FINAL REPORT

South Bay Maintenance Facility (SBMF) ZEB Master Plan

Metropolitan Transit System (MTS)

San Diego, CA

Prepared by:

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wsp

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CHAPTER 1 – INTRODUCTION

INTRODUCTION

BACKGROUND

On Friday, December 14, 2018, the California Air Resources Board (CARB) adopted the Innovative Clean Transit (ICT) regulation that has been in development for almost four years. The ICT requires California transit agencies to begin purchasing Zero Emission Buses (ZEBs) as early as 2023, with the goal of transitioning all transit buses to zero emission technology by 2040. Today, that zero emission technology includes Battery Electric Buses (BEBs) and Fuel Cell Electric Buses (FCEBs). San Diego Metropolitan Transit Systems (MTS) has already started paving the way for this transition, due to its commitment to continue providing safe, reliable transit service while also striving to improve air quality in the region. MTS's Zero-Emissions Bus Pilot Program has already taken steps toward accomplishing the goals set forth in the ICT. Further, this Master Plan provides a template for charging 253 new ZEBs to be purchased in accordance with CARB requirements at the South Bay Maintenance Facility (SBMF) in Chula Vista, California, and to help MTS develop and implement a ZEB rollout plan (required by ICT) with MTS's next purchase of ZEBs. In addition, this project will set the tone for future implementation of ZEB infrastructure at MTS's other bus facilities at the Kearny Mesa Division (KMD), East County Bus Maintenance Facility (ECBMF), Copley Park Maintenance Facility (CPMF), and Imperial Avenue Division (IAD)

For SBMF, MTS will have procured an initial 60-foot ZEB fleet of 12 buses by March 2022. Beyond March 2022, MTS will comply with state regulations requiring 25% ZEB purchases starting in 2023, transitioning to 50% at a later date.

MTS OBJECTIVE

The SBMF ZEB Master Plan will provide a road map for charging infrastructure installation, timed to coincide with ZEB bus purchases, matching new charging technology with new buses in a phased approach. The first 12 ZEBs will be Phase 1 or the first implementation of the full ZEB Master Plan. The ZEB Master Plan will develop an infrastructure and operational improvement and phasing plan that must:

- Be compatible with MTS's long-range ZEB vision.
- Confirm the fleet size and mix able to be parked and provided with electrified parking / charging capabilities at the SBMF.
- Identify specific infrastructure needed to support the recommended 253 ZEB fleet mix.
- Make recommendations that can be implemented within the constraints of available funding and physical site.

PROJECT GOALS

The following goals were developed through discussions with key MTS staff.

1. The design must provide for **implementation without disruptions** with smooth yard operations and the ability to continue providing reliable revenue service.
2. The solution must be **cost efficient**.
3. The project must **meet project milestones and adhere to the Innovative Clean Transit regulation**.
4. The solution must be **scalable, modular, and flexible**.
5. The solution must **provide resiliency** to fleet operations during utility power outages at all phases **and redundancy** to utility power losses once the ZEB fleet grows beyond 50% of total on-site fleet.

INTRODUCTION

PROJECT PARAMETERS

The following parameters were established for the project through discussions with MTS.

1. The project is to accommodate a total of **253 ZEBs, (12 additional buses to the current total fleet).**
2. The project must **make the best use of the capital budget.**
3. The project must **consider only technology that is currently available**.
4. The project is to continue to **accommodate employee parking** on-site
5. The project will continue to **accommodate the existing CNG buses** until those buses have been replaced with the ZEBs.

PRELIMINARY ENGINEERING METHODOLOGY

The first step was to collect and review existing documents provided by MTS that are pertinent to SBMF, including:

- Facility As-built drawings
- Facility's current bus parking layout
- Current circulation routes
- Historic electricity and gas usage information
- Existing fleet Inventory

After the existing documentation was reviewed, a ZEB checklist was developed to document key findings for both the existing facility and proposed on-site operations. An in-person site tour was conducted to acquire missing data not ascertainable from the received existing condition documentation and previous operational discussions.

Upon reviewing the existing operational and facility information with the documented understanding of MTS's preferred future ZEB operational needs and holding bi-weekly meetings with an in-person Concept Design Workshop with MTS, various master site layouts were developed around three (3) available charging technologies. The 3 charging technology options studied were Induction, manual plug-in chargers, and automatic overhead charging. Pros and Cons for these options are discussed in Chapter 4 along with the recommended infrastructure option. The pros and cons also included SBMF specific tangibles such as a master plan ability to park the desired 253 ZEBs, constructability in phases, and physical space to accommodate the electrical service and specific charging equipment needed to support the ZEB fleet. All the developed master plan concepts, including those that utilized a specific charging technology but were unsuccessful in accommodating all the ZEB 's Master Plan Goals are included in this report.

Once the Preferred Master site plan was selected by MTS, the phasing of the infrastructure was developed. Refer to Chapter 6 for phasing details. The Phase 1 location was chosen to minimize disruption to the current operations, as well as limit the capital expenditure needed on opening day knowing that only 12 ZEB's out of the total 253 ZEB buses would be delivered. The phasing plan for the project identifies how to accommodate the first 12 60-foot ZEB's scheduled to arrive in the near term of March 2022, and then continues in subsequent infrastructure phases based on MTS's bus procurement schedule and the ability to allow for construction phasing and staging on site without reducing the number of buses being operated out of SBMF or having a detrimental impact to SBMF existing operations.

CHAPTER 2 & 3– EXISTING CONDITIONS REPORT & CHARGING TECHNOLOGY MEMO

EXISTING CONDITIONS REPORT & BEB CHARGING TECHNOLOGY

CHAPTER 2 – EXISTING CONDITIONS REPORT

The Existing Conditions Report was previously submitted to MTS on May 27, 2020 and is attached to this ZEB Master Plan Report as Appendix A. The Existing Conditions Report examined and documented the existing SBMF facility and the existing on-site operations to determine site specific limitations and opportunities to support a fully 100% ZEB fleet. Additionally, the report contains a glossary of terms and acronyms used within itself and applicable to this report and other previously issued memorandums as part of this ZEB Master Plan project.

CHAPTER 3 – BEB CHARGING TECHNOLOGY OVERVIEW

The BEB Charging Technology Overview Memo was previously submitted to MTS on June 19, 2020 and is attached to this ZEB Master Plan Report as Appendix B. The Charging Technology Memo introduces the various charging technologies, charging equipment and support infrastructure equipment, product availability, and pros and cons of each charging technology. Additional ZEB charging technology terms are defined within this memo that are applicable and referenced within this ZEB Master Plan report.

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CHAPTER 4 – ELECTRICAL SERVICE APPROACH & CONCEPT PLAN OPTIONS

ELECTRICAL SERVICE APPROACH & CONCEPT PLAN OPTIONS

ELECTRICAL SERVICE APPROACH

GOALS

Fleet conversion to all-electric buses requires a great deal of power to charge the vehicles. The relationship between the transit agency and the utility changes because the utility is more like a fuel provider. If they can't provide the fuel, the buses don't run the next day. Similarly, with electric buses, if there is a power outage, it could have a substantial impact on the next day's rollouts. This means that the power coming from the utility needs to be reliable and the grid needs to be able to support the increased load that BEBs require. This section will discuss how the utility, SDG&E, can supply sufficient power, reliably, and discuss resiliency options for if there is a power outage.

UTILITY RELIABILTY

INDEX	MEASURE	UNITS
System Average Interruption Duration Index (SAIDI)	Average outage duration per customer	Minutes per outage (per customer)
System Average Interruption Frequency Index (SAIFI)	How often a customer can expect to experience an outage	Number of outages a year (average)
Customer Average Interruption Duration Index (CAIDI)	Average outage duration if an outage is experienced, or average restoration time	Minutes Per Year (per customer)
Momentary Average Interruption Frequency Index (MAIFI)	The frequency of momentary interruptions	Number of instantaneous outages per year (average)

1. REALIABILITY INDICES

Power reliability is an important factor when considering the transition to BEBs. Without an understanding of existing reliability or measures in place to mitigate the risks of an outage, any disruption in electrical flows can be devastating to MTS's service.

The California Public Utilities Commission (CPUC) monitors reliability for regulated, investor-owned utilities around the State to ensure that performance is upheld. Information was gathered from the CPUC (see Table 1 and Figure 4.1) as it relates to San Diego Gas & Electric (SDG&E), the local distribution utility.

Table 1. Electric Power Distribution Reliability Indices

Source: CPUC

2. SDG&E RELIABILITY

Reliability metrics can vary from year to year based on large power outage events, such as, the Camp Fire in Paradise, California in 2018, or the Southwest Blackout of 2011. Therefore, CPUC generally uses 10-year rolling averages to show improvements over time. After Pacific Gas & Electric's transmission lines caused the deadliest fire in California history (the Camp Fire), the CPUC and regulated utilities began to implement public safety power shutoffs (PSPS) in 2019. The resulting harm to SDG&E's reliability has not been publicly reported yet. While the SBMF is located outside of the wildfire zones of California, it relies on transmission lines that cross the wildfire zones which is a risk to the site. SDG&E reliability in this region shows a consistent, high level of performance. For all four metrics shown in Table 1, lower numbers indicate more reliability. For example, if an average outage duration (CAIDI) is experienced, the number represents the number of minutes of the outage, so an outage of only 10 minutes shows a more robust system then an average outage of 45 minutes.

Figure 4.1 presents metrics for the San Diego Construction Metro district.

The left side of each chart is the year 2006, and the end of each chart is the year 2015, when this comprehensive overview was completed. In 2011, there was a regional power outage called the Southwest Blackout. This event shows up as the large spike on each chart, but the red line is the overall trend line.

ELECTRICAL SERVICE APPROACH & CONCEPT PLAN OPTIONS

Each customer within SDG&E's Construction Metro district can expect just over one power outage within two years, and it will probably last around 118 minutes. (By multiplying 0.598 average outages per year * 118 minutes per outage = 71 minutes of average outage minutes per year). Similarly, there are only 0.42 momentary outages per year, or less than one every other year. SD MTS confirms that they experience roughly 71 minutes of power outage each year.

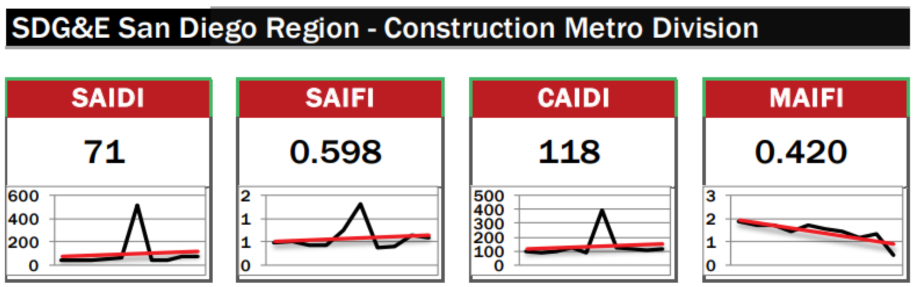


Figure 4.1. Construction Metro Division Metrics (2006-2015)

Source: CPUC

BACKUP GENERATOR REQUIREMENTS *(MEMO FROM CHARLES BARKER, LTE)*

1. EMERGENCY ENGINES

Internal combustion emergency engines (either Diesel or CNG) with brake horsepower (bhp) ratings of 50 bhp or greater are subject to air quality permitting through the San Diego Air Pollution Control District (SDAPCD) prior to construction in San Diego county. Properly sizing a generator and its needs can be complex based on other Distributed Energy Resources, Bus Route Modeling, and Charge Management Modeling. However, a rough estimate of a 380 kW generator is about $400,000 for just the generator itself. Assuming a 174 kW peak load for a charger, this could theoretically power 2 charging positions to charge 12 electric buses by cycling a bus onto the charger as each previous bus finished the charging process over a day if run constantly. Conversely, a 1.5 MW generator would cost roughly $1.1MM and could power 8 charging positions simultaneously to much more quickly cycle the same 12 (or more) buses in an emergency situation. Additional input from battery and/or solar panels would augment this capability.

2. PERMIT COST AND TURNAROUND

SDAPCD targets a turnaround time of 60 days from receipt of a complete application although permitting may take as much as 180 days or longer if the engine is constructed within 1,000 feet of a school or is of such great size that it triggers an impact analysis. Estimated application fees are approximately $4,700 to obtain a construction permit. Replacement of engines also require fees dependent on if the unit is a like-kind ($500) or a cleaner engine ($2,500).

3. OPERATING RESTRICTIONS

An emergency engine is intended to operate in the event the primary energy supply is disrupted or discontinued during outages and disaster outside the control of the owner or operator of the emergency engine. Federal regulations allow operations for non-emergency purposes up to 100 hours per calendar year, SDAPCD Rule 69.4.1. limits non-emergency operation to 52 hours per calendar year unless SDAPCD provides written authorization to exceed the limit. Engines that operate more than 200 hours per year are subject to additional emission, monitoring, inspection, and stack testing requirements. All operation is subject to recordkeeping which documents the purpose and duration of operation as measured by the non-resettable hour meter.

4. EMISSION CONSIDERATIONS

All emergency engines manufactured on or after January 1, 2009 are required to meet emission limits by design or with an emission control device such as a catalyst. Further, SDAPCD requires emergency engines operating more than 200 hours per year to reduce emissions of nitrogen oxide (NOx), carbon monoxide, and volatile organic compounds (VOC). Emissions are verified by stack testing initially for engine subject to Federal standards and every 24 months for those subject to SDAPCD emission limitations.

5. REPORTING CONSIDERATIONS

Emergency engines are required to perform annual maintenance or more frequently based on hours of operation. Emergency engines operating more than 200 hours per year are required by SDAPCD to conduct inspection every 6 months and to monitor exhaust characteristics of the engine at least once every month. All inspection, monitoring, and maintenance is subject to recordkeeping of the measurement or occurrence of the event.

6. REPORTING CONSIDERATIONS

Emergency engines that enter into a contractual obligation to be available for more than 15 hours per year at the direction of the North American Electric Reliability Corporation (NERC) Coordinator, to address voltage deviation or frequency, or to be dispatched by the local balancing authority or transmission operator shall submit annual reports.

7. SUMMARY

The requirement threshold for air quality monitoring is anything about 50 bhp which is roughly a 150-kW generator. Any new generator for this effort, even if it just supports the initial 12 bus deployments, would likely need to be larger than this and subsequently would be required to be monitored and total runtime would be limited. The cost-benefit analysis of this must be done while considering what realistic resiliency needs are.

STATIONARY BATTERY ENERGY STORAGE

Stationary batteries are not an alternative energy source, but instead are simply a mechanism to store electrical energy. Batteries can be used to avoid peak demand charges by storing energy during times of low usage and discharging during peak usage times. Batteries do not currently qualify for federal incentives but can be paired with solar to be eligible for the ITC.

1. BENEFITS

Batteries can help achieve a lower utility category. For example, SCE (Southern California Edison) and LADWP (Los Angeles Department of Water and Power) both require additional customer requirements for connections larger than 10MW. When coordinated with the utility, a battery can be used to consume more than 10MW for short durations.

If backup power is required by local codes, sometimes battery energy storage can meet that requirement, avoiding the purchase or maintenance of diesel generators.
There is potential to use stationary batteries as a source of revenue to MTS. Batteries can respond to changing conditions very rapidly and can participate in frequency response or ramping markets. MTS might be able to use the stationary batteries during the day to participate in these markets, while then using the batteries to charge the battery electric bus fleet at night.

Stationary battery energy storage requirements are usually less onerous than the requirements for batteries used for transportation (like battery electric buses). It is expected that in the next 10 years, a large secondary market will become available for buying used batteries.

