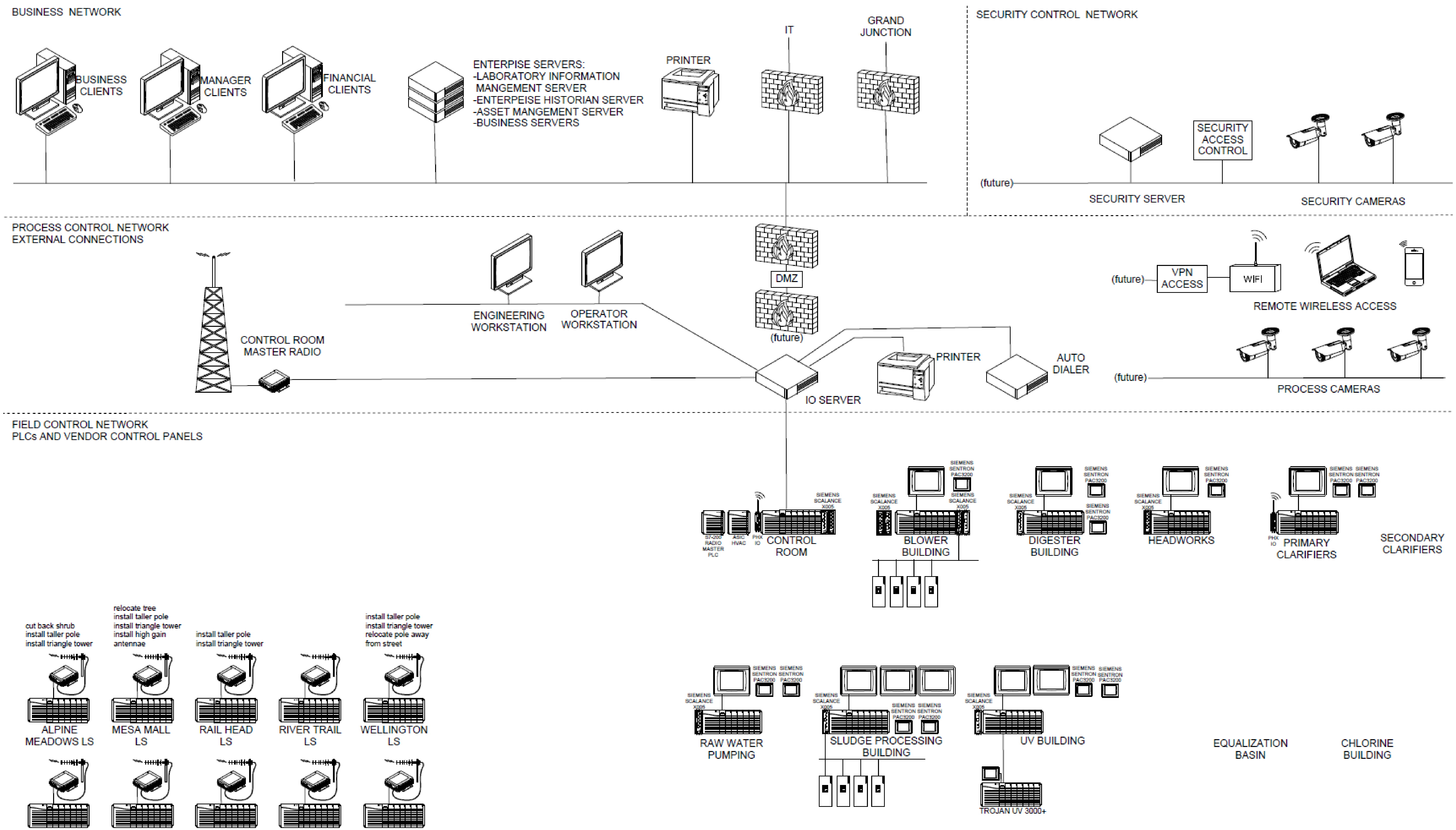

Figure 7.5 Persigo WWTP Current Network Diagram

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Figure 7.6 illustrates the eight different policy areas that were discussed during the I&C visioning exercises. By understanding the current network architecture and the City's vision, the following themes and recommendations were established.

Figure 7.6 I&C Policy Areas Discussed

1. **Operational / Staffing Needs –** The Persigo WWTP staff would like to have the ability to monitor and control operations remotely. As technologies and level of instrumentation increase, the Persigo WWTP staff will need to increase the headcount and number of I&C staff (instrument technicians, SCADA/network managers, etc.).
2. **IT Security –** The City will be managing security requirements and should be modeled after industry standards such as America's Water Infrastructure Act (AIWA) or American Water Works Association (AWWA) cyber security standards. City and Persigo WWTP staff should implement security protocols prior to implementing cellular improvements for the lift stations.
3. **City IT Staff** – The City IT staff will support the Persigo WWTP networks and can be used as a resource. It is assumed the process control and human-machine interface (HMI) networks will remain the responsibility of the Persigo WWTP staff.
4. **Process Monitoring / Controls –** The Siemens PLCs have been used and maintained through the years. Per Persigo WWTP staff, these PLCs have been easy to use and support has been available when needed. Connecting these PLCs to a fiber network will improve the data transfer and use needed.
5. **Alarm Management –** Improvements to the alarm management needs to be evaluated in the future as there are a number of alarms received and staff would like the ability to address remotely.
6. **Data Management –** Improved data management will take a coordinated effort with the City IT to ensure server space is available for the data historian and data analytic platforms desired. The City may evaluate the use of cloud-based servers to minimize capital investments. Data access and management will be greatly enhanced with the installation of a fiber network.
7. **Reporting –** The City should invest in developing dashboard and reporting software to simplify the process for developing, submitting, and analyzing process and financial reports.

7.2.2 Instrumentation

The Persigo WWTP has invested in functional instrumentation appropriate for the level of treatment required. However, as treatment processes change and evolve, the staff will be challenged to continue deploying new instruments and invest in additional instruments and controls that will add to the reliability of the plant's automation strategy and enable Operators to better control the plant 24/7 with enhanced functionality for remote operations. These investments will increase the facilities' efficiency and improve operational performance and controls.

No specific instrumentation deficiencies were identified during the project development. However, each project identified has an allowance for evaluating and implementing instrumentation. A key area to focus on increased IC is the flow management in the flow EQ basins and the aeration basins. In addition, when replacing MCCs and electrical equipment, the City should evaluate the use of smart-MCCs and power measurement throughout the facility.

7.2.3 Control Hardware and Software

The I&C visioning recommended the following instrumentation and control upgrades.

- Evaluate the Persigo WWTP SCADA HMI software and operator interface to ensure it meets the growing needs for remote 24/7 monitoring with base level control. Consider high-performance HMI graphics development for future upgrades.
- Upgrade the process alarm features and notification systems and procedures in the SCADA systems.
- Evaluate the Persigo WWTP facilities, duct banks, and site plan for deployment of a plant-wide, industrial Ethernet network.
- Evaluate and upgrade the Persigo WWTP and lift station PLC control network as infrastructure reaches end of useful life. Recommend completing a SCADA Upgrades Study, which will identify the technology, manufacturer, and additional functionality needed from the SCADA system.
- Retire the radio communications and move towards a cellular network for the Persigo WWTP lift station controls, and remote facilities.

The plant staff indicated the existing Siemens SCADA system functions well and the plant has proactively replaced and maintained the Siemens SCADA system and PLCs. A software upgrade would be recommended to modernize the SCADA system. However, at this point, a complete overhaul or change of SCADA platforms is not recommended. The Siemens SCADA system is one of the top five systems implemented in the United States. The City should develop a technical support or on-call contract with a Siemens certified programmer to support the Persigo WWTP staff with integration of new capital projects into the existing SCADA platform.

A multi-faceted SCADA Upgrades Study is suggested. This study will serve as a long-term implementation approach for evaluating the security, reliability, and responsibilities of the overall network infrastructure and control system. As part of the SCADA Upgrades Study, the Persigo WWTP should consider conducting a facility-wide cyber security audit, implementing a plant-wide industrial Ethernet network, and developing a responsible approach to achieve enhanced remote monitoring and operations. Looking to the future, regular reviews of new technologies are essential to making the Persigo WWTP system more robust and efficient. Adding a recurring SCADA Upgrades Study effort every 5 to 8 years is recommended to maintain perspective on new/evolving technology.

Control panels are one of the more expensive assets to account for in this project. Many of the hardware components in the facility's area process control cabinets are becoming obsolete. Upgrading control panels can be completed on a project-by-project basis or as a separate project. This replacement approach should be further defined in a future SCADA Upgrade Study. For master planning purposes, a budgetary line item for PLC replacements will be added to the capital schedule.

7.2.4 Data Management

As part of the IC Visioning, it was recommended to complete a data mapping exercise to better understand the functionality of each data system and better streamline the use, management, and presentation of data. This would include analyzing your laboratory information system, the operations data, SCADA network, Lucity database, business network/financial information, and process control data and reports.

7.2.5 Process Control Center

The existing process control center does not meet the security and staffing needs for the Persigo WWTP. As a result, Carollo recommends building a security process control center and increasing the number of workstations for operators to monitor treatment plant activities. This process control center is assumed to be included in the existing administration building improvements. The SCADA Upgrades Study will further identify the requirements and types of audio-visual equipment required for the control room.

Additionally, it is considered best practice to have a redundant location located off-site to operate the treatment facility in the event of an emergency. This facility would have a redundant data center and connection to the process network. Carollo recommends constructing a secondary process control location and backup data center at another City owned facility to provide this service.

7.2.6 Recommended Capital Improvement Projects

Table 7.2 lists the recommended CIPs for the instrumentation and controls systems.

Table 7.2 Recommended Instrumentation and Controls System Improvements

Implementation Period	Identified Projects	Capital Costs (2021 $)
2021-2025	Industrial fiber installation at Persigo WWTP installed with new MV electrical distribution system as discussed in Table 7.1.	Included above
	SCADA Upgrades Study with cyber-security assessment.	$150,000
	Connect lift stations and remote assets to cellular network and retire radio communications.	$200,000
	PLC Replacement Program (annual cost – 1 per year).	$150,000
	Upgrade the Persigo WWTP SCADA HMI, alarming, call-out/paging software and operator hardware.	$125,000
2026-2030	Continuous IT master planning.	$200,000
	Security improvements (access control, video surveillance, etc.).	$250,000
	Redundant Data Center infrastructure.	$125,000
	Upgrade lift station controllers to newer PLC (included as part of lift station upgrades).	NA
	Replacement of PLCs and control panels (annual allowance).	$200,000
2031-2040	Replacement of PLCs and control panels (annual allowance).	$200,000

7.3 Site Security

The site is secured by a perimeter fence and a gate entry access system. Inside the facility, security is limited. After implementation of a fiber loop, a security evaluation is recommended to consider the installation of cameras and an access system for each building.

To improve the access control and visibility, it is recommended that the front gate and the septic receiving station both have surveillance cameras installed.

In October 2018, the United States Congress signed into law the AWIA. The AWIA focuses on drinking water systems and is not explicitly required for WWTP. It is recommended, as good practice, that WWTP facilities conduct a Risk and Resilience Assessment to understand the physical and cyber threats that could impact the safety of the Persigo WWTP staff and the operations of the facility.

7.4 Site Utilities (Natural Gas, Potable, and Plant Water)

The Persigo WWTP site has underground utilities, which include natural gas service provided by Xcel and potable water service provided by the City. In addition, the facility has a distribution network of non-potable water owned and operated by the Persigo WWTP.

7.4.1 Natural Gas

Xcel provides natural gas to the Persigo WWTP and maintains the natural gas piping to each facility. According to Persigo staff, the distribution gas piping on the Persigo WWTP site were recently updated by Xcel and there are no known improvements needed. This 2020 Master Plan assumes since Xcel owns the natural gas piping, future replacement or rehabilitation will be Xcel's responsibility.

7.4.2 Potable Water Systems

Ute Water provides potable water to the Persigo WWTP site. According to staff, the existing potable water system is adequate for all current and anticipated process needs, and no expansions or improvements are necessary.

7.4.3 Non-Potable Water System

The Persigo WWTP has a non-potable water system used for process water and irrigation uses around the facility site. Disinfected secondary effluent is pumped and provides non-potable water to the system at approximately 80 psi. The pump station includes three vertical turbine pumps at 600 gpm and one vertical turbine pump at 320 gpm.

The replacement or rehabilitation needs for the plant water system were identified as part of the Disinfection Building improvements as identified in Chapter 4.

7.4.4 Recommended Capital Improvement Projects

No specific asset revitalization projects were identified for the gas, potable, and non-potable water systems.

7.5 Administration Building

The existing Administration Building is over 40 years old and requires improvements to address the following:

1. Modernize the facility to meet current code requirements, enhance operational safety, and security.
2. Replace aging assets to improve building operations and efficiencies.
3. Increased staffing levels and assumed growth in staffing for the future requires additional workspaces and resources.
4. Provide dedicated area for the plant SCADA control center.

The following near-term projects or improvements to the Administration Building have been identified and included in the implementation plan.

7.5.1 Modernization and Expansion of Administration Building

Improvements to modernize and increase capacity of the existing facilities in order to address staffing and additional maintenance space have been identified as follows.

1. Contract with an Architectural Engineering firm to complete a plant-wide personnel and facilities storage architectural programming study. This will refine and update the long-term plans and budgetary numbers for the laboratory space and storage facilities across the plant. Storage facilities across the plant and inside the Administration Building will become a priority as additional staffing or office remodels occur.
2. Create an updated control room with updated control stations, central monitoring point, and improved security to room. This area should have one central common station along with four additional workstations. Assume workstations would be open concept with potential cubicle walls creating separation, as needed.
3. Modernize the entry way to accommodate larger groups and create shared workstations for floating staff or individuals not requiring office space.
4. Remodel the laboratory office space to create one office and two workstations in the existing footprint. Improve and replace existing HVAC systems in the laboratory area and for the building.
5. Replace and relocate the existing electrical equipment or improve the safety levels associated with the electrical equipment.
6. Provide up to up to seven enclosed offices based on discussions with Persigo WWTP staff for following roles: Plant Manager, Supervisors (three - Collection, Maintenance, Operations), office space for use by City engineers or staff, future biosolids management role or septic elimination program role, and a future office space. Adding these spaces to the Administration Building will require additional planning and determination of space can be configured to accommodate these additional enclosed offices. Potential considerations for providing additional office space:
   a. Relocate items in storage spaces to other buildings on-site.
   b. Re-purpose the kitchen area and relocate kitchen facilities to existing patio/breezeway.
   c. Provide temporary trailer to accommodate the additional spaces needed, or
   d. Expand the storage/maintenance facility to the north of the Administration Building to add personnel offices.
7. Improvements to the maintenance facilities include adding bench space, which could be accommodated by moving storage items or less used equipment to adjacent storage areas on the plant.
8. Additionally, as the City's collection system maintenance requirements increase, an additional jetter truck will be needed. To provide additional space for storage and cleaning of this additional equipment, another truck bay is recommended.

To achieve the goals and improvements listed above and shown in Figure 7.7, additional storage space has been planned to be constructed adjacent to the existing storage building to the north of the Administration Building. Figure 7.8 illustrates the intended expansion to provide additional office spaces, storage area (for supplies, files, and equipment), and includes truck bay for future jetter truck.

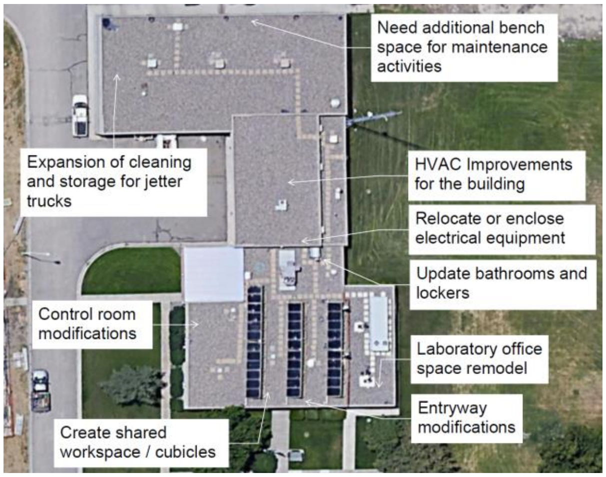

Figure 7.7 Recommended Improvements to Administration Building

Figure 7.8 Additional Storage Facility

7.5.2 Recommended Capital Improvement Projects

Table 7.3 lists the recommended capital improvements for the Support Facility Building improvements carried forward into the CIP.

Table 7.3 Recommended Capital Improvements for Support Facility Building

Implementation Period	Identified Projects	Capital Costs (2021 $)
2021-2025	Personnel and Storage Facilities Master Plan.	$75,000
	Administration Building improvements and storage facility.	$2,500,000
2026-2030	None identified.	
2031-2040	Renovate laboratory space and other facilities or construct new Administration Building.(1)	NA

Notes:
(1) Assumed the long-term vision for the laboratory space and entire Administration Building would be evaluated by the architectural consultant that completes the Administration Building repairs project.

7.6 Yard Piping

A detailed assessment of the yard piping condition was not performed as part of this 2020 Master Plan. A project to complete a condition assessment or survey of the buried yard piping is recommended to develop mitigation strategies for reducing pipeline failure events. The evaluation phase could include closed-circuit television (CCTV), soil corrosivity testing, and electromagnetic testing.

The original pipelines have reached 40 years of life expectancy and may require rehabilitation to preserve the pipeline integrity and to avoid pipeline failures. A pipeline rehabilitation allowance was established to allocate future funding to rehabilitate existing pipelines.

7.7 Site/Civil Improvements

Table 7.4 shows the recommended capital improvement projects to address yard piping and site/civil improvements. Project costs are shown in 2021 dollars. Annual budget allocation should be made to repair and replace aging asphalt, concrete sidewalk, curb and gutters, and general landscaping improvements. It is assumed these re-occurring budgeting items would be categorized as part of the Annual Operations Budget and not included in the capital improvement plan.

Table 7.4 Summary of Yard Piping and Site/Civil Improvements

Implementation Period	Identified Projects	Capital Costs (2021 $)
2021-2025	Civil improvements (annually).	$50,000
	Pipeline inspection program.	$200,000
2026-2030	Civil improvements (annually).	$75,000
2031-2040	Civil improvements (annually)..	$100,000
	Pipeline rehabilitation allowance	$5,000,000

7.8 Energy Baseline

The Persigo WWTP receives electrical power from Xcel Energy under the Commercial and Industrial Primary Service – Primary General tariff. After reviewing 2 years of Xcel electrical bills from January 2018 through December 2019, the following observations were developed.

1. The peak electrical demand expressed as highest kilowatt (kW) use over a 15-minute period was less than 950 kW. The variation of these demands month to month was less than 8 percent.
2. The electrical energy used, expressed as kWh, was less than 7,000,000 kWh for the year. Electrical use during the winter months were 15 to 20 percent higher than the summer months, which is likely a result of the facility heating demands.

Benchmarking energy use against other utilities can be challenging due to the differences in electrical tariffs, discharge permits, treatment processes, and operational goals. However, NACWA publishes benchmarking data for over 130 wastewater utilities. Based on the data from 2018, the following statistics provide a comparison to the Persigo WWTP facility.

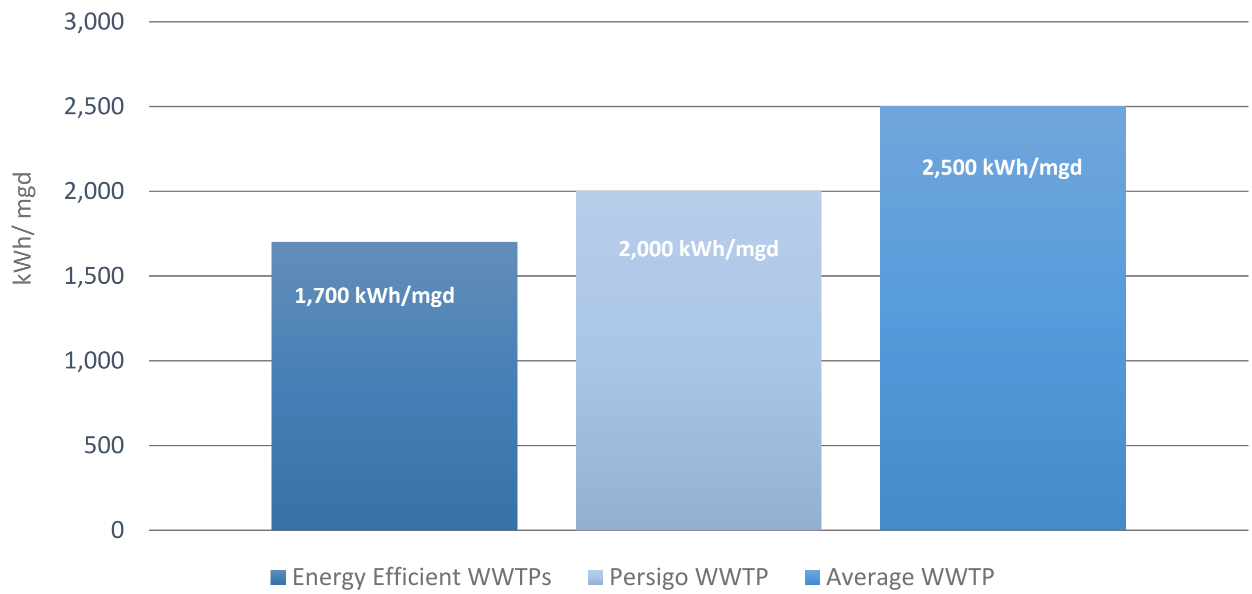

Figure 7.9 Comparison of Persigo WWTP Energy Use to Average and Energy Efficient Utilities (NACWA, 2018)

The Persigo WWTP is more efficient than the average wastewater utility. Further reductions in energy use will occur based on the recommendations provided in Chapter 5. The recommended improvements in Chapter 5 which will have the biggest impact in reducing the electrical use include:

- Replacing the existing blowers used in the activated sludge process with higher efficiency technologies will reduce the aeration electrical use significantly.
- Converting to an anaerobic digestion process will eliminate the aeration requirements for aerobic digestion.
- Upgrading existing heating and ventilation equipment using more efficient equipment and controls.

7.8.1.1 Electrical Submetering

Measuring the electrical use by each facility at the MCCs can be incorporated when replacing and upgrading the existing MCCs. Submetering is recommended in the following areas to better optimize electrical use and eventually provide the data for real-time operational control based on energy use and costs.

1. Raw sewage pumping.
2. Aeration basins.
3. Disinfection Facility/Plant Water Station.
4. Sludge Processing Building.
5. Administration Building.

7.9 Renewable Energy – Photovoltaic Systems

Solar energy is a viable, available, and affordable resource in Colorado, with more than 300 days of sunshine a year. Photovoltaic (PV) systems require very little maintenance, are reliable, and produce energy during all daylight hours. PV systems are clean, providing renewable energy with no harmful greenhouse gas emissions and no noise, which make them good neighbors.

The Persigo WWTP currently has a 100-kW PV system that provides power to the Administration Building behind the meter. This PV system supplies less than 5-percent of the average energy consumption at the Persigo WWTP. Carollo evaluated locations to increase the amount of renewable energy produced through a PV system at the Persigo WWTP site. The Figure 7.9 illustrates five areas that addition PV systems could be added. For this analysis, it was assumed a ground mounted PV system would be the most economical approach due to the availability of space. Table 7.5 provides the size and financial information for each of these sites.

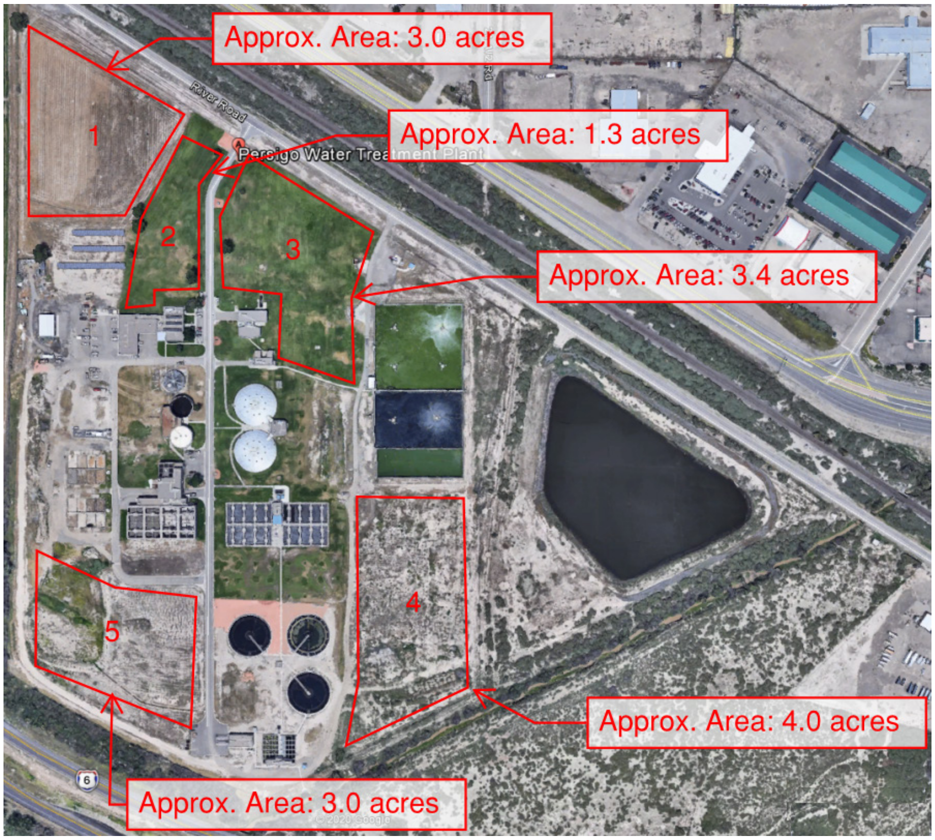

Figure 7.10 Locations for Future PV System

Table 7.5 PV Sizing and Financial Details

Site	Available Land (acres)	Size of PV System (kW)(1)	Energy Produced (kWh/year)(2)	Capital Costs ($)(3)	Annual Electrical Savings ($)(4)
1	3.0	900	1,685,000	$1,890,000	$101,000
2	1.3	390	730,000	$819,000	$44,000
3	3.4	1,020	1,910,000	$2,142,000	$115,000
4	4.0	1,200	2,247,000	$2,520,000	$135,000
5	3.0	900	1,685,000	$1,890,000	$101,000
Total	**14.7**	**4,410**	**8,257,000**	**$9,261,000**	**$495,000**

Notes:
(1) Size of the PV system assumes 300 kW/acre, which includes space for access.
(2) Amount of energy produced calculated using National Renewal Energy Laboratories (NREL) PV watts model for ground mounted single axis tracking system.
(3) Capital costs assume design, construction, and installation of PV system at $2.1/watt.
(4) Electrical savings calculated using $0.06/kWh.

Based on the financial analysis for installing a PV system only using City financing the estimated simple pay back is between 18 and 20 years. Depending on the City's energy management goals, there is adequate space available for the Persigo WWTP to produce excess energy and provide back to the electrical grid.

7.9.1.1 Battery Energy Storage System

The commercial availability and cost for energy storage systems has decreased dramatically in the past 5 years and will continue to decrease in the future. In water and wastewater applications, the most commonly used battery energy storage system (BESS) is a lithium ion battery. The BESS provides the system reliability, improves power quality, provides immediate response to instantaneous peak demands, and can reduce energy used for a longer period.

Most PV systems today will include a BESS to provide storage during periods of excess power generation. For the size and demands from the Persigo WWTP, the estimated BESS sizing would be between likely between a 250 kW/1 megawatt-hour (MWh) to 500 kW/2 MWh lithium ion battery system. The estimated installed capital costs for this system would be between $1,000,000 and 1,500,000. When combined with the PV analysis above, the simple payback period would be 15 to 18 years.

7.9.1.2 Equipment Replacement and Annual Maintenance Costs

PV panels typically have a 20- to 25-year manufacturer's warranty. Per manufacturer's published data, a typical panel will lose about 0.2 percent of its energy production output per year. PV systems are typically estimated to have a useful life of 25 years; however, there are installations installed greater than 25 years ago that operate at the reduced efficiency. The PV inverters and BESS systems have a lifespan of 10 to 15 years.

7.9.1.3 Solar Rewards / Incentive Options

Net metering is a utility billing mechanism that credits solar energy system owners for the electricity they over produce and sell back to the electrical grid. The utility customer is only billed for their "net" energy used. Net metering allows net excess generation (NEG) in a given month to be applied as a credit to the client's bill the following month. Every kWh of NEG shall produce a 1 kWh credit back to the customer on the future bill. At the end of the calendar year, if the customer's generation exceeds consumption, or if the customer terminates service, the utility must reimburse the customer for the NEG at the utility's average incremental cost over the most recent calendar year. The customer has a one-time option to request in writing that the NEG at the end of the calendar year be carried over from month to month indefinitely.

If using the Solar Rewards Standard offer, the NEG is sold back to the electrical utility at a rate dependent on the size of the system and type of customer. The maximum annual kWh of renewable energy that will be credited per Xcel Energy is a 2-MWh PV system. This needs to be confirmed with Xcel Energy. This incentive has not been included in the financial analysis to this point as it is undetermined how much renewable energy will be required to meet the electrical demands of the NTP.

7.9.1.4 Interconnection Costs

The interconnection costs depend on the PV system size, the incentive program enrolled in, and the required utility infrastructure improvements. Xcel Energy offers an evaluation study for a fee of $2,000 and will provide within 10 business days a rough order of magnitude pricing for interconnect.

7.9.1.5 Ownership Options

The current understanding and analysis provided assumes Persigo WWTP will own and operate the PV system. Other ownership options are dependent on the overall organizational energy management goals, site security and access, and if federal tax credits are available. Other ownership options include:

- Power purchase agreement with a third-party provider, or energy as a service, to construction and operate the PV system.
- Leasing agreement where Persigo WWTP could own the PV system in the future.
- Own the PV system and operate system as a community solar garden.

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Chapter 8

CAPITAL IMPROVEMENT PLAN

Previous chapters in this 2020 Master Plan document regulatory requirements, current and projected flows and loads through the 2040 planning horizon, unit process treatment and hydraulic capacity, process control improvements, condition assessment, process optimization, and treatment alternatives. Those chapters build the framework for future planned improvements to the Persigo WWTP.

This chapter summarizes the recommended improvements for the Persigo WWTP that were described in previous chapters. The projects identified in this chapter meet the overall objectives set forth in Chapter 1, as shown in Figure 8.1:

Figure 8.1 2020 Master Plan Goals

Projects identified in previous chapters are included and arranged into larger groupings according to the type of project, the proximity of projects, and the criticality of project interdependencies. Grouping several smaller projects into a few larger projects benefits the City in the following ways:

- Reducing administrative efforts associated with procurement and management functions.
- Improving coordination between fewer contractors and engineers and allotting fewer points of responsibility.
- Coordination of improvements to minimize interruptions of plant operations.

The improvement projects from the previous chapters were combined into a prioritized CIP. Table 8.1 summarizes the number of projects and total cost estimates for the 20-year CIP by phases. Figure 8.2 illustrates the location and timing of the recommended improvements described in Table 8.1 and shown in Figure 8.3.

Table 8.1 20-Year Capital Improvement Plan Summary

Project Category	Number of Projects	Total Distribution of Capital Expenditures
2021-2025 Projects	10	$59,242,000
2026-2030 Projects	6	$65,454,000
2031-2040 Projects	4	$75,306,000
Reoccurring Projects	2	
Total 20-Year CIP	**19**	**$200,002,000**

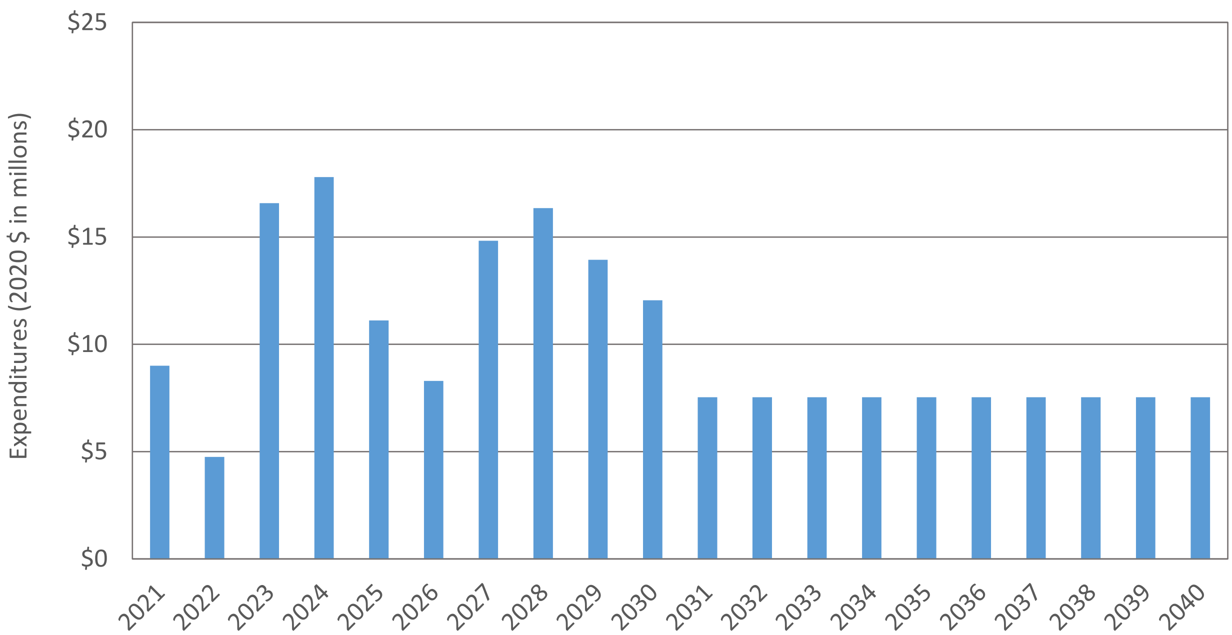

Figure 8.2 Persigo WWTP 20-Year Capital Improvement Plan Summary

The following sections discuss the project cost assumptions and prioritization method used to develop this CIP.

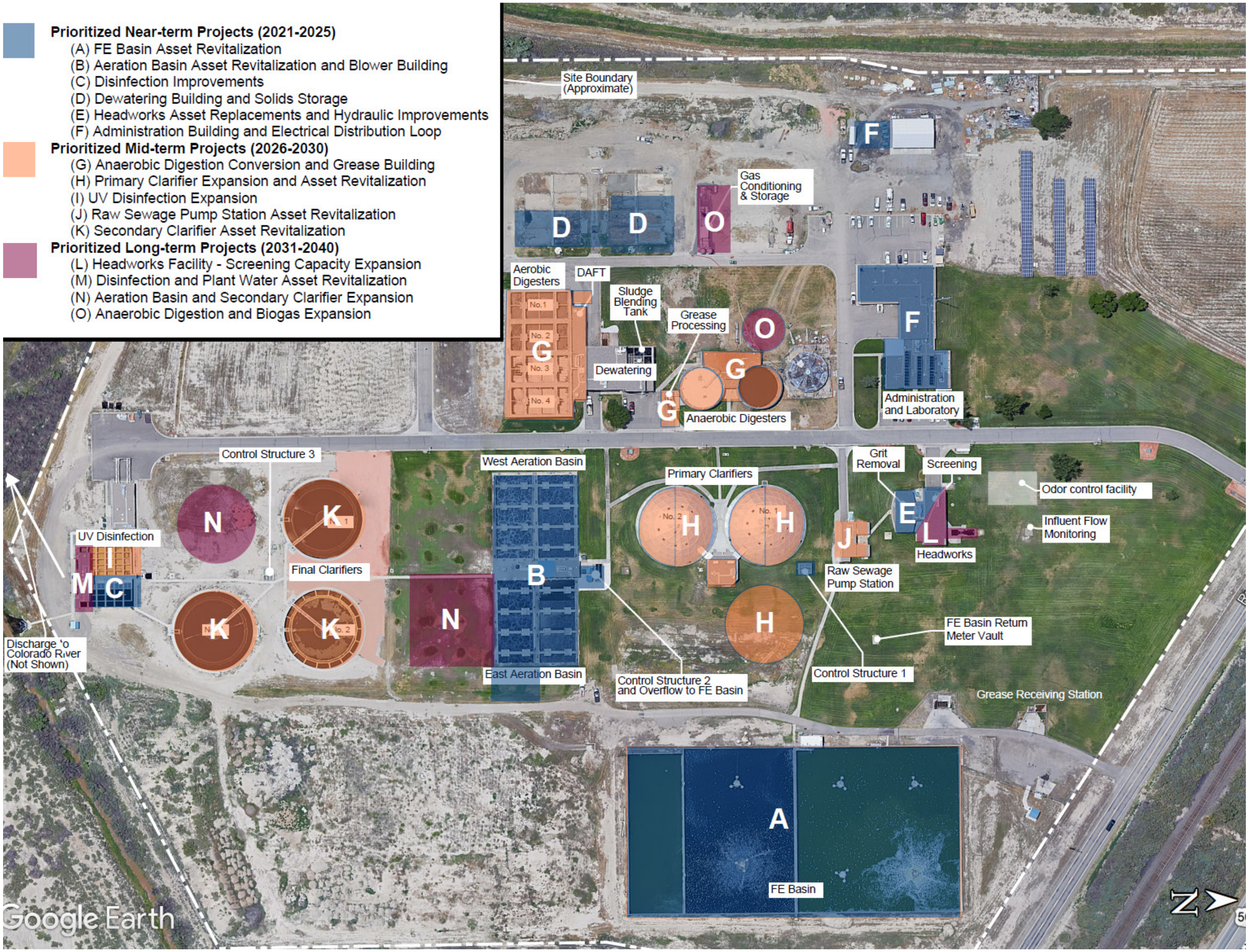

Figure 8.3 Site Plan with Project Phasing

8.1 Estimating and Schedule Assumptions

Total project cost estimates (TPCE) were prepared for all projects with a capital cost greater than $1 million. TPCEs use the financial assumptions documented in Chapter 1. If exceptions or adjustments were made, they were noted in the TPCE. All cost estimates developed represent an AACE International criteria for a Class 5 Planning Level or Design Technical Feasibility Estimate. For this class of estimate, the accuracy is typically -30 to + 50 percent. The accuracy of any cost estimate may change according to the design, mobilization, economies of scale, and project phasing. Cost estimates are comprised of both direct and indirect costs estimated for all planning, design, construction, construction management, and administration activities of the project. Appendix H includes the prepared TPCEs.

Understanding the timing and distribution of costs based on different phases of work (study, engineering, construction, and post-construction) provides a more realistic picture for cash-flow perspectives and rate setting. To account for the cash flow sequencing, the City budgets costs based on when funds are allocated to the individual phase of work. Therefore, for developing cash flow projections, all projects were assumed to be funded in the following approach:

- Year 1 – Design Phase begins. It is estimated the design phase would be approximately 10 percent of the TPCE and this budget would be allocated in the first year. The design phase duration is assumed to be approximately 1 to 1.5 years for all projects.
- Year 2 – Construction Phase begins. It is assumed starting in Year 2, the City would have bid design projects, selected a construction contractor, and appropriated budget for the project. The funding for the construction phase was assumed to be split over 2 years at 45 percent each year assuming most projects would have a 2-year duration.

8.2 Planning and Design Approvals from Others

The following sections identify potential permitting steps that may be required depending on how the projects are implemented and the regulatory agencies involved.

