Process Hazard Analysis (PHA) Study

San Jose – Santa Clara Regional Wastewater Facility
Digester & Thickener Facilities Upgrade Project

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1.0 Management Summary

This report documents the result of a process hazard analysis (PHA) workshop of the Digester and Thickener Facilities Upgrade Project at the San Jose-Santa Clara Regional Wastewater Facility. The technique selected for the PHA was the Hazard and Operability (HAZOP) methodology. This report documents the methodology and findings of the PHA workshop.

The primary objective of the PHA study was to identify credible causes and consequences of major safety hazards and operability concerns associated with the Digester & Thickener Facilities Upgrade Project equipment during normal operating and upset conditions. Other activities included suggesting means to reduce the risks of serious hazards, noting any previous incidents that have occurred and reviewing the process operations to determine areas for potential improvements in operations and reliability.

The PHA workshop was conducted in accordance with recognized industry standards including the requirements of OSHA's Process Safety Management Standard, 29 CFR §1910.119 and EPA Risk Management Program, 40 CFR Part 68 (§68.67).

A team knowledgeable in the equipment and in the HAZOP methodology conducted the study. The PHA team consisted of engineering, operations, maintenance and health and safety personnel from the City of San Jose and engineering personnel from Brown & Caldwell and Black & Veatch. Two representatives from Eichleay were also present and served as study facilitator and recorder. PHA team meetings were recorded directly into an Excel worksheet. The PHA study session documentation is included in Appendix B.

To assist in evaluating the hazards and establishing potential prioritization of findings, the team utilized a risk ranking matrix developed by Eichleay and approved by the City of San Jose. The ranking selected for a given scenario was a best guess judgment of the team. The hazard analysis team identified a total of 34 recommendations for management consideration, which address many different issues from reducing the potential hazards in the equipment to improvements in its operability. The following table depicts the number and percentage of new recommendations for each priority level grouping. The levels are based on the risk ranking criteria described in Section 4.0 and Section 5.0.

PHA Study DAFT / Digester		
Risk Ranking (R)	**No. of Recommendations**	**%**
1	0 / 0	0 / 0
2	0 / 0	0 / 0
3	3 / 7	15 / 50
4	17 / 7	85 / 50
Total:	20 / 14	100 / 100

The City of San Jose and Brown and Caldwell should review the recommendations to determine relative priorities and develop an implementation schedule. After each recommendation has been reviewed, the resolution of each should be recorded and kept for the life of the process. It is suggested that this information be retained with this report to provide a permanent record for auditing and resolution tracking purposes. While Eichleay can suggest methods for managing recommendations, Eichleay is not responsible for the implementation of them.

2.0 Introduction

2.1. PHA Study Introduction

This report documents the results of a process hazard analysis (PHA) workshop of the Digester & Thickener Facilities Upgrade Project at the San Jose-Santa Clara Wastewater Facility. The study was performed on June 22 & 23, 2015 at the Wastewater Facility. The technique selected for the PHA was the Hazard and Operability (HAZOP) methodology. This report documents the methodology and findings of the PHA study.

2.2. PHA Study Report Overview

The study team members were guided through a systematic approach designed to address possible releases that have the potential to injure or affect the health of employees, damage facilities, or injure the environment within facility boundaries. A detailed description of the methodology used for the analysis is given in Section 4.0.

The primary objective of the PHA workshop was to identify credible causes and consequences of major safety hazards and operability concerns associated with the process equipment during normal operating and upset conditions. Other activities included suggesting means to reduce the risks of serious hazards, noting any previous incidents that have occurred with similar operations and reviewing the process operations to determine areas for potential improvements in operations and reliability.

The study was conducted by a team knowledgeable in the design and operation of the process equipment and in the HAZOP methodology. The PHA team consisted of engineering, operations, maintenance and health and safety personnel from the City of San Jose, engineering personnel from Brown & Caldwell and Black & Veatch, and two Eichleay consultants who served as study facilitator and recorder. The team reviewed the design of each system using the guideword HAZOP methodology as recognized by the American Institute of Chemical Engineers (AIChE), OSHA Process Safety Management (29 CFR §1910.119[e]) and EPA Risk Management Plan Rule (40 CFR Part 68). Discussions in the PHA meeting were recorded directly into an Excel worksheet. The PHA study session documentation is included in Appendix B of this report.

Refer to the Management Summary for an overview of this study. Section 3.0 describes the objectives of the hazard analysis and presents the scope of the study; Section 4.0 provides the methodology employed in conducting this HAZOP study and Section 5.0 discusses the results.

The equipment in the study was grouped and divided into a total of 12 equipment specific nodes (5 for the DAFT area and 7 for the Digester area) and 5 global nodes. Appendix A contains a complete node list and details of equipment that was included in the study. Appendix B contains the HAZOP study session worksheets, which summarize the discussions held during each HAZOP workshop.

The PHA study team identified a total of 34 recommendations for future consideration. These items pertain to many different issues including safety improvements, information revisions, opportunities for improvement in operations/reliability, etc. Prior to implementation, the recommendations should be reviewed and addressed by the appropriate Brown & Caldwell and City of San Jose personnel.

Eichleay has expended its best professional efforts in performing this work. However, it should be noted that this study was a joint effort between the City of San Jose, Brown and Caldwell, Black & Veatch and Eichleay personnel and is based on the information and discussions provided by the site personnel during the study. Consequently, Eichleay can accept no liability for any use that the City of San Jose, Brown and Caldwell or Black & Veatch may make of the information contained herein or the accuracy of the information generated by the team.

2.3. PHA Team Composition

A team knowledgeable in the design and operation of the equipment and in the HAZOP methodology conducted the study. The PHA team consisted of engineering, operations, maintenance and health and safety personnel from the City of San Jose, engineering personnel from Brown & Caldwell and Black & Veatch, and two Eichleay consultants who served as study facilitator and recorder. The team reviewed the equipment design using the guideword HAZOP methodology as recognized by the American Institute of Chemical Engineers (AlChE) and OSHA.

Discussions in the PHA team meetings were recorded directly into an Excel worksheet. The display of the worksheet was projected to enable the entire team to view the study documentation in real-time.

The meetings were held at the San Jose-Santa Clara Wastewater Facility in San Jose, CA. Most of the personnel participated in the initial kickoff project training session. Once the main study session began, the team members participated throughout. Subject matter experts were requested to participate whenever the team required their expertise.

Table 1 identifies the team members that participated in the DAFT PHA workshop and Table 2 identifies the team members that participated in the Digester PHA workshop.

2.4. PHA Team Leader Qualifications

Mr. Coutu is qualified to lead PHA teams utilizing several techniques including HAZOP, What-If, What-If/Checklist and FMEA. Mr. Coutu holds a B.S. degree in chemical engineering and has over thirty years of experience providing support services to industry clients. He has conducted numerous HAZOP and FMEA studies for clients in a number of industries.

Table 1 – DAFT PHA Study Team Members

June 22, 2015

Name	Department/Title	Company
Alicia Alba	CIP – Associate Engineer	City of San Jose
Geoff Carthew	CIP - Engineering Manager	City of San Jose
Mariana Chavez-Vazquez	CIP – Project Manager	City of San Jose
Steve Colby	Sr. Process Control Specialist	City of San Jose
Robert Cuellar	Maintenance Superintendent	City of San Jose
Mike D'Arcy	Operations	City of San Jose
Max Hildebrand	CIP - OML	Carollo
Satya Nand	Ops – Primary & Sludge Control Superintendent	City of San Jose
Bruce Petrik	CIP – Biosolids Package Mgr	MWH
Rich Whaley	CSJ – Safety	City of San Jose
Tim Banyai	DAFT Project Engineer	Brown & Caldwell
Adam Ross	Project Engineer	Brown & Caldwell
Lloyd Slezak	Project Manager	Brown & Caldwell
Lou Verduzco	I&C Task Manager	Brown & Caldwell
Dale Coutu	PHA Team Leader	Eichleay
Fang Lin Zhao	PHA Recorder	Eichleay

Table 2 – Digester PHA Study Team Members

June 23, 2015

Name	Department/Title	Company
Alicia Alba	CIP – Associate Engineer	City of San Jose
Geoff Carthew	CIP - Engineering Manager	City of San Jose
Mariana Chavez-Vazquez	CIP – Project Manager	City of San Jose
Steve Colby	Sr. Process Control Specialist	City of San Jose
Robert Cuellar	Maintenance Superintendent	City of San Jose
Mike D'Arcy	Operations	City of San Jose
Max Hildebrand	CIP - OML	Carollo
David Huerta	Maintenance Superintendent	City of San Jose
Satya Nand	Ops – Primary & Sludge Control Superintendent	City of San Jose
Morayo Noibi	CIP – Program Engineer	Carollo
Bruce Petrik	CIP – Biosolids Package Mgr	MWH
Rich Whaley	CSJ – Safety	City of San Jose
Adam Ross	Project Engineer	Brown & Caldwell
Lloyd Slezak	Project Manager	Brown & Caldwell
Lou Verduzco	I&C Task Manager	Brown & Caldwell
Jesse Wallin	Pipe Rack Project Engineer	Black & Veatch
Dale Coutu	PHA Team Leader	Eichleay
Fang Lin Zhao	PHA Recorder	Eichleay

3.0 Objectives and Scope

3.1. Objectives

The objectives established for the process hazard analysis were:

In general to address:

- The hazards inherent in the operation
- The potential for upset and/or exposure and the consequences
- Applicable engineering and administrative controls
- Safeguards and mitigating factors
- Human factors
- Operational experience

More specifically:

- To identify potential safety hazards, environmental hazards and operability problems attributable to deviations from normal operating conditions.
- To evaluate existing safeguards and identify areas where additional risk reduction measures may be needed.
- To identify and rank the major safety hazards and operability concerns relating to the plant according to risk.
- To identify preliminary recommendations for changes to equipment design and operating procedures to enhance the safeguards where necessary.
- Review the changes that have occurred in the process and to ensure that the process hazard analysis is consistent with the current process.

3.2. Scope of Work

The HAZOP study considered releases of hazardous materials (flammables and or toxics) in quantities sufficient to have the potential to injure or affect the health of employees, the public or the environment. Environmental hazards include scenarios which could result in vapor releases or liquid spills, particularly as to the impact they could have beyond the property line. If a potential release scenario was identified as credible, it was further analyzed to identify the potential impact to both employees and the public. Operability problems, which include scenarios that can result in equipment damage, unanticipated shutdowns and rate reductions were also discussed during the study.

The analysis was conducted primarily for normal operating conditions including start-up, shutdown and emergency conditions. "Double jeopardy" scenarios, situations that represent extremely unlikely incidents where two or more independent equipment safeguards simultaneously fail, were not considered.

Equipment evaluated included piping, vessels, pumps, instrumentation and associated utilities. A listing of the nodes, identifying all process equipment reviewed, and a process description are provided in Appendix A.

Onsite utilities were considered implicitly in the scope. The potential failure of these systems was examined with their associated process equipment to the extent that such failures affect the process equipment's operation.