2. DRAWBACKS

Batteries are expensive but costs have been coming down every year. The costs of batteries heavily depend on the amount of energy to be stored, so short duration batteries are more cost effective than long duration.

Batteries take up valuable real estate, though they could be raised onto supporting steel since they have no moving parts.

There are energy losses in converting energy for storage and back again to grid power. This penalty is usually ~20%.

Additionally, battery capacity reduces overtime, and eventually will hold insufficient charge and will need to be replaced and recycled. Proper disposal or recycling of end of life batteries can be very costly and hazardous if not done correctly. While there are many suggested cases of "second-life" uses of degraded batteries, this is still largely a complex and unknown industry issue, both for stationary storage and batteries in vehicles.

3. EXAMPLES AND SIZES OF STATIONARY BATTERIES

The first phase of the project would be 12 buses at an estimated 600 kWh battery per bus, since these will likely be larger, 60' buses. If each bus needs 80% charge to complete its route, that is a total of 5,760 kWh of energy needed. Stationary Batteries often come in shipping container sizes and each 40' shipping container can hold around 4MWH, depending on brand. Additionally, SD MTS could use three (3) 20' containers for 6,000 kWh storage, or a single 53' container with ~5MWH. There are significant auxiliary equipment loads, but for space considerations, WSP roughly estimates that 3x20' containers plus auxiliaries could fit in a 4,000SF area. This would provide enough load to fully charge the 12 buses in the event of a total power outage.

DETERMINING RESILIENCY NEEDS

There are many different ways to add resiliency to the fleet demands: solar panels, battery storage, backup generators, redundant power feeds, microgrids, etc. These technologies are discussed in more detail on page 4.8. With enough space, time, and money, almost any amount of resiliency is achievable, but at what cost? It is important to integrate needs for resiliency into the overall resiliency effort and planning. The first stage of the project aims to be able to support fully charging 12 BEBs to full in the event of a power outage. For a full buildout beyond the first 12 buses, charging multiple BEBs to full has a much more substantial cost, and further analysis can help determine the most cost effective way of providing resiliency. There are two main aspects that adding these technologies can help with:

1) Reducing overall operational/electricity cost
2) Ensuring backup power exists to meet a certain rollout time in the event of an outage.

Both of these items require further analysis of the demands of the BEB network, the resiliency of the utility, and the level of comfortability that the transit authority has for estimating those needs. The Resiliency statistics in section 1 are a great place to start, especially for determining how much backup power a depot really needs. For the 12 bus, Phase 1 project, there are probably enough CNG (Compressed Natural Gas) buses to fill any gaps in service if there is an outage, but as those get phased out and the fleet is converted to all electric, what happens if there is an outage overnight and all of the chargers go down?

To determine this, modeling needs to be done to estimate that amount of time the BEBs will need to charge versus the time they are at the depot. It is possible that some buses may come in close to empty that require substantially more charge time, whereas some buses may come in at 40% or more battery power. Therefore, it is important to measure what the average differential in time sitting at the depot versus time charging really is. From there, you can look at the resiliency statistics for the area to determine what the impact of a power outage would be.

For example, the SAIDI statistic, which is the average number of minutes the power is down when there is an outage, can help determine the gap that you need to cover. For the MTS South Bay site, the average outage is 118 minutes. When looking at fleet times, you then want to see what percentage of your buses would not be able to charge enough to complete their routes if an outage lasted that long, or some multiple of that amount based on Transit Agency comfort level with those statistics and their effects if a rollout is not achieved. If only 5% of buses wouldn't be able to charge to full if the power was out for over 2 hours, it might not be a concern and little to no resiliency may be required. However, if something like 50% of buses would not be able to complete their routes if the power went out for only an hour, then that is a much bigger concern and substantial investment in alternative generation and storage technologies could be critical.

To help look at electricity cost, you can also use microgrid technologies that would allow some or all of the site to operate in an "islanded" mode for a period of time, or use it to balance power from when it can be acquired cheaply to when it is needed. SDG&E has rates that change based on when the electricity is used, so if there are some buses that need to charge during peak times, using something like solar + battery storage to charge those buses could substantially decrease that operational cost.

ELECTRICAL SERVICE APPROACH & CONCEPT PLAN OPTIONS

1. EXISTING INFRASTRUCTURE

The site's existing electrical service is provided by SDG&E from Main St. to SDG&E owned transformers. The lines go to two different transformers and are split between the Old Maintenance Building (Building 3610), and the new Maintenance Building (Building 3650). Figure 2-3, from the Existing Conditions Report (Appendix A) highlights key electrical infrastructure at the SBMF. The Transformer that powers Building 3650 is a 12.47 kV to 480/277 V transformer that feeds into 1200A switchgear. The CNG system has a 250A breaker off of this switchgear that goes to an automatic Transfer Switch (ATS) that connects to a 200-kW backup generator for the CNG systems. This is shown in Figure 2-5 of the Existing Conditions Report (Appendix A).

Building 3610 also has an SDG&E provided transformer to 600A switch gear. There is a backup generator also connected to this bus via an ATS. This is shown in Figure 2-6 of the Existing Conditions Report (Appendix A).

There also appears to be electrical service to a four (4) bus BEB Pilot that is not identified on the electrical one-line drawings and the path was unverified during the site visit since the service comes in underground. Photovoltaic cells are present on the roof of the new maintenance building with associated equipment located in the building's electrical room.

The existing infrastructure does not have enough capacity to support the proposed BEB buildout and new Electrical infrastructure will be required. For a full fleet buildout, it is estimated at a 2:1 charging ratio that the EVSE (Electric Vehicle Supply Equipment) could pull a maximum of 16.9 MW, though automatic charge management systems can lower this peak, even with only half of the chargers working at a time, the existing infrastructure will not support the needs of the system. While nighttime and off-peak charging will help regulate the cost of that much electricity, and charge management software can help reduce peaks and spread out the power needed, the infrastructure must be designed to support the full possible load, especially for emergency scenarios, The exception being that the feeder and line connecting the full load can be rated to a maximum a charge management system can control it too. Similar controls can also help reduce demand charges from the utility. However, SDG&E's EV rates also help ameliorate the demand charge costs.

2. NEW INFRASTRUCTURE CONCEPTUAL DESIGN

Two new 12 kV service lines will be anticipated to supply power for 253 Battery Electric Buses (BEB's). This fleet of BEB's comprised an estimated maximum available load of 10MW per line. For the initial deployment, only 1 new service will be required. The charging equipment operates at 480V. Pending SDG&E's approval, the existing service to the SBMF is expected to remain untouched. The new BEB service would be separately metered.

- Each new incoming service (total of two (2) will be a 12kV service and each feeds a new pad mounted 4-way switch, rated for 600A, 15kV (3ph, 3W), 65kAIC.
- The 4-way switch will feed three new 3000kVA 12.47kV-480/277V pad mounted transformers.
- Each transformer will feed its own switchboard rated for 5000A at 480/277V (3ph, 4W), 100kAIC.
- Each switchboard will feed five panelboards.
    - Four panelboards, each rated 1200A, will feed a total of 20 chargers for a fleet of 40 BEB's at a 2:1 charging ratio.
    - The fifth panelboard will feed auxiliary loads, via a step-down transformer, for equipment monitoring, hoist motors, etc.

Equipment List Summary

- 4-way switch – 600A, 15kV, 2ph, 3W, 65kAIC qty. two (2)
- Transformers – 3000kVA 12.47kV – 480V/277V, pad-mounted qty. six (6)
- Switchboards – 5000A, 480/277C, 3ph, 4W, 1000kAIC qty. two (2)
- Panelboards – 1200A, 480V, 3ph, 3W, 100kAIC qty. six (6)

The first 12 buses will only need 1 transformer and switchboard, and this approach allows for the additional transformers and switchboards to be added in the future in conjunction with the expanding BEB fleet. This modular approach allows for adaptability as the fleet expands from its initial 12 buses to a full 240 bus fleet.

The chargers will be fed from the 480V panelboards but auxiliary devices including: 1) hoists for the cable to the power dispenser, 2) the power dispenser itself which plugs into the bus, 3) communication devices will be fed from 120/208V panelboards. Cable ladder tray and/or conduit will be used to route the cable from source to load.

All devices will be properly grounded to the facility's existing ground system. The 4-way switches and service entrance switchgear will be grounded according to SDG&E's standards.

In the event of a utility outage, "microgrid ready" switchgear will continue to feed a portion of the fleet. This microgrid will have provisions within the switchgear, likely on the low voltage side, and at each of the Distributed Energy Resources (DERs) for intelligent monitoring of its loads and will be able to operate in an island mode and power some buses during an outage. Ideally, the charge management software that controls the EVSE would also be able to talk to the intelligent devices for the microgrid for better load management and determining which DERs to use at what time. The fleet will receive power via the following DER sources available:

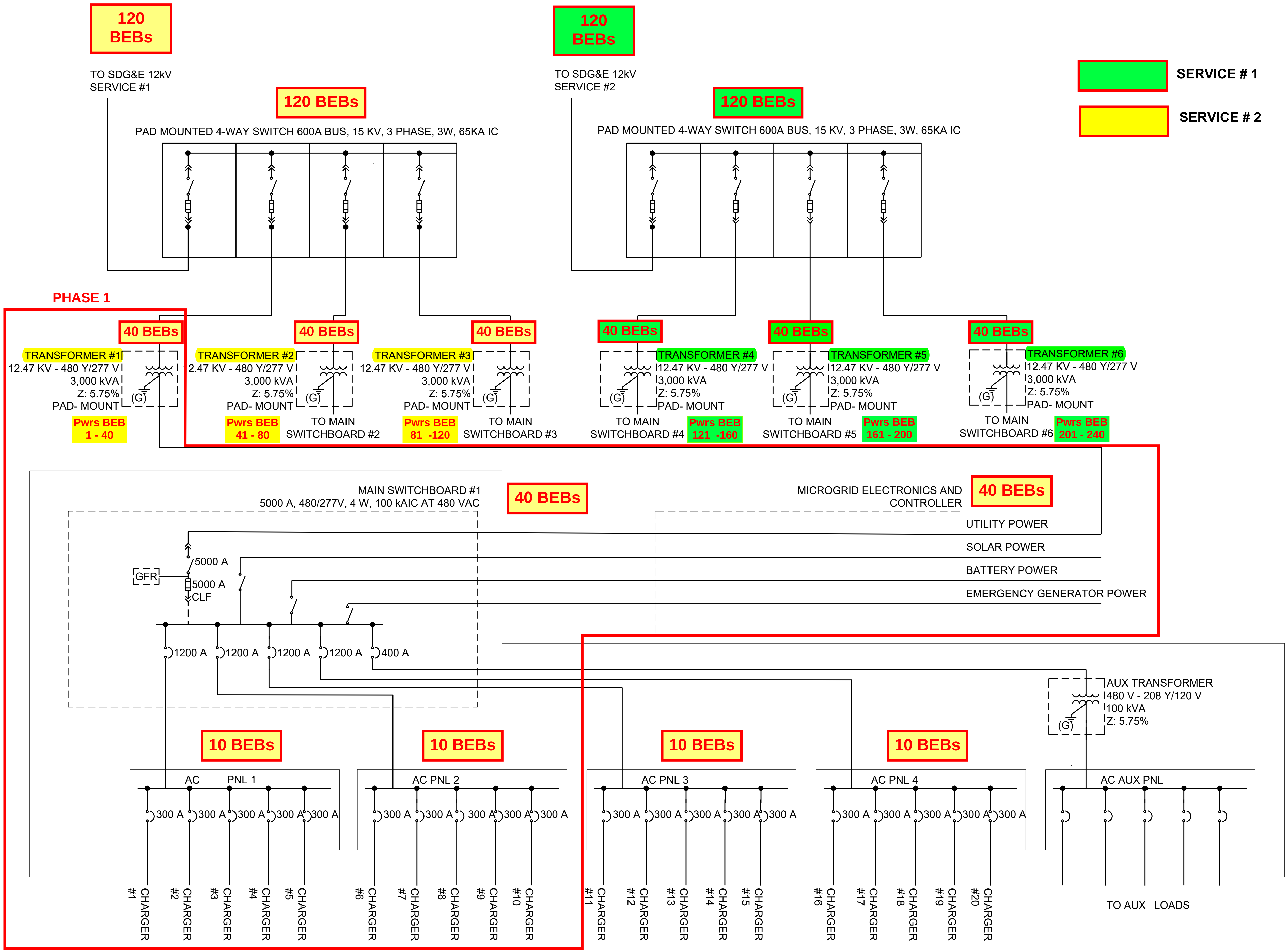
- **Solar power** – photovoltaic cells are planned to be added on top of the new gantry system that will be installed to support overhead charging. The estimated peak power supplied by the fully built-out solar system is 2.8 MW (with Employee Parking Deck), 3.4 MW (with no Employee Parking Deck), and for Phase 1 is 0.28 MW.. The solar power available can be used to assist with mid-day charging or charging a large stationary battery to help shift loads depending on the time of day.

- **Battery power** – Currently there is enough room for a 6 MWh battery on site that would fit in a 53' storage container based on preliminary designs. Additional modeling, resiliency, and economic factors should be employed to "right size" the battery for the design.

- **Emergency Generator power** – an existing 200kW natural gas generator is available at the DBMB switchboard which may be used to feed auxiliary loads during a power outage. Per the resiliency section above, a new Genset may be possible, but may have limited runtime capabilities due to CARB (California Air Regulation Board) air regulation laws.

The final choice of DERs must account for the duration of an anticipated outage (per the Resiliency section above) and the ability of the buses to still meet rollout schedules based on detailed modeling. This modeling should take into consideration overnight idle time versus how long each bus needs to charge overnight. Some buses may arrive at the depot with low power and require substantially longer charge times, and thus a power outage would more dramatically affect that bus's ability to meet rollout the next day. Some buses that do mid-day or on-route charging may come back to the depot with a much higher battery % and may not need a full batter in order to make their rollouts the next day, and thus would be less susceptible to the effects of a power outage. Doing this detailed analysis and taking into consideration the probability of an outage and outage durations will allow the client to make better informed decisions on the type, size, and quantity of DERs from both a technical feasibility perspective and an economic perspective. The current conceptual design allows for the flexibility to integrate these DERs as needed based on that analysis taking into account that all MTS facilities are site-constrained and may require the purchase of new property to effectively scale.

FIGURE 4.2 - SBMF ZEB MASTER PLAN SINGLE LINE DIAGRAM



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ELECTRICAL SERVICE APPROACH & CONCEPT PLAN OPTIONS

CONCEPT PLAN OPTIONS

The design team worked with key project representatives from MTS to develop and test various alternate facility concept layouts based on the various charging technologies and how each charging technologies, once applied to the SBMF facility, impacted the site's functional on-site vehicle and work flow and physical requirements such as accommodating the full anticipated fleet parking and space to accommodate new electrical charging service infrastructure . All developed concepts, including concepts tested that failed to produce a viable master plan, are described in this chapter. An MTS preferred and selected SBMF ZEB Master Plan option was chosen which will form the basis of design of the preliminary design. This selected master option(s) will be further discussed in Chapter 5.