8.2.1 Site Location Approval

A Site Location Approval from CDPHE is required to construct a new domestic wastewater treatment facility, increase design capacity of wastewater treatment works, change unit processes, and replace assets. This approval process requires the submittal of an engineering report, which must include detailed definitions of the treatment improvements and evaluate how those changes will affect the facility. The engineering report is typically developed during the preliminary design phase and submitted to CDPHE with figures and justifications for requesting the approvals. PELs may be needed in the future as the plant rated capacity changes due to increased flow and loading conditions. The PELs will be the first part of the site location approval process to expand future treatment capacity.

8.2.2 Design Approval

The Design Approval from CDPHE is typically received after the Site Location Approval and before construction activities commence. There are two ways to receive a Design Approval:

1. Self-Certification.
2. Detailed Review.

Both require the City to submit design drawings along with a Process Design Report (PDR) to the CDPHE for review and approval. The PDR must contain the required information as indicated in Policy WPC-DR-1.

Once Site Location and Design Approvals are received from the CDPHE, construction activities can begin. These approvals are usually received during the design phase. The wait time will not significantly affect the schedules provided below.

8.3 Procurement Approaches

The City and Persigo WWTP have used the following procurement approaches to deliver recommended capital improvement projects.

- Self-Perform: Work activities that are performed solely by the City or Persigo staff. This could be used in the planning and design phases or considered for small construction projects. This could include asset replacement projects.
- Design-Bid-Build (DBB) Procurement: The traditional approach of using an engineer (internal or external) to complete the design and bidding phases and then hiring a third-party contractor to construction the facilities.
- Construction Manager at Risk (CMAR) or Construction Manager/General Contractor (CMGC) Procurement: An alternative delivery method in which the construction manager participates early in the design phase to provide constructability and estimate support. The Owner still holds separate contracts with the Engineer and the CMAR or CMGC.
- Design-Build (DB) Procurement: An alternative delivery method in which the DB team completes the design and construction as one functional team. The Owner holds the contract with the DB team, which could be the engineer or the contractor depending on how the team is structured.

All of the larger projects could be completed using DBB, CMAR, or DB. No schedule or construction constraints are known that would significantly affect the projects outlined below. However, to make scheduling and budget decisions, the DBB procurement approach was used. On a project-by-project basis, the City may elect to use another procurement approach that creates the best value for the organization.

Additionally, if the City determined there was internal capacity to self-perform the work or projects discussed below there would be reductions to the developed TPCEs associated with engineering and construction costs.

As projects are packaged, the City should consider other procurement strategies that provide value for the organization:

- Pre-purchase or pre-select equipment based on a best value selection process: Equipment is selected based on competitive pricing, which includes capital and operating costs in addition to non-economic considerations.
- Prequalify general contractors and subcontractors: They ensure that only qualified applicants submit bids for the project. This should be considered for larger projects.

8.4 Prioritized Near Term Projects 2021-2025

The previous chapters identified recommended capital improvement projects and the drivers for those projects. This section further categorizes the near-term projects expected to occur between 2021 and 2025 according to drivers, schedule, type of project, and proximity of the projects. They have been listed in order of priority based on criticality to increase operational efficiencies, replace aging asset, expand available treatment capacity, and overall cash flow of the CIP.

The site plan shown in Figure 8.4 illustrates a summary of prioritized near-term projects (2021-2025).

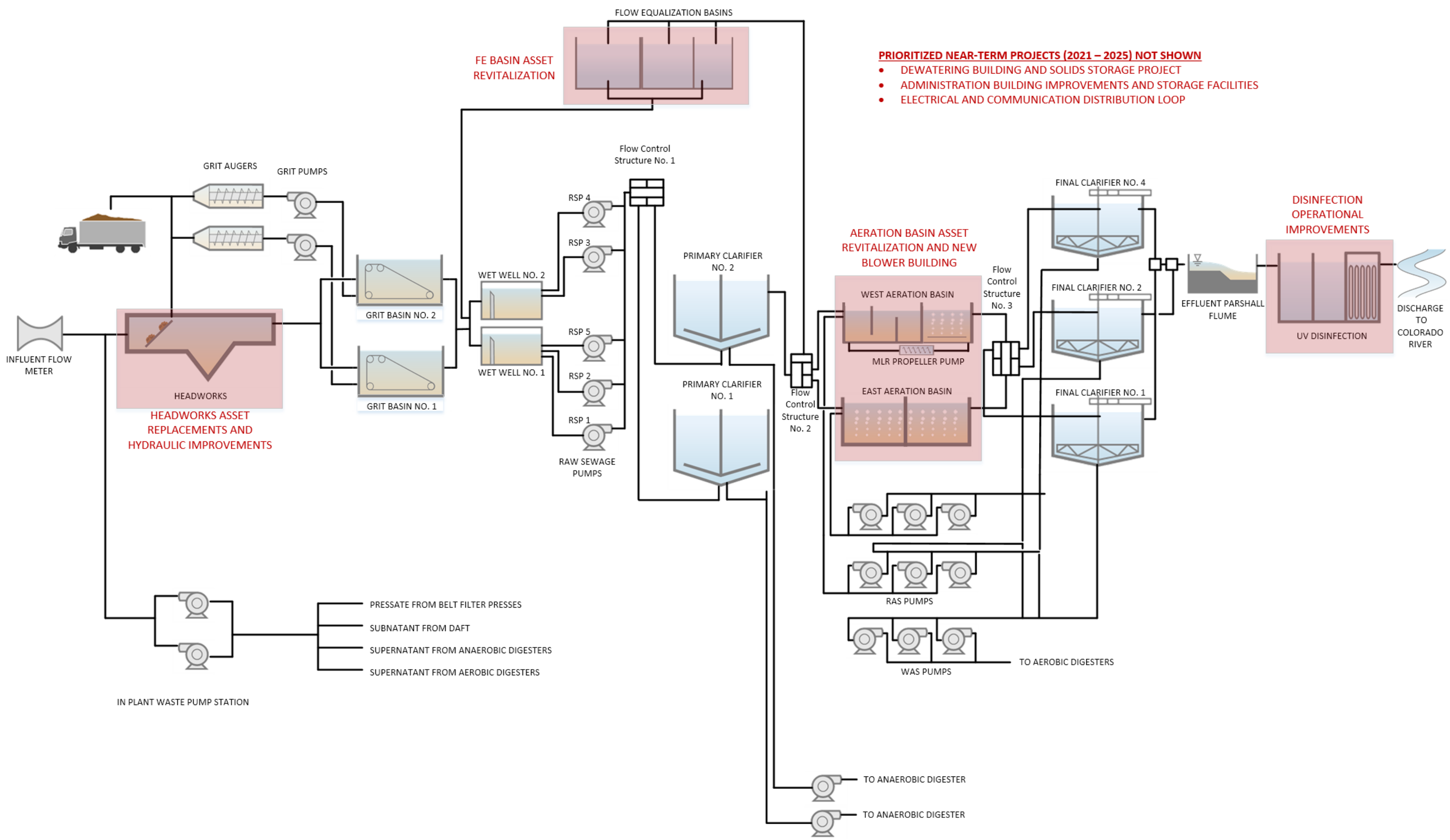

Figure 8.4 Simplified Summary of Prioritized Near-Term Projects (2021-2025)

8.4.1 FE Basin Asset Revitalization Project

The mixers in the FE Basins have exceeded their useful life and two have been partially damaged due to the structural failure in the basin. The mixers are scheduled to be replaced to continue to provide efficient mixing for the flow equalization process. Appendix H includes the scope and costing assumptions (FEB data sheet) for this project.

Project Drivers

Asset Revitalization

Schedule: Begin procurement and design in 2021

Project Triggers

1. Equipment failure

Budget: $584,000

8.4.2 Aeration Basin Asset Revitalization and Blower Building Project

This project includes a combination of near-term asset replacement projects for the Aeration Building as identified in Chapter 4, a new Blower Building, and improved aeration controls. Appendix H includes the scope and costing assumptions (AB-1 and AB-2 data sheets) for this project. The project scope includes increasing operational reliability by replacing assets that have reached their useful life, improving overall treatment performance, and increasing cost effectiveness of the aeration system. Additionally, by implementing an aeration controls approach, the City should be able to increase secondary treatment capacity and complete a paper re-rating of the Persigo WWTP rated capacity.

Project Drivers

Asset Revitalization, Operational Efficiencies, Innovation, Future Service

Schedule: Begin procurement and design in 2022

Project Triggers

1. Equipment failure and environment conditions.
2. Need to improve process control
3. Funding availability

Budget: $16,200,000

8.4.3 Disinfection Operational Improvements Project

As defined in Chapter 5, this project improves the hydraulic distribution and efficiencies for the existing UV disinfection system. Based on input from City staff, Carollo recommends purchasing additional UV modules to ensure the existing UV system has appropriate redundancy to meet the current and future service levels. Appendix H includes the scope and costing assumptions (UV1 data sheet) for this project.

Project Drivers

Operational Efficiencies, Future Service

Schedule: Begin procurement and design in 2022

Project Triggers

1. Reliability of critical unit process
2. Funding availability

Budget: $580,000

8.4.4 Dewatering Building and Solids Storage Project

This project includes replacement of the existing dewatering processes with a new Centrifuge Dewatering Building and Solids Storage Facility, as defined in Chapter 5. The new Centrifuge Dewatering Facility will replace the existing belt filter press dewatering process, which has exceeded its' useful life. The new facility will improve operational performance and reliability for the solids dewatering process and decrease the hauling and landfill costs associated with the current biosolids management approach recommended in Chapter 6. Biosolids storage has been included to provide operational flexibility when dewatered solids are not transportable to the landfill due to weather conditions. Appendix H includes the scope and costing assumptions (DEW data sheet) for this project.

Project Drivers

Asset Revitalization, Operational Efficiencies, Innovation, Existing and Future Service, Resource Recovery

Project Triggers

1. Equipment failures increasing
2. O&M costs to maintain and operate
3. Increasing landfill costs
4. Funding availability

Schedule: Begin procurement and design in 2022

Budget: $19,300,000

8.4.5 Headworks Asset Replacements and Hydraulic Improvements Project

This project includes the replacement of aging assets in the Headworks Building, as identified in Chapter 4, and hydraulic improvements to Control Structure No. 1, as identified in Chapter 3. The equipment allocated for replacement includes step screens, the screening conveyor, grit and screenings washer/compactors, electrical, and controls equipment. Allowances have been included to upgrade, rehabilitate, or replace other components of the facility such as building mechanical, electrical, and structural. Improvements to Control Structure No. 1 are recommended to eliminate hydraulic bottlenecks, determine hydraulic capacity of the FE basins, and to develop plant flow curves to maximize effectiveness of existing assets. Appendix H includes the scope and costing assumptions (HW1 data sheet) for this project.

Project Drivers

Asset Revitalization, Operational Efficiencies, Innovation, Existing and Future Service

Project Triggers

1. Hydraulic capacity
2. Equipment failures increasing
3. O&M costs to maintain and operate
4. Funding availability

Schedule: Begin procurement and design in 2024

Budget: $5,586,000

8.4.6 Administration Building Improvements and Electrical Distribution Loop Project

This project will update and expand the Administration Building and provide a looped medium voltage electrical distribution and fiber communication system around the facility, as identified in Chapter 7. The Administration Building improvements include modifications to upgrade existing building systems, improve the overall safety for staff, provide a new facility controls room, and expand personnel and maintenance space needed to accommodate staffing needs. The electrical distribution loop includes installing duct banks across the facility to replace electrical medium voltage distribution cabling which at times is in submerged manholes and to provide plant-wide fiber connectivity to each facility for SCADA integration. Appendix H includes the scope and costing assumptions (ADM and E data sheets) for this project.

Project Drivers

Existing and Future Service, Operational Efficiencies, Health and Safety, Asset Revitalization

Project Triggers

1. Personnel facility capacity
2. Modernized network communications
3. Electrical safety
4. Equipment failures increasing
5. Funding availability

Schedule: Begin procurement and design in 2024

Budget: $11,840,000

8.5 Prioritized Projects 2026-2030

The previous chapters identified the recommended capital improvement projects and the drivers for those projects. This section further categorizes the projects expected to occur between 2026 and 2030 according to drivers, schedule, type of project, and proximity of the projects. They have been listed in order of priority based on criticality to increase operational efficiencies, replace aging asset, expand available treatment capacity, and overall cash flow of the CIP.

The site plan shown in Figure 8.5 illustrates the location and timing of prioritized projects and Table 8.1 provides the financial forecast.

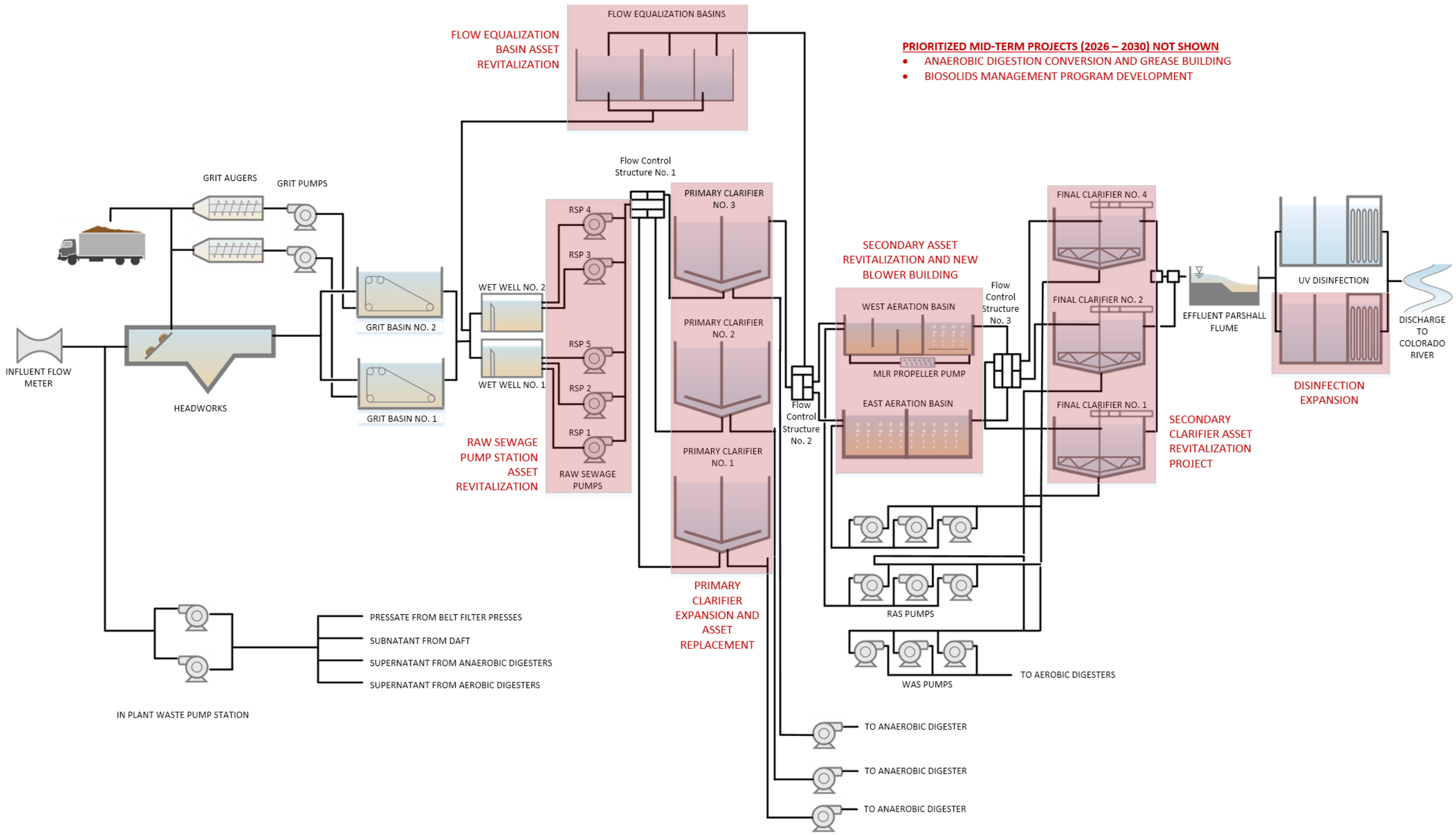

Figure 8.5 Simplified Summary of Prioritized Mid-Term Projects (2026-2030)

8.5.1 Anaerobic Digestion Conversion and Grease Building Project

This project will change the current digestion process from aerobic to anaerobic treatment to modernize the treatment process and improve operational efficiencies and capacity using existing infrastructure, as identified in Chapter 5. The aerobic digesters and solids mixing tank will be converted to a Solids Storage Facility to provide an operational wide spot to equalize flow and to increase operational flexibility for the digestion process. The project includes a significant asset revitalization effort to replace and improve the digester mixing system, heating system, gas storage cover, and sludge piping modifications, as identified in Chapter 4.

Additionally, to improve grease handling and treatment, a new grease receiving station and grease processing building were recommended to be located adjacent to the existing anaerobic digesters, as identified in Chapter 5. Appendix H includes the scope and costing assumptions (DIG1 and DIG2 data sheets) for this project.

Project Drivers

Existing and Future Service, Operational Efficiencies, Asset Revitalization, Innovation, Resource Recovery

Project Triggers

1. Modernized digestion facility
2. Increase in solids production
3. Equipment failures increasing
4. Increase biogas revenue
5. Funding availability

Schedule: Begin procurement and design in 2026

Budget: $22,900,000

8.5.2 Primary Clarifier Expansion and Asset Replacement Project

This project includes the design and construction of a third primary clarifier, as identified in Chapter 5. This clarifier provides operational flexibility and redundancy necessary to maintain the existing primary clarifiers. The existing two primary clarifier have assets that are reaching the end of their useful life and need to be modified and replaced, as identified in Chapter 4. This includes the mechanisms, the sludge and scum pumping equipment and building / structural improvements. Appendix H includes the scope and costing assumptions (PC1 and PC2 data sheets) for this project.

Project Drivers

Existing and Future Service, Operational Efficiencies, Asset Revitalization

Project Triggers

1. Equipment failures increasing
2. Funding availability

Schedule: Begin procurement and design in 2027

Budget: $13,278,000

8.5.3 UV Disinfection Expansion

This project includes the addition of second UV system to provide operational redundancy and improved operational efficiencies and increase overall disinfection capacity, as identified in Chapter 5. The redundant UV disinfection system provides the redundancy and reliability to replace the existing UV reactors based on their useful life being exceeded around 2030. Appendix H includes the scope and costing assumptions (UV2 data sheet) for this project.

Project Drivers

Existing and Future Service, Operational Efficiencies, Asset Revitalization

Project Triggers

1. Funding availability
2. Equipment failures increasing
3. Increasing plant flow

Schedule: Begin procurement and design in 2028

Budget: $9,551,000

8.5.4 Raw Sewage Pump Station – Asset Revitalization

This project includes the replacement or rehabilitation of aging assets in the raw sewage pump station, as defined in Chapter 4. Equipment rehabilitation to the pumps, replacement of VFDs, and miscellaneous building improvements. Appendix H includes the scope and costing assumptions (RSPS data sheet) for this project.

Project Drivers

Operational Efficiencies, Asset Revitalization

Project Triggers

1. Equipment failures

Schedule: Begin procurement and design in 2028

Budget: $5,149,000

8.5.5 Secondary Clarifier Asset Revitalization Project

This project includes replacement of the secondary clarifier aging assets, as identified in Chapter 4. Equipment replacements include clarifier mechanisms, sludge pumping equipment, and concrete improvements. Appendix H includes the scope and costing assumptions (SC1 data sheet) for this project.

Project Drivers

Operational Efficiencies, Asset Revitalization

Project Triggers

1. Equipment failures

Schedule: Begin procurement and design in 2028

Budget: $7,976,000

8.5.6 Biosolids Management Program Development

With the implementation of the Anaerobic Digestion Conversion Project, the new dewatering process operating, and the anticipated increases in landfill costs, it is recommended the City continue to evaluate and shift their biosolids management program away from landfill disposal, as discussed in Chapter 6. While commissioning the converted anaerobic digesters and achieving Class B biosolids, transitioning to a Class B land application program provides financial benefits and allows for the beneficial reuse of biosolids. Appendix E includes the scope and costing assumptions to implement this program.

Project Drivers

Resource Recovery, Operational Efficiencies, Fiscal Responsibility, Environmental Protection

Schedule: Begin in 2028

Project Triggers

1. Anaerobic Digestion
2. Landfill tipping costs and capacity

Budget: $756,000

8.6 Prioritized Projects 2031-2040

The previous chapters identified the recommended capital improvement projects and the drivers for those projects. This section further categorizes the long-term projects expected to occur between 2031 and 2040 according to drivers, schedule, type of project, and proximity of the projects. They have been listed in order of priority based on criticality to increase operational efficiencies, replace aging asset, expand available treatment capacity, and overall cash flow of the CIP.

The site plan shown in Figure 8.6 illustrates the location and timing of prioritized projects and Table 8.1 provides the financial forecast.

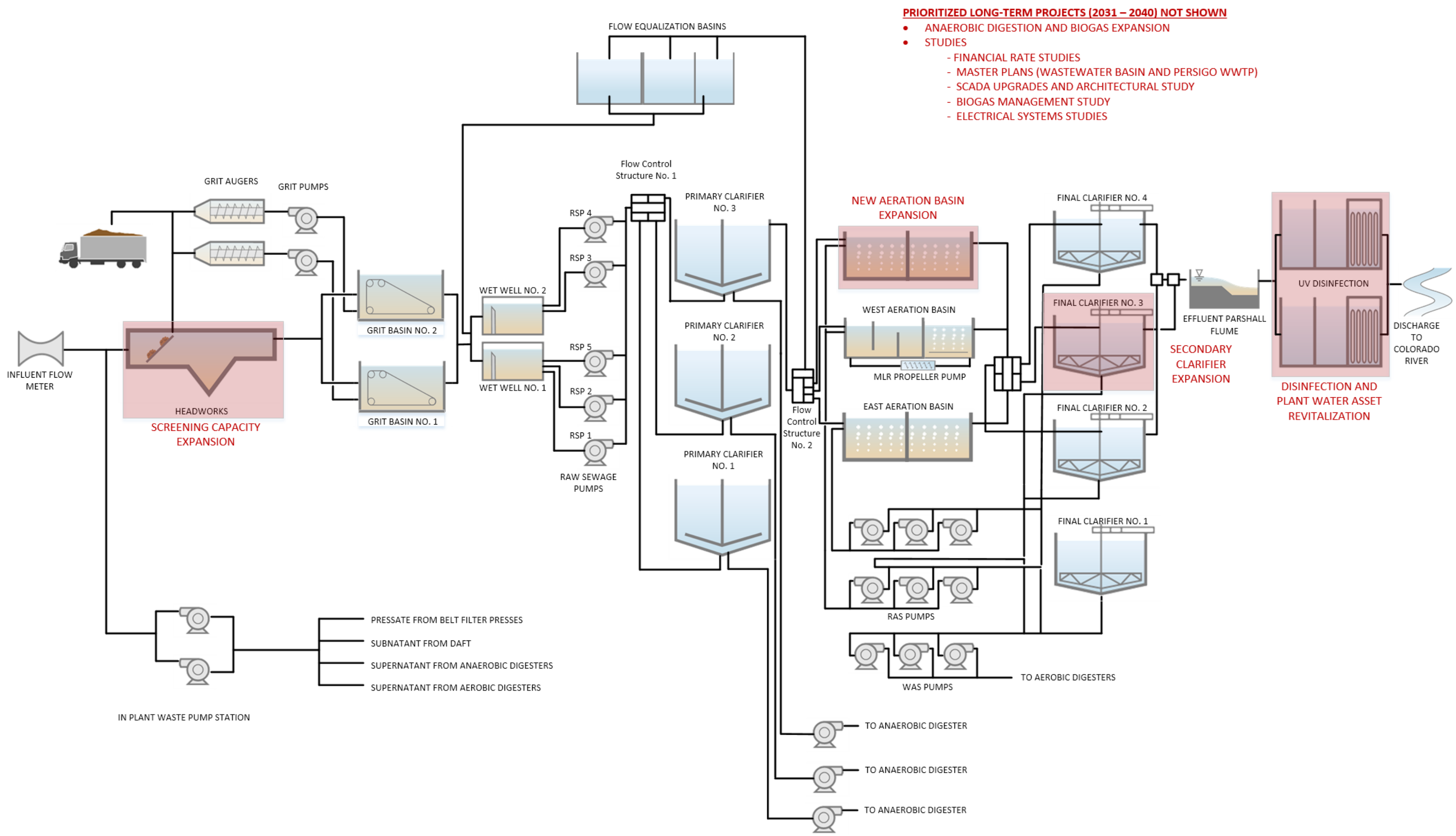

Figure 8.6 Simplified Summary of Prioritized Long-Term Projects (2031-2040)

8.6.1 Headworks Facility – Screening Capacity Expansion

This project includes the installation of a third step screen, washer compactor, and extension of the screening conveyor. This is to address the increased capacity for the facility and will allow the City to have one train off-line for maintenance while still meeting future capacity requirements. Based on anticipated growth projections and hydraulic assumptions, this improvement will be needed after 2030. Appendix H includes the scope and costing assumptions (HW2 data sheet) for this project.

Project Drivers

Existing and Future Service, Operational Efficiencies

Schedule: Begin procurement and design in 2031

Project Triggers

1. Hydraulic capacity

Budget: $3,380,000

8.6.2 Disinfection and Plant Water Asset Revitalization

This project includes the asset replacements as identified in Chapter 4 for the existing UV disinfection system and plant water infrastructure. Appendix H includes the scope and costing assumptions (UV3 data sheet) for this project.

Project Drivers

Operational Efficiencies, Asset Revitalization

Schedule: Begin procurement and design in 2034

Project Triggers

1. Aging infrastructure and equipment failures

Budget: $5,441,000

8.6.3 Aeration Basin and Secondary Clarifier Expansion

This project includes the expansion of the existing aeration basins and secondary clarifier to meet future hydraulic and organic growth conditions. The additional aeration and secondary clarifier capacity provides operational redundancy and flexibility for operations while maintaining the existing aeration basins. This project includes the addition of a fourth secondary clarifier to provide operational reliability and redundancy before replacing the secondary clarifier mechanisms and sludge pumping for the existing clarifiers. Additionally, the additional capacity will expand the treatment capability past the 2040 planning period. Appendix H includes the scope and costing assumptions (AB3 and SC2 data sheets) for this project.

Project Drivers

Existing and Future Service, Operational Efficiencies

Schedule: Begin procurement and design in 2032/33

Project Triggers

1. Hydraulic and organic capacity

Budget: $38,780,000

8.6.4 Anaerobic Digestion and Biogas Expansion

This project includes the expansion of the anaerobic digestion tanks by adding a third digester and associated heating and pumping equipment as discussed in Chapter 5. The additional anaerobic digestion tank provides operational redundancy and flexibility for operations while maintaining the existing digesters. This project includes the expansion of the biogas system based on the increased gas production realized by converting to anaerobic digestion, due to increased growth, and improved operations, as defined in Chapter 5. Additionally, this project allocates funding to replace the existing biogas treatment system as defined in Chapter 4. Appendix H includes the scope and costing assumptions (DIG3 and BG1 data sheets) for this project.

Project Drivers

Existing and Future Service, Operational Efficiencies, Asset Revitalization, Resource Recovery

Project Triggers

1. Digestion and biogas capacity.
2. Equipment failures
3. Revenue generation

Schedule: Begin in 2036

Budget: $19,416,000

8.7 Studies

To stay current with financial and infrastructure planning, the following studies are recommended for inclusion in the CIP. Timing of these studies may change based on the priorities at the Persigo WWTP and should be evaluated annually.

8.7.1 Financial Rate Studies

It is recommended that financial rate studies be updated approximately every five years in correlation with updates to infrastructure planning.

8.7.2 Master Plans (Wastewater Basin and Persigo WWTP)

The City's Comprehensive Wastewater Basin Update Plans should be updated concurrent with updates to the City's Comprehensive Plan. These updates should occur at a minimum every 7 to 10 years depending on the changes in service area growth.

The Persigo WWTP Master Plan should be updated approximately every 5 to 7 years to coincide with updates to the City's Comprehensive Plan and with renewal of discharge permits. These updates will revise the capacity projections and integrate innovative treatment technologies to refine future recommendations.

8.7.3 SCADA Upgrades and Architectural Programming Study

Additional planning and design efforts are needed to identify the implementation strategy and scope for upgrading the existing SCADA and communications systems on the plant site. The personnel and storage facilities located at the Persigo WWTP and off-site should be further analyzed to determine detailed plans for expansion of facilities to meet personnel needs and asset replacements.

8.7.4 Biosolids Management Study

As the City transitions to land application of biosolids, it is recommended to allocate budget for future biosolids management and implementation studies. These studies will access effectiveness of a biosolids management program and determine future land-uses and opportunities for the beneficial reuse of produced biosolids.

8.7.5 Electrical Systems Studies

It is recommended for each capital infrastructure project, that the Contractor or sub-contractor update the City's electrical system study. These updates will reflect the newly installed equipment and impacts to the electrical systems. Future electrical systems studies may be needed to evaluate new electrical code impacts, electrical innovation, and technologies to assess their impacts on the system wide electrical model.

8.8 Recurring Projects

The following projects have been identified as reoccurring needs for the Persigo WWTP. These efforts are budgeted through annual maintenance budgets and have not been integrated into the CIP. Internally, the Persigo WWTP staff reviews the priorities annually as part of the budgeting process and initiates projects as needed.

8.8.1 Civil Improvements

Reoccurring improvements such as repairs to asphalt roads, concrete sidewalks, site drainage improvements, and other civil related improvements would be included.

8.8.2 MCC Replacements

Reoccurring and planned replacements of existing MCCs, identified in Chapter 7, have allocated long-term CIP funding. These MCC replacements may be designated to a specific project as prioritized by the Persigo staff on an annual basis. It is anticipated that MCCs will be replaced every 20 to 25 years.

8.8.3 PLC Replacements

Reoccurring replacements of existing PLCs, as identified in Chapter 7, have been included in the maintenance budget. When replacing or overhauling major process components, the existing PLCs are expected to be replaced and upgraded with those projects. This cost is included as an allowance for those projects. It is anticipated that PLCs will be replaced every 10 to 15 years.

8.8.4 Underground Piping Inspection and Rehabilitation Program

An evaluation of the underground yard and process piping should be considered in the future as the existing piping reaches its useful life expectancy at the end of this planning period. The evaluation will further identify and prioritize the rehabilitation and/or replacement of the buried piping.

8.8.5 Security Improvements Program

Recurring investment for security provides funding to conduct vulnerability assessments and implement low-cost security and access control improvements.

8.8.6 Transformer and Switchgear Replacements

Replacement of existing transformers and switchgear as identified in Chapter 7 have been identified and long-term funding has been allocated. These replacements may be designated to a specific project as prioritized by the Persigo staff on an annual basis. It is anticipated that infrastructure will be replaced every 20 to 25 years.

8.9 Recommended Capital Improvement Plan

The total capital expenditures for the 20-year planning period equals $200 million, as shown in Table 8.2. The costs are represented as the total project costs, which include expenditures for engineering, construction, and other allowances or contingencies. All costs shown are represented in 2020 dollars.

Table 8.2 Capital Expenditures Projected for Planning Period

Time Period	Total Capital Expenditures
2021 to 2025	$59,242,000
2026 to 2030	$65,454,000
2031 to 2040	$75,306,000
Total	**$200,002,000**

Appendix H includes all the capital cost estimates used to build the individual project cost estimates.

Figure 8.7 illustrates the projected cash flows by year and Figure 8.8 shows the various project development phases from study to design through construction and commissioning. The design phase includes preliminary and final design efforts, as well as the bidding phase. In addition, during the design phase, the engineer is expected to complete the necessary regulatory submittals, such as the Site Location Approval and Design Approvals required by the CDPHE. The schedule was developed assuming that the conventional design-bid-build procurement approach is used for each project.

Identified Project Groupings	20-Year Total	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031-2040
WWTP Asset Replacements - 2020 and 2021 Projects	**$ 5,732,179**	$ 5,732,179										
Odor Control Improvements	**$ 2,345,000**	$ 1,745,000		$ 600,000								
CNG Gas Storage / Enhanced Fueling Station	**$ 1,080,000**	$ 1,080,000										
Persigo WWTP Master Plan	**$ 164,660**	$ 164,660										
Flow Equalization Basin - Asset Revitalization	**$ 584,000**	$ 205,000	$ 379,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Aeration Basin Asset Revitalization and Blower Building	**$ 16,209,000**	**$ -**	$ 1,621,000	$ 7,294,000	$ 7,294,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Disinfection Operational Improvements	**$ 600,000**	**$ -**	$ 600,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
New Dewatering Building and Solids Storage	**$ 19,300,000**	**$ -**	$ 1,930,000	$ 8,685,000	$ 8,685,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Headworks Asset Replacements and Hydraulic Improvements	**$ 6,287,000**	$ -	$ -	$ -	$ 629,000	$ 5,658,000	$ -	$ -	$ -	$ -	$ -	$ -
Admin Building Improvements and Electrical Distribution Loop	**$ 11,840,000**	$ -	$ -	$ -	$ 1,184,000	$ 5,328,000	$ 5,328,000	$ -	$ -	$ -	$ -	$ -
Anaerobic Digestion Conversion and Grease Building	**$ 22,990,000**	$ -	$ -	$ -	$ -	$ -	$ 2,299,000	$ 12,897,000	$ 7,794,000	$ -	$ -	$ -
Primary Clarifier Expansion and Asset Revitalization Projects	**$ 13,278,000**	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,328,000	$ 5,975,000	$ 5,975,000	$ -	$ -
UV Disinfection Expansion	**$ 9,551,000**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 955,000	$ 4,298,000	$ 4,298,000	$ -
Biosolids Management - Class B Program	**$ 756,000**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 756,000	$ -	$ -	$ -
Raw Sewage Pump Station (RSPS) - Asset Revitalization	**$ 5,149,000**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 515,000	$ 2,317,000	$ 2,317,000	$ -
Secondary Clarifier - Asset Revitalization	**$ 7,976,000**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 798,000	$ 3,589,000	$ 3,589,000
Headworks Facility - Screening Capacity Expansion	**$ 3,380,000**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,380,000
Disinfection and Plant Water Asset Rehabilitation	**$ 5,441,000**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,441,000
Aeration Basin and Secondary Clarifier - Expansion	**$ 38,780,000**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 38,780,000
Anaerobic Digestion and Biogas - Expansion	**$ 19,416,000**	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 19,416,000
Studies and Evaluations	**$ 2,843,161**	$ 78,161	$ 225,000	$ -	$ -	$ 125,000	$ 665,000	$ 100,000	$ -	$ 200,000	$ -	$ 1,450,000
Electrical Systems (MCC, Transformer, Switchgear) Replacements	**$ 6,300,000**	$ -	$ -	$ -	$ -	$ -	$ -	$ 500,000	$ 350,000	$ 350,000	$ 1,850,000	$ 3,250,000
Grand Total	**$ 200,002,000**	**$ 9,005,000**	**$ 4,755,000**	**$ 16,579,000**	**$ 17,792,000**	**$ 11,111,000**	**$ 8,292,000**	**$ 14,825,000**	**$ 16,345,000**	**$ 13,938,000**	**$ 12,054,000**	**$ 75,306,000**
1. Values shown are in expressed in 2021 dollars.					**5-Year Total**	**$ 59,242,000**				**10-Year Total**	**$ 124,696,000**	

Figure 8.7 Projected Cash Flow Expenditures by Year

Identified Project Groupings	20-Year Project Budget	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
WWTP Asset Replacements - 2020 and 2021 Projects	$5,732,179										
Odor Control Improvements	$2,345,000										
CNG Gas Storage / Enhanced Fueling Station	$1,080,000										
Persigo WWTP Master Plan	$164,660										
Flow Equalization Basin - Asset Revitalization	$584,000										
Aeration Basin Asset Revitalization and Blower Building	$16,209,000										
Disinfection Operational Improvements	$600,000										
New Dewatering Building and Solids Storage	$19,300,000										
Headworks Asset Replacements and Hydraulic Improvements	$6,287,000										
Admin Building Improvements and Electrical Distribution Loop	$11,840,000										
Anaerobic Digestion Conversion and Grease Building	$22,990,000										
Primary Clarifier Expansion and Asset Revitalization Projects	$13,278,000										
UV Disinfection Expansion	$9,551,000										
Biosolids Management - Class B Program	$756,000										
Raw Sewage Pump Station (RSPS) - Asset Revitalization	$5,149,000										
Secondary Clarifier - Asset Revitalization	$7,976,000										
Headworks Facility - Screening Capacity Expansion	$3,380,000										
Disinfection and Plant Water Asset Rehabilitation	$5,441,000										
Aeration Basin and Secondary Clarifier - Expansion	$38,780,000										
Anaerobic Digestion and Biogas - Expansion	$19,416,000										
Studies and Evaluations	$2,843,161										
Electrical Systems (MCC, Transformer, Switchgear) Replacements	$6,300,000										
Total Annual Capital Expenditures		**$9,005,000**	**$4,755,000**	**$16,579,000**	**$17,792,000**	**$11,111,000**	**$8,292,000**	**$14,825,000**	**$16,345,000**	**$13,938,000**	**$12,054,000**
LEGEND: Project Development Phases					**5-Year Total =**	**$ 59,242,000**				**10-Year Total =**	**$ 124,696,000**
Study Phase	Design	Construction	Commissioning								

Figure 8.8 Project Implementation Schedule by Phases

8.9.1 Comparison to the City's 2021 Budget

Table 8.3 compares the differences in capital expenditures recommended as part of this 2020 Master Plan as compared to the current Persigo WWTP capital projects included in the City's 2021 Budget. For the initial 3-year comparison period, the projects identified in 2020 Master Plan identified additional asset revitalization and capacity improvement projects replacement needs for the facility which are not currently included in the City's 2021 Budget.

Table 8.3 Comparison of Capital Improvement Plans

2020 Master Plan	Capital Improvement Plan Projected Expenditures
2020 Persigo WWTP Master Plan CIP	Period (2021-2023) = $30,339,000
City's 2021 Budget – Persigo WWTP Projects only	Period (2021-2023) = $31,595,000

8.10 Impacts to Staffing and Operating Costs

Based on the projected implementation plan shown above, the Persigo WWTP should consider the impacts on staffing and annual operating costs. A comprehensive assessment of existing staffing positions and O&M costs was not conducted as part of this study. However, the information provided below provides a relative impact for the City to consider for future budgeting purposes.

8.10.1 Staffing Levels

The City currently has identified 39.25 full-time equivalents (FTE) based on the City's 2021 Budget. Table 8.4 identifies the staffing positions. Based on industry benchmarking data provided by NACWA in 2018, the City's staffing levels for wastewater operations, maintenance, and management are in-line with national and statewide averages. As a result, there are no immediate staffing recommendations based on the benchmarking data shown in Figure 8.9.

However, based on the size and complexity of the CIP, there are some specific roles recommended for the City to successfully manage the program and minimize operational risks. Table 8.4 includes potential roles the City should consider.

Table 8.4 Persigo WWTP Staffing Positions (2021)

Category	FTEs
Managerial / Supervisors / Administrative Director / Administrative Assistant	7.25
Plant Operators	7
Industrial Pretreatment Specialists	2
Plant Maintenance	7
SCADA Technicians/Electrician	3
Safety Program Coordinator	0.5
Asset Management Specialist	0.5
Collection System Operator(s)	8
Laboratory Staff	4
Total FTEs(1)	**39.25**

Notes:
(1) Information from 2021 approved budget. Includes collection system and treatment plant staff.

