



Tahoe-Truckee Sanitation Agency
Organizational Assessment

SUMMARY OF FINDINGS AND RECOMMENDATIONS

FINAL | November 2020





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Abbreviations

AAF	average annual flow
ADF	average daily flow
ALK	Alkaline
BOD	Biochemical Oxygen Demand
Carollo	Carollo Engineers, Inc.
CASA	California Association of Sanitation Agencies
Cl ³	Chloride
CMMS	Computerized Maintenance Management System
COD	Chemical Oxygen Demand
E&I	Electrical and Instrumentation
ELAP	Environmental Laboratory Accreditation Program
EPG	Effective Practice Guidelines
FIS	Financial Information System
FTE	full-time equivalent
GIS	Geographic Information System
HMI	human machine interface
IT	Information Technology
KPI	key performance indicator
mgd	million gallons per day
MPN	most probable number
NACWA	National Association of Clean Water Agencies
NH ³	Un-ionized Ammonia
NO ⁵	Nitrate and Nitrite
OJT	On the Job Training
OP	Orthophosphate
PIS	Plant Information System
SCADA	Supervisory Control and Data Acquisition
SOP	Standard Operating Procedure
TDS	Total Dissolved Solids
THM	Trihalomethane
TKN	Total Kjeldahl Nitrogen
TN	Total Nitrogen
TNI	The NELAC Institute
TOC	Total Organic Carbon
TP	Total Phosphorus
TRI	Truckee River Interceptor

TSS	Total Suspended Solids
T-TSA, Agency	Tahoe-Truckee Sanitation Agency
WDR	Waste Discharge Requirements
WEF	Water Environment Federation
WRP	Water Reclamation Plant

1.0 Executive Summary

The Tahoe-Truckee Sanitation Agency (T-TSA, Agency) commissioned an organizational assessment, in part to prepare for the impending capital improvement projects, and to review the current organizational alignment and practices with respect to comparable agencies.

The tasks within the request for proposal are:

Overall Organizational Assessment

1. To assess the effectiveness of the Agency and its ability to meet current demands by providing an objective analysis utilizing the knowledge, experience and “best practices” of other organizations and wastewater agencies
2. To make recommendations for a cost effective and efficient organizational structure (including staffing levels and span of control), division of work and workload review that provides optimum customer service, added value, efficiency, and flexibility that will result in meeting the Agency’s mission.
3. Evaluate whether the Agency’s organization is structured in a manner that facilitates and promotes the achievement of Agency’s mission. Assess whether changes to the manner in how the organization is structured could improve the organization’s performance, efficiency and effectiveness.
4. Evaluate whether the Agency’s current performance measures are the most appropriate ones available. Where applicable, develop recommendations for new performance measures based on industry best practices, and provide guidance on how those new measures should be implemented.

Department Assessment

1. Evaluate measures utilized to track department productivity, performance, and efficiency against the Agency mission.
2. Review and assess staffing levels (FTE) for each department, including the number of positions and core competencies necessary for high-performance. This evaluation should incorporate analyses of the use of outside services and consulting services.
3. Review the reporting structure for each department, the existing performance measures, and develop recommendations for changes to existing measures, or new measures, where appropriate, based on industry best practices and the consultant’s expertise.

Use of Consultants Assessment

1. Review and evaluate the functions for which the Agency currently utilizes the services of consultants.
2. Determine whether there are out-sourced functions where the use of existing staff resources or the development of in-house expertise in certain areas, would be more cost effective.

3. Determine whether there are in-house functions where the use of consultants would be more cost effective.

The assessment is comprised of an analysis of T-TSA staffing levels compared to similar-sized national and State agencies; feedback from wide-ranging interviews with Agency staff; and suggestions founded partly on items revealed in the interviews with Agency staff but also generated from observations, continuity with industry-best practices.

The Agency has an enviable compliance record, a primary metric when evaluating the performance of a wastewater treatment agency. Ongoing compliance typically indicates systems and an organization that is working well. The organizational assessment acknowledges the Agency's past and its successes, as change for the sake of change may not result in improvements. One intent is to reflect upon and acknowledge past shortcomings or failures as to not repeat them.

Carollo Engineers, Inc. (Carollo) was also mindful of the Agency's mission statement criteria, as they are foundational to the ways and means the Agency conducts its work.

The suggestions within this report are proposed with the intent of maintaining an organizational structure that:

- Provides:
 - Appropriate levels of service
 - Business process improvements
 - More efficient and effective operations
 - More efficient and effective maintenance
- Anticipates:
 - Future growth of the service area
 - Changes in skill sets driven by technology
 - Ever-increasing reliance on information technology and cyber security
- Maintains or Improves:
 - Employee satisfaction
 - Working conditions

1.1 Strengths, Concerns, Opportunities

Interviews were conducted in March 2020. Almost every person working at the Agency at that time attended an interview session. Generally, staff were thoughtful, not reluctant to speak up, and appreciative of the opportunity to have a voice. The feedback from the interviews helped us understand the workloads and assignments, interactions, and tools used to complete the work.

Strengths, concerns and opportunities for Operations/Laboratory Services, Maintenance, Engineering/Safety, Information Technology, and Administration were developed as follows:

- Strengths are positive items
- Concerns are items that may hinder the organizational growth of the Agency into the future and supervisory or management staff may want to address
- Opportunities are considerations to potentially address the concerns

Carollo's recommendations address gaps between current practices and programs and industry-best practices. A level of urgency is suggested.

1.2 Staffing Recommendations

The North American Clean Water Association (NACWA) conducts a periodic survey of wastewater treatment agencies. Responding is voluntary. Survey data provided in 2018 was used to compare the staffing count at T-TSA to other comparable sized utilities, although the data for approximately 5+/-million gallons per day (mgd) treatment plants is limited.

T-TSA aligns favorably with two other California special districts. The current staffing count – approximately 46 staff members – generally addresses the needs of the Agency to provide the expected levels of service and compliance.

Near-term adjustments for the Agency to consider include:

- Evaluate current laboratory staffing based on analysis of FTE requirements, and proposed alternatives. Currently T-TSA has three laboratory staff and a FTE requirement of 2.6
- Establish a Computerized Maintenance Management System/Geographic Information System (CMMS/GIS) position
- Increasing the Information Technology (IT) division staffing by one to supplement supervisory control and data acquisition (SCADA) and automation expertise
- Using Lucity CMMS results to right size the mechanical and Electrical and Instrumentation (E&I) staffing count
- Establish a new Associate/Assistant Engineer position and consider hiring or contracting additional Engineering expertise
- Establish an Executive Secretary – Board Clerk position
- Consolidate the Administrative Department by eliminating the Customer Services Supervisor position and replacing one Administrative Assistant position with an Accounting Technician
- Modify the Administration Manager job description to include more robust financial management experience

Staff development recommendations are provided in Chapter 5.

1.3 Programmatic Development Suggestions

The alignment of work practices between the Agency and industry-leading organizations was assessed during the interviews and site visits. Suggestions to improve the alignment of the Agency with these practices are provided in Chapter 6.

Areas to consider for increased focus and development include:

- Increase performance-based focus
- Develop IT/SCADA Master Plan
- Develop standard workflows and procedures
- Integrate Lucity CMMS into daily use
- Establish SCADA and Instrumentation comprehensiveness
- Conduct a cyber security evaluation
- Evaluate physical site security

1.4 Contracted Services Options

Services that the Agency could contract to operate and maintain the facility and achieve its mission-stated goals more effectively are provided. Services to consider contracting include:

- Process and compliance laboratory analyses
- Systems administration and integration
- Engineering support

2.0 Overview

T-TSA provides regional wastewater treatment service communities through the Agency's five-member sewage collection districts - the North Tahoe Public Utility District, the Tahoe City Public Utility District, the Alpine Springs County Water District, the Olympic Valley Public Service District, and the Truckee Sanitary District. The Northstar Community Services District is also served by T-TSA facilities through an agreement with the Truckee Sanitary District.

T-TSA owns, operates and maintains the Truckee River Interceptor (TRI) and Water Reclamation Plant (WRP). The TRI conveys wastewater from Tahoe City to the WRP in Martis Valley, east of the town of Truckee, California. The TRI collects flows from the five member districts that comprise T-TSA.

T-TSA commissioned an organizational assessment to prepare for the impending capital improvements projects, and to compare the current alignment and practices with similar-sized agencies. Ensuring that the Agency continues to align with its five-part mission statement (Figure 1) is one goal of the assessment. Some of the suggested initiatives are proposed to sustain that focus as the agency transitions through increasing capital improvements and ever-changing work force expectations.