The following options were developed and presented to MTS:

- **Option 1: Overhead Frame, Inverted Pantograph, Ground Mounted Electrical Equipment, Employee Parking Deck.** Full fleet with overhead frame and inverted pantograph charging with existing maintenance building removed and lot re-striped. Ground mounted new electric service and charging and distribution infrastructure equipment. Private car parking on elevated deck. *This is the preferred master plan concept option and it will be discussed further in Chapter 5.*
- **Option 2**: **Overhead Frame, Inverted Pantograph, Ground Mounted Electrical Equipment, NO Employee Parking Deck.** Identical to Option 1 but without the private car parking on elevated deck. *This is the preferred master plan concept option and it will be discussed further in Chapter 5.*
- **Option 3: Overhead Frame, Inverted Pantograph, Platform Mounted Electrical Equipment.** Ground mounted new electric service, overhead distribution infrastructure and overhead charging equipment (platform mounted). This option was deemed non-viable as suspending equipment from the roof would require a manlift or catwalk for maintenance, and service. Charging cabinets and switchboards located in the platform above, would also require a type of lift and stair case for equipment access.
- **Option 4: Induction Charging.** Ground mounted new electric service, distribution infrastructure, and charging equipment.
- **Option 5: Overhead Frame, Plug-in Charger with Retractor Reels.** Overhead frame and plug-in charger with retractor / reels with existing maintenance building removed and lot re-striped. Private car parking on elevated deck and ground mounted new electric service, overhead distribution infrastructure and charging equipment.
- **Option 6: Ground Mounted Plug-In Charging.** Ground mounted plug-in cabinets, existing maintenance building removed and lot re-striped. Private car parking on elevated deck and ground mounted new electric service.
- **Option 7: Hydrogen Fuel.** Conceptual footprint of hydrogen compression yard.
- **Option 8: Overhead Frame, Inverted Pantograph, Old Maintenance Bldg. to Remain.** Overhead frame and inverted pantograph charging with existing maintenance remaining. Ground mounted new electrical service, overhead distribution infrastructure and charging equipment.

ELECTRICAL SERVICE APPROACH & CONCEPT PLAN OPTIONS

OPTION 1 – OVERHEAD FRAME, INVERTED PANTOGRAPH, GROUND MOUNTED ELECTRICAL EQUIPMENT, PARKING DECK

This is the preferred master plan concept option and it will be discussed further in Chapter 5.

OPTION 2 – OVERHEAD FRAME, INVERTED PANTOGRAPH, GROUND MOUNTED ELECTRICAL EQUIPMENT, NO PARKING DECK

This is the preferred master plan concept option and it will be discussed further in Chapter 5.

OPTION 3 – OVERHEAD FRAME, INVERTED PANTOGRAPH, PLATFORM MOUNTED ELECTRICAL EQUIPMENT (NON-VIABLE)

In this option it is proposed to install overhead frame structures to support inverted pantograph charging. The Old Maintenance Building will need to be demolished and the bus lot would need to be re-striped. New electrical service (transformers) to be ground mounted and charging equipment and switchgear to be mounted on a concrete platform above pantograph frame structure as shown on Exhibit 4.3 and 4.4. A new parking deck would need to be constructed for private car parking as shown on Exhibit 4.5.

Pros:	**Cons:**
• Mature technology, with standards established • DC charging cabinets can be remotely located overhead to the bus parking areas. • The overhead pantograph eliminates the need for floor space for ground-mounted charging dispensers. • Minimal operator intervention is required at the charging position. • There is no need for cord management.	• Suspending equipment from the roof would require a manlift or catwalk for maintenance and service. • Charging cabinets and switchboards located in the platform above, would require a type of lift or staircase for equipment access. • Pantographs require adequate space under enclosed garage roof structures or new overhead frame support structures at exterior bus parking areas. • Mixed fleet requires different spacing when in tracks. • Scheduling proper routes will be critical

This option was discarded because of the need to have a lift or staircase to access the charging cabinets and switchboards located above the platform.

OPTION 4 – INDUCTION CHARGING (NON-VIABLE)

In this option it is proposed to install induction pads for bus charging. The existing maintenance building would be removed, and the bus lot would be re-striped. New electric service and charging and distribution infrastructure equipment to be ground mounted. Exhibits 4.6, 4.7, and 4.8 show the master plan and details developed for this option.

Pros:	Cons:
• Requires no overhead structure to mount charging equipment. • Requires no mechanical moving parts. • Very limited operator interaction required during charging process. • Receiving pads can be retrofitted or installed as part of original OEM equipment to any battery electric bus. • Can be driven over • Not affected by heat, cold, rain	• No standards currently established (in progress) • Added weight to the buses (approx.. 200 lb./75 kwh) • Experience is minimal • Distance between the above-ground modules and the transmitter pad(s) is limited to 60-75 feet. Therefore, the above-ground modules cannot be remotely installed away from bus parking. • Requires extensive underground trenching for conduits. • Above-ground modules require ground space in the parking area for the full length and width of a parking track. • Above-ground modules vent heat into the bus parking enclosure.

This option was discarded because of the extensive underground trenching required for conduits and the lack of flexibility due to having all conduits buried underground.

OPTION 5 – OVERHEAD FRAME, PLUG IN CHARGER WITH RETRACTOR REELS (NON-VIABLE)

In this option it is proposed to install overhead frame structures to support retractor reels. The Old Maintenance Building will need to be demolished and the bus lot would need to be re-striped. New electrical service (transformers) to be ground mounted and charging equipment and switchgear to be mounted on a concrete platform above pantograph frame structure as shown on Exhibit 4.9. A new parking deck would need to be constructed for private car parking.

Pros:	Cons:
• DC charging equipment is compatible with multiple bus OEMs if both the chargers and the bus adhere to the J1772 standard. • DC charging cabinets can be remotely located away from the immediate bus parking areas. • Dispensers can be remotely located overhead to eliminate the need for any ground mounted space taken up by charging equipment. • DC chargers save weight on the bus because the rectifier is located within the charging cabinet. • Depending on manufacturer, shared charging may be feasible. • The same DC charging cabinet can support overhead pantograph charging as well as plug-in dispensers.	• If charging cabinets are located remotely, DC power diminishes quickly with distance of transmission. • Charging cabinets are larger than AC systems due to the need to accommodate the rectifier. • DC power from the charging cabinet to the dispensers requires vendor-specific controls and data wiring. • Remote charging cabinets require three separate conduits between the charging cabinet and each dispenser. • Cord management can be a challenge, especially when the dispenser is located overhead. Additional cord retractor, power and controls are required.

This option was discarded because inverted pantograph in lieu of overhead reels is preferred. If pantograph technology does not move along quickly enough, this option will be considered in the short term.

OPTION 6 – GROUND MOUNTED PLUG-IN CHARGING (NON-VIABLE)

This option requires a 4'-6" island in between every two rows reducing the space for bus parking to (172) spaces for 40' buses, and (27) spaces for 60' buses as shown on Exhibit 4.10. This option does meet the master plan fleet requirement of 253 ZEBs.

Pros:	**Cons:**
• Charging stations come at no extra cost with the provided battery electric buses (typical for BYD, negotiable with CCW). • Does not require extra rectifying equipment taking up floor space. • Power distribution to the charging station is generic single conduit AC power circuit, not charger manufacturer-specific DC power with additional control and data wiring.	• Not enough parking spaces. This option does not meet the fleet requirement of 253 ZEBs. • Suspending equipment from the roof would require a manlift or catwalk for maintenance and service. • Charging cabinets and switchboards located in the platform above, would require a type of lift or staircase for equipment access. • Pantographs require adequate space under enclosed garage roof structures or new overhead frame support structures at exterior bus parking areas. • Mixed fleet requires different spacing when in tracks. • Scheduling proper routes will be critical

This option was discarded because it does not meet the master plan fleet requirement of 253 ZEBs.

OPTION 7 – HYDROGEN FUEL (NON-VIABLE)

This option was not further developed because of the space and clearances required for the hydrogen fuel equipment. There are certain clearances that need to be kept from air intakes and buildings, lot / property lines, parked vehicles, and sprinkled buildings of noncombustible construction. A footprint of approximately 322 feet x 180 feet (58,000 sf), as shown on Exhibit 4.11.1 and 4.11.2. is required for a hydrogen yard to fuel 250 buses (including clearances required). To provide a scalable hydrogen fueling option, Exhibit 4.11.1 has an assumed hydrogen compression / storage yard "module" to fuel 50 fuel cell electric buses (FCEB). To support a growing FCEB fleet, multiple hydrogen yard modules would be constructed as needed to reach the fueling capacity to support 250 FCEBs. The base 50 FCEB "module" is an assumed representative equipment layout and multiple alternative equipment configurations are possible. However, the representative modules illustrate the challenges of retrofitting a hydrogen compression and storage yard on to a dense transit operations site. Even if the existing CNG compression yard were to be removed and its site square footage made available the hydrogen yard would still extend into the SBMF site due to hydrogen's setback requirements from property lines. Additionally, the code mandated setback requirement of parked vehicles to the storage tanks would also eliminate on-site parking capacity. MTS currently owns 6 battery electric buses and has committed to purchase an additional 14, therefore a 100 percent hydrogen fuel cell electric bus fleet solution is not applicable to SBMF.

Pros:	**Cons:**
• FCEB would not require as significant an increase to electrical service at the depot, similar to a CNG yard, and would not incur large demand factor costs from the utility company. • Small scale hydrogen fueling doesn't typically require additional electrical service be installed at the depot. • Fuel cell will not depreciate as fast as batteries of a BEB • While the FCEB has batteries, it has fewer than a standard BEB. • With minor backup generator capacity, buses could still be fueled and ready for service even during a power outage. • Fueling infrastructure stays in one concentrated spot on site. Bus facility can operate traditionally with shared pump / dispenses and do not have to worry about compatibility issues between buses and battery charging equipment.	• On site storage and dispensing of H2 takes up a lot of concentrated site area and has large clearances requirements between the storage tanks and other uses on the site including buildings and parking. • While on-site generation of H2 is possible, the amount of equipment required plus its size makes it impractical to provide the bulk of the H2 required for a large FCEB fleet at the SBMF. The upfront cost for on-site generation equipment is also very high. • H2 deliveries will be required. There are limited vendors who provide this service and depending on location of the nearest vendor it could be costly. • There are currently fewer bus manufacturers supplying FCEBs and they are less prevalent and less readily available than BEBs at the time of this report. • Delivery of H2 fuel to the site may not be via a sustainable or zero emission technology vehicle (i.e. brought in by diesel truck). • FCEB vehicles currently cost more than a comparable BEB vehicles. • Equipment required to store and dispense H2 comes with a higher upfront cost. • Maintenance facilities for FCEB must comply with building code requirements for lighter than air fuels and be equipped with H2 gas detection systems. Existing maintenance buildings would require retrofitting to comply. • Addition of a fuel cell to the bus adds another layer of complexity and maintenance above and beyond that of a traditional BEB

OPTION 8 – OVERHEAD FRAME, INVERTED PANTOGRAPH, OLD MAINTENANCE BUILDING TO REMAIN (NON-VIABLE)

Keeping the Old Maintenance Building reduces the space for bus parking to (151) spaces for 40’ buses, and (27) spaces for 60’ buses as shown on Exhibit 4.12. This option does not meet the master plan fleet requirement of 253 ZEBs.

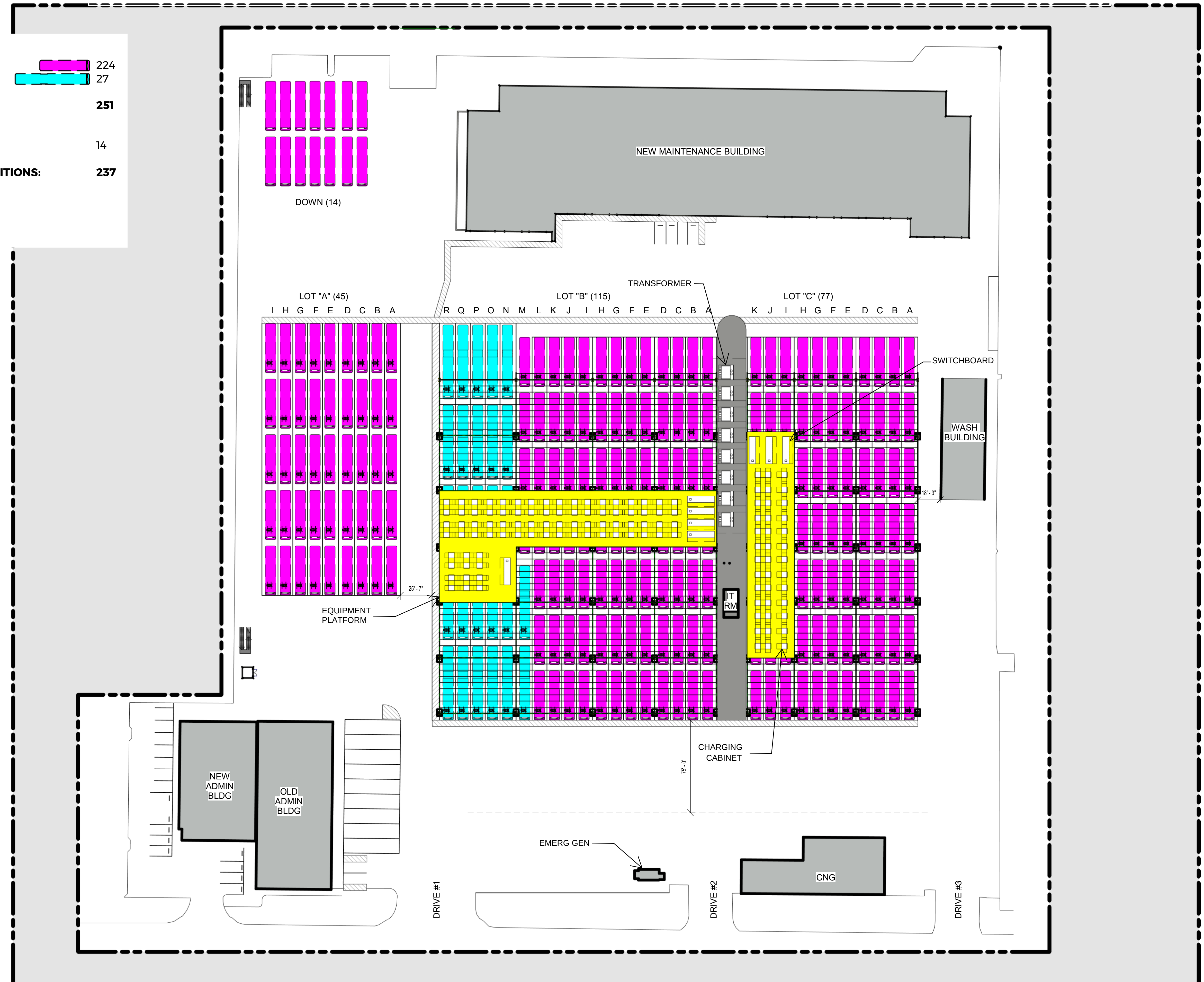
Pros:	Cons:
• In keeping the Old Maintenance Building, there is minimal disturbance to the site. • Mature technology, with standards established • The overhead pantograph eliminates the need for floor space for ground-mounted charging dispensers. • Minimal operator intervention is required at the charging position. • There is no need for cord management.	• Keeping the Old Maintenance Building reduces the parking spaces. This option does not meet the fleet requirement of 253 ZEBs. • Suspending equipment from the roof would require a manlift or catwalk for maintenance and service. • Pantographs require adequate space under enclosed garage roof structures or new overhead frame support structures at exterior bus parking areas. • Mixed fleet requires different spacing when in tracks. • Scheduling proper routes will be critical

This option was discarded because it does not meet the master plan fleet requirement of 253 ZEBs.