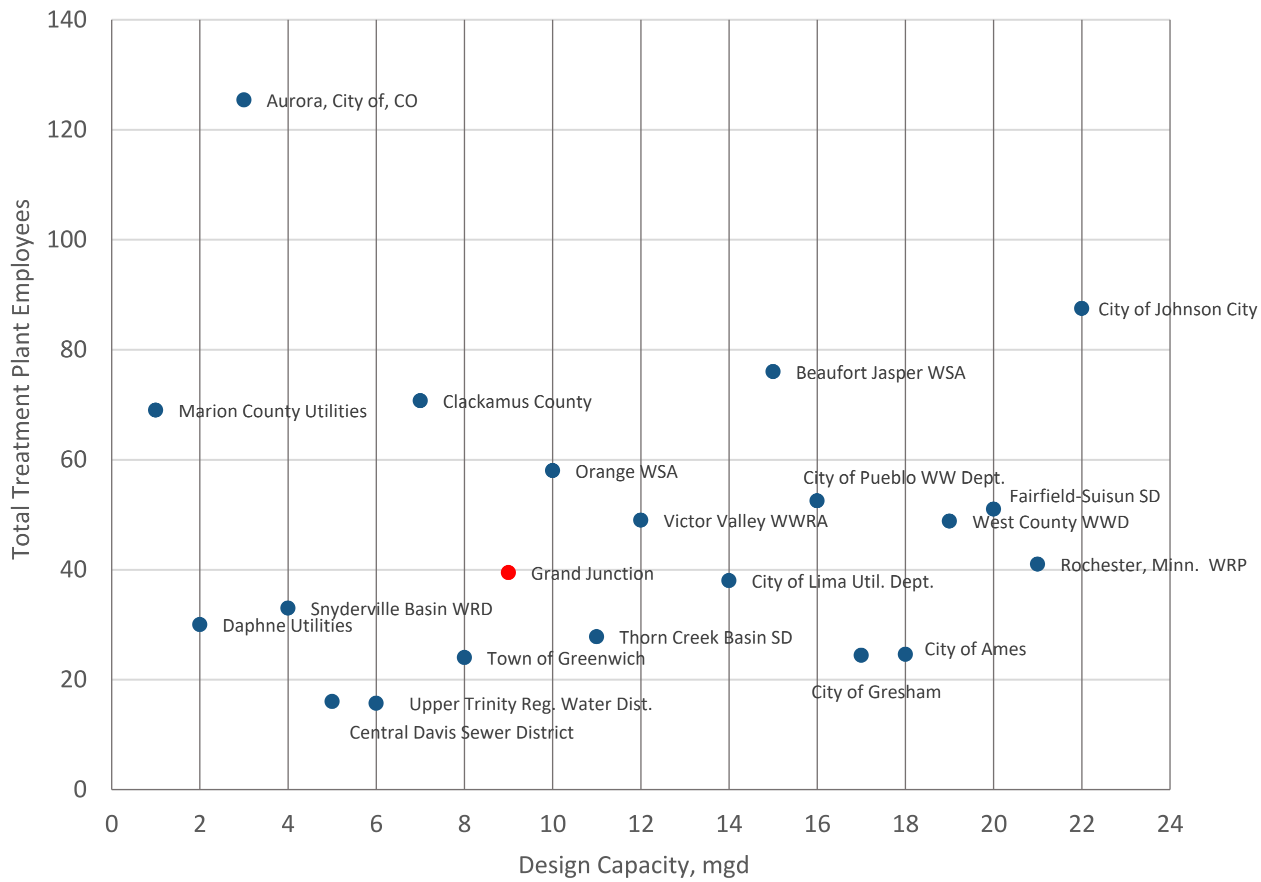

Figure 8.9 Staffing Benchmark Data from NACWA, 2018

1. **Project Managers**. Carollo recommends two to three project managers, which can assist with managing, procuring, and delivering CIP projects. Carollo typically recommends that a single project manager can manage between three to five active projects with a dollar range between $1 million to $7.5 million.
2. **O&M Construction Liaison.** Many Utilities have identified the importance of an O&M construction liaison to facility construction sequencing between multiple projects and to support scheduling and commissioning. It is recommended that the City add one FTE to support the construction efforts from an O&M perspective.
3. **Sewer Improvement Districts / Septic Elimination Program.** To meet the City's goal in eliminating septic systems, one to two FTEs are recommended to manage the logistics, resident coordination, and hiring contractors to perform the necessary improvements.
4. **IT/SCADA.** Ensuring the organization has sufficient IT/SCADA resources is critical as the Persigo WWTP implements a higher level of controls and instrumentation. The current staffing levels appear appropriate; however, this should be further coordinated with the City's IT planning and long-term SCADA upgrades.
5. **New Technologies or Programs.** As the Persigo WWTP continues to invest in more instrumentation, inclusion of an instrument technician who would be tasked with calibration and tracking of probes and instrument is recommended. As the City migrates to a Class B biosolids management program, it is recommended that the City add one to two FTEs to manage and administer the program depending on the final approach selected.

8.10.2 Estimated Impacts to Operating Costs

In evaluating specific treatment and unit process alternatives as documented in Chapter 5, comparative O&M costs were developed and provided in Appendix E. The comparative costs have been coalesced to illustrate the potential operating cost impacts for the Persigo WWTP operations over the next 10 years. Table 8.5 shows the O&M costs for the projects included in the CIP above.

Table 8.5 Comparative O&M Costs (2021)

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Aeration Basin Asset Revitalization and Blower Building Project(1)			($38,000)	($38,000)	($39,000)	($39,000)	($39,000)	($40,000)	($40,000)	($41,000)
Dewatering Building and Solids Storage Project(2)				($97,000)	($106,000)	($115,000)	($126,000)	($137,000)	($148,000)	($161,000)
Anaerobic Digestion Conversion Project(3)							($250,000)	($258,000)	($267,000)	($276,000)
TOTAL	$0	$0	($38,000)	($135,000)	($145,000)	($154,000)	($415,000)	($435,000)	($455,000)	($478,000)

Notes:
(1) Reduction in energy with blower optimization and improved aeration controls.
(2) Reduction in biosolids hauling and tipping costs.
(3) Reduction of biosolids hauling and tipping costs, increase in biogas revenue.

8.11 Combined Capital Improvement Plan

The City's combined CIP plan includes the treatment projects identified above and the collection system improvements as documented in the 2020 Wastewater Basin Master Plan Update. Figure 8.10 and Table 8.6 show the combined Collection System and Persigo WWTP expenditures for the 20-year period. Over the first 10-year period, the City will average an annual expenditure of approximately $21.5 million to meet the capital investment needs identified in both Master Plans. This average annual expenditure rate drops to approximately $15.7 million for the follow 10-year period (2031-2040).

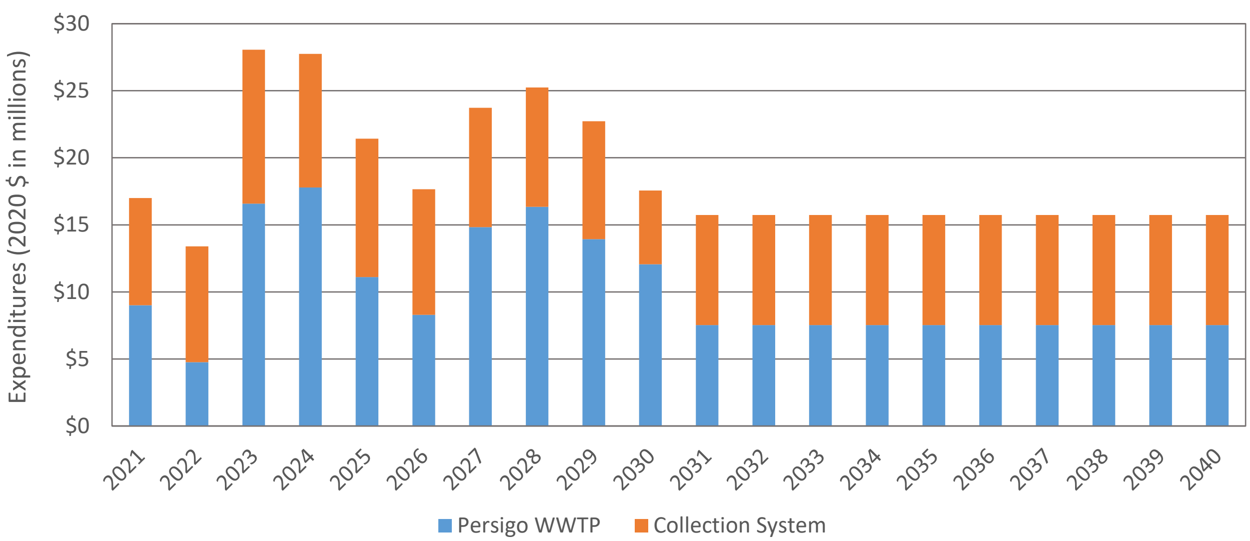

Figure 8.10 Combined Annual CIP Expenditures

Table 8.6 Summarized CIP Expenditures

Time Period	Collection System	Persigo WWTP	Total
2021 to 2025	$48.4 million	$59.2 million	**$107.6 million**
2026 to 2030	$41.5 million	$65.5 million	**$107.0 million**
2031 to 2040	$82.0 million	$75.3 million	**$157.3 million**
Total	**$171.9 million**	**$200.0 million**	**$371.9 million**

Figure 8.11 illustrates the distribution of funding sources based on the City's capital allocation approach. For the 10-year period shown, the total capacity related expenditures equal $82.2 million or 38 percent of the total CIP expenditures. Capacity related projects include the following:

- **Collection System** – Hydraulic capacity improvements and extension projects. Between 2022 and 2026, the collection system capacity projects account for 60 percent of the total capacity related expenditures.
- **Persigo WWTP** – Unit process capacity expansions. Between 2027 and 2030, the treatment system capacity projects account for 66 percent of the total capacity related expenditures.

Other projects identified have been categorized as asset revitalization or other operational improvement projects, which are drive by capacity limitations.

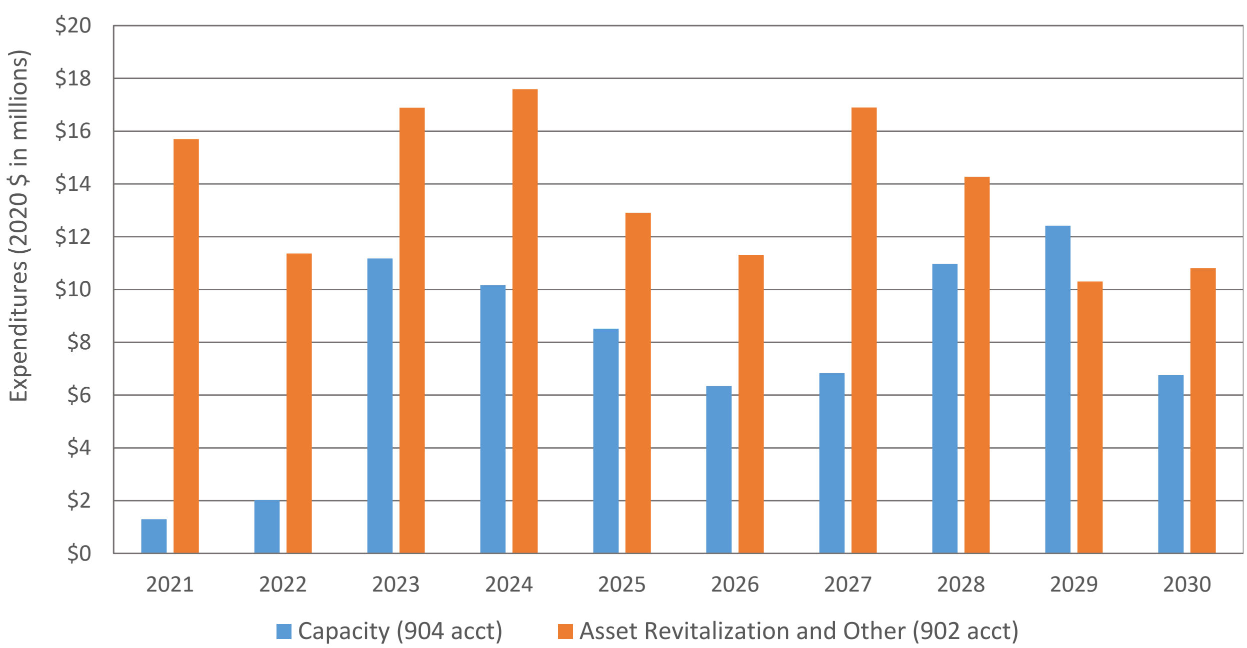

Figure 8.11 Annual Expenditures Allocated by Funding Source

Appendix A

PROCESS DATA EVALUATION

Carollo Engineers, Inc.

W.O./Client:	11789A.00	
PROJECT:	Persigo WWTP Master Plan Development Project	
SUBJECT:	Unit Process Capacity Spreadsheet	Engineers...Working Wonders With Water®

By	Date	Chk by	Chk date
BDC	7/16/2020		

FLOW RATES	UNITS	CURRENT DESIGN
ADAF	mgd	10.7
ADMMF	mgd	12.5
PHF (Upstream of EQ)	mgd	28.8
PHF (Downstream of EQ)	mgd	12.5

PRELIMINARY TREATMENT

INFLUENT FLOW MEASUREMENT		
Number of Units	-	1
Flow Range	mgd	Adjustable (Currently 0-20)
Type	-	HACH FLO-DAR
INFLUENT SCREENING		
Total Number of Units	-	2
Type	-	Huber Step Screen (SSV 5300x876x6)
Bar Spacing	inch	0.25
Capacity, Each	mgd	12.5 (Per O&M Manual)
Capacity, Total	mgd	25
Capacity, Firm	mgd	12.50
Drive Horsepower	HP	3
Velocity through Screen	ft/sec	Not Avialable from Manufacturer
SCREENINGS CONVEYORS		
Total Number of Units	-	1
Type	-	Hyber Transport Screw Conveyor (Ro8T/273)
Capacity, Each	ft^3/hr	140
Drive Horsepower	HP	1.5
SCREENINGS PRESS		
Total Number of Units	-	1
Type	-	Huber Washpress WAP-4
Capacity, Each	ft^3/hr	20
Drive Horsepower	HP	4
GRIT BASIN		
Total Number of Units	-	2
Type	-	Square - mechanically cleaned
Length	ft	20
Width	ft	20
Sidewater Depth	ft	2
Capacity, Each	mgd	33.6
Capacity, Total	mgd	67.2
Horizontal Flow Velocity	ft/sec	1.3
GRIT PUMPS		
Total Number of Units	-	2
Type	-	Morris 3HS10 Centrifugal
Capacity, Each	gpm	150
Capacity, Total	gpm	300
Capacity, Firm	gpm	150
Drive Type	-	Constant Speed
Drive Horsepower	HP	15
GRIT CYCLONE SEPARATORS		
Total Number of Units	-	2
Type	-	Hydrotech H105BC-AS8-NE with two dewatering clasifiers
Capacity, Each	gpm	150-300
Capacity, Total	gpm	300-600

RAW SEWAGE PUMPS		
Raw Sewage Pumps		
Total Number of Units	-	5
Type	-	Fairbanks Morse Centrifugal
Capacity, Each	mgd	10
Capacity, Total	mgd	50
Capacity, Firm	gpm	40
Drive Type	-	Variable Speed
Drive Horsepower, Each	HP	100
PRIMARY TREATMENT		
PRIMARY CLARIFIERS		
Total Number of Units	-	2
Diameter	ft	115
Side Water Depth	ft	8
Surface Area, Total	ft^2	20,774
Weir Length, Each	ft	342
Surface Overflow Rate at ADMMF	gpd/ft^2	602
Surface Overflow Rate at PHF	gpd/ft^2	1,386
Weir Loading Rate at PHF	gpd/ft	42,105
PRIMARY SLUDGE PUMPING		
Number of Units	-	2
Type	-	Borger Rotary Lobe
Capacity, Each	gpm	100
Capacity, Total	gpm	200
Drive Type	-	Constant Speed
Drive Horsepower, Each	HP	5
PRIMARY SCUM PUMPING		
Number of Units	-	2
Type	-	Positive Displacement Plunger Type
Capacity, Each	gpm	150
Capacity, Total	gpm	300
Drive Type	-	Constant Speed
Drive Horsepower, Each	HP	10
SECONDARY TREATMENT		
AERATION BASINS		
Total Number of Aeration Basins	-	4
Length	ft	120
Width	ft	60.0
Side Water Depth	ft	15
Total Aeration Basin Volume	ft^3	417,752
Total Aeration Basin Volume	MG	3.13
Total Aeration Basin Volume	1,000 ft^3	418
Total Number of Anoxic Zones	-	3
Length	ft	10
Width	ft	60
Anoxic Zone Volume	MG	0.20
Anoxic Zone HRT @ ADMMF	Hrs	0.4
Anoxic Zone - Percent Total Volume	%	6%
Total Number of Aerated Zones	-	3
Aerated Zone Volume	MG	2.92
Aerated Zone HRT @ ADMMF	Hrs	5.6
Aerated Volume - Percent Total Volume	%	94%
AERATION DIFFUSERS		
Type	-	Sanitaire 9-Inch Ceramic
Active Diffusers, Total	-	8,091
Active Diffusers, Per Basin		
Aeration Basin 1	-	2,126
Aeration Basin 2	-	2,126
Aeration Basin 3	-	1,702
Aeration Basin 4	-	2,137
UNAERATED ZONE MIXERS		
Number	-	3
Type	-	Submersible
Horsepower, Each	HP	Unknown

MIXED LIQUOR RECYCLE (MLR) PUMPING		
Number of Units	-	1
Type	-	Submersible Propeller Pump
Capacity, Each	mgd	18 @ 0.9 ft TDH
Capacity, Total	% East Train Flow	288%
BLOWERS		
Total Number of Units	-	4
Type	-	Multi-stage Centrifugal
Capacity, Each	-	
3 Units	scfm	3,100
1 Units	scfm	4,500
Capacity, Total	scfm	13,800
Capacity, Firm	scfm	9,300
FINAL CLARIFIERS		
Total Number of Clarifiers	-	3
Diameter	ft	115
Side Water Depth	ft	14
Surface Area, Each	ft^2	10,387
Surface Area, Total	ft^2	31,161
RETURN ACTIVATED SLUDGE (RAS) PUMPING		
Number of Units	-	6
Type	-	Centrifugal
Capacity, Each	mgd	3.2
Capacity, Total	mgd	19.2
Capacity, Firm	mgd	12.8
Firm RAS Capacity	% INF Flow	102
Drive Type	-	Variable Speed
WASTE ACTIVATED SLUDGE (WAS) PUMPING		
Number of Units	-	3
Type	-	Centrifugal
Capacity, Each	gpm	400
Capacity, Total	gpm	1,200
DISINFECTION		
ULTRAVIOLET (UV) DISINFECTION		
Number of Channels	-	1
Number of Banks Per Channel	-	3 (2 duty, 1 standby)
Total Number of Lamps	-	168
Maximum Daily Flow	mgd	12.5
Maximum Peak Hour Flow	mgd	12.5
Minimum UV Dose	mJ/cm^2	30.74 @ 65% UVT or 19.76 @ 55% UVT
Design UV Transmittance	%	55% - 65%
EFFLUENT FLOW MEASUREMENT		
Number of Units	-	1
Type	-	Parshall Flume
Capacity, Each	mgd	32.6
Capacity, Total	mgd	32.6
EFFLUENT DISCHARGE OUTFALL		
Type	-	Diffuser in Colorado River
Size	Inch	54
Number of discharge ports	-	17
Peak hydraulic capacity at 100-yr flood	mgd	42

Appendix B

BIOWIN PROCESS MODELING AND CALIBRATION

Process Model Calibration

A BioWin process model was developed for Persigo WWTP using daily average influent, unit process, and effluent data collected by operations staff. The steady state process model was calibrated based on historical influent wastewater flows and loads from January 1, 2019 to March 31, 2019. This period was chosen as the baseline for the steady state calibration because it corresponds with winter temperatures, which have correlated with moderate influent loading and more challenging treatment conditions in the secondary treatment system in recent years.

Two influent wastewater fractionation parameters and one global kinetic parameter were adjusted in the model to more closely match unit process performance and overall effluent quality (Table B.1). Wastewater temperature, flow rates through individual unit processes (e.g., primary sludge, RAS, WAS), DO profiles in the aeration basins, and solids capture in the clarifiers were added as inputs into the BioWin model prior to changing the calibration parameters noted in Table B.1.

Table B.1 BioWin Model Calibration Parameters

Parameter	Unit	Persigo Model Calibration	BioWin Default
Influent Wastewater Fractionation			
Fbs - Readily biodegradable (including acetate)	gCOD/g of total COD	0.17(1)	0.16
Fxsp – Non-colloidal slowly biodegradable	gCOD/g of slowly degradable COD	0.80(2)	0.75
Global Kinetic Parameters			
Anaerobic hydrolysis factor	-	0.4810(3)	0.50

Notes:
(1) Adjusted to achieve secondary effluent total inorganic nitrogen calibration.
(2) Adjusted to achieve solids mass balance across the primary and secondary treatment systems.
(3) Adjusted to achieve anaerobic digester biogas production calibration.

The steady state model calibration was successful and the model output was in agreement with average historical process data over the calibration period. An abbreviated table comparing historical process performance with key BioWin model output parameters is shown in Table B.2.

Table B.2 Comparison of Actual Performance with Calibrated BioWin Model Output

Parameter	Unit	Average Plant Performance 01/01/2019 - 03/31/2019	BioWin Model Output
Influent			
Flow	mgd	8.6	8.6
BOD_5	mg/L	283	295
TSS	mg/L	273	276
VSS	mg/L	244	246
TKN	mg/L	Not Measured	52.7
NH_4	mg/L	34.8	34.8
pH	S.U.	7.6	7.6
Alkalinity	mg/L as $CaCO_3$	290	290
Temperature	°C	13.9	13.9

Parameter	Unit	Average Plant Performance 01/01/2019 - 03/31/2019	BioWin Model Output
Primary Clarifiers			
BOD_5 Removal	%	35	31
Effluent BOD_5	mg/L	183	203
TSS Removal	%	65	50
Effluent TSS	mg/L	96	138
Effluent Ammonia	mg/L	33.2	36.7
Primary Sludge TS	ppd	8,881	9,996
Primary Sludge VS	ppd	7,652	8896
Aeration Basins			
West Train MLSS	mg/L	2,920	2,900
West Train MLVSS	mg/L	2,402	2,384
West Train WAS	ppd	4,565	4,451
East Train MLSS	mg/L	2,975	2,962
East Train MLVSS	mg/L	2,407	2,429
East Train WAS	ppd	4,253	4,311
Secondary Effluent			
TSS	mg/L	8.0	8.2
Ammonia	mg/L	0.87	0.12
TIN	mg/L	22.6	22.9
pH	S.U.	6.9	6.6
Alkalinity	mg/L as $CaCO_3$	107	84
Anaerobic Digesters			
Gas Production	CFD	87,025	96,869
Methane Fraction	%	62	63
VS Reduction	%	70	68
Pressate			
Cake	%TS	11.8	11.9
Flow	mgd	0.05	0.05
TSS	mg/L	393	397
VSS	mg/L	286	293
NH_4	mg/L	285	432

Development of Key Design Assumptions for Capacity Evaluation Modeling

Design assumptions (e.g., influent temperature, RAS flow) were derived from historical process performance and were used to evaluate facility capacity when operating under the current permitted ADMMF flow and organic load. The facility was modeled with an assumed DO concentration of 0 mg/L in all unaerated zones. However, BioWin models oxygen Acarryover from internal recycle streams and simulates process performance accordingly. All other aeration basins were modeled as fully aerated (2.0 mg/L DO).

The historical range of RAS flows (Figure B.1) at the facility is approximately 25 to 40 percent of the individual train flow in the East and approximately 30 to 60 percent in the West since 2018. An average RAS flow of 40 percent was assumed for this capacity analysis in both trains, which is most typical of operating performance since mid-2019.

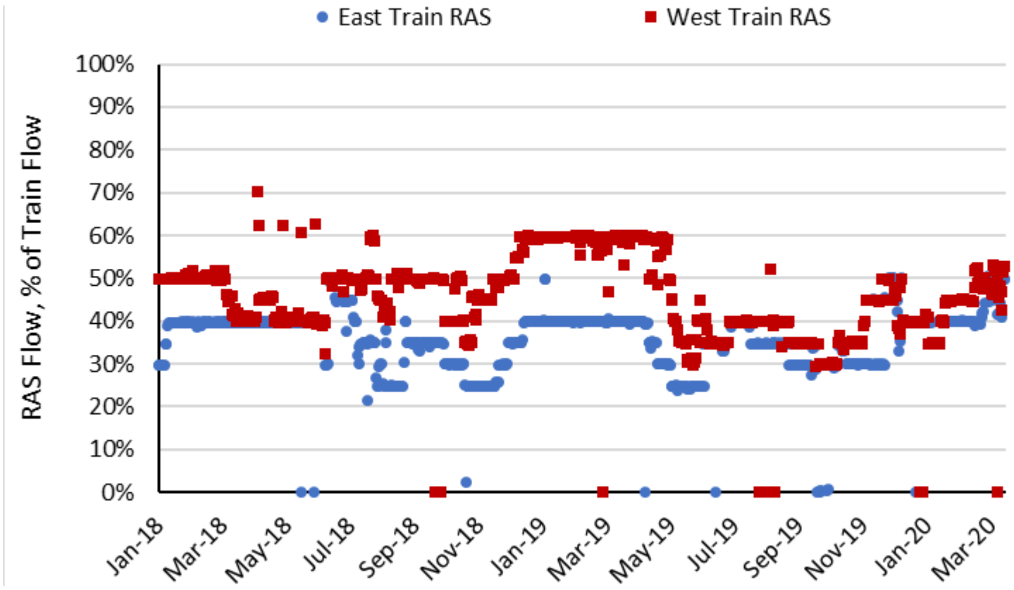

Figure B.1 Historical RAS Flow Rate as Percentage of East and West Train Influent Flow

Historically, influent BOD_5 (Figure B.2) and ammonia (Figure B.3) loading peak to the WWTP in late spring. During these same months, the wastewater temperature in the aeration basins is transitioning from colder winter temperatures (~13 degrees Celsius) to warmer summer temperatures (~25 degrees Celsius). Generally, wastewater temperatures in the aeration basins have ranged from approximately 15.7 degrees Celsius to as high as 23 degrees Celsius. A 30-day rolling average temperature of 15.7 degrees Celsius was selected as the design temperature for this capacity analysis. Previous design assumptions for wastewater temperature could not be located in the plant's historical records or design reports.

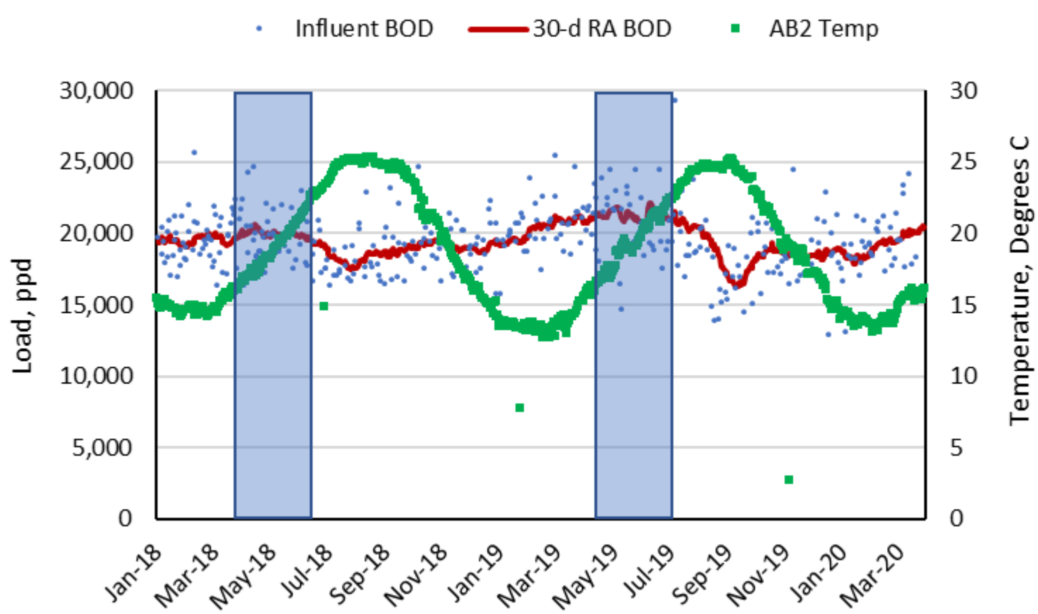

Figure B.2 Historical Influent BOD_5 and Aeration Basin Temperature

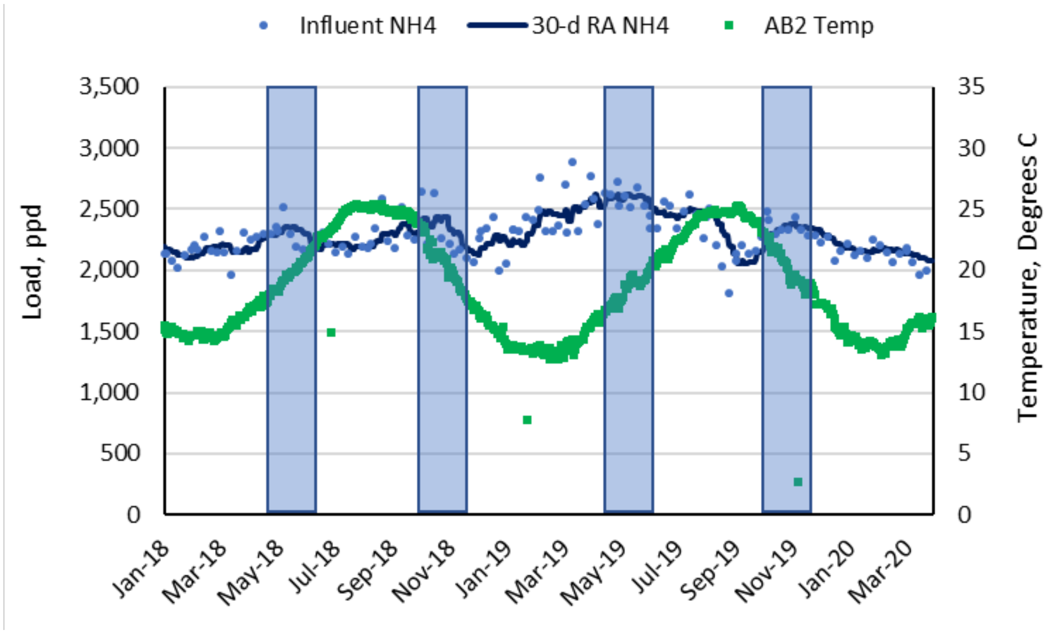

Figure B.3 Historical Influent Ammonia and Aeration Basin Temperature

Primary clarifier TSS and BOD_5 removal (60 percent and 31 percent, respectively) were adopted from the calibrated steady state process model. Generally, the calculated TSS removal at the WWTP has ranged from about 55 percent to as high as 80 percent while BOD_5 removal has varied between approximately 25 percent and 55 percent (Figure B.4). However, there is a discrepancy between primary sludge reported by the WWTP and calculated primary sludge based on primary influent and effluent water quality data (Figure B.5). The reported primary sludge data (approximately 7,000 ppd to 13,000 ppd) is typically low as compared to the calculated primary sludge (approximately 8,000 ppd to 19,000 ppd).

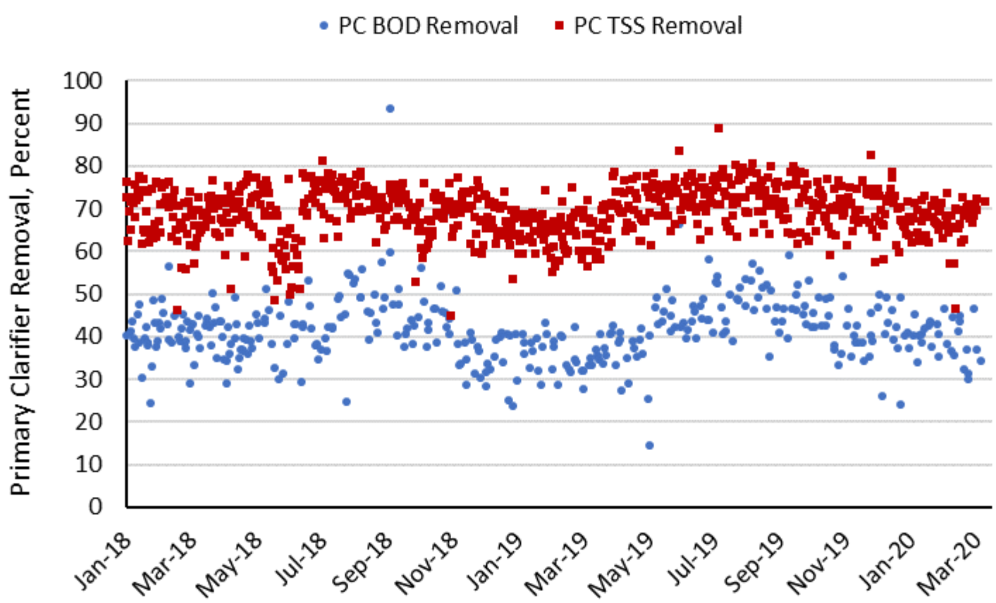

Figure B.4 Historical BOD_5 and TSS Removal in the Primary Clarifiers

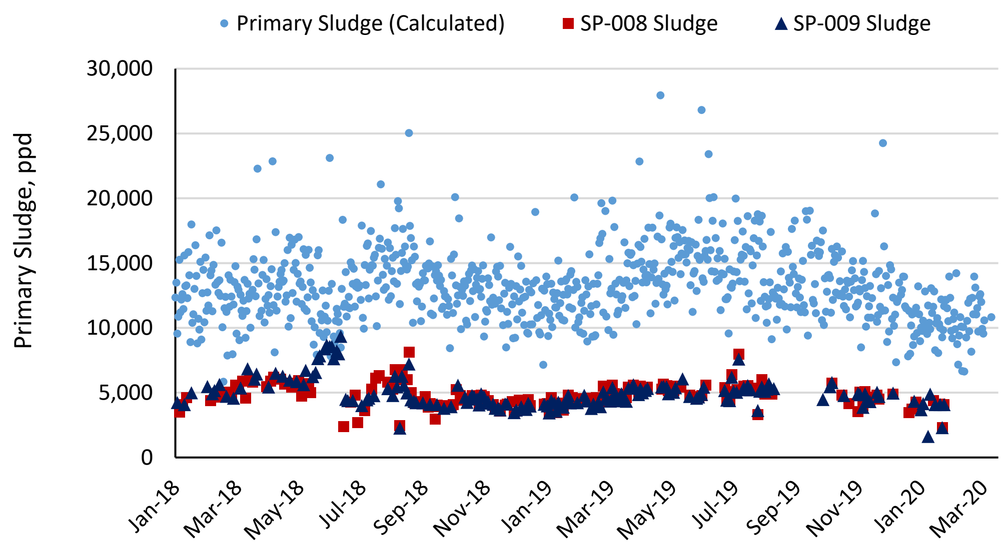

Figure B.5 Historical BOD_5 and TSS Removal in the Primary Clarifiers

A design aSRT of 8 days or maximum MLSS concentration of 3,500 mg/L was targeted in the both the east and west treatment trains. This aSRT was selected to ensure adequate nitrification safety factor was achievable in the existing basin volume based on historic process performance (Figure B.6). For reference, a design SRT of 5.6 days and estimated MLSS concentration range of approximately 2,630 mg/L to 2,940 mg/L were reported in the 1980 Basis of Design Report for the existing aeration basins assuming no nitrification.

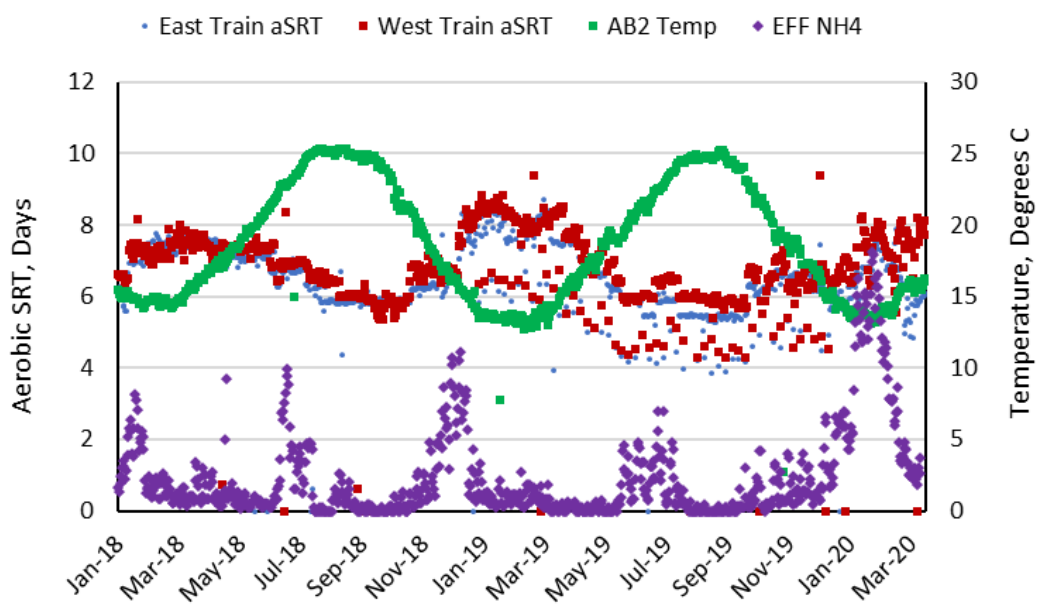

Figure B.6 Historical aSRT, Wastewater Temperature, and Effluent Ammonia Concentrations

For evaluating secondary clarifier capacity using SPA, a design 30-minute SVI of 150 mL/g was assumed. This SVI represents the 91st percentile and 79th percentile of historical SVI recorded in the East and West treatment trains, respectively, since 2018. SVI has typically ranged from approximately 30 mL/g to 220 mL/g in both treatment trains over the last 2 years, excluding the two excursions that occurred in early 2020

(Figure B.7). Future design intent, when assuming an SVI of 150 mL/g, should include provisions for polymer addition to the secondary clarifiers to control sludge settling when SVI values begin to increase. Previous design assumptions for SVI could not be located in the historical records or design reports.