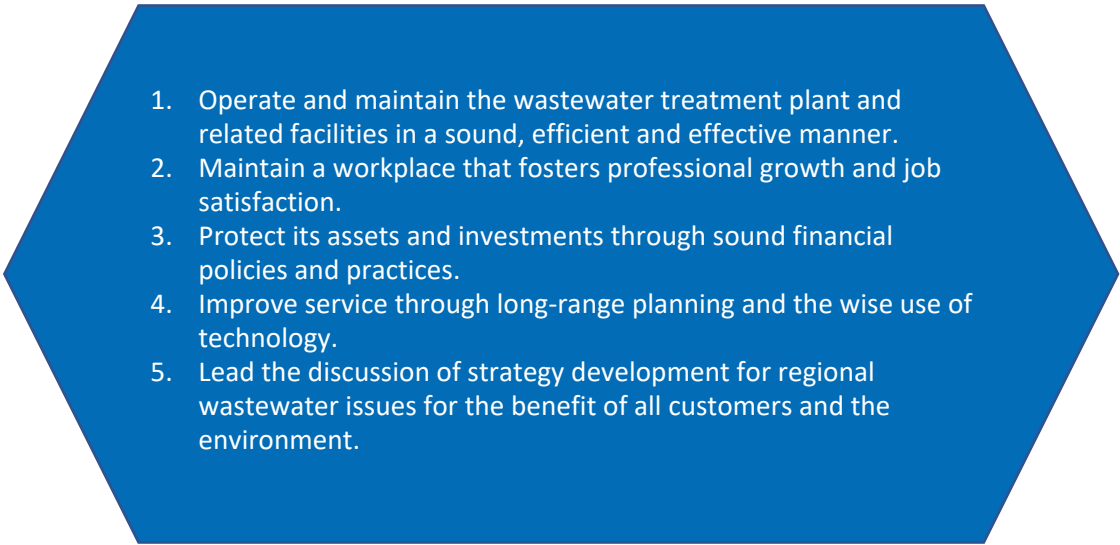
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1. Operate and maintain the wastewater treatment plant and related facilities in a sound, efficient and effective manner.
 2. Maintain a workplace that fosters professional growth and job satisfaction.
 3. Protect its assets and investments through sound financial policies and practices.
 4. Improve service through long-range planning and the wise use of technology.
 5. Lead the discussion of strategy development for regional wastewater issues for the benefit of all customers and the environment.

Figure 1 T-TSA's Mission Statement

Outcomes of the Organizational Assessment include maintaining an organizational structure that:

- Provides:
 - Appropriate levels of service
 - Flexibility
 - Business process improvements
 - More efficient and effective operations
 - More efficient and effective maintenance
- Anticipates:
 - Future growth of the service area
 - Changes in skill sets driven by technology
 - Ever-increasing reliance on information technology and cyber security
- Improves:
 - Employee satisfaction
 - Working conditions

The assessment foundation has three components, as illustrated in Figure 2. The 2018 National Association of Clean Water Agencies (NACWA) Financial Survey information provides an understanding of the staffing levels of comparable agencies. To better understand how work is currently completed, almost every member (94 percent) of the current staff was interviewed. These interviews allowed Carollo to better understand the expectations of the staff. This report provides digested results of those interviews, with feedback noted as strengths, concerns and opportunities. The strengths, concerns and opportunities also provide comparisons to industry best practices.

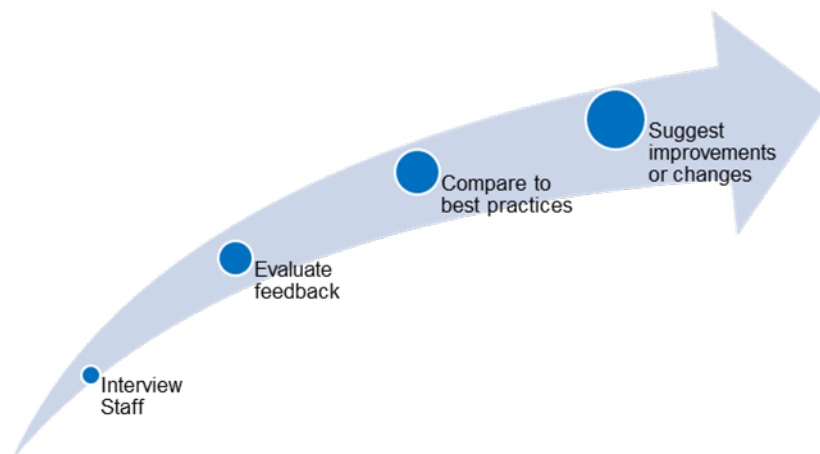


Figure 2 Organizational Assessment Approach

Feedback and observations result in suggested improvements or changes. Carollo recommends that T-TSA evaluate the proposed suggestions to determine which are best fit for continuing to achieve the mission statement goals.

3.0 NACWA Financial Survey Comparison

The North American Clean Water Association (NACWA) completed a staffing survey of over 110 facilities in the Opportunities and Challenges in Clean Water Utility Financing and Management report published in July 2015. In this report, the agencies surveyed reported an average of 3.5 full-time equivalents (FTEs) per mgd treated and 4.3 FTEs per 10,000 population served. This results in a range of 16 to 20 FTEs, based on the T-TSA's current average daily flow (ADF) and population. T-TSA's staffing count is 46 at the time of this report, which is high when compared to the average of all NACWA-surveyed agencies, but in alignment when compared to similar-sized agencies, as will be discussed in this chapter.

NACWA periodically circulates a survey that agencies voluntarily respond to. The latest was initiated in 2017 with the results published in 2018. The 2018 feedback from facilities with similar flow are provided to illustrate how T-TSA compares to others within the industry. Unfortunately, the number of approximately 5-mgd average annual flow (AAF) plants that responded is rather small. The survey data is supplemented with staffing information from T-TSA's closest neighbor, South Tahoe Public Utility District.

Many factors affect staffing levels and comparisons. Generally high-level categorical information is provided in the survey. Among those details that are not defined in the NACWA survey but that relate to T-TSA are:

- Differing processes. Figure 3 illustrates the Water Reclamation Plant's current treatment footprint.
- The service life and age of equipment, facilities and structures.
- Discharge permit requirements.
- Varying complexities of IT and SCADA systems.
- Differing financial systems.
- Supporting staff from another agency or city may have administrative, billing, or engineering staff that are not reported. As an example, a City may have engineering, laboratory or IT staff that support a variety of services, not just wastewater treatment.

The NACWA 2018 Financial Survey was used to understand and compare staffing levels to other comparable agencies. Survey information was first filtered by total effluent flow as a common metric. An average annual flow of 4.5 mgd was used for T-TSA.

The treatment plants used for this comparison may or may not have similar treatment processes. The Water Reclamation Plant has a treatment footprint that is unique to the industry, based on physical, biological and chemical treatment necessary to achieve low effluent requirements for nitrogen and phosphorus compounds (nutrients). The processes have a moderate amount of automation, meaning more operator intervention is required to adjust and optimize the processes. Chlorine gas is used as the disinfectant, resulting in operators onsite 24/7/365 to monitor the storage and makedown equipment and provide an immediate response if a safety issue arises.

Compliance requirements are likely not comparable. The Water Reclamation Plant's Waste Discharge Requirements (WDR) are more stringent than most. Compliance with a more stringent permit typically requires greater attention to detail, more frequent process analyses, more complex equipment, and increased operator observations and adjustments.

Table 1 displays the plants used for comparison to T-TSA's staffing. All but three have higher AAF flow than the Water Reclamation Plant, but all are medium sized plants. Two California plants that provided responses have roughly double the influent flow. South Tahoe PUD volunteered their staffing data for this assessment.

Table 2 displays the staffing numbers by category and the total number of staff reported. The survey results are not edited by NACWA. As a result, the numbers for a certain category (i.e., treatment) may also include other staffing, such as maintenance and/or management staff.

These agencies may or may not have a comparable structure to T-TSA. For instance, a city may have administrative, billing, or engineering staff that are not reported. In general, California plants have more staff treating the service area wastewater, no matter what the AAF is. These staffing levels may be driven by State regulations and requirements, a desire to provide high quality service, or a myriad of other reasons not provided as part of the survey information.

Table 3 focuses on the California plants only. Three metrics are used to clarify staffing counts. The metric and conclusions follow:

1. The total staffing number is divided by the AAF flow to determine the number of people involved treating each mgd. The Bay-area plants employ about 4.5 staff for each mgd treated, where the mountain-area plants use over double that amount.
2. The population of the service area is divided by the AAF to reflect the volume of wastewater generated within the service area. Roughly the same population provides a comparable amount of flow.
3. The population of the service area is divided by the total staffing number to reflect the population served by each person. The Bay-area plants serve over twice as many citizens as the mountain-area plants.

