TJC and ASSOCIATES, Inc.

Structural Engineering

SCADA

Electrical Engineering

Instrumentation

Controls

Control Systems Programming

# Final Technical Memorandum

| | |
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| *To:* | *Nelson Schlater, P.E., SRT Consultants* |
| *From:* | *Jacqueline Okubo, TJC and Associates, Inc.*<br>*Paul Giorsetto, P.E., TJC and Associates, Inc.* |
| *Project Name:* | *SAM, Electrical Reliability Improvements Project* |
| *Project Number:* | *113023* |
| *Subject:* | *Replacement and Relocation of Electrical Service Equipment* |
| *File to:* | *113023-6.02* |
| *Date:* | *June 26, 2013* |

## 1. Executive Summary

The purpose of this Technical Memorandum (TM) is to evaluate the existing main electrical service equipment at the Sewer Authority of Mid-Coastside's (SAM's) Wastewater Treatment Plant (WWTP), identify and review potential alternatives for improvements, and recommend an approach to increase reliability of the WWTP's electrical service. This was brought forth by a recent fault condition at the plant that exposed the limitations of the existing electrical service equipment, location and configuration. The electrical service components consist of the PG&E pad-mounted transformer, PG&E's connecting 480 V bus duct, SAM's 480 V main service switchgear, and SAM's 480 V, 800 kW backup standby generator.

To address the situation, the following improvement alternatives were developed:

- Alternative 1: Demolish existing Switchgear A and relocate MCC-15 to this location. Create a main-tie-main configuration on existing Switchgear MD by adding a new switchgear with main, tie, and generator breakers, and feeder breakers to feed the existing loads.

- Alternative 2: Demolish existing Switchgear MD and replace with new switchgear. Provide new elevated structure at existing Temporary Chemical Area and install new switchgear on structure.

- Alternative 3: Demolish existing Switchgear MD and replace with new switchgear. Renovate Shop Building and provide elevated platform. Install new switchgear and relocate existing generator to platform.

- Alternative 4: Demolish existing Switchgear MD and replace with new switchgear. Provide new structure South of Mechanical Building 2. Install new service switchgear, relocate existing 800 kW generator in the structure, and relocate the PG&E main service padmounted transformer adjacent to the new structure.

- Alternative 5: Demolish existing Switchgear MD and replace with new switchgear. Provide new structure at open grass location next to the Administration Building. Install new service switchgear, relocate existing 800 kW generator in the structure, and relocate the PG&E main service

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padmounted transformer adjacent to the new structure.

The evaluation criteria used to evaluate the improvement alternatives were as follows:

- Safety – Extent of arc flash reduction or mitigation.
- Reliability – Modification of the main service switchgear to improve reliability by eliminating the main bus single point of failure.
- Survivability - Location of electrical switchgear, utility, and backup power sources in relation to flood level. This may be partial (one or two of the components would be relocated above flood level), or full (all of the components would be relocated above flood level).
- Opinion of probable construction cost - Cost of the construction and materials for a new structure, electrical equipment, and conduit routing and trenching.
- General impacts on WWTP operations during construction - Effect on ability to maintain daily WWTP operation-related activities such as truck deliveries and facility maintenance.
- Switchover impacts on WWTP operations during conduit and conductor installation - Switchover impact and downtime of operations during routing of conduit from relocated and new equipment to MCCs in the Electrical Room, conductor installation, and final conductor terminations.
- Demand on SAM staff time – High, medium, or low.
- Environmental impact on neighbors – Neighbors line of sight to new structures or relocated equipment, or noise produced by normally operating generator, and impact on air quality due to generator emissions.

It is recommended to replace the existing old main service switchgear with new equipment to mitigate arc flash hazards, remove a single point of failure by creating a “main-tie-main” configuration, and to address the potential for flooding of the main electrical service components by relocating them to a new structure constructed above flood level. This recommendation is further outlined as Alternative 5 in this TM.

## 2. Scope and Background

The scope of this TM is to provide a preliminary evaluation of the main electrical service at SAM’s WWTP. The intent of this effort is to provide a summary of the existing service condition, identify potential alternatives for improvements, prepare conceptual level feasibility review of alternatives, and identify a recommended approach for service upgrades to improve the WWTP’s electrical reliability.

For the purposes of the this TM, the “electrical service” will be assumed to mean the PG&E pad-mounted transformer, PG&E’s connecting 480 V bus duct, SAM’s 480 V main service switchgear, and SAM’s 480 V, 800 kW backup standby generator. The goal of the identified improvements is to enhance the reliability of the WWTP’s main electrical service and by extension, reliability of the WWTP. This TM summarizes the evaluation approach, evaluation design criteria, requirements for essential electrical project elements, viable alternatives, and the recommended alternative.

The WWTP recently had a fault condition at the main switchgear (Switchgear MD) that did not result in equipment failure, but created a sense of urgency regarding shortcomings in the existing electrical system. Of particular concern are a number of items associated specifically with Switchgear MD, including the following:

- The existing 480 V Switchgear equipment is based on Eaton Corporation (Westinghouse) DSII circuit breakers. The technology used for these circuit breakers was developed in 1996, are considered obsolete, and present a potential arc flash safety hazard.

- Spare parts, while still technically available, are quite costly, and require lead times of 3 to 4 weeks for acquisition.

- The existing configuration results in a single point of failure for the entire WWTP electrical system; single points of failure for main electrical distribution do not conform to Environmental Protection Agency (EPA) Design Criteria for Mechanical, Electric, and Fluid System and Component Reliability recommendations.

- The existing configuration, designed with a common utility and generator bus, cannot be taken out of service without a full plant outage. Any industry standard preventive maintenance procedures that include exposure to internal switchgear components require a full plant shutdown. As a result, preventive maintenance procedures are very disruptive to plant operations and extremely difficult to implement in practice.

- The existing system arc flash hazards as defined under the National Electrical Code (NEC), NFPA 70E (Standards for Electrical Safety in the Workplace), and California Occupational Safety and Health Administration (OSHA) are nearly certain to be very high. New equipment would incorporate modern design safety features to lower the arc flash level and/or provide protective operational strategies for meeting safety requirements of current codes.

- The existing equipment locations are vulnerable to flooding from the ocean, Pilarcitos Creek, or incoming sewage flows. If pumping is unavailable due to an electrical outage, flooding can occur within a matter of hours.

- Failure of the electrical service could easily result in an escalating problem, threatening other equipment and assets.

While this TM only addresses issues with the main service equipment, the process level motor control centers (MCCs) and control systems also have similar reliability issues. While beyond the scope of this TM, these issues are generally described later in this TM and ultimately should be addressed by SAM. However, a new design for the main service equipment can be developed to support future electrical and control reliability improvements.

In summary, the component design and configuration of Switchgear MD and the locations of the utility and backup power sources present a significant risk to SAM. Failure of this equipment could result in flooding of the WWTP, significant disruption or failure of the treatment process, and extended water quality violations. For these reasons, SAM staff has requested that SRT Consultants and TJC and Associates, Inc. prepare this technical memorandum.

## 3. Approach

The WWTP is built at the bottom of a gravity well for receiving the flow of incoming sewage. Furthermore, the electrical service equipment is located at the lowest part of the plant below the flood level. In the event of a flood, the PG&E transformer, (adjacent to Mechanical Building 1) would be partially submerged to some level, likely interrupting utility power feeding the main service switchgear in the Electrical Room. Similarly, the switchgear and generator are roughly at the same elevation as the utility transformer and will also likely be partially submerged, resulting in a full plant outage.

Because of this condition, it is recommended to elevate the electrical equipment components on platforms or relocate them to an elevated portion of the plant, if possible above the flood level. Five alternative locations could serve to mitigate flooding of some or all of the electrical equipment. The locations were selected to address the criteria which are described in Section 5.