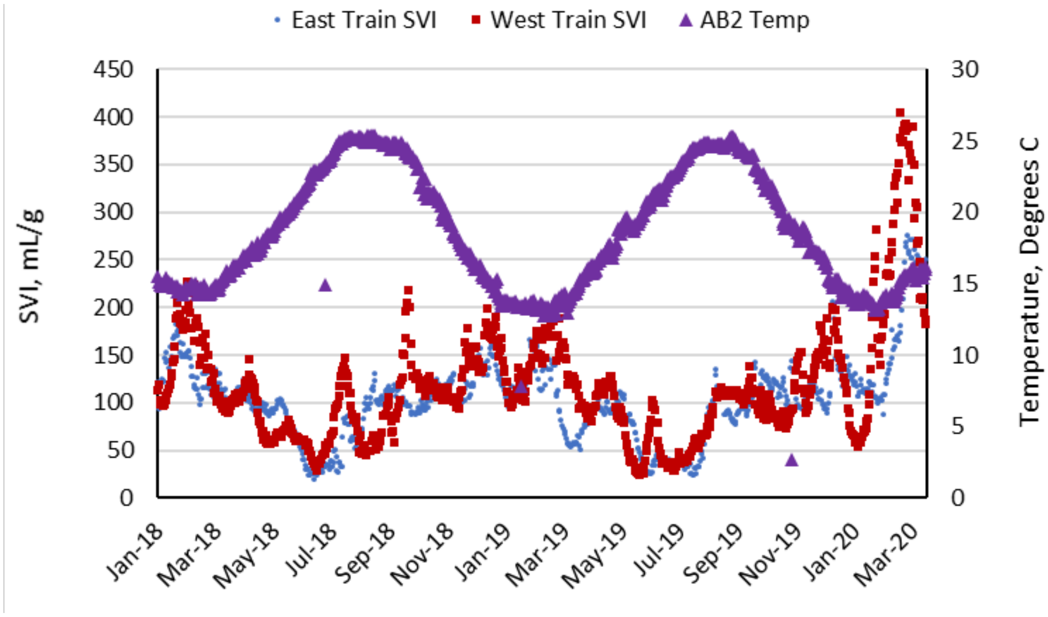

Figure B.7 Historical Wastewater Temperature and SVI

Appendix C

CAPITAL COST ESTIMATE – ASSETS

APPENDIX C CAPITAL COST ESTIMATES FOR ASSET REVITALIZATION PROJECTS

UPDATED:	Dec-20
BY :	JK, LM, BL, BC
CHECKED:	DSP

CLIENT: City of Grand Junction -
PROJECT : 2020 Persigo WWTP Master Plan
Process: Estimating Assumptions

Estimate Basis (year) = 2021
Mid point of Construction = TBD

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	10			
Structural / Archectural Allowance (could be demo also)	10	%		
Building Coatings and Finishes	1	%		
Mechanical System Allowance (HVAC, Plumbing, etc)	10	%		
Electrical, IC, Programming Allowances	25	%		
Equipment installation	20	%		
Construction contingency	30	%		
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		
GC Overhead, Profit, Insurance, Bonds, Mob	25	%		
City Taxes, other fees	4.5	%		
Annual Inflation	3	%		
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		
Owner maintained project contingency	10	%		

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UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT City of Grand Junction -
PROJECT: Asset Replacements - Baseline Condition (Chapter 4) — Estimate Basis (year) = 2021
Process Area: Headworks Facility - Asset Replacements — Mid point of Construction (year) = 2022

Class V Cost Estimate for replacement and rehabilitation of Headworks Building assets, which includes the screening facilities, washer compactor, and grit treatment and conveyance. These assets are assumed to have a 20 year useful life. Estimated project costs include odor control improvements identified by Garver.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Replace roofing membrane	1	LS	$ 75,000	$ 75,000
Replace and Rerate step screens	2	EA	$ 230,000	$ 460,000
Manual bar screen	1	LS	$ 45,000	$ 45,000
Replace screening conveyor	1	LS	$ 85,000	$ 85,000
Replace 1 screenings compactor / washer	1	LS	$ 150,000	$ 150,000
Replace grit pumps	2	EA	$ 35,000	$ 70,000
Replace grit washer/compactor	2	EA	$ 115,000	$ 230,000
Replace 2 dumpsters (screenings and grit)	2	EA	$ 5,000	$ 10,000
				$ -
MCC Replacments	1	LS	$ 85,000	$ 85,000
Replace HW Generator	0	LS	$ 500,000	$ -
PLC Replacement	1	LS	$ 75,000	$ 75,000
				$ -
Flow Monitoring Equipment	0	LS	$ 15,000	$ -
Covering for Bar Screen, conveyor, dumpster	400	FT2	$ 200	$ 80,000
Biofilter for Odor Control (Garver, 2020)	0	LS	$ 603,000	$ -
Persigo Wash Air Jumper (By Garver, 2020)	0	LS	$ 193,000	$ -
		BASE ASSET COST		**$ 1,365,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	10	%		$ 136,500
Structural / Architectural Allowance (Including Demolition)	10	%		$ 136,500
Coatings and Finishes	5	%		$ 68,250
Mechanical System Allowance (HVAC, Plumbing, etc)	10	%		$ 136,500
Electrical, IC, Programming Allowances	25	%		$ 341,250
Equipment installation	20	%		$ 273,000
Construction contingency	30	%		$ 737,000
		SUBTOTAL DIRECT COST		**$3,194,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 319,400
GC Overhead, Profit, Bonds, Mob	25	%		$ 799,000
City Taxes, other fees	4.5	%		$ 144,000
Cost Escalation to Mid-Point of Construction	3.0	%		
		TOTAL CONSTRUCTION COST		**$4,456,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 891,000
Owner maintained project contingency	10	%		$ 446,000
		TOTAL PROJECT COST (2021 $'s)		**$5,793,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Costs for hoists and garage door replacements
2. Assume gates, small pumps included in allowance
3. HVAC improvements included as contingency
4. Miscellaneous coatings included with the allowance above.
5. Misc. electrical improvements included as building allowance
6. Inplant waste pumping is covered in the mechanical allowance.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*

Escalated $'s	2021	2022	2023	2024	2025	2026
$ 5,967,000	$ 895,000	$ 5,072,000	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

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UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT City of Grand Junction -
PROJECT: Asset Replacements - Chapter 4
Process Area: Raw Sewage Pump Station (PS) - Asset Replacements

Estimate Basis (year) = 2021
Mid point of Construction (year) = 2028

Class V cost estimate to rehabiltiate and replace assets in the Raw Sewage Pump Station as defined in Chapter 4.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Perform Vibration / Cavitation Analysis	1	LS	$ 35,000	$ 35,000
Replace roofing membrane	1	LS	$ 45,000	$ 45,000
Rehabilitate Influent Pumps	5	LS	$ 75,000	$ 375,000
MCC Replacements	0	LS	$ 85,000	$ -
VFD Replacements	5	LS	$ 55,000	$ 275,000
Stand-by RSPS Generator	1	LS	$ 500,000	$ 500,000
PLC Replacement	1	LS	$ 75,000	$ 75,000
Medium Priority - Structural Modifications (per WJE Assessm	1	LS	$ 265,000	$ 265,000
Low Priority - Structural Modifications (per WJE Assessment	0	LS	$ 75,000	$ -
		BASE ASSET COST		**$ 1,570,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	10	%		$ 31,400
Structural / Architectural Allowance (Including Demolition)	0	%		$ -
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	10	%		$ 157,000
Electrical, IC, Programming Allowances	15	%		$ 236,000
Equipment installation	20	%		$ 314,000
Construction contingency	30	%		$ 692,000
		SUBTOTAL DIRECT COST		**$3,000,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 300,000
GC Overhead, Profit, Bonds, Mob	25	%		$ 750,000
City Taxes, other fees	4.5	%		$ 135,000
Cost Escalation to Mid-Point of Construction	3.0	%		
		TOTAL CONSTRUCTION COST		**$4,185,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	15	%		$ 628,000
Owner maintained project contingency	10	%		$ 419,000
			TOTAL PROJECT COST	**$5,232,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Assume underground piping evaluations in general site
2. Grease facilities identified elsewhere
3. Costs for hoists and garage door replacements
4. Assume air compressor included in allowance
5. HVAC improvements included as contingency (and major fans/motors improvements provided as part of HW building)
6. Misc. electrical improvements included as building allowance
7. Structural and coatings identified by WJE Report
8. Lowered the Engineering fees on this as only rehabilitation of efforts
9. Lowered the E,IC assumptions due to large itemized scope items.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Dollars shown will be combined with alternatives from Chapter 5 and included in the implementation plan for Chapter 8.

Esclated $'s	2021	2022	2023	2024	2025	2026
$ 6,435,000	$ -	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ 965,000	$ 5,470,000	$ -	$ -	$ -

carollo

UPDATED:	Dec-20
BY :	JK, LM, BL, BC
CHECKED:	DSP

CLIENT City of Grand Junction -
PROJECT: Asset Replacement Projects (Chapter 4) — Estimate Basis (year) = 2021
Process Area: Primary Sludge Buiding and Clarifiers - Asset Replacements — Mid point of Construction (year) = 2025

Class V cost estimate for the replacement and rehabilitation of the primary clarifiers and primary sludge pumping systems. Additionally, structural improvements have been included as identified by others.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Rebuild / Replace Primary Clarifier Mechanisms	2	EA	$ 300,000	$ 600,000
Replace Sludge Pumps	2	EA	$ 55,000	$ 110,000
Replace plunger-type pumps	2	EA	$ 45,000	$ 90,000
Remove the primary clarifier covers and odor control	2	LS	$ 12,500	$ 25,000
Control Structure No. 1 Improvements - Alternative 1				
Demo Work	1	LS	$ 15,000	$ 15,000
Concrete and Handrail	1	LS	$ 20,000	$ 20,000
Replace existing gates	4	EA	$ 19,000	$ 76,000
High Priority Structural Modifications (per WJE Assessment 2	0	LS	$ 108,000	$ -
Medium Priority Structural Modifications (per WJE Assessme	0	LS	$ 1,870,000	$ -
				$ -
MCC Replacments	0	LS	$ 85,000	$ -
VFD Replacements	2	LS	$ 35,000	$ 70,000
PLC Replacement	0	LS	$ 75,000	$ -
				$ -
		BASE ASSET COST		**$ 1,006,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	10	%		$ 101,000
Structural / Architectural Allowance (Including Demolition)	0	%		$ -
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	10	%		$ 101,000
Electrical, IC, Programming Allowances	25	%		$ 252,000
Equipment installation	20	%		$ 201,200
Construction contingency	30	%		$ 498,000
		SUBTOTAL DIRECT COST		**$2,159,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 215,900
GC Overhead, Profit, Bonds, Mob	25	%		$ 540,000
City Taxes, other fees	4.5	%		$ 97,000
Cost Escalation to Mid-Point of Construction	3.0	%		
		TOTAL CONSTRUCTION COST		**$3,012,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 602,000
Owner maintained project contingency	10	%		$ 301,000
		TOTAL PROJECT COST (2021 $'s)		**$3,915,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER
1. Assume underground piping evaluations in general site
2. Coatings is covered by WJE Report
3. Used ALT 1 for Control Structure 1 Improvements, as higher cost
4. Hoist and water heater assumed in the contingency allowance
HVAC improvements included as contingency
Misc. electrical improvements included as building allowance

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Dollars shown will be combined with alternatives from Chapter 5 and included in the implementation plan for Chapter 8.

Esclated $'s	2021	2022	2023	2024	2025	2026
$ 4,406,000	$ -	$ -	$ -	$ 661,000	$ 3,745,000	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

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		UPDATED:	Dec-20
		BY :	JK, LM, BL, BC
		CHECKED:	DSP
CLIENT	City of Grand Junction -		
PROJECT:	Asset Replacement Projects (Chapter 4)	Estimate Basis (year) =	2021
Process Area:	FEB Mixers - Asset Replacements	Mid point of Construction (year) =	2027

Replacement costs for the floating mixers. This estimate will be carried forward for the implementation plan.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Floating Mixer Replacements	8	LS	$ 35,000	$ 280,000
Allowance for FEB foundation drain valves	1	LS	$ 50,000	$ 50,000
MCC Replacments	0	LS	$ 85,000	$ -
PLC Replacement	0	LS	$ 75,000	$ -
Allowance for Instruments	1	LS	$ 15,000	$ 15,000
			BASE ASSET COST	**$ 345,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	10	%		$ 34,500
Structural / Architectural Allowance (Including Demolition)	10	%		$ 34,500
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Electrical, IC, Programming Allowances	25	%		$ 86,000
Equipment installation	20	%		$ 69,000
Construction contingency	30	%		$ 171,000
			SUBTOTAL DIRECT COST	**$740,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 74,000
GC Overhead, Profit, Bonds, Mob	25	%		$ 185,000
City Taxes, other fees	4.5	%		$ 33,000
Cost Escalation to Mid-Point of Construction	3.0	%		
			TOTAL CONSTRUCTION COST	**$1,032,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	15	%		$ 155,000
Owner maintained project contingency	10	%		$ 103,000
			TOTAL PROJECT COST (2021 $'s)	**$1,290,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Assume underground piping evaluations in general site
2. Influent and effluent gates not included above

No HVAC needed for the basins.

3. FE storm water pump not included

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Dollars shown will be combined with alternatives from Chapter 5 and included in the implementation plan for Chapter 8.

Esclated $'s	2021	2022	2023	2024	2025	2026
$ 1,540,000	$ -	$ -	$ -	$ -	$ -	$ 231,000

2027	2028	2029	2030	2031 - 2040
$ 1,309,000	$ -	$ -	$ -	$ -

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CLIENT City of Grand Junction -
PROJECT: Asset Replacement Projects (Chapter 4) — Estimate Basis (year) = 2021
Process Area: Aeration Basin - Asset Replacements — Mid point of Construction (year) = 2024

Class V cost estimate to replace the existing assets in the aeration basins in the near-term which include mixers, instrumentation, and structural modifications identified by others.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Diffuser Testing, and cleaning	4	EA	$ 15,000	$ 60,000
Air flow control valves, flow meters, actuators, piping	0	EA	$ 45,000	$ -
Aeration Basin mixers	6	EA	$ 15,000	$ 90,000
Replacement of MLR pump (through wall pump)	0	EA	$ 40,000	$ -
Rehabilitate corroded valve stems, gates ,etc	4	EA	$ 15,000	$ 60,000
Replace existing instruments	4	EA	$ 25,000	$ 100,000
Replacement of diffusers (all ceramic membranes)	0	LS	$ 340,000	$ -
MCC Replacments	0	LS	$ 85,000	$ -
PLC Replacement	1	LS	$ 75,000	$ 75,000
VFD Mixer replacment	6	EA	$ 10,000	$ 60,000
High Priority Structural Modifications (per WJE Assessment 2	1	LS	$ 108,000	$ 108,000
Medium Priority Structural Modifications (per WJE Assessme	1	LS	$ 27,000	$ 27,000
Low Priority Structural Modifications (per WJE Assessment 2(	0	LS	$ 3,602,000	$ -
		BASE ASSET COST		**$ 580,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	0	%		$ -
Structural / Architectural Allowance (Including Demolition)	20	%		$ 116,000
Coatings and Finishes	2	%		$ 11,600
Mechanical System Allowance (HVAC, Plumbing, etc)	10	%		$ 58,000
Electrical, IC, Programming Allowances	25	%		$ 145,000
Equipment installation	20	%		$ 116,000
Construction contingency	30	%		$ 308,000
		SUBTOTAL DIRECT COST		**$1,335,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 133,500
GC Overhead, Profit, Bonds, Mob	25	%		$ 334,000
City Taxes, other fees	4.5	%		$ 60,000
Cost Escalation to Mid-Point of Construction	3.0	%		
		TOTAL CONSTRUCTION COST		**$1,863,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 373,000
Owner maintained project contingency	10	%		$ 186,000
		TOTAL PROJECT COST (2021 $'s)		**$2,422,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Assume underground piping evaluations in general site
2. Coatings is covered by WJE Report
3. Hoisting devices not included
4. Sample pumps not included as itemized assumed in allowance
5. No HVAC improvements
6. Misc. electrical improvements included as building allowance

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Dollars shown will be combined with alternatives from Chapter 5 and included in the implementation plan for Chapter 8.

Esclated $'s	2021	2022	2023	2024	2025	2026
$ 2,647,000	$ -	$ -	$ 397,000	$ 2,250,000	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

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UPDATED: Dec-20
BY : JK, LM, BL, BC
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CLIENT City of Grand Junction -
PROJECT: Asset Replacement Projects (Chapter 4) — Estimate Basis (year) = 2021
Process Area: Secondary Sludge Pumping Systems - Asset Replacements — Mid point of Construction (year) = 2034

Class V cost estimate for the replacement of the secondary sludge pumping systems (RAS and WAS) as shown below and described in Chapter 4.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
RAS Pump Replacements	6	EA	$ 65,000	$ 390,000
WAS Pump Replacements	3	EA	$ 35,000	$ 105,000
MCC Replacements	0	LS	$ 85,000	$ -
VFDs (WAS Pumps)	6	EA	$ 35,000	$ 210,000
PLC Replacement	0	LS	$ 75,000	$ -
		BASE ASSET COST		**$ 705,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	0	%		$ -
Structural / Architectural Allowance (Including Demolition)	10	%		$ 70,500
Coatings and Finishes	1	%		$ 7,050
Mechanical System Allowance (HVAC, Plumbing, etc)	20	%		$ 141,000
Electrical, IC, Programming Allowances	30	%		$ 211,500
Equipment installation	20	%		$ 141,000
Construction contingency	30	%		$ 383,000
		SUBTOTAL DIRECT COST		**$1,659,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 165,900
GC Overhead, Profit, Bonds, Mob	25	%		$ 415,000
City Taxes, other fees	4.5	%		$ 75,000
Cost Escalation to Mid-Point of Construction	3.0	%		
		TOTAL CONSTRUCTION COST		**$2,315,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 463,000
Owner maintained project contingency	10	%		$ 232,000
		TOTAL PROJECT COST (2021 $'s)		**$3,010,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Assumes in-kind replacement of existing pumps. Pumps station in current location.

2. No changes to electrical or controls infrastructure for the pumping systems.

3. Increase mechanical allowance to account for improvements to the HVAC systems (AHU's, fans, etc).

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Dollars shown will be combined with alternatives from Chapter 5 and included in the implementation plan for Chapter 8.

Esclated $'s	2021	2022	2023	2024	2025	2026
$ 4,420,000	$ -	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ 4,420,000

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UPDATED: Dec-20
BY : JK, LM, BL, BC
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CLIENT City of Grand Junction -
PROJECT: Asset Replacement Projects (Chapter 4) — Estimate Basis (year) = 2021
Process Area: Secondary Clarifier Improvements - Asset Replacements — Mid point of Construction (year) = 2029

Class V cost estimate for the replacement and revitalization of the secondary clarifier mechanisms and improvements to Control Structure No. 3 as identified in Chapter 4.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
New Clarifier Mechanisms	2	EA	$ 300,000	$ 600,000
Rehabilitate or Refurbish Clarifier No. 4 Mechanism (tow-bro)	1	LS	$ 300,000	$ 300,000
Repair and rehabilitate concrete clarifiers, launders and weirs	3	LS	$ 75,000	$ 225,000
Control Structure No. 3	1	LS	$ 75,000	$ 75,000
			BASE ASSET COST	**$ 1,200,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	0	%		$ -
Structural / Architectural Allowance (Including Demolition)	25	%		$ 300,000
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Electrical, IC, Programming Allowances	15	%		$ 180,000
Equipment installation	20	%		$ 240,000
Construction contingency	30	%		$ 576,000
			SUBTOTAL DIRECT COST	**$2,496,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 249,600
GC Overhead, Profit, Bonds, Mob	25	%		$ 624,000
City Taxes, other fees	4.5	%		$ 112,000
Cost Escalation to Mid-Point of Construction	3.0	%		
			TOTAL CONSTRUCTION COST	**$3,482,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 696,000
Owner maintained project contingency	10	%		$ 348,000
			TOTAL PROJECT COST (2021 $'s)	**$4,526,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER
1. Assumes replace mechanisms with Tow-Bro type of style mechanism
2. Assumed increased structural allowance for center-well modificaitons (specifically)on two original clarifiers
3. Assume in-kind replacement and no significant electrical / IC improvements required.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Dollars shown will be combined with alternatives from Chapter 5 and included in the implementation plan for Chapter 8.

Esclated $'s	2021	2022	2023	2024	2025	2026
$ 5,733,000	$ -	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ 860,000	$ 4,873,000	$ -	$ -

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UPDATED: Dec-20
BY : JK, LM, BL, BC
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CLIENT City of Grand Junction -
PROJECT: Asset Replacement Projects (Chapter 4) — Estimate Basis (year) = 2021
Process Area: Disinfection Area - Asset Revitilization Projects — Mid point of Construction (year) = 2035

Class V cost estimate for asset replacement and rehabiliation needs for the UV disinfection system as identified in Chapter 4.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Replacement of UV System (> 2025)	1	LS	$ 700,000	$ 700,000
Rehab and repalcement of gates, concrete, (>2025)	1	LS	$ 32,000	$ 32,000
Allowance for plant water pumping systems (> 2025)	4	EA	$ 35,000	$ 140,000
Effluent Flow monitoring improvements	1	LS	$ 25,000	$ 25,000
CFD Modeling for Hydraulic Modificaitons	1	LS	$ 20,000	$ 20,000
Hydraulic Improvements for flow conditioning	1	LS	$ 50,000	$ 50,000
MCC Replacments	1	LS	$ 85,000	$ 85,000
VFD Replacements (plant water)	4	EA	$ 35,000	$ 140,000
PLC Replacement	2	LS	$ 75,000	$ 150,000
			BASE ASSET COST	**$ 1,342,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	10	%		$ 134,200
Structural / Architectural Allowance (Including Demolition)	10	%		$ 134,200
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	10	%		$ 134,000
Electrical, IC, Programming Allowances	25	%		$ 336,000
Equipment installation	20	%		$ 268,400
Construction contingency	30	%		$ 705,000
			SUBTOTAL DIRECT COST	**$3,054,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 305,400
GC Overhead, Profit, Bonds, Mob	25	%		$ 764,000
City Taxes, other fees	4.5	%		$ 137,000
Cost Escalation to Mid-Point of Construction	3.0	%		
			TOTAL CONSTRUCTION COST	**$4,260,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 852,000
Owner maintained project contingency	10	%		$ 426,000
			TOTAL PROJECT COST (2021 $'s)	**$5,538,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. City installing generator for UV system in 2021 (not included above).
2. PLC replacements for the UV system and for the plant water system

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Dollars shown will be combined with alternatives from Chapter 5 and included in the implementation plan for Chapter 8.

Esclated $'s	2021	2022	2023	2024	2025	2026
$ 8,377,000	$ -	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ 8,377,000

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UPDATED: Dec-20
BY : JK, LM, BL, BC
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CLIENT City of Grand Junction -
PROJECT: Asset Replacement Projects (Chapter 4) — Estimate Basis (year) = 2021
Process Area: Anaerobic Digestion — Mid point of Construction (year) = 2023

Class V Cost Estimate for anaerobic digestion improvements to replace existing assets and to conver from secondary anearobic digestion to a primary anaerobic process. Project scope is in-kind asset replacements for the anaerobic digestion system. The assumptions include digester cover and mixing to convert anaerobic digester operations to be in parallel instead of series.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Digester Cover Replacement	1	LS	$ 320,000	$ 320,000
Heat Exchanger (>2025)	2	LS	$ 125,000	$ 250,000
Replace sludge transfer pumps	2	EA	$ 55,000	$ 110,000
Replace recirculation pumps	2	EA	$ 55,000	$ 110,000
Replace communitors	2	EA	$ 45,000	$ 90,000
Replace secondary digester mixing with linear motion mixer	1	LS	$ 230,000	$ 230,000
Replace boilers and hot water system	2	EA	$ 120,000	$ 240,000
Modify sludge piping	1	EA	$ 75,000	$ 75,000
High Priority Structural Modifications (per WJE Assessment 20	1	LS	$ 185,000	$ 185,000
Medium Priority Structural Modifications (per WJE Assessmen	0	LS		$ -
Low Priority Structural Modifications (per WJE Assessment 20	0	LS	$ 855,000	$ -
MCC Replacments	0	LS	$ 85,000	$ -
VFD Replacements (Sludge Tranfer Pumps)	2	LS	$ 25,000	$ 50,000
PLC Replacement	0	LS	$ 75,000	$ -
			BASE ASSET COST	**$ 1,660,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	10	%		$ 166,000
Structural / Architectural Allowance (Including Demolition)	20	%		$ 332,000
Coatings and Finishes	10	%		$ 166,000
Mechanical System Allowance (HVAC, Plumbing, etc)	10	%		$ 166,000
Electrical, IC, Programming Allowances	20	%		$ 332,000
Equipment installation	20	%		$ 332,000
Construction contingency	30	%		$ 946,000
			SUBTOTAL DIRECT COST	**$ 4,100,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 410,000
GC Overhead, Profit, Bonds, Mob	25	%		$ 1,025,000
City Taxes, other fees	4.5	%		$ 185,000
Cost Escalation to Mid-Point of Construction	3.0	%		
			TOTAL CONSTRUCTION COST	**$5,720,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 1,144,000
Owner maintained project contingency	10	%		$ 572,000
			TOTAL PROJECT COST (2021 $'s)	**$7,436,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Dollars shown will be combined with alternatives from Chapter 5 and included in the implementation plan for Chapter 8.

Esclated $'s	2021	2022	2023	2024	2025	2026
$ 7,889,000	$ -	$ 1,183,000	$ 6,706,000	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

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UPDATED:	Dec-20
BY :	JK, LM, BL, BC
CHECKED:	DSP

CLIENT	City of Grand Junction -		
PROJECT:	Asset Replacement Projects (Chapter 4)	Estimate Basis (year) =	2021
Process Area:	Aerobic Digestion - Assets	Mid point of Construction (year) =	2027

Class V cost estimate for aerobic digestion asset renewals. Estimate is used for evaluate costs for the baseline condition, as discussed in Chapter 4. These asset renewal and replacement elements were not carried forward for implementation in Chapter 8.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Replace Blowers (100HP)	3	EA	$ 115,000	$ 345,000
Replace aeration system	4	EA	$ 50,000	$ 200,000
Sludge Tranfers Pumps	4	EA	$ 35,000	$ 140,000
Replace mixing system	8	EA	$ 18,000	$ 144,000
MCC Replacments	1	LS	$ 85,000	$ 85,000
VFD Replacements (Sludge transfer pumps)	2	EA	$ 15,000	$ 30,000
PLC Replacement	0	LS	$ 75,000	$ -
		BASE ASSET COST		**$ 944,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	0	%		$ -
Structural / Architectural Allowance (Including Demolition)	20	%		$ 188,800
Coatings and Finishes	10	%		$ 94,400
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Electrical, IC, Programming Allowances	20	%		$ 189,000
Equipment installation	20	%		$ 188,800
Construction contingency	30	%		$ 482,000
		SUBTOTAL DIRECT COST		**$2,087,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 208,700
GC Overhead, Profit, Bonds, Mob	25	%		$ 522,000
City Taxes, other fees	4.5	%		$ 94,000
Cost Escalation to Mid-Point of Construction		%		$ -
		TOTAL CONSTRUCTION COST		**$2,912,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 582,000
Owner maintained project contingency	10	%		$ 291,000
		TOTAL PROJECT COST (2021 $'s)		**$3,785,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Replacement of assets in-kind (same size / MFR) as existing. Assumed minimal electrical and IC changes.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Dollars shown will be combined with alternatives from Chapter 5 and included in the implementation plan for Chapter 8.

Esclated $'s	2021	2022	2023	2024	2025	2026
$ 3,785,000	$ -	$ -	$ -	$ -	$ -	$ 568,000

2027	2028	2029	2030	2031 - 2040
$ 3,217,000	$ -	$ -	$ -	$ -

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UPDATED:	Dec-20
BY :	JK, LM, BL, BC
CHECKED:	DSP

CLIENT City of Grand Junction -
PROJECT: Asset Replacement Projects (Chapter 4)
Process Area: Dissolved Air Floatation Assets

Estimate Basis (year) = 2021
Mid point of Construction (year) = 2032

Class V cost estimate for future replacement of the DAFT infrastructure. Costs will be included in the implementation plan, Chapter 8.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Replace DAF mechanical components	1	EA	$ 460,000	$ 460,000
Replace DAF effluent solids pumps	1	EA	$ 45,000	$ 45,000
		BASE ASSET COST		**$ 505,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	0	%		$ -
Structural / Architectural Allowance (Including Demolition)	10	%		$ 50,500
Coatings and Finishes	5	%		$ 25,250
Mechanical System Allowance (HVAC, Plumbing, etc)	10	%		$ 51,000
Electrical, IC, Programming Allowances	20	%		$ 101,000
Equipment installation	20	%		$ 101,000
Construction contingency	30	%		$ 250,000
		SUBTOTAL DIRECT COST		**$1,084,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 108,400
GC Overhead, Profit, Bonds, Mob	25	%		$ 271,000
City Taxes, other fees	4.5	%		$ 49,000
Cost Escalation to Mid-Point of Construction	3.0	%		$ 45,000
		TOTAL CONSTRUCTION COST		**$1,557,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 311,000
Owner maintained project contingency	10	%		$ 156,000
		TOTAL PROJECT COST (2021 $'s)		**$2,024,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Assume replacement of mechanical components
2. DAFT replacements will be after 2030.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Dollars shown will be combined with alternatives from Chapter 5 and included in the implementation plan for Chapter 8.

Esclated $'s	2021	2022	2023	2024	2025	2026
$ 2,802,000	$ -	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ 2,802,000

carollo

UPDATED:	Dec-20
BY :	JK, LM, BL, BC
CHECKED:	DSP

CLIENT	City of Grand Junction -		
PROJECT:	Asset Replacement Projects (Chapter 4)	Estimate Basis (year) =	2021
Process Area:	Biogas System Assets	Mid point of Construction (year) =	2035

Class V cost estimate to project the asset renewal costs for rehabiltiation of the existing 100cfm biogas treatment system.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Asset Renwals for biogas system	0.4	LS	$ 1,344,000	$ 538,000
			BASE ASSET COST	**$ 538,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	10	%		$ 53,800
Structural / Architectural Allowance (Including Demolition)	10	%		$ 53,800
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Electrical, IC, Programming Allowances	10	%		$ 54,000
Equipment installation	20	%		$ 107,600
Construction contingency	30	%		$ 242,000
			SUBTOTAL DIRECT COST	**$1,049,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 104,900
GC Overhead, Profit, Bonds, Mob	25	%		$ 262,000
City Taxes, other fees	4.5	%		$ 47,000
Cost Escalation to Mid-Point of Construction	3.0	%		$ 44,000
			TOTAL CONSTRUCTION COST	**$1,507,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 301,000
Owner maintained project contingency	10	%		$ 151,000
			TOTAL PROJECT COST (2021 $'s)	**$1,959,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Assumed replacement of 40% original skid unit. Further condition assessments should be conducted to determine actual.

2. Assumed engineering support would be needed; however, the City could replace and purchase parts independently.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*

Dollars shown will be combined with alternatives from Chapter 5 and included in the implementation plan for Chapter 8.

Esclated $'s	2021	2022	2023	2024	2025	2026
$ 2,963,000	$ -	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ 2,963,000

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UPDATED:	Dec-20
BY :	JK, LM, BL, BC
CHECKED:	DSP

CLIENT	City of Grand Junction -		
PROJECT:	Asset Replacement Projects (Chapter 4)	Estimate Basis (year) =	2021
Process Area:	Belt Filter Press Dewatering Equipment	Mid point of Construction (year) =	2025

Class V cost estimate for Dewatering asset renewals and replacements. This estimate is used for comparitive analysis as described in Chapter 4. This option was not carried forward int the final implementation plan, as discussed in Chapter 8.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Replace existing BFP	4	EA	$ 185,000	$ 740,000
Replace conveyors	2	EA	$ 135,000	$ 270,000
Replace the sludge feed pumps	4	EA	$ 45,000	$ 180,000
Replace existing polymer feed pumps, storage, pumping, cont	1	LS	$ 320,000	$ 320,000
				$ -
MCC Replacments	0	LS	$ 85,000	$ -
VFD Replacement for sludge feed pumps	4	EA	$ 25,000	$ 100,000
PLC Replacement	1	LS	$ 75,000	$ 75,000
High Priority Structural Modifications (per WJE Assessment 20	0	LS		$ -
Medium Priority Structural Modifications (per WJE Assessmen	1	LS	$ 5,500	$ 6,000
Low Priority Structural Modifications (per WJE Assessment 20	1	LS	$ 258,000	$ 258,000
				$ -
		BASE ASSET COST		**$ 1,949,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	15	%		$ 292,350
Structural / Architectural Allowance (Including Demolition)	20	%		$ 389,800
Coatings and Finishes	5	%		$ 97,450
Mechanical System Allowance (HVAC, Plumbing, etc)	20	%		$ 390,000
Electrical, IC, Programming Allowances	25	%		$ 487,000
Equipment installation	35	%		$ 682,150
Construction contingency	30	%		$ 1,286,000
		SUBTOTAL DIRECT COST		**$5,574,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 557,400
GC Overhead, Profit, Bonds, Mob	25	%		$ 1,394,000
City Taxes, other fees	4.5	%		$ 251,000
Cost Escalation to Mid-Point of Construction	3.0	%		
		TOTAL CONSTRUCTION COST		**$7,776,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 1,555,000
Owner maintained project contingency	10	%		$ 778,000
		TOTAL PROJECT COST (2021 $'s)		**$10,109,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Increased allowances for in-kind replacements
2. HVAC improvements included as allowance
3. Miscellaneous coatings included with the allowance above.
4. Structural and coatings identified by WJE Report
5. Assume dewater cake storage hopper - corrosion and ventilation included as contingency
6. Increased equipment installation due to sequencing factors.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Dollars shown will be combined with alternatives from Chapter 5 and included in the implementation plan for Chapter 8.

Esclated $'s	2021	2022	2023	2024	2025	2026
$ 11,378,000	$ -	$ -	$ -	$ 1,707,000	$ 9,671,000	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

carollo

UPDATED:	Dec-20
BY :	JK, LM, BL, BC
CHECKED:	DSP

CLIENT	City of Grand Junction -		
PROJECT:	Asset Replacement Projects (Chapter 4)	Estimate Basis (year) =	2021
Process Area:	Sludge Blend Tank Assets	Mid point of Construction (year) =	2027

Class V cost estimate to replace assets in the sludge blend tank.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Sludge Blending Tank coatings and corrosion improvements	1	LS	$ 100,000	$ 100,000
Sludge blending tank mixer replacements (or rehabilitation)	1	LS	$ 75,000	$ 75,000
Piping / modification to sludge flow stream	1	LS	$ 75,000	$ 75,000
			BASE ASSET COST	**$ 250,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	10	%		$ 25,000
Structural / Architectural Allowance (Including Demolition)	10	%		$ 25,000
Coatings and Finishes	25	%		$ 62,500
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Electrical, IC, Programming Allowances	25	%		$ 63,000
Equipment installation	20	%		$ 50,000
Construction contingency	30	%		$ 143,000
			SUBTOTAL DIRECT COST	**$619,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 61,900
GC Overhead, Profit, Bonds, Mob	25	%		$ 155,000
City Taxes, other fees	4.5	%		$ 28,000
Cost Escalation to Mid-Point of Construction	3.0	%		$ 26,000
		TOTAL CONSTRUCTION COST		**$890,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 178,000
Owner maintained project contingency	10	%		$ 89,000
		TOTAL PROJECT COST (2021 $'s)		**$1,157,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Timing of this work is dependent on the decision to convert digestion process to full anaerobic treatment.

2. This project may not be needed depending on the converstion of the aerobic digesters to mixing/solids storage.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Dollars shown will be combined with alternatives from Chapter 5 and included in the implementation plan for Chapter 8.

Esclated $'s	2021	2022	2023	2024	2025	2026
$ 1,382,000	$ -	$ -	$ -	$ -	$ -	$ 207,000

2027	2028	2029	2030	2031 - 2040
$ 1,175,000	$ -	$ -	$ -	$ -

Appendix D

ALTERNATIVE CAPITAL COSTS

APPENDIX D - CAPITAL COST ESTIMATES FOR ALTERNATIVES

carollo

UPDATED:	Dec-20
BY :	JK, LM, BL, BC
CHECKED:	DSP

CLIENT: City of Grand Junction
PROJECT : 2020 Persigo WWTP Master Plan
Process: Estimating Assumptions

Estimate Basis (year) = 2021
Mid point of Construction = 2021

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	10			
Structural / Archectural Allowance (could be demo also)	10	%		
Building Coatings and Finishes	1	%		
Mechanical System Allowance (HVAC, Plumbing, etc)	10	%		
Electrical, IC, Programming Allowances	25	%		
Equipment installation	20	%		
Construction contingency	30	%		
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		
GC Overhead, Profit, Bonds, Mob	25	%		
City Taxes, other fees	5	%		
Annual Inflation	3	%		
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		
Owner maintained project contingency	10	%		

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UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT: City of Grand Junction
PROJECT: HW ALTERNATIVE 1- Screening Capacity Expansion — Estimate Basis (year) = 2021
Process Area: Headworks Facility - Alternative Evaluations — Mid point of Construction (year) = 2021

Alternative 1 - Increase screening reliability by adding a third step screen and redundancy for conveyance and screenings washing. The Class V cost estimate includes asset revitalization projects, for the Headworks as identified in Chapter 4. These costs are shown in 2021 dollars as to compare baseline alternative.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Baseline - Chapter 4 Asset Revitalization Direct Costs	1	LS	$ 1,365,000	$ 1,365,000
Add 3rd Step Screen, conveyor, and washer/compactor				
Step screen, sluice channel conveyor, addition of second	1	LS	$ 600,000	$ 600,000
		EQUIPMENT AND DIRECT COSTS		**$ 1,965,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	10	%		$ 196,500
Structural / Architectural Allowance (Including Demolition)	10	%		$ 196,500
Coatings and Finishes	5	%		$ 98,250
Mechanical System Allowance (HVAC, Plumbing, etc)	10	%		$ 197,000
Electrical, IC, Programming Allowances	25	%		$ 491,250
Construction contingency	30	%		$ 1,061,000
		SUBTOTAL DIRECT COST		**$ 4,599,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 196,500
GC Overhead, Profit, Bonds, Mob	25	%		$ 1,150,000
City Taxes, other fees	4.5	%		$ 207,000
Cost Escalation to Mid-Point of Construction	3	%		
		TOTAL CONSTRUCTION COST		**$ 6,153,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 1,231,000
Owner maintained project contingency	10	%		$ 615,000
		TOTAL PROJECT COST (2021 $'s)		**$ 8,000,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. A future passive by-pass when all three step screens are installed was not included(assumed after 2030).
2. Electrical supply and power supplied assumed sufficient for additional infrastructure.
3. Assumed existing building provides sufficent space for third step-screen.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Sequencing of expenditures used for CIP planning based on project milestone (design, construction)

	Escalated $'s	2021	2022	2023	2024	2025	2026
Fraction of cost per year		1.00	0.00	0.00	0.00	0.00	0.00
	$ 8,000,000	$ 8,000,000	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

carollo

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT City of Grand Junction - 2020 Persigo WWTP Master Plan
PROJECT: HW Alternative 2 - Enhanced Grit Washing — Estimate Basis (year) = 2021
Process Area: Headworks Facility — Mid point of Construction (year) = 2021

Alternative 2 - Includes the costs from the Baseline Condition and the costs developed for the third step-screen (Alternative 1). Class V cost estimate shown in 2021 dollars to provide comparison between alternatives.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Baseline - Chapter 4 Asset Revitalization Direct Costs	1	LS	$ 1,365,000	$ 1,365,000
Alternative 1 - 3rd Step Screen Direct Costs	1	LS	$ 600,000	$ 600,000
Grit Washing				
Replace with two (2) Coanda Units	2	EA	$ 165,000	$ 330,000
Deduct for existing washer replacement (baseline)	2	EA	$ (115,000)	$ (230,000)
				$ -
		EQUIPMENT AND DIRECT COSTS		**$ 2,065,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	10	%		$ 206,500
Structural / Architectural Allowance (Including Demolition)	10	%		$ 206,500
Coatings and Finishes	5	%		$ 103,250
Electrical, IC, Programming Allowances	25	%		$ 516,250
Equipment installation	20	%		$ 413,000
Construction contingency	30	%		$ 1,115,000
		SUBTOTAL DIRECT COST		**$ 4,833,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 483,300
GC Overhead, Profit, Bonds, Mob	25.0	%		$ 1,208,000
City Taxes, other fees	4.5		%	$ 217,000
Cost Escalation to Mid-Point of Construction	3			
		TOTAL CONSTRUCTION COST		**$ 6,741,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 1,348,000
Owner maintained project contingency	10	%		$ 674,000
		TOTAL PROJECT COST (2021 $'s)		**$ 8,760,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. City may want a future passive by-pass when all three step screens are installed (assumed after 2030).
2. Electrical supply and power supplied assumed sufficient for additional infrastructure.
3. Assumed existing building provides sufficent space for third step-screen.
4. Grit testing should be completed prior to decision on new grit washing compacting equipment.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Sequencing of project expenditures used for CIP implementation plan in Chapter 8.