The organizational assessment revealed possible additions and subtractions to the current staffing levels, described later in this report. In general, about 50 total staff are needed to meet the Agency's goals and to provide the desired level of service.

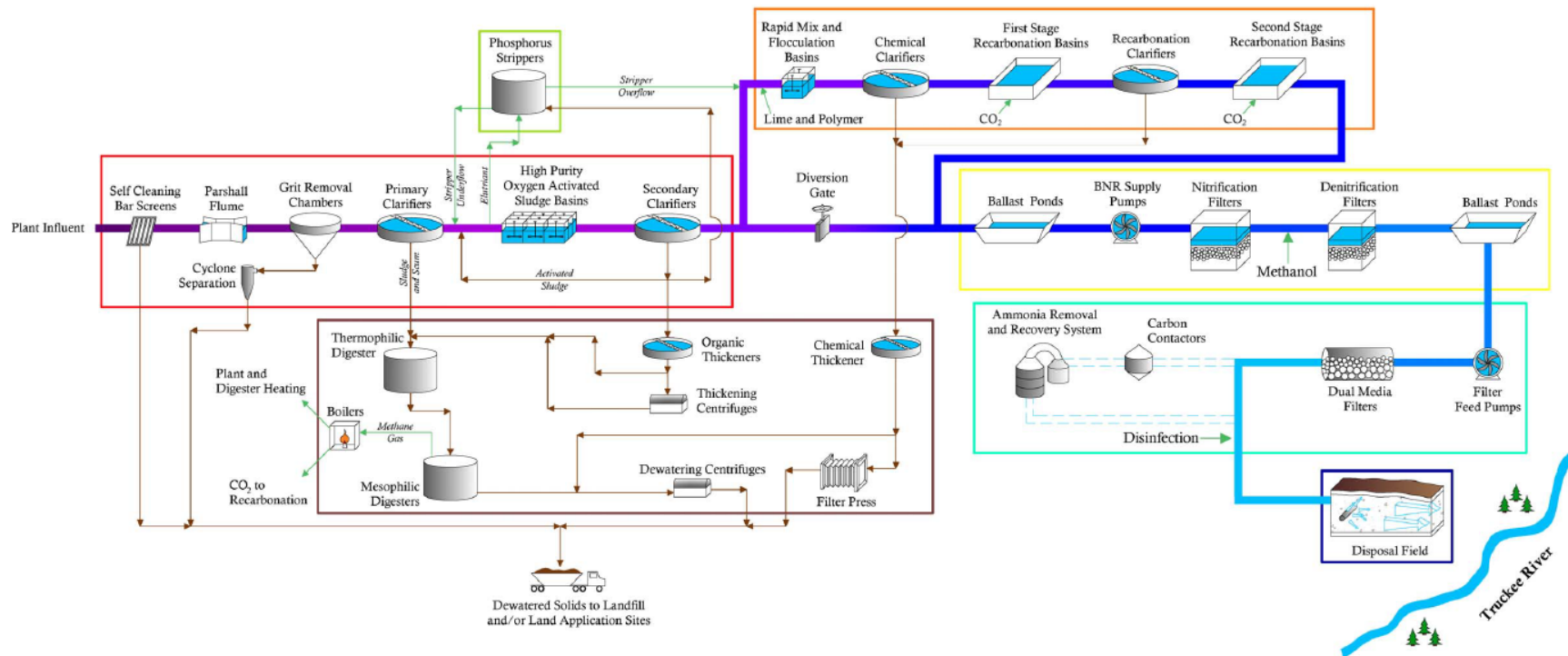


Figure 3 T-TSA's WRP Process Flow

Table 1 NACWA Plant Comparisons

Agency	City	State	Total Population Served	Average Flow (mgd)
Tahoe-Truckee Sanitation Agency	Truckee	CA	47,000	4.5
Fairfield-Suisun Sewer District	Fairfield	CA	142,000	12.6
West County Wastewater District	Oakland	CA	104,000	9.9
South Tahoe PUD	South Tahoe	CA	42,000	4.0
Daphne Utilities	Daphne	AL	25,000	3.5
Pine Bluff Wastewater Utility	Pine Bluff	AR	50,000	10.1
The Town of Greenwich	Greenwich	CT	61,171	8.1
Jefferson City Public Works Department	Jefferson City	MO	74,700	8.9
Orange Water & Sewer Authority	Carrboro	NC	83,000	8.6
Water Environment Services of Clackamas County	Oregon City	OR	95,366	8.6
City of Albany, OR	Albany	OR	54,885	10.4
Greenwood Metropolitan District	Greenwood	SC	50,000	6.9
Upper Trinity Regional Water District	Lewisville	TX	104,560	6.9
Central Davis Sewer District	Farmington	UT	60,500	6.5
Snyderville Basin Water Reclamation District	Park City	UT	31,079	3.8
	Minimum		25,000	3.5
	Maximum		141,728	12.6
	Average		71,988	8.1

Table 2 Staffing Numbers by General Category

Agency	Management, Admin, & Support	Billing & Collection/ Customer Service	Engineering	Industrial Pretreatment	Treatment	Water Reuse	Biosolids	Total
Tahoe-Truckee Sanitation Agency	12	2	3	0	29	0	0	46⁽¹⁾
Fairfield-Suisun	7		6	4	40			57
West County	10		9		25			44
South Tahoe	11.5	11	12	0	28	4	0	66.5
Daphne	11	3	2	1	6			23
City of Pine Bluff	11			8				19
Town of Greenwich	4	1			13			18
Jefferson City	1		1	1	13		3	19
Orange	22				19		4	45
Clackamas County	29		6		25		5	64
City of Albany	3			3	7			13
Greenwood	14		6		16		1	37
Upper Trinity	2			1	10	0	2	14
Central Davis	3		1		5		2	11
Snyderville Basin	4	1	7	1	12		2	27
Average	10	5	5	2	18	1	2	33

Notes:

(1) Staffing count as of April 2020.

Table 3 Staffing Results for California Plants

Agency	Total Population Served	Annual Average Flow (mgd)	Mgmt, Admin, and Support	Billing & Customer Service	Engineering	Industrial Pretreat	O&M	Total	Staff per mgd	Population per mgd	Population per Staff
Tahoe-Truckee Sanitation Agency	47,000	4.5	12	2	3	0	29	46	11	10,500	1,020
Fairfield-Suisun	142,000	12.6	7		6	4	40	57	4.5	11,250	2,500
West County	104,000	9.9	10		9		25	44	4.4	10,500	2,350
South Tahoe	42,000	4.0	11.5	11	12	0	28	66.5	16.5	10,500	650

4.0 Staff Interviews

To better understand how T-TSA uses the employees to meet Mission Statement Goals 1 and 2, Carollo used seventeen sessions to interview 45 staff members (Figure 4). The groupings were determined by T-TSA management based on availability and schedule. As an example, the timing of the two Operator III sessions occurred as the operators were completing their shifts. The interviews allowed Carollo to gauge if the plant is being operated and maintained soundly, effectively and efficiently. Feedback allowed Carollo to assess if professional growth opportunities are available.

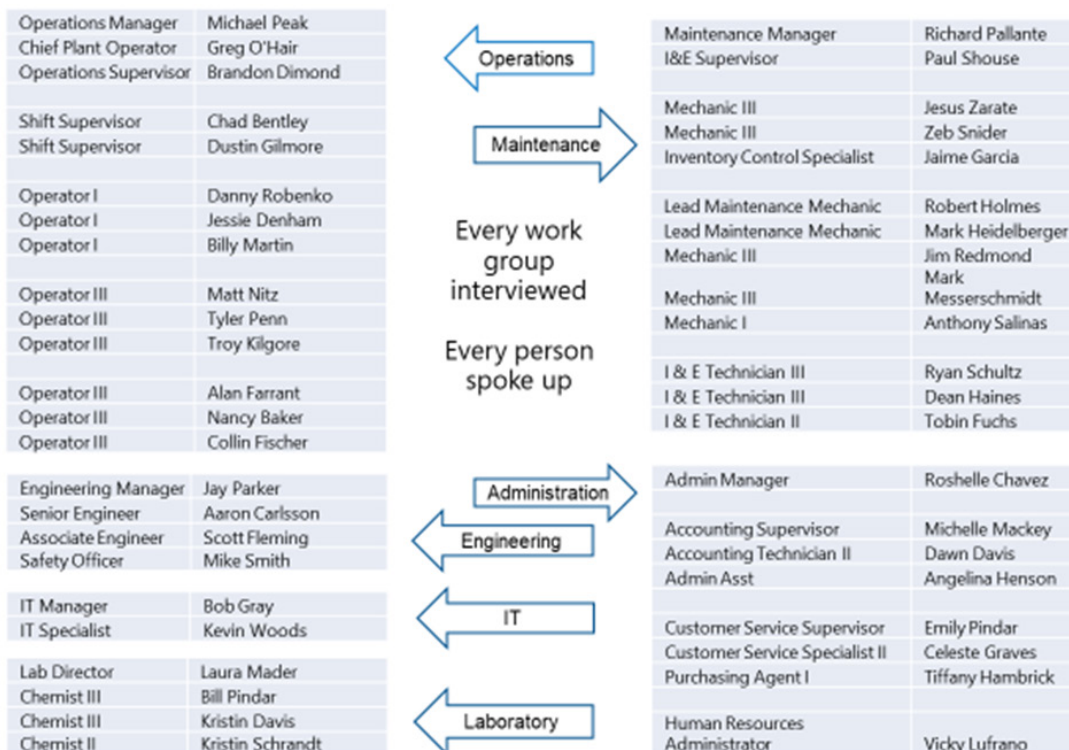


Figure 4 Staff Interviews

The feedback from the wide-ranging interviews was distilled into strengths, concerns, and opportunities for each workgroup. For example, all feedback from the mechanics is shown as one workgroup. Strengths, concerns, and opportunities for Operations/Laboratory Services, Maintenance, Engineering/Safety, Information Technology, Administration are provided.