A final, do nothing alternative (Alternative 0) also exists. This alternative retains the existing configuration and does not make any modifications or relocate equipment to address the reliability and safety issues of the current lineup. Alternative 0 will only be presented in Table 1 for comparison purposes and will not be discussed further in the body of this TM since it does not address any system shortcomings nor meet any of the criteria in Section 5.

## 4. Alternatives

The work under this project includes reviewing methods to do the following:

- Replace and relocate the existing 480V main service switchgear.
- Relocate the PG&E transformer and/or backup power source, to mitigate flooding.
- Modify the main electrical distribution configuration to eliminate a single point of failure.

Five site alternatives were developed:

1. Location Vacated by Demolition of existing Switchgear A
2. Elevated Structure at existing Temporary Chemical Area
3. Elevated Platform in Renovated WWTP Shop Building
4. New Structure South of Mechanical Building 2
5. New Structure at Open Location next to the Administration Building

Figure 6 shows a site plan of the WWTP with the five alternative locations and preliminary conduit routing identified.

## 5. Evaluation Criteria

The evaluation criteria for evaluating the alternatives are as follows:

- Safety – Extent of arc flash reduction or mitigation.
- Reliability – Modification of the main service switchgear to improve reliability by eliminating the main bus single point of failure.
- Survivability - Location of electrical switchgear, utility, and backup power sources in relation to vulnerability to flooding. This may be partial (one or two of the components would be relocated above flood level), or full (all of the components would be relocated above flood level).
- Opinion of probable construction cost - Cost of the construction and materials for a new structure, electrical equipment, and conduit routing and trenching.
- General impacts on WWTP operations during construction - Effect on ability to maintain daily WWTP operation-related activities such as truck deliveries and facility maintenance.
- Switchover impacts on WWTP operations during conduit and conductor installation - Switchover impact and downtime of operations during routing of conduit from relocated and new equipment to MCCs in the Electrical Room, conductor installation, and final conductor terminations.
- Demand on SAM staff time – High, medium, or low.
- Environmental impact on neighbors – Neighbors line of sight to new structures or relocated equipment, or noise produced by normally operating generator, and impact on air quality due to generator emissions.

## 6. Discussion

Figure 1 presents a single line diagram of the current configuration, while Figure 2 illustrates an ultimate plant-wide preliminary single line diagram for the proposed configuration to eliminate single points of failure. Figure 1 demonstrates that the electrical service addressed in this TM is not the only potential single point of failure within the WWTP. Specifically, critical process equipment served by single MCC lineups are also single points of failure and vulnerable to flooding. Similarly, while not shown on the Figure or described in detail, the WWTP’s control system programmable logic controllers are located in areas subject to flooding and represent another risk to WWTP operations during emergency conditions.

For the purposes of this TM, implementation of the electrical improvements is assumed to occur in two or three phases as required to coordinate the reliability improvements with costs. The initial phase encompasses the main electrical switchgear and is outlined in this technical memorandum. Subsequent phases would encompass future improvements to eliminate single points of failure on electrical equipment (i.e., MCCs) serving critical process equipment and/or control system component relocation or enhancements to eliminate vulnerability to flooding.

This phases approach is common to all the service upgrade alternatives. Figures 3 and 4, show preliminary single line diagrams for the proposed “main-tie-main” configuration for the proposed work to reconfigure the existing switchgear (Switchgear "MD"). Figure 3 is exclusive to Alternative 1, while Alternatives 2 through 5 are presented by Figure 4.

Current industry standard practice for WWTP electrical distribution conforms to EPA Design Criteria recommendations, which include the following:

- Incorporation of dual, independent power sources.
- "Main-tie-main" configuration - two separate and independent feeders of electrical power to critical equipment.
- Splitting of critical loads serving the same function in order to eliminate single points of failure in power distribution systems.

Implementing these recommendations would also improve service maintenance capability by allowing SAM staff to shut down portions of the plant as part of a planned maintenance strategy. That is, the proposed electrical system modifications eliminate the need for a full plant power outage for performing preventive maintenance functions. This approach has also been incorporated in all five alternatives.

Switchgear "MD" is based on Westinghouse DSII circuit breakers. These circuit breakers are old technology, have limited sources for spare parts, and present a potential arc flash safety hazard. Installation of new switchgear with remote operation and remote racking capabilities would mitigate this safety hazard. In addition, updated circuit breakers can incorporate other protective features (e.g., differential protection and zone selective interlocking) to reduce arc flash levels at other locations. These safety improvements are common to all alternatives except Alternative 1 (reuse of the existing switchgear.)

## 7. Alternative Descriptions and Evaluation

The five site alternatives to increase the plant's electrical system reliability are described below, and presented in Figure 6. Table 1 summarizes an evaluation of these alternatives using qualitative comparisons: flood mitigation, opinion of probable construction cost, maintenance of operations during construction, impact of conduit routing on existing operations, SAM staff time requirements, visual/noise impact on neighbors, and safety improvement.

Figure 7 presents the extent of a 3-foot flood in the vicinity of Mechanical Building 1, where the plant electrical switchgear is located. The flooded area is represented by shading; hatching represents buildings in the area that will be partially flooded. A 3-foot flood level was selected as a representative level that would most likely damage the electrical switchgear equipment. Based on the average dry weather flow rate of 3.2 MGD, it would take approximately 11.50-hours to flood the area in the vicinity of the electrical switchgear equipment (Montara and Portola storage facilities provide 6-hours of storage at this flow rate; and the switchgear area reaches 3-foot flood level in 5.5 hours at this flow rate). For a wet weather flow rate of 11 MGD, it would take approximately 3.25-hours to achieve the 3-foot flooding in the vicinity where the switchgear is located (Montara and Portola storage facilities provide 1.75-hours of storage at this flow rate; and the switchgear area reaches 3-foot flood level in 1.5 hours at this flow rate).

*Alternative 1: Location Vacated by Demolition of (E) Switchgear A (See Figure 3)*

Alternative 1 would include the following:

- Demolish old Switchgear A and relocate the existing MCC-15 to this vacated location.
- Create a main-tie-main configuration on Switchgear MD by adding a new switchgear with main, tie, and generator breakers, and feeder breakers to feed the existing loads.
- Transfer all the loads from Switchgear A and split the loads between Bus A and Bus B of Switchgear MD.
- Transfer half of the existing loads, along with the existing generator on Switchgear MD, to a new switchgear lineup—Bus B of Switchgear MD.

*Alternative 2: Elevated Structure at (E) Temporary Chemical Area (See Figures 4 and 5)*

Alternative 2 would include the following:

- Demolish entire Switchgear MD and replace with new switchgear.
- Provide a new elevated structure constructed at existing Temporary Chemical Area. Structural seismic assessment and potential upgrades to the existing structure may be required.
- Install new switchgear on the elevated structure.
- Leave the existing transformer and generator in place below the flood level.

*Alternative 3: Elevated Platform in Renovated WWTP Shop Building (See Figures 4 and 5)*

Alternative 3 would include the following:

- Demolish entire Switchgear MD and replace with new switchgear.
- Renovate existing WWTP Shop Building and provide elevated platform. Structural seismic assessment and potential upgrades to the existing structure may be required.
- Install new switchgear and relocate existing generator from Mechanical Building 1 to elevated platform.
- Leave the existing transformer in place, below the flood level.

*Alternative 4: New Structure South of Mechanical Building 2 (See Figures 4 and 5)*

Alternative 4 would include the following:

- Demolish entire Switchgear MD and replace with new switchgear.
- Provide new structure adjacent to the south side of Mechanical Building 2.

- Install new switchgear, relocate existing generator in the structure, and relocate utility service transformer adjacent to the structure. Coordination with PG&E to relocate the transformer may require lead times of 6 months or longer.