A risk ranking matrix was developed by Eichleay and utilized for this PHA study for the following reasons:

- To evaluate the risk of each hypothesized scenario
- To assess whether additional safeguards are required for scenarios with unacceptable levels of risk
- To provide a means to prioritize recommendations

3.3. Reference Information

The primary engineering documents to which the team referred are as follows:

DAFT PHA Workshop
PFDs
GD-1-601-73: Sludge Screening and Blend Tanks
GD-2-601-73: Polymer Storage and Blend Units
GD-3-603-72: DAFT 5 and 6 Tanks, PRTs, and TS Pumps
GD-4-601-73: Odor Control
P&IDs
DI-1-608-72: DAFT Feed Pump 3
DI-2-601-73: Polymer Storage Tanks 1 and 2
DI-2-602-73: Polymer Storage Tank Recirculation Pumps 1 and 2
DI-2-603-73: Polymer Blend Unit 1
DI-2-614-72: Pressurization Flow Pumps 4 and 5
DI-3-601-72: Pressurization Retention Tank 1
DI-3-602-72: Dissolved Air Flotation Thickener 1
DI-4-603-73: Odor Control Sources 1
DI-4-604-73: Odor Control Sources 2
DI-4-605-73: Odor Control Biotrickling Filter
DI-4-606-73: Odor Control Adsorption Units

Digester PHA Workshop
PFDs
GD-5-601-71: First Stage Sludge Distribution
GD-5-602-71: Second Stage Sludge Distribution and Sludge Cooling
GD-6-602-71: Digester Gas and Hazardous Piping (First Stage)
P&IDs
DI-4-609-71: Digester 5 Feed Pumps and Flow Meter
DI-5-650-71: Digester 5 and 6 Foam Suppression Pumps
DI-5-651-71: Digester 5 with Foam Suppression Circulation
DI-5-652-71: Digester 5 Circulating Sludge
DI-5-653-71: Digester 5 Gas Mixing
DI-5-654-71: Digester 5 Gas Mixing Compressor
DI-5-656-71: Digester 5 Bottom Withdrawal and Standby Pumps
DI-5-657-71: Digester 5 Standpipe and Pump
DI-5-691-71: Sludge Cooling HEX 1
DI-6-601-71: Digester 5 and 6 Flow Metering and Header
DI-6-610-71: Gas Header – Gas Compressor to CHP

3.4. Previous Incidents

The PHA study team discussed incidents that have occurred with the existing operation including operating upsets, personnel exposures and injuries. Any identified hazardous or potentially hazardous scenario was evaluated by the team and incorporated into the study worksheets as "Causes".

3.5. Human Factors

Human factors were considered and addressed throughout the HAZOP study documentation as causes of deviations. For example, human factors play a role in operator errors such as valves left in the incorrect position.

Examples of causes that explicitly involve human factors are:

- failure to close drain valve
- failure to open manual valve
- failure to follow written operating procedure or standard practice

Human factors were also taken into consideration when assessing the existing safeguards and when making recommendations. Some examples of these human factor considerations include:

- reference to existing written operating procedures
- identification of audible and visual alarms
- identification of routine system inspections and data recording for monitoring purposes
- identification of written operating procedures which require development or revision

3.6. Facility Siting

Facility siting was considered throughout the PHA study, addressing the potential impact of hazardous materials on the adjacent equipment and off-site receptors. Facility siting considerations also included evaluation of the impact of surrounding equipment and activities as a potential cause of hazards. Operator experience provided the basis for identifying these issues.

3.7. Node List

In order to facilitate the PHA study, the process equipment was divided into the following nodes:

DAFT 60% Design
Polymer Receiving, Storage and Recirculation System
Polymer Blend System
Pressurization System
Sludge Feed System
Odor Control System

Digester 60% Design
Thickened Sludge Feed System
Standpipe and Withdrawal Pump System
Circulating Sludge System
Foam Suppression System
Bottom Withdrawal and Sludge Cooling System
Gas Mixing Compressor System
Gas Metering and Header System
Global Categories

4.0 HAZOP Methodology

The Process Hazard Analysis utilized the Hazard and Operability (HAZOP) technique to review the process for hazards associated with all modes of operation. The guideword HAZOP technique is a means of systematically reviewing a process to identify potential hazards and operability problems resulting from credible deviations from design intent and developing preliminary recommendations to reduce or eliminate the likelihood or severity of the hazards. HAZOP is recognized as an acceptable process hazard analysis method by OSHA Process Safety Management (29 CFR §1910.119[e]) and EPA Risk Management (40 CFR Part 68) regulations and is preferable for all but simple processes as it is a highly structured technique. Figure 1 shows a typical logic diagram for the HAZOP methodology. The following describes the methodology in more detail.

A team of individuals with knowledge of process and project engineering, process safety, operations and maintenance conducted the HAZOP. The PHA study was facilitated and recorded by individuals with expertise in the HAZOP technique from Eichleay.

The HAZOP study proceeded sequentially, studying each applicable piece of equipment contained in the selected processing area. Each processing area was partitioned into nodes, which were composed of one or more pieces of equipment where there is a distinct intention for process parameters (e.g.: a specific intended temperature, pressure or flow rate). The nodes are listed above and described in Appendix A.

The guideword HAZOP technique is based on the premise that hazards and operability problems stem from deviations from design intent. Common guide words capture the ways in which process parameters can deviate from design intent: No, More, Less, As Well As, Reverse, Part Of, and Other Than. Other guidewords were used as necessary. These guidewords were systematically combined with process parameters to yield deviations, which were then judged for credibility. If credible causes existed, the deviations were further examined and documented. The HAZOP Deviation Matrix depicted in Figure 2 summarizes commonly used combinations of guidewords with process parameters.

Figure 1 - Typical HAZOP Methodology Logic Diagram

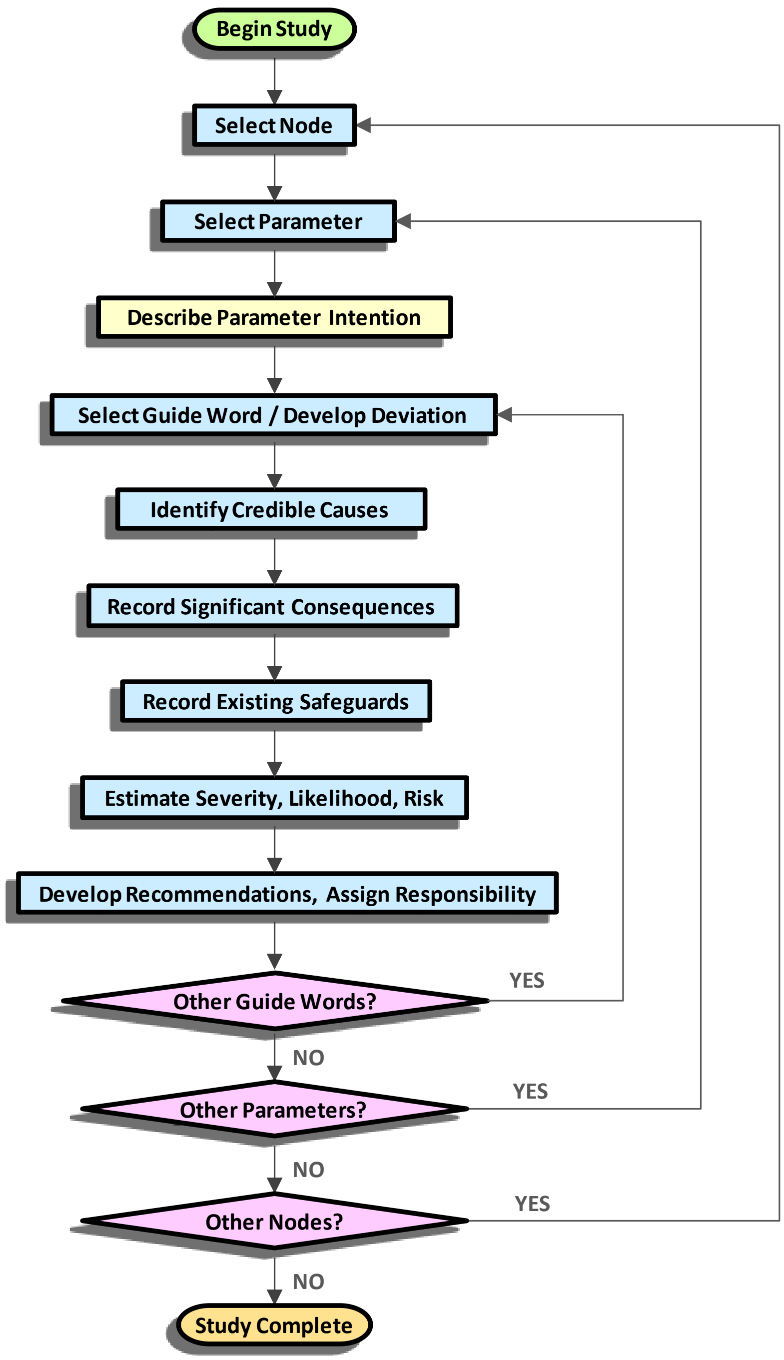

Figure 2 - HAZOP Deviation Matrix

Design Parameter	Guide Word						
	More	Less	None	Reverse	Part Of	As Well As	Other Than
Flow	High Flow	Low Flow	No Flow	Back Flow or Misdirected	Wrong Amount	Added Component	Wrong Component
Pressure	High Pressure	Low Pressure	Vacuum				
Temperature	High Temp	Low Temp					
Level	High Level	Low Level	No Level				
Agitation	Too Much	Too Little					
Reaction	High Rate	Low Rate	No Reaction	Decompose	Incomplete	Side Reaction	Wrong Reaction
Time	Too Much	Too Little					
Step	Step Late	Step Early	Missed Step	Back Step	Partial Step	Extra Action	Wrong Action
Composition	High Concentration	Low Concentration	None			Extra Component	Wrong Component
Phase	Too Many	Too Few	Single	Inversion	Emulsion		
Addition	Too Much	Too Little					
Mixing	Too Much	Too Little	None				

4.1. HAZOP Worksheets

For those deviations that were considered by the HAZOP team to be credible, the following information was recorded in the HAZOP worksheets (Refer to Appendix B for study documentation).

Deviation: The combination of guideword and process parameter. For example, "None" combined with "Flow" yields deviation "No Flow".

Causes: The events or failures that result in a deviation from design intent for a process parameter. For example, "No Flow" may be caused by a pump not pumping. While it is often adequate to list a cause, it is sometimes preferable to list root causes (for example, pump not turned on or coupling failed) where consequences or safeguards are unique to a particular root cause. By convention, causes were considered only within the node under study. Causes outside the node being reviewed were deferred until that node was discussed.

Consequences: A description of the hazard or series of hazards or operability problems that could result from the cause if subsequent events were to proceed without consideration of safeguards which may exist. Consequences may arise beyond the node under study. If so, these were documented accordingly.

Safeguards: Existing or proposed (for new projects) measures that detect or warn of a deviation or consequence, prevent a deviation or consequence or mitigate the effects of a consequence.

Severity (S): A semi-quantitative ranking of the worst consequence associated with each credible cause. Definitions of the severity rankings are shown in Table 3.

Likelihood (L): A semi-quantitative ranking of the probability of a cause occurring which leads to a consequence of concern, given the stated level of safeguards. Definitions of likelihood rankings are shown in Table 4.

Risk Ranking (R): A numerical ranking of the mitigated risk, considering both the severity and likelihood of an occurrence (See Figure 3). The risk ranking was used to assist in determining the need for additional safeguards and as an aid in prioritizing recommendations.

Recommendations: Design, operating or maintenance changes that reduce or eliminate deviations, causes and/or consequences.

During the workshop, the team discussed all of the possible causes of a particular deviation from the design intent and listed them. Once all of the causes were documented, the team focused on the consequences for each identified cause. The consequences documented were those that may credibly arise, given that the cause occurred. Once the consequences were documented, the team reviewed the process design for safeguards that would prevent, detect, or mitigate each cause/consequence scenario. Any recommendations made are for additional safeguards that are not currently shown on the project documentation.

The purposes of the recommendations are to:

- reduce the probability of occurrence of an incident
- reduce the severity of the consequences, in the event the incident was to occur
- request further information, when the scenario could not be fully described due to a lack of data

- request an update of or addition to a particular document

4.2. Risk-based Recommendations

Each identified scenario was risk ranked unless the team deemed there to be no credible hazardous consequences or operability issues.

There are various thresholds that apply for each category, such as the severity of injury, community health, and environmental and operational impact. Exceeding any one of the thresholds is sufficient to categorize a consequence as a certain severity. The severity code for each risk designation can be seen in Table 3. The severity ranking was evaluated without consideration for existing safeguards (detection, preventative or mitigative measures).

The team listed safeguards for each scenario that are intended to detect or prevent a cause or deviation, or detect, prevent or mitigate a consequence. At this point, the team evaluated the relative likelihood of the scenario occurring, given the existence of prevention, detection or mitigation measures. The code used to assign the relative likelihood of a scenario occurring is listed in Table 4.

Given the likelihood and severity codes, a risk rank was determined based on the risk matrix shown in Figure 3.

Guidelines for suggested action based on the overall risk ranking (R) are shown in Table 5.