- Strengths are positive items for the group. These provide the backbone to build programs, initiatives, and work efforts from.
- Concerns are items that may hinder growth of the Agency into the future and is something that supervisory or management staff may want to address. These concerns may not be negative but could hinder achieving Goals 1 and 2.
- Opportunities are items that the Agency may decide to act on, as they are considerations to address the concerns.

4.1 Operations

Strengths

- Knowledge of how the plant operates and adjustments needed to maintain compliance
- Confident in their abilities
- Experienced staff that will tackle anything
- Well-educated staff that wants to be involved in process control decisions. The number of college-educated plant operators is greater than in many other facilities
- Utility crew staff are eager and willing

Concerns

- Communication of actual results against unit process performance indicators
- Consistent knowledge transfer between experienced workers and new hires

Opportunities

- Further involve all operators into process and plant optimization initiatives
- Refine unit process key performance indicators (KPIs)
- Publish optimization results to demonstrate success and further drive optimization efforts
- Provide additional training to optimize interaction with the Plant Information System to use the results to further optimize unit processes and operating costs
- Bolster the On-the-Job training program by adding written objectives to realize consistent knowledge transfer
- Share and learn operational practices through interaction with other local, state, and national organizations (California Association of Sanitation Agencies [CASA], Water Environment Federation [WEF], etc.)
- Integrate tablets and other methods that support remote operations
- Use video/voice over (GoPro, iPad, or similar) technology to document the unique operational events that rarely occur

4.2 Laboratory Services

Strengths

- Well educated and informed team
- Dedication to the environment
- Commitment to the Agency and its mission
- Programs and procedures in use to retain the State of California's Environmental Laboratory Accreditation Program (ELAP) verification

Concerns

- Workload and staffing count may not align
- The in-house evaluation of the WDR requirements resulted in a significant reduction in analyses for lab staff to conduct
- Conformance with the revised California ELAP Regulations modeled after The NELAC Institute (TNI) standards (compliance expected by late 2023)

Opportunities

- Evaluate the current means and methods used to provide service and results
- Detailing the programmatic tasks and the time required to complete them may reveal opportunities for staff to take on other work
- Conversely, mapping out workload may reveal the potential to downsize the work group
- Confirm lab data management robustness
- Confirm documentation and practices with current ELAP requirements and proposed TNI requirements

4.3 Maintenance

Strengths

- Well-rounded skill sets
- Pride of ownership
- Pride of ability
- Have the tools to do the work
- Have a machine shop to manufacture parts if needed
- Willing to tackle any project

Concerns

- Integrating the historical data within the Plant Information System with the new Lucy platform
- Limited comprehensive communication – both verbal and graphical - of key performance indicators and the goals
- Non-industry standard remote telemetry equipment
- Consistent knowledge transfer between experienced workers and new hires

Opportunities

- Establish a CMMS/GIS technician position
- Drive asset management and cost awareness using Lucy CMMS and other commercial software
- Prioritize critical equipment repair needs regardless of the impending master plan recommendations and address these needs before failure
- Increase the E&I group involvement in SCADA hardware maintenance. This allows the E&I staff to increase their value to the Agency while allowing the IT staff to focus on other support needs and new systems integration
- Bolster the craft-specific On-the-Job training programs by adding written objectives to realize consistent knowledge transfer
- Reevaluate use of non-industry standard equipment for remote telemetry
- Share and learn maintenance practices through interaction with other local, state, and national organizations (CASA, WEF, etc.)
- Use video/voice over (GoPro, iPad, or similar) technology to document the unique maintenance events that rarely occur

4.4 Engineering

Strengths

- Eager and energetic
- Competent

Concerns

- Inadequately staffed for impending CIP workload
- Record and as-built drawings not easily accessible or developed

Opportunities

- Implement electronic data and documents management system
- Consider adding additional staff prior to the impending projects
- Consider increased consultant support for implementation of plant improvements and upgrades (e.g. staff augmentation)

4.5 Information Technology

Strengths

- Cost-effective IT approaches
- Dedicated and enthusiastic staff
- Pride of ownership
- Support for virtualization and cloud-based technologies
- Upgrading to latest version SCADA human machine interface (HMI) (Wonderware 2014)

Concerns

- No recent cyber security review
- No IT strategic/master plan
- Agency-developed system for laboratory and operations data management limits support capability from outside of the Agency

Opportunities

- Use outside consultant to conduct IT/SCADA assessment and develop IT/SCADA master plan based on industry best practices
- Confirm the future for laboratory and operations data management
- Consider using E&I staff for SCADA maintenance and programming support
- Phase out Plant Information System (PIS) functionality that overlaps with CMMS
- Implement Wi-Fi improvements and increase availability of mobile devices for CMMS use. Improved Wi-Fi will benefit the contractors that will execute future capital upgrades
- Conduct cyber security evaluation and implement recommendations

4.6 Administration

Strengths

- Talented and experienced staff with a long work history
- Optimistic that the new Financial Information System (FIS) will provide many accounting and reporting improvements

Concerns

- Minimal IT support for new FIS and dependence on single remote vendor
- Need for in house financial staff to support current management and administration

Opportunities

- Evaluate potential efficiencies to streamline workflows for approvals, increased use of electronic documentation, and automation of reports
- As Lucity matures, use to increase purchasing, warehouse, and receiving efficiencies

5.0 Staffing Recommendations

The June 2020 T-TSA organizational structure, shown in Figure 5, reflects typical industry alignment around administration, engineering, information technology, operations, and maintenance functions.

A high-level evaluation indicates that the current employee count is close to appropriate for the variety of mandated compliance tasks, and services that the Agency undertakes, and that the public expects to achieve ongoing compliance with all operating permits.

However, several changes to the organizational structure were evaluated and suggested to optimize the performance of the Agency and increase the ability of the Agency to transition into and embrace the technical and modern changes being implemented as related to modernization of the agency's work processes. Those modifications include:

