East and West Blower Switchgear

Project Purpose:

The purpose of this project is to replace the switchgear that powers the blower motors in the East and West Blower Buildings.

Project History and Status:

The East Blower Building and the West Blower Building each house medium-voltage (4.16 kV) switchgear lineups with starters for each blower motor, except for Blower No. 1 in the East Blower Building, which is powered with a digester gas-fueled engine. The East Blower Building has a main switchgear lineup with the main and tie switches and starters for Blowers No. 4 and No. 5, as well as a remote switchgear lineup with starters for Blowers No. 2 and 3. The remote lineup is powered from the main switchgear lineup with redundant power feeds. All motor starters in the West Blower Building switchgear are part of one continuous lineup. The switchgear in both buildings are powered with redundant 4.16-kV power feeds from either side of the main switchgear S1 bus-tie circuit breaker.

Both of the medium-voltage switchgear lineups are regularly inspected and maintained, but are operating beyond their expected service life of 30 years. The East Blower Building's switchgear was installed in 1963 and the West Blower Building's switchgear was installed in 1985.
The East Blower Building's medium-voltage switchgear (S141 & S142) powers the following equipment:

- Blower No. 2: 600 horsepower (HP)
- Blower No. 3: 600 HP
- Blower No. 4: 375/500 HP (two-speed, two-winding motor)
- Blower No. 5: 315/450 HP (two-speed, two-winding motor)

The West Blower Building's medium-voltage switchgear (M51) powers the following equipment:

- Blower No. 1: 1,250 HP

- Blower No. 2: 1,250 HP
- Blower No. 3: 1,250 HP

Alternatives:

The following alternatives were evaluated in detail in the 2016 Liquid Processing Facilities Plan:

A. Alternative No. 0–No Change (Null Alternative)

Alternative No. 0 would leave both the existing East Blower Building and West Blower Building medium-voltage switchgear in place and powering the blower motors. The West Blower Building switchgear has been in service for about 32 years and the East Blower Building switchgear has been in service for over 50 years, but it has maintained consistent, reliable operation thus far. While there are many examples of switchgear equipment operating for more than 50 years, the expected service life for medium-voltage switchgear is about 30 years. Operating beyond 30 years introduces a greater chance for arc-fault events due to failed insulation, failed switch mechanisms, failed bus hardware, and other potential causes. Operating switchgear beyond its expected service life is possible with proper routine maintenance and testing, but the risk of equipment failure will still increase as equipment ages. Risks can be minimized by reconditioning switchgear with new components, but reconditioning efforts would still not account for the improved reliability and safety that could be provided with modern switchgear.

Since the original switchgear installations, advancements have been made in switchgear insulating technologies, switch mechanism reliability, and enclosure safety. New arc-resistant switchgear is also available to redirect the massive expansion of gas and molten conductor metal out of ducted passages and away from personnel in front of the switchgear. Photo-sensors and high-speed relays can now be used to quickly detect and clear arc-faults. Draw-out motor controller construction can also be used to improve equipment access and improve safety when maintaining equipment.

In addition to failures resulting from equipment aging, equipment grounding systems must also be considered for regular replacement. It is not uncommon for below-grade ground rods and conductors to corrode beyond the point where it can successfully transmit ground-fault currents.

B. Alternative No. 1–Replace East Blower Building Switchgear

This alternative includes replacing the East Blower Building switchgear with a new switchgear to power the existing blower motors. A switchgear would be installed in the same location as the existing switchgear and existing below-grade, concrete-encased duct bank could be reused to refeed the new switchgear with new medium-voltage cables from main switchgear S1 in the Effluent Building. The existing switchgear configuration allows switchgear replacement on one side of the tie while Blower Nos. 2, 3, and 5 remain energized and replacement on the other side once Blower No. 4 is energized from the new switchgear.

Future blower equipment upgrades could potentially include a change from blowers using

medium-voltage motors to blowers using multiple 480-volt motors. If 480-volt blower motors are selected for the upgrade, new 480-volt variable frequency drives or reduced-voltage solid-state starters, and potentially a new unit substation, would have to be installed. As a result, the new medium-voltage motor starters proposed as part of this alternative would no longer be used to power the blowers.