OPTION 3 – OVERHEAD FRAME, INVERTED PANTOGRAPH, PLATFORM MOUNTED ELECTRICAL EQUIPMENT

STATISTICS

40' Buses	224
60' Buses	27
TOTAL:	**251**
Spare Ratio	
Spare 40' Buses	14
TOTAL CHARGING POSITIONS:	**237**



1 OVHD PANTO PLATFORM OVERALL FLOOR PLAN
1" = 40'-0"

PROJECT NO.	12127B
DRAWN BY	Author
DATE	06/01/20
SCALE	NTS

PROJECT TITLE
SBMF ELECTRIC BUS

MTS

DOKKEN ENGINEERING

WSP

DRAWING TITLE
MASTER PLAN PANTO, PLAT MTD ELEC EQP

DRAWING NUMBER
4.3

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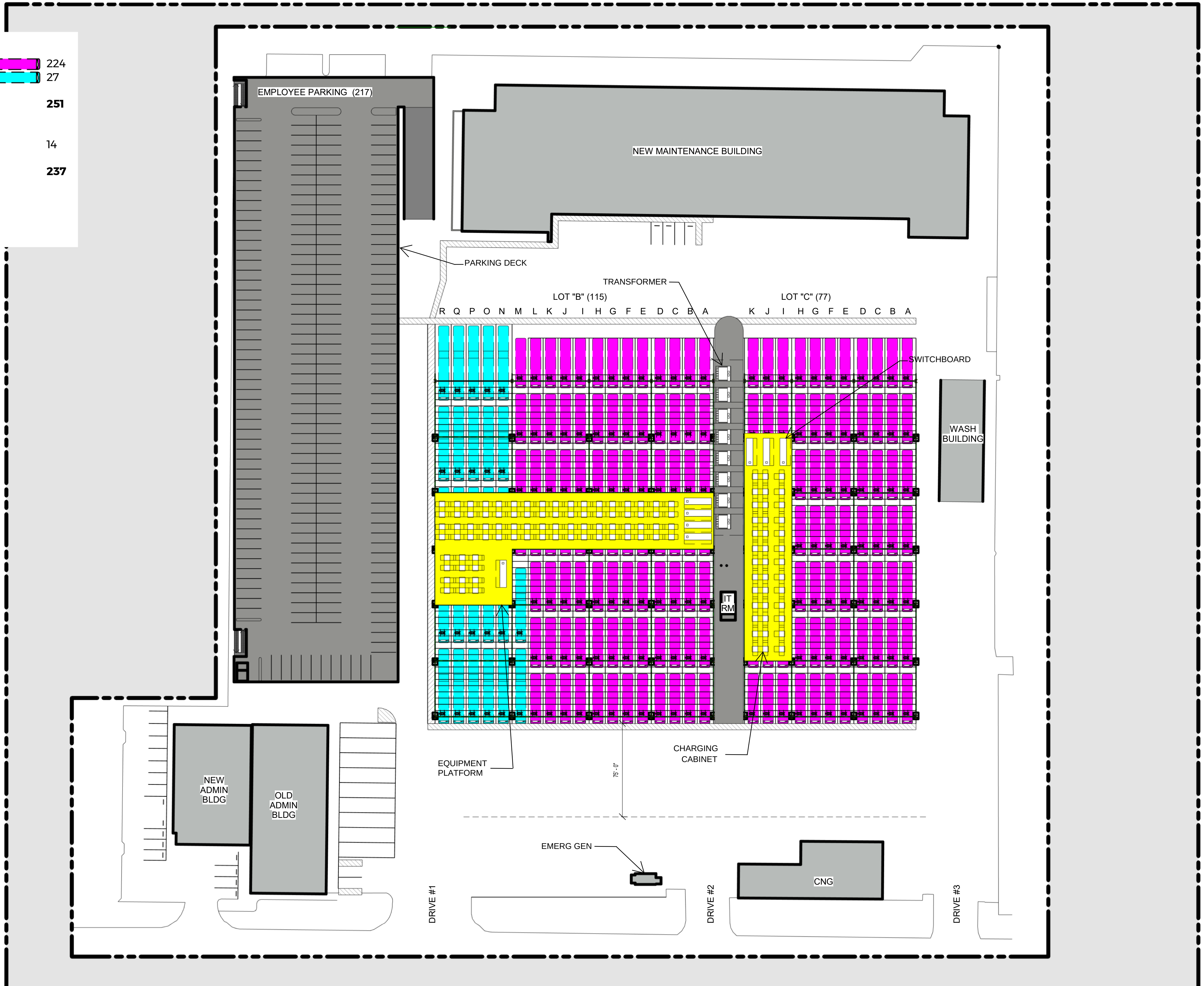
OPTION 3 – OVERHEAD FRAME, INVERTED PANTOGRAPH, PLATFORM MOUNTED ELECTRICAL EQUIPMENT

STATISTICS

40' Buses	224
60' Buses	27
TOTAL:	**251**
Spare Ratio	
Spare 40' Buses	14
TOTAL CHARGING POSITIONS:	**237**



1 OHVD PANTO PLATFORM EQ OVERALL PLAN
1" = 40'-0"

PROJECT NO.	12127B
DRAWN BY	PCG
DATE	06/02/2020
SCALE	As indicated

PROJECT TITLE
SBMF ELECTRIC BUS

MTS

DOKKEN ENGINEERING

WSP

DRAWING TITLE
PANTOGRAPH, PLAT MTD ELECT EQUIP, PARKING DECK

DRAWING NUMBER
4.4

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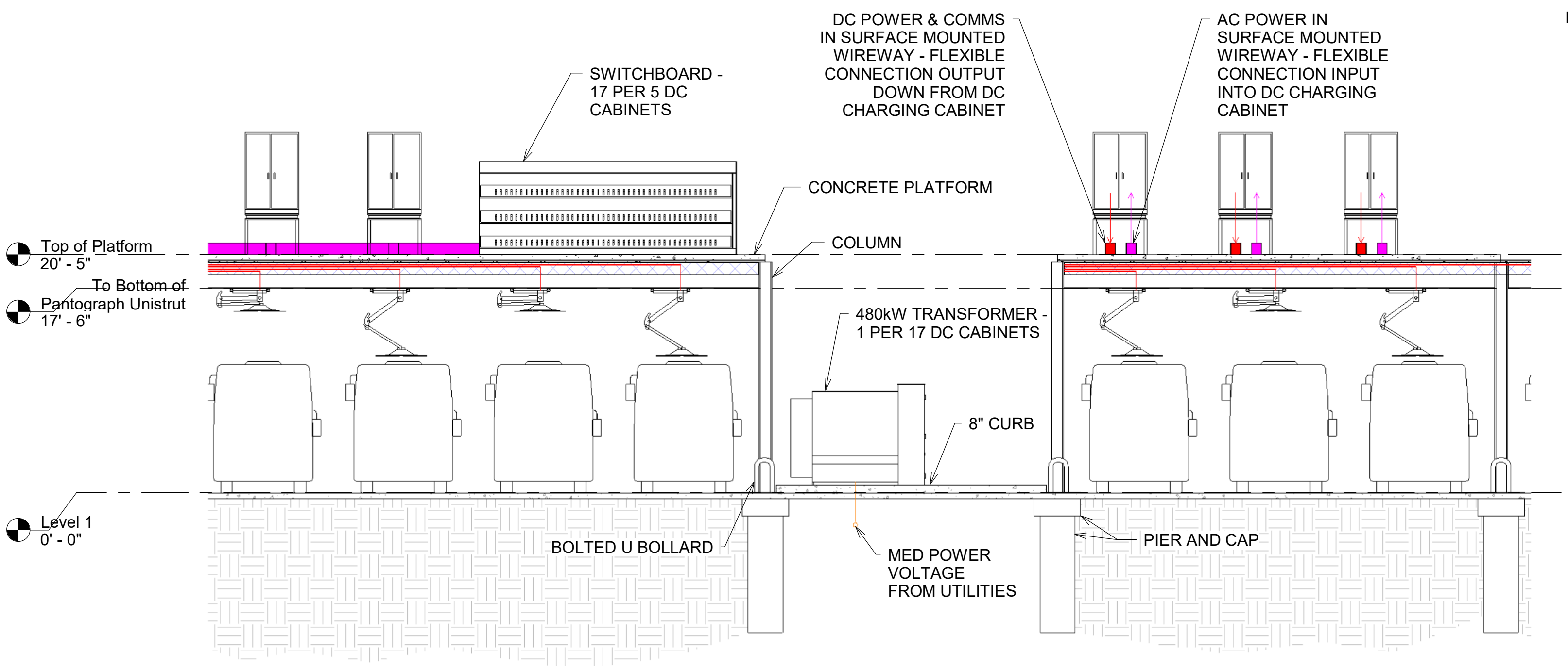
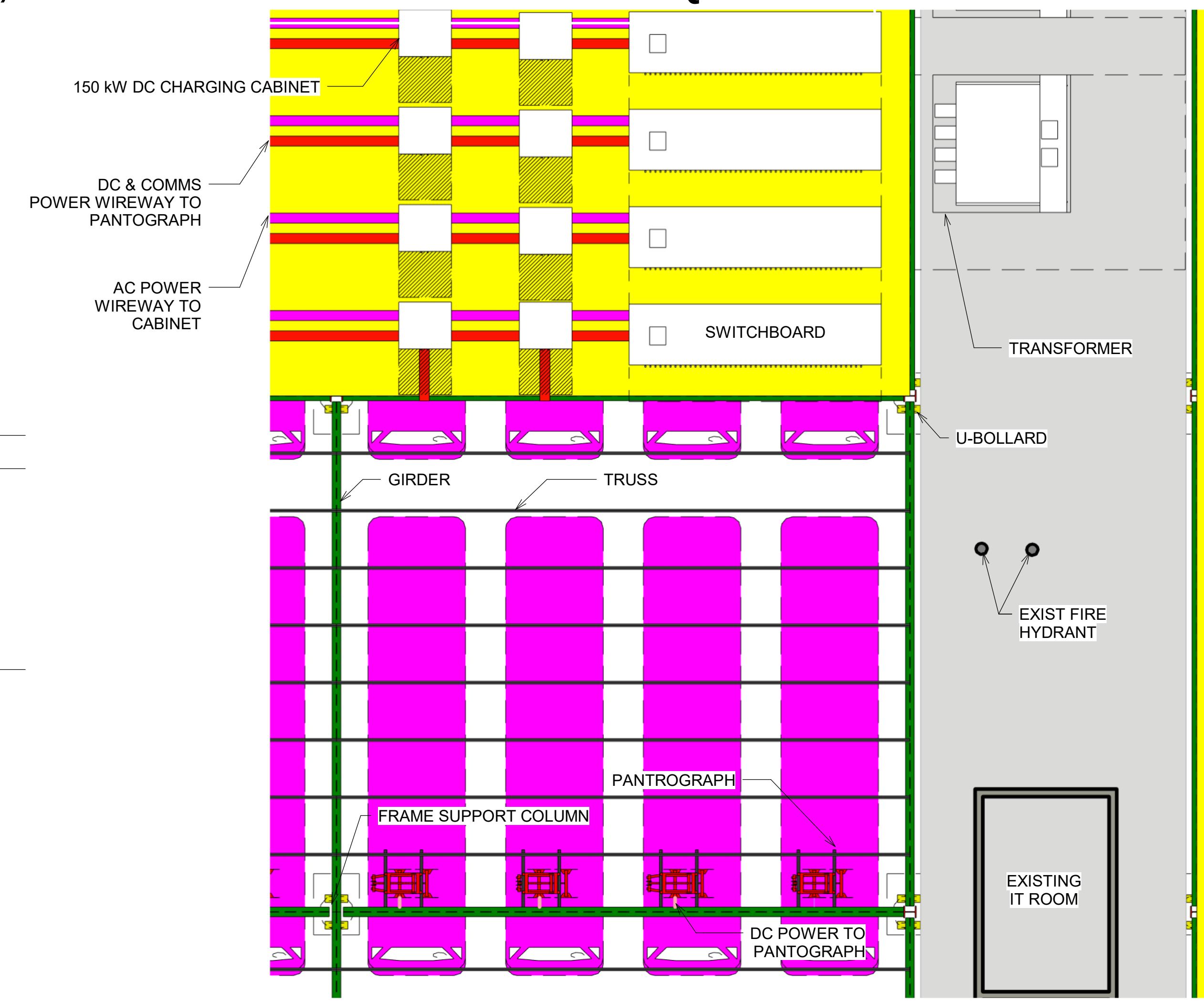
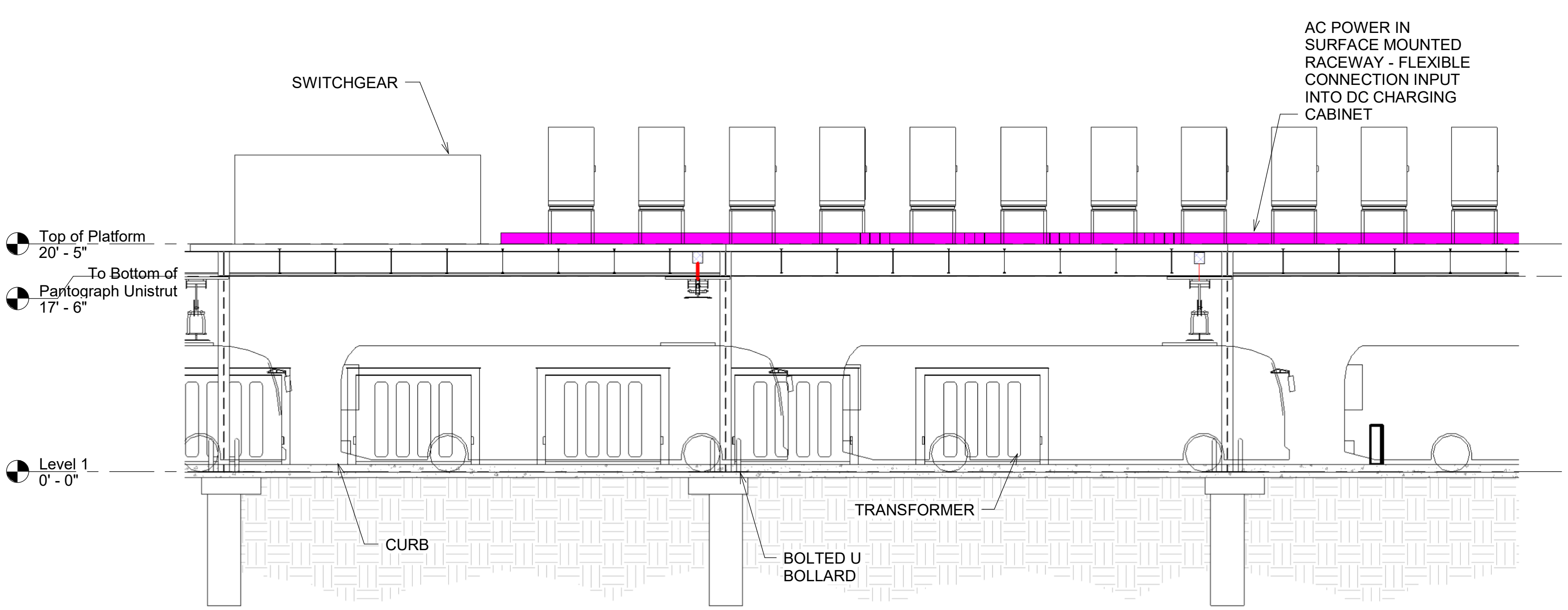
OPTION 3 – OVERHEAD FRAME, INVERTED PANTOGRAPH, PLATFORM MOUNTED ELECTRICAL EQUIPMENT