	Escalated $'s	2021	2022	2023	2024	2025	2026
Fraction of cost per year		1.00	0.00	0.00	0.00	0.00	0.00
	$ 8,760,000	$ 8,760,000	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

carollo

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT City of Grand Junction
PROJECT: PC Alternative 1 - Chemically Enhanced Primary Treatment — Estimate Basis (year) = 2021
Process Area: Primary Clarification — Mid point of Construction (year) = 2021

Primary Clarification Alternative 1 - Assessment of CEPT is to improve primary clarifier BOD/TSS removal to reduce expansion for activated sludge process. Class V Estimate for a Chemical Additional Facility for CEPT. Costs used for Alternative Comparison as discussed in Chapter 5.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Baseline - Chapter 4 Primary Clarifier Asset Revitalization	1	LS		$ 1,006,000
Chemical Feed Facility (3,600sf) Facility	1	LS	$ 1,600,000	$ 1,600,000
Site Civil/Yard Piping allowance	1	LS	$ 250,000	$ 250,000
Site Electrical Allowance	1	LS	$ 750,000	$ 750,000
		EQUIPMENT AND DIRECT COSTS		**$ 3,606,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	0	LS		$ -
Structural / Architectural Allowance (Including Demolition)	10	%		$ 360,600
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Electrical, IC, Programming Allowances	20	%		$ 721,200
Equipment installation	0	%		$ -
Construction contingency	30	%		$ 1,406,000
		SUBTOTAL DIRECT COST		**$6,094,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 609,400
GC Overhead, Profit, Bonds, Mob	25	%		$ 1,524,000
City Taxes, other fees	4.5	%		$ 274,000
Cost Escalation to Mid-Point of Construction	3	%		
		TOTAL CONSTRUCTION COST		**$8,501,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 1,700,000
Owner maintained project contingency	10	%		$ 850,000
		TOTAL PROJECT COST (2021 $'s)		**$11,050,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Need to confirm electrical capacity. Included an allowance for site electrical in the event new switchgear needed.
2. Included allowance for site civil and yard piping connections
3. NPV analysis with chemicals included in Chapter 5 discussion (see comparison under Secondary Treatment)

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above. Sequencing of project expenditures used for CIP implementation plan in Chapter 8.*

Escalated $'s	2021	2022	2023	2024	2025	2026
	1.00	0.00	0.00	0.00	0.00	0.00
$ 11,050,000	$ 11,050,000	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

carollo

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT City of Grand Junction
PROJECT: PC Alternative 2 - Addition of Third Primary Clarifier — Estimate Basis (year) = 2021
Process Area: Primary Clarification — Mid point of Construction (year) = 2021

Alternative 2 - Includes the direct costs from the Baseline Asset Revitalization (Chapter 4) and the additional scope and work for a third primary clarifier. The addition of third primary clarifier meets the City's reliability and redundancy objectives when upgrading one of the existing clarifiers. Estimate does not include the addition of CEPT (Alternative 1)

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Baseline - Chapter 4 Primary Clarifier Asset Revitalization	1	LS		$ 1,006,000
Primary Clarifier No.3	1	LS	$ 2,620,000	$ 2,620,000
Site Construction, concrete, metals, finishes, equipment, mechanical, electrical				
			EQUIPMENT AND DIRECT COSTS	**$ 3,626,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	10	%		$ 362,600
Structural / Architectural Allowance (Including Demolition)	0	%		$ -
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Electrical, IC, Programming Allowances	10	%		$ 362,600
Equipment installation	0	%		$ -
Construction contingency	30	%		$ 1,305,000
			SUBTOTAL DIRECT COST	**$5,656,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 565,600
GC Overhead, Profit, Bonds, Mob	25	%		$ 1,414,000
City Taxes, other fees	4.5	%		$ 255,000
Cost Escalation to Mid-Point of Construction	3	%		
			TOTAL CONSTRUCTION COST	**$7,891,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 1,578,000
Owner maintained project contingency	10	%		$ 789,000
			TOTAL PROJECT COST (2021 $'s)	**$10,260,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Added allows for site civil and yard piping.

2. Assume existing primary sludge pumping building has adequate space and electrical feed for additional primary clarifier.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above. Sequencing of project expenditures used for CIP implementation plan in Chapter 8.*

Escalated $'s	2021	2022	2023	2024	2025	2026
	1.00	0.00	0.00	0.00	0.00	0.00
$ 10,260,000	$ 10,260,000	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

APPENDIX D - CAPITAL COST ESTIMATES FOR ALTERNATIVES

carollo

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT City of Grand Junction
PROJECT: Flow Equalization Basin - Alternative 1 New Mixing System — Estimate Basis (year) = 2021
Process Area: Flow Equalization Basin — Mid point of Construction (year) = 2021

FEB- ALTERNATIVE 1 - Using large bubble mixing system could increase capacity of FEB basins and improve mixing performance. Class V cost estimate to install coarse bubble diffusers in the FEB basins. Compressed air blowers would be installed in existing FEB building. Project was not carried forward into the implementation plan.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Coarse Bubble Diffsuers / Aeration System	1	LS	$ 2,745,000	$ 2,745,000
Allowance for FEB foundation drain valves	1	LS	$ 50,000	$ 50,000
MCC Replacments	0	LS	$ 85,000	$ -
PLC Replacement	0	LS	$ 75,000	$ -
Allowance for Instruments	1	LS	$ 15,000	$ 15,000
		EQUIPMENT AND DIRECT COSTS		**$ 2,810,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	10	%		$ 281,000
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Electrical, IC, Programming Allowances	10	%		$ 281,000
Equipment installation	10	%		$ 281,000
Construction contingency	30	%		$ 1,180,000
		SUBTOTAL DIRECT COST		**$5,114,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 511,400
GC Overhead, Profit, Bonds, Mob	25	%		$ 1,279,000
City Taxes, other fees	4.5	%		$ 230,000
Cost Escalation to Mid-Point of Construction	3	%		
		TOTAL CONSTRUCTION COST		**$7,134,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	15	%		$ 1,070,000
Owner maintained project contingency	10	%		$ 713,000
		TOTAL PROJECT COST (2021 $'s)		**$8,920,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Added allows for site civil and yard piping.
2. Assume existing primary sludge pumping building has adequate space and electrical feed for additional primary clarifier.
3. Assume additional electrical capacity would be same or less as baseline (mixer replacement).

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above. Sequencing of project expenditures used for CIP implementation plan in Chapter 8.*

Escalated $'s	2021	2022	2023	2024	2025	2026
	1.00	0.00	0.00	0.00	0.00	0.00
$ 8,920,000	$ 8,920,000	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

carollo

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT City of Grand Junction
PROJECT: AB Baseline Condition - Asset Revitalization & Expansion — Estimate Basis (year) = 2021
Process Area: Secondary Treatment — Mid point of Construction (year) = 2021

Aeration Basin - Baseline condition includes asset replacements, as identified in Chapter 4, and additional activiated sludge volume (1 train = 1.6mgd). The additional activated sludge volume provides additional capacity that may be needed after 2035, and provides operational reliability and redundancy to have 1 unit off-line for maintenance. Class V level cost estimate.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Aeration Basin - Asset Revitalization Costs (Chapter 4)	1	LS		$ 580,000
Additional Aeration Basin Volume go from 12.5 to 13.5mgd Concrete, equipment for aeration, site/civil misc metals, diffusers, mixers, pumping,	1.6	MG	$ 2,500,000	$ 4,000,000
		EQUIPMENT AND DIRECT COSTS		**$ 4,580,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	1	LS		$ 350,000
Structural / Architectural Allowance (Including Demolition)	10	%		$ 458,000
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Electrical, IC, Programming Allowances	21	%		$ 976,000
Equipment installation	0	%		$ -
Construction contingency	30	%		$ 1,909,000
		SUBTOTAL DIRECT COST		**$8,273,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 827,300
GC Overhead, Profit, Bonds, Mob	25	%		$ 2,068,000
City Taxes, other fees	4.5	%		$ 372,000
Cost Escalation to Mid-Point of Construction	3	%		
		TOTAL CONSTRUCTION COST		**$11,540,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 2,308,000
Owner maintained project contingency	10	%		$ 1,154,000
		TOTAL PROJECT COST (2021 $'s)		**$15,000,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Electrical capacity upgrades assumed to be included in the new Blower Building, if needed.
2. Yard piping allowances included, assumed existing RAS/WAS pumping maintained in current locations.
3. Site electrical and site civil allowances were provided as allowance.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above. Sequencing of project expenditures used for CIP implementation plan in Chapter 8.*

Escalated $'s	2021	2022	2023	2024	2025	2026
	1.00	0.00	0.00	0.00	0.00	0.00
$ 15,000,000	$ 15,000,000	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

carollo

UPDATED:	Dec-20
BY :	JK, LM, BL, BC
CHECKED:	DSP

CLIENT City of Grand Junction
PROJECT: AB Alternative 1 - CEPT and Asset Revitalization — Estimate Basis (year) = 2021
Process Area: Aeration Basin — Mid point of Construction (year) = 2021

Aeration Basin - Alternative 1 Cost Summary shows the anticipated costs for the aeration basin asset revitalization program as described in Chapter 4 and includes the capital infrastructure for a new CEPT facility to be constructed adjacent to the Primary Clarifiers. Does not include costs for redundancy in the activated sludge process (which is provided in the baseline condition).

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Baseline Condition - Aeration Basins Asset Revitalization (C	1	LS		$ 580,000
Chemical Feed Facility (3,600sf) Facility	1	LS	$ 1,600,000	$ 1,600,000
Site Civil/Yard Piping allowance	1	LS	$ 250,000	$ 250,000
Site Electrical Allowance	1	LS	$ 750,000	$ 750,000
		EQUIPMENT AND DIRECT COSTS		**$ 3,180,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	0	%		$ -
Structural / Architectural Allowance (Including Demolition)	10	%		$ 318,000
Coatings and Finishes	5	%		$ 143,100
Mechanical System Allowance (HVAC, Plumbing, etc)	5	%		$ 143,000
Electrical, IC, Programming Allowances	20	%		$ 636,000
Equipment installation	0	%		$ -
Construction contingency	30	%		$ 1,326,000
		SUBTOTAL DIRECT COST		**$5,746,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 574,600
GC Overhead, Profit, Bonds, Mob	25	%		$ 1,437,000
City Taxes, other fees	4.5	%		$ 259,000
Cost Escalation to Mid-Point of Construction	3	%		
		TOTAL CONSTRUCTION COST		**$8,017,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 1,603,000
Owner maintained project contingency	10	%		$ 802,000
		TOTAL PROJECT COST (2021 $'s)		**$10,420,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Need to validate the electrical capacity. Included an allowance for site electrical if expansion needed.

2. Included allowance for site civil and yard piping connections

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*

Sequencing of project expenditures used for CIP implementation plan in Chapter 8.

Escalated $'s	2021	2022	2023	2024	2025	2026
	1.00	0.00	0.00	0.00	0.00	0.00
$ 10,420,000	$ 10,420,000	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

carollo

UPDATED:	Dec-20
BY :	JK, LM, BL, BC
CHECKED:	DSP

CLIENT City of Grand Junction - 2020 Persigo WWTP Master Plan
PROJECT: AB Alternative 2 - Baseline Condition with Advanced Control — Estimate Basis (year) = 2021
Process Area: Secondary Treatment — Mid point of Construction (year) = 2021

Aeration Basin - Alternative 2: Baseline Condition with advanced SRT/Aeration control for the aeration basins. A NPV analysis was completed for this alternative, as documented in Chapter 5. Evaluation does include costs for an activated sludge basin expansion to provide redundancy and reliability goals of the City by providing an N+1 configuraiton for the future. Cost estimate includes baseline asset replacement needs in addition to costs for the SRT controls improvements.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
SRT & Aeration control programs	1	LS	$ 175,000	$ 175,000
Aeration Basin - Asset Revitalization Costs (Chapter 4)	1	LS		$ 580,000
Additional Aeration Basin Volume go from 12.5 to 13.5mgd	1.6	MG	$ 2,500,000	$ 4,000,000
Concrete, equipment for aeration, site/civil, misc metals, diffusers, mixers, pumping,				
			EQUIPMENT AND DIRECT COSTS	**$ 4,755,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	1	LS		$ 350,000
Structural / Architectural Allowance (Including Demolition)	10	%		$ 475,500
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Equipment installation	0	%		$ -
Construction contingency	30	%		$ 1,988,000
			SUBTOTAL DIRECT COST	**$8,615,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 861,500
GC Overhead, Profit, Bonds, Mob	25	%		$ 2,154,000
City Taxes, other fees	4.5	%		$ 388,000
Cost Escalation to Mid-Point of Construction	3	%		
			TOTAL CONSTRUCTION COST	**$12,019,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 2,404,000
Owner maintained project contingency	10	%		$ 1,202,000
			TOTAL PROJECT COST (2021 $'s)	**$15,630,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Assume underground piping evaluations in general site
2. Coatings is covered by WJE Report
3. Hoisting devices not included
4. Sample pumps not included as itemized assumed in allowance
5. Building mechanical and building electrical included in allowance above.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Sequencing of project expenditures used for CIP implementation plan in Chapter 8.

Escalated $'s	2021	2022	2023	2024	2025	2026
	1.00	0.00	0.00	0.00	0.00	0.00
$ 15,630,000	$ 15,630,000	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

carollo

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT City of Grand Junction - 2020 Persigo WWTP Master Plan
PROJECT: New Blower Building — Estimate Basis (year) = 2021
Process Area: Secondary Treatment — Mid point of Construction (year) = 2021

Common Improvement for Secondary Treatment - A new blower building with new blowers improves the operational environment and optimizes energy use. The new blower building provides additional space for expansions to activiated sludge pumping. The new blower building would be sized to accomodate 2040 flow and loading conditions and includes electrical and controls room with environmental controls. Estimate provided is a Class V level estimate.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
New Blower Building (2,100 SF)	1	LS	$ 4,250,000	$ 4,250,000
Building, blowers, piping, equipment				
Structural, arch, building mechanical,				
New Electrical Switchgear for Blower Facility	1	LS	$ 750,000	$ 750,000
			EQUIPMENT AND DIRECT COSTS	**$ 5,000,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	1	LS		$ 250,000
Structural / Architectural Allowance (Including Demolition)	0	%		$ -
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Electrical, IC, Programming Allowances	0	%		$ -
Equipment installation	0	%		$ -
Construction contingency	30	%		$ 1,575,000
			SUBTOTAL DIRECT COST	**$6,825,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 682,500
GC Overhead, Profit, Bonds, Mob	25	%		$ 1,706,000
City Taxes, other fees	4.5	%		$ 307,000
Cost Escalation to Mid-Point of Construction	3	%		
			TOTAL CONSTRUCTION COST	**$9,521,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 1,904,000
Owner maintained project contingency	10	%		$ 952,000
			TOTAL PROJECT COST (2021 $'s)	**$12,380,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Assume new switchgear would be needed as part of the site civil. May be possible to re-route from existing in new duct bank.
2. Assume RAS/WAS piping remains as currently installed.
3. Site allowances included for civil preparation and routing of air piping to existing basin headers.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Sequencing of project expenditures used for CIP implementation plan in Chapter 8.

Escalated $'s	2021	2022	2023	2024	2025	2026
	1.00	0.00	0.00	0.00	0.00	0.00
$ 12,380,000	$ 12,380,000	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

APPENDIX D - CAPITAL COST ESTIMATES FOR ALTERNATIVES

carollo

UPDATED:	Dec-20
BY :	JK, LM, BL, BC
CHECKED:	DSP

CLIENT	City of Grand Junction - 2020 Persigo WWTP Master Plan		
PROJECT:	Secondary Clarifier Expansion (#4)	Estimate Basis (year) =	2021
Process Area:	Secondary Treatment	Mid point of Construction (year) =	2021

Common Improvement - The fourth clarifier provides operational redundancy and reliability when taking existing clarifiers off-line for mechanism replacement. This meet's the City's requirements to have an N+1 configuration for reliability and redundancy. Estimate is a Class V level estimate.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Additional Secondary Clarifier with equipment, concrete, coatings, electrical/IC	1	EA	$ 2,000,000	$ 2,000,000
		EQUIPMENT AND DIRECT COSTS		**$ 2,000,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	1	LS		$ 350,000
Structural / Architectural Allowance (Including Demolition)	10	%		$ 200,000
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Electrical, IC, Programming Allowances	10	%		$ 200,000
Equipment installation	0	%		$ -
Construction contingency	30	%		$ 825,000
		SUBTOTAL DIRECT COST		**$3,575,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 357,500
GC Overhead, Profit, Bonds, Mob	25	%		$ 894,000
City Taxes, other fees	4.5	%		$ 161,000
Cost Escalation to Mid-Point of Construction	3	%		
		TOTAL CONSTRUCTION COST		**$4,988,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20		%	$ 998,000
Owner maintained project contingency	10	%		$ 499,000
		TOTAL PROJECT COST (2021 $'s)		**$6,490,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Assumes existing electrical service would not need to be upsized for additional mechanical equipment and pumping.
2. Assumes clarifier RAS and WAS pumping upsized with asset revitalization improvements for RAS/WAS pumping.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Sequencing of project expenditures used for CIP implementation plan in Chapter 8.

Escalated $'s	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
	1.00	0.00	0.00	0.00	0.00	0.00
$ 6,490,000	$ 6,490,000	$ -	$ -	$ -	$ -	$ -

2027	**2028**	**2029**	**2030**	**2031 - 2040**
$ -	$ -	$ -	$ -	$ -

carollo

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT City of Grand Junction - 2020 Persigo WWTP Master Plan
PROJECT: UV Alternative 1 - New UV System + Asset Revitalization — Estimate Basis (year) = 2021
Process Area: UV Disinfection System — Mid point of Construction (year) = 2021

UV Alternative 1 - Includes the revitalization and improvements to the existing UV system along with installation of a new UV unit. The new UV system was recommended to provide the treatment redundancy and reliability per City (N+1 configuration). It is assumed the new UV system may be installed before rehabilitating the existing UV channel. Estimate below is a Class V level estimate.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Asset Revitalization Costs - Chapter 4	1	LS		$ 1,332,000
Improvements for New UV System				
Flow Control/Isolation Gates	5	EA	$ 25,000	$ 125,000
Effluent Control Weir	1	LS	$ 75,000	$ 75,000
Trojan Signa/ Wedeco Duron	1	LS	$ 700,000	$ 700,000
UV Building over chanels	2,000	$/SF	$ 200	$ 400,000
Electrical Room / TXFMR / Switchgear Upgrades	1	LS	$ 750,000	$ 750,000
		EQUIPMENT AND DIRECT COSTS		**$ 3,382,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	0	LS		$ -
Structural / Architectural Allowance (Including Demolition)	15	%		$ 507,300
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	1	%		$ 34,000
Electrical, IC, Programming Allowances	20	%		$ 676,400
Equipment installation	20	%		$ 676,400
Construction contingency	30	%		$ 1,583,000
		SUBTOTAL DIRECT COST		**$ 6,859,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 685,900
GC Overhead, Profit, Bonds, Mob	25	%		$ 1,715,000
City Taxes, other fees	4.5	%		$ 309,000
Cost Escalation to Mid-Point of Construction	3	%		
		TOTAL CONSTRUCTION COST		**$ 9,569,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 1,914,000
Owner maintained project contingency	10	%		$ 957,000
		TOTAL PROJECT COST (2021 $'s)		**$ 12,440,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Sequencing of the UV improvements will be sequential to improve reliability and redundancy immediately.
2. New UV system anticipated to be installed prior to replacing the existing system.
3. Included new electrical switchgear as allowance. Location and sizing of switchgear replacement should be re-evaluated.
4. Assume there will be structural work in the existing chlorine contact basins to accommodate the new UV system.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Sequencing of project expenditures used for CIP implementation plan in Chapter 8.

Escalated $'s	2021	2022	2023	2024	2025	2026
	1.00	0.00	0.00	0.00	0.00	0.00
$ 12,440,000	$ 12,440,000	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

carollo

UPDATED:	Dec-20
BY :	JK, LM, BL, BC
CHECKED:	DSP

CLIENT City of Grand Junction
PROJECT: UV Hydraulics and Reliability
Process Area: Disinfection

Estimate Basis (year) = 2021
Mid point of Construction (year) = 2021

Class V cost estimate to make improvements to hydraulic issues and address limited UV redundancy immediately. This project is driven by operational performance and equipment reliability until the new UV system can be installed.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
CFD Modeling for Hydraulic Modifications	1	LS	$ 20,000	$ 20,000
Flodar - relocate effluent flow metering	1	EA	$ 25,000	$ 25,000
Hydraulic Improvements	1	LS	$ 50,000	$ 50,000
Shelf Spare UV modules (9)	1	(below)		$ -
			EQUIPMENT AND DIRECT COSTS	**$ 95,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	0	LS		$ -
Structural / Architectural Allowance (Including Demolition)	20	%		$ 19,000
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	5	%		$ 5,000
Electrical, IC, Programming Allowances	25	%		$ 23,750
Equipment installation	20	%		$ 19,000
Construction contingency	30	%		$ 49,000
			SUBTOTAL DIRECT COST	**$211,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 21,100
GC Overhead, Profit, Bonds, Mob	25	%		$ 53,000
City Taxes, other fees	4.5	%		$ 9,000
Cost Escalation to Mid-Point of Construction	3.0	%		
			TOTAL CONSTRUCTION COST	**$294,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 59,000
Owner maintained project contingency	10	%		$ 29,000
Owner purchased (nine) UV modules as shelf spare				$ 200,000
			TOTAL PROJECT COST (2021 $'s)	**$582,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. This is an interim improvement until the new UV system will be installed.
2. Assumes owner will directly purchase UV modules from the existing MFR.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Sequencing of project expenditures used for CIP implementation plan in Chapter 8.

	Escalated $'s	2021	2022	2023	2024	2025	2026
Fraction of cost per year		1.00	0.00	0.00	0.00	0.00	0.00
	$ 580,000	$ 580,000	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

APPENDIX D - CAPITAL COST ESTIMATES FOR ALTERNATIVES

carollo

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT City of Grand Junction
PROJECT: New Grease Building
Process Area: Digestion Area

Estimate Basis (year) = 2021
Mid point of Construction (year) = 2021

Class V cost estimate for the new grease receiving station. Project estimate includes receiving station, additional yard piping, site electrical and allowance for heating the grease. Assumed location will be in current location for grease removal.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
FOG Receiving Station	1	LS	$ 1,023,000	$ 1,023,000
Yard Piping Allowance	1	LS	$ 150,000	$ 150,000
Site Electrical Allowance	1	LS	$ 500,000	$ 500,000
Allowance for Heating grease	1	EA	$ 50,000	$ 50,000
			EQUIPMENT AND DIRECT COSTS	**$ 1,723,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	0	%		$ -
Structural / Architectural Allowance (Including Demolition)	0	%		$ -
Building Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Electrical, IC, Programming Allowances	20	%		$ 345,000
Equipment installation	0	%		$ -
Construction Contingency	30	%		$ 620,000
			SUBTOTAL DIRECT COST	**$ 2,688,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 172,000
GC Overhead, Profit, Bonds, Mob	25	%		$ 672,000
City Taxes, other fees	4.5	%		$ 121,000
Cost Escalation to mid-Point of Construction	3	%		
			TOTAL CONSTRUCTION COST	**$3,653,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 731,000
Owner maintained project contingency	10	%		$ 365,000
			TOTAL PROJECT COST (2021 $'s)	**$ 4,750,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Assumed location is in existing location for grease processing.
2. Assumes existing electrical capacity is sufficient for new facility.
3. Assume pumping facilities from primary clarifier and headworks are sufficient, if needed at reduced use/volume.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above. Sequencing of project expenditures used for CIP implementation plan in Chapter 8.*

Escalated $'s	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
	1.00	0.00	0.00	0.00	0.00	0.00
$ 4,750,000	$ 4,750,000	$ -	$ -	$ -	$ -	$ -

2027	**2028**	**2029**	**2030**	**2031 - 2040**
$ -	$ -	$ -	$ -	$ -

carollo

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT City of Grand Junction
PROJECT: DIG ALT 1 - Aerobic / Anaerobic Class B — Estimate Basis (year) = 2021
Process Area: Digestion — Mid point of Construction (year) = 2021

Digestion Alternative 1 - Class V cost esimate for the new facilities, which include new DAF thickening system to increase reliability of the anaerobic digestion system and new aerobic digester for capacity concerns to achieve a Class B biosolids. Include asset replacement costs from Chapter 4 as part of the baseline condition (costs not shown in table)

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
New DAFT System	1	EA	$ 460,000	$ 460,000
Floc Feed System	1	EA	$ 25,000	$ 25,000
New Building	1,100	SF	$ 200	$ 220,000
Site Electrical Allowance	1	LS	$ 250,000	$ 250,000
New Aerobic Digestion	800	CY	$ 650	$ 520,000
Sitework	1	LS	$ 200,000	$ 200,000
Mixers, Blowers, and Aeration System	1	LS	$ 207,000	$ 207,000
		EQUIPMENT AND DIRECT COSTS		**$ 1,422,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	10	%		$ 142,000
Structural / Architectural Allowance (Including Demolition)	10	%		$ 142,000
Building Coatings and Finishes	5	%		$ 71,000
Mechanical System Allowance (HVAC, Plumbing, etc)	10	%		$ 142,000
Electrical, IC, Programming Allowances	25	%		$ 356,000
Equipment installation	20	%		$ 284,000
Construction Contingency	30	%		$ 768,000
		SUBTOTAL DIRECT COST		**$ 3,327,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 333,000
GC Overhead, Profit, Bonds, Mob	25	%		$ 832,000
City Taxes, other fees	4.5	%		$ 150,000
Cost Escalation to mid-Point of Construction	3	%		
		TOTAL CONSTRUCTION COST		**$ 4,642,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 928,000
Owner maintained project contingency	10	%		$ 464,000
		TOTAL PROJECT COST (2021 $'s)		**$ 6,030,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Assumed connect mechanical equipment to existing switchgear and MCC.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above. Sequencing of project expenditures used for CIP implementation plan in Chapter 8.*

Escalated $'s	2021	2022	2023	2024	2025	2026
	1.00	0.00	0.00	0.00	0.00	0.00
$ 6,030,000	$ 6,030,000	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

UPDATED:	Dec-20
BY :	JK, LM, BL, BC
CHECKED:	DSP

CLIENT City of Grand Junction
PROJECT: DIG ALT 2 - Anaerobic Conversion w. Class B — Estimate Basis (year) = 2021
Process Area: Digestion — Mid point of Construction (year) = 2021

Digestion Alternative 2 - Converts the existing digestion process to a complete anaerobic digestion approach to achieve Class B biosolids and increase biogas production. Class V cost estimate

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Conversion of aerobic digestion to mixing / storage system				
Sludge Tranfers Pumps	2	EA	$ 50,000	$ 100,000
Replace mixing system	4	EA	$ 18,000	$ 72,000
Structural Modifications	1	LS	$ 120,000	$ 120,000
Cover for Mixing	1	EA	$ 250,000	$ 250,000
New DAFT Unit Process				
New DAFT System (same as existing unit)	1	EA	$ 460,000	$ 460,000
Floc Feed System	1	EA	$ 25,000	$ 25,000
Relay Logic Control System	1	EA	$ 31,000	$ 31,000
Piping Allowance	1	LS	$ 100,000	$ 100,000
New Building	1,100	SF	$ 200	$ 220,000
Site Electrical Allowance	1	LS	$ 250,000	$ 250,000
		EQUIPMENT AND DIRECT COSTS		**$ 1,628,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	10	%		$ 163,000
Structural / Architectural Allowance (Including Demolition)	10	%		$ 163,000
Building Coatings and Finishes	5	%		$ 81,000
Mechanical System Allowance (HVAC, Plumbing, etc)	10	%		$ 163,000
Electrical, IC, Programming Allowances	25	%		$ 407,000
Equipment installation	20	%		$ 326,000
Construction Contingency	30	%		
		SUBTOTAL DIRECT COST		**$ 2,931,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 293,000
GC Overhead, Profit, Bonds, Mob	25	%		$ 733,000
City Taxes, other fees	4.5	%		$ 132,000
Cost Escalation to mid-Point of Construction	3	%		
		TOTAL CONSTRUCTION COST		**$ 4,089,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 818,000
Owner maintained project contingency	10	%		$ 409,000
		TOTAL PROJECT COST (2021 $'s)		**$ 5,320,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Assumes new electrical equipment will be provided and a new building will be constructed as enclosure. Similar in size and space t

2. Replacement of assets in-kind (same size / MFR) as existing. Assumed minimal electrical and IC changes.

3. Increased coatings and structural allowance based on feedback from City for impacts of concrete and corrosion concerns.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Sequencing of project expenditures used for CIP implementation plan in Chapter 8.

Escalated $'s	2021	2022	2023	2024	2025	2026
	1.00	0.00	0.00	0.00	0.00	0.00
$ 5,320,000	$ 5,320,000	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

carollo

		UPDATED:	Dec-20
		BY :	JK, LM, BL, BC
		CHECKED:	DSP
CLIENT	City of Grand Junction		
PROJECT:	Anaerobic Digester Expansion	Estimate Basis (year) =	2021
Process Area:	Digestion	Mid point of Construction (year) =	2021

Third Anaerobic Digester - The additioanal digester would be required to provide operational reliability and redundnacy as the O&M staff requested an N+1 configuration to allow for maintenance of other anaerobic digesters. Class V level cost estimate provided below.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Sitework	1	LS	$ 100,000	$ 100,000
Digester Cast-in-place Concrete	1	LS	$ 300,000	$ 300,000
Digester Steel Gas Holder Cover	1	EA	$ 320,000	$ 320,000
Linear Motion Mixer	1	EA	$ 230,000	$ 230,000
Heating Allowance (HEX, hot water, boiler)	1	LS	$ 175,000	$ 175,000
Sludge pumping (recirc, transfer pumps)	1	LS	$ 155,000	$ 155,000
Piping Allowance	1	LS	$ 250,000	$ 250,000
Digester Control Building	2,500	SF	$ 200	$ 500,000
Site Electrical Allowance	1	LS	$ 250,000	$ 250,000
		EQUIPMENT AND DIRECT COSTS		**$ 2,280,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	0	%		$ -
Building Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	10	%		$ 228,000
Electrical, IC, Programming Allowances	25	%		$ 570,000
Equipment installation	20	%		$ 456,000
Construction Contingency	30	%		$ 1,060,000
		SUBTOTAL DIRECT COST		**$ 4,594,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATI		%		
General Conditions Allowance	10	%		$ 459,000
GC Overhead, Profit, Bonds, Mob	25	%		$ 1,149,000
City Taxes, other fees	4.5	%		$ 207,000
Cost Escalation to mid-Point of Construction	3	%		$ 138,000
		TOTAL CONSTRUCTION COST		**$ 6,547,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 1,309,000
Owner maintained project contingency	10	%		$ 655,000
		TOTAL PROJECT COST (2021 $'s)		**$ 8,510,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Assume the heating and pumping equipment can be located in Digestion Building.
2. Assume existing electrical capacity sufficent for new digester and pumping requirements.
3. An allowance for new digester control building has been provided. The existing control room could be modified and used.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Sequencing of project expenditures used for CIP implementation plan in Chapter 8.

Escalated $'s	2021	2022	2023	2024	2025	2026
	1.00	0.00	0.00	0.00	0.00	0.00
$ 8,510,000	$ 8,510,000	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

APPENDIX D - CAPITAL COST ESTIMATES FOR ALTERNATIVES

carollo

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT City of Grand Junction
PROJECT: DEW ALT 1 - Screw Press w. Solar Drying.
Process Area: Dewatering

Estimate Basis (year) = 2021
Mid point of Construction (year) = 2021

Dewatering Alternative 1 - This solution replaces the existing BFP operations with a new facility. The new facility would include screw press technology, which is more energy efficient. Five units were assumed to provide an N+1 configuration. Biosolids management assumed a solar drying facility (could be coupled) and would be sized to achieve a Class B biosolids.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
New Screw Press Dewatering Building				
Screw Presses	5	EA	$ 412,000	$ 2,060,000
Polymer System	1	EA	$ 340,000	$ 340,000
Conveyance	1	EA	$ 250,000	$ 250,000
Site Electrical Allowance	1	EA	$ 750,000	$ 750,000
New Building	14,000	SF	$ 200	$ 2,800,000
Piping Allowance	1	LS	$ 200,000	$ 210,000
Solar Drying Facilities				
Sitework	1	LS	$ 100,000	$ 100,000
Demolition of Existing Solar Drying Beds	1	LS	$ 200,000	$ 200,000
Solar Drying Greenhouse and Equipment	1	LS	$ 4,430,000	$ 4,430,000
Concrete slab on grade	2,800	CY	$ 550	$ 1,540,000
		EQUIPMENT AND DIRECT COSTS		**$ 12,680,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	0	%		$ -
Structural / Architectural Allowance (Including Demolition)	0	%		$ -
Building Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Electrical, IC, Programming Allowances	10	%		$ 1,268,000
Equipment installation	0	%		$ -
Construction Contingency	30	%		$ 4,184,000
		SUBTOTAL DIRECT COST		**$ 18,132,000**
CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 1,813,000
GC Overhead, Profit, Bonds, Mob	25	%		$ 4,533,000
City Taxes, other fees	4.5	%		$ 816,000
Cost Escalation to mid-Point of Construction	3	%		
		TOTAL CONSTRUCTION COST		**$ 25,294,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 5,059,000
Owner maintained project contingency	10	%		$ 2,529,000
		TOTAL PROJECT COST (2021 $'s)		**$ 32,880,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. New electrical facilities were assumed for building. The existing electrical service would be demolished or downsized.
2. Allowances were included for yard piping to and from the new dewatering building.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Sequencing of project expenditures used for CIP implementation plan in Chapter 8.

Escalated $'s	2021	2022	2023	2024	2025	2026
	1.00	0.00	0.00	0.00	0.00	0.00
$ 32,880,000	$ 32,880,000	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

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UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT City of Grand Junction
PROJECT: DEW ALT 2 - Conversion to Anaerobic Digestion
Process Area: Dewatering

Estimate Basis (year) = 2021
Mid point of Construction (year) = 2021

Dewatering Alterantive 2- Replaces aging BFP operations with a new dewatering centrifuge building and operations. The new facility also includes a 100-day covered biosolids storage facility. A NPV analysis was completed on this alternative and presented in Chapter 5. Estimate shown below is a Class V level estimate.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Centrifuge Dewatering Building				
Centrifuges	3	EA	$ 623,150	$ 1,869,450
Polymer System	1	EA	$ 340,000	$ 340,000
Conveyance	1	EA	$ 250,000	$ 250,000
New Building	10,000	SF	$ 200	$ 2,000,000
Electrical Site Allowance	1	LS	$ 1,250,000	$ 1,250,000
Piping Allowance	1	LS	$ 200,000	$ 200,000
Dewatered biosolids storage (100days)				
Sitework	1	LS	$ 100,000	$ 100,000
Demolition of Existing Solar Drying Beds	1	LS	$ 200,000	$ 200,000
Concrete slab on grade	740	CY	$ 550	$ 407,000
Cake Storage Building	20,000	SF	$ 20	$ 400,000
	EQUIPMENT AND DIRECT COSTS			**$ 7,016,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	0	%		$ -
Structural / Architectural Allowance (Including Demolition)	0	%		$ -
Building Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Electrical, IC, Programming Allowances	10	%		$ 702,000
Equipment installation	0	%		$ -
Construction Contingency	30	%		$ 2,315,000
		SUBTOTAL DIRECT COST		**$ 10,033,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 1,003,000
GC Overhead, Profit, Bonds, Mob	25	%		$ 2,508,000
City Taxes, other fees	4.5	%		$ 451,000
Cost Escalation to mid-Point of Construction	3	%		
		TOTAL CONSTRUCTION COST		**$ 13,995,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 2,799,000
Owner maintained project contingency	10	%		$ 1,400,000
	TOTAL PROJECT COST (2021 $'s)			**$ 18,190,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. New electrical facilities were assumed for building. The existing electrical service would be demolished or downsized.
2. Allowances were included for yard piping to and from the new dewatering building.
3. Assumed 100days of storage. This can be reduced most likely depending on the final biosolids management approach.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Sequencing of project expenditures used for CIP implementation plan in Chapter 8.

Escalated $'s	2021	2022	2023	2024	2025	2026
	1.00	0.00	0.00	0.00	0.00	0.00
$ 18,190,000	$ 18,190,000	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

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UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT City of Grand Junction
PROJECT: Expansion of Biogas Treatment
Process Area: Digestion / Biogas

Estimate Basis (year) = 2021
Mid point of Construction (year) = 2021

CLASS V cost estimate for new biogas treatment system (100cfm) expected when reach capacity in future. Chapter 5 projects increased biogas production will exceed current treatment capacity. Assume this project would occur in the 2035 to 2040 timeframe.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Asset Revitalization Improvements of Existing				
Direct costs for system replacement (Chapter 4)	1	LS		$538,000
New Biogas Treatment System for Capacity				
Sitework	1	LS	$ 25,000	$ 25,000
Equipment Pad	50	CY	$ 650	$ 32,500
BioCNG 100	1	EA	$ 1,186,500	$ 1,186,500
Piping Allowance	1	LS	$ 100,000	$ 100,000
		EQUIPMENT AND DIRECT COSTS		**$1,882,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	0	%		$ -
Structural / Architectural Allowance (Including Demolition)	10	%		$ 188,000
Building Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	10	%		$ 188,000
Electrical, IC, Programming Allowances	25	%		$ 471,000
Equipment installation	20	%		$ 376,000
Construction Contingency	30	%		$ 932,000
		SUBTOTAL DIRECT COST		**$ 4,037,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 404,000
GC Overhead, Profit, Bonds, Mob	25	%		$ 1,009,000
City Taxes, other fees	4.5	%		$ 182,000
Cost Escalation to mid-Point of Construction	3	%		
		TOTAL CONSTRUCTION COST		**$ 5,632,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 1,126,000
Owner maintained project contingency	10	%		$ 563,000
		TOTAL PROJECT COST (2021 $'s)		**$ 7,320,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Estimate assumes exisitng yard piping for biogas would not be upsized or expanded.

2. Existing electrical service has not been upsized - assume existing can provide capacity.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Sequencing of project expenditures used for CIP implementation plan in Chapter 8.

Escalated $'s	2021	2022	2023	2024	2025	2026
	1.00	0.00	0.00	0.00	0.00	0.00
$ 7,320,000	$ 7,320,000	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

Appendix E

NET PRESENT VALUE FINANCIAL MODELS

APPENDIX E - Net Present Value Calculations for Alternative Analysis

carollo

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT: City of Grand Junction
PROJECT : 2020 Persigo WWTP Master Plan
Process: NPV Summary

Summary of the NPV analysis completed for alternative anlaysis. Detailes for the NPV analysis are provided on subsequent worksheets.

Activated Sludge Alternatives Summary:

Item Description	Baseline Condition - Aeration Basins Expansion	CEPT Treatment	aSRT Controls
Capital Costs	$15,000,000	$10,442,000	$15,630,000
Operations Costs - Annual	NA	$422,000	($37,000)
Operations Costs - 20yr period	NA	$10,333,000	($865,258)
Net Present Value	**$15,000,000**	**$20,777,000**	**$14,764,000**

Assumptions
1. See inputs worksheet for baseline cost information
2. Operating and chemical dosing assumpsions are included on individual NPV analysis.
3. O&M costs included electrical, chemical, biogas generation, and impacts to biosolids management.