The listed recommendations are not intended to represent the only solutions to reducing the hazards. Other, more appropriate solutions may become apparent when a detailed engineering or operational review of the recommendations is performed. Each recommendation offered for consideration must be carefully studied to ensure that it meets the intended goal of solving a potential hazard and that its implementation does not create other hazards or complications.

Table 3 - Definitions of Severity

SEVERITY						
Criteria	Metric	**1**	**2**	**3**	**4**	**5**
		Worst Case	**Severe**	**Major**	**Moderate**	**Minor**
Financial	Life Cycle or Capital Cost	> 20% > $5M	15% - 20% $1M - $5M	10% - 15% $500k - $1M	5% - 10% $100k - $500k	< 5% < $100k
Safety	Safety Incidents	OSHA Recordable Injury with Fatality	OSHA Recordable Injury with Lost Time	OSHA Recordable Injury (No Lost Time)	First-Aid	No Injury
Environment	Permit Violations	Effluent Discharge Permit Violation; Requirement for Extensive Clean-Up Likely; Off-Site Exposure	Effluent Discharge Permit Violation; Requirement for Significant Clean-Up Likely; No Off-Site Exposure	Significant Localized Release with Shelter-in-Place or Evacuation; Requirement for Clean-Up Likely; Potential Effluent Discharge Permit Violation	Larger Localized Release with Possible Shelter-in-Place	Localized Release (Odor) (No Shelter-in-Place); No Clean-Up Required
Operations	Operational Impact	Inability to Process Flow Leading to Permit Violation and Flooding/Spillage	Inability to Process Flow Leading to Permit Violation	Flow Re-Routing and Temporary Work Required; No Redundancy	Flow Re-Routing and Temporary Work Required	No Process Upset; Flow Re-Routing Required

Table 4 - Definitions of Likelihood

LIKELIHOOD		
≥ 95% Probability	Almost Certain	1
≥ 75% Probability	Very Likely	2
≥ 25% Probability	Even Odds	3
≥ 5% Probability	Unlikely	4
< 5% Probability	Remote	5

Figure 3 - Risk Ranking Matrix

		SEVERITY				
		1	2	3	4	5
LIKELIHOOD	1	1	1	2	3	3
	2	1	2	2	3	4
	3	2	2	3	4	4
	4	3	3	4	4	4
	5	3	4	4	4	4

Table 5 - Risk Ranking Suggested Actions

RISK CATEGORIES			MITIGATION*
1	**HIGH RISK**	Immediate Action Required: Additional Engineering and/or Administrative Controls Required to Reduce Risk Ranking to 3 or Less	May Require at Least 2 Independent Means of Detection/Mitigation/Prevention with at Least 1 not Requiring Human Intervention
2	**MODERATE RISK**	Timely Action Required: Additional Engineering and/or Administrative Controls Required to Reduce Risk Ranking to 3 or Less	May Require at Least 2 Independent Means of Detection/Mitigation/Prevention that May Require Human Intervention
3	**LOW RISK**	Timely Action Required: Procedures or Controls should be Verified to be in Place or Developed and Documented	May Require at Least 1 Independent Means of Detection/Mitigation/Prevention that May Require Human Intervention
4	**NEGLIGIBLE RISK**	No Mitigation Required	None

* Shutdown Systems, Automatic Valves, Process Interlocks, Alarms, etc.

4.3. Reading HAZOP Study Documentation

Reports containing a node listing, HAZOP worksheets and study team recommendations are in Appendices A-C of this report.

The Worksheets are organized by node. The worksheets are presented by deviation within each node, and within each deviation a list of the causes and the related consequences, safeguards, and recommendations is provided.

The Recommendations Report has a list of the particular causes with which each recommendation is associated. Some recommendations are associated with multiple causes.

4.4. Assumptions

Several general and specific assumptions were made during the course of the PHA Study:

General:

- Simultaneous failures of multiple equipment items and/or safeguards were not considered as credible causes of deviations. (In certain cases, one equipment item may have failed, with no indication to the operator of its failure, when another device also failed. These instances are not true "simultaneous" failures, and were considered during the review process.)
- Extraordinary operator action, such as misoperation of a manual valve that is ordinarily inaccessible or the arbitrary removal of an inline blind was not considered a credible cause of deviations.
- Deviations were considered at the reference point of each node, which was defined as the most downstream point of the node, i.e. “No Flow” at the end of a pipe section or piece of equipment.

Specific:

- The operator error frequency rates assume that the processes are operated by trained operators and written instructions are followed where they are available.
- The relief valves have been properly designed to relieve any reasonable pressure surge. Further, the relief valves are assumed to be in good working order and any block valves in the inlet and outlet lines are car sealed open (CSO) or equivalent.
- The materials of construction of piping, gaskets, vessels, and valves have been correctly selected according to applicable design standards.
- All of the valves shown in the P&IDs as open or closed are normally in the position shown.
- The P&IDs are the controlling point of reference with comments based upon what they indicate.
- Deviations resulting from two or more independent events that occur concurrently were generally not considered unless one of the events had a high probability rating and the consequences of the resulting event was high.
- In each scenario where various degrees of severity are possible, such as the failure of a pump seal, the maximum consequence of the event was used to determine both the likelihood and consequence.

5.0 Study Results and Action Items

The PHA study resulted in thorough documentation of credible hazard scenarios and operability problems and suggested 34 recommendations. Each recommendation was carefully reviewed for clarity and to ensure that it is based on an accurate assessment of the design and proposed operation of the process.

The purposes of the PHA study recommendations are to propose actions that the PHA study team believes should be considered:

- to reduce the probability of occurrence of an incident
- to reduce the severity of the consequences in the event an incident were to occur
- to request further information when the scenario could not be fully described due to a lack of data available to the study team

A complete list of the recommendations made during the PHA study is included in the Recommendations Report in Appendix C.

Also included are recommendations that address operability issues including, but not limited to,:

- equipment damage
- equipment downtime

The suggested recommendations are not necessarily the only or best solutions to the hazards identified. More appropriate approaches may become apparent when a detailed engineering or operational review of the recommendations is undertaken. Each recommendation offered for consideration must be carefully studied to ensure that it meets the intended goal of solving a potential hazard and that its implementation does not create other hazards or complications.

It is suggested that after the recommendations have been reviewed, a notation as to the final disposition of each recommendation be made to provide a permanent record.

Recommendations are ranked primarily by the maximum risk ranking with which they are associated; the priority of the recommendations is based on the maximum risk. Table 6 indicates the priority levels and the distribution of the recommendations among these priority rankings.

Table 6 - Recommendation Priority Levels

PHA Study DAFT / Digester		
Risk Ranking (R)	**No. of Recommendations**	**%**
1	0 / 0	0 / 0
2	0 / 0	0 / 0
3	3 / 7	15 / 50
4	17 / 7	85 / 50
Total:	20 / 14	100 / 100

Refer to Appendix C for a complete listing of study recommendations.

Appendix A

Node Descriptions and Intentions

Project Overview
The objective of the DTFU (Digester and Thickener Facilities Upgrade) Project is to renew the sludge and biosolids processing facilities of the San Jose-Santa Clara Regional Wastewater Facility. This involves rehabilitating and reconfiguring the first four of the existing sixteen digesters to thicken a combined stream of PS and WAS to a target solids concentration of 5.5%. Digestion process changes will include a new thickened sludge feed distribution system, conversion of the digestion process to TPAD (first stage thermophilic digestion followed by second stage mesophilic digestion) and converting the first four rehabilitated digesters to submerged fixed-cover reactors.

Nodes	Design Conditions / Parameters
DAFT 60% Design	
1. Polymer Receiving, Storage and Recirculation System	Polymer is received and unloaded from a 5000 gallon tanker truck to one of the two 6000 gallon fiberglass storage tanks using pressurized air. The recirculation system runs intermittently (~2x/day) to maintain the polymer emulsion.
2. Polymer Blend System	The Polymer Blend Unit meters and mixes polymer from the Polymer Storage Tanks and WTR 3 to produce a polymer solution of desired concentration. The solution then flows into the Blended Sludge line, upstream of the intended DAFT. There are seven (7) Polymer Blend Units, one for each of the six (6) DAFTs and one (1) common standby unit.
3. Pressurization System	The pressurization system saturates a water stream (DAFT subnatant or secondary effluent) with air (primarily oxygen) to promote solids flotation in the DAFTs. Air is supplied at ~85 psig from the instrument air compressors (reduced from a ~120 psig discharge pressure) and further reduced to ~60 psig by a local PCV. Water is supplied by constant speed pressurization pumps, with flow controlled solely by adjusting the number of operating pumps (the total water flow is equally divided amongst all in-service DAFTs).
4. Sludge Feed System	Blended sludge, a combination of WAS and PS, is pumped from the Blend Tanks to the DAFTs. These DAFT feed pumps have VFD motors with starts, stops and operating speed controlled by signals from the Blend Tank level instrumentation.
5. Odor Control System	Foul air from multiple sources, including the DAFTs and Equalization and Blend Tanks, are collected and routed through a biotrickling filter for bacterial removal (oxidation) of the odorous compounds. The stream is then exhausted to atmosphere through the exhaust stack via the adsorption vessel fan (1 duty, 1 standby). The adsorption vessels, intended as the second stage of a two-stage foul air treating process, have been removed from the project scope.

Nodes	Design Conditions / Parameters
Digester 60% Design	
1. Thickened Sludge Feed System	Thickened sludge (TS) from the TS Equalization (TSE) Tanks is pumped into the Digester Feed Loop; the loop circulates sludge at a minimum continuous rate to prevent solids accumulation. Dedicated Digester Feed Pumps, equipped with VFDs, route sludge from the loop to the associated digester. Pumping (feed) rate is controlled based on the level in the TSE Tanks.
2. Standpipe and Withdrawal Pump System	Digested sludge, floating scum and foam residue continuously overflows from the liquid surface of the Digester Dome to the lower elevation standpipe (wet well). Standpipe level controls sludge pump VFD operation. The overhead of the standpipe is connected to the vapor space of the Digester Dome.
3. Circulating Sludge System	This system maintains the Digester at thermophilic operating temperature by circulating sludge at high rates through a concentric-tube hot water heat exchanger. Two heat transfer systems are required per Digester, each containing an 850 gpm circulation pump and heat exchanger.
4. Foam Suppression System	To minimize foaming, sludge is continuously withdrawn from the bottom of the Digester, circulated via a constant speed centrifugal pump and returned to the Digester Dome.
5. Bottom Withdrawal and Sludge Cooling System	Approximately 50% of the sludge contained in the Digester is withdrawn from the bottom of the Digester (the remaining sludge overflows to the Standpipe). The Withdrawal Pump transfers the sludge from the Digester to one of two transfer headers, where it combines with sludge from the Standpipe Withdrawal Pump. The combined stream then flows through two concentric-tube heat exchangers and on to the second stage Digesters. The two heat exchangers per header operate in parallel and utilize cooling water to reduce the sludge temperature to a 100F target, suitable for mesophilic operation.
6. Gas Mixing Compressor System	Low pressure gas from the Digester Dome is collected and compressed by a liquid ring compressor. The compressed gas is piped to a manifold and distributed amongst 24 lances (6 lances per each of 4 draft tubes) within the Digester. The gas induces an upward flow in each draft tube, creating a downward flow in the remainder of the Digester, effectively mixing the Digester contents.
7. Gas Metering and Header System	Low pressure gas from the Digester Dome is routed to a common 30" collection header, where it joins the gas from the other three Digesters. The combined stream is routed to an existing 18" header which connects to the existing gas compressor suction header.
Global	
1. Global Categories	N/A

Appendix B

PHA Study Session Documentation Report

(PHA Study Worksheets)

DAFT 60% Design

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: DAFT 60% Design: Polymer Receiving, Storage and Recirculation System
Polymer is received and unloaded from a 5000 gallon tanker truck to one of the two 6000 gallon fiberglass storage tanks using pressurized air.
The recirculation system runs intermittently (~2x/day) to maintain the polymer emulsion.