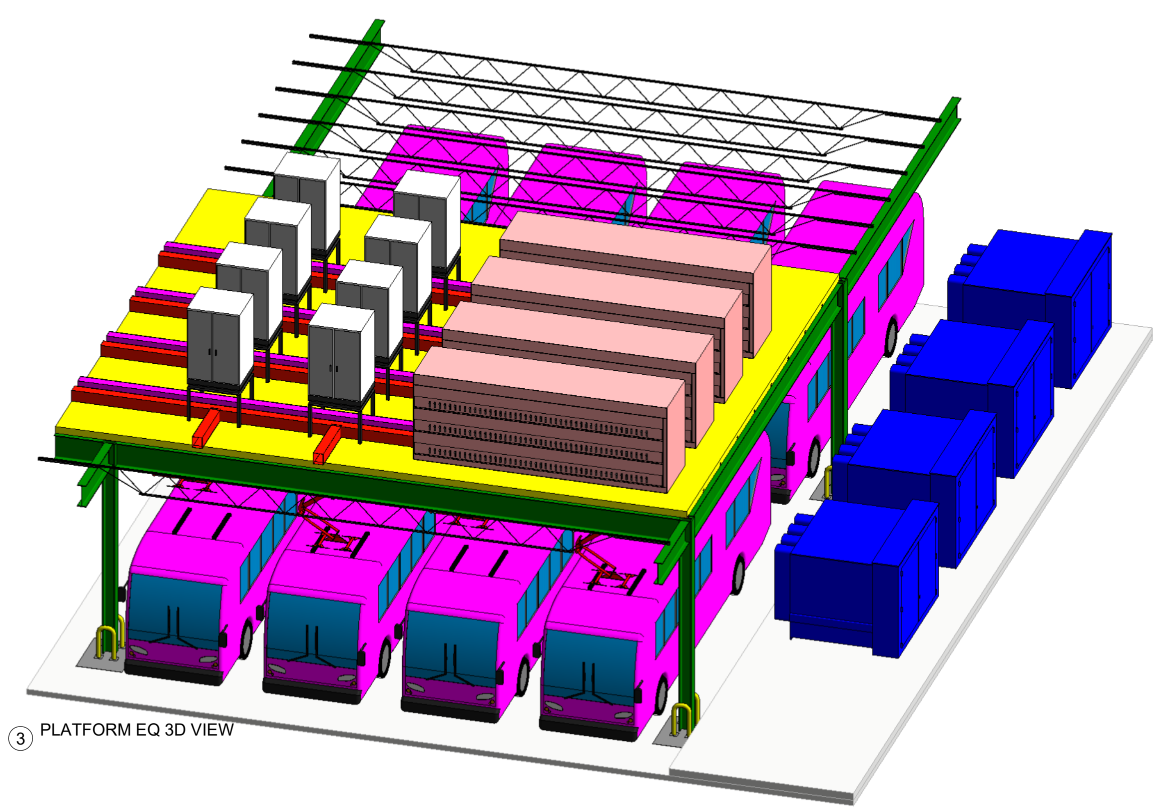
1 OVERHEAD PLATFORM EQUIPMENT CROSS SECTION 1/8" = 1'-0"



4 Panto EQ above 1/8" = 1'-0"



2 OVERHEAD PLATFORM EQUIPMENT LONGITUDINAL SECTION 1/8" = 1'-0"



3 PLATFORM EQ 3D VIEW

PROJECT NO.	12127B
DRAWN BY	Author
DATE	05/08/20
SCALE	1/8" = 1'-0"

PROJECT TITLE
SBMF ELECTRIC BUS

DOKKEN ENGINEERING

WSP

DRAWING TITLE
DETAILS - PANTO, PLAT MTD ELEC EQP

DRAWING NUMBER
4.5

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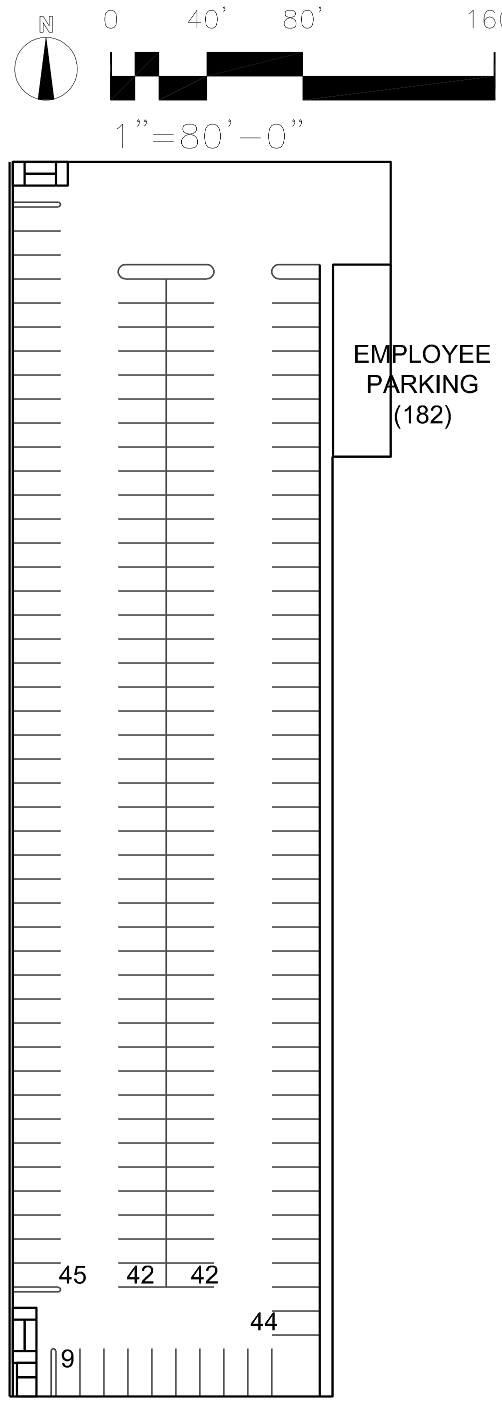
OPTION 4 - INDUCTION CHARGING



STATISTICS

Assigned Buses:	
40' CNG	0
40' CNG- DOWN	0
40' BEB	227
60' CNG (Rapid 225)	0
60' CNG (artic transit)	0
60' BEB	27
TOTAL	254

PROJECT NO.	12127B
DRAWN BY	JVC
DATE	06/1/20
SCALE	1" = 80'-0"

PROJECT TITLE

MTS

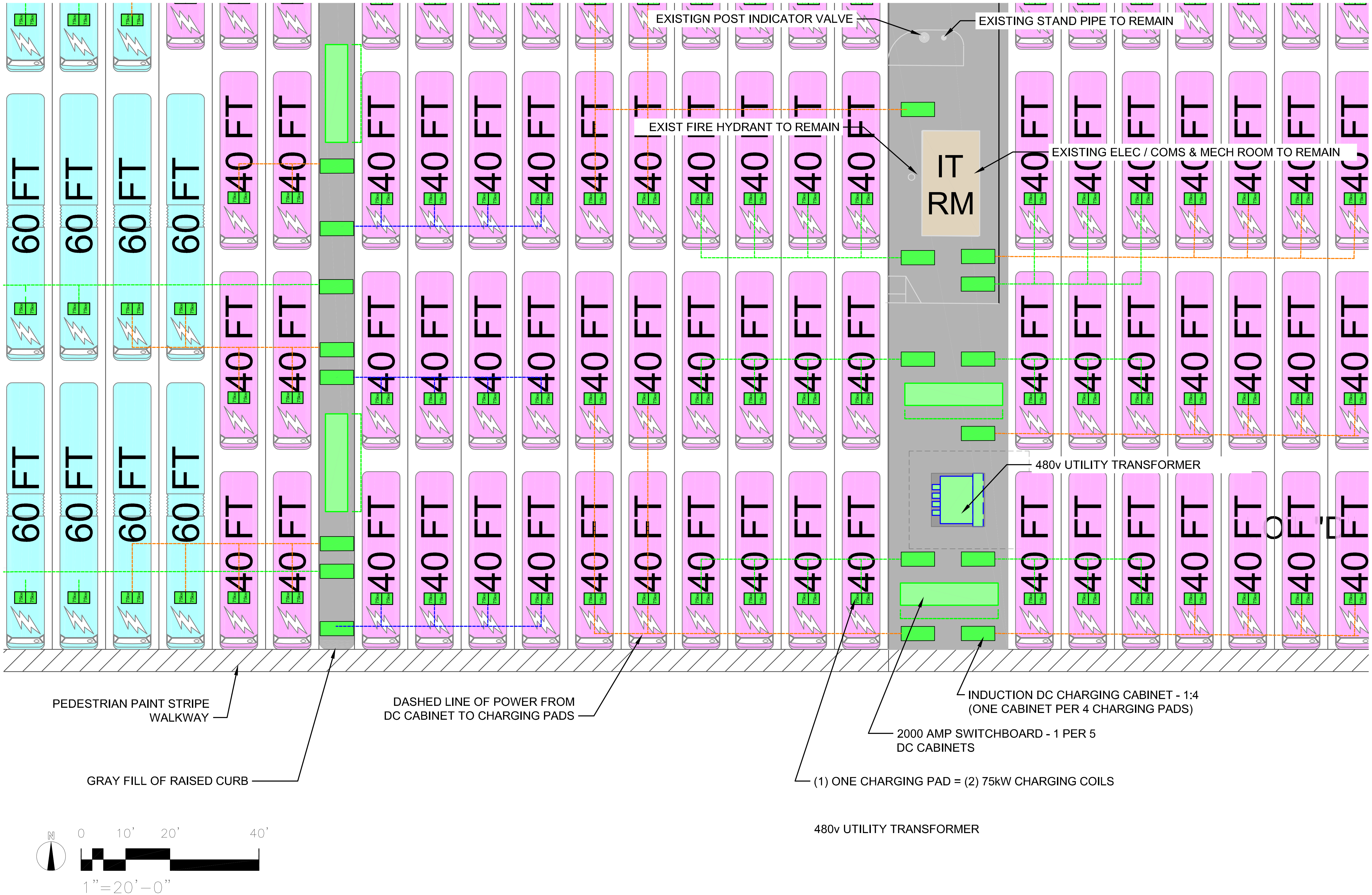
DOKKEN ENGINEERING

WSP USA Inc.
16200 PARK ROW
SUITE 200
HOUSTON, TEXAS 77084
TEL (281) 589-5900
FAX (281) 759-5164

DRAWING TITLE
MASTER PLAN
INDUCTION
MAX BUS PARK

DRAWING NUMBER
4.6

OPTION 4 - INDUCTION CHARGING



PROJECT NO. 12127B

DRAWN BY JVC

DATE 06/1/20

SCALE 1" = 80'-0"

PROJECT TITLE

MTS

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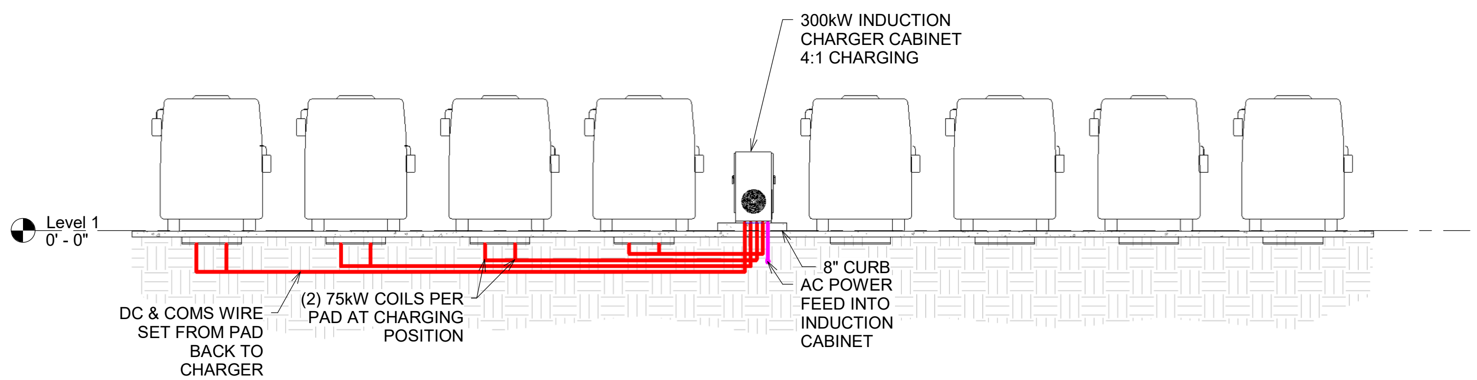
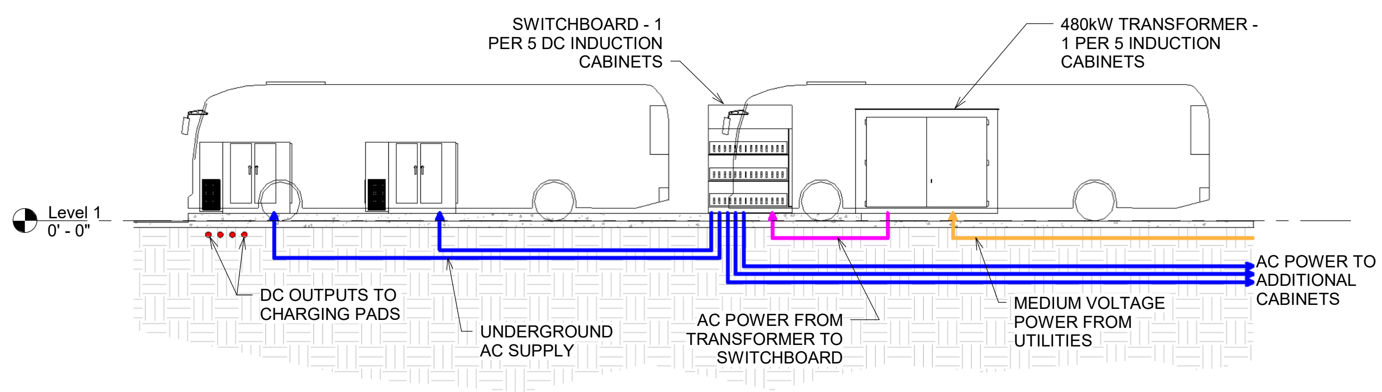
DRAWING TITLE
MASTER PLAN
INDUCTION
MAX BUS PARK

DRAWING NUMBER
4.7

OPTION 4 - INDUCTION CHARGING



1 INDUCTION CROSS SECTION
1/8" = 1'-0"



2 INDUCTION LONGITUDINAL SECTION
1/8" = 1'-0"

3 INDUCTION FLOOR PLAN
1/8" = 1'-0"

4 INDUCTION 3D VIEW

PROJECT NO.	12127B
DRAWN BY	PCG
DATE	05/31/20
SCALE	1/8" = 1'-0"
PROJECT TITLE	SBMF ELECTRIC BUS
DRAWING TITLE	INDUCTION DETAILS
DRAWING NUMBER	4.8