- Route PG&E service feeder from the transformer to the switchgear and feeder conductors from the switchgear to the existing MCCs in the Electrical Room in Mechanical Building 1.

- Possible overhead bus installation as an alternative to a duct bank, as the route for the new duct bank from the switchgear to existing MCCs in Mechanical Building 1 may be congested with existing underground pipework: this would be expensive.

*Alternative 5: New Structure at Open Location next to the Administration Building (See Figures 4 and 5)*

Alternative 5 would include the following:

- Demolish entire Switchgear MD and replace with new switchgear.

- Provide new structure at open grass location next to the Administration Building.

- Install new switchgear, relocate generator in the structure, and relocate utility service transformer adjacent to the structure. Coordination with PG&E to relocate the transformer may require lead times of 6 months or longer.

- Route feeders from the switchgear to existing MCCs in Mechanical Building 1.

## 8. Cost Considerations

At this conceptual stage of the project, we have generally considered the site alternatives and prepared conceptual level opinions of probable construction costs for each alternative. Table 1 shows these opinions of costs for each alternative. More detailed opinions of probable construction costs would be developed during the design stage of the project.

## 9. Schedule

Construction schedule is primarily limited by time for utility relocation of the main service primary and secondary conductors and installation of the service transformer. Lead time for some of the equipment (480V power switchgear) can be extensive roughly 16 weeks after submittal approval) may also be a critical path element that constrains the construction schedule. Lastly, work at the plant will benefit if operational impacts are limited to dry weather periods when flows are low.

A general schedule without any incentives or acceleration strategies can be expected to be:

- Two months - Conceptual Engineering Report: developing sequencing and constraints, site investigations, circuit routing, initial PG&E coordination, and performing selective potholing., and  done)
- Four months - Final construction documents: 60%, 90% and final submittals

- Two months – SAM board review, approval, and bidding
- 20 months – construction time to beneficial occupancy

A benefit of this schedule is allowing project costs to be spread across multiple fiscal years. Should SAM determine that quicker installation is desired, removal of a design submittal, prepurchase of critical lead time equipment, SAM early performance of PG&E engineering coordination, and/or incentives/penalties to achieve accelerated equipment delivery are options that could be applied to speed completion of the work.

While a design/build delivery method could be considered to expedite the project, it does not appear to be a good fit. This conclusion is based on the complexity and sensitivity of operations to the availability of the equipment and the very congested underground utility conditions along the anticipated conduit routing alignments. These aspects make development of a sound design/build proposal difficult and represent additional risk for SAM.

## 10. Recommendations

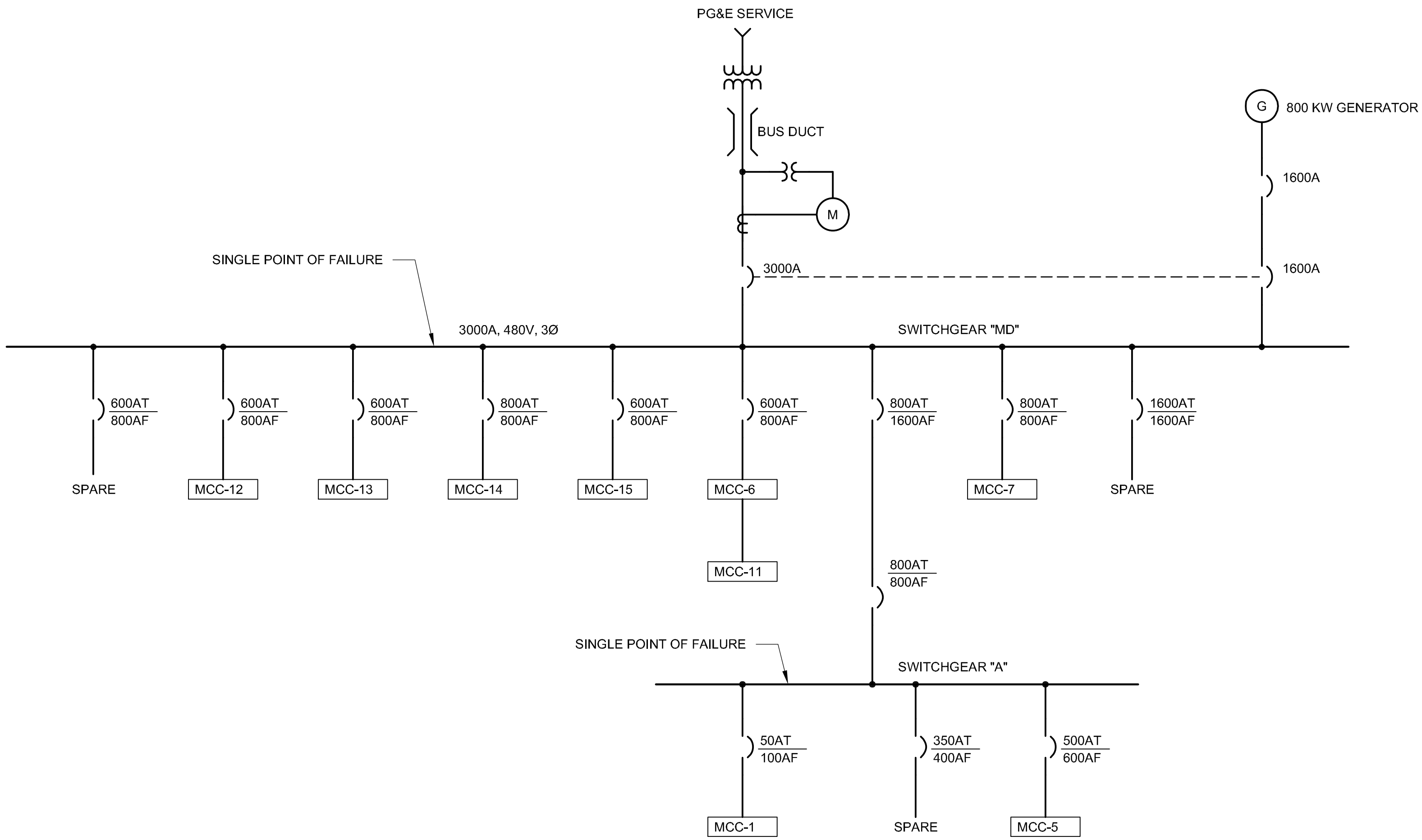
Based on the alternative evaluation, relocation of all three electrical equipment components to a new structure at a higher elevation (Alternative 5) is the recommended alternative for addressing the key concerns and issues related to the electrical service.

## 11. References


- Environmental Protection Agency (EPA) Design Criteria for Mechanical, Electric, and Fluid System and Component Reliability

- National Fire Protection Agency – NFPA 70E: Standard for Electrical Safety in the Workplace

- National Fire Protection Agency – NFPA 70: National Electrical Code

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SRT, SAM WWTP ELECTRICAL SUPPORT

FIGURE 1
SWITCHGEAR MD: EXISTING SINGLE LINE DIAGRAM

THIS BAR SCALES EXACTLY ONE-HALF INCH AT FULL SCALE

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FIG-1

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TJC and ASSOCIATES, Inc.