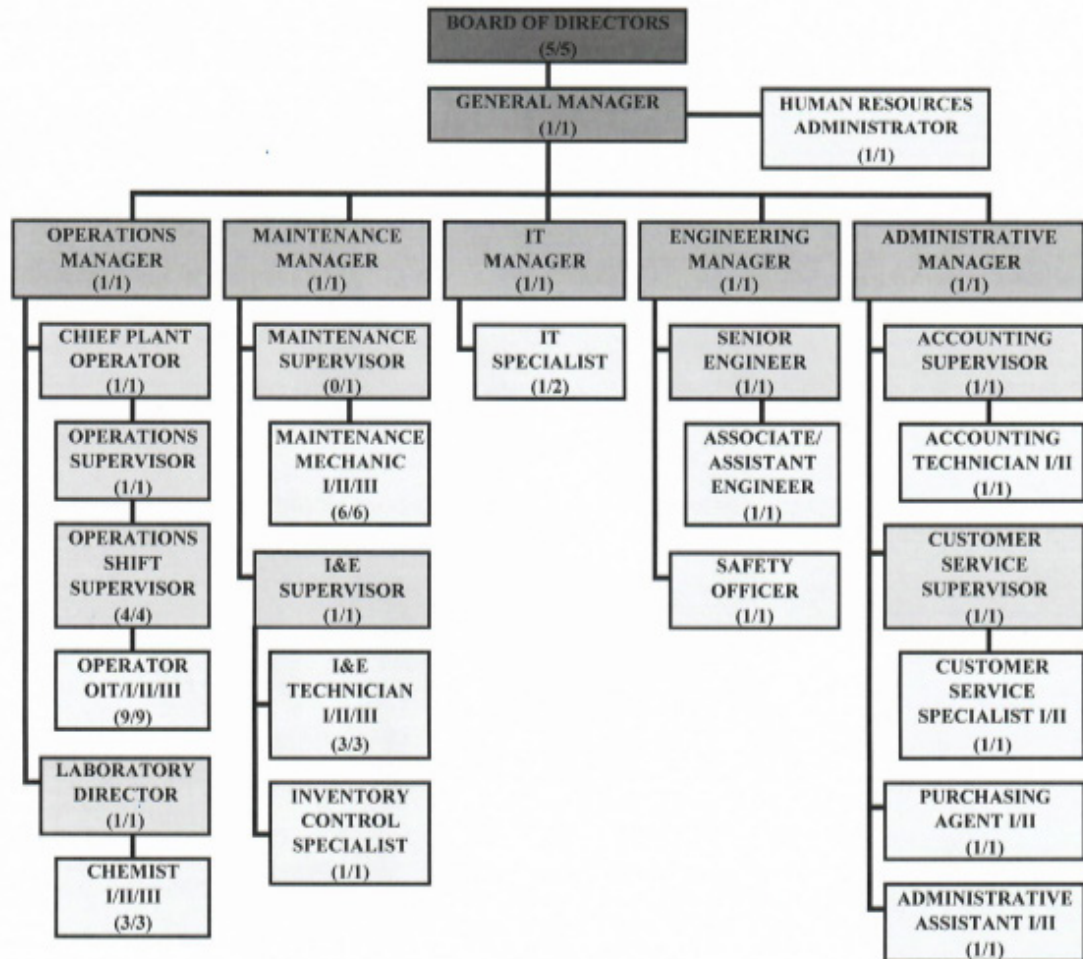
- Options for the placement of Laboratory Services were evaluated. Within the industry, it is not unusual for Lab Services to report to the Operations Manager. Other options were considered but the integrity expected by the State of California for Operators-in-Responsible Charge surpassed any concerns.
- Options for the structure of laboratory services were evaluated given the transition from ELAP to TNI certifications, and transition of some sampling and analysis activities from the Laboratory to Operations.
- Modifications of the administration services, given recently realized efficiencies and the elimination of the customer inspections have allowed the elimination of the Customer Services Supervisor position
- Replacing an existing Administration Assistant position with an Accounting Technician position
- Creation of an Executive Secretary – Board Clerk position
- Change job description for the Administrative Manager to require more robust financial experience
- Increase the number of FTEs in the Associate/Assistant Engineer role from one (1) to two (2) in anticipation of the increased workload from the Master Plan recommended Capital Program
- The inclusion of a CMMS/GIS role with staff for the implementation of CMMS and data management responsibilities across the Agency.

- Placing the Safety responsibilities under the Operations or Maintenance Manager was considered. In the past this alignment proved to be ineffective. Retaining Safety within Engineering appears to be the best option for the Agency.



TAHOE-TRUCKEE SANITATION AGENCY ORGANIZATIONAL CHART

Approved and Adopted by Board of Directors: June 17, 2020



Note: (0/0) identifies quantity of full-time equivalent's (FTE's) - (FTE's Filled/FTE's Total)

Approval Signature: _____

Figure 5 Current Organizational Structure

5.1 Laboratory Staffing Review and Evaluation

Carollo conducted a review of the current laboratory staffing workload and regulatory responsibilities based on inquiries related to the number of FTE's currently responsible for the collection and analysis of compliance and operations sampling. Carollo worked closely with plant operations and with a database developed by the Agency's recently departed Laboratory Director to evaluate the required number of FTE's based on current sampling and reporting requirements. In Appendix A, Figure A1 provides a breakdown of the daily tasks required of the Laboratory Staff. The daily schedule included time blocks for when specific duties were required. The table of daily work provides a detailed look at the required task to complete all of the regulatory and operational sampling and analyses requirements for the three Laboratory working stations in use. The schedule was developed by the previous Lab Director, and includes Daily Monitoring, Analysis and Compliance Reporting, as well as Non-Daily Compliance activities. As developed, the schedule includes approximately 68 hours per week (3,552 hours per year) of daily compliance and reporting tasks. The remaining portion of the schedule not filled with daily tasks was allocated to Non-daily work, that portion of the schedule totals approximately 37 hours per week (1,900 hours per year). The hours were allocated based on the Laboratory Director's scheduling.

Carollo worked closely with agency staff to calculate the actual staff time required to complete both Daily Monitoring, Analysis, and Compliance Reporting, as well as Non-Daily Compliance activities and compare the calculated values versus the existing Laboratory Director's schedule to determine the required FTE for monitoring and tracking Agency compliance. Table 4 below summarizes the calculations. Based on the summary in Table 4, the Agency needs 2.6 FTEs to complete the required sampling. Currently the Agency has 3 FTEs assigned to the Laboratory.

Table 4 Summarized Calculations of Laboratory Task

Laboratory Task	Existing Time Allocation (Hours/Year)	Calculated Time Required (Hours/Year)
Daily Monitoring, Analysis, and Compliance Reporting	3,552	3,552
Non-Daily Compliance	1,900	400 ⁽¹⁾
Staff Breaks	1,170 ⁽²⁾	1,170
Total Time Required	6,622	5,222
Time Per FTE	2,000 ⁽³⁾	2,000
Required FTE	3.3	2.6

Notes:

- (1) Non-Daily hours were calculated at 71 hours per year, Carollo assumed an allowance for approximate 400 hours to account for unknown tasks and unforeseen work efforts, to total approximately 500 hours a year or 25 percent of an FTE.
- (2) Staff breaks were calculated at 22.5 hours per week.
- (3) An FTE is estimated to provide 2,000 hours per year after paid time off is removed.

5.1.1 Laboratory Staff Options

Based on the calculated FTE requirements, Carollo developed three Laboratory staffing alternatives that included options for maintaining existing staffing levels and responsibilities, to contracting out all laboratory services. Alternatives considered requirements to transition from ELAP to TNI certifications, projected workload, and compliance risk. Table 5 summarizes the elements of each alternative and the associated annual costs.

Table 5 Alternative Elements Summarized and Associated Annual Costs

Laboratory Staff Alternatives	Description
Alternative 1 – Maintain Current Staffing	<ul style="list-style-type: none"> Maintain three Laboratory Staff including a Lab Director⁽¹⁾ and two Chemist II/III. Provides sufficient staff to meet 2.6 FTE requirements. Provides internal staff to support ELAP to TNI certification Sampling and compliance testing and analysis to be completed by Laboratory Staff Staffing to include Laboratory Director and two Chemists Annual Cost = \$612, 000⁽²⁾ annually plus TNI accreditation support
Alternative 2 – Two Full Time Laboratory Staff	<ul style="list-style-type: none"> Two full time Laboratory Staff (two FTE) including a Lab Director⁽¹⁾ and a Chemist III 0.6 FTE support provided by Operations Staff Operations Staff to provide DO and Temperature, support most probable number (MPN), and other support including weekends Requires consultant support with ELAP to TNI certification Annual Cost = \$445,000⁽³⁾ annually plus TNI accreditation support
Alternative 3 – One Laboratory Staff and Contracted Sampling Analysis	<ul style="list-style-type: none"> One Lab Director⁽¹⁾-level staff member responsible for compliance, reporting, and analysis quality control Operations Staff to provide DO, Temperature, MPN, and other support including weekends Contract sampling analysis to a National TNI Certified Laboratory Requires consultant support with ELAP to TNI certification Annual Cost = \$360,000⁽⁴⁾ annually plus TNI accreditation support

Notes:

- (1) Currently the T-TSA description for a Laboratory Director includes supervisory responsibilities. Laboratory Director in Alternative 1 and 2 includes the supervisory responsibilities. Under Alternative 3, the Laboratory Director position does not include supervisory responsibilities, and may require adjustments to the current T-TSA job descriptions.
- (2) Alternative costs include staffing and assumed costs for outsourcing testing and sample analysis. O&M costs assumed to be minimal across all alternatives as compared to staffing costs
- (3) Staff costs were provided by the Agency based on existing total compensation.
- (4) Costs for Alternative 3 include staffing costs of \$216,000 plus the costs of sampling analysis at a TNI accredited laboratory

The Alternatives were evaluated based on benefit cost effectiveness regarding overall T-TSA operations. Currently Alternative 1 results in an overstaffing of the Laboratory tasks, and results in the highest annual cost. Alternative 2 optimizes staffing by reducing laboratory staff to match the required FTEs by utilizing operations staff for operational sampling. Alternative 2 will utilize contracted services to help meet the TNI certification requirements over the short term.