Digestion Alternatives Summary:

Item Description	Baseline Condition - landfill biosolids	Digester Alternative 1 - Achieve Class B with Aerobic / Anaerobic Digestion	Digester Alternative 2 - Achieve Class B with Anaerobic Digestion
Capital Costs	$11,200,000	$19,221,000	$14,336,000
Operations Costs - Annual	NA	($61,000)	($204,000)
Operations Costs - 20yr period	NA	($2,432,000)	($5,978,000)
Net Present Value	**$11,200,000**	**$16,790,000**	**$8,358,000**

Assumptions
1. See inputs worksheet for baseline cost information
2. Operating and chemical dosing assumpsions are included on individual NPV analysis.
3. O&M costs included electrical, chemical, biogas generation, and impacts to biosolids management.

Dewatering Process and Biosolids Storage Alterantives Summary

Item Description	Baseline Condition - landfill biosolids	Dewater Alternative 1 - Screw Press w. Solar Drying	Dewater Alternative 2 - Centrifuge w. Storage
Capital Costs	$10,400,000	$32,860,000	$18,200,000
Operations Costs - Annual	NA	($126,000)	($67,000)
Operations Costs - 20yr period	NA	($7,128,000)	($3,717,000)
Net Present Value	**$10,400,000**	**$25,732,000**	**$14,481,000**

Assumptions
1. See inputs worksheet for baseline cost information
2. Operating and chemical dosing assumpsions are included on individual NPV analysis.
3. O&M costs included electrical, chemical, biogas generation, and impacts to biosolids management.

APPENDIX E - Net Present Value Calculations for Alternative Analysis

carollo

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT: City of Grand Junction
PROJECT : 2020 Persigo WWTP Master Plan
Process: Input Assumptions for the NPV Analysis.

Input assumptions used for the NPV, values have been documented in Chapter 1 of the Master Plan, which were reviewed in Q2

CHEMICAL	Median	SOURCE:
Ferrous Chloride ($/ton)	**$980**	GJ
Ferric Chloride ($/gal)	**$1.35**	
Polymer ($/lb)	**$1.33**	GJ
Polymer ($/gal)	**$9.11**	GJ performance data
Electricity ($/kWh)	**$0.06**	GJ
NaOH ($/gal)		
Natural Gas ($/MMBtu)	**$5.30**	GJ
Potable Water ($/gallons)	**$0.01**	GJ
Diesel Fuel Costs ($/gallon)	**$2.77**	GJ
Compressed Natural Gas Fuel Costs ($/gallon)	**$1.57**	GJ
Biosolids Tipping Fees ($/ton)	**$23.75**	GJ
Grit/Grease/ Screening Tipping Fees ($/ton)	**$33.00**	GJ
Tipping Fee Annual Increase (%)	**5%**	GJ
Fuel Efficiency of Transport Increase (miles/gallon)	**5**	GJ
Roundtrip Distance to Mesa County Landfill (miles)	**28**	GJ
RIN ($/RIN)	**1.25**	GJ
Gallon of Gasoline Equivalent Value (GGE)	**1.25**	GJ
Labor Average Hourly Rate ($/hour)	**$ 46.00**	GJ
Labor Average- O$M Staff (% of capital cost)		GJ
Volume of Biosoldis Truck (cy/truck)	**12**	GJ
Density of Biosolids (wet lb/cf)	**55**	Assumed in analysis
DAFT (HP)	**40**	DAFT 2010 Quote
Aerobic Digester (HP)	**9**	See below
Anaerobic Digester Mixer (HP)	**5**	Assumed per Becky
Pre-dewatering Mixer (HP)	**50**	GJ
BFP (HP)	**5**	GJ data
Screw Press (HP)	**6.5**	Quote for Sioux Falls
Centrifuge (HP)	**50**	Adjusted Quote for Sioux Falls
Biosolids Conveyor (HP)	**10**	Adjusted Quote for Sioux Falls
Solar Drying Electrical Consumpion (kwh/yr)	**301,897**	Quote
Biogas Conditioning (kWh per year)	**2,285,556**	Quote for Littleton-Englewood (400 scfm)
Assumed operational % of nameplate HP (%)	**80%**	Assumed in analysis
Future DAFT Polymer (lb active polymer/dry ton solid	**10**	Assumed in analysis; per metcalf and eddy
Current DAFT Polymer (lb active polymer/dry ton soli	**4**	Based on data from Jan 2018 - Mar 2020
Centrifuge Polymer (lb active polymer/dry ton solids)	**40**	Assumed in analysis; from old longmont analysis
Screw Press Polymer (lb active polymer/dry ton solid	**35**	Assumed in analysis; from old longmont analysis
BFP Polymer (lb active polymer/dry ton solids)	**20**	Assumed in analysis; from old longmont analysis
Front End Loader Diesel use (gph)	**8**	ezyquip.com.au/DownloadAttachment.ashx?AttachmentId=1813
Wet tons solids / truck load (US tons / load)	**12**	Calculated from 2019 Data
# Truck loads in 2019 (baseline	**1015.00**	Provided in 2019 data from GJ
Electrical cost ($/kWh)	**$0.084**	L/E past bills from Biogas Study
Biogas Value ($/scf)	**$0.0062**	Net revenue of raw biogas (RIN + brown gas revenue minus O&M
Financial Parameters	**Median**	**SOURCE:**
Escalation rate	3.0%	
	4.0%	

APPENDIX E - Net Present Value Calculations for Alternative Analysis

CLIENT:	City of Grand Junction	**UPDATED:**	Oct-20
PROJECT :	2020 Persigo WWTP Master Plan	**BY :**	BC
Process:	NPV - Alternative #1 - Chemically Enhanced Primary Treatment (CEPT)	**CHECKED:**	DSP

	Item Description	**Year 0** 2020	**Year 1** 2021	**Year 2** 2022	**Year 3** 2023	**Year 4** 2024	**Year 5** 2025	**Year 6** 2026	**Year 7** 2027	**Year 8** 2028	**Year 9** 2029	**Year 10** 2030	**Year 11** 2031	**Year 12** 2032	**Year 13** 2033	**Year 14** 2034	**Year 15** 2035	**Year 16** 2036	**Year 17** 2037	**Year 18** 2038	**Year 19** 2039	**Year 20** 2040
Projections																						
Flow	Average Daily Annual Flow - ADAF (MGD)	9.0	9.1	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8	10.0	10.1	10.2	10.4	10.5	10.6	10.7	10.9	11.0	11.1	11.2
Chemicals	CEPT dosing of Ferric (gal/yr)	244,241	245,387	246,916	248,736	250,924	253,550	256,478	259,408	262,464	265,791	269,243	272,890	276,514	280,102	283,652	287,162	290,623	294,036	297,396	300,701	303,949
	CEPT dosing of Polymer (gal/yr)	9,525	9,570	9,630	9,701	9,786	9,888	10,003	10,117	10,236	10,366	10,500	10,643	10,784	10,924	11,062	11,199	11,334	11,467	11,598	11,727	11,854
	CEPT dosing of Alkalinity (gal/yr as NaOH)	114,305	114,841	115,557	116,408	117,432	118,662	120,032	121,403	122,833	124,390	126,006	127,713	129,408	131,088	132,749	134,392	136,012	137,609	139,181	140,728	142,248
Aeration Impacts	ease in Aeration (10% reduction) (in kWh/yr)	(412,734)	(414,671)	(417,255)	(420,330)	(424,027)	(428,466)	(433,414)	(438,364)	(443,529)	(449,150)	(454,984)	(461,147)	(467,271)	(473,335)	(479,334)	(485,265)	(491,113)	(496,881)	(502,559)	(508,144)	(513,632)
Solids	Increase solids due to CEPT (wet tons/yr)	1,480 10%	1,487	1,496	1,507	1,520	1,536	1,554	1,572	1,590	1,610	1,631	1,653	1,675	1,697	1,719	1,740	1,761	1,781	1,802	1,822	1,842
Chemicals	dditional polymer for thickening and dewatering	4,626	4,648	4,677	4,711	4,752	4,802	4,858	4,913	4,971	5,034	5,099	5,168	5,237	5,305	5,372	5,439	5,504	5,569	5,633	5,695	5,757
Electricity	Electrical impacts for solids neglible																					
Biogas Production	Increase in biogas production (scfm/yr)	8,010,108	8,047,696	8,097,846	8,157,526	8,229,266	8,315,416	8,411,443	8,507,507	8,607,745	8,716,849	8,830,068	8,949,675	9,068,517	9,186,216	9,302,629	9,417,737	9,531,241	9,643,174	9,753,373	9,861,771	9,968,276
Biosolids Hauling	Increase in biosoilds hauling (# truck loads)	102	102	103	103	104	105	107	108	109	110	112	113	115	116	118	119	121	122	124	125	126
Capital Costs (in 2020 Dollars)																						
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Aeration Basin Asset Renewals		$ -	$ -	$ -	$ 2,022,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	CEPT Facility	$ -	$ -	$ -	$ -	$ 8,420,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		$ -	$ -	$ -	$ -	$ -
	Total Capital Cost	**$ -**	**$ -**	**$ -**	**$ -**	**$ 10,442,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Operations Costs (in 2020 Dollars)																						
	Chemicals	$ 416,502	$ 418,456	$ 421,064	$ 424,167	$ 427,897	$ 432,377	$ 437,370	$ 442,365	$ 447,577	$ 453,250	$ 459,137	$ 465,357	$ 471,536	$ 477,656	$ 483,709	$ 489,694	$ 495,596	$ 501,416	$ 507,146	$ 512,783	$ 518,321
	Electricity	$ (24,764)	$ (24,880)	$ (25,035)	$ (25,220)	$ (25,442)	$ (25,708)	$ (26,005)	$ (26,302)	$ (26,612)	$ (26,949)	$ (27,299)	$ (27,669)	$ (28,036)	$ (28,400)	$ (28,760)	$ (29,116)	$ (29,467)	$ (29,813)	$ (30,154)	$ (30,489)	$ (30,818)
	Biosolids Hauling	$ 1,574	$ 1,582	$ 1,592	$ 1,603	$ 1,618	$ 1,634	$ 1,653	$ 1,672	$ 1,692	$ 1,713	$ 1,736	$ 1,759	$ 1,783	$ 1,806	$ 1,829	$ 1,851	$ 1,873	$ 1,895	$ 1,917	$ 1,938	$ 1,959
	Biosolids Tipping	$ 28,928	$ 30,516	$ 32,242	$ 34,103	$ 36,124	$ 38,327	$ 40,708	$ 43,231	$ 45,928	$ 48,836	$ 51,943	$ 55,279	$ 58,814	$ 62,556	$ 66,516	$ 70,706	$ 75,136	$ 79,820	$ 84,769	$ 89,996	$ 95,517
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total O&M Cost	**$ 422,000**	**$ 425,674**	**$ 429,862**	**$ 434,654**	**$ 440,197**	**$ 446,630**	**$ 453,727**	**$ 460,967**	**$ 468,585**	**$ 476,850**	**$ 485,517**	**$ 494,726**	**$ 504,096**	**$ 513,618**	**$ 523,294**	**$ 533,136**	**$ 543,139**	**$ 553,319**	**$ 563,679**	**$ 574,229**	**$ 584,979**
Cost Summary (in 2020 Dollars)																						
Capital Cost $	10,442,000	$ -	$ -	$ -	$ -	$ 10,442,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
O&M Cost $	10,333,000	$ 422,000	$ 425,674	$ 429,862	$ 434,654	$ 440,197	$ 446,630	$ 453,727	$ 460,967	$ 468,585	$ 476,850	$ 485,517	$ 494,726	$ 504,096	$ 513,618	$ 523,294	$ 533,136	$ 543,139	$ 553,319	$ 563,679	$ 574,229	$ 584,979
	Total	**$ 422,000**	**$ 425,674**	**$ 429,862**	**$ 434,654**	**$ 10,882,197**	**$ 446,630**	**$ 453,727**	**$ 460,967**	**$ 468,585**	**$ 476,850**	**$ 485,517**	**$ 494,726**	**$ 504,096**	**$ 513,618**	**$ 523,294**	**$ 533,136**	**$ 543,139**	**$ 553,319**	**$ 563,679**	**$ 574,229**	**$ 584,979**
Net Present Value (shown in discounted 2020 dollars)																						
Discount Rate =	3%																					
Escalation Rate =	3%																					
Capital NPV = $	10,442,000	$0	$0	$0	$0	$10,442,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
O&M NPV = $	10,335,000	$422,000	$426,000	$430,000	$435,000	$440,000	$447,000	$454,000	$461,000	$469,000	$477,000	$486,000	$495,000	$504,000	$514,000	$523,000	$533,000	$543,000	$553,000	$564,000	$574,000	$585,000
Total NPV = $	**20,777,000**	**$422,000**	**$426,000**	**$430,000**	**$435,000**	**$10,882,000**	**$447,000**	**$454,000**	**$461,000**	**$469,000**	**$477,000**	**$486,000**	**$495,000**	**$504,000**	**$514,000**	**$523,000**	**$533,000**	**$543,000**	**$553,000**	**$564,000**	**$574,000**	**$585,000**

Assumptions

1. Ferric addition for CEPT could range from 20mg/l to 40mg/l. At 40mg/L at 13.5mgd = 1,000 gal/day for CEPT
2. Polymer addition could range from= 0.5 to 1mg/L for CEPT. For financial analysis used 1mg/L
3. Aeration reduction based on CEPT - decreases 10% to aeration basins. Assume 2 blowers on - at 600HP. Delta is 60HP
4. Adding CEPT increases solids concentrations by 10%

CLIENT:	City of Grand Junction	**UPDATED:**	Oct-20
PROJECT :	2020 Persigo WWTP Master Plan	**BY :**	BC
Process:	NPV - Alternative #2 - Aeration Basin Modifications with SRT Control	**CHECKED:**	DSP

Item Description		**Year 0** 2020	**Year 1** 2021	**Year 2** 2022	**Year 3** 2023	**Year 4** 2024	**Year 5** 2025	**Year 6** 2026	**Year 7** 2027	**Year 8** 2028	**Year 9** 2029	**Year 10** 2030	**Year 11** 2031	**Year 12** 2032	**Year 13** 2033	**Year 14** 2034	**Year 15** 2035	**Year 16** 2036	**Year 17** 2037	**Year 18** 2038	**Year 19** 2039	**Year 20** 2040
Projections																						
Flow Average Daily Annual Flow - ADAF (MGD)		9.0	9.1	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8	10.0	10.1	10.2	10.4	10.5	10.6	10.7	10.9	11.0	11.1	11.2
Aeration Impacts																						
Decrease in Aeration (15% reduction) (in kWh/yr)		(619,101)	(622,007)	(625,883)	(630,495)	(636,040)	(642,699)	(650,121)	(657,545)	(665,293)	(673,725)	(682,476)	(691,721)	(700,906)	(710,003)	(719,000)	(727,897)	(736,670)	(745,321)	(753,838)	(762,216)	(770,448)
Solids Assume no change to solids																						
Biogas Production No change in biogas production																						
Biosolids Hauling No change in biosolids		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital Costs (in 2020 Dollars)																						
Aeration Basin Asset Renewals		$ -	$ -	$ -	$ -	$ 2,422,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Aeration Basins Expansion		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,838,000	$ -	$ -	$ -	$ -	$ -
SRT Controls / Piping			$ -	$ -	$ -	$ 1,370,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Cost		**$ -**	**$ -**	**$ -**	**$ -**	**$ 3,792,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 11,838,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Operations Costs (in 2020 Dollars)																						
Chemicals																						
Electricity		$ (37,146)	$ (37,320)	$ (37,553)	$ (37,830)	$ (38,162)	$ (38,562)	$ (39,007)	$ (39,453)	$ (39,918)	$ (40,424)	$ (40,949)	$ (41,503)	$ (42,054)	$ (42,600)	$ (43,140)	$ (43,674)	$ (44,200)	$ (44,719)	$ (45,230)	$ (45,733)	$ (46,227)
Biosolids Hauling		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Biosolids Tipping		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total O&M Cost		**$ (37,146)**	**$ (37,320)**	**$ (37,553)**	**$ (37,830)**	**$ (38,162)**	**$ (38,562)**	**$ (39,007)**	**$ (39,453)**	**$ (39,918)**	**$ (40,424)**	**$ (40,949)**	**$ (41,503)**	**$ (42,054)**	**$ (42,600)**	**$ (43,140)**	**$ (43,674)**	**$ (44,200)**	**$ (44,719)**	**$ (45,230)**	**$ (45,733)**	**$ (46,227)**
Cost Summary (in 2020 Dollars)																						
Capital Cost $	15,630,000	$ -	$ -	$ -	$ -	$ 3,792,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,838,000	$ -	$ -	$ -	$ -	$ -
O&M Cost $	(865,258)	$ (37,000)	$ (37,320)	$ (37,553)	$ (37,830)	$ (38,162)	$ (38,562)	$ (39,007)	$ (39,453)	$ (39,918)	$ (40,424)	$ (40,949)	$ (41,503)	$ (42,054)	$ (42,600)	$ (43,140)	$ (43,674)	$ (44,200)	$ (44,719)	$ (45,230)	$ (45,733)	$ (46,227)
Total		**$ (37,000)**	**$ (37,320)**	**$ (37,553)**	**$ (37,830)**	**$ 3,753,838**	**$ (38,562)**	**$ (39,007)**	**$ (39,453)**	**$ (39,918)**	**$ (40,424)**	**$ (40,949)**	**$ (41,503)**	**$ (42,054)**	**$ (42,600)**	**$ (43,140)**	**$ 11,794,326**	**$ (44,200)**	**$ (44,719)**	**$ (45,230)**	**$ (45,733)**	**$ (46,227)**
Net Present Value (shown in discounted 2020 dollars)																						
Discount Rate =	3%																					
Escalation Rate =	3%																					
Capital NPV = $	15,630,000	$0	$0	$0	$0	$3,792,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$11,838,000	$0	$0	$0	$0	$0
O&M NPV = $	(866,000)	($37,000)	($37,000)	($38,000)	($38,000)	($38,000)	($39,000)	($39,000)	($39,000)	($40,000)	($40,000)	($41,000)	($42,000)	($42,000)	($43,000)	($43,000)	($44,000)	($44,000)	($45,000)	($45,000)	($46,000)	($46,000)
Total NPV = $	**14,764,000**	**($37,000)**	**($37,000)**	**($38,000)**	**($38,000)**	**$3,754,000**	**($39,000)**	**($39,000)**	**($39,000)**	**($40,000)**	**($40,000)**	**($41,000)**	**($42,000)**	**($42,000)**	**($43,000)**	**($43,000)**	**$11,794,000**	**($44,000)**	**($45,000)**	**($45,000)**	**($46,000)**	**($46,000)**

Assumptions

1. Ferric addition at 13.5mgd = 1,000 gal/day for CEPT
2. Polymer addition = 1mg/L for CEPT
3. Aeration reduction based on CEPT - decreases 10% to aeration basins. Assume 2 blowers on - at 600HP. Delta is 60HP
4. Adding CEPT increases solids concentrations by 10%

carollo

CLIENT: City of Grand Junction
PROJECT : 2020 Persigo WWTP Master Plan
Process: NPV - Digestion Alternative #1 - Use Aerobic and Anaerobic Digestion for Class B Biosolic

UPDATED: Oct-20
BY : BC
CHECKED: DSP

Item Description	Year 0 2020	Year 1 2021	Year 2 2022	Year 3 2023	Year 4 2024	Year 5 2025	Year 6 2026	Year 7 2027	Year 8 2028	Year 9 2029	Year 10 2030	Year 11 2031	Year 12 2032	Year 13 2033	Year 14 2034	Year 15 2035	Year 16 2036	Year 17 2037	Year 18 2038	Year 19 2039	Year 20 2040
Projections																					
Flow Average Daily Annual Flow - ADAF (MGD)	9.0	9.1	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8	10.0	10.1	10.2	10.4	10.5	10.6	10.7	10.9	11.0	11.1	11.2
Difference in biosolids quantities to baseline (wet tns/yr)	(3,791)	(3,809)	(3,832)	(3,861)	(3,895)	(3,935)	(3,981)	(4,026)	(4,074)	(4,125)	(4,179)	(4,236)	(4,292)	(4,347)	(4,403)	(4,457)	(4,511)	(4,564)	(4,616)	(4,667)	(4,718)
% difference from baseline	-20%																				
Chemicals perational change (2.5% to 5%)(lb chemical/yr)	7,211	7,245	7,290	7,344	7,409	7,486	7,573	7,659	7,749	7,848	7,949	8,057	8,164	8,270	8,375	8,479	8,581	8,681	8,781	8,878	8,974
ewatering operations due to decrease in solids (lb chemical/yr)	(7,496)	(7,531)	(7,578)	(7,634)	(7,701)	(7,781)	(7,871)	(7,961)	(8,055)	(8,157)	(8,263)	(8,375)	(8,486)	(8,596)	(8,705)	(8,813)	(8,919)	(9,024)	(9,127)	(9,228)	(9,328)
Electricity to run unit 24hr/5d instead of 10h/5d (kWh/yr)	26,308	26,431	26,596	26,792	27,027	27,310	27,626	27,941	28,271	28,629	29,001	29,394	29,784	30,170	30,553	30,931	31,304	31,671	32,033	32,389	32,739
Aerobic electrical costs additional (1 digester) (kWh/year)	50,249	50,485	50,800	51,174	51,624	52,165	52,767	53,370	53,999	54,683	55,393	56,144	56,889	57,627	58,358	59,080	59,792	60,494	61,185	61,865	62,533
Decrease in mixing energy for pre-digestion mixing (kWh/yr)	(44,585)	(44,794)	(45,074)	(45,406)	(45,805)	(46,285)	(46,819)	(47,354)	(47,912)	(48,519)	(49,149)	(49,815)	(50,476)	(51,132)	(51,780)	(52,420)	(53,052)	(53,675)	(54,288)	(54,892)	(55,485)
Change in dewatering electricity amounts (kWh/yr)	(5,330)	(5,355)	(5,380)	(5,405)	(5,430)	(5,456)	(5,481)	(5,507)	(5,533)	(5,559)	(5,585)	(5,611)	(5,637)	(5,664)	(5,691)	(5,717)	(5,744)	(5,771)	(5,798)	(5,825)	(5,853)
Biosolids Hauling Decrease in biosoilds hauling (# truck loads)	(207)	(208)	(209)	(211)	(213)	(215)	(217)	(220)	(222)	(225)	(228)	(231)	(234)	(237)	(240)	(243)	(246)	(249)	(252)	(255)	(258)
Capital Costs (in 2020 Dollars)																					
Asset R&R - Aerobic Digesters		$ -	$ -	$ -	$ -	$ -	$ -	$ 3,785,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Asset R&R - Anaerobic Digesters		$ -	$ -	$ -	$ 7,436,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Second DAFT		$ -	$ -	$ 4,000,000	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Additional Aerobic Digester (2040)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		$ 4,000,000	$ -	$ -	$ -	$ -
Total Capital Cost	**$ -**	**$ -**	**$ -**	**$ 4,000,000**	**$ 7,436,000**	**$ -**	**$ -**	**$ 3,785,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 4,000,000**	**$ -**	**$ -**	**$ -**	**$ -**
Operations Costs (in 2020 Dollars)																					
Polymer	$ (378)	$ (380)	$ (382)	$ (385)	$ (388)	$ (393)	$ (397)	$ (402)	$ (406)	$ (411)	$ (417)	$ (422)	$ (428)	$ (434)	$ (439)	$ (445)	$ (450)	$ (455)	$ (460)	$ (466)	$ (471)
Electricity	$ 1,599	$ 1,606	$ 1,617	$ 1,629	$ 1,645	$ 1,664	$ 1,686	$ 1,707	$ 1,729	$ 1,754	$ 1,780	$ 1,807	$ 1,834	$ 1,860	$ 1,886	$ 1,912	$ 1,938	$ 1,963	$ 1,988	$ 2,012	$ 2,036
Biosolids Hauling	$ (3,211)	$ (3,226)	$ (3,246)	$ (3,270)	$ (3,299)	$ (3,333)	$ (3,372)	$ (3,410)	$ (3,450)	$ (3,494)	$ (3,540)	$ (3,588)	$ (3,635)	$ (3,682)	$ (3,729)	$ (3,775)	$ (3,821)	$ (3,865)	$ (3,910)	$ (3,953)	$ (3,996)
Biosolids Tipping	$ (58,993)	$ (62,233)	$ (65,752)	$ (69,549)	$ (73,668)	$ (78,161)	$ (83,017)	$ (88,164)	$ (93,663)	$ (99,592)	$ (105,930)	$ (112,733)	$ (119,942)	$ (127,573)	$ (135,650)	$ (144,194)	$ (153,229)	$ (162,780)	$ (172,872)	$ (183,533)	$ (194,791)
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total O&M Cost	**$ (61,000)**	**$ (64,233)**	**$ (67,764)**	**$ (71,574)**	**$ (75,711)**	**$ (80,223)**	**$ (85,101)**	**$ (90,269)**	**$ (95,790)**	**$ (101,744)**	**$ (108,107)**	**$ (114,937)**	**$ (122,171)**	**$ (129,829)**	**$ (137,931)**	**$ (146,502)**	**$ (155,561)**	**$ (165,137)**	**$ (175,254)**	**$ (185,939)**	**$ (197,221)**
Cost Summary (in 2020 Dollars)																					
Capital Cost $ 19,221,000	$ -	$ -	$ -	$ 4,000,000	$ 7,436,000	$ -	$ -	$ 3,785,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 4,000,000	$ -	$ -	$ -	$ -
O&M Cost $ (2,432,000)	$ (61,000)	$ (64,233)	$ (67,764)	$ (71,574)	$ (75,711)	$ (80,223)	$ (85,101)	$ (90,269)	$ (95,790)	$ (101,744)	$ (108,107)	$ (114,937)	$ (122,171)	$ (129,829)	$ (137,931)	$ (146,502)	$ (155,561)	$ (165,137)	$ (175,254)	$ (185,939)	$ (197,221)
Total	**$ (61,000)**	**$ (64,233)**	**$ (67,764)**	**$ 3,928,426**	**$ 7,360,289**	**$ (80,223)**	**$ (85,101)**	**$ 3,694,731**	**$ (95,790)**	**$ (101,744)**	**$ (108,107)**	**$ (114,937)**	**$ (122,171)**	**$ (129,829)**	**$ (137,931)**	**$ (146,502)**	**$ 3,844,439**	**$ (165,137)**	**$ (175,254)**	**$ (185,939)**	**$ (197,221)**
Net Present Value (shown in discounted 2020 dollars)																					
Discount Rate = 3%																					
Escalation Rate = 3%																					
Capital NPV = $ 19,221,000	$0	$0	$0	$4,000,000	$7,436,000	$0	$0	$3,785,000	$0	$0	$0	$0	$0	$0	$0	$0	$4,000,000	$0	$0	$0	$0
O&M NPV = $ (2,433,000)	($61,000)	($64,000)	($68,000)	($72,000)	($76,000)	($80,000)	($85,000)	($90,000)	($96,000)	($102,000)	($108,000)	($115,000)	($122,000)	($130,000)	($138,000)	($147,000)	($156,000)	($165,000)	($175,000)	($186,000)	($197,000)
Total NPV = $ 16,788,000	**($61,000)**	**($64,000)**	**($68,000)**	**$3,928,000**	**$7,360,000**	**($80,000)**	**($85,000)**	**$3,695,000**	**($96,000)**	**($102,000)**	**($108,000)**	**($115,000)**	**($122,000)**	**($130,000)**	**($138,000)**	**($147,000)**	**$3,844,000**	**($165,000)**	**($175,000)**	**($186,000)**	**($197,000)**
Assumptions																					

APPENDIX E - Net Present Value Calculations for Alternative Analysis

carollo

CLIENT:	City of Grand Junction	UPDATED:	Oct-20
PROJECT :	2020 Persigo WWTP Master Plan	BY :	BC
Process:	NPV - Digester Alternative #2 - Conversion to full Anaerobic Digestion Treatment	CHECKED:	DSP

Item Description		Year 0 2020	Year 1 2021	Year 2 2022	Year 3 2023	Year 4 2024	Year 5 2025	Year 6 2026	Year 7 2027	Year 8 2028	Year 9 2029	Year 10 2030
Projections												
Flow Average Daily Annual Flow (MGD)		9.0	9.1	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8	10.0
Difference in Solids quantities compared to baseline		(5,427) -29%	(5,452)	(5,486)	(5,526)	(5,575)	(5,633)	(5,699)	(5,764)	(5,831)	(5,905)	(5,982)
Chemicals Jsage (increase from baseline) (lb chemical/yr)		8,685	8,726	8,780	8,845	8,922	9,016	9,120	9,224	9,333	9,451	9,574
CREDIT (diff in digested sludge from baseline) (lb chemical/yr)		(11,780)	(11,836)	(11,909)	(11,997)	(12,103)	(12,229)	(12,371)	(12,512)	(12,659)	(12,820)	(12,986)
Electricity ctricity (increase from baseline) (kWh per year)		31,698	31,847	32,046	32,282	32,566	32,907	33,287	33,667	34,063	34,495	34,943
cal CREDIT for Aerobic Digesters (4 digesters) (kWh per year)		(200,998)	(201,941)	(203,199)	(204,697)	(206,497)	(208,659)	(211,068)	(213,479)	(215,994)	(218,732)	(221,573)
sts for Anaerobic Digesters (TWAS adder only) (kWh per year)		23,116	23,224	23,369	23,541	23,748	23,997	24,274	24,551	24,841	25,155	25,482
CREDIT (diff in digested sludge from baseline) (kWh per year)		(70,072)	(70,401)	(70,840)	(71,362)	(71,989)	(72,743)	(73,583)	(74,423)	(75,300)	(76,255)	(77,245)
CREDIT (diff in digested sludge from baseline) (kWh per year)		(3,328)	(3,343)	(3,364)	(3,389)	(3,419)	(3,454)	(3,494)	(3,534)	(3,576)	(3,621)	(3,668)
Natural Gas												
Biogas Generation Biogas quantity (scf per year)		15,768,000	15,841,991	15,940,713	16,058,195	16,199,415	16,369,002	16,558,033	16,747,136	16,944,454	17,159,228	17,382,101
Biosolids Hauling Decrease in biosoilds hauling (# truck loads)		(296)	(298)	(299)	(300)	(302)	(303)	(305)	(306)	(308)	(309)	(311)
Capital Costs (2020 Dollars)												
Asset R&R - Aerobic Digesters		$ -	$ -		$ 2,900,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Asset R&R - Anaerobic Digesters		$ -	$ -	$ 7,436,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Asset R&R - DAFT		$ -	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
FOG Receiving Station		$ -	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Second DAFT		$ -	$ -		$ 4,000,000	$ -		$ -	$ -	$ -	$ -	$ -
Additional Primary Anaerobic Digester		$ -	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Additional Biogas Conditioning (2027)		$ -	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Cost		**$ -**	**$ -**	**$ 7,436,000**	**$ 6,900,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Operations Costs (2020 Dollars)												
Polymer		($4,117)	($4,136)	($4,162)	($4,193)	($4,230)	($4,274)	($4,323)	($4,373)	($4,424)	($4,480)	($4,539)
Electricity		($13,175)	($13,237)	($13,319)	($13,417)	($13,535)	($13,677)	($13,835)	($13,993)	($14,158)	($14,337)	($14,524)
Natural Gas												
Biosolids Hauling		($4,596)	($4,618)	($4,640)	($4,661)	($4,683)	($4,705)	($4,727)	($4,749)	($4,772)	($4,794)	($4,817)
Biosolids Tipping		($84,448)	($89,086)	($93,980)	($99,142)	($104,587)	($110,332)	($116,392)	($122,785)	($129,529)	($136,644)	($144,150)
Biogas RIN Revenue		($98,144)	($98,605)	($99,219)	($99,950)	($100,829)	($101,885)	($103,062)	($104,239)	($105,467)	($106,804)	($108,191)
O&M Labor & Parts (1% of Total Capital Cost)												
Total O&M Cost		**$ (204,000)**	**$ (209,682)**	**$ (215,320)**	**$ (221,364)**	**$ (227,865)**	**$ (234,873)**	**$ (242,339)**	**$ (250,139)**	**$ (258,350)**	**$ (267,060)**	**$ (276,219)**
Cost Summary (2020 Values)												
Capital Cost	$ 14,336,000	$ -	$ -	$ 7,436,000	$ 6,900,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -
O&M Cost	$ (5,978,000)	$ (204,000)	$ (209,682)	$ (215,320)	$ (221,364)	$ (227,865)	$ (234,873)	$ (242,339)	$ (250,139)	$ (258,350)	$ (267,060)	$ (276,219)
Total		**$ (204,000)**	**$ (209,682)**	**$ 7,220,680**	**$ 6,678,636**	**$ (227,865)**	**$ (234,873)**	**$ (242,339)**	**$ (250,139)**	**$ (258,350)**	**$ (267,060)**	**$ (276,219)**
Net Present Value												
Discount Rate =	3%											
Escalation Rate =	3%											
Capital NPV =	$ 14,336,000	$ -	$0	$7,436,000	$6,900,000	$0	$0	$0	$0	$0	$0	$0
O&M NPV =	$ (5,978,000)	(204,000)	(210,000)	(215,000)	(221,000)	(228,000)	(235,000)	(242,000)	(250,000)	(258,000)	(267,000)	(276,000)
Total NPV =	**$ 8,358,000**	**$ (204,000)**	**$ (210,000)**	**$ 7,221,000**	**$ 6,679,000**	**$ (228,000)**	**$ (235,000)**	**$ (242,000)**	**$ (250,000)**	**$ (258,000)**	**$ (267,000)**	**$ (276,000)**

Item Description	Year 11 2031	Year 12 2032	Year 13 2033	Year 14 2034	Year 15 2035	Year 16 2036	Year 17 2037	Year 18 2038	Year 19 2039	Year 20 2040
Projections										
Flow Average Daily Annual Flow (MGD)	10.1	10.2	10.4	10.5	10.6	10.7	10.9	11.0	11.1	11.2
Difference in Solids quantities compared to baseline	(6,063)	(6,144)	(6,223)	(6,302)	(6,380)	(6,457)	(6,533)	(6,608)	(6,681)	(6,753)
Chemicals Jsage (increase from baseline) (lb chemical/yr)	9,703	9,832	9,960	10,086	10,211	10,334	10,455	10,575	10,692	10,808
CREDIT (diff in digested sludge from baseline) (lb chemical/yr)	(13,162)	(13,337)	(13,510)	(13,681)	(13,851)	(14,017)	(14,182)	(14,344)	(14,504)	(14,660)
Electricity ctricity (increase from baseline) (kWh per year)	35,417	35,887	36,353	36,813	37,269	37,718	38,161	38,597	39,026	39,447
cal CREDIT for Aerobic Digesters (4 digesters) (kWh per year)	(224,574)	(227,556)	(230,510)	(233,431)	(236,319)	(239,167)	(241,976)	(244,741)	(247,461)	(250,134)
sts for Anaerobic Digesters (TWAS adder only) (kWh per year)	25,827	26,170	26,510	26,846	27,178	27,506	27,829	28,147	28,460	28,767
CREDIT (diff in digested sludge from baseline) (kWh per year)	(78,291)	(79,331)	(80,361)	(81,379)	(82,386)	(83,379)	(84,358)	(85,322)	(86,270)	(87,202)
CREDIT (diff in digested sludge from baseline) (kWh per year)	(3,718)	(3,767)	(3,816)	(3,865)	(3,912)	(3,960)	(4,006)	(4,052)	(4,097)	(4,141)
Natural Gas										
Biogas Generation Biogas quantity (scf per year)	17,617,550	17,851,492	18,083,182	18,312,344	18,538,935	18,762,369	18,982,711	19,199,639	19,413,021	19,622,678
Biosolids Hauling Decrease in biosoilds hauling (# truck loads)	(312)	(313)	(315)	(316)	(318)	(319)	(321)	(322)	(324)	(325)
Capital Costs (2020 Dollars)										
Asset R&R - Aerobic Digesters	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Asset R&R - Anaerobic Digesters	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Asset R&R - DAFT	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
FOG Receiving Station	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Second DAFT	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Additional Primary Anaerobic Digester	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Additional Biogas Conditioning (2027)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Cost	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Operations Costs (2020 Dollars)										
Polymer	($4,600)	($4,661)	($4,722)	($4,781)	($4,841)	($4,899)	($4,957)	($5,013)	($5,069)	($5,124)
Electricity	($14,720)	($14,916)	($15,109)	($15,301)	($15,490)	($15,677)	($15,861)	($16,042)	($16,221)	($16,396)
Natural Gas										
Biosolids Hauling	($4,839)	($4,862)	($4,885)	($4,908)	($4,931)	($4,954)	($4,977)	($5,000)	($5,024)	($5,047)
Biosolids Tipping	($152,067)	($160,420)	($169,231)	($178,527)	($188,333)	($198,677)	($209,590)	($221,102)	($233,247)	($246,058)
Biogas RIN Revenue	($109,656)	($111,112)	($112,554)	($113,981)	($115,391)	($116,782)	($118,153)	($119,504)	($120,832)	($122,137)
O&M Labor & Parts (1% of Total Capital Cost)										
Total O&M Cost	**$ (285,883)**	**$ (295,971)**	**$ (306,502)**	**$ (317,498)**	**$ (328,985)**	**$ (340,989)**	**$ (353,538)**	**$ (366,662)**	**$ (380,392)**	**$ (394,762)**
Cost Summary (2020 Values)										
Capital Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
O&M Cost	$ (285,883)	$ (295,971)	$ (306,502)	$ (317,498)	$ (328,985)	$ (340,989)	$ (353,538)	$ (366,662)	$ (380,392)	$ (394,762)
Total	**$ (285,883)**	**$ (295,971)**	**$ (306,502)**	**$ (317,498)**	**$ (328,985)**	**$ (340,989)**	**$ (353,538)**	**$ (366,662)**	**$ (380,392)**	**$ (394,762)**
Net Present Value										
Capital NPV =	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
O&M NPV =	(286,000)	(296,000)	(307,000)	(317,000)	(329,000)	(341,000)	(354,000)	(367,000)	(380,000)	(395,000)
Total NPV =	**$ (286,000)**	**$ (296,000)**	**$ (307,000)**	**$ (317,000)**	**$ (329,000)**	**$ (341,000)**	**$ (354,000)**	**$ (367,000)**	**$ (380,000)**	**$ (395,000)**

Assumptions

1. Capex for Aerobic digesters assumes infrastructure repurposed for mixing and storage.

APPENDIX E - Net Present Value Calculations for Alternative Analysis

CLIENT:	City of Grand Junction	**UPDATED:**	Oct-20
PROJECT :	2020 Persigo WWTP Master Plan	**BY :**	BC
Process:	NPV - Dewatering Alternative #1 - Screw Press Dewatering Process with solar drying	**CHECKED:**	DSP