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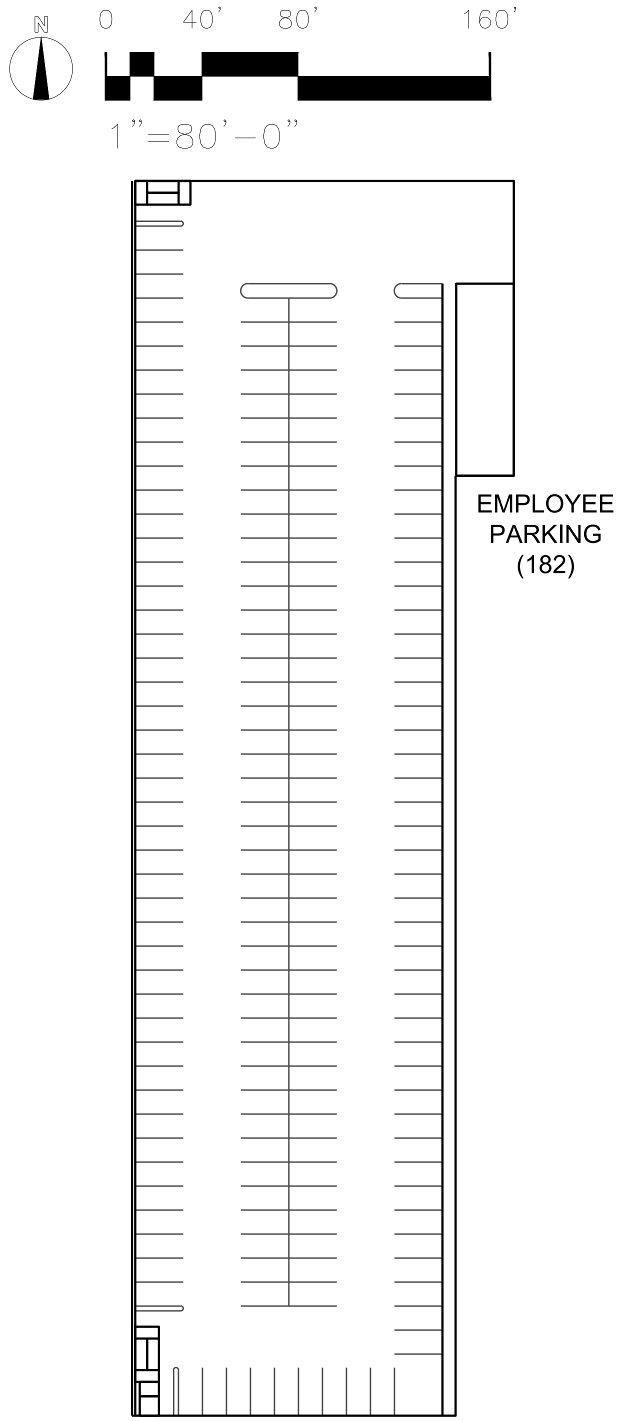
OPTION 5 – OVERHEAD FRAME, PLUG IN CHARGER WITH RETRACTOR REELS



STATISTICS

Assigned Buses:

40' CNG	0
40' CNG- DOWN	0
40' BEB	228
60' CNG (Rapid 225)	0
60' CNG (artic transit)	0
60' BEB	27
TOTAL	255

PROJECT NO.	12127B
DRAWN BY	JVC
DATE	06/24/2020
SCALE	1" = 80'-0"

PROJECT TITLE

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TEL: (281) 589-5900
FAX: (281) 759-5164

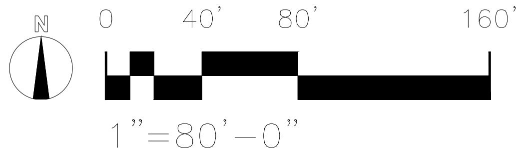
DRAWING TITLE

MASTER PLAN
PLUG IN CHRGR
W/ REELS

DRAWING NUMBER

4.9

OPTION 6 – GROUND MOUNTED PLUG-IN CHARGING



STATISTICS

Based on SBBMF as builts and Bus Line up Blank 1 (1-26-2019):

Assigned Buses:

40' CNG	0
40' CNG- DOWN	0
40' BEB	165
60' CNG (Rapid 225)	0
60' CNG (artic transit)	0
60' BEB	27
TOTAL	199

PROJECT NO.	12127B
DRAWN BY	JVC
DATE	06/24/2020
SCALE	1" = 80'-0"

PROJECT TITLE

MTS

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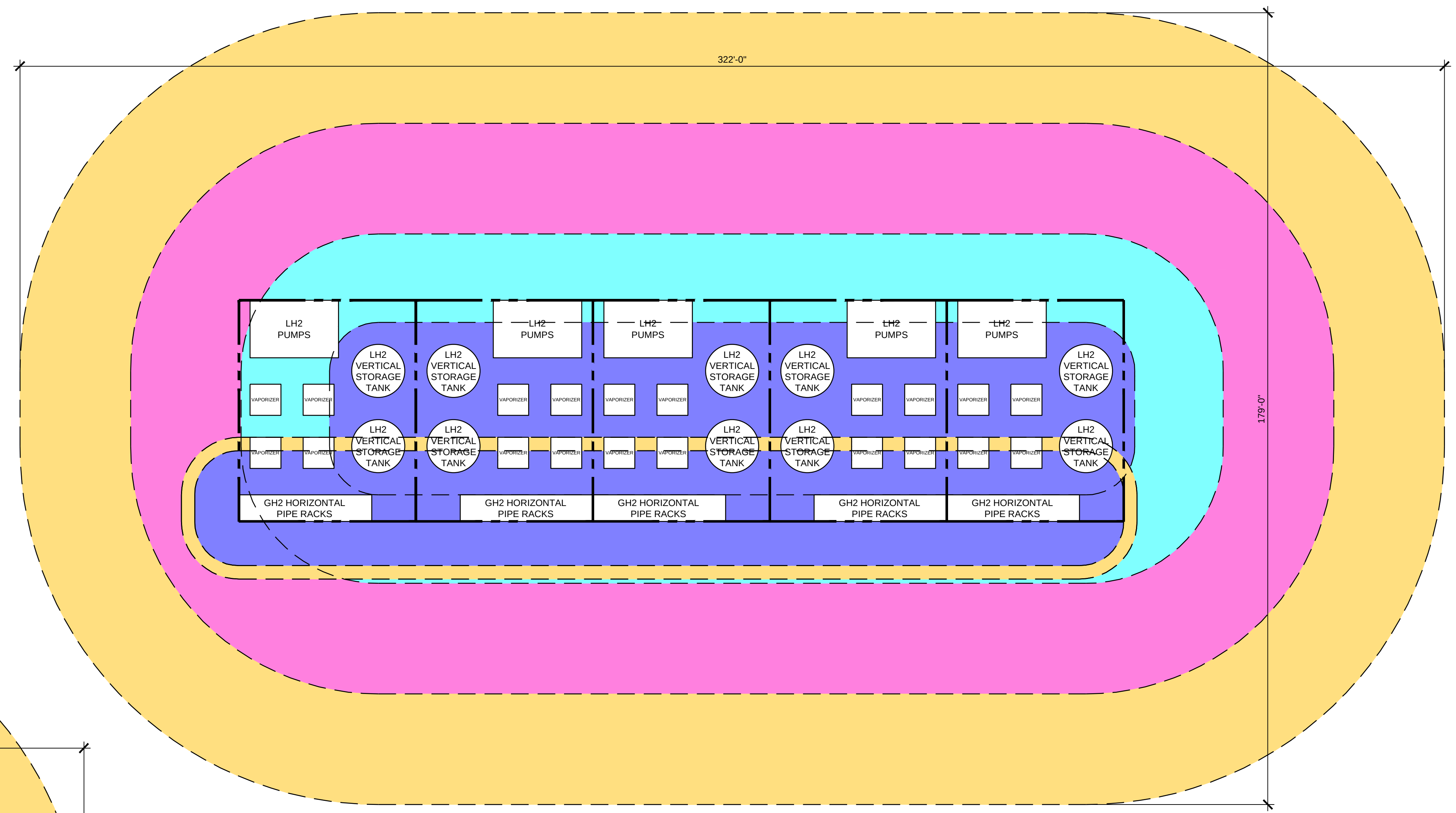
DRAWING TITLE

MASTER PLAN
PLUG-IN CABINET
GRND MTD

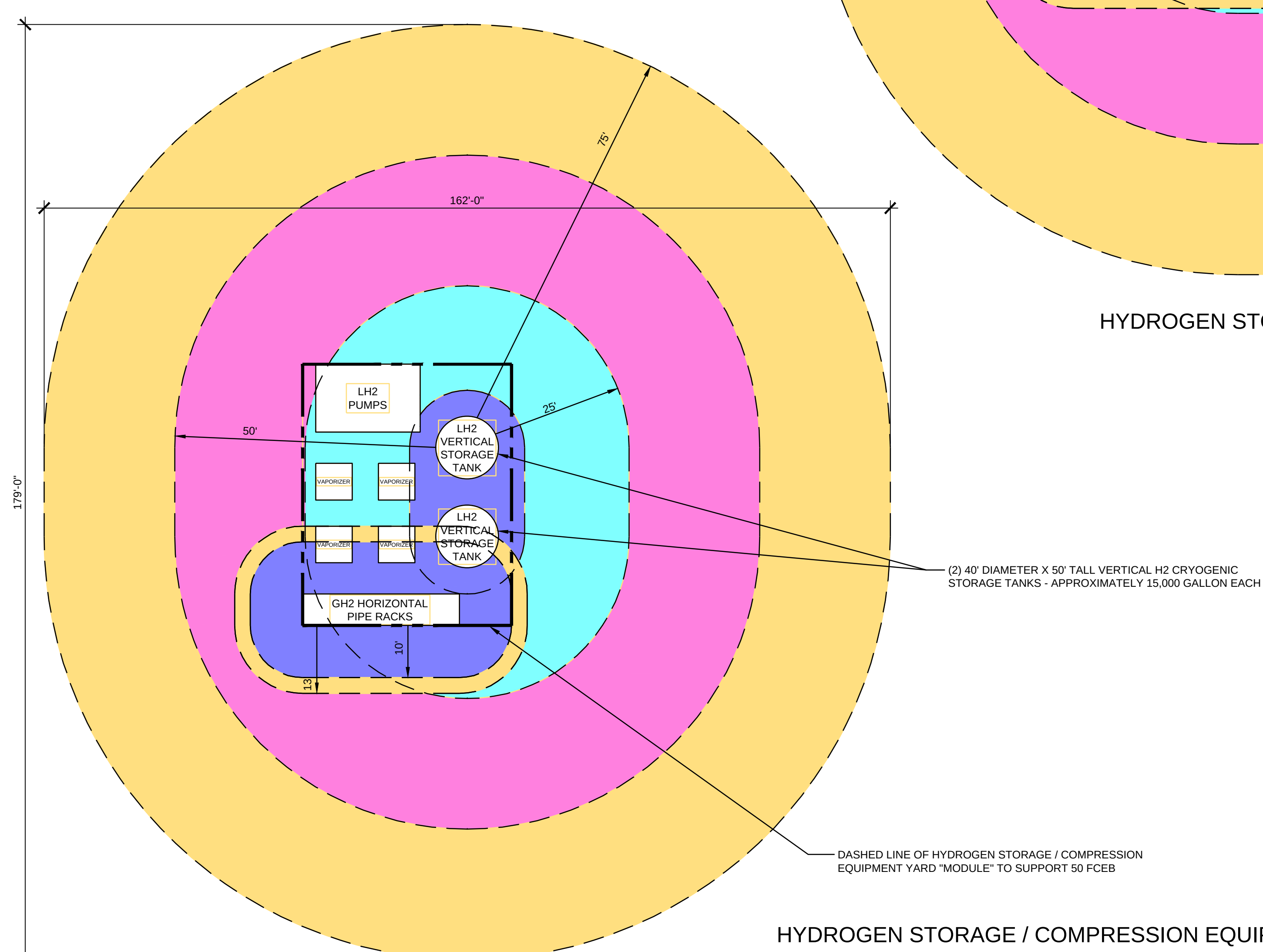
DRAWING NUMBER

4.10

OPTION 7 – HYDROGEN FUEL



HYDROGEN STORAGE / COMPRESSION EQUIPMENT YARD TO SUPPORT UP TO 250 FCEB = 5 H2 YARD MODULES



HYDROGEN STORAGE / COMPRESSION EQUIPMENT YARD "MODULE" TO SUPPORT 50 FCEB

- TO AIR INTAKES AND BUILDING OPENINGS
- TO LOT/PROPERTY LINES
- TO PARKED CARS
- TO SPRINKLED BUILDINGS OF NON-COMBUSTIBLE CONSTRUCTION

SETBACKS BASED ON NFPA 2, 2016 EDITION

0 5' 10' 20' 40'
1/16"=1'-0"

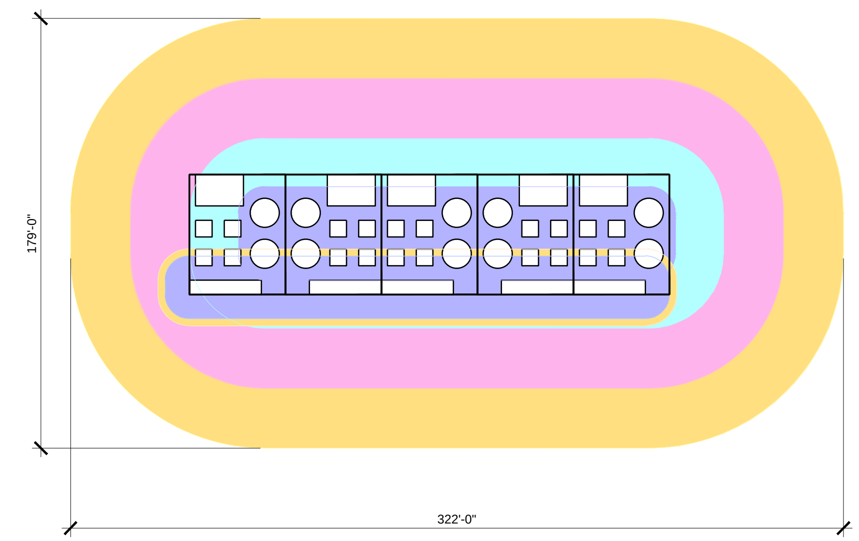
PROJECT NO. 12127B
DRAWN BY JVC
DATE 08-25-20
SCALE 22x34 1/16"= 1'-0" 11 X 17 1/32" = 1'-0"

PROJECT TITLE
SOUTH BAY MAINTENANCE FACILITY (SBMF)
ZERO EMISSION BUS CONCEPT LAYOUT

DRAWING TITLE
EXTERIOR HYDROGEN COMPRESS / STORE YARD SETBACKS

DRAWING NUMBER
4.11.1

OPTION 7 – HYDROGEN FUEL



TO AIR INTAKES AND BUILDING OPENINGS

TO LOT/PROPERTY LINES

TO PARKED CARS

TO SPRINKLED BUILDINGS OF NON-COMBUSTIBLE CONSTRUCTION

0' 20' 40' 80'

SCALE: 1"=40'–0"

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PROJECT NO.	189247A
DRAWN BY	MAG / JVC
DATE	8/25/2020
SCALE	22x34 1"=40'-0" 11 X 17 1"=80'-0"