Alternative 3 provides the minimal level of staffing to provide oversight and quality control of the contracted sampling analysis, and similar to Alternative 2 requires consulting services to meet TNI certification requirement. Alternative 3 would also require courier services to transport

samples from the plant to a TNI certified testing laboratory in Reno, Nevada. This alternative would also require consulting services to meet TNI certification requirements.

The conversion from ELAP to TNI accreditation has not been adopted by the Water Quality Control Board but is expected. An estimated cost for consultant support to achieve this accreditation is \$80,000 over a three-year period. A dedicated 0.25 - 0.5 FTE yearly is forecast to work with the consultant on the transition.

5.2 Staffing and Organizational Recommendations

Table 6 illustrates suggestions that relate to staffing alternatives, prioritized by Carollo's suggested urgency based on the interviews, observations, and industry trends or standards. Reasoning why the change is suggested and considerations about the change are provided. Some suggestions address the present; some anticipate demands that will arise as future projects – study, design, construction, and operating phases – occur. These are suggestions but T-TSA is advised to consider the overall impact to how work is presently conducted and what these changes may do to that workflow. Figure 6 illustrated the proposed modifications to the Agency Organizational Chart to account for the changes recommended in Table 6.

Table 6 Recommended Staff Modifications

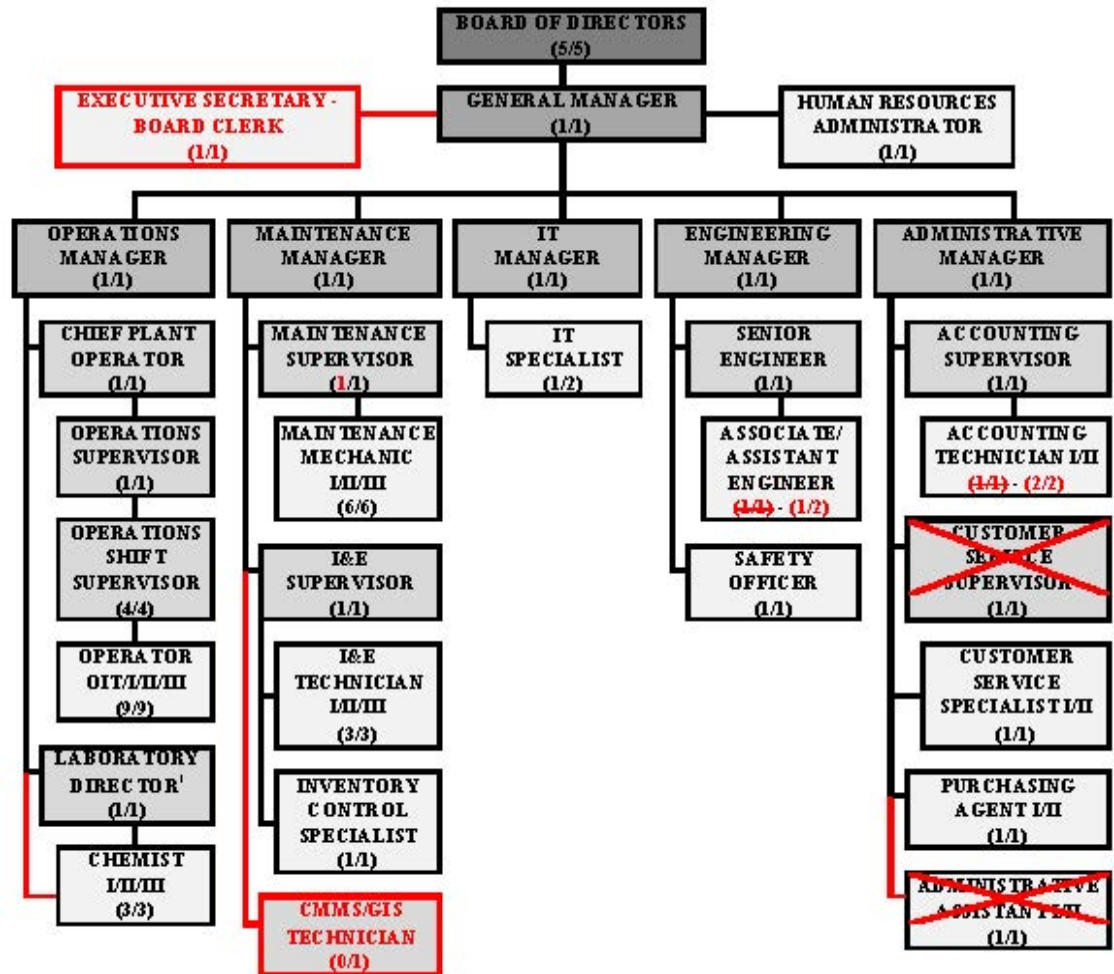
Suggestion	Why/How	Considerations	Urgency
Optimize Lab Services staffing by with support of operations staff	<ul style="list-style-type: none"> In 2019, the number and frequency of process analyses completed by Lab Services staff was modified Laboratory workload analysis revealed that the current required workload is 2.6 FTEs. Revised California ELAP Regulations modeled after The NELAC Institute (TNI) standards are anticipated to become effective by the end of 2020, with compliance expected by the end of 2023 	<ul style="list-style-type: none"> Continue to: <ul style="list-style-type: none"> Retain ELAP accreditation and transition to TNI certifications Maintain permit compliance documentation and data Complete special studies Complete non-routine lab analyses Use approved technologies or techniques to streamline analyses Determine the Laboratory's current status with TNI standards <ul style="list-style-type: none"> Consider third-party support if needed to meet the 2023 deadline Evaluate the use of a contracted laboratory services provider for routine analyses Determine what additional work could be delegated for Lab Services staff 	High
Create CMMS/GIS position	<ul style="list-style-type: none"> Need for GIS based data and O&M management Agency-wide 	<ul style="list-style-type: none"> Work with Lucity system Works under the direction of the Maintenance Supervisors Implement and manage CMMS data and planner scheduler role Manage GIS Data and Electronic records/O&M records for treatment and conveyance 	High
Assess IT organization and staffing as part of IT/SCADA master plan	<ul style="list-style-type: none"> Implement industry IT best practices Refocus IT for increased enterprise systems support 	<ul style="list-style-type: none"> Implement recommendations of IT/SCADA master planning consultant 	High
Create Executive Secretary – Board Clerk	<ul style="list-style-type: none"> Support Board and overall administration of meetings and management functions 	<ul style="list-style-type: none"> Consider advertising for open position or moving an existing administration employee 	Medium
Eliminate Customer Service Supervisor and one Administrative Assistant position	<ul style="list-style-type: none"> Business process improvements have resulted increased efficiencies 	<ul style="list-style-type: none"> Currently the existing staffing is meeting these suggested modifications and new action is not required beyond a modification to the Agency Organizational Chart 	Medium

Suggestion	Why/How	Considerations	Urgency
Create Accounting Technician Position	<ul style="list-style-type: none"> Additional accounting needs facilitate this addition 	<ul style="list-style-type: none"> Advertise for new open position to be posted under the current Accounting Supervisor 	High
Create New Associate/Assistant Engineer	<ul style="list-style-type: none"> Projected workload related to Master Plan improvements surpasses existing staffing 	<ul style="list-style-type: none"> Advertise for new open position to be posted under the current Senior Engineer 	High
Modify Administration Manager Job Description to include More Robust Financial Qualifications	<ul style="list-style-type: none"> Agency currently doesn't have in-house financial support 	<ul style="list-style-type: none"> Industry standard is for in-house financial expertise Agency needs to provide internal accountability from internal staff expertise 	High
Right-size the mechanic and E&I staff counts based on CMMS data	<ul style="list-style-type: none"> Reevaluate the level of effort and complexity of tasks as a result of Lucity CMMS implementation may expose inefficiencies. 	<ul style="list-style-type: none"> Determine actual effects of pending staff retirements Specific contracted services options may be able to replace unique retiring skills 	Medium
Add third party Owner's Advisor management to Engineering Manager's workload	<ul style="list-style-type: none"> Contracted services will be needed for project management, construction oversight, design/build expertise and other CIP-driven duties 	<ul style="list-style-type: none"> Delegate less essential management work to Senior Engineer 	Medium
Modify Senior Engineer's job responsibilities	<ul style="list-style-type: none"> Anticipate CIP projects with focus on project specifications, document handling and storage 	<ul style="list-style-type: none"> Delegate pretreatment inspection Engineering retains pretreatment plans and specification review for new or modified businesses 	Medium
Evaluate means to change to unmanned operation	<ul style="list-style-type: none"> Potential to reduce staffing count Improve working hours Have staffing onsite to support construction activities 	<ul style="list-style-type: none"> Strategies can be tested and refined before committing 	Medium



TAHOE-TRUCKEE SANITATION ORGANIZATIONAL CHART

Approved and Adopted by Board of Directors: XXXX XX, XXXX



Notes:

(1) Roles and responsibilities of the Lab Director to be defined based on alternative selection of the Lab services alternative.