Item Description	Year 0 2020	Year 1 2021	Year 2 2022	Year 3 2023	Year 4 2024	Year 5 2025	Year 6 2026	Year 7 2027	Year 8 2028	Year 9 2029	Year 10 2030	Year 11 2031	Year 12 2032	Year 13 2033	Year 14 2034	Year 15 2035	Year 16 2036	Year 17 2037	Year 18 2038	Year 19 2039	Year 20 2040
Projections																					
Flows Average Daily Annual Flow (MGD)	9.0	9.1	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8	10.0	10.1	10.2	10.4	10.5	10.6	10.7	10.9	11.0	11.1	11.2
s based change in screw press as compared to baseline (wt/yr)	(5,739)	(5,766)	(5,802)	(5,845)	(5,896)	(5,958)	(6,027)	(6,096)	(6,167)	(6,246)	(6,327)	(6,412)	(6,497)	(6,582)	(6,665)	(6,748)	(6,829)	(6,909)	(6,988)	(7,066)	(7,142)
% difference from baseline	-31%																				
Chemicals Isage (increase from baseline) (lb chemical/yr)	34,694	34,857	35,074	35,333	35,643	36,016	36,432	36,848	37,283	37,755	38,246	38,764	39,278	39,788	40,292	40,791	41,283	41,767	42,245	42,714	43,175
Electricity :tricity (increase from baseline) (kWh per year)	3,789	3,807	3,830	3,859	3,892	3,933	3,979	4,024	4,071	4,123	4,177	4,233	4,289	4,345	4,400	4,455	4,508	4,561	4,613	4,665	4,715
iosolids Storage Electricity Used (all biosolids) (kWh per year)	314,964	316,442	318,414	320,760	323,581	326,969	330,745	334,522	338,463	342,753	347,205	351,908	356,581	361,209	365,787	370,313	374,776	379,177	383,510	387,773	391,960
Biosolids Haulingentration = 70% (change from 12% to 70%)	(15,285)	(15,356)	(15,452)	(15,566)	(15,703)	(15,867)	(16,050)	(16,234)	(16,425)	(16,633)	(16,849)	(17,077)	(17,304)	(17,529)	(17,751)	(17,971)	(18,187)	(18,401)	(18,611)	(18,818)	(19,021)
	-82%																				
Decrease in biosolids hualing (#trucks)	(835)	(838)	(844)	(850)	(857)	(866)	(876)	(886)	(897)	(908)	(920)	(932)	(945)	(957)	(969)	(981)	(993)	(1,005)	(1,016)	(1,028)	(1,039)
Decrease in truck mileage and diesel used (gal/yr)	(4,674)	(4,696)	(4,725)	(4,760)	(4,802)	(4,852)	(4,908)	(4,964)	(5,022)	(5,086)	(5,152)	(5,222)	(5,291)	(5,360)	(5,428)	(5,495)	(5,561)	(5,627)	(5,691)	(5,754)	(5,816)
	4,160	4,180	4,206	4,237	4,274	4,319	4,368	4,418	4,470	4,527	4,586	4,648	4,710	4,771	4,831	4,891	4,950	5,008	5,065	5,122	5,177
Personnel Ided 0.5FTE for management of solar (Hours)	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040
Capital Costs																					
$ 18,100,000 Screw Presses	$ -	$ -	$ 16,600,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 17,800,000 Solar Drying	$ -	$ -	$ 16,260,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 35,900,000																					
Total Capital Cost	**$ -**	**$ -**	**$ 32,860,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Operations Costs																					
Polymer	46,143	46,360	46,649	46,992	47,406	47,902	48,455	49,008	49,586	50,214	50,867	51,556	52,240	52,918	53,589	54,252	54,906	55,551	56,185	56,810	57,423
Electricity	19,125	19,215	19,335	19,477	19,648	19,854	20,083	20,313	20,552	20,813	21,083	21,368	21,652	21,933	22,211	22,486	22,757	23,024	23,287	23,546	23,801
Biosolids Hauling + Solar Farm Equip Diesel	(1,423)	(1,430)	(1,438)	(1,449)	(1,462)	(1,477)	(1,494)	(1,511)	(1,529)	(1,548)	(1,568)	(1,590)	(1,611)	(1,632)	(1,652)	(1,673)	(1,693)	(1,713)	(1,732)	(1,752)	(1,771)
Biosolids Tipping	(237,856)	(250,921)	(265,108)	(280,415)	(297,025)	(315,142)	(334,720)	(355,470)	(377,641)	(401,549)	(427,103)	(454,532)	(483,597)	(514,367)	(546,929)	(581,382)	(617,808)	(656,317)	(697,008)	(739,992)	(785,383)
O&M Labor & Parts (0.5FTE for solar drying operations)	47,840	47,840	47,840	47,840	47,840	47,840	47,840	47,840	47,840	47,840	47,840	47,840	47,840	47,840	47,840	47,840	47,840	47,840	47,840	47,840	47,840
Total O&M Cost	**(126,000)**	**(138,935)**	**(152,724)**	**(167,555)**	**(183,593)**	**(201,023)**	**(219,836)**	**(239,820)**	**(261,192)**	**(284,230)**	**(308,882)**	**(335,358)**	**(363,475)**	**(393,307)**	**(424,942)**	**(458,477)**	**(493,998)**	**(531,615)**	**(571,427)**	**(613,547)**	**(658,090)**
Cost Summary																					
Capital Cost $ 32,860,000	0	0	32,860,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O&M Cost $ (7,128,000)	(126,000)	(138,935)	(152,724)	(167,555)	(183,593)	(201,023)	(219,836)	(239,820)	(261,192)	(284,230)	(308,882)	(335,358)	(363,475)	(393,307)	(424,942)	(458,477)	(493,998)	(531,615)	(571,427)	(613,547)	(658,090)
Total	**(126,000)**	**(138,935)**	**32,707,276**	**(167,555)**	**(183,593)**	**(201,023)**	**(219,836)**	**(239,820)**	**(261,192)**	**(284,230)**	**(308,882)**	**(335,358)**	**(363,475)**	**(393,307)**	**(424,942)**	**(458,477)**	**(493,998)**	**(531,615)**	**(571,427)**	**(613,547)**	**(658,090)**
Net Present Value																					
Discount Rate = 3%																					
Escalation Rate = 3%																					
Capital NPV = $ 32,860,000	0	0	32,860,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O&M NPV = $ (7,128,000)	(126,000)	(139,000)	(153,000)	(168,000)	(184,000)	(201,000)	(220,000)	(240,000)	(261,000)	(284,000)	(309,000)	(335,000)	(363,000)	(393,000)	(425,000)	(458,000)	(494,000)	(532,000)	(571,000)	(614,000)	(658,000)
Total NPV = $ 25,732,000	**(126,000)**	**(139,000)**	**32,707,000**	**(168,000)**	**(184,000)**	**(201,000)**	**(220,000)**	**(240,000)**	**(261,000)**	**(284,000)**	**(309,000)**	**(335,000)**	**(363,000)**	**(393,000)**	**(425,000)**	**(458,000)**	**(494,000)**	**(532,000)**	**(571,000)**	**(614,000)**	**(658,000)**
Assumptions																					

APPENDIX E - Net Present Value Calculations for Alternative Analysis

CLIENT:	City of Grand Junction	**UPDATED:**	44,120
PROJECT :	2020 Persigo WWTP Master Plan	**BY :**	BC
Process:	NPV - Dewatering Alternative #2 - Centrifuge Dewatering Process with 100 Days of bioso	**CHECKED:**	DSP

Item Description		Year 0 2020	Year 1 2021	Year 2 2022	Year 3 2023	Year 4 2024	Year 5 2025	Year 6 2026	Year 7 2027	Year 8 2028	Year 9 2029	Year 10 2030
Projections												
Flow Average Daily Annual Flow (MGD)		9.0	9.1	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8	10.0
olids Quantity CREDIT (decrease from baseline) (wet ton/year)		(8,075)	(8,113)	(8,164)	(8,224)	(8,296)	(8,383)	(8,480)	(8,577)	(8,678)	(8,788)	(8,902)
% difference from baseline		(0)										
Chemicals Jsage (increase from baseline) (lb chemical/yr)		46,259	46,476	46,765	47,110	47,524	48,022	48,576	49,131	49,710	50,340	50,994
Electricity ctricity (increase from baseline) (kWh per year)		52,345	52,591	52,919	53,309	53,777	54,340	54,968	55,596	56,251	56,964	57,704
iosolids Storage Electricity Used (all biosolids) (kWh per year)		13,067	13,128	13,210	13,307	13,424	13,565	13,721	13,878	14,042	14,220	14,404
Biosolids Hauling Decrease in biosolids hauling from baseline		(441)	(443)	(446)	(449)	(453)	(458)	(463)	(468)	(474)	(480)	(486)
Capital Costs												
Centrifuge Bldg			0	15,330,000	0	0	0	0	0	0	0	0
100 Days of Storage			0	2,870,000	0	0	0	0	0	0	0	0
Total Capital Cost		**0**	**0**	**18,200,000**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Operations Costs												
Polymer		61,524	61,813	62,198	62,656	63,207	63,869	64,607	65,345	66,114	66,952	67,822
Electricity		3,925	3,943	3,968	3,997	4,032	4,074	4,121	4,168	4,218	4,271	4,326
Biosolids Hauling		(6,840)	(6,872)	(6,915)	(6,966)	(7,027)	(7,101)	(7,183)	(7,265)	(7,350)	(7,443)	(7,540)
Biosolids Tipping		(125,668)	(132,571)	(140,067)	(148,154)	(156,930)	(166,502)	(176,846)	(187,808)	(199,522)	(212,154)	(225,655)
O&M Labor & Parts (1% of Total Capital Cost)												
Total O&M Cost		**(67,000)**	**(73,687)**	**(80,816)**	**(88,467)**	**(96,717)**	**(105,659)**	**(115,300)**	**(125,560)**	**(136,541)**	**(148,374)**	**(161,046)**
Cost Summary												
Capital Cost	18,200,000	0	0	18,200,000	0	0	0	0	0	0	0	0
O&M Cost	(3,717,000)	(67,000)	(73,687)	(80,816)	(88,467)	(96,717)	(105,659)	(115,300)	(125,560)	(136,541)	(148,374)	(161,046)
Total		**(67,000)**	**(73,687)**	**18,119,184**	**(88,467)**	**(96,717)**	**(105,659)**	**(115,300)**	**(125,560)**	**(136,541)**	**(148,374)**	**(161,046)**
Net Present Value												
Discount Rate =	3											
Escalation Rate =	3											
Capital NPV =	18,200,000	0	0	18,200,000	0	0	0	0	0	0	0	0
O&M NPV =	(3,719,000)	(67,000)	(74,000)	(81,000)	(88,000)	(97,000)	(106,000)	(115,000)	(126,000)	(137,000)	(148,000)	(161,000)
Total NPV =	**14,481,000**	**(67,000)**	**(74,000)**	**18,119,000**	**(88,000)**	**(97,000)**	**(106,000)**	**(115,000)**	**(126,000)**	**(137,000)**	**(148,000)**	**(161,000)**
Assumptions												

Item Description	Year 11 2031	Year 12 2032	Year 13 2033	Year 14 2034	Year 15 2035	Year 16 2036	Year 17 2037	Year 18 2038	Year 19 2039	Year 20 2040
Projections										
Flow Average Daily Annual Flow (MGD)	10.1	10.2	10.4	10.5	10.6	10.7	10.9	11.0	11.1	11.2
olids Quantity CREDIT (decrease from baseline) (wet ton/year)	(9,023)	(9,142)	(9,261)	(9,379)	(9,495)	(9,609)	(9,722)	(9,833)	(9,942)	(10,050)
% difference from baseline										
Chemicals Jsage (increase from baseline) (lb chemical/yr)	51,685	52,371	53,051	53,723	54,388	55,043	55,690	56,326	56,952	57,567
Electricity ctricity (increase from baseline) (kWh per year)	58,485	59,262	60,031	60,792	61,544	62,286	63,017	63,737	64,446	65,142
iosolids Storage Electricity Used (all biosolids) (kWh per year)	14,599	14,793	14,985	15,175	15,363	15,548	15,731	15,911	16,087	16,261
Biosolids Hauling Decrease in biosolids hauling from baseline	(493)	(499)	(506)	(512)	(518)	(525)	(531)	(537)	(543)	(549)
Capital Costs										
Centrifuge Bldg	0	0	0	0	0	0	0	0	0	0
100 Days of Storage	0	0	0	0	0	0	0	0	0	0
Total Capital Cost	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Operations Costs										
Polymer	68,741	69,654	70,558	71,452	72,336	73,208	74,067	74,914	75,746	76,564
Electricity	4,385	4,443	4,501	4,558	4,614	4,670	4,725	4,779	4,832	4,884
Biosolids Hauling	(7,642)	(7,744)	(7,844)	(7,944)	(8,042)	(8,139)	(8,234)	(8,328)	(8,421)	(8,512)
Biosolids Tipping	(240,147)	(255,503)	(271,760)	(288,964)	(307,166)	(326,412)	(346,757)	(368,256)	(390,966)	(414,948)
O&M Labor & Parts (1% of Total Capital Cost)										
Total O&M Cost	**(174,663)**	**(189,150)**	**(204,545)**	**(220,898)**	**(238,258)**	**(256,673)**	**(276,200)**	**(296,892)**	**(318,809)**	**(342,011)**
Cost Summary										
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Cost	(174,663)	(189,150)	(204,545)	(220,898)	(238,258)	(256,673)	(276,200)	(296,892)	(318,809)	(342,011)
Total	**(174,663)**	**(189,150)**	**(204,545)**	**(220,898)**	**(238,258)**	**(256,673)**	**(276,200)**	**(296,892)**	**(318,809)**	**(342,011)**
Net Present Value										
Discount Rate =										
Escalation Rate =										
Capital NPV =	0	0	0	0	0	0	0	0	0	0
O&M NPV =	(175,000)	(189,000)	(205,000)	(221,000)	(238,000)	(257,000)	(276,000)	(297,000)	(319,000)	(342,000)
Total NPV =	**(175,000)**	**(189,000)**	**(205,000)**	**(221,000)**	**(238,000)**	**(257,000)**	**(276,000)**	**(297,000)**	**(319,000)**	**(342,000)**
Assumptions										

Appendix F

PROCESS MODELING FOR ALTERNATIVES

BIOWIN MODEL RESULTS – CEPT

CEPT was modeled in BioWin using the steady state process model developed and calibrated for the capacity evaluation of the current facility (see Chapter 3). Table F.1 summarizes the model inputs and simulation results. Key assumptions adopted in the process model included:

- Design ADMMF = 13.5 mgd with design influent concentrations adopted from Chapter 2.
- Current solids handling configuration; anaerobic digestion of primary sludge and aerobic digestion of WAS
- Minimum aSRT = 8 days.
- All primary clarifiers in service; average BOD removal = 44%, average TSS removal = 60% as simulated by BioWin with CEPT at mainstream dose of 40 mg/L as ferric chloride.
- All aeration basins in service, operated in the two-train configuration and as a combined sludge system.
- Three secondary clarifiers in service (for operation in the two-train configuration and as a combined sludge system).
- Wastewater temperature = 15.7 degrees Celsius (60.3°F).
- Maximum MLSS concentration = 3,500 mg/L based on verbal discussions with plant staff.
- Design SVI under ADMM conditions = 150 mL/g.

Table F.1 BioWin Model Output of Secondary Treatment Capacity with CEPT

Parameter	Unit	CDPHE Guidance Criteria[1]	Simulated ADMMF Condition in BioWin
Influent			
ADMMF	mgd	12.5 mgd (Current Permitted Capacity)	13.5
BOD_5	ppd	26,480 (Current Permitted Capacity)	29,865
TSS	ppd	-	29,972
TKN	ppd	-	5,337
Ammonia	ppd	-	3,524
Temperature	degrees Celsius	-	15.7
Primary Clarifiers			
SOR	gpm/sq ft	800-1,200	725
TSS Removal	%	-	60
BOD_5 Removal	%	-	44

Parameter	Unit	CDPHE Guidance Criteria[1]	Simulated ADMMF Condition in BioWin
Aeration Basin Operation			
BOD_5 Loading	ppd/1,000 cu ft	5-20 (nitrification) 20-40	40
F:M Ratio	lbs BOD_5/d/lb MLVSS	0.1-0.25	0.26
Anoxic	hours	0.5-1.0	0.7[3]
Aerobic	hours	4-8	5.1[4]
aSRT	days	8-20	8
East Train MLSS	mg/L	2,000-3,500	3,750
East Train MLVSS			2,540
West Train MLSS	mg/L	2,000-3,500	3,750
West Train MLVSS	mg/L		2,540
Secondary Clarifier Operation[2]			
SLR	ppd/sq ft	29	24
SOR	gpd/sq ft	600	424
RAS Recycle	%	50-150	80
Effluent Quality			
BOD_5	mg/L	-	5.0
TSS	mg/L	-	13
Ammonia	mg/L	-	0.1
Nitrate	mg/L	-	20.4
Pressate			
Cake	%TS		19.7
Flow	mgd		0.8
TSS	mg/L		613
VSS	mg/L		404
NH_4	mg/L		170

Notes
(1) State of Colorado Design Criteria for Domestic Wastewater Treatment Works (CDPHE, 2012)
(2) SOR and SLR are presented for the ADMMF condition only.
(3) Assumes a forward flow of approximately 6.3 mgd through the east treatment train.
(4) Aerobic hydraulic retention time (HRT) varies between the east and west treatment trains given the anoxic volume in the east train.

Under the projected 2040 ADMMF flow and organic load, steady state process modeling suggests that the WWTP has sufficient treatment capacity and can comply with effluent permit requirements and most design criteria recommended by CDPHE if primary clarifier BOD_5 and TSS removal can be increased through CEPT to at least 44 percent and 60 percent, respectively. Note that this modeled performance was achieved with at a mainstream ferric chloride dose of 40 mg/L. The modeled BOD_5 loading to the aeration basins (40 ppd/1,000 cu ft) and the F:M ratio (0.26 lb BOD_5/lb MLVSS) are above the CDPHE design recommendations (5 to 20 for single stage nitrification and 20 to 40 for conventional activated sludge) and exceed design values observed at other Colorado facilities. However, the modeled values are similar to the currently rated treatment capacity as modeled in Chapter 3. These values could be further reduced by the City, should they choose to adopt CEPT in the future, by increasing the ferric dosage upstream of the primary clarifiers.

Based on projected chemical demands through the planning horizon and permitted capacity of the facility (Table F.2), a standalone chemical feed and storage facility will be required in the CIP.

Table F.2 Future Anticipated Chemical Demand for CEPT

Category	Current Conditions	13.5 mgd ADMMF Capacity
Annual Average $FeCl_3$ Demand (gpd)(1)	640	860
Annual Polymer Demand (gpd)(2)	25	35
Annual Average NaOH Demand (gpd)(3)	300	400

Notes:
(1) Assumes 38 percent wt. ferric chloride dosed at 40 mg/L as $FeCl_3$.
(2) Assumes active polyacrylamide concentration of 35 percent and dose of 1 mg/L.
(3) Assumes 48 percent wt. sodium hydroxide dosed to offset alkalinity consumption of ferric chloride dose.

Chemical and alkalinity addition for CEPT will add TDS to the effluent. A 20 to 40 mg/L increase in effluent TDS may occur under the above assumptions. As noted in Chapter 2, the City currently has a monthly salinity monitoring and reporting requirement in their permit for TDS in a representative sample of the final effluent when discharging into the Colorado River. According to the current discharge permit, the total salinity loading from the WWTP exceeds allowable limits in Regulation No. 61. As a result, the City was required to submit a report addressing salinity by January 1, 2019 to CDPHE.

Ferric addition will also result in increased solids loading to the digesters and dewatering system. An approximate 10 to 20 percent increase in current solids loading to the digesters may be observed based on the above assumptions, mainly in the form of chemical sludge (additional details provided in the solids handling sections below). Regardless, no additional solids handling capacity is required within the planning horizon. However, this increase in solids loading was accounted for in the NPV calculation.

BIOWIN MODEL RESULTS – SRT Control

Table B.2 in Appendix B summarizes the model inputs and simulation results. Key assumptions adopted in the process model included:

- Design ADMMF = 13.5 mgd with design influent concentrations adopted from Chapter 2.
- Current solids handling configuration; anaerobic digestion of primary sludge and aerobic digestion of WAS.
- All primary clarifiers in service; average BOD removal = 31%, average TSS removal = 50% as adopted during steady state model calibration and summarized in Chapter 3.
- All aeration basins in service, operated in the two-train configuration and as a combined sludge system.
- Three secondary clarifiers in service (for operation in the two-train configuration and as a combined sludge system).
- Wastewater temperature = 15.7°C (60.3°F).
- Maximum MLSS concentration = 3,500 mg/L based on verbal discussions with plant staff.
- Design SVI under ADMM conditions = 150 mL/g.

While ABAC was discussed as an opportunity to reduce aeration costs, reduce ammonia spikes in the effluent, and/or to better balance nitrification and denitrification to meet specific treatment goals and increase alkalinity recovery, the operations staff preferred that conventional DO control be pursued in the near-term. Once the plant is operating with well-tuned DO control, ABAC will be considered as part of future secondary treatment enhancements to the aeration system. As such, a steady state DO concentration of 2 mg/L was assumed in all aerated zones during process modeling.

Steady state process modeling suggests that the WWTP has sufficient treatment capacity and can comply with effluent permit requirements and most design criteria recommended by CDPHE if operations staff can reduce the design aSRT from 8 days (as demonstrated in Chapter 3) to approximately 6.3 days. Note that the modeled BOD_5 loading to the aeration basins (50 ppd/1,000 cu ft) and the F:M ratio (0.31 lb BOD_5/lb MLVSS) are above the CDPHE design recommendations (5 to 20 for single stage nitrification and 20 to 40 for conventional activated sludge) and exceed design values observed at other Colorado facilities. Should the City select this alternative for demonstrating treatment capacity through the 2040 planning horizon, Carollo recommends that the City further investigate:

- Opportunities to automate aSRT control, as a well controlled biomass inventory and sludge wasting system is critical for safely reducing nitrification safety factor and demonstrating additional treatment capacity at the planning horizon. This is particularly true given that projected BOD_5 loading to the aeration basins will exceed the criteria recommended by CDPHE, and therefore a site-specific variance may be required.
- Operating the aeration basins and secondary clarifiers as a combined MLSS system, rather than a separate sludge system. Operating as a combined MLSS system allows the WWTP to operate with all three secondary clarifiers in service with equal flow split, which helps to maintain solids loading rate and surface overflow rate below criteria recommended by CDPHE.
- The discrepancy between primary sludge reported by the WWTP and calculated primary sludge based on primary influent and effluent water quality data. As discussed in Chapter 3, the calculated primary clarifier percent removals and mass balance calculations may be unreliable for several reasons. Therefore, the project team agreed to adjust the primary clarifier percent removals in the calibrated BioWin model to achieve acceptable calibration with historical secondary treatment performance. This assumption has a direct impact on modeled treatment performance herein and therefore operations staff should investigate opportunities to close the mass balance and verify the

assumptions adopted in this Master Plan. This information will be critical when pursuing a capacity re-rating through CDPHE.

- Opportunities to record aeration air flow to each aeration basin in scfm). At this time, the installed flow meters only report air flow in cfm at site conditions and there is no instrumentation currently installed to monitor both temperature and pressure in the system. Therefore, a conversion from cfm to scfm to accurately size aeration equipment during the 2020 Master Plan was not possible and outside the scope of work. Having historical scfm data in the future will inform design improvements for both the baseline condition and this alternative, specifically sizing of improved aeration control equipment (e.g., valves, flow meters), diffuser modifications (e.g., calibrating aeration requirements to a site specific alpha value), aeration piping to each basin, and blower modifications / replacements.

Table F.3 BioWin Model Output of Secondary Treatment Capacity with Reduced aSRT and Aeration Control

Parameter	Unit	CDPHE Guidance Criteria[1]	Simulated ADMMF Condition in BioWin
Influent			
ADMMF	mgd	12.5 mgd (Permitted Capacity)	13.5
BOD_5	ppd	26,480 (Permitted Capacity)	29,865
TSS	ppd	-	29,972
TKN	ppd	-	5,337
Ammonia	ppd	-	3,524
Temperature	degrees Celsius	-	15.7
Primary Clarifiers			
SOR	gpm/sq ft	800-1,200	725
TSS Removal	%	-	50
BOD_5 Removal	%	-	31
Aeration Basin Operation			
BOD_5 Loading	ppd/1,000 cu ft	5-20 (nitrification) 20-40	50
F:M Ratio	lbs BOD_5/d/lb MLVSS	0.1-0.25	0.30
Anoxic	hours	0.5-1.0	0.7[3]
Aerobic	hours	4-8	5.1[4]
aSRT	days	8-20	6.3
East Train MLSS	mg/L	2,000-3,500	3,500
East Train MLVSS			2,694
West Train MLSS	mg/L	2,000-3,500	3,504
West Train MLVSS	mg/L		2,693
Secondary Clarifier Operation[2]			
SLR	ppd/sq ft	29	23
SOR	gpd/sq ft	600	432
RAS Recycle	%	50-150	80

Parameter	Unit	CDPHE Guidance Criteria(1)	Simulated ADMMF Condition in BioWin
Effluent Quality			
BOD_5	mg/L	-	5
TSS	mg/L	-	12
Ammonia	mg/L	-	0.15
Nitrate	mg/L	-	17.9
Pressate			
Cake	%TS		19.7
Flow	mgd		0.06
TSS	mg/L		570
VSS	mg/L		384
NH_4	mg/L		490

Notes

(1) State of Colorado Design Criteria for Domestic Wastewater Treatment Works (CDPHE, 2012)

(2) SOR and SLR are presented for the ADMMF condition only and assumes all three secondary clarifiers in service operating as a combined sludge system.

(3) Assumes a forward flow of approximately 6.84 mgd through the east treatment train.

(4) Aerobic hydraulic retention time (HRT) varies between the east and west treatment trains given the anoxic volume in the east train.

Appendix G

CAPITAL COST ESTIMATE – ELECTRICAL AND FIBER LOOP

APPENDIX G CAPITAL COST ESTIMATE - ELECTRICAL and FIBER LOOP

UPDATED:	Dec-20
BY :	AM
CHECKED:	DSP, CH

CLIENT	City of Grand Junction -		
PROJECT:	Rehabilitation of Adminstration Building	Estimate Basis (year) =	2021
Process Area:	General Site	Mid point of Construction (year) =	2024

Class V cost estimate to complete the rehabilitation, replacement, and facility improvements for the Administration Building at the Persigo Facility.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Remodeled Control Room	1	LS	$ 100,000	$ 100,000
Entryway remodel and facility improvements (bathrooms, HVA	1	LS	$ 125,000	$ 125,000
Laboratory Improvements	1	LS	$ 50,000	$ 50,000
Electrical equipment (replace and relocate)	1	LS	$ 225,000	$ 225,000
Additional office space (4 new offices)	1	LS	$ 85,000	$ 85,000
Additional Storage Facility	1	LS	$ 250,000	$ 250,000
			BASE ASSET COST	**$ 835,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	0	%		$ -
Structural / Architectural Allowance (Including Demolition)	10	%		$ 83,500
Coatings and Finishes	5	%		$ 41,750
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Electrical, IC, Programming Allowances	15	%		$ 125,000
Equipment installation	0	%		
Construction contingency	30	%		$ 326,000
			SUBTOTAL DIRECT COST	**$1,411,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 141,000
GC Overhead, Profit, Bonds, Mob	25	%		$ 353,000
City Taxes, other fees	4.5	%		$ 63,000
Cost Escalation to Mid-Point of Construction	3.0	%		
			TOTAL CONSTRUCTION COST	**$1,968,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	15	%		$ 295,000
Owner maintained project contingency	10	%		$ 197,000
			TOTAL PROJECT COST (2021 $'s)	**$2,460,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*

Esclated $'s	2021	2022	2023	2024	2025	2026
$ 2,688,000	$ -	$ -	$ 403,000	$ 2,285,000	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

carollo

UPDATED:	Dec-20
BY :	AM
CHECKED:	DSP, CH

CLIENT City of Grand Junction -
PROJECT: Electrical and Fiber Loop for Facility — Estimate Basis (year) = 2021
Process Area: General Site — Mid point of Construction (year) = 2025

Class V cost estimate to install a medium voltage electrical distribution and fiber loop at the Persigo Facility. This eliminates the single point of failure for the existing electrical ductbanks and provides a fiber loop to connect process buildings and provide networking capabilities for the site. The fiber would be used for the SCADA and communication systems.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Ductbank, manholes, cable and fiber	1	LS	$ 2,100,000	$ 2,100,000
Electrical Equipment (XFMR, SWG,) and terminations	1	LS	$ 550,000	$ 550,000
Site Civil Allowance	1	LS	$ 300,000	$ 300,000
			BASE ASSET COST	**$ 2,950,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	0	%		$ -
Structural / Architectural Allowance (Including Demolition)	10	%		$ 295,000
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Electrical, IC, Programming Allowances	0	%		$ -
Equipment installation	0	%		Included above
Construction contingency	30	%		$ 974,000
			SUBTOTAL DIRECT COST	**$4,219,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	0	%		included above
GC Overhead, Profit, Bonds, Mob	25	%		$ 1,055,000
City Taxes, other fees	4.5	%		$ 190,000
Cost Escalation to Mid-Point of Construction	3.0	%		
			TOTAL CONSTRUCTION COST	**$5,464,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 1,093,000
Owner maintained project contingency	10	%		$ 546,000
			TOTAL PROJECT COST (2021 $'s)	**$7,103,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Timing of this work is dependent on existing operations and other facility upgrades.
2. Project assumes a electrical contractor will be subcontractor to the civil general contractor.
3. Assumes work inside the building, such as MCC or PLC replacement, not included in costs. Work completed under other project.
4. Estimate based on conceptual layout of ductbank and infrastructure as shown on Figure 7.2 in Chapter 7.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*

Esclated $'s	2021	2022	2023	2024	2025	2026
$ 7,994,000	$ -	$ -	$ -	$ 1,199,000	$ 6,795,000	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

Appendix H

COST ESTIMATES FOR CAPITAL IMPROVEMENT PLAN

APPENDIX H COST ESTIMATES FOR CAPITAL IMPLEMENTATION PLAN (CIP)

carollo

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT City of Grand Junction -
PROJECT: HW1-Asset Replacements - Baseline
Process Area: Headworks Facility - Asset Replacements

Estimate Basis (year) = 2021
Mid point of Construction (year) = 2023

Class V Cost Estimate for replacement and rehabilitation of Headworks Building assets, which includes the screening facilities, washer compactor, and grit treatment and conveyance. These assets are assumed to have a 20 year useful life. Estimated project costs include odor control improvements identified by Garver.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Replace roofing membrane	1	LS	$ 75,000	$ 75,000
Replace and Rerate step screens	2	EA	$ 230,000	$ 460,000
Manual bar screen	1	LS	$ 45,000	$ 45,000
Replace screening conveyor	1	LS	$ 85,000	$ 85,000
Replace 1 screenings compactor / washer	1	LS	$ 150,000	$ 150,000
Replace grit pumps	2	EA	$ 35,000	$ 70,000
Replace grit washer/compactor	2	EA	$ 115,000	$ 230,000
Replace 2 dumpsters (screenings and grit)	2	EA	$ 5,000	$ 10,000
				$ -
MCC Replacments	1	LS	$ 85,000	$ 85,000
Replace HW Generator	0	LS	$ 500,000	$ -
PLC Replacement	1	LS	$ 75,000	$ 75,000
				$ -
Flow Monitoring Equipment	0	LS	$ 15,000	$ -
Covering for Bar Screen, conveyor, dumpster	400	FT2	$ 200	$ 80,000
Biofilter for Odor Control (Garver, 2020)	0	LS	$ 603,000	$ -
Persigo Wash Air Jumper (By Garver, 2020)	0	LS	$ 193,000	$ -
			BASE ASSET COST	**$ 1,365,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	10	%		$ 136,500
Structural / Architectural Allowance (Including Demolition)	10	%		$ 136,500
Coatings and Finishes	5	%		$ 68,250
Mechanical System Allowance (HVAC, Plumbing, etc)	10	%		$ 136,500
Electrical, IC, Programming Allowances	25	%		$ 341,250
Equipment installation	20	%		$ 273,000
Construction contingency	30	%		$ 737,000
			SUBTOTAL DIRECT COST	**$3,194,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 319,400
GC Overhead, Profit, Bonds, Mob	25	%		$ 799,000
City Taxes, other fees	4.5	%		$ 144,000
Cost Escalation to Mid-Point of Construction	3.0	%		
			TOTAL CONSTRUCTION COST	**$4,456,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 891,000
Owner maintained project contingency	10	%		$ 446,000
			TOTAL PROJECT COST (2021 $'s)	**$5,793,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Costs for hoists and garage door replacements
2. Assume gates, small pumps included in allowance
3. HVAC improvements included as contingency
4. Miscellaneous coatings included with the allowance above.
5. Misc. electrical improvements included as building allowance
6. Inplant waste pumping is covered in the mechanical allowance.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*

Escalated $'s	2021	2022	2023	2024	2025	2026
$ 6,146,000	$ -	$ 922,000	$ 5,224,000	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

carollo

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT: City of Grand Junction
PROJECT: HW2- Capacity: Screening Capacity Expansion — Estimate Basis (year) = 2021
Process Area Headworks Facility - Alternative Evaluations — Mid point of Construction (year) = 2032

Alternative 1 - Increase screening reliability by adding a third step screen and redundancy for conveyance and screenings washing. The Class V cost estimate includes asset revitalization projects, for the Headworks as identified in Chapter 4. These costs are shown in 2021 dollars as to compare baseline alternative.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Add 3rd Step Screen, conveyor, and washer/compactor				
Step screen, sluice channel conveyor, addition of second	1	LS	$ 600,000	$ 600,000
	EQUIPMENT AND DIRECT COSTS			**$ 600,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	10	%		$ 60,000
Structural / Architectural Allowance (Including Demolition)	10	%		$ 60,000
Coatings and Finishes	5	%		$ 30,000
Mechanical System Allowance (HVAC, Plumbing, etc)	10	%		$ 60,000
Electrical, IC, Programming Allowances	25	%		$ 150,000
Construction contingency	30	%		$ 324,000
		SUBTOTAL DIRECT COST		**$ 1,404,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 60,000
GC Overhead, Profit, Bonds, Mob	25	%		$ 351,000
City Taxes, other fees	4.5	%		$ 63,000
Cost Escalation to Mid-Point of Construction	3	%		
		TOTAL CONSTRUCTION COST		**$ 1,878,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 376,000
Owner maintained project contingency	10	%		$ 188,000
		TOTAL PROJECT COST (2021 $'s)		**$ 2,440,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. A future passive by-pass when all three step screens are installed was not included(assumed after 2030).
2. Electrical supply and power supplied assumed sufficient for additional infrastructure.
3. Assumed existing building provides sufficent space for third step-screen.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Sequencing of expenditures used for CIP planning based on project milestone (design, construction)

	Escalated $'s	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
Fraction of cost per year		0.00	0.00	0.00	0.00	0.00	0.00
	$ 3,380,000	$ -	$ -	$ -	$ -	$ -	$ -

2027	**2028**	**2029**	**2030**	**2031 - 2040**
$ -	$ -	$ -	$ -	$ 3,380,000

carollo

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT City of Grand Junction -
PROJECT: RSPS - Raw Sewage Pump Station Asset Replacements — Estimate Basis (year) = 2021
Process Area: Raw Sewage Pump Station (PS) - Asset Replacements — Mid point of Construction (year) = 2029

Class V cost estimate to rehabiltiate and replace assets in the Raw Sewage Pump Station as defined in Chapter 4.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Perform Vibration / Cavitation Analysis	1	LS	$ 35,000	$ 35,000
Replace roofing membrane	1	LS	$ 45,000	$ 45,000
Rehabilitate Influent Pumps	5	LS	$ 75,000	$ 375,000
MCC Replacements	0	LS	$ 85,000	$ -
VFD Replacements	5	LS	$ 55,000	$ 275,000
Stand-by RSPS Generator	1	LS	$ 500,000	$ 500,000
PLC Replacement	1	LS	$ 75,000	$ 75,000
Medium Priority - Structural Modifications (per WJE Assessm	1	LS	$ 265,000	$ 265,000
Low Priority - Structural Modifications (per WJE Assessment	0	LS	$ 75,000	$ -
		BASE ASSET COST		**$ 1,570,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	10	%		$ 31,400
Structural / Architectural Allowance (Including Demolition)	0	%		$ -
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	10	%		$ 157,000
Electrical, IC, Programming Allowances	15	%		$ 236,000
Equipment installation	20	%		$ 314,000
Construction contingency	30	%		$ 692,000
		SUBTOTAL DIRECT COST		**$3,000,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 300,000
GC Overhead, Profit, Bonds, Mob	25	%		$ 750,000
City Taxes, other fees	4.5	%		$ 135,000
Cost Escalation to Mid-Point of Construction	3.0	%		
		TOTAL CONSTRUCTION COST		**$4,185,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	15	%		$ 628,000
Owner maintained project contingency	10	%		$ 419,000
			TOTAL PROJECT COST	**$5,232,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER
1. Assume underground piping evaluations in general site
2. Grease facilities identified elsewhere
3. Costs for hoists and garage door replacements
4. Assume air compressor included in allowance
5. HVAC improvements included as contingency (and major fans/motors improvements provided as part of HW building)
6. Misc. electrical improvements included as building allowance
7. Structural and coatings identified by WJE Report
8. Lowered the Engineering fees on this as only rehabilitation of efforts
9. Lowered the E,IC assumptions due to large itemized scope items.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Dollars shown will be combined with alternatives from Chapter 5 and included in the implementation plan for Chapter 8.

Esclated $'s	2021	2022	2023	2024	2025	2026
$ 6,628,000	$ -	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ 994,000	$ 5,634,000	$ -	$ -

carollo

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT City of Grand Junction -
PROJECT: PC1 - Primary Clarifier - Control Structure 1 and PC Cover Demo — Estimate Basis (year) = 2021
Process Area: Primary Sludge Buiding and Clarifiers - Asset Replacements — Mid point of Construction (year) = 2023

Class V cost estimate for the replacement and rehabilitation of the primary clarifiers and primary sludge pumping systems. Additionally, structural improvements have been included as identified by others.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Remove the primary clarifier covers and odor control	2	LS	$ 25,000	$ 50,000
Control Structure No. 1 Improvements - Alternative 1				
Demo Work	1	LS	$ 15,000	$ 15,000
Concrete and Handrail	1	LS	$ 20,000	$ 20,000
Replace existing gates	4	EA	$ 19,000	$ 76,000
High Priority Structural Modifications (per WJE Assessment 2	0	LS	$ 108,000	$ -
Medium Priority Structural Modifications (per WJE Assessme	0	LS	$ 1,870,000	$ -
				$ -
MCC Replacments	0	LS	$ 85,000	$ -
VFD Replacements		LS	$ 35,000	$ -
PLC Replacement	0	LS	$ 75,000	$ -
				$ -
		BASE ASSET COST		**$ 161,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	10	%		$ 16,000
Structural / Architectural Allowance (Including Demolition)	0	%		$ -
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	10	%		$ 16,000
Electrical, IC, Programming Allowances	25	%		$ 40,000
Equipment installation	20	%		$ 32,200
Construction contingency	30	%		$ 80,000
		SUBTOTAL DIRECT COST		**$345,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 34,500
GC Overhead, Profit, Bonds, Mob	25	%		$ 86,000
City Taxes, other fees	4.5	%		$ 16,000
Cost Escalation to Mid-Point of Construction	3.0	%		
		TOTAL CONSTRUCTION COST		**$482,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 96,000
Owner maintained project contingency	10	%		$ 48,000
		TOTAL PROJECT COST (2021 $'s)		**$626,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Assume underground piping evaluations in general site
2. Coatings is covered by WJE Report
3. Used ALT 1 for Control Structure 1 Improvements, as higher cost
4. Hoist and water heater assumed in the contingency allowance

HVAC improvements included as contingency
Misc. electrical improvements included as building allowance

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Dollars shown will be combined with alternatives from Chapter 5 and included in the implementation plan for Chapter 8.