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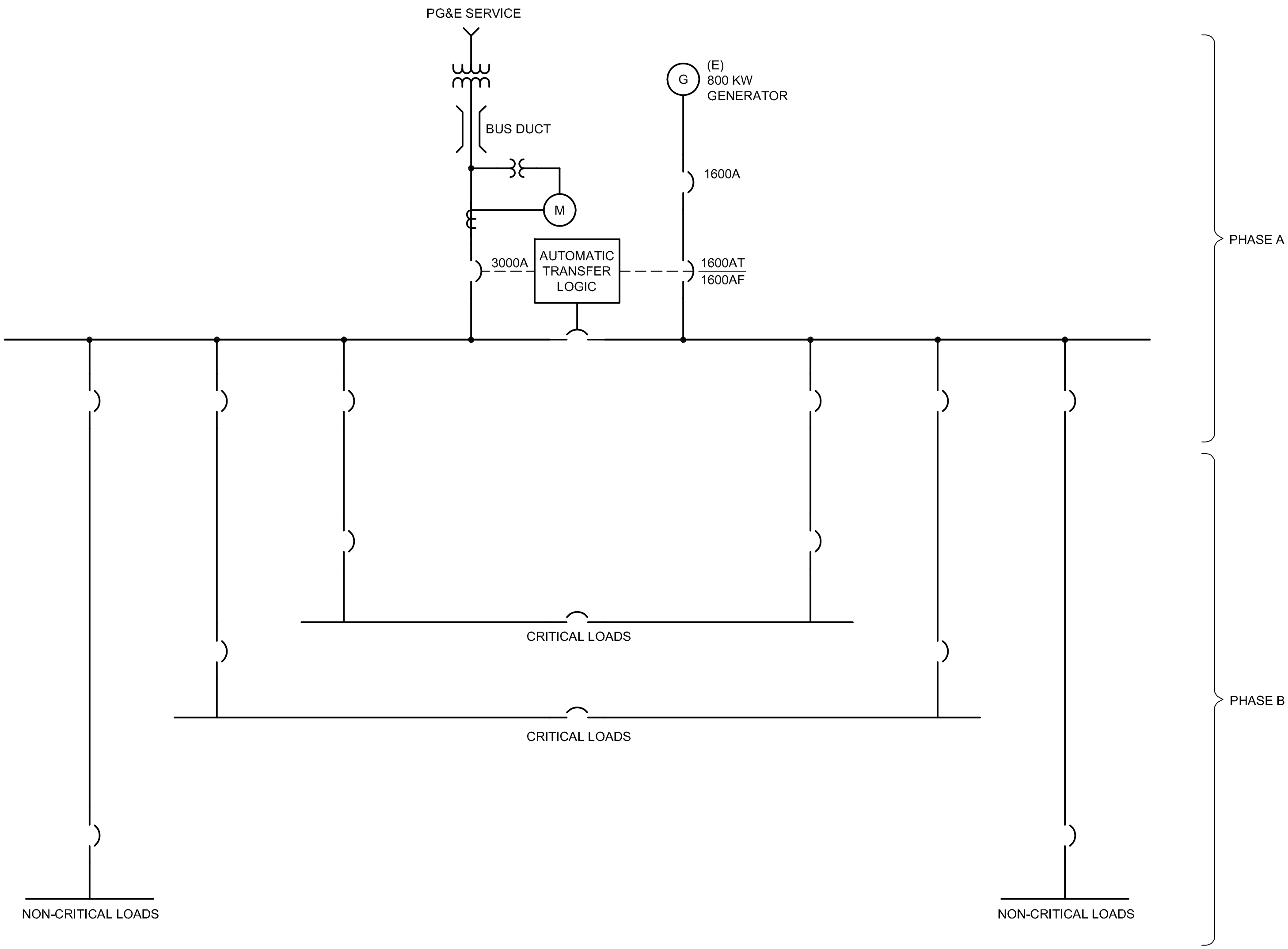


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FIGURE 2
PRELIMINARY MAIN PLANT SINGLE LINE DIAGRAM

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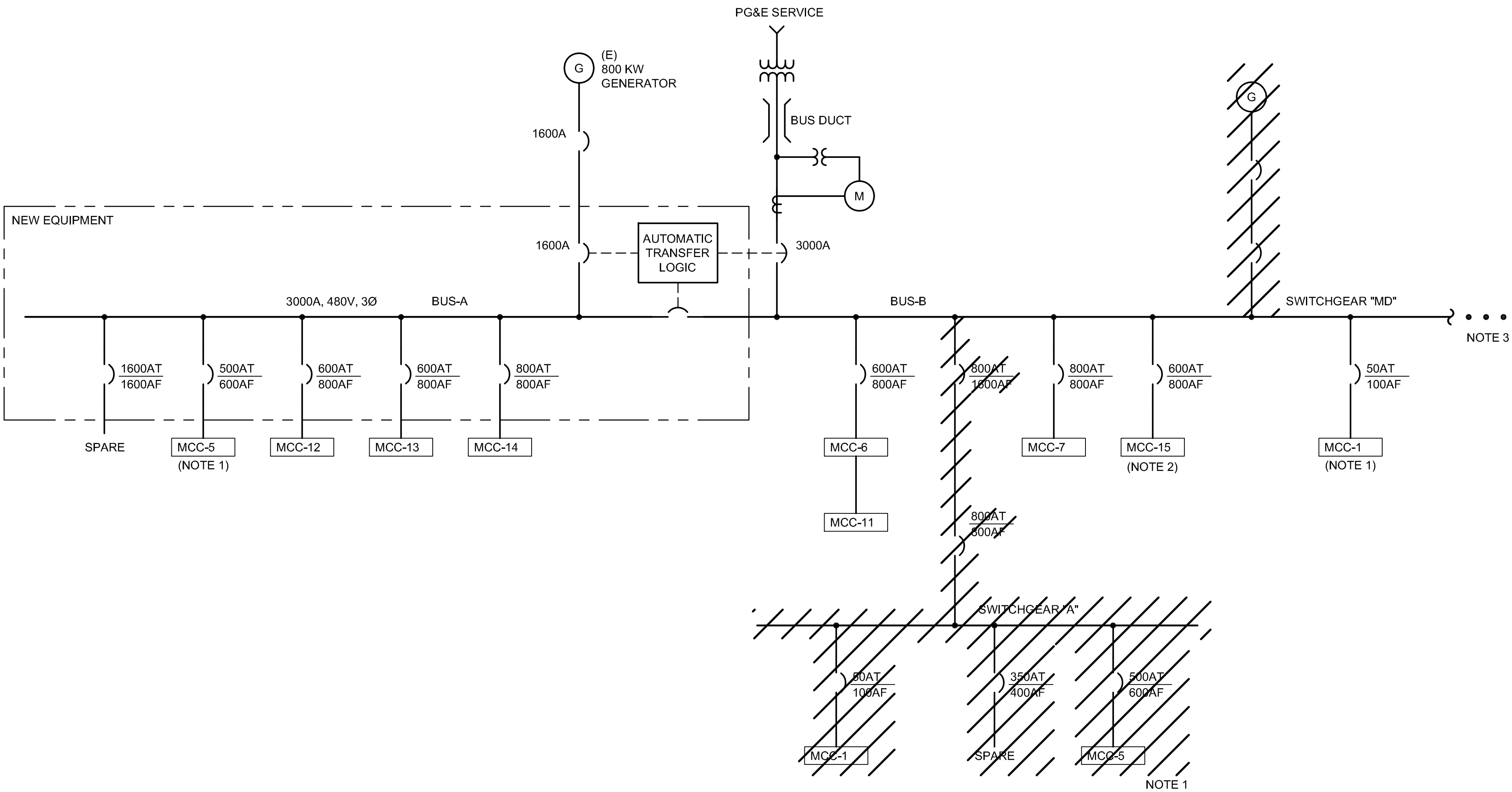


NOTES:

1. TRANSFER ANCILLARY LOADS, AND MCC-1 AND MCC-5 FEEDERS FROM SWITCHGEAR A TO SWITCHGEAR MD. DEMOLISH SWITCHGEAR A.
2. RELOCATE MCC-15 TO SPACE VACATED BY SWITCHGEAR A.
3. TRANSFER EXISTING SWITCHGEAR MD LOADS TO NEW SWITCHGEAR AS SHOWN. CONVERT EXISTING BREAKERS TO SPARES.