Figure 6 Proposed Organizational Structure

5.3 O&M Staff Development Recommendations

Table 7 displays suggestions to more comprehensively achieve mission statements goals 1 and 2, categorized by Carollo's suggested urgency.

Table 7 O&M Staff Development Suggestions

Suggestion	Why	Considerations	Urgency
Staff Development - Operations			
Conduct process optimization discussions with all operations staff frequently	<ul style="list-style-type: none"> Maximize staff abilities and contributions Increase interaction between supervision and frontline staff Use defined and communicated process indicators to measure results and refine actions as needed Grow overall awareness to develop future supervisory staff 	<ul style="list-style-type: none"> This will grow the overall staff knowledge and involvement Use and grow the collective skills and knowledge to meet mission statement goals 1 and 2 Involve Lab Services to evaluate means and instrumentation to increase online monitoring and adjustments 	Immediate
Improve process performance indicators, tracking and feedback methods	<ul style="list-style-type: none"> Further optimize treatment processes, therefore operating costs 	<ul style="list-style-type: none"> Tie operator observations and adjustments to metrics longer-term and more comprehensive than SCADA trends 	High
Add written objectives and criteria to On-the-Job Training for OITs	<ul style="list-style-type: none"> Demonstrate proficiency Establish understanding of key performance indicators 	<ul style="list-style-type: none"> Establish a consistent foundation for all new hires Support transfer of institutional knowledge 	Medium
Staff Development - Maintenance			
Conduct optimization discussions with all maintenance staff frequently	<ul style="list-style-type: none"> Maximize staff abilities and contributions Increase interaction between supervision and frontline staff 	<ul style="list-style-type: none"> This will grow the overall staff knowledge and involvement 	Immediate
Refine maintenance performance indicators, tracking and feedback methods	<ul style="list-style-type: none"> Optimize maintenance work, therefore operating costs 	<ul style="list-style-type: none"> Tie staff observations and adjustments to CMMS-based metrics 	High
Add written objectives and criteria to On-the-Job Training for Crafts	<ul style="list-style-type: none"> Demonstrate proficiency Establish understanding of performance metrics 	<ul style="list-style-type: none"> Establish a consistent foundation for all new hires Support transfer of institutional knowledge 	Medium

Suggestion	Why	Considerations	Urgency
Use the most skilled craftsman to train others on specific learning domains	<ul style="list-style-type: none"> • Ensure continuity with training • Maintain pride of ownership demonstrated by current staff 	<ul style="list-style-type: none"> • Provide expertise of current means and methods into upcoming CIP projects • Upgrade On-the-Job Training (OJT) modules to match project-provided changes 	Medium
Obtain CMMS Implementation Support	<ul style="list-style-type: none"> • Optimize the use of the CMMS solutions by training employees in the effective use of the CMMS and proper work order management 	<ul style="list-style-type: none"> • Fully leverage these core business applications and populate the CMMS and GIS with requisite asset attributes for each asset class 	Medium

Changing from gaseous chlorine to an alternative disinfectant is a potential capital improvement project that could affect plant staffing. Figure 7 illustrates how to methodically move to unmanned operations. The timeline is an example and not tied to any current Agency upgrades.

Reasons for making this transition are many and varied, including reducing the less desirable (therefore harder to fill) off-hour shifts. A systematic approach tied to SCADA alarm and communication upgrades and mechanical and electrical reliability improvements could provide comfort to test and ultimately adopt unmanned operation. Evaluating the results could result in a reduced staffing count with more operators onsite during the construction activities. The operators could better learn the new equipment and process upgrades while supporting the adjustments and outages that arise during a project.

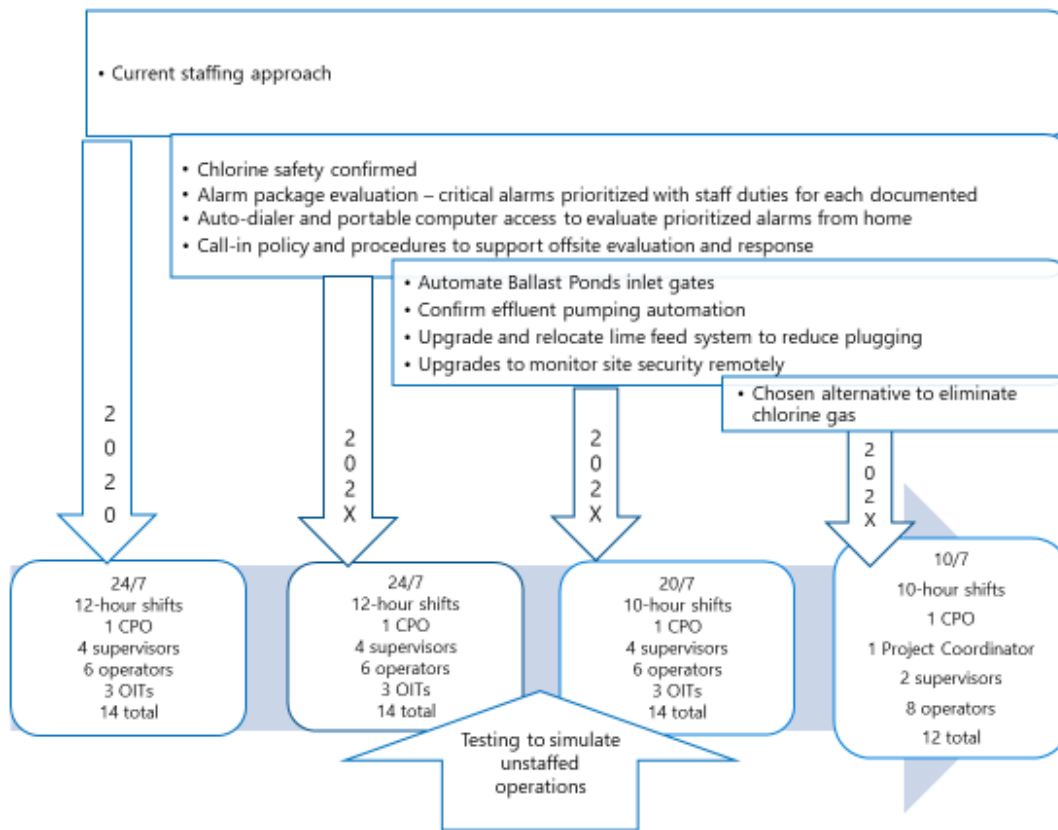


Figure 7 Unmanned Operations Transition Workflow

6.0 Programmatic Development Suggestions

Table 8 displays suggestions to more comprehensively achieve Goals 1, 2, 3 and 4, categorized by Carollo's suggested urgency.

Table 8 Programmatic Development Suggestions

Suggested Improvements	Why	How	Urgency
Strategic Growth			
Increase Performance-Based Focus	<ul style="list-style-type: none"> Implement a performance-based focus with sets of tiered, integrated performance measures within each major workgroup tied to the Agency's Strategic Plan and desired Levels of Service for its customers 	<ul style="list-style-type: none"> Monitor and trend actual levels of performance against desired business targets Communicate performance to all employees and other stakeholders 	High
Hire 3 rd Party Consultant to develop IT/SCADA Master Plan	<ul style="list-style-type: none"> Implement use of industry IT best practices Refocus IT for increased enterprise systems support 	<ul style="list-style-type: none"> Implement staffing, process, and technology recommendations from comprehensive IT/SCADA master plan 	High
Develop Standard Workflows and Procedures	<ul style="list-style-type: none"> Develop Standard Operating Procedures (SOPs) and Effective Practice Guidelines (EPGs) for routine field activities and train staff in the use of the business process workflows and SOPs/EPGs to improve overall work efficiency and effectiveness 	<ul style="list-style-type: none"> Document as-is and to-be business process workflows using consistent Process Functional Chart standards 	Medium
Evaluate the time required to complete basic workload for each job category	<ul style="list-style-type: none"> Determine the actual workload Adjust staffing to align with required work Forecast future alignment and staffing count 	<ul style="list-style-type: none"> Measure work using CMMS, Excel, and/or comparable data management tools 	Medium
Efficiency and Risk			
Evaluate the Laboratory's current documentation and procedures against to the 2023 TNI standards	<ul style="list-style-type: none"> On May 5, 2020, the California State Water Resources Control Board adopted new regulations to update the ELAP. These newly adopted regulations include the implementation of the 2016 TNI Standard. Beginning October 1, 2020 laboratories will have a transition period of 3 years to ensure they meet requirements for the TNI Standard for both management and technical requirements. 	<ul style="list-style-type: none"> Dedicate one or more FTEs to completing or strengthening the current documentation Hire a TNI Standards-knowledgeable 3rd party to augment staff's work and support the Operations Manager 	Immediate