Drawings: P&IDs DI-2-601-73, DI-2-602-73
Parameters: Recirculation System: 50 gpm circulation rate

	DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
	Polymer Receiving and Storage							
1	No Flow	Manual valve closed on the tanker truck offloading line	Potential pipe failure Potential failure of the tanker truck (outside PHA scope) Potential personnel exposure to polymer Potential slip hazard (polymer causes surfaces to be slippery) Potential for spilled polymer to drain to the sewer	4	Valves are visible from truck offloading Standard Operating Procedure Flowing polymer from tanker makes audible sound Truck offloading area is contained (separate from tanks) and containment valve is normally open Pipe is Sch 80 PVC, tested to 150 psi Safety shower in the area	4	4	1) Consider modifying the Standard Operating Procedure to keep the containment isolation valve closed 2) Consider relocating the tanker truck hose connection to inside the tank containment area
2	Other Than Flow (Moist Air Into Tank)	Spent desiccant	Potential negative impact to polymer effectiveness Potential for polymer viscosity to increase Potential pump plugging	5	Visible desiccant status indicator on the vent dryer	3	4	3) Consider adding a second desiccant dryer (one operating / one standby)

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: DAFT 60% Design: Polymer Receiving, Storage and Recirculation System
Polymer is received and unloaded from a 5000 gallon tanker truck to one of the two 6000 gallon fiberglass storage tanks using pressurized air.
The recirculation system runs intermittently (~2x/day) to maintain the polymer emulsion.

Drawings: P&IDs DI-2-601-73, DI-2-602-73
Parameters: Recirculation System: 50 gpm circulation rate

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
3 More Flow	Truck driver offloads polymer faster than design	Potential to overwhelm tank vent Potential increase in tank pressure Potential damage to the polymer tank	5	Polymer tanks are interconnected Tank equipped with an overflow line Tank vents are open	5	4	
4 High Level	Polymer shipment received when it is not needed or offloaded into wrong tank	Potential for polymer to overflow tank into containment area Potential personnel exposure and slip hazard	5	Safety shower in the area Tank level indication with high level alarm Tank level gauge Polymer tanks are interconnected Containment valve is normally closed	4	4	4) Consider adding local audible high level alarm to polymer tanks
5 No / Low Level	Failure of a flexible coupling at one of the tank connections	Potential loss of polymer to the containment Potential personnel exposure and slip hazard	5	Operator rounds (part of the Standard Operating Procedure) Safety shower in the area	5	4	5) Consider relocating tank isolation valves from the piping to directly on the tank, upstream of the flexible coupling

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: DAFT 60% Design: Polymer Receiving, Storage and Recirculation System
Polymer is received and unloaded from a 5000 gallon tanker truck to one of the two 6000 gallon fiberglass storage tanks using pressurized air.
The recirculation system runs intermittently (~2x/day) to maintain the polymer emulsion.

Drawings: P&IDs DI-2-601-73, DI-2-602-73
Parameters: Recirculation System: 50 gpm circulation rate

	DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
6	Tank Maintenance	Accessing instruments on top of the tank	Potential personnel fall hazard	2	Tanks supposed to be equipped with guardrails and caged vertical ladder Standard Operating Procedure	4	3	6) Consider verifying ladder and guardrails are included on the tank specification
	Recirculation System							
7	No / Less Flow	Closed or pinched valve anywhere in circulation line on discharge side of pump	Potential pipe overpressure with polymer release to the atmosphere Potential personnel exposure	4	High pressure alarm in the DCS with local indication (light) Pipe is Sch 80 PVC, tested to 150 psi High pressure switch on the pump discharge with pump trip Standard Operating Procedure Safety shower in the area	4	4	7) Consider using safety glasses/goggles and/or face shield in the area 8) Consider putting in a placard (for safety glasses/goggles requirement)
8	No / Less Flow	Closed or pinched valve anywhere in circulation line on suction side of pump Circulation pump is offline (due to seal failure (loss of seal water) or other) No level in the polymer tank	Potential for circulation pump to run dry and overheat	4	Low pressure alarm in the DCS with local indication (light) Standard Operating Procedure Routine pump maintenance Tank level transmitter will shut down the circulation pump	4	4	9) Consider showing circulating pump seal water system on the P&IDs

Company: Brown and Caldwell

Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: DAFT 60% Design: Polymer Receiving, Storage and Recirculation System

Polymer is received and unloaded from a 5000 gallon tanker truck to one of the two 6000 gallon fiberglass storage tanks using pressurized air.
The recirculation system runs intermittently (~2x/day) to maintain the polymer emulsion.

Drawings: P&IDs DI-2-601-73, DI-2-602-73

Parameters: Recirculation System: 50 gpm circulation rate

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
9 Pump Maintenance	Pipe is not depressurized	Potential personnel exposure	4	Standard Operating Procedure Safety shower in the area	3	4	10) Consider adding bleeder valves to the piping on the suction and discharge side of the pump
10 Slips, Trips and Falls	Piping layout (pipe routed near grade around/near walk path)	Potential personnel injury	3	Visual observation of path	4	4	11) Consider reviewing the 3D model for piping layout/walk path obstructions

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: DAFT 60% Design: Polymer Blend System
The Polymer Blend Unit meters and mixes polymer from the Polymer Storage Tanks and WTR 3 to produce a polymer solution of desired concentration. The solution then flows into the Blended Sludge line, upstream of the intended DAFT. There are seven (7) Polymer Blend Units, one for each of the six (6) DAFTs and one (1) common standby unit.

Drawings: P&IDs DI-2-601-73, DI-2-603-73, DI-3-601-72
Parameters: Target polymer concentration: 0.1 - 0.5%

	DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
1	No Flow (Polymer)	Closed block valve anywhere in polymer piping Polymer blend unit is down for whatever reason	Potential for lower percent solids removal in the DAFT Potential for higher percent solids in the subnatant	5	Standard Operating Procedure Standby blend unit Blend unit failure alarm Total flow reduced only 1/6 (assuming other 5 DAFTs in service)	4	4	
2	No Flow (Water)	Closed block valve anywhere in water piping Polymer blend unit is down for whatever reason	Potential for lower percent solids removal in the DAFT Potential for higher percent solids in the subnatant	5	Standard Operating Procedure Standby blend unit Blend unit failure alarm Total flow reduced only 1/6 (assuming other 5 DAFTs in service)	4	4	
3	Other Than Flow (Too Much Recycled Water (TPS))	WTR 3 flow is low for any reason	Potential for water with high residual chlorine content to be introduced into the system Potential negative impact to polymer effectiveness (chlorine breaks the polymer chain, rendering it ineffective)	5	Typical water system low in residual chlorine	4	4	12) Consider ensuring that residual chlorine is below allowable limits prior to starting the polymer blend unit 13) Consider using WTR 2 as alternate source of water

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell

Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: DAFT 60% Design: Polymer Blend System

The Polymer Blend Unit meters and mixes polymer from the Polymer Storage Tanks and WTR 3 to produce a polymer solution of desired concentration. The solution then flows into the Blended Sludge line, upstream of the intended DAFT. There are seven (7) Polymer Blend Units, one for each of the six (6) DAFTs and one (1) common standby unit.

Drawings: P&IDs DI-2-601-73, DI-2-603-73, DI-3-601-72

Parameters: Target polymer concentration: 0.1 - 0.5%

DEVIATION		CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
4	Other Than Flow (Too Much Polymer Addition)	Incorrect set point in DCS Polymer blend unit failure	Waste of polymer	5	Polymer flow meter on the blend unit HMI Water flow meter on the blend unit HMI Standard Operating Procedure	4	4	14) Consider clamping the polymer flow range in the DCS 15) Consider adding DCS/blend unit interface symbology to the P&IDs
5	Other Than Flow (Too Little Polymer Addition)	Incorrect set point in DCS Polymer blend unit failure	Potential for lower percent solids removal in the DAFT Potential for higher percent solids in the subnatant	5	Polymer flow meter on the blend unit HMI Water flow meter on the blend unit HMI Standard Operating Procedure Routine Operator sampling of the subnatant for solids	4	4	16) Consider adding a solids analyzer on the subnatant stream

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell

Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: DAFT 60% Design: Polymer Blend System

The Polymer Blend Unit meters and mixes polymer from the Polymer Storage Tanks and WTR 3 to produce a polymer solution of desired concentration. The solution then flows into the Blended Sludge line, upstream of the intended DAFT. There are seven (7) Polymer Blend Units, one for each of the six (6) DAFTs and one (1) common standby unit.

Drawings: P&IDs DI-2-601-73, DI-2-603-73, DI-3-601-72

Parameters: Target polymer concentration: 0.1 - 0.5%

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
6 Low Pressure	Polymer blend unit failure	Inability of polymer to get into the DAFT feed Potential for pressurization water/sludge to flow into the blend unit discharge piping Potential for lower percent solids removal from the DAFT Potential for higher percent solids in subnatant	5	Check valves in polymer and water piping at the Polymer Blend Unit	4	4	
7 High Pressure	Closed valve downstream of the Polymer Blend Unit	Inability of polymer to get into the DAFT feed Potential pipe failure Potential personnel exposure to polymer Potential for lower percent solids removal from the DAFT Potential for higher percent solids in subnatant	5	Standard Operating Procedure Blend unit equipped with high pressure switch with pump shutdown and failure alarm Safety shower in the area	4	4	

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: DAFT 60% Design: Pressurization System

The pressurization system saturates a water stream (DAFT subnatant or secondary effluent) with air (primarily oxygen) to promote solids flotation in the DAFTs. Air is supplied at ~85 psig from the instrument air compressors (reduced from a ~120 psig discharge pressure) and further reduced to ~60 psig by a local PCV. Water is supplied by constant speed pressurization pumps, with flow controlled solely by adjusting the number of operating pumps (the total water flow is equally divided amongst all in-service DAFTs).

Drawings: P&IDs DI-2-614-72, DI-3-601-72
Parameters: Target DAFT air/solids ratio: 0.03

	DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
	Water (Subnatant / Secondary Effluent)							
1	No / Less Flow	Pump inlet isolation valve (motor operated knife gate valve) closed or pinched	Potential pump cavitation Potential pump failure Potential for loss of pressurization water to the DAFT with loss of ability to float solids (solids settle to the bottom and are removed by the bottom sludge pump)	5	Standby pressurization pumps Valve equipped with position switches with indication in the DCS Standard Operating Procedure Flow indication in the DCS	5	4	
2	No / Less Flow	Pump outlet isolation valve (motor operated knife gate valve) closed or pinched	Potential to dead head pump (150 ft) Potential pump failure Potential for loss of pressurization water to the DAFT with loss of ability to float solids (solids settle to the bottom and are removed by the bottom sludge pump)	5	Standby pressurization pumps Valve equipped with position switches with indication in the DCS Standard Operating Procedure High pressure switch trips pump Flow indication in DCS	5	4	
3	More Flow	One or more DAFTs offline so more water is distributed to the remaining in-service DAFTs	No credible hazardous consequences or operability issues					

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell

Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: DAFT 60% Design: Pressurization System

The pressurization system saturates a water stream (DAFT subnatant or secondary effluent) with air (primarily oxygen) to promote solids flotation in the DAFTs. Air is supplied at ~85 psig from the instrument air compressors (reduced from a ~120 psig discharge pressure) and further reduced to ~60 psig by a local PCV. Water is supplied by constant speed pressurization pumps, with flow controlled solely by adjusting the number of operating pumps (the total water flow is equally divided amongst all in-service DAFTs).

Drawings: P&IDs DI-2-614-72, DI-3-601-72

Parameters: Target DAFT air/solids ratio: 0.03

	DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
	Instrument Air							
4	No / Less Flow	Motor operated gate valve closed or pinched	Potential for reduced or loss of dissolved air flow to the DAFT with loss of ability to float solids (solids settle to the bottom and are removed by the bottom sludge pump)	5	Valve equipped with position switches with indication in the DCS Standard Operating Procedure	5	4	
5	More Flow	Pressure reducing valve fails open	Potential for increased air flow to the pressure retention tank Potential for lower water level Potential for increased air bleed off to atmosphere Potential reduction of air flow to other pressure retention tanks	5	Rotameter will approximately maintain the intended flow Pressure transmitter on the retention tank Level transmitter on the retention tank	5	4	

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: DAFT 60% Design: Pressurization System

The pressurization system saturates a water stream (DAFT subnatant or secondary effluent) with air (primarily oxygen) to promote solids flotation in the DAFTs. Air is supplied at ~85 psig from the instrument air compressors (reduced from a ~120 psig discharge pressure) and further reduced to ~60 psig by a local PCV. Water is supplied by constant speed pressurization pumps, with flow controlled solely by adjusting the number of operating pumps (the total water flow is equally divided amongst all in-service DAFTs).