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FIGURE 3
SWITCHGEAR MD SINGLE LINE DIAGRAM MODIFICATIONS
ALTERNATIVE 1

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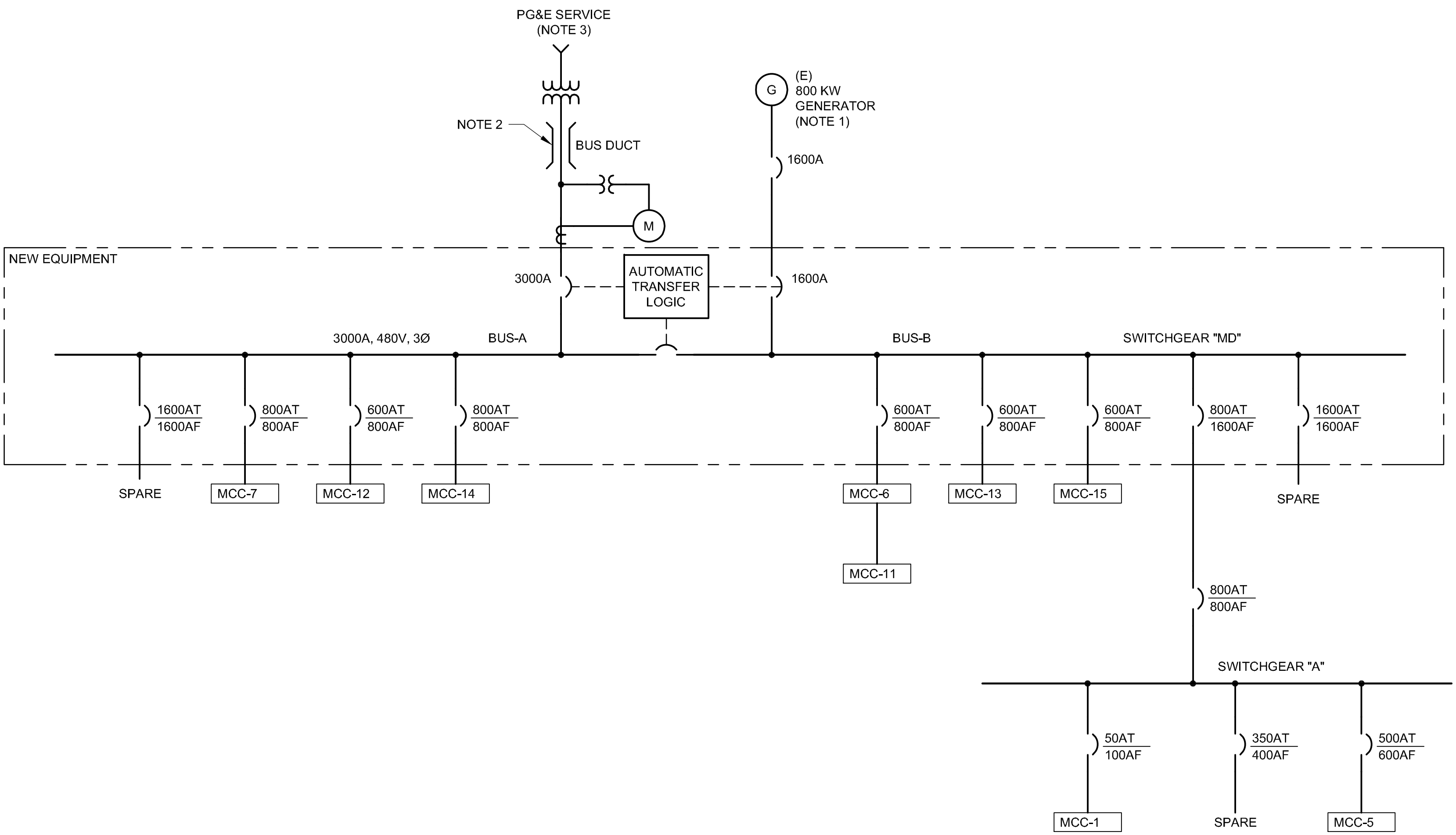


NOTES:

1. RELOCATE EXISTING GENERATOR TO ELEVATED LOCATION.
2. REUSE EXISTING PG&E BUS DUCT UNDER ALTERNATIVES 2 AND 3; PROVIDE NEW CONCRETE DUCT BANK UNDER ALTERNATIVES 4 AND 5.
3. PG&E SERVICE RELOCATED TO ELEVATED LOCATION UNDER ALTERNATIVE 5.

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SRT, SAM WWTP ELECTRICAL SUPPORT

FIGURE 4
SWITCHGEAR MD SINGLE LINE DIAGRAM
ALTERNATIVES 2 TO 5

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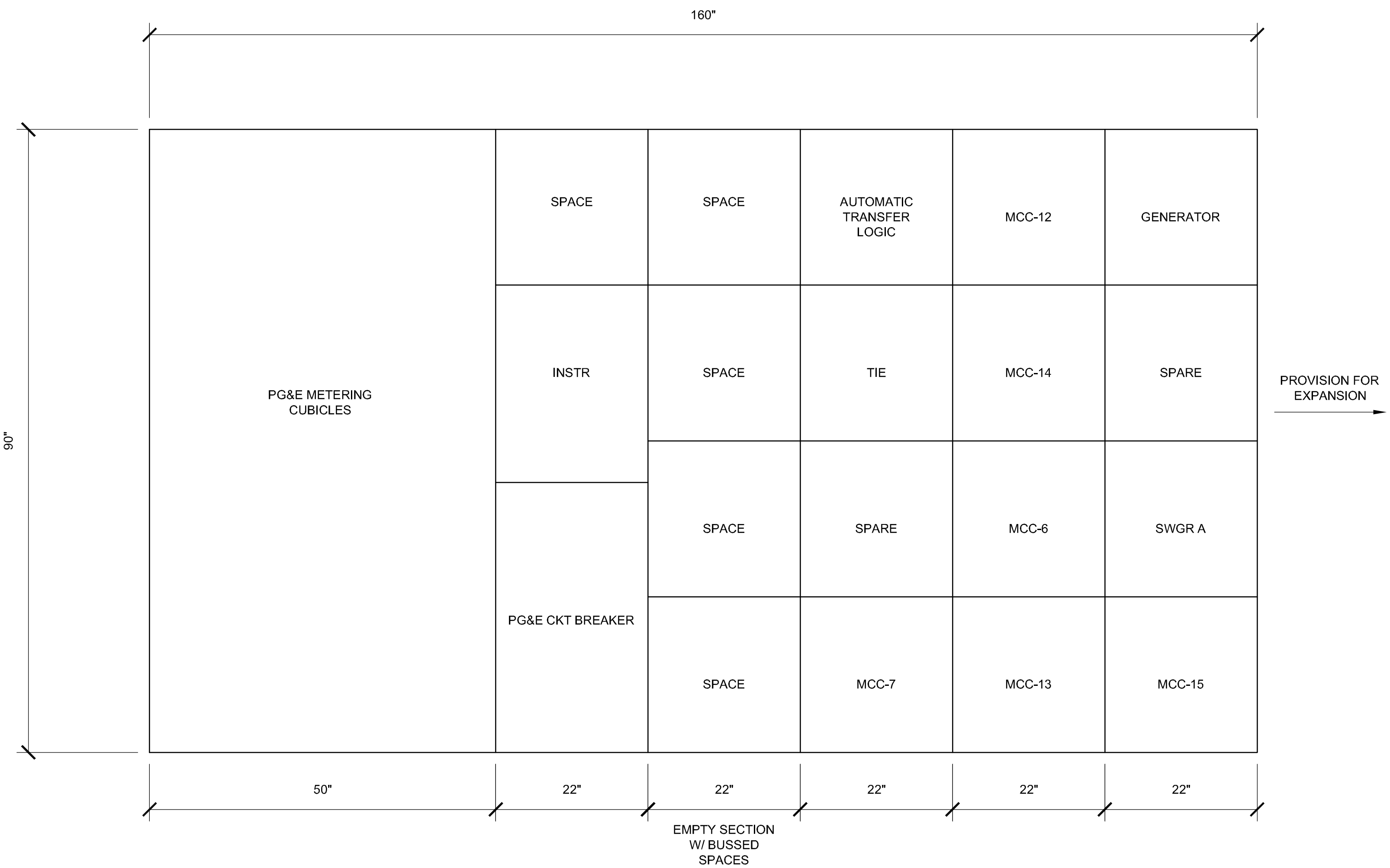