C. Alternative No. 2–Replace West Blower Building Switchgear

This alternative includes replacing the West Blower Building switchgear with new switchgear to power the existing blower motors. Switchgear would be installed in the same location as the existing switchgear and existing below-grade, concrete-encased duct bank could be reused to refeed the new switchgear with new medium-voltage cables from main switchgear S1 in the Effluent Building. The existing switchgear configuration allows switchgear replacement on one side of the tie while Blowers Nos. 2 and 3 remain energized and replacement on the other side once Blower No. 1 is energized from the new switchgear.

Future blower equipment upgrades could potentially include a change from blowers using medium-voltage motors to blowers using multiple 480-volt motors. If 480-volt blower motors are selected for the upgrade, new 480-volt variable frequency drives or reduced-voltage solid-state starters, and potentially a new unit substation, would have to be installed. As a result, the new medium-voltage motor starters proposed as part of this alternative would no longer be used to power the blowers.

Key Risks and Issues

The key social, environmental, and other nonmonetary considerations of each alternative are summarized in Table 1.

Table 1 – East and West Switchgear Alternative Nonmonetary Considerations Summary

Alternative	Benefits	Limitations
Alternative No. 0 – No Change (Null Alternative)	• If the blowers are eventually replaced with blowers using 480-volt motors, the district would avoid buying new switchgear that could not be reused to power the new 480-volt blower motors.	• The switchgear equipment is operating beyond its expected service life and the potential for equipment failures will increase as equipment ages. • Switchgear reliability and safety could be improved if replaced with new equipment using improved operating mechanisms and draw-out motor controller construction. • Newer draw-out style motor starters would improve access to equipment and simplify maintenance.
Alternative No. 1 – Replace East Blower Building Switchgear	• Switchgear reliability and safety would be improved. • Replacing aging medium-voltage cables would address concerns with the increasing potential for arc-fault events. • Newer draw-out style motor starters would improve access to equipment and simplify maintenance.	• If new blower equipment uses 480-volt motors, this new switchgear would need to be replaced with 480-volt VFDs and motor controls.
Alternative No. 2 – Replace West Blower Building Switchgear	• Switchgear reliability and safety would be improved. • Replacing aging medium-voltage cables would address concerns with the increasing potential for arc-fault events. • Newer draw-out style motor starters would improve access to equipment and simplify maintenance.	• If new blower equipment uses 480-volt motors, this new switchgear would need to be replaced with 480-volt VFDs and motor controls.

Economic Analysis

A summary of the opinion of probable construction costs for each alternative, as presented in the Liquid Processing Facilities Plan, is presented below in Table 2. Additional detail for Alternatives 1 and 2 are provided at the end of this document.

Table 2 – Opinion of Probable Construction Costs (2017$)

	Alternative 0	Alternative 1	Alternative 2
Total Opinion of Capital Cost	$0	$1,136,000	$902,000

Project Recommendation

The district must first select the type of future blower equipment that will be installed before deciding on which medium-voltage switchgear to replace. If future blower equipment upgrades will also use medium voltage motors, then both Alternatives No. 1 and No. 2 should be prioritized in order to upgrade all of the existing blower building switchgear lineups with new switchgear. The existing switchgear and associated medium-voltage conductors are operating beyond their expected service life, and new equipment would address reliability concerns and introduce equipment with enhanced operating and safety features.

Project Schedule:

	Start Date	Completion Date
Planning	2018	2023
Design	2024	2024
Construction	2025	2026

Financial Summary (2019$):

Total Project Cost	
District Staff & Engineering	$365,000
Contractor	$1,810,000
Total	$2,175,000

Fiscal Year Allocation (2019$):

	2023	2024	2025	2026
District staff	$5,000	$30,000	$40,000	$40,000
Consultant	$0	$160,000	$45,000	$45,000
Construction	$0	$0	$905,000	$905,000
Total	$5,000	$190,000	$990,000	$990,000

Fiscal Year Allocation (actual $):

	2023	2024	2025	2026
District staff	$5,000	$35,000	$45,000	$45,000
Consultant	$0	$185,000	$55,000	$60,000
Construction	$0	$0	$1,080,000	$1,110,000
Total	$5,000	$220,000	$1,180,000	$1,215,000