Drawings: P&IDs DI-2-614-72, DI-3-601-72
Parameters: Target DAFT air/solids ratio: 0.03

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
6 More Flow	Incorrect high rotameter setting	Potential for increased air flow to the pressure retention tank Potential for lower water level Potential for increased air bleed off to atmosphere Potential reduction of air flow to other pressure retention tanks	5	Pressure transmitter on retention tank Level transmitter on retention tank Standard Operating Procedure	5	4	
Nitrogen Bleed-Off System							
7 More Flow	Solenoid valve fails open or is left open	No credible hazardous consequences or operability issues (purge line at 1/2" is much smaller than 1" air supply line)					
8 Less Flow	Incorrect low rotameter setting	Potential for nitrogen buildup in the retention tank, lowering O2 absorption and reducing efficiency	5	None	5	4	

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell

Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: DAFT 60% Design: Pressurization System

The pressurization system saturates a water stream (DAFT subnatant or secondary effluent) with air (primarily oxygen) to promote solids flotation in the DAFTs. Air is supplied at ~85 psig from the instrument air compressors (reduced from a ~120 psig discharge pressure) and further reduced to ~60 psig by a local PCV. Water is supplied by constant speed pressurization pumps, with flow controlled solely by adjusting the number of operating pumps (the total water flow is equally divided amongst all in-service DAFTs).

Drawings: P&IDs DI-2-614-72, DI-3-601-72

Parameters: Target DAFT air/solids ratio: 0.03

	DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
	Pressurization Retention Tank							
9	No / Less Flow	Outlet isolation plug valve closed or pinched	Potential to dead head pump (150 ft) Potential pump failure Potential for loss of pressurization water to the DAFT with loss of ability to float solids (solids settle to the bottom and are removed by the bottom sludge pump)	5	Standby pressurization pumps Standard Operating Procedure High pressure switch trips pump Flow indication in DCS	5	4	
10	More Flow	Back pressure regulator fails open	Potential for increased pressurization water flow to the associated DAFT Potential for lower water level in the pressurization tank Potential reduction of pressurization water flow to other DAFTs	5	Pressure transmitter on the retention tank Level transmitter on the retention tank	5	4	

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: DAFT 60% Design: Pressurization System

The pressurization system saturates a water stream (DAFT subnatant or secondary effluent) with air (primarily oxygen) to promote solids flotation in the DAFTs. Air is supplied at ~85 psig from the instrument air compressors (reduced from a ~120 psig discharge pressure) and further reduced to ~60 psig by a local PCV. Water is supplied by constant speed pressurization pumps, with flow controlled solely by adjusting the number of operating pumps (the total water flow is equally divided amongst all in-service DAFTs).

Drawings: P&IDs DI-2-614-72, DI-3-601-72
Parameters: Target DAFT air/solids ratio: 0.03

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
11 High Level	Level transmitter fails low	Potential to have subnatant or secondary effluent flow through nitrogen purge to atmosphere Potential personnel exposure to subnatant or secondary effluent	5	Visual observation of DAFT (no bubbling of surface)	5	4	
12 Low Level	Level transmitter fails high	Potential loss of the blanket layer in the DAFT Potential accumulation of solids in the bottom layer Potential for high subnatant solids content	5	Visual observation of DAFT Standard Operating Procedure (sampling)	4	4	

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: DAFT 60% Design: Sludge Feed System

Blended sludge, a combination of WAS and PS, is pumped from the Blend Tanks to the DAFTs. These DAFT feed pumps have VFD motors with starts, stops and operating speed controlled by signals from the Blend Tank level instrumentation.

NOTE: The decision was made to remove the Blend Tanks from the Project scope; since these tanks were viewed as mere wide spots in the piping (with no associated potentially hazardous consequences or operability issues), they were not explicitly reviewed. Therefore, their removal has no impact on this PHA.

Drawings: P&IDs DI-1-608-72, DI-3-601-72, DI-3-602-72
Parameters: Pump Design: 2200 gpm @ 25 ft TDH

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
1 No / Less Flow	Closed or pinched isolation valve anywhere in the sludge feed piping downstream of the feed pump	Potential to dead head pump Potential for decreased blended sludge flow into associated DAFT and higher flow into other DAFTs Potential for waste of polymer (polymer continues being injected at normal rates) Potential loss of the blanket layer in the DAFT	5	Feed pumps are equipped with VFDs Sludge flow transmitter with indication in the DCS Standard Operating Procedure Operator rounds	5	4	
2 No / Less Flow	Motor operated plug valve fails closed Flow transmitter fails high causing incorrect LOW adjustment	Potential to dead head pump Potential for decreased blended sludge flow into associated DAFT and higher flow into other DAFTs Potential for waste of polymer (polymer continues being injected at normal rates) Potential loss of the blanket layer in the DAFT	5	Feed pumps are equipped with VFDs Operator rounds Plug valve equipped with limit switches with indication in the DCS	4	4	17) Consider moving the plug valve from downstream of the flow meter to downstream of the motor operated valve to improve isolation for maintenance

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: DAFT 60% Design: Sludge Feed System
Blended sludge, a combination of WAS and PS, is pumped from the Blend Tanks to the DAFTs. These DAFT feed pumps have VFD motors with starts, stops and operating speed controlled by signals from the Blend Tank level instrumentation.
NOTE: The decision was made to remove the Blend Tanks from the Project scope; since these tanks were viewed as mere wide spots in the piping (with no associated potentially hazardous consequences or operability issues), they were not explicitly reviewed. Therefore, their removal has no impact on this PHA.

Drawings: P&IDs DI-1-608-72, DI-3-601-72, DI-3-602-72
Parameters: Pump Design: 2200 gpm @ 25 ft TDH

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
3 More Flow	Motor operated plug valve fails open Flow transmitter fails low causing incorrect HIGH adjustment	Potential for increased blended sludge flow to associated DAFT Potential for loss of efficiency in DAFT Potential for thinner blanket in DAFT	5	Feed pumps are equipped with VFDs Operator rounds Plug valve equipped with limit switches with indication in the DCS	4	4	

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: DAFT 60% Design: Odor Control System
Foul air from multiple sources, including the DAFTs and Equalization and Blend Tanks, are collected and routed through a biotrickling filter for bacterial removal (oxidation) of the odorous compounds. The stream is then exhausted to atmosphere through the exhaust stack via the adsorption vessel fan (1 duty, 1 standby). The adsorption vessels, intended as the second stage of a two-stage foul air treating process, have been removed from the project scope.

Drawings: P&IDs DI-3-602-72, DI-4-603-73, DI-4-604-73, DI-4-605-73, DI-4-606-73
Parameters: Adsorption Fan Design: 9150 scfm @ 12" WC

DEVIATION		CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
1	More Flow	DAFT cover observation doors left open or are leaking	Potential for increased flow (load) on the adsorption fan Potential for localized areas of high H2S under the DAFT cover (DAFT vapor space should remain under negative pressure, so no personnel exposure)	5	Standard Operating Procedure Flow indication in the DCS	2	4	18) Consider adding an isolation damper to each DAFT foul air collection header
2	No / Less Flow	Adsorption fan fails for any reason	Potential for localized areas of high H2S content with potential personnel exposure from opening the observation doors Potential explosion hazard	1	Standby blower All instrumentation within 3 ft of the odor control system or DAFT covers is Class I Div 2 Flow indication in the DCS	4	3	19) Consider modifying the Standard Operating Procedure to address potential H2S buildup issues if the fan is down 20) Consider adding audible and visible alarms if fan trips
3	No / Less Flow	Closed/partially closed isolation damper anywhere in the foul air system	Potential to starve or dead head fan resulting in potential fan overheating (damage unlikely) Potential for localized areas of high H2S content with potential personnel exposure from opening the observation doors Potential explosion hazard	1	Standby blower All instrumentation within 3 ft of the odor control system or DAFT covers is Class I Div 2 Standard Operating Procedure Flow indication in the DCS	4	3	

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: DAFT 60% Design: Odor Control System
Foul air from multiple sources, including the DAFTs and Equalization and Blend Tanks, are collected and routed through a biotrickling filter for bacterial removal (oxidation) of the odorous compounds. The stream is then exhausted to atmosphere through the exhaust stack via the adsorption vessel fan (1 duty, 1 standby). The adsorption vessels, intended as the second stage of a two-stage foul air treating process, have been removed from the project scope.

Drawings: P&IDs DI-3-602-72, DI-4-603-73, DI-4-604-73, DI-4-605-73, DI-4-606-73
Parameters: Adsorption Fan Design: 9150 scfm @ 12" WC

	DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
4	No Flow (Biotrickling Filter circulating stream)	Pump fails for any reason	Potential for microorganisms to lose nutrient supply and die off Potential to lose ability to remove odors Potential onsite odor	5	Pump failure alarm in the DCS (pump trip may not alarm in all cases) Standby pump	3	4	
5	Less Flow (Biotrickling Filter circulating stream)	Incorrect low set point on the rotameter	Potential for microorganisms to lose nutrient supply and die off Potential to lose ability to remove odors Potential onsite odor	5	Standard Operating Procedure	4	4	
6	More Flow (Biotrickling Filter circulating stream)	Incorrect high set point on the rotameter	No credible hazardous consequences or operability issues					

Digesters 60% Design

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell

Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: Digesters 60% Design: Thickened Sludge Feed System

Thickened sludge (TS) from the TS Equalization (TSE) Tanks is pumped into the Digester Feed Loop; the loop circulates sludge at a minimum continuous rate to prevent solids accumulation. Dedicated Digester Feed Pumps, equipped with VFDs, route sludge from the loop to the associated digester. Pumping (feed) rate is controlled based on the level in the TSE Tanks.

Drawings: P&IDs DI-4-601-73, DI-4-602-73, DI-4-608-73, DI-4-609-71, DI-5-651-71

Parameters: The average Digester feed rate is 200 gpm; the target feed loop return flow rate is 400 gpm (maintain 5 fps velocity)

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
1 Less Flow	Plug valve is closed around the flow meter In the Digester Feed Loop (TSE Tank return line)	Potential to overpressure pipe with potential personnel exposure to TS	4	Standard Operating Procedure Digester Feed Loop flow indication in the DCS Pumps are equipped with VFDs High pressure switch with local and DCS alarms	4	4	
2 Less Flow	Valves are pinched Grease accumulation in piping Incorrect LOW set point in DCS	Potential rise in pump discharge pressure with potential for pump to trip Potential decrease in circulation rate Potential buildup of solids if condition persists Potential need to shutdown and flush feed loop if grease buildup is severe	5	Standard Operating Procedure Digester feed flow indication in the DCS Local pressure indicator Pump trip alarm in the DCS High pressure switch with local and DCS alarms Flushing connections on piping Ability to circulate digested (hot) sludge	4	4	

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell

Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: Digesters 60% Design: Thickened Sludge Feed System

Thickened sludge (TS) from the TS Equalization (TSE) Tanks is pumped into the Digester Feed Loop; the loop circulates sludge at a minimum continuous rate to prevent solids accumulation. Dedicated Digester Feed Pumps, equipped with VFDs, route sludge from the loop to the associated digester. Pumping (feed) rate is controlled based on the level in the TSE Tanks.