PROJECT TITLE
SOUTH BAY MAINTENANCE FACILITY (SBMF) ZERO EMISSION BUS CONCEPT LAYOUT

MTS

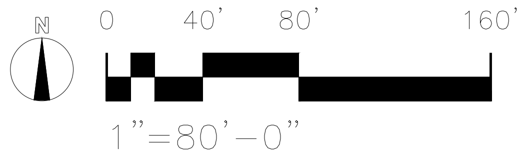
DOKKEN ENGINEERING

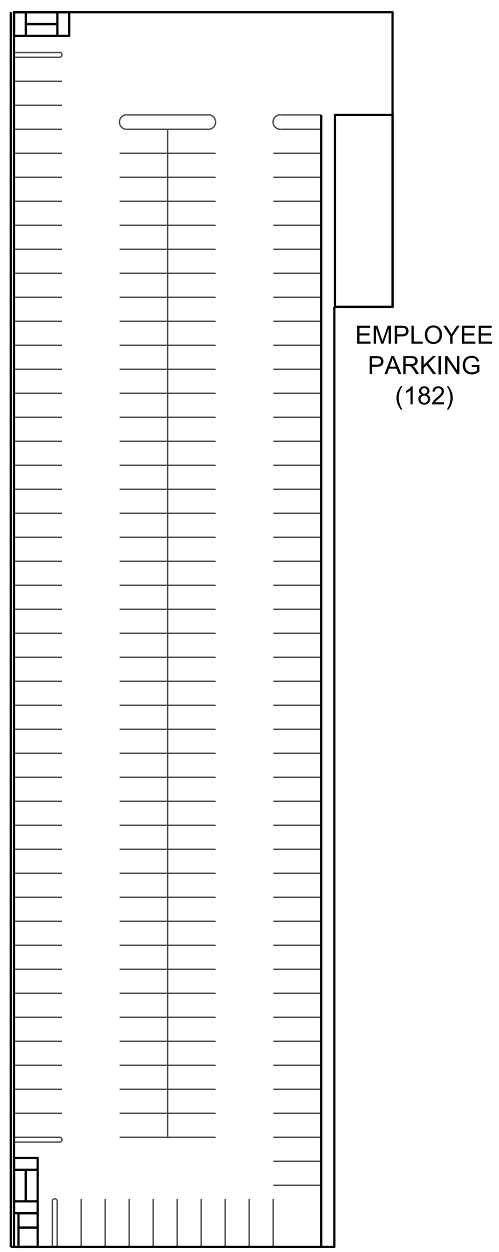
wsp

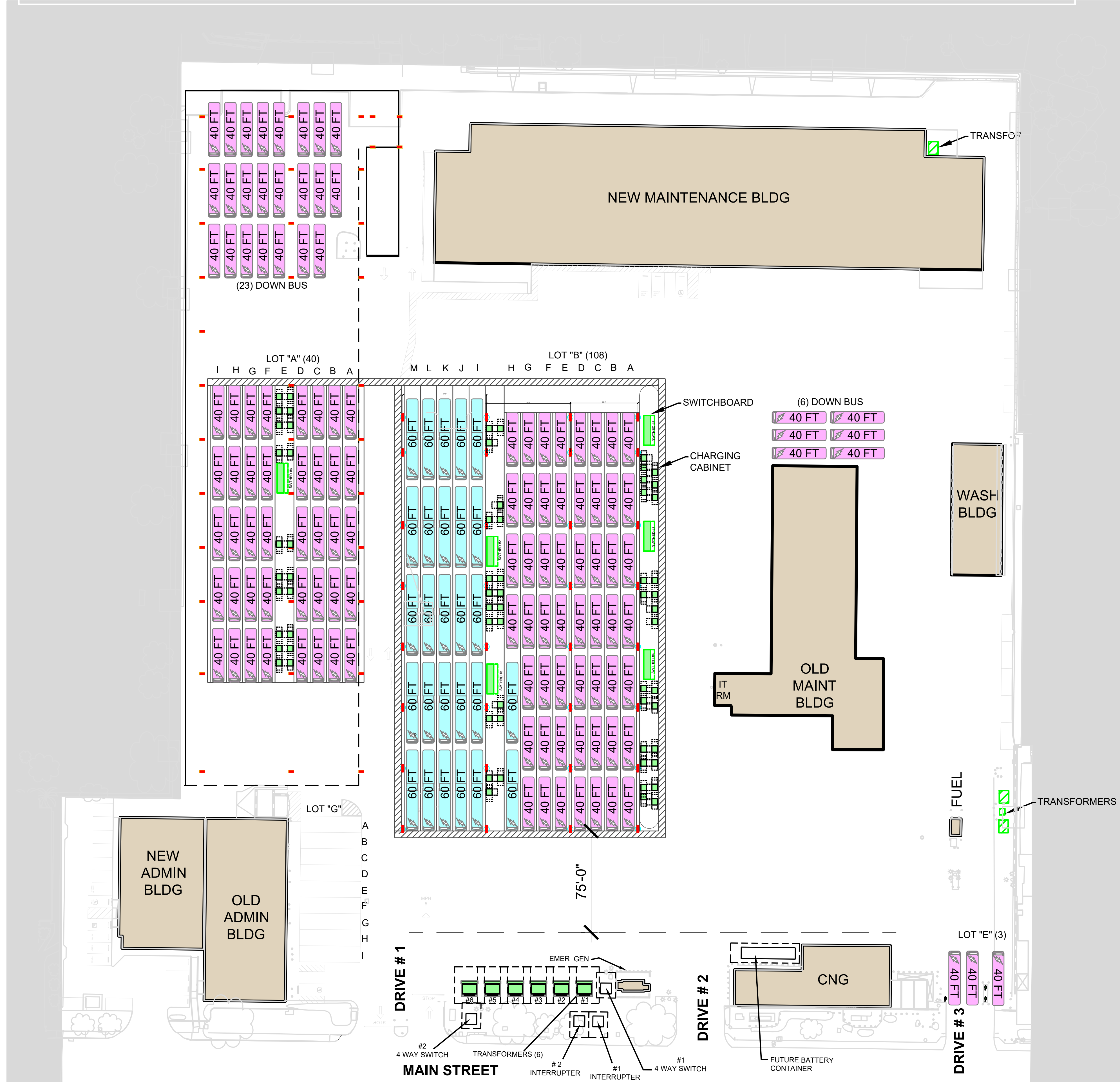
DRAWING TITLE
HYDROGEN FUEL COMPRES / STORE YARD ON SITE

DRAWING NUMBER
4.11.2

OPTION 8 – OVERHEAD FRAME, INVERTED PANTOGRAPH, OLD MAINTENANCE BUILDING TO REMAIN







STATISTICS

Assigned Buses:	
40' CNG	0
40' CNG- DOWN	0
40' BEB	151
60' CNG (Rapid 225)	0
60' CNG (artic transit)	0
60' BEB	27
TOTAL	178

PROJECT NO.	12127B
DRAWN BY	MAG
DATE	08/20/20
SCALE	1" = 80'-0"

PROJECT TITLE

MTS

DOKKEN ENGINEERING

WSP USA Inc.
16200 PARK ROW
SUITE 200
HOUSTON, TEXAS 77084
TEL: (281) 589-5900
FAX: (281) 759-5164

DRAWING TITLE
OVHD PANTO OLD MAINT. BLDG

DRAWING NUMBER
4.12

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CHAPTER 5 – MASTER PLANS & RECOMMENDATION

MASTER PLAN AND RECOMMENDATION

INTRODUCTION

The MTS selected master plan design concepts outlined in this chapter are based on:

- Meeting the project goals and parameters set forth in Chapter 1.
- Total fleet of 253 BEBs.
- Utilizing overhead inverted pantograph DC charging equipment energized and controlled by ground mounted DC charging cabinets.
- Minimizing underground routing of electrical conduit to maximize flexibility in the future
- Minimizing disturbance of underground stormwater retention and biofiltration vaults as shown on Exhibit 5.2.

Two master plans were developed and refined based on MTS feedback and comments:

Option 1: Overhead Frame, Inverted Pantograph, Ground Mounted Electrical Equipment, Employee Parking Deck. This option accommodates a total of 253 ZEBs with overhead frame and inverted pantograph charging with existing maintenance building removed and lot re-striped. Ground mounted new electric service and charging and distribution infrastructure equipment. Private car parking on elevated deck.

Option 2: Overhead Frame, Inverted Pantograph, Ground Mounted Electrical Equipment, NO Employee Parking Deck. Identical to Option 1 but without the private car parking on elevated deck.

OPTION 1 - OVERHEAD FRAME, INVERTED PANTOGRAPH, GROUND MOUNTED ELECTRICAL EQUIPMENT, PARKING DECK

A site layout (Exhibit 5.1) was developed for the SBMF to accommodate the charging and storage of battery electric buses.

This option allows the existing New & Old Maintenance Buildings and Wash Bay to remain operational during construction.

The Old Maintenance Building will be demolished in order to accommodate new bus parking. The only room to remain will be the existing Electrical / Communications & Mechanical Room (MTS explore the option to move these spaces to new Maintenance Building), and the existing fire hydrant, the existing post indicator valve, and the exiting standpipe; all located on the southwest corner of the Old Maintenance Building.

Existing bus entry/exit will remain the same. Buses will enter/leave site from Main St. via Driveway 1 maintaining the existing flow. Buses will circulate through the site and proceed to the wash facility and then return to the bus parking area where they are parked nose-to-tail in vertical tracks.

While the flow is maintained, some site features such as parking track capacity, track widths, track locations, bypass-lane location and on-site parking for staff personal vehicle is changed from the existing layout.

The bus parking area will be reconfigured, and a gantry system will need to be constructed to support overhead pantograph charging and solar panels. New concrete islands will need to be constructed to locate charging cabinets and switchgear. Transformers will be located adjacent to the existing Emergency Generator, on the south side of the site.

A new concrete deck (Exhibit 5.3) will be constructed on the north west side of the site to support employee parking. Below the parking structure, bus parking will be configured. The deck will be designed to support the overhead pantograph charging system.

The original tracks would be replaced with new track locations as shown on Exhibit 5.1:

- Lot A will store (40) 40'-buses and will remain where employee parking is currently located. It will have 8 tracks, labeled A through I, and an island in the middle for charging equipment. Pantographs will be suspended from the parking deck structure.

- Lot B will store 108 buses, (27) 60'-buses, and (81) 40'-buses. This lot will be in the center part of the site and it will have 17 tracks, labeled A through R and an island adjacent to track L for charging equipment. Pantographs will be suspended from new gantry system.
- Lot C will store (77) 40'-buses and will be in the area where the Old Maintenance Building is currently located. This lot will have 11 tracks, labeled A through K, and an island adjacent to track K for charging equipment, existing Elect/Comm&Mech room, and existing fire hydrant.

Pros:	**Cons:**
• Employee parking deck can accommodate all employee parking required. • Employee parking deck allows separation of employee parking and bus parking. • Mature technology, with standards established. • Ground mounted charging equipment does not require platform above, thus the need of manlift or catwalk for maintenance and service. • Easy access for maintenance when charging cabinets and switchboards are located on the ground. • DC charging cabinets can be remotely located. • The overhead pantograph eliminates the need for floor space for ground-mounted charging dispensers. • Minimal operator intervention is required at the charging position. • There is no need for cord management.	• Parking deck cost. • Pantographs require adequate space under enclosed garage roof structures or new overhead frame support structures at exterior bus parking areas. • Mixed fleet requires different spacing when in tracks. • Scheduling proper routes will be critical.

OPTION 2 – OVERHEAD FRAME, INVERTED PANTOGRAPH, GROUND MOUNTED ELECTRICAL EQUIPMENT, NO PARKING DECK

Like Master Plan Option 1, this master plan does not require the construction of a parking deck for employee parking as shown on Exhibit 5.4. Buses will park during the night on the employee parking on the west side of the site "Lot A". (22) down buses will be parked on the northwest corner of the site, reducing the number of employee parking spaces to (113) (Exhibit 5.5).

This option allows the existing New & Old Maintenance Buildings, Wash Bay to remain operational during construction.

The Old Maintenance Building will be demolished in order to accommodate new bus parking. The only room to remain will be the existing Electrical / Communications & Mechanical Room (MTS explore the option to move these spaces to new Maintenance Building), and the existing fire hydrant, the existing post indicator valve, and the exiting standpipe; all located on the southwest corner of the Old Maintenance Building.

Site flow, existing bus entry/exit will remain the same.

The bus parking area will be reconfigured, and a gantry system will need to be constructed to support overhead pantograph charging and solar panels. New concrete islands will need to be constructed to locate charging cabinets and switchgear. Transformers will be located adjacent to the existing Emergency Generator, on the south side of the site.

The original tracks would be replaced with new track locations as shown on Exhibit 5.4:

- Lot A will store (40) 40'-buses and will remain where employee parking is currently located. It will have 8 tracks, labeled A through I, and an island in the middle for charging equipment. Pantographs will be suspended from new gantry system.

- Lot B will store 108 buses, (27) 60'-buses, and (81) 40'-buses. This lot will be in the center part of the site and it will have 17 tracks, labeled A through R and an island adjacent to track L for charging equipment. Pantographs will be suspended from new gantry system.
- Lot C will store (77) 40'-buses and will be in the area where the Old Maintenance Building is currently located. This lot will have 11 tracks, labeled A through K, and an island adjacent to track K for charging equipment, existing Elect/Comm&Mech Room, and existing fire hydrant.

Pros:	**Cons:**
• Major savings due to not having to construct parking deck for employees. • Ground mounted charging equipment does not require platform above, thus the need of manlift or catwalk for maintenance and service. • Easy access for maintenance when charging cabinets and switchboards are located on the ground. • Mature technology, with standards established. • DC charging cabinets can be remotely located. • The overhead pantograph eliminates the need for floor space for ground-mounted charging dispensers. • Minimal operator intervention is required at the charging position. • There is no need for cord management.	• Shared employee parking and bus parking. • Scheduling proper routes will be even more critical with this option with shared parking. • Pantographs require adequate space under enclosed garage roof structures or new overhead frame support structures at exterior bus parking areas. • Mixed fleet requires different spacing when in tracks.

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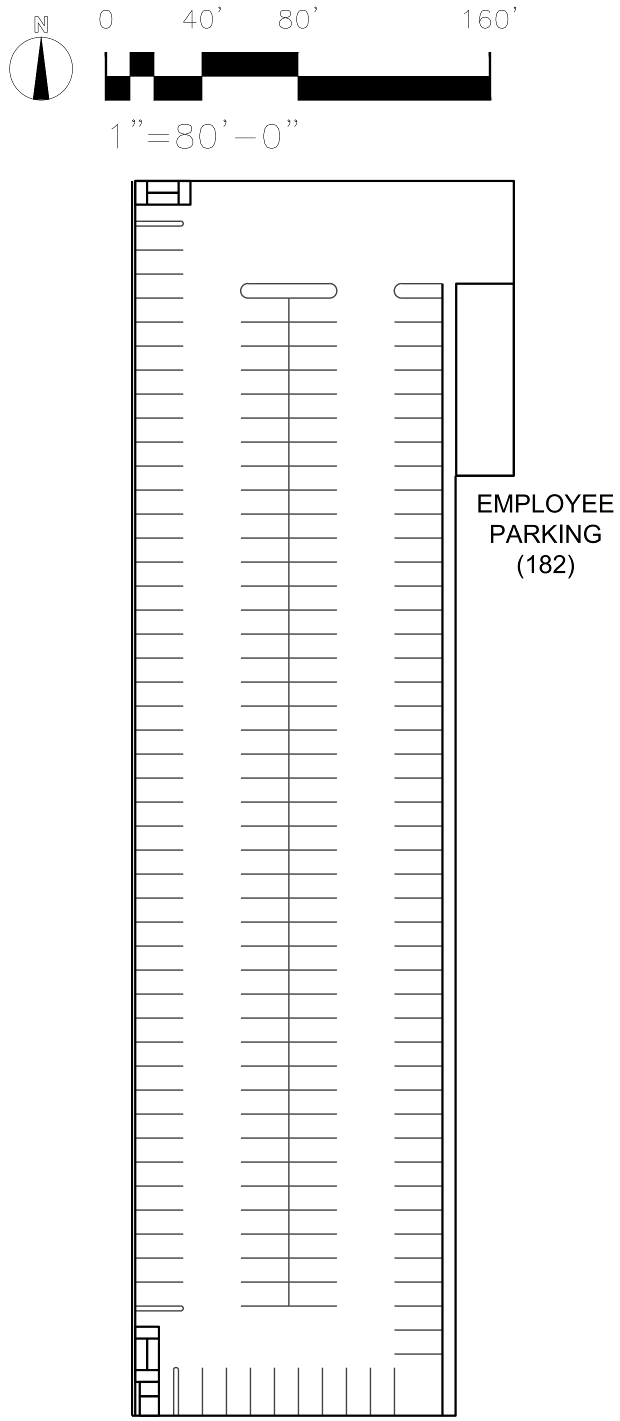