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FIGURE 5
SWITCHGEAR MD ELEVATION
ALTERNATIVES 2 TO 5

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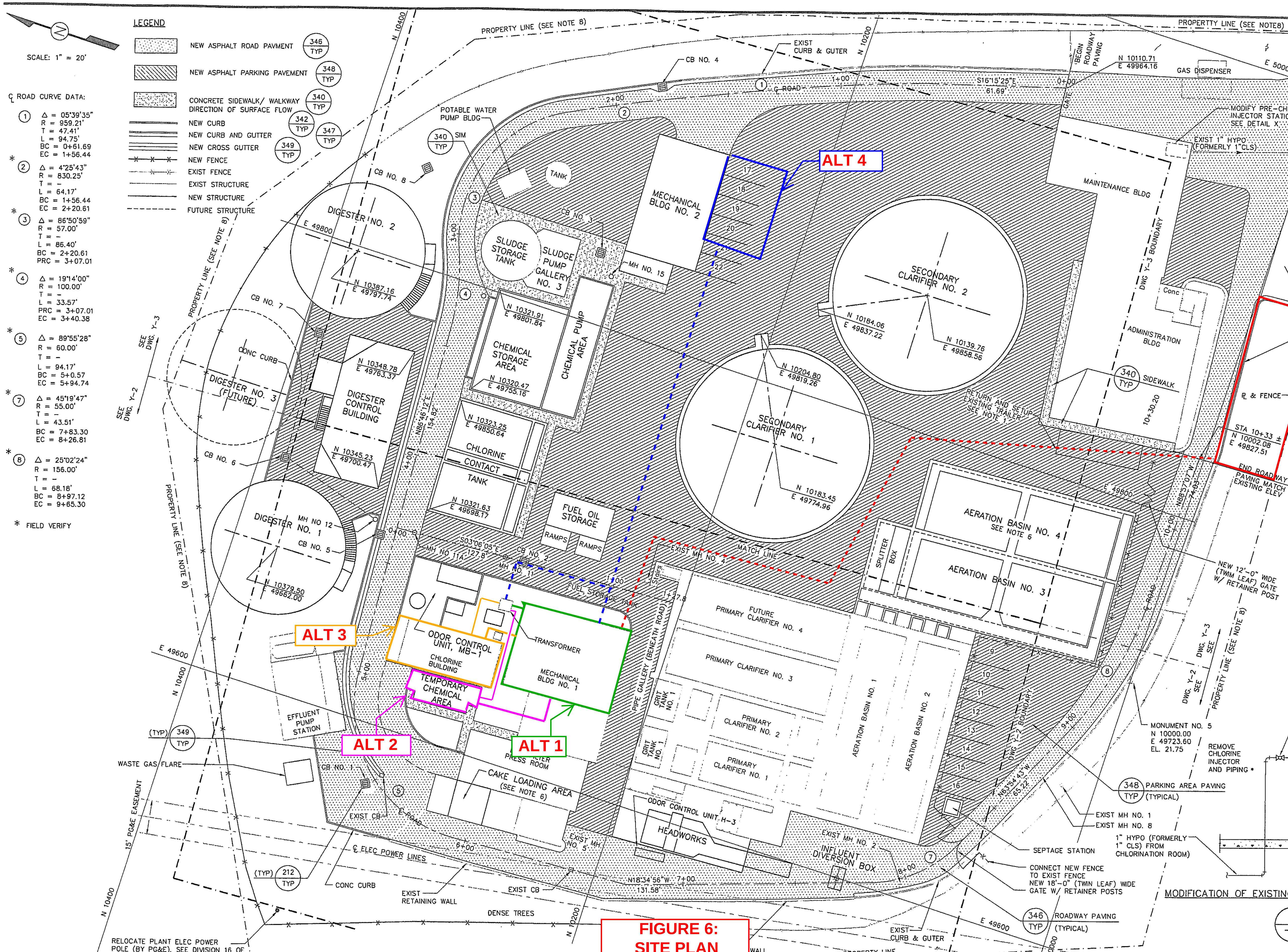


FIGURE 6: SITE PLAN

LEGEND

- NEW ASPHALT ROAD PAVMENT (346 TYP)
- NEW ASPHALT PARKING PAVEMENT (348 TYP)
- CONCRETE SIDEWALK/ WALKWAY DIRECTION OF SURFACE FLOW (340 TYP, 342 TYP)
- NEW CURB (347 TYP)
- NEW CURB AND GUTTER (349 TYP)
- NEW CROSS GUTTER
- NEW FENCE
- EXIST FENCE
- EXIST STRUCTURE
- NEW STRUCTURE
- FUTURE STRUCTURE

℄ ROAD CURVE DATA:

1. Δ = 05°39'35", R = 959.21', T = 47.41', L = 94.75', BC = 0+61.69, EC = 1+56.44
2. * Δ = 4°25'43", R = 830.25', T = -, L = 64.17', BC = 1+56.44, EC = 2+20.61
3. * Δ = 86°50'59", R = 57.00', T = -, L = 86.40', BC = 2+20.61, PRC = 3+07.01
4. * Δ = 19°14'00", R = 100.00', T = -, L = 33.57', PRC = 3+07.01, EC = 3+40.38
5. * Δ = 89°55'28", R = 60.00', T = -, L = 94.17', BC = 5+0.57, EC = 5+94.74
7. * Δ = 45°19'47", R = 55.00', T = -, L = 43.51', BC = 7+83.30, EC = 8+26.81
8. * Δ = 25°02'24", R = 156.00', T = -, L = 68.18', BC = 8+97.12, EC = 9+65.30

* FIELD VERIFY

NOTE:

1. RETURN EXISTING TRAILER FROM OFF-SITE LOCATION (SEE NOTE 3, DWG DM-1) AND SETUP AT LOCATION SHOWN. RESTORE ELECTRICAL, SEWER, WATER AND OTHER UTILITIES.
2. PAVEMENT SHALL BE 0.08 FEET LOWER THAN FINISHED FLOOR ELEVATIONS AT ALL DOOR THRESHOLDS. PAVEMENT SHALL BE SLOPED TO DRAIN AWAY FROM ALL DOORS.
3. UNLESS OTHERWISE NOTED ALL CURB AND GUTTER SHALL BE PER TYPICAL DETAIL 347.
4. PAINT 4" WIDE STRIPES ON EACH SIDE OF PAVEMENT (EXCEPT WHERE CURBED) BETWEEN ℄ STA. 4+75 AND 10+29)
5. PAINT PARKING STALL STRIPES ON PAVEMENT WHERE INDICATED. USE 4" WIDE WHITE STRIPE.
6. LOCATION COORDINATES NOT GIVEN BECAUSE THESE STRUCTURES ARE CONTIGUOUS WITH EXISTING STRUCTURES. SEE APPROPRIATE DWGS. FOR LAYOUT DETAILS
7. SEE DRAWING Y-1B FOR FINISHED GRADING ELEVATIONS AND DRAINAGE DETAILS.
8. PROPERTY LINE ESTABLISHED FROM FIELD SURVEY BY TOWILL INC. INFORMATION IS AVAILABLE TO CONTRACTOR UPON REQUEST TO OWNER.