Drawings: P&IDs DI-4-601-73, DI-4-602-73, DI-4-608-73, DI-4-609-71, DI-5-651-71

Parameters: The average Digester feed rate is 200 gpm; the target feed loop return flow rate is 400 gpm (maintain 5 fps velocity)

	DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
3	More Flow	Incorrect HIGH set point in DCS	Potential erosion of glass lined piping due to solids in sludge	5	Standard Operating Procedure	4	4	1) Consider adding high and low TS flow alarms or clamping flow set point range 2) Consider implementing routine inspections to validate glass lining integrity
4	Other Than Flow (WTR3 Valve Open when Feeding Sludge)	Incorrect opening of WTR3 valve (assume 95 psi supply pressure)	Potential to dilute TS, defeating the purpose of the DTFU project Potential to trip sludge pump Potential cooling of digesters	5	Standard Operating Procedure Digester sludge heating system (will attempt to maintain temperature)	4	4	3) Confirm that WTR3 is on the 95 psi system (if not, consider adding protection to prevent backflow of sludge into the WTR3 system)
5	Water Flush	Preparing equipment for maintenance Flushing out system	Water may not clean all material/grease out of pipe	5	None	4	4	4) Consider providing steam/hot water injection ports for cleaning piping

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: Digesters 60% Design: Standpipe and Withdrawal Pump System
Digested sludge, floating scum and foam residue continuously overflows from the liquid surface of the Digester Dome to the lower elevation standpipe (wet well). Standpipe level controls sludge pump VFD operation. The overhead of the standpipe is connected to the vapor space of the Digester Dome.

Drawings: P&IDs DI-5-651-71, DI-5-657-71
Parameters: Sludge removal is split approximately 50/50 between the bottom withdrawal (fixed flow) and the overflow/standpipe (variable flow)

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
1 No Flow	Standpipe inlet plug valve closed	Lose sludge flow to the standpipe Potential loss of level in the standpipe Potential for sludge to back-up in the gas dome and flow through the emergency overflow to the plant drain Potential need to retreat sludge (added operational cost) Potential to run standpipe withdrawal pump dry and overheat	5	Standard Operating Procedure Standpipe level indication in the DCS Sight glass on the emergency overflow Sludge withdrawal flow indication in the DCS Sludge withdrawal pumps equipped with VFDs	4	4	

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: Digesters 60% Design: Standpipe and Withdrawal Pump System
Digested sludge, floating scum and foam residue continuously overflows from the liquid surface of the Digester Dome to the lower elevation standpipe (wet well). Standpipe level controls sludge pump VFD operation. The overhead of the standpipe is connected to the vapor space of the Digester Dome.

Drawings: P&IDs DI-5-651-71, DI-5-657-71
Parameters: Sludge removal is split approximately 50/50 between the bottom withdrawal (fixed flow) and the overflow/standpipe (variable flow)

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
2 No Flow	Pump trips for any reason Standpipe bottom plug valve closed	Potential for sludge to back-up in the gas dome and flow through the emergency overflow to the plant drain Potential need to retreat sludge (added operational cost) Potential to run standpipe withdrawal pump dry and overheat	5	Standard Operating Procedure Standpipe level indication in the DCS Sight glass on the emergency overflow Sludge withdrawal flow indication in the DCS Sludge withdrawal pumps equipped with VFDs	4	4	
3 High Level	Failure of level transmitter LOW	Potential for reduced withdrawal pump VFD speed Potential for sludge to back-up in the gas dome and flow through the emergency overflow to the plant drain Potential need to retreat sludge (added operational cost)	5	Sight glass on the emergency overflow Sludge withdrawal flow indication in the DCS	3	4	5) Consider using DCS as backup to use bottom pump

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell

Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: Digesters 60% Design: Standpipe and Withdrawal Pump System

Digested sludge, floating scum and foam residue continuously overflows from the liquid surface of the Digester Dome to the lower elevation standpipe (wet well). Standpipe level controls sludge pump VFD operation. The overhead of the standpipe is connected to the vapor space of the Digester Dome.

Drawings: P&IDs DI-5-651-71, DI-5-657-71

Parameters: Sludge removal is split approximately 50/50 between the bottom withdrawal (fixed flow) and the overflow/standpipe (variable flow)

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
4 Low Level	Failure of level transmitter HIGH Inlet block valve closed	Potential for increased withdrawal pump VFD speed Potential to run standpipe withdrawal pump dry and overheat	5	Standard Operating Procedure Sight glass on the emergency overflow Sludge withdrawal flow indication in the DCS Low pressure switch with local and DCS alarms and pump trip	3	4	

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: <u>Digesters 60% Design: Circulating Sludge System</u>
This system maintains the Digester at thermophilic operating temperature by circulating sludge at high rates through a concentric-tube hot water heat exchanger. Two heat transfer systems are required per Digester, each containing an 850 gpm circulation pump and heat exchanger.

Drawings: P&IDs DI-5-651-71, DI-5-652-71
Parameters: Pump Design: 1,700 gpm @ 65 ft TDH (2 pumps in parallel)
TPAD Design Temp: 135 F

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
1 Less Flow	One pump trips for any reason Closed valve on one of the pump lines Pinched isolation valves	Potential to cavitate or dead head pump Potential for a reduced sludge circulation rate Potential reduction in digester temperature	5	Standard Operating Procedure Temperature indication in the DCS Local temperature and pressure indicators Pump failure alarm in the DCS	4	4	

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: Digesters 60% Design: Circulating Sludge System
This system maintains the Digester at thermophilic operating temperature by circulating sludge at high rates through a concentric-tube hot water heat exchanger. Two heat transfer systems are required per Digester, each containing an 850 gpm circulation pump and heat exchanger.

Drawings: P&IDs DI-5-651-71, DI-5-652-71
Parameters: Pump Design: 1,700 gpm @ 65 ft TDH (2 pumps in parallel)
TPAD Design Temp: 135 F

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
2 Low Temperature	Loss of hot water loop Heat exchanger fouling Block valve pinched or closed	Potential reduction in digester temperature (estimated to be one degree per day when heat transfer is lost)	5	Dual heating loops TPAD operation requires a temperature of only 121F, giving ~14 days of operation without concern Mesophilic operation is acceptable and requires a temperature of only 98F, providing additional operating time Temperature indication in the DCS Local temperature and pressure indicators Pump failure alarm in the DCS Ability to switch feed to other digesters	4	4	

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell

Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: Digesters 60% Design: Circulating Sludge System

This system maintains the Digester at thermophilic operating temperature by circulating sludge at high rates through a concentric-tube hot water heat exchanger. Two heat transfer systems are required per Digester, each containing an 850 gpm circulation pump and heat exchanger.

Drawings: P&IDs DI-5-651-71, DI-5-652-71

Parameters: Pump Design: 1,700 gpm @ 65 ft TDH (2 pumps in parallel)

TPAD Design Temp: 135 F

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
3 High Temperature (150F Maximum)	Three way valve on the hot water loop fails Hot water temperature transmitter fails LOW	Potential overheating of sludge with potential to kill microorganisms Potential decrease in digester efficiency Potential personnel exposure to hot fluids (>140F)	5	Temperature indication in the DCS Local temperature indicators Hot pipes are insulated (sludge and hot water) Ability to switch feed to other digesters	3	4	

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell

Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: Digesters 60% Design: Foam Suppression System

To minimize foaming, sludge is continuously withdrawn from the bottom of the Digester, circulated via a constant speed centrifugal pump and returned to the Digester Dome.

Drawings: P&IDs DI-5-651-71, DI-5-650-71

Parameters: Pump Design: 600 gpm @ 33 ft TDH

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
1 No credible hazardous consequences or operability issues associated with this system							

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: Digesters 60% Design: Bottom Withdrawal and Sludge Cooling System

Approximately 50% of the sludge contained in the Digester is withdrawn from the bottom of the Digester (the remaining sludge overflows to the Standpipe). The Withdrawal Pump transfers the sludge from the Digester to one of two transfer headers, where it combines with sludge from the Standpipe Withdrawal Pump. The combined stream then flows through two concentric-tube heat exchangers and on to the second stage Digesters. The two heat exchangers per header operate in parallel and utilize cooling water to reduce the sludge temperature to a 100F target, suitable for mesophilic operation.

Drawings: P&IDs DI-5-651-71, DI-5-656-71, DI-5-657-71, DI-5-691-71
Parameters: Pump Design: 400 gpm @ 50 psi TDH

	DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
1	Less Flow	Pinched valve anywhere in the common piping or closed valve to one of the two heat exchangers	Potential for sludge temperature to the second stage digesters to increase (estimate <1 degree/day) Potential impact to the second stage digester operation Potential for mesophilic microorganisms to become inactive	5	Ability to route sludge directly to DSEPS Local temperature indicators Temperature indication in the DCS Flow indication in the DCS Standard Operating Procedure	4	4	
2	More Flow	Operator route sludge from all 4 digesters to a single header	Potential for sludge temperature to the second stage digesters to increase (estimate <1 degree/day) Potential impact to the second stage digester operation Potential for mesophilic microorganisms to become inactive	5	Ability to route sludge directly to DSEPS Local temperature indicators Temperature indication in the DCS Flow indication in the DCS Standard Operating Procedure	4	4	

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: <u>Digesters 60% Design: Bottom Withdrawal and Sludge Cooling System</u>
Approximately 50% of the sludge contained in the Digester is withdrawn from the bottom of the Digester (the remaining sludge overflows to the Standpipe). The Withdrawal Pump transfers the sludge from the Digester to one of two transfer headers, where it combines with sludge from the Standpipe Withdrawal Pump. The combined stream then flows through two concentric-tube heat exchangers and on to the second stage Digesters. The two heat exchangers per header operate in parallel and utilize cooling water to reduce the sludge temperature to a 100F target, suitable for mesophilic operation.

Drawings: P&IDs DI-5-651-71, DI-5-656-71, DI-5-657-71, DI-5-691-71
Parameters: Pump Design: 400 gpm @ 50 psi TDH

	DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
3	High Temperature	Closed isolation valve in the cooling water line to the heat exchanger Heat exchanger fouling	Potential for sludge temperature to the second stage digesters to increase (estimate <1 degree/day) Potential impact to the second stage digester operation Potential for mesophilic microorganisms to become inactive	5	Ability to route sludge directly to DSEPS Local temperature indicators Temperature indication in the DCS Standard Operating Procedure	4	4	
4	Low Temperature	Motor operator valve on the cooling water line fails open (too much cooling water to the heat exchangers)	Potential for sludge temperature to the second stage digesters to decrease Potential impact to the second stage digester operation Potential for mesophilic microorganisms to become inactive	5	Ability to route sludge directly to DSEPS Local temperature indicators Temperature indication in the DCS Standard Operating Procedure	4	4	

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: Digesters 60% Design: Gas Mixing Compressor System
Low pressure gas from the Digester Dome is collected and compressed by a liquid ring compressor. The compressed gas is piped to a manifold and distributed amongst 24 lances (6 lances per each of 4 draft tubes) within the Digester. The gas induces an upward flow in each draft tube, creating a downward flow in the remainder of the Digester, effectively mixing the Digester contents.

Drawings: P&IDs DI-5-651-71, DI-5-654-71, DI-5-653-71
Parameters: Compressor Design: 1,200 cfm @ 15 psig discharge

	DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
1	No Flow	Closed valve anywhere in the gas path Motor operated valve fails closed Compressor trips for any reason	Potential to starve or dead head compressor Potential loss of digester mixing Potential for a rapid rise event (sludge specific gravity change resulting in a rapid volume increase)	5	Digester equipped with an emergency overflow Standpipe sludge pump equipped with VFD (pump speed will increase with high standpipe level) Low pressure switch with local and DCS alarms and compressor trip Separator drum (compressor skid) equipped with a PSV Local pressure indicators Standard Operating Procedure	4	4	
2	Less Flow	Pinched isolation valve anywhere in the gas path	Potential for reduced digester mixing No short term implications	5	Standard Operating Procedure Local pressure indicators	4	4	
3	Misdirected Flow	Some lance isolation valves are closed, routing mixing gas to fewer draft tubes than design	Potential for inefficient mixing No credible hazardous consequences or operability issues					

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: Digesters 60% Design: Gas Mixing Compressor System
Low pressure gas from the Digester Dome is collected and compressed by a liquid ring compressor. The compressed gas is piped to a manifold and distributed amongst 24 lances (6 lances per each of 4 draft tubes) within the Digester. The gas induces an upward flow in each draft tube, creating a downward flow in the remainder of the Digester, effectively mixing the Digester contents.