STATISTICS

Assigned Buses:

40' CNG	0
40' CNG- DOWN	0
40' BEB	228
60' CNG (Rapid 225)	0
60' CNG (artic transit)	0
60' BEB	27
TOTAL	255

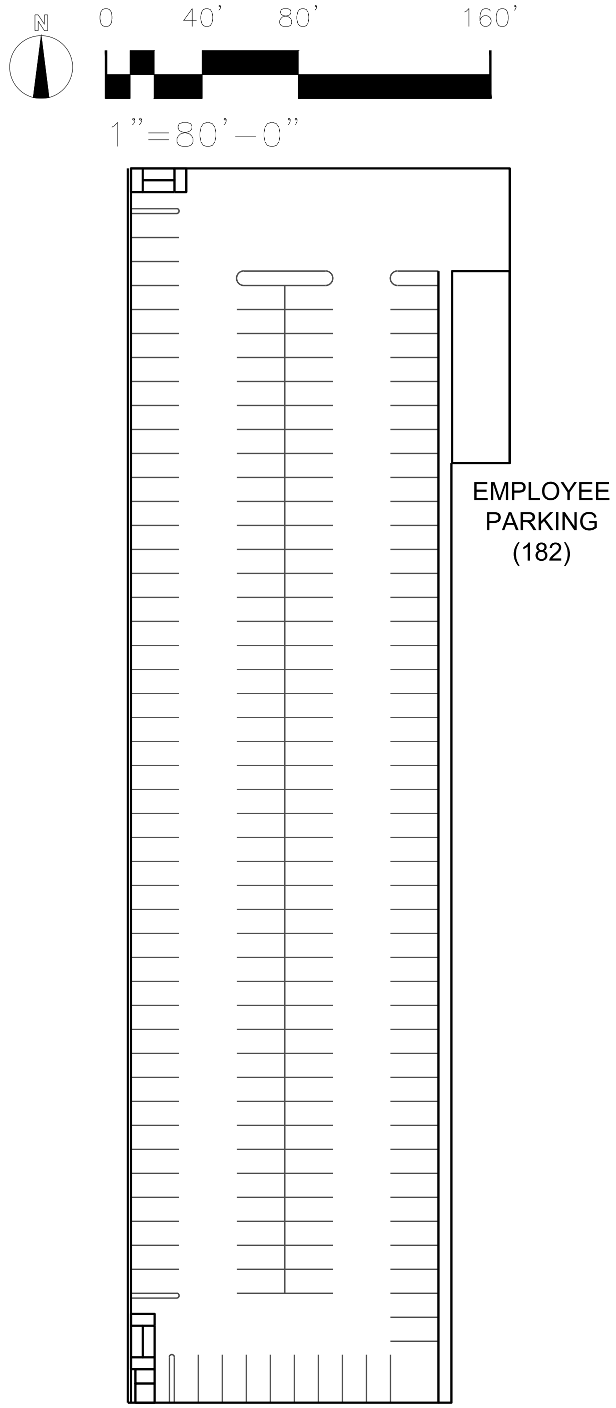
OPTION 1 - EMPLOYEE PARKING DECK

DRAWING TITLE
MASTER PLAN
OVHD CHARGER
GRND MTD CABS

DRAWING NUMBER
5.1

PROJECT TITLE

PROJECT NO.	12127B
DRAWN BY	JVC
DATE	06/24/2020
SCALE	1" = 80'-0"



STATISTICS

Assigned Buses:	
40' CNG	0
40' CNG- DOWN	0
40' BEB	228
60' CNG (Rapid 225)	0
60' CNG (artic transit)	0
60' BEB	27
TOTAL	255

OPTION 1 - EMPLOYEE PARKING DECK - UTILITIES OVERLAY

PROJECT NO.	12127B
DRAWN BY	JVC
DATE	06/24/2020
SCALE	1" = 80'-0"

PROJECT TITLE

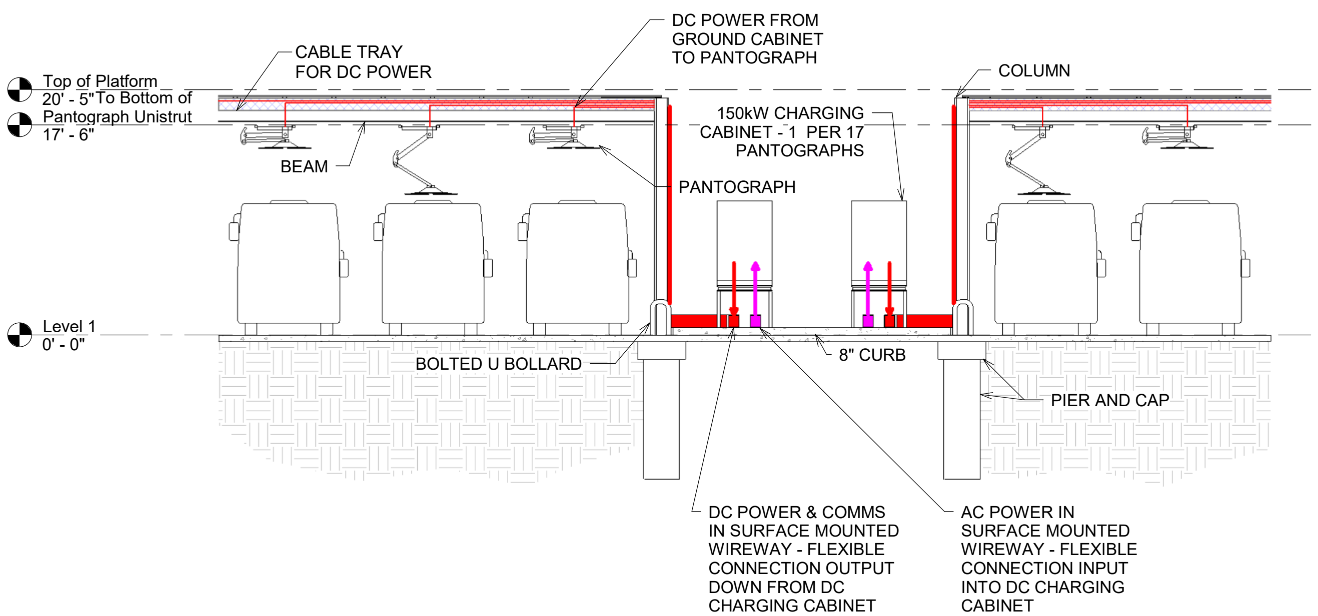
MTS

DOKKEN ENGINEERING

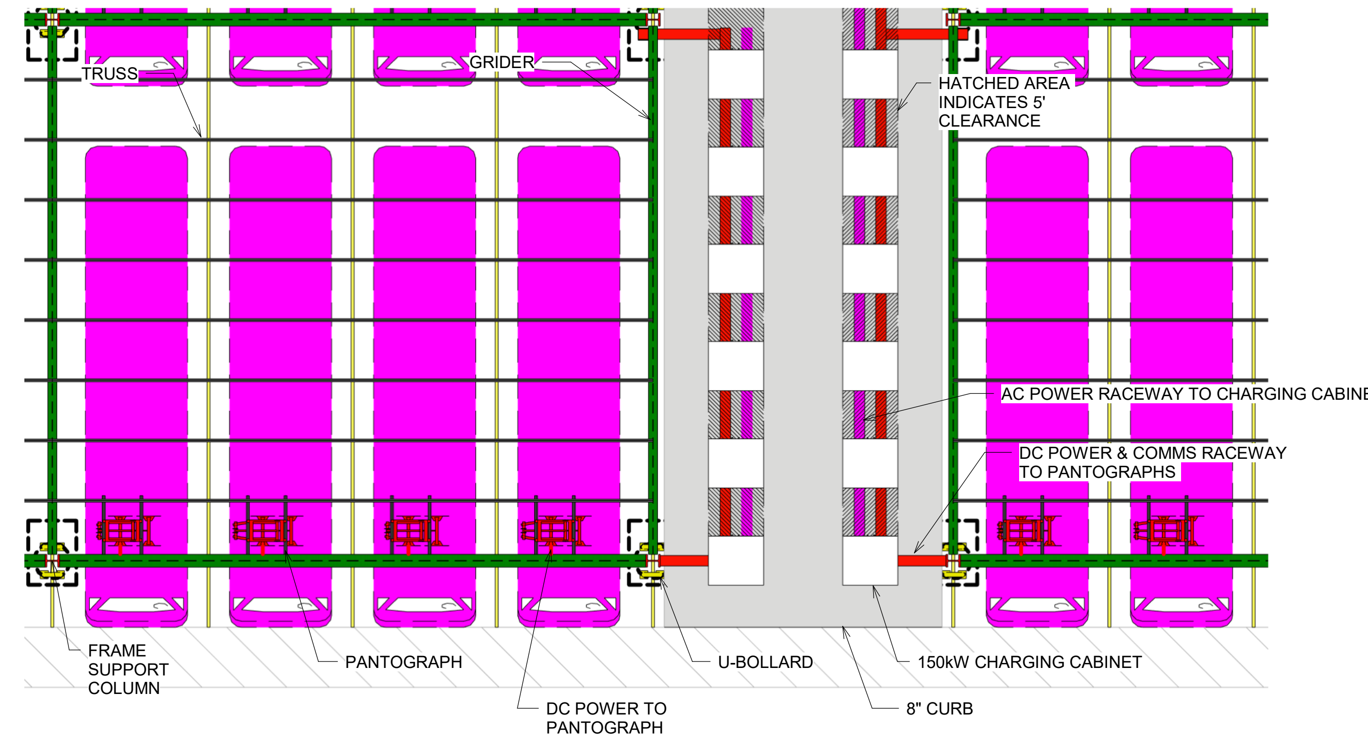
WSP USA Inc.

DRAWING TITLE
MASTER PLAN
OVHD CHARGER
GRND MTD CABS

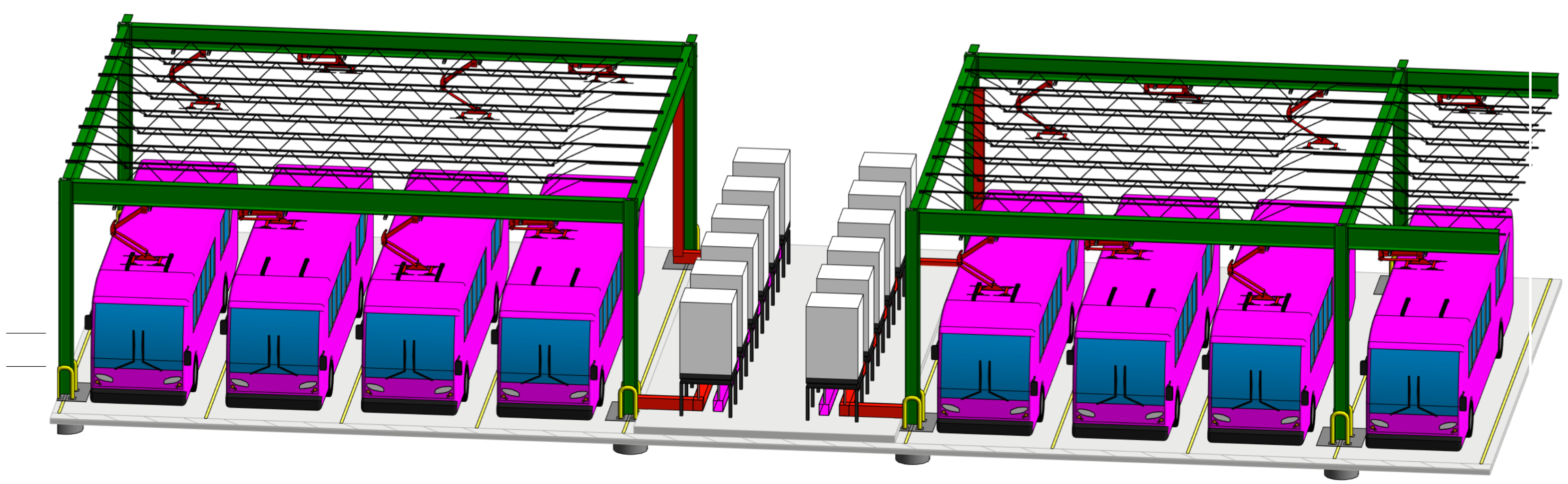
DRAWING NUMBER
5.2



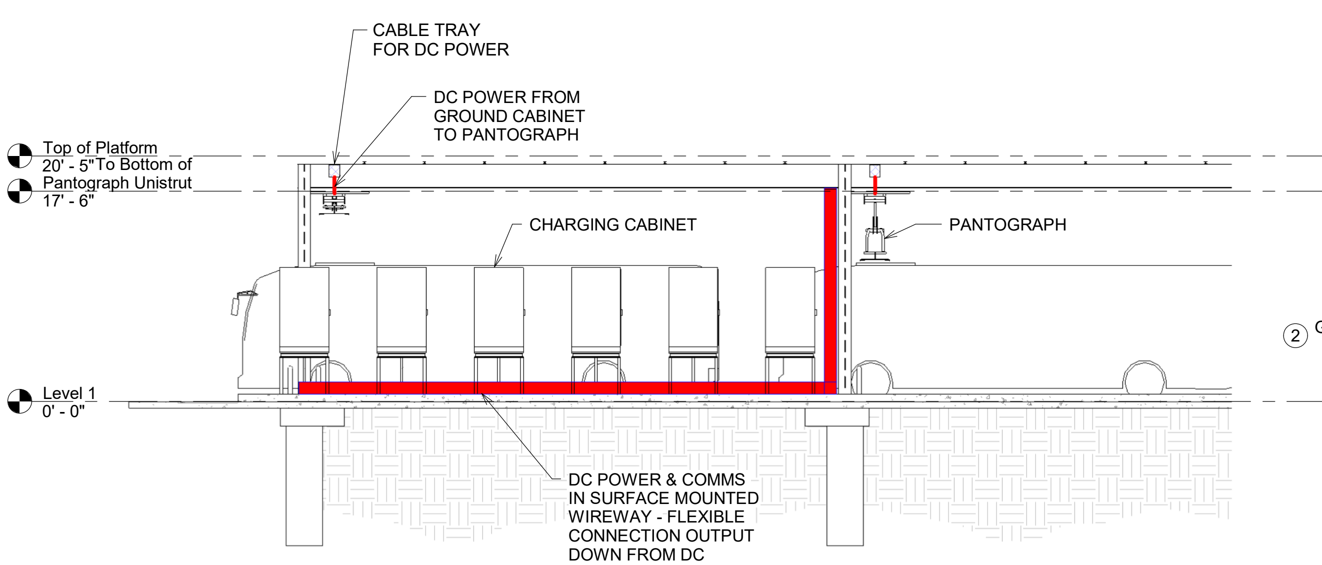
1 GROUND CABINET CROSS SECTION
1/8" = 1'-0"



3 GROUND CABINET FLOOR PLAN
1/8" = 1'-0"



2 GROUND CABINETS 3D VIEW



4 GROUND CABINET LONGITUDINAL
SECTION
1/8" = 1'-0"

PROJECT NO.	12127B
DRAWN BY	Author
DATE	05/28/20
SCALE	1/8" = 1'-0"

PROJECT TITLE
SBMF ELECTRIC BUS