Suggested Improvements	Why	How	Urgency
Integrate Lucity CMMS into daily use	<ul style="list-style-type: none"> Track I&E and Mechanical workload Understanding workloads may result in additions or reductions with current staffing alignments to meet actual needs Track and forecast budgets Track and forecast parts and supplies Provide reporting metrics for continual optimization Track outside contractor hours and costs Consider adding Operations, Engineering or Environmental Compliance tasks and track the time and costs of initiated tasks 	<ul style="list-style-type: none"> Establish Planner/Scheduler position Dedicate a portion the I&C and Mechanical Supervisors time to build out the system Use a I&C Technician and/or Mechanic as needed for subject matter expertise 	Immediate
Improve SCADA and Instrumentation comprehensiveness	<ul style="list-style-type: none"> Modernize IT workload and focus Plan automation upgrades Standardize VFD and equipment drives Establish fiber backbone Improve engineering specs before CIP projects ramp up 	<ul style="list-style-type: none"> Hire a knowledgeable 3rd party Program Manager to evaluate the current approach and set the path forward including resources, schedule and budget and to oversee the successful completion 	High
Conduct cyber security evaluation	<ul style="list-style-type: none"> High risk exposure of cyber terrorism directly affecting operations Previous cyber security assessments are outdated Supports grant/loan funding applications 	<ul style="list-style-type: none"> Include cyber security as part of the IT master plan 	High
Evaluate site security	<ul style="list-style-type: none"> Intruder access could affect employee safety and permit compliance Support possible unmanned operations 	<ul style="list-style-type: none"> Initiate study 	Medium
Create an online GIS system	<ul style="list-style-type: none"> Modernize access to electronically stored drawings, vendor manuals, and training Provide location for CIP-project documentation as it arrives Provide location for typical procedures 	<ul style="list-style-type: none"> Add to first Capital Improvement Project 	Low

7.0 Contracted Services Options

Table 9 briefly discusses services that could be, or may already be, handled by non-Agency staff. Contracted services still require T-TSA staff to manage the contract and monitor the work.

Table 9 Specialized Services Options

Suggested Service	Why
Process and compliance laboratory analyses ⁽¹⁾	<ul style="list-style-type: none"> Contracted laboratory can provide comparable service
Systems administration and integration	<ul style="list-style-type: none"> Third party support for the IT staff could help complete the Lucity and FIS upgrades comprehensively while also completing their daily work, Note: this is near-term and not tied to the IT Master Plan initiative.
Engineering support	<ul style="list-style-type: none"> When capital projects ramp up, the Engineering staff is not large enough to complete daily and project work in a timely manner

Notes:

(1) See Appendix A

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Appendix A

LABORATORY ANALYSIS

The Laboratory staff performs a large variety of analyses. The results are used to demonstrate unit process performance, compliance with waste discharge requirements, river monitoring of the Truckee River, and periodic analyses for connectors, among other varied activities.

A 2019 in-house analysis showed that there was an overlap of WDR analyses between Lab Services and Operations. This resulted in an overall reduction of testing by Lab Services that reduced the volume of analyses, the volume of work required and the corresponding costs for reagents. At that time, the staffing level of four was retained, although the volume of work diminished.

The Agency could contract out Lab-related activities and many analyses (Table A1). However, it is likely in the Agency's best interests to align the volume of work to an appropriate number of Lab staff and use contracted services judiciously. If analyses are contracted to an outside laboratory, there is still the need to properly prepare the samples, evaluate the results for quality and applicability, input the data into the PIS, and add or subtract analyses based on unit process changes. If a contracted service is used, completing the data sets required for compliance reporting shifts from T-TSA to the contractor.

Discrete or special studies may arise as the treatment footprint is altered over time. Studies may be needed to determine the best technology changes, addition of online analyzers, or other work that dovetails with capital improvements.

T-TSA is currently ELAP certified, and desires to retain that status. Criteria to retain this accreditation must be adhered to and proactively tracked to retain this status.

Carollo conducted a comprehensive review of the Laboratory's current workload as part of this assessment. We were provided a spreadsheet of the current scheduled work. Compliance related analyses, daily tasks, and non-daily tasks are blocked out over a seven-day period between the hours of 8:00 am and 4:30 pm. The spreadsheet shows the complexity and variety of work the staff completes. Our evaluation noted measures that could be taken to streamline the work and/or the analyses to provide monetary savings or staffing reductions to the Agency.

Actions to consider to right-size the Lab staff include:

- Continue using alternative staff for weekend sampling and observing/adjusting analytical processes. This eliminates the need for scheduling Lab staff over two weekend days and periodic holidays.
- Require the Lab Director to take an active role in daily analyst activities depending on the ultimate staffing alignment recommendations implemented.
- Consider changing coliform testing from 15-tube MPN to IDEXX or Quanti-Tray analysis technology, which would provide a major time savings. IDEXX's Colilert test simultaneously detects or quantifies both total coliforms and E. coli, with results in 24 hours. It is U.S. EPA approved and included in Standard Methods for Examination of Water and Wastewater, and aligns with TNI and ELAP considerations. This change will reduce the time required to set up and analyze WDR-required coliform results and reduce costs for reagents and other supplies. An initial capital cost is required to obtain the equipment and ongoing materials and supplies will be required.
- Determine which types of samples can be analyzed as bundles instead of discrete samples shown in the current schedule. Bundling means using approved sample hold

times, preservatives and storage to analyze several to many samples at once. This approach reduces the aggregate time for sample set-up, analysis, and cleanup.:

- Depending on operational needs, TKN, TP, COD, TOC, CL, phenols (all 28-day hold times), ALK (14-day hold time), TSS (7-day hold time) are analyses that can be batched/bundled.
- ALK, TOC and COD and possibly BOD are analyses that can be automated depending on sample load and volume of samples.
- Batching or bundling would compress the scattered analysis efforts for prep, sampling, analysis, readout, reporting and cleanup into larger focused time blocks.
- Consider pre-made reagent purchases, as the current schedule earmarks large amounts of time for reagent make up. If the loaded hourly wage rate is factored in, the cost is competitive for most reagents.
- Evaluate alternative staff instead of Lab staff to complete tasks such as:
 - Transporting samples to the contract lab in Reno.
 - Sampling Wells MG-5-TO, MG-1-TO, MG-2 TO, MG-4-TO, MG-6-TO and MG-7-TO. If alternative staff is used, this procedure must be included in the quality assurance manual with proficiency demonstrations by staff that complete the work.
 - Obtaining instantaneous analyses (pH, DO, temp).
 - Boiler chemistry collection and analyses.
 - Administrative tasks such producing monthly lab data sheets, folders and quality control charts.
- Review the Chain-of-Custody processes and documentation that alternative staff would have to adhere to.
- Structuring larger uninterrupted time blocks for SOP development or TNI standard compliance is more conducive than smaller, scattered blocks as shown in the current schedule.
- Consider 4/10-hour or 5/9-hour shifts. This expands the window for expertise and proficiency testing further into plant operations shifts.

Adopting these measures would reduce the various tasks, volume of work and amount of time. After the changes are understood the impacts will likely indicate that the total staffing number could be reduced from four to three or even two.

Before downsizing the staff, it is recommended that the Agency's current status with impending TNI standards be determined.

- Determine what gaps exist between the current status and the 2023 quality assurance standards
- Dedicate a portion of each FTE's work to completing or solidifying the current documentation to fill the gaps, if any

Additional work could be delegated for Lab Services staff. This work would build on the staff's skills and knowledge but may require additional training.

- Process instrumentation evaluations with a goal of reducing process sampling
- Process optimization support
- Pretreatment inspections
- Commercial inspections
- Community outreach
- Environmental compliance concerns that arise with future permits and programs

Table A1 Potential Contracted Analyses

Types of Analysis
Chemical Oxygen Demand (COD)
Total Suspended Solids (TSS)
Biochemical Oxygen Demand (BOD)
Total Organic Carbon (TOC)
Total Phosphorus (TP)
Orthophosphate (OP)
Total Kjeldhal Nitrogen (TKN)
Total Nitrogen (TN)
Un-ionized Ammonia (NH ³)
Nitrate and Nitrite (NO ⁵)
Alkalinity (ALK)
Total Dissolved Solids (TDS)
Chloride (Cl ³)
Trihalomethane (THM)
Phenols
Metals

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Figure A1 Weekly Lab Schedule

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