Drawings: P&IDs DI-5-651-71, DI-5-654-71, DI-5-653-71
Parameters: Compressor Design: 1,200 cfm @ 15 psig discharge

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
4 Loss of WTR3 Supply to Compressor	Closed isolation valve	Potential for internal gas recirculation in compressor Potential loss of digester mixing Potential for a rapid rise event (sludge specific gravity change resulting in a rapid volume increase)	5	Low flow switch will trip compressor	4	4	6) Confirm WTR3 operating pressure is suitable for its use as compressor seal water

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell

Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: Digesters 60% Design: Gas Metering and Header System

Low pressure gas from the Digester Dome is routed to a common 30" collection header, where it joins the gas from the other three Digesters. The combined stream is routed to an existing 18" header which connects to the existing gas compressor suction header.

Drawings: P&IDs DI-5-651-71, DI-6-601-71, DI-6-610-71

Parameters: Digester Design / Operating Pressure: 18"WC / 8" WC (Digester Pressure/Vacuum Safety Valves set at +10"WC/-2"WC)

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
1 No Flow	Closed valve anywhere in the gas path Spectable blind incorrectly left in the closed position	Potential to overpressure the emergency overflow trap (set at 24" WC) Potential release of flammable gas to the atmosphere (60% methane, 40% CO_2) from the U-trap vents with potential explosion if ignition source is present Potential personnel injury/fatality Potential environmental permit violation	1	Pressure/vacuum safety valves (set at +10"/-2" WC) Pressure relief hatch on top of the Digester concrete cover Pressure indication in the DCS High pressure alarm in the DCS with trip of the Digester feed pump All equipment in the Digester area is Class 1 Div 2 rated	4	3	7) Consider installing flame arresters on the U-trap vents

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: Digesters 60% Design: Gas Metering and Header System
Low pressure gas from the Digester Dome is routed to a common 30" collection header, where it joins the gas from the other three Digesters. The combined stream is routed to an existing 18" header which connects to the existing gas compressor suction header.

Drawings: P&IDs DI-5-651-71, DI-6-601-71, DI-6-610-71
Parameters: Digester Design / Operating Pressure: 18"WC / 8" WC (Digester Pressure/Vacuum Safety Valves set at +10"WC/-2"WC)

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
2 Less Flow	Pinched valve anywhere in the gas path Plugged sediment trap	Potential to overpressure the emergency overflow trap (set at 24" WC) Potential release of flammable gas to the atmosphere (60% methane, 40% CO_2) from the U-trap vents with potential explosion if ignition source is present Potential personnel injury/fatality Potential environmental permit violation	1	Pressure/vacuum safety valves (set at +10"/-2" WC) Pressure relief hatch on top of the Digester concrete cover Pressure indication in the DCS High pressure alarm in the DCS with trip of the Digester feed pump All equipment in the Digester area is Class 1 Div 2 rated PM of Varecs and sediment traps	4	3	7) Consider installing flame arresters on the U-trap vents

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: Digesters 60% Design: Gas Metering and Header System
Low pressure gas from the Digester Dome is routed to a common 30" collection header, where it joins the gas from the other three Digesters. The combined stream is routed to an existing 18" header which connects to the existing gas compressor suction header.

Drawings: P&IDs DI-5-651-71, DI-6-601-71, DI-6-610-71
Parameters: Digester Design / Operating Pressure: 18"WC / 8" WC (Digester Pressure/Vacuum Safety Valves set at +10"WC/-2"WC)

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
3 No Level in Condensate Accumulator	Low level switch fails Closed isolation valve in the make-up (RWF) water supply line	Potential for condensate accumulator to run dry Potential release of flammable gas to the atmosphere (60% methane, 40% CO2) from the accumulator with potential explosion if ignition source is present Potential personnel injury/fatality Potential environmental permit violation	1	Standard Operating Procedure	4	3	8) Consider adding a flame arrester to the outlet of the condensate accumulator 9) Consider continuous water injection into the condensate accumulator to ensure that the liquid level (seal) is maintained
4 High Level in Condensate Accumulator	Overflow plugged High level switch fails	No credible hazardous consequences or operability issues					

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: Digesters 60% Design: Global Categories
Drawings: N/A
Parameters: N/A

	DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
1	Maintenance	Lack of bleeder valves	Potential operator exposure to pipe and/or equipment contents if the piping is not depressurized/drained prior to opening	4	Standard Operating Procedure	3	4	10) Consider adding an adequate quantity and size of bleeders around equipment/isolatable piping
2	Pressure Safety Valve Inspection and Testing	Lack of PSV inspection and testing	Potential vessel failure and personnel injury	1	None	5	3	11) Consider developing a pressure safety valve inspection and test plan in accordance with recommended industry practice
3	Pressure Vessel Inspection and Maintenance	Lack of pressure vessel inspection and maintenance	Potential vessel failure and personnel injury	1	None	5	3	12) Consider developing a pressure vessel inspection plan in accordance with recommended industry practice
4	Loss of WTR3 Supply	Unplanned outage of the WTR3 system (pipe break, etc.)	Potential trip of compressors and pumps Potential inability to process sludge Potential Digester rapid rise event Potential for delayed restart due to operator manual reset requirement	3	None	3	3	13) Consider adding booster pumps for DTFU project scope only 14) Consider tying in WTR2 as a backup water source

PHA Study Session Documentation Report (PHA Study Worksheets)

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: Digesters 60% Design: Global Categories
Drawings: N/A
Parameters: N/A

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
5 Earthquake		Potential vessel failure and personnel injury	1	All equipment is designed to current code (CBC 2012), risk category 3 Digester gas piping designed to a 1.5 importance factor per City request DAFT and Digesters designed to a 1.25 importance factor per code requirements (not practical to design to 1.5 importance factor) Plant emergency response	5	3	

Appendix C

Recommendations Report

DAFT 60% Design

Recommendations Report

Company: Brown and Caldwell

Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: DAFT 60% Design: Polymer Receiving, Storage and Recirculation System

Polymer is received and unloaded from a 5000 gallon tanker truck to one of the two 6000 gallon fiberglass storage tanks using pressurized air. The recirculation system runs intermittently (~2x/day) to maintain the polymer emulsion.

Drawings: P&IDs DI-2-601-73, DI-2-602-73

Parameters: Recirculation System: 50 gpm circulation rate

	DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
	Polymer Receiving and Storage							
1	No Flow	Manual valve closed on the tanker truck offloading line	Potential pipe failure Potential failure of the tanker truck (outside PHA scope) Potential personnel exposure to polymer Potential slip hazard (polymer causes surfaces to be slippery) Potential for spilled polymer to drain to the sewer	4	Valves are visible from truck offloading Standard Operating Procedure Flowing polymer from tanker makes audible sound Truck offloading area is contained (separate from tanks) and containment valve is normally open Pipe is Sch 80 PVC, tested to 150 psi Safety shower in the area	4	4	1) Consider modifying the Standard Operating Procedure to keep the containment isolation valve closed 2) Consider relocating the tanker truck hose connection to inside the tank containment area
2	Other Than Flow (Moist Air Into Tank)	Spent desiccant	Potential negative impact to polymer effectiveness Potential for polymer viscosity to increase Potential pump plugging	5	Visible desiccant status indicator on the vent dryer	3	4	3) Consider adding a second desiccant dryer (one operating / one standby)

Recommendations Report

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: DAFT 60% Design: Polymer Receiving, Storage and Recirculation System
Polymer is received and unloaded from a 5000 gallon tanker truck to one of the two 6000 gallon fiberglass storage tanks using pressurized air.
The recirculation system runs intermittently (~2x/day) to maintain the polymer emulsion.

Drawings: P&IDs DI-2-601-73, DI-2-602-73
Parameters: Recirculation System: 50 gpm circulation rate

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
4 High Level	Polymer shipment received when it is not needed or offloaded into wrong tank	Potential for polymer to overflow tank into containment area Potential personnel exposure and slip hazard	5	Safety shower in the area Tank level indication with high level alarm Tank level gauge Polymer tanks are interconnected Containment valve is normally closed	4	4	4) Consider adding local audible high level alarm to polymer tanks
5 No / Low Level	Failure of a flexible coupling at one of the tank connections	Potential loss of polymer to the containment Potential personnel exposure and slip hazard	5	Operator rounds (part of the Standard Operating Procedure) Safety shower in the area	5	4	5) Consider relocating tank isolation valves from the piping to directly on the tank, upstream of the flexible coupling

Recommendations Report

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: DAFT 60% Design: Polymer Receiving, Storage and Recirculation System
Polymer is received and unloaded from a 5000 gallon tanker truck to one of the two 6000 gallon fiberglass storage tanks using pressurized air.
The recirculation system runs intermittently (~2x/day) to maintain the polymer emulsion.

Drawings: P&IDs DI-2-601-73, DI-2-602-73
Parameters: Recirculation System: 50 gpm circulation rate

	DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
6	Tank Maintenance	Accessing instruments on top of the tank	Potential personnel fall hazard	2	Tanks supposed to be equipped with guardrails and caged vertical ladder Standard Operating Procedure	4	3	6) Consider verifying ladder and guardrails are included on the tank specification
	Recirculation System							
7	No / Less Flow	Closed or pinched valve anywhere in circulation line on discharge side of pump	Potential pipe overpressure with polymer release to the atmosphere Potential personnel exposure	4	High pressure alarm in the DCS with local indication (light) Pipe is Sch 80 PVC, tested to 150 psi High pressure switch on the pump discharge with pump trip Standard Operating Procedure Safety shower in the area	4	4	7) Consider using safety glasses/goggles and/or face shield in the area 8) Consider putting in a placard (for safety glasses/goggles requirement)
8	No / Less Flow	Closed or pinched valve anywhere in circulation line on suction side of pump Circulation pump is offline (due to seal failure (loss of seal water) or other) No level in the polymer tank	Potential for circulation pump to run dry and overheat	4	Low pressure alarm in the DCS with local indication (light) Standard Operating Procedure Routine pump maintenance Tank level transmitter will shut down the circulation pump	4	4	9) Consider showing circulating pump seal water system on the P&IDs

Recommendations Report

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: DAFT 60% Design: Polymer Receiving, Storage and Recirculation System
Polymer is received and unloaded from a 5000 gallon tanker truck to one of the two 6000 gallon fiberglass storage tanks using pressurized air.
The recirculation system runs intermittently (~2x/day) to maintain the polymer emulsion.

Drawings: P&IDs DI-2-601-73, DI-2-602-73
Parameters: Recirculation System: 50 gpm circulation rate

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
9 Pump Maintenance	Pipe is not depressurized	Potential personnel exposure	4	Standard Operating Procedure Safety shower in the area	3	4	10) Consider adding bleeder valves to the piping on the suction and discharge side of the pump
10 Slips, Trips and Falls	Piping layout (pipe routed near grade around/near walk path)	Potential personnel injury	3	Visual observation of path	4	4	11) Consider reviewing the 3D model for piping layout/walk path obstructions

Node: DAFT 60% Design: Polymer Blend System
The Polymer Blend Unit meters and mixes polymer from the Polymer Storage Tanks and WTR 3 to produce a polymer solution of desired concentration. The solution then flows into the Blended Sludge line, upstream of the intended DAFT. There are seven (7) Polymer Blend Units, one for each of the six (6) DAFTs and one (1) common standby unit.

Drawings: P&IDs DI-2-601-73, DI-2-603-73, DI-3-601-72
Parameters: Target polymer concentration: 0.1 - 0.5%

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
3 Other Than Flow (Too Much Recycled Water (TPS))	WTR 3 flow is low for any reason	Potential for water with high residual chlorine content to be introduced into the system Potential negative impact to polymer effectiveness (chlorine breaks the polymer chain, rendering it ineffective)	5	Typical water system low in residual chlorine	4	4	12) Consider ensuring that residual chlorine is below allowable limits prior to starting the polymer blend unit 13) Consider using WTR 2 as alternate source of water

Recommendations Report

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: DAFT 60% Design: Polymer Blend System
The Polymer Blend Unit meters and mixes polymer from the Polymer Storage Tanks and WTR 3 to produce a polymer solution of desired concentration. The solution then flows into the Blended Sludge line, upstream of the intended DAFT. There are seven (7) Polymer Blend Units, one for each of the six (6) DAFTs and one (1) common standby unit.