Esclated $'s	2021	2022	2023	2024	2025	2026
$ 664,000	$ -	$ 100,000	$ 564,000	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

carollo

UPDATED:	Dec-20
BY :	JK, LM, BL, BC
CHECKED:	DSP

CLIENT	City of Grand Junction		
PROJECT:	PC2 - Primary Clarifier Addition	Estimate Basis (year) =	2021
Process Area:	Primary Clarification	Mid point of Construction (year) =	2025

Alternative 2 - Includes the direct costs from the Baseline Asset Revitalization (Chapter 4) and the additional scope and work for a third primary clarifier. The addition of third primary clarifier meets the City's reliability and redundancy objectives when upgrading one of the existing clarifiers. Estimate does not include the addition of CEPT (Alternative 1)

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Primary Clarifier No.3	1	LS	$ 2,620,000	$ 2,620,000
Site Construction, concrete, metals, finishes, equipment, mechanical, electrical				
			EQUIPMENT AND DIRECT COSTS	**$ 2,620,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	10	%		$ 262,000
Structural / Architectural Allowance (Including Demolition)	0	%		$ -
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Electrical, IC, Programming Allowances	10	%		$ 262,000
Equipment installation	0	%		$ -
Construction contingency	30	%		$ 943,000
			SUBTOTAL DIRECT COST	**$4,087,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 408,700
GC Overhead, Profit, Bonds, Mob	25	%		$ 1,022,000
City Taxes, other fees	4.5	%		$ 184,000
Cost Escalation to Mid-Point of Construction	3	%		
			TOTAL CONSTRUCTION COST	**$5,702,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 1,140,000
Owner maintained project contingency	10	%		$ 570,000
			TOTAL PROJECT COST (2021 $'s)	**$7,410,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Added allows for site civil and yard piping.

2. Assume existing primary sludge pumping building has adequate space and electrical feed for additional primary clarifier.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above. Sequencing of project expenditures used for CIP implementation plan in Chapter 8.*

Escalated $'s	2021	2022	2023	2024	2025	2026
	0.00	0.00	0.00	0.15	0.85	0.00
$ 8,340,000	$ -	$ -	$ -	$ 1,251,000	$ 7,089,000	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

UPDATED:	Dec-20
BY :	JK, LM, BL, BC
CHECKED:	DSP

CLIENT	City of Grand Junction -		
PROJECT:	PC3 - Primary Clarifier Asset Replacement Projects	Estimate Basis (year) =	2021
Process Area:	Primary Sludge Buiding and Clarifiers - Asset Replacements	Mid point of Construction (year) =	2027

Class V cost estimate for the replacement and rehabilitation of the primary clarifiers and primary sludge pumping systems. Additionally, structural improvements have been included as identified by others.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Rebuild / Replace Primary Clarifier Mechanisms	2	EA	$ 300,000	$ 600,000
Replace Sludge Pumps	2	EA	$ 55,000	$ 110,000
Replace plunger-type pumps	2	EA	$ 45,000	$ 90,000
VFD Replacements	2	LS	$ 35,000	$ 70,000
				$ -
		BASE ASSET COST		**$ 870,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	10	%		$ 87,000
Structural / Architectural Allowance (Including Demolition)	0	%		$ -
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	10	%		$ 87,000
Electrical, IC, Programming Allowances	25	%		$ 218,000
Equipment installation	20	%		$ 174,000
Construction contingency	30	%		$ 431,000
		SUBTOTAL DIRECT COST		**$1,867,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 186,700
GC Overhead, Profit, Bonds, Mob	25	%		$ 467,000
City Taxes, other fees	4.5	%		$ 84,000
Cost Escalation to Mid-Point of Construction	3.0	%		
		TOTAL CONSTRUCTION COST		**$2,605,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 521,000
Owner maintained project contingency	10	%		$ 261,000
		TOTAL PROJECT COST (2021 $'s)		**$3,387,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Assume underground piping evaluations in general site
2. Coatings is covered by WJE Report
3. Used ALT 1 for Control Structure 1 Improvements, as higher cost
4. Hoist and water heater assumed in the contingency allowance

HVAC improvements included as contingency

Misc. electrical improvements included as building allowance

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Dollars shown will be combined with alternatives from Chapter 5 and included in the implementation plan for Chapter 8.

Esclated $'s	2021	2022	2023	2024	2025	2026
$ 4,044,000	$ -	$ -	$ -	$ -	$ -	$ 607,000

2027	2028	2029	2030	2031 - 2040
$ 3,437,000	$ -	$ -	$ -	$ -

carollo

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT City of Grand Junction -
PROJECT: Flow Equalization Basin (FEB) - Asset Replacement Project — Estimate Basis (year) = 2021
Process Area: FEB Mixers - Asset Replacements — Mid point of Construction (year) = 2027

Replacement costs for the floating mixers. This estimate will be carried forward for the implementation plan.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Floating Mixer Replacements	8	LS	$ 35,000	$ 280,000
Allowance for FEB foundation drain valves	1	LS	$ 50,000	$ 50,000
MCC Replacments	0	LS	$ 85,000	$ -
PLC Replacement	0	LS	$ 75,000	$ -
Allowance for Instruments	1	LS	$ 15,000	$ 15,000
			BASE ASSET COST	**$ 345,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	10	%		$ 34,500
Structural / Architectural Allowance (Including Demolition)	10	%		$ 34,500
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Electrical, IC, Programming Allowances	25	%		$ 86,000
Equipment installation	20	%		$ 69,000
Construction contingency	30	%		$ 171,000
			SUBTOTAL DIRECT COST	**$740,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 74,000
GC Overhead, Profit, Bonds, Mob	25	%		$ 185,000
City Taxes, other fees	4.5	%		$ 33,000
Cost Escalation to Mid-Point of Construction	3.0	%		
			TOTAL CONSTRUCTION COST	**$1,032,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	15	%		$ 155,000
Owner maintained project contingency	10	%		$ 103,000
			TOTAL PROJECT COST (2021 $'s)	**$1,290,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Assume underground piping evaluations in general site
2. Influent and effluent gates not included above
No HVAC needed for the basins.
3. FE storm water pump not included

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Dollars shown will be combined with alternatives from Chapter 5 and included in the implementation plan for Chapter 8.

Esclated $'s	2021	2022	2023	2024	2025	2026
$ 1,540,000	$ -	$ -	$ -	$ -	$ -	$ 231,000

2027	2028	2029	2030	2031 - 2040
$ 1,309,000	$ -	$ -	$ -	$ -

carollo

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT City of Grand Junction -
PROJECT: Aeration Basin (AB-1) - Asset Replacement Projects
Process Area: Aeration Basin - Asset Replacements

Estimate Basis (year) = 2021
Mid point of Construction (year) = 2022

Class V cost estimate to replace the existing assets in the aeration basins in the near-term which include mixers, instrumentation, and structural modifications identified by others. Estimate includs the advanced SRT/Aeration control recommended for the aeration basins.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Diffuser Testing, and cleaning	4	EA	$ 15,000	$ 60,000
Aeration Basin mixers	6	EA	$ 15,000	$ 90,000
Rehabilitate corroded valve stems, gates ,etc	4	EA	$ 15,000	$ 60,000
Replace existing instruments	4	EA	$ 25,000	$ 100,000
SRT & Aeration control programs	1	LS	$ 175,000	$ 175,000
PLC Replacement	1	LS	$ 75,000	$ 75,000
VFD Mixer replacment	6	EA	$ 10,000	$ 60,000
High Priority Structural Modifications (per WJE Assessment 2	1	LS	$ 108,000	$ 108,000
Medium Priority Structural Modifications (per WJE Assessme	1	LS	$ 27,000	$ 27,000
Control Structure No. 3	1	LS	$ 75,000	$ 75,000
		BASE ASSET COST		**$ 830,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	0	%		$ -
Structural / Architectural Allowance (Including Demolition)	20	%		$ 166,000
Coatings and Finishes	2	%		$ 16,600
Mechanical System Allowance (HVAC, Plumbing, etc)	10	%		$ 83,000
Electrical, IC, Programming Allowances	25	%		$ 207,500
Equipment installation	20	%		$ 166,000
Construction contingency	30	%		$ 441,000
		SUBTOTAL DIRECT COST		**$1,910,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 191,000
GC Overhead, Profit, Bonds, Mob	25	%		$ 478,000
City Taxes, other fees	4.5	%		$ 86,000
Cost Escalation to Mid-Point of Construction	3.0	%		
		TOTAL CONSTRUCTION COST		**$2,665,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 533,000
Owner maintained project contingency	10	%		$ 267,000
		TOTAL PROJECT COST (2021 $'s)		**$3,465,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER
1. Assume underground piping evaluations in general site
2. Coatings is covered by WJE Report
3. Hoisting devices not included
4. Sample pumps not included as itemized assumed in allowance
5. No HVAC improvements
6. Misc. electrical improvements included as building allowance

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Dollars shown will be combined with alternatives from Chapter 5 and included in the implementation plan for Chapter 8.

Escalated $'s	2021	2022	2023	2024	2025	2026
$ 3,569,000	$ 535,000	$ 3,034,000	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

carollo

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT 2020 Persigo WWTP Master Plan
PROJECT: New Blower Building (AB2) — Estimate Basis (year) = 2021
Process Area: Secondary Treatment — Mid point of Construction (year) = 2022

Common Improvement for Secondary Treatment - A new blower building with new blowers improves the operational environment and optimizes energy use. The new blower building provides additional space for expansions to activiated sludge pumping. The new blower building would be sized to accomodate 2040 flow and loading conditions and includes electrical and controls room with environmental controls. Estimate provided is a Class V level estimate.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
New Blower Building (2,100 SF)	1	LS	$ 4,250,000	$ 4,250,000
Building, blowers, piping, equipment				
Structural, arch, building mechanical,				
New Electrical Switchgear for Blower Facility	1	LS	$ 750,000	$ 750,000
			EQUIPMENT AND DIRECT COSTS	**$ 5,000,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	1	LS		$ 250,000
Structural / Architectural Allowance (Including Demolition)	0	%		$ -
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Electrical, IC, Programming Allowances	0	%		$ -
Equipment installation	0	%		$ -
Construction contingency	30	%		$ 1,575,000
			SUBTOTAL DIRECT COST	**$6,825,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 682,500
GC Overhead, Profit, Bonds, Mob	25	%		$ 1,706,000
City Taxes, other fees	4.5	%		$ 307,000
Cost Escalation to Mid-Point of Construction	3	%		
			TOTAL CONSTRUCTION COST	**$9,521,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 1,904,000
Owner maintained project contingency	10	%		$ 952,000
			TOTAL PROJECT COST (2021 $'s)	**$12,380,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Assume new switchgear would be needed as part of the site civil. May be possible to re-route from existing in new duct bank.
2. Assume RAS/WAS piping remains as currently installed.
3. Site allowances included for civil preparation and routing of air piping to existing basin headers.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Sequencing of project expenditures used for CIP implementation plan in Chapter 8.

Escalated $'s	2021	2022	2023	2024	2025	2026
	0.15	0.85	0.00	0.00	0.00	0.00
$ 12,750,000	$ 1,913,000	$ 10,838,000	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT 2020 Persigo WWTP Master Plan
PROJECT: Aeration Basin Expansion (AB3) — Estimate Basis (year) = 2021
Process Area: Secondary Treatment — Mid point of Construction (year) = 2032

Class V Cost estimate to increase the aeration basin volume and to replace the existing diffusers.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Diffuser Replacements	1	LS	$ 340,000	$ 340,000
Additional Aeration Basin Volume go from 12.5 to 13.5mgd	1.6	MG	$ 2,500,000	$ 4,000,000
Concrete, equipment for aeration, site/civil, misc metals, diffusers, mixers, pumping,				
			EQUIPMENT AND DIRECT COSTS	**$ 4,340,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	1	LS		$ 350,000
Structural / Architectural Allowance (Including Demolition)	10	%		$ 434,000
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Equipment installation	0	%		$ -
Construction contingency	30	%		$ 1,824,000
			SUBTOTAL DIRECT COST	**$7,903,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 790,300
GC Overhead, Profit, Bonds, Mob	25	%		$ 1,976,000
City Taxes, other fees	4.5	%		$ 356,000
Cost Escalation to Mid-Point of Construction	3	%		
			TOTAL CONSTRUCTION COST	**$11,025,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 2,205,000
Owner maintained project contingency	10	%		$ 1,103,000
			TOTAL PROJECT COST (2021 $'s)	**$14,330,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Assume underground piping evaluations in general site
2. Coatings is covered by WJE Report
3. Hoisting devices not included
4. Sample pumps not included as itemized assumed in allowance
5. Building mechanical and building electrical included in allowance above.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Sequencing of project expenditures used for CIP implementation plan in Chapter 8.

Escalated $'s	2021	2022	2023	2024	2025	2026
	0.00	0.00	0.00	0.00	0.00	0.00
$ 19,840,000	$ -	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ 19,840,000

carollo

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT 2020 Persigo WWTP Master Plan
PROJECT: Secondary Clarifier Expansion (SC1)
Process Area: Secondary Treatment

Estimate Basis (year) = 2021
Mid point of Construction (year) = 2027

Common Improvement - The fourth clarifier provides operational redundancy and reliability when taking existing clarifiers off-line for mechanism replacement. This meet's the City's requirements to have an N+1 configuration for reliability and redundancy. Estimate is a Class V level estimate.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Additional Secondary Clarifier with equipment, concrete, coatings, electrical/IC	1	EA	$ 2,000,000	$ 2,000,000
		EQUIPMENT AND DIRECT COSTS		**$ 2,000,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	1	LS		$ 350,000
Structural / Architectural Allowance (Including Demolition)	10	%		$ 200,000
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Electrical, IC, Programming Allowances	10	%		$ 200,000
Equipment installation	0	%		$ -
Construction contingency	30	%		$ 825,000
		SUBTOTAL DIRECT COST		**$3,575,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 357,500
GC Overhead, Profit, Bonds, Mob	25	%		$ 894,000
City Taxes, other fees	4.5	%		$ 161,000
Cost Escalation to Mid-Point of Construction	3	%		
		TOTAL CONSTRUCTION COST		**$4,988,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20		%	$ 998,000
Owner maintained project contingency	10	%		$ 499,000
		TOTAL PROJECT COST (2021 $'s)		**$6,490,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Assumes existing electrical service would not need to be upsized for additional mechanical equipment and pumping.
2. Assumes clarifier RAS and WAS pumping upsized with asset revitalization improvements for RAS/WAS pumping.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Sequencing of project expenditures used for CIP implementation plan in Chapter 8.

Escalated $'s	2021	2022	2023	2024	2025	2026
	0.00	0.00	0.00	0.00	0.00	0.15
$ 7,750,000	$ -	$ -	$ -	$ -	$ -	$ 1,163,000

2027	2028	2029	2030	2031 - 2040
$ 6,588,000	$ -	$ -	$ -	$ -

carollo

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT City of Grand Junction -
PROJECT: Secondary Clarifier Asset Replacement Projects (SC2) — Estimate Basis (year) = 2021
Process Area: Secondary Clarifier Improvements - Asset Replacements — Mid point of Construction (year) = 2030

Class V cost estimate for the replacement and revitalization of the secondary clarifier mechanisms and improvements to Control Structure No. 3 as identified in Chapter 4.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
New Clarifier Mechanisms	2	EA	$ 300,000	$ 600,000
Rehabilitate or Refurbish Clarifier No. 4 Mechanism (tow-bro)	1	LS	$ 300,000	$ 300,000
Repair and rehabilitate concrete clarifiers, launders and weirs	3	LS	$ 75,000	$ 225,000
RAS Pump Replacements	6	EA	$ 65,000	$ 390,000
WAS Pump Replacements	3	EA	$ 35,000	$ 105,000
VFDs (WAS Pumps)	6	EA	$ 35,000	$ 210,000
			BASE ASSET COST	**$ 1,830,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	0	%		$ -
Structural / Architectural Allowance (Including Demolition)	25	%		$ 457,500
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Electrical, IC, Programming Allowances	15	%		$ 275,000
Equipment installation	20	%		$ 366,000
Construction contingency	30	%		$ 879,000
			SUBTOTAL DIRECT COST	**$3,808,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 380,800
GC Overhead, Profit, Bonds, Mob	25	%		$ 952,000
City Taxes, other fees	4.5	%		$ 171,000
Cost Escalation to Mid-Point of Construction	3.0	%		
			TOTAL CONSTRUCTION COST	**$5,312,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 1,062,000
Owner maintained project contingency	10	%		$ 531,000
			TOTAL PROJECT COST (2021 $'s)	**$6,905,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Assumes replace mechanisms with Tow-Bro type of style mechanism
2. Assumed increased structural allowance for center-well modificaitons (specifically)on two original clarifiers
3. Assume in-kind replacement and no significant electrical / IC improvements required.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Dollars shown will be combined with alternatives from Chapter 5 and included in the implementation plan for Chapter 8.

Esclated $'s	2021	2022	2023	2024	2025	2026
$ 9,009,000	$ -	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ 1,351,000	$ 7,658,000	$ -

carollo

UPDATED:	Dec-20
BY :	JK, LM, BL, BC
CHECKED:	DSP

CLIENT	City of Grand Junction		
PROJECT:	UV Hydraulics and Reliability (UV1)	Estimate Basis (year) =	2021
Process Area:	Disinfection	Mid point of Construction (year) =	2021

Class V cost estimate to make improvements to hydraulic issues and address limited UV redundancy immediately. This project is driven by operational performance and equipment reliability until the new UV system can be installed.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
CFD Modeling for Hydraulic Modifications	1	LS	$ 20,000	$ 20,000
Flodar - relocate effluent flow metering	1	EA	$ 25,000	$ 25,000
Hydraulic Improvements	1	LS	$ 50,000	$ 50,000
Shelf Spare UV modules (9)	1	(below)		$ -
		EQUIPMENT AND DIRECT COSTS		**$ 95,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	0	LS		$ -
Structural / Architectural Allowance (Including Demolition)	20	%		$ 19,000
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	5	%		$ 5,000
Electrical, IC, Programming Allowances	25	%		$ 23,750
Equipment installation	20	%		$ 19,000
Construction contingency	30	%		$ 49,000
		SUBTOTAL DIRECT COST		**$211,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 21,100
GC Overhead, Profit, Bonds, Mob	25	%		$ 53,000
City Taxes, other fees	4.5	%		$ 9,000
Cost Escalation to Mid-Point of Construction	3.0	%		
		TOTAL CONSTRUCTION COST		**$294,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 59,000
Owner maintained project contingency	10	%		$ 29,000
Owner purchased (nine) UV modules as shelf spare				$ 200,000
		TOTAL PROJECT COST (2021 $'s)		**$582,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. This is an interim improvement until the new UV system will be installed.

2. Assumes owner will directly purchase UV modules from the existing MFR.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Sequencing of project expenditures used for CIP implementation plan in Chapter 8.

	Escalated $'s	2021	2022	2023	2024	2025	2026
Fraction of cost per year		1.00	0.00	0.00	0.00	0.00	0.00
	$ 580,000	$ 580,000	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

carollo

UPDATED:	Dec-20
BY :	JK, LM, BL, BC
CHECKED:	DSP

CLIENT	City of Grand Junction - 2020 Persigo WWTP Master Plan		
PROJECT:	New UV System + Asset Revitalization (UV2)	Estimate Basis (year) =	2021
Process Area:	UV Disinfection System	Mid point of Construction (year) =	2028

UV Alternative 1 - Includes the revitalization and improvements to the existing UV system along with installation of a new UV unit. The new UV system was recommended to provide the treatment redundancy and reliability per City (N+1 configuration). It is assumed the new UV system may be installed before rehabilitating the existing UV channel. Estimate below is a Class V level estimate.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Improvements for New UV System				
Flow Control/Isolation Gates	5	EA	$ 25,000	$ 125,000
Effluent Control Weir	1	LS	$ 75,000	$ 75,000
Trojan Signa/ Wedeco Duron	1	LS	$ 700,000	$ 700,000
UV Building over chanels	2,000	$/SF	$ 200	$ 400,000
Electrical Room / TXFMR / Switchgear Upgrades	1	LS	$ 750,000	$ 750,000
		EQUIPMENT AND DIRECT COSTS		**$ 2,050,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	0	LS		$ -
Structural / Architectural Allowance (Including Demolition)	15	%		$ 307,500
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	1	%		$ 21,000
Electrical, IC, Programming Allowances	20	%		$ 410,000
Equipment installation	20	%		$ 410,000
Construction contingency	30	%		$ 960,000
		SUBTOTAL DIRECT COST		**$ 4,159,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 415,900
GC Overhead, Profit, Bonds, Mob	25	%		$ 1,040,000
City Taxes, other fees	4.5	%		$ 187,000
Cost Escalation to Mid-Point of Construction	3	%		
		TOTAL CONSTRUCTION COST		**$ 5,802,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 1,160,000
Owner maintained project contingency	10	%		$ 580,000
		TOTAL PROJECT COST (2021 $'s)		**$ 7,542,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Sequencing of the UV improvements will be sequential to improve reliability and redundancy immediately.
2. New UV system anticipated to be installed prior to replacing the existing system.
3. Included new electrical switchgear as allowance. Location and sizing of switchgear replacement should be re-evaluated.
4. Assume there will be structural work in the existing chlorine contact basins to accommodate the new UV system.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Sequencing of project expenditures used for CIP implementation plan in Chapter 8.

Escalated $'s	2021	2022	2023	2024	2025	2026
	0.00	0.00	0.00	0.00	0.00	0.00
$ 9,280,000	$ -	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ 1,392,000	$ 7,888,000	$ -	$ -	$ -

carollo

UPDATED:	Dec-20
BY :	JK, LM, BL, BC
CHECKED:	DSP

CLIENT	City of Grand Junction -		
PROJECT:	Disinfection Area - Asset Revitalization (UV3)	Estimate Basis (year) =	2021
Process Area:	Disinfection Area - Asset Revitilization Projects	Mid point of Construction (year) =	2035

Class V cost estimate for asset replacement and rehabiliation needs for the UV disinfection system as identified in Chapter 4.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Replacement of UV System (> 2025)	1	LS	$ 700,000	$ 700,000
Rehab and repalcement of gates, concrete, (>2025)	1	LS	$ 32,000	$ 32,000
Allowance for plant water pumping systems (> 2025)	4	EA	$ 35,000	$ 140,000
VFD Replacements (plant water)	4	EA	$ 35,000	$ 140,000
			BASE ASSET COST	**$ 1,012,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	10	%		$ 101,200
Structural / Architectural Allowance (Including Demolition)	10	%		$ 101,200
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	10	%		$ 101,000
Electrical, IC, Programming Allowances	25	%		$ 253,000
Equipment installation	20	%		$ 202,400
Construction contingency	30	%		$ 531,000
			SUBTOTAL DIRECT COST	**$2,302,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 230,200
GC Overhead, Profit, Bonds, Mob	25	%		$ 576,000
City Taxes, other fees	4.5	%		$ 104,000
Cost Escalation to Mid-Point of Construction	3.0	%		
			TOTAL CONSTRUCTION COST	**$3,212,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 642,000
Owner maintained project contingency	10	%		$ 321,000
			TOTAL PROJECT COST (2021 $'s)	**$4,175,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. City installing generator for UV system in 2021 (not included above).
2. PLC replacements for the UV system and for the plant water system

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Dollars shown will be combined with alternatives from Chapter 5 and included in the implementation plan for Chapter 8.

Esclated $'s	2021	2022	2023	2024	2025	2026
$ 6,315,000	$ -	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ 6,315,000

carollo

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT City of Grand Junction
PROJECT: New Grease Building (DIG1)
Process Area: Digestion Area

Estimate Basis (year) = 2021
Mid point of Construction (year) = 2024

Class V cost estimate for the new grease receiving station. Project estimate includes receiving station, additional yard piping, site electrical and allowance for heating the grease. Assumed location will be in current location for grease removal.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
FOG Receiving Station	1	LS	$ 1,023,000	$ 1,023,000
Yard Piping Allowance	1	LS	$ 150,000	$ 150,000
Site Electrical Allowance	1	LS	$ 500,000	$ 500,000
Allowance for Heating grease	1	EA	$ 50,000	$ 50,000
			EQUIPMENT AND DIRECT COSTS	**$ 1,723,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	0	%		$ -
Structural / Architectural Allowance (Including Demolition)	0	%		$ -
Building Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Electrical, IC, Programming Allowances	20	%		$ 345,000
Equipment installation	0	%		$ -
Construction Contingency	30	%		$ 620,000
			SUBTOTAL DIRECT COST	**$ 2,688,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 172,000
GC Overhead, Profit, Bonds, Mob	25	%		$ 672,000
City Taxes, other fees	4.5	%		$ 121,000
Cost Escalation to mid-Point of Construction	3	%		
			TOTAL CONSTRUCTION COST	**$3,653,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 731,000
Owner maintained project contingency	10	%		$ 365,000
			TOTAL PROJECT COST (2021 $'s)	**$ 4,750,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Assumed location is in existing location for grease processing.
2. Assumes existing electrical capacity is sufficient for new facility.
3. Assume pumping facilities from primary clarifier and headworks are sufficient, if needed at reduced use/volume.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Sequencing of project expenditures used for CIP implementation plan in Chapter 8.

Escalated $'s	2021	2022	2023	2024	2025	2026
	0.00	0.00	0.15	0.85	0.00	0.00
$ 5,190,000	$ -	$ -	$ 779,000	$ 4,412,000	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

carollo

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT City of Grand Junction
PROJECT: Anaerobic Digestion Improvements (DIG2) — Estimate Basis (year) = 2021
Process Area: Anaerobic Digestion — Mid point of Construction (year) = 2024

Class V Cost Estimate for anaerobic digestion improvements to replace existing assets and to conver from secondary anearobic digestion to a primary anaerobic process. Project scope is in-kind asset replacements for the anaerobic digestion system. The assumptions include digester cover and mixing to convert anaerobic digester operations to be in parallel instead of series.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Digester Cover Replacement	1	LS	$ 320,000	$ 320,000
Heat Exchanger	2	LS	$ 125,000	$ 250,000
Replace sludge transfer pumps	2	EA	$ 55,000	$ 110,000
Replace recirculation pumps	2	EA	$ 55,000	$ 110,000
Replace communitors	2	EA	$ 45,000	$ 90,000
Replace secondary digester mixing with linear motion mixer	1	LS	$ 230,000	$ 230,000
Replace boilers and hot water system	2	EA	$ 120,000	$ 240,000
Modify sludge piping	1	EA	$ 75,000	$ 75,000
Conversion of Aerobic Digestion to storage and mixing tanks	1	LS	$ 542,000	$ 542,000
New DAFT System and Building	1	LS	$ 1,086,000	$ 1,086,000
Sludge Blend Tank Conversion and Assets	1	LS	$ 250,000	$ 250,000
High Priority Structural Modifications (per WJE Assessment 2	1	LS	$ 185,000	$ 185,000
			BASE ASSET COST	**$ 3,488,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	10	%		$ 348,800
Structural / Architectural Allowance (Including Demolition)	20	%		$ 697,600
Coatings and Finishes	10	%		$ 348,800
Mechanical System Allowance (HVAC, Plumbing, etc)	10	%		$ 348,800
Electrical, IC, Programming Allowances	20	%		$ 697,600
Equipment installation	20	%		$ 697,600
Construction contingency	30	%		$ 1,988,000
			SUBTOTAL DIRECT COST	**$ 8,615,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 861,500
GC Overhead, Profit, Bonds, Mob	25	%		$ 2,154,000
City Taxes, other fees	4.5	%		$ 388,000
Cost Escalation to Mid-Point of Construction	3.0	%		
			TOTAL CONSTRUCTION COST	**$12,019,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 2,404,000
Owner maintained project contingency	10	%		$ 1,202,000
			TOTAL PROJECT COST (2021 $'s)	**$15,625,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Details for the aerobic digester conversion and the new DAF system and building are provided in Chapter 5 TPCE.

2. Details for the sludge blend tank assumptions provided in Chapter 4 TPCE.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Dollars shown will be combined with alternatives from Chapter 5 and included in the implementation plan for Chapter 8.

Escalated $'s	2021	2022	2023	2024	2025	2026
$ 17,074,000	$ -	$ -	$ 2,561,000	$ 14,513,000	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

carollo

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT City of Grand Junction
PROJECT: Anaerobic Digester Expansion (DIG3)
Process Area: Digestion

Estimate Basis (year) = 2021
Mid point of Construction (year) = 2036

Third Anaerobic Digester - The additioanal digester would be required to provide operational reliability and redundnacy as the O&M staff requested an N+1 configuration to allow for maintenance of other anaerobic digesters. Class V level cost estimate provided below.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Sitework	1	LS	$ 100,000	$ 100,000
Digester Cast-in-place Concrete	1	LS	$ 300,000	$ 300,000
Digester Steel Gas Holder Cover	1	EA	$ -	$ -
Linear Motion Mixer	1	EA	$ 230,000	$ 230,000
Heating Allowance (HEX, hot water, boiler)	1	LS	$ 175,000	$ 175,000
Sludge pumping (recirc, transfer pumps)	1	LS	$ 155,000	$ 155,000
Piping Allowance	1	LS	$ 250,000	$ 250,000
Digester Control Building	2,500	SF	$ 200	$ 500,000
Site Electrical Allowance	1	LS	$ 250,000	$ 250,000
				$ -
Existing DAF Asset Replacements	1	LS	$ 505,000	$ 505,000
			EQUIPMENT AND DIRECT COSTS	**$ 2,065,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	0	%		$ -
Building Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	10	%		$ 207,000
Electrical, IC, Programming Allowances	25	%		$ 516,000
Equipment installation	20	%		$ 413,000
Construction Contingency	30	%		$ 960,000
			SUBTOTAL DIRECT COST	**$ 4,161,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALA		%		
General Conditions Allowance	10	%		$ 416,000
GC Overhead, Profit, Bonds, Mob	25	%		$ 1,040,000
City Taxes, other fees	4.5	%		$ 187,000
Cost Escalation to mid-Point of Construction	3	%		$ 125,000
			TOTAL CONSTRUCTION COST	**$ 5,929,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 1,186,000
Owner maintained project contingency	10	%		$ 593,000
			TOTAL PROJECT COST (2021 $'s)	**$ 7,710,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Assume the heating and pumping equipment can be located in Digestion Building.
2. Assume existing electrical capacity sufficent for new digester and pumping requirements.
3. An allowance for new digester control building has been provided. The existing control room could be modified and used.
4. Details for the existing DAF asset replacements provided in Chapter 4 TPCEs.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Sequencing of project expenditures used for CIP implementation plan in Chapter 8.

Escalated $'s	2021	2022	2023	2024	2025	2026
	0.00	0.00	0.00	0.00	0.00	0.00
$ 12,010,000	$ -	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ 12,010,000

carollo

UPDATED: Dec-20
BY : JK, LM, BL, BC
CHECKED: DSP

CLIENT City of Grand Junction
PROJECT: New Dewatering Facilities and Solids Storage (DEW 1) — Estimate Basis (year) = 2021
Process Area: Dewatering — Mid point of Construction (year) = 2026

Dewatering Alterantive 2- Replaces aging BFP operations with a new dewatering centrifuge building and operations. The new facility also includes a 100-day covered biosolids storage facility. A NPV analysis was completed on this alternative and presented in Chapter 5. Estimate shown below is a Class V level estimate.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Centrifuge Dewatering Building				
Centrifuges	3	EA	$ 623,150	$ 1,869,450
Polymer System	1	EA	$ 340,000	$ 340,000
Conveyance	1	EA	$ 250,000	$ 250,000
New Building	10,000	SF	$ 200	$ 2,000,000
Electrical Site Allowance	1	LS	$ 1,250,000	$ 1,250,000
Piping Allowance	1	LS	$ 200,000	$ 200,000
Dewatered biosolids storage (100days)				
Sitework	1	LS	$ 100,000	$ 100,000
Demolition of Existing Solar Drying Beds	1	LS	$ 200,000	$ 200,000
Concrete slab on grade	740	CY	$ 550	$ 407,000
Cake Storage Building	20,000	SF	$ 20	$ 400,000
			EQUIPMENT AND DIRECT COSTS	**$ 7,016,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	0	%		$ -
Structural / Architectural Allowance (Including Demolition)	0	%		$ -
Building Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Electrical, IC, Programming Allowances	10	%		$ 702,000
Equipment installation	0	%		$ -
Construction Contingency	30	%		$ 2,315,000
			SUBTOTAL DIRECT COST	**$ 10,033,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 1,003,000
GC Overhead, Profit, Bonds, Mob	25	%		$ 2,508,000
City Taxes, other fees	4.5	%		$ 451,000
Cost Escalation to mid-Point of Construction	3	%		
			TOTAL CONSTRUCTION COST	**$ 13,995,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 2,799,000
Owner maintained project contingency	10	%		$ 1,400,000
			TOTAL PROJECT COST (2021 $'s)	**$ 18,190,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. New electrical facilities were assumed for building. The existing electrical service would be demolished or downsized.
2. Allowances were included for yard piping to and from the new dewatering building.
3. Assumed 100days of storage. This can be reduced most likely depending on the final biosolids management approach.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above. Sequencing of project expenditures used for CIP implementation plan in Chapter 8.*

Escalated $'s	2021	2022	2023	2024	2025	2026
	0.00	0.00	0.00	0.00	0.15	0.85
$ 21,090,000	$ -	$ -	$ -	$ -	$ 3,164,000	$ 17,927,000

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

carollo

UPDATED:	Dec-20
BY :	JK, LM, BL, BC
CHECKED:	DSP

CLIENT City of Grand Junction -
PROJECT: Biogas Expansion and Asset Revitalization (BG1) — Estimate Basis (year) = 2021
Process Area: Biogas System Assets — Mid point of Construction (year) = 2035

Class V cost estimate to project the asset renewal costs for rehabiltiation of the existing 100cfm biogas treatment system.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Asset Renwals for biogas system	0.4	LS	$ 1,344,000	$ 538,000
New Biogas Treatment System for Capacity				
Sitework	1	LS	$ 25,000	$ 25,000
Equipment Pad	50	CY	$ 650	$ 32,500
BioCNG 100	1	EA	$ 1,186,500	$ 1,186,500
Piping Allowance	1	LS	$ 100,000	$ 100,000
		BASE ASSET COST		**$ 1,882,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	10	%		$ 188,200
Structural / Architectural Allowance (Including Demolition)	10	%		$ 188,200
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Electrical, IC, Programming Allowances	10	%		$ 188,000
Equipment installation	20	%		$ 376,400
Construction contingency	30	%		$ 847,000
		SUBTOTAL DIRECT COST		**$3,670,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 367,000
GC Overhead, Profit, Bonds, Mob	25	%		$ 918,000
City Taxes, other fees	4.5	%		$ 165,000
Cost Escalation to Mid-Point of Construction	3.0	%		$ 154,000
		TOTAL CONSTRUCTION COST		**$5,274,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 1,055,000
Owner maintained project contingency	10	%		$ 527,000
		TOTAL PROJECT COST (2021 $'s)		**$6,856,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER
1. Assumed replacement of 40% original skid unit. Further condition assessments should be conducted to determine actual.
2. Assumed engineering support would be needed; however, the City could replace and purchase parts independently.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*
Dollars shown will be combined with alternatives from Chapter 5 and included in the implementation plan for Chapter 8.

Esclated $'s	2021	2022	2023	2024	2025	2026
$ 10,370,000	$ -	$ -	$ -	$ -	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ 10,370,000

carollo

UPDATED:	Dec-20
BY :	AM
CHECKED:	DSP, CH

CLIENT City of Grand Junction -
PROJECT: Administration Building Improvments (ADM1) — Estimate Basis (year) = 2021
Process Area: General Site — Mid point of Construction (year) = 2024

Class V cost estimate to complete the rehabilitation, replacement, and facility improvements for the Administration Building at the Persigo Facility.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Remodeled Control Room	1	LS	$ 100,000	$ 100,000
Entryway remodel and facility improvements (bathrooms, HV/	1	LS	$ 125,000	$ 125,000
Laboratory Improvements	1	LS	$ 50,000	$ 50,000
Electrical equipment (replace and relocate)	1	LS	$ 225,000	$ 225,000
Additional office space (4 new offices)	1	LS	$ 85,000	$ 85,000
Additional Storage Facility	1	LS	$ 250,000	$ 250,000
			BASE ASSET COST	**$ 835,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	0	%		$ -
Structural / Architectural Allowance (Including Demolition)	10	%		$ 83,500
Coatings and Finishes	5	%		$ 41,750
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Electrical, IC, Programming Allowances	15	%		$ 125,000
Equipment installation	0	%		
Construction contingency	30	%		$ 326,000
			SUBTOTAL DIRECT COST	**$1,411,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	10	%		$ 141,000
GC Overhead, Profit, Bonds, Mob	25	%		$ 353,000
City Taxes, other fees	4.5	%		$ 63,000
Cost Escalation to Mid-Point of Construction	3.0	%		
			TOTAL CONSTRUCTION COST	**$1,968,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	15	%		$ 295,000
Owner maintained project contingency	10	%		$ 197,000
			TOTAL PROJECT COST (2021 $'s)	**$2,460,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*

Esclated $'s	2021	2022	2023	2024	2025	2026
$ 2,688,000	$ -	$ -	$ 403,000	$ 2,285,000	$ -	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -

UPDATED:	Dec-20
BY :	AM
CHECKED:	DSP, CH

CLIENT City of Grand Junction
PROJECT: Electrical and Fiber Loop for Facility (E1) — Estimate Basis (year) = 2021
Process Area: General Site — Mid point of Construction (year) = 2025

Class V cost estimate to install a medium voltage electrical distribution and fiber loop at the Persigo Facility. This eliminates the single point of failure for the existing electrical ductbanks and provides a fiber loop to connect process buildings and provide networking capabilities for the site. The fiber would be used for the SCADA and communication systems.

DESCRIPTION	QTY.	UNIT	UNIT PRICE	TOTAL
DIRECT COSTS				
Ductbank, manholes, cable and fiber	1	LS	$ 2,100,000	$ 2,100,000
Electrical Equipment (XFMR, SWG,) and terminations	1	LS	$ 550,000	$ 550,000
Site Civil Allowance	1	LS	$ 300,000	$ 300,000
			BASE ASSET COST	**$ 2,950,000**
ALLOWANCE FOR CONSTRUCTION SERVICES				
Site/Civil/Yard Piping Allowance	0	%		$ -
Structural / Architectural Allowance (Including Demolition)	10	%		$ 295,000
Coatings and Finishes	0	%		$ -
Mechanical System Allowance (HVAC, Plumbing, etc)	0	%		$ -
Electrical, IC, Programming Allowances	0	%		$ -
Equipment installation	0	%		Included above
Construction contingency	30	%		$ 974,000
			SUBTOTAL DIRECT COST	**$4,219,000**
GENERAL CONDITIONS, CONTRACTOR MARKUPS, TAXES, AND ESCALATION				
General Conditions Allowance	0	%		included above
GC Overhead, Profit, Bonds, Mob	25	%		$ 1,055,000
City Taxes, other fees	4.5	%		$ 190,000
Cost Escalation to Mid-Point of Construction	3.0	%		
			TOTAL CONSTRUCTION COST	**$5,464,000**
TOTAL PROJECT COST ALLOWANCES (NON-CONSTRUCTION)				
Engineering, legal, and administrative fees	20	%		$ 1,093,000
Owner maintained project contingency	10	%		$ 546,000
			TOTAL PROJECT COST (2021 $'s)	**$7,103,000**

UNCERTAINTY WITH ESTIMATE, ADDITIONAL INFORMATION TO BE CONSIDERED FURTHER

1. Timing of this work is dependent on existing operations and other facility upgrades.
2. Project assumes a electrical contractor will be subcontractor to the civil general contractor.
3. Assumes work inside the building, such as MCC or PLC replacement, not included in costs. Work completed under other project.
4. Estimate based on conceptual layout of ductbank and infrastructure as shown on Figure 7.2 in Chapter 7.

DISTRIBUTION OF CAPITAL EXPENDITURES - *Shown in future values based on the escalation rate above.*

Esclated $'s	2021	2022	2023	2024	2025	2026
$ 7,994,000	$ -	$ -	$ -	$ 1,199,000	$ 6,795,000	$ -

2027	2028	2029	2030	2031 - 2040
$ -	$ -	$ -	$ -	$ -