RECORD DRAWINGS

THESE RECORD DRAWINGS HAVE BEEN PREPARED BASED IN PART ON INFORMATION PROVIDED BY OTHERS.

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| 5/2000 | JF | RECORD DRAWING | |

DESIGNED JCI\GAR · DRAWN RG · CHECKED KAG · DATE APR 1996

carollo engineers

SEWER AUTHORITY MID-COASTSIDE

EXPANSION OF REGIONAL WASTEWATER TREATMENT FACILITY

YARD

SITE PLAN

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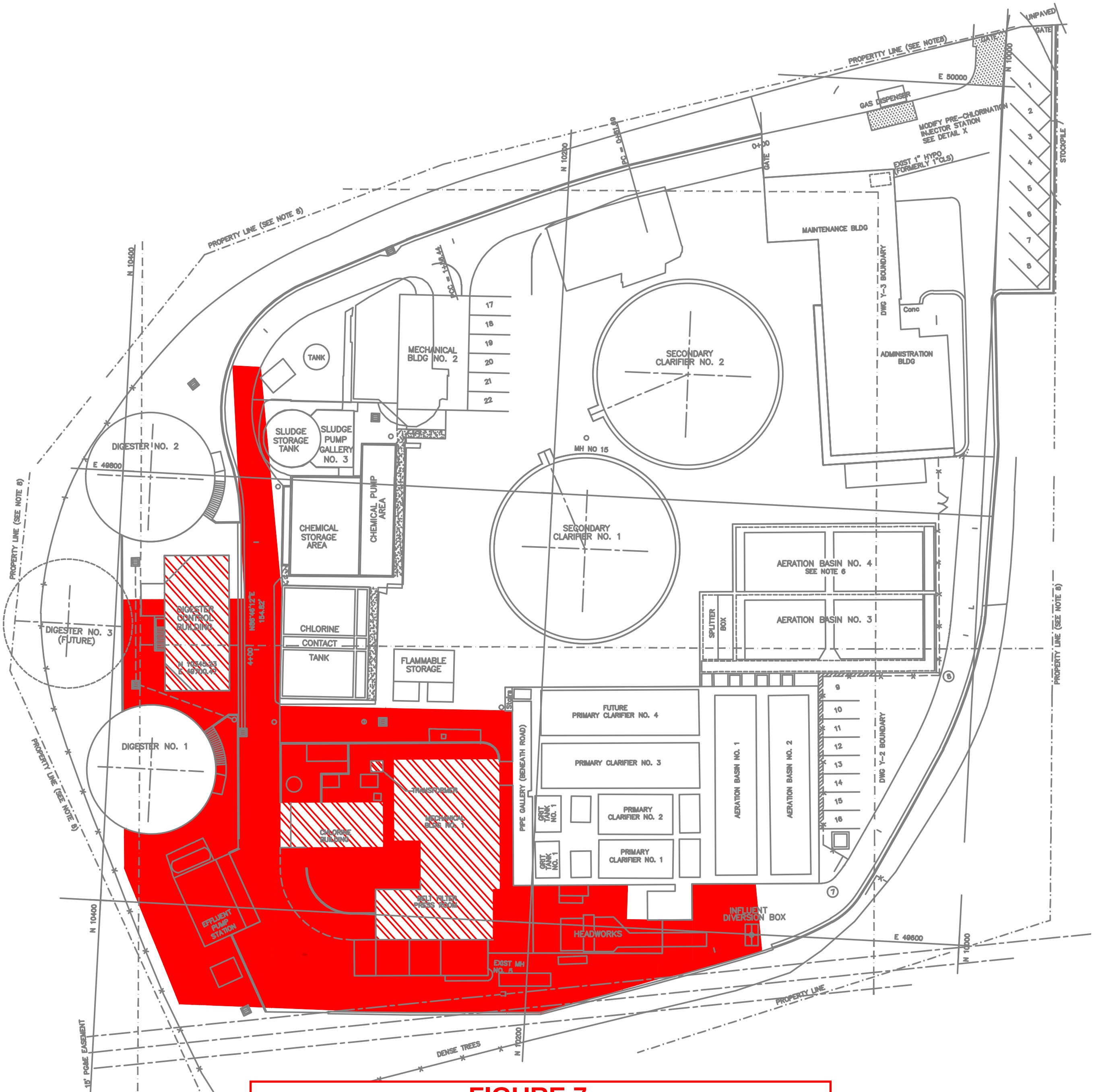
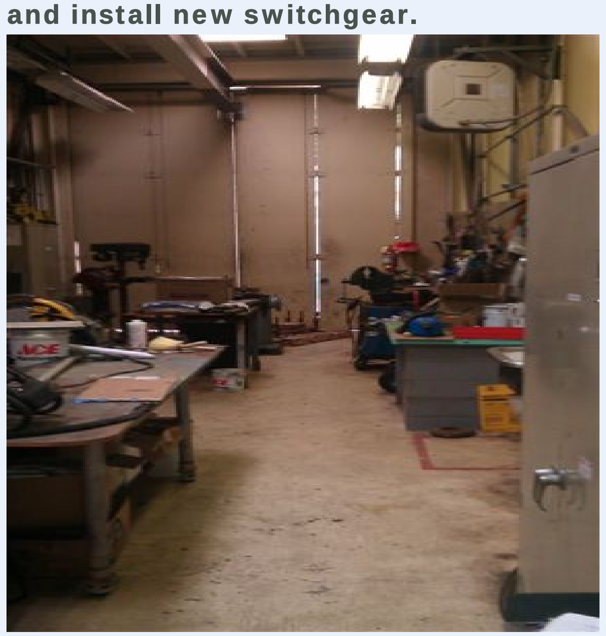



**FIGURE 7:**
**EXTENT OF 3-FOOT FLOOD IN VICINITY OF BUILDING HOUSING PLANT SWITCHGEAR**

| TABLE 1: COMPARISON OF SERVICE, SWITCHGEAR AND GENERATOR LOCATION ALTERNATIVES | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ALTERNATIVE LOCATIONS | SAFETY | RELIABILITY | SURVIVABILITY | OPINION OF PROBABLE CONSTRUCTION COST (NOTE 1) | SITE IMPACTS | | | ENVIRONMENTAL IMPACT ON NEIGHBORS |
| | | | | | MAINTENANCE OF OPERATION DURING CONSTRUCTION | IMPACT OF CONDUIT ROUTING ON EXISTING OPERATIONS | SAM STAFF TIME REQUIREMENTS | |
| **0 – Current location. No modifications to equipment configuration, or relocation of equipment.** | None. Reuse of old switchgear. | Low. Switchgear MD main bus remains a single point of failure | None. Retains present location of transformer, generator and switchgear in area subject to flooding. | N/A | N/A | N/A | N/A | No change to existing conditions |
| **1 – Location vacated by demolition of (E) Switchgear A. Relocate MCC-15 to this location and extend Switchgear MD to include tie breaker and secondary generator breaker.**  | None. Reuse of old switchgear. | High. Main-tie-main configuration eliminates single point of failure on Switchgear MD | None. Retains present location of transformer, generator and switchgear in area subject to flooding. | Switchgear: $ 250,000<br>Misc. Conduit/Wiring: $ 100,000<br>Control Systems Upgrade: $150,000<br>Existing Equipment Relocation and Modifications: $150,000<br>Sub Total: $650,000<br>33% Contingency: $ 215,000<br>Design & Engineering: $195,000<br>___________________<br>Total: $ 1.06 million | Low. Construction would be limited to the electrical room in Mechanical Building 1 | High. Downtime of many processes would be required to relocate loads and associated conduits on Switchgear A and MCC-15, and extension of Switchgear MD. | High | Aesthetic: Not in line of neighbors.<br><br>Noise: Generator noise production will not change.<br><br>Air quality: Low. Generator located far from neighbors |

| TABLE 1: COMPARISON OF SERVICE, SWITCHGEAR AND GENERATOR LOCATION ALTERNATIVES | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ALTERNATIVE LOCATIONS | SAFETY | RELIABILITY | SURVIVABILITY | OPINION OF PROBABLE CONSTRUCTION COST (NOTE 1) | SITE IMPACTS | | | ENVIRONMENTAL IMPACT ON NEIGHBORS |
| | | | | | MAINTENANCE OF OPERATION DURING CONSTRUCTION | IMPACT OF CONDUIT ROUTING ON EXISTING OPERATIONS | SAM STAFF TIME REQUIREMENTS | |
| **2 – New elevated structure at location of (E) temporary chemical area. Relocate generator, if possible, and install new switchgear.**<br> | Mitigation of arc flash hazards due to use of new equipment with protective features and/or remote operation and racking mechanisms. | High.<br>Main-tie-main configuration eliminates single point of failure on Switchgear MD | Partial. Spatial limitation. Only switchgear would be elevated above flood level; transformer and generator would remain in a potential flood area. | Switchgear:<br>$ 350,000<br>Misc. Conduit/Wiring:<br>$ 125,000<br>Control Systems Upgrade:<br>$ 150,000<br>Mezzanine Structure:<br>$ 25,000<br>Sub-Total:<br>$650,000<br>33% Contingency:<br>$ 215,000<br>Design & Engineering:<br>$195,000<br>___________________<br>Total: $ 1.06 million | Low. Construction would be limited to the electrical room in Mechanical Building 1 and containment area. This would be out of the way of access roads for delivery. | Low. Installation of new switchgear and conduits would allow for plant processes to stay online during construction, and would allow phasing of process downtime as new connections from the new switchgear are made to existing MCCs. | Medium | Aesthetic: Not in line of sight of neighbors.<br><br>Noise: Generator noise production at elevated location could result in changed noise perception from neighbors.<br><br>Air quality: Low. Generator located far from neighbors |
| **3 – Elevated platform in (E) renovated WWTP Shop Building. Relocate generator and install new switchgear.**<br> | Mitigation of arc flash hazards due to use of new equipment with protective features and/or remote operation and racking mechanisms. | High.<br>Main-tie-main configuration eliminates single point of failure on Switchgear MD | Partial. Only generator and switchgear would be elevated above flood level; transformer would remain in a potential flood area. | Switchgear:<br>$ 330,000<br>Misc. Conduit/Wiring:<br>$125,000<br>Control Systems Upgrade:<br>$ 150,000<br>Mezzanine Structure:<br>$ 40,000<br>Sub-Total:<br>$645,000<br>33% Contingency:<br>$ 215,000<br>Design & Engineering:<br>$195,000<br>___________________<br>Total: $ 1.06 million | Low. Construction would be limited to the electrical room in Mechanical Building 1 and Shop Building. This would be out of the way of access roads for delivery. | Low. Installation of new switchgear and conduits would allow for plant processes to stay online during construction, and would allow phasing of process downtime as new connections from the switchgear are made to existing MCCs. | Medium | Aesthetic: Not in light of sight of neighbors.<br><br>Noise: Generator noise production at elevated location could result in changed noise perception from neighbors.<br><br>Air quality: Low. Generator located far from neighbors |

| TABLE 1: COMPARISON OF SERVICE, SWITCHGEAR AND GENERATOR LOCATION ALTERNATIVES | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ALTERNATIVE LOCATIONS | SAFETY | RELIABILITY | SURVIVABILITY | OPINION OF PROBABLE CONSTRUCTION COST (NOTE 1) | SITE IMPACTS | | | ENVIRONMENTAL IMPACT ON NEIGHBORS |
| | | | | | MAINTENANCE OF OPERATION DURING CONSTRUCTION | IMPACT OF CONDUIT ROUTING ON EXISTING OPERATIONS | SAM STAFF TIME REQUIREMENTS | |
| **4 – New structure South of Mechanical Building 2. Relocate generator and transformer, and install new switchgear.**  | Mitigation of arc flash hazards due to use of new equipment with protective features and/or remote operation and racking mechanisms. | High. Main-tie-main configuration eliminates single point of failure on Switchgear MD | Best: Switchgear, generator and transformer would be elevated above flood level. | Switchgear: $ 330,000<br>Trenching & Backfill: $ 48,000<br>Misc. Conduit/Wiring: $ 200,000<br>Control Systems Upgrade: $ 150,000<br>CMU Structure 40'-0" x 25'-0": $ 400,000<br>Transformer Relocation: $20,000<br>Sub-Total: $1,150,000<br>33% Contingency: $ 380,000<br>Design & Engineering: $350,000<br>___________________<br>Total: $ 1.90 million | Medium. Digging and repaving of roads would mainly be on paths that are not essential to primary operations, such as delivery of chemicals. | Low. Installation of new switchgear and conduits would allow for plant processes to stay online during construction, and would allow phasing of process downtime as new connections from the switchgear are made to existing MCCs. | Medium | Aesthetic: In direct line of sight of neighbors.<br><br>Noise: Noise from new generator location could be a concern to neighbors.<br><br>Air quality: High. Generator located near neighbors |

**TABLE 1: COMPARISON OF SERVICE, SWITCHGEAR AND GENERATOR LOCATION ALTERNATIVES**

| ALTERNATIVE LOCATIONS | SAFETY | RELIABILITY | SURVIVABILITY | OPINION OF PROBABLE CONSTRUCTION COST (NOTE 1) | SITE IMPACTS | | | ENVIRONMENTAL IMPACT ON NEIGHBORS |
|---|---|---|---|---|---|---|---|---|
| | | | | | MAINTENANCE OF OPERATION DURING CONSTRUCTION | IMPACT OF CONDUIT ROUTING ON EXISTING OPERATIONS | SAM STAFF TIME REQUIREMENTS | |
| **5 – New structure at open location next to administration building. Relocate transformer and generator, and install new Switchgear.**<br> | Mitigation of arc flash hazards due to use of new equipment with protective features and/or remote racking mechanisms. | High.<br>Main-tie-main configuration eliminates single point of failure on Switchgear MD | Best: Switchgear, generator and transformer would be elevated above flood level. | Switchgear: $ 330,000<br>Trenching & Backfill: $ 50,000<br>Misc. Conduit/Wiring: $ 250,000<br>Control Systems Upgrade: $ 150,000<br>CMU Structure 40'-0" x 25'-0": $ 400,000<br>Transformer Relocation: $ 20,000<br>Sub-Total: $1,200,000<br>33% Contingency: $ 400,000<br>Design & Engineering: $360,000<br>_________________<br>Total: $ 1.96 million | Medium. Digging and repaving of access roads may hinder plant operations such as chemical deliveries and SAM staff mobility. | Low. Installation of new switchgear and conduits would allow for plant processes to stay online during construction, and would allow phasing of process downtime as new connections from the switchgear are made to existing MCCs. | Medium | Aesthetic: Not in direct line of sight of neighbors.<br><br>Noise: Noise from new generator location may be a concern to neighbors.<br><br>Air quality: Low. Generator located far from neighbors<br><br>NOTE: Generator located adjacent to administration building. Aesthetics, noise and air quality impacts may be a concern to SAM staff. |

NOTES

1. 33% CONTINGENCY AND 30% DESIGN AND ENGINEERING COSTS APPLIED TO SUB-TOTAL OF LINE ITEMS.