Drawings: P&IDs DI-2-601-73, DI-2-603-73, DI-3-601-72
Parameters: Target polymer concentration: 0.1 - 0.5%

	DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
4	Other Than Flow (Too Much Polymer Addition)	Incorrect set point in DCS Polymer blend unit failure	Waste of polymer	5	Polymer flow meter on the blend unit HMI Water flow meter on the blend unit HMI Standard Operating Procedure	4	4	14) Consider clamping the polymer flow range in the DCS 15) Consider adding DCS/blend unit interface symbology to the P&IDs
5	Other Than Flow (Too Little Polymer Addition)	Incorrect set point in DCS Polymer blend unit failure	Potential for lower percent solids removal in the DAFT Potential for higher percent solids in the subnatant	5	Polymer flow meter on the blend unit HMI Water flow meter on the blend unit HMI Standard Operating Procedure Routine Operator sampling of the subnatant for solids	4	4	16) Consider adding a solids analyzer on the subnatant stream

Recommendations Report

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: DAFT 60% Design: Sludge Feed System
Blended sludge, a combination of WAS and PS, is pumped from the Blend Tanks to the DAFTs. These DAFT feed pumps have VFD motors with starts, stops and operating speed controlled by signals from the Blend Tank level instrumentation.
NOTE: The decision was made to remove the Blend Tanks from the Project scope; since these tanks were viewed as mere wide spots in the piping (with no associated potentially hazardous consequences or operability issues), they were not explicitly reviewed. Therefore, their removal has no impact on this PHA.

Drawings: P&IDs DI-1-608-72, DI-3-601-72, DI-3-602-72
Parameters: Pump Design: 2200 gpm @ 25 ft TDH

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
2 No / Less Flow	Motor operated plug valve fails closed Flow transmitter fails high causing incorrect LOW adjustment	Potential to dead head pump Potential for decreased blended sludge flow into associated DAFT and higher flow into other DAFTs Potential for waste of polymer (polymer continues being injected at normal rates) Potential loss of the blanket layer in the DAFT	5	Feed pumps are equipped with VFDs Operator rounds Plug valve equipped with limit switches with indication in the DCS	4	4	17) Consider moving the plug valve from downstream of the flow meter to downstream of the motor operated valve to improve isolation for maintenance

Recommendations Report

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: DAFT 60% Design: Odor Control System

Foul air from multiple sources, including the DAFTs and Equalization and Blend Tanks, are collected and routed through a biotrickling filter for bacterial removal (oxidation) of the odorous compounds. The stream is then exhausted to atmosphere through the exhaust stack via the adsorption vessel fan (1 duty, 1 standby). The adsorption vessels, intended as the second stage of a two-stage foul air treating process, have been removed from the project scope.

Drawings: P&IDs DI-3-602-72, DI-4-603-73, DI-4-604-73, DI-4-605-73, DI-4-606-73
Parameters: Adsorption Fan Design: 9150 scfm @ 12" WC

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
1 More Flow	DAFT cover observation doors left open or are leaking	Potential for increased flow (load) on the adsorption fan Potential for localized areas of high H2S under the DAFT cover (DAFT vapor space should remain under negative pressure, so no personnel exposure)	5	Standard Operating Procedure Flow indication in the DCS	2	4	18) Consider adding an isolation damper to each DAFT foul air collection header
2 No / Less Flow	Adsorption fan fails for any reason	Potential for localized areas of high H2S content with potential personnel exposure from opening the observation doors Potential explosion hazard	1	Standby blower All instrumentation within 3 ft of the odor control system or DAFT covers is Class I Div 2 Flow indication in the DCS	4	3	19) Consider modifying the Standard Operating Procedure to address potential H2S buildup issues if the fan is down 20) Consider adding audible and visible alarms if fan trips

Digesters 60% Design

Recommendations Report

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: Digesters 60% Design: Thickened Sludge Feed System
Thickened sludge (TS) from the TS Equalization (TSE) Tanks is pumped into the Digester Feed Loop; the loop circulates sludge at a minimum continuous rate to prevent solids accumulation. Dedicated Digester Feed Pumps, equipped with VFDs, route sludge from the loop to the associated digester. Pumping (feed) rate is controlled based on the level in the TSE Tanks.

Drawings: P&IDs DI-4-601-73, DI-4-602-73, DI-4-608-73, DI-4-609-71, DI-5-651-71
Parameters: The average Digester feed rate is 200 gpm; the target feed loop return flow rate is 400 gpm (maintain 5 fps velocity)

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
3 More Flow	Incorrect HIGH set point in DCS	Potential erosion of glass lined piping due to solids in sludge	5	Standard Operating Procedure	4	4	1) Consider adding high and low TS flow alarms or clamping flow set point range 2) Consider implementing routine inspections to validate glass lining integrity
4 Other Than Flow (WTR3 Valve Open when Feeding Sludge)	Incorrect opening of WTR3 valve (assume 95 psi supply pressure)	Potential to dilute TS, defeating the purpose of the DTFU project Potential to trip sludge pump Potential cooling of digesters	5	Standard Operating Procedure Digester sludge heating system (will attempt to maintain temperature)	4	4	3) Confirm that WTR3 is on the 95 psi system (if not, consider adding protection to prevent backflow of sludge into the WTR3 system)
5 Water Flush	Preparing equipment for maintenance Flushing out system	Water may not clean all material/grease out of pipe	5	None	4	4	4) Consider providing steam/hot water injection ports for cleaning piping

Recommendations Report

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: Digesters 60% Design: Standpipe and Withdrawal Pump System
Digested sludge, floating scum and foam residue continuously overflows from the liquid surface of the Digester Dome to the lower elevation standpipe (wet well). Standpipe level controls sludge pump VFD operation. The overhead of the standpipe is connected to the vapor space of the Digester Dome.

Drawings: P&IDs DI-5-651-71, DI-5-657-71
Parameters: Sludge removal is split approximately 50/50 between the bottom withdrawal (fixed flow) and the overflow/standpipe (variable flow)

	DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
3	High Level	Failure of level transmitter LOW	Potential for reduced withdrawal pump VFD speed Potential for sludge to back-up in the gas dome and flow through the emergency overflow to the plant drain Potential need to retreat sludge (added operational cost)	5	Sight glass on the emergency overflow Sludge withdrawal flow indication in the DCS	3	4	5) Consider using DCS as backup to use bottom pump

Node: Digesters 60% Design: Gas Mixing Compressor System
Low pressure gas from the Digester Dome is collected and compressed by a liquid ring compressor. The compressed gas is piped to a manifold and distributed amongst 24 lances (6 lances per each of 4 draft tubes) within the Digester. The gas induces an upward flow in each draft tube, creating a downward flow in the remainder of the Digester, effectively mixing the Digester contents.

Drawings: P&IDs DI-5-651-71, DI-5-654-71, DI-5-653-71
Parameters: Compressor Design: 1,200 cfm @ 15 psig discharge

	DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
4	Loss of WTR3 Supply to Compressor	Closed isolation valve	Potential for internal gas recirculation in compressor Potential loss of digester mixing Potential for a rapid rise event (sludge specific gravity change resulting in a rapid volume increase)	5	Low flow switch will trip compressor	4	4	6) Confirm WTR3 operating pressure is suitable for its use as compressor seal water

Recommendations Report

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: Digesters 60% Design: Gas Metering and Header System
Low pressure gas from the Digester Dome is routed to a common 30" collection header, where it joins the gas from the other three Digesters. The combined stream is routed to an existing 18" header which connects to the existing gas compressor suction header.

Drawings: P&IDs DI-5-651-71, DI-6-601-71, DI-6-610-71
Parameters: Digester Design / Operating Pressure: 18"WC / 8" WC (Digester Pressure/Vacuum Safety Valves set at +10"WC/-2"WC)

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
1 No Flow	Closed valve anywhere in the gas path Spectable blind incorrectly left in the closed position	Potential to overpressure the emergency overflow trap (set at 24" WC) Potential release of flammable gas to the atmosphere (60% methane, 40% CO_2) from the U-trap vents with potential explosion if ignition source is present Potential personnel injury/fatality Potential environmental permit violation	1	Pressure/vacuum safety valves (set at +10"/-2" WC) Pressure relief hatch on top of the Digester concrete cover Pressure indication in the DCS High pressure alarm in the DCS with trip of the Digester feed pump All equipment in the Digester area is Class 1 Div 2 rated	4	3	7) Consider installing flame arresters on the U-trap vents

Recommendations Report

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

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Low pressure gas from the Digester Dome is routed to a common 30" collection header, where it joins the gas from the other three Digesters. The combined stream is routed to an existing 18" header which connects to the existing gas compressor suction header.

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Parameters: Digester Design / Operating Pressure: 18"WC / 8" WC (Digester Pressure/Vacuum Safety Valves set at +10"WC/-2"WC)

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
2 Less Flow	Pinched valve anywhere in the gas path Plugged sediment trap	Potential to overpressure the emergency overflow trap (set at 24" WC) Potential release of flammable gas to the atmosphere (60% methane, 40% CO_2) from the U-trap vents with potential explosion if ignition source is present Potential personnel injury/fatality Potential environmental permit violation	1	Pressure/vacuum safety valves (set at +10"/-2" WC) Pressure relief hatch on top of the Digester concrete cover Pressure indication in the DCS High pressure alarm in the DCS with trip of the Digester feed pump All equipment in the Digester area is Class 1 Div 2 rated PM of Varecs and sediment traps	4	3	7) Consider installing flame arresters on the U-trap vents

Recommendations Report

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: Digesters 60% Design: Gas Metering and Header System
Low pressure gas from the Digester Dome is routed to a common 30" collection header, where it joins the gas from the other three Digesters. The combined stream is routed to an existing 18" header which connects to the existing gas compressor suction header.

Drawings: P&IDs DI-5-651-71, DI-6-601-71, DI-6-610-71
Parameters: Digester Design / Operating Pressure: 18"WC / 8" WC (Digester Pressure/Vacuum Safety Valves set at +10"WC/-2"WC)

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
3 No Level in Condensate Accumulator	Low level switch fails Closed isolation valve in the make-up (RWF) water supply line	Potential for condensate accumulator to run dry Potential release of flammable gas to the atmosphere (60% methane, 40% CO2) from the accumulator with potential explosion if ignition source is present Potential personnel injury/fatality Potential environmental permit violation	1	Standard Operating Procedure	4	3	8) Consider adding a flame arrester to the outlet of the condensate accumulator 9) Consider continuous water injection into the condensate accumulator to ensure that the liquid level (seal) is maintained

Recommendations Report

Company: Brown and Caldwell
Facility: San Jose - Santa Clara Regional Wastewater Facility

Node: Digesters 60% Design: Global Categories
Drawings: N/A
Parameters: N/A

DEVIATION	CAUSES	CONSEQUENCES	S	SAFEGUARDS	L	R	RECOMMENDATIONS
1 Maintenance	Lack of bleeder valves	Potential operator exposure to pipe and/or equipment contents if the piping is not depressurized/drained prior to opening	4	Standard Operating Procedure	3	4	10) Consider adding an adequate quantity and size of bleeders around equipment/isolatable piping
2 Pressure Safety Valve Inspection and Testing	Lack of PSV inspection and testing	Potential vessel failure and personnel injury	1	None	5	3	11) Consider developing a pressure safety valve inspection and test plan in accordance with recommended industry practice
3 Pressure Vessel Inspection and Maintenance	Lack of pressure vessel inspection and maintenance	Potential vessel failure and personnel injury	1	None	5	3	12) Consider developing a pressure vessel inspection plan in accordance with recommended industry practice
4 Loss of WTR3 Supply	Unplanned outage of the WTR3 system (pipe break, etc.)	Potential trip of compressors and pumps Potential inability to process sludge Potential Digester rapid rise event Potential for delayed restart due to operator manual reset requirement	3	None	3	3	13) Consider adding booster pumps for DTFU project scope only 14) Consider tying in WTR2 as a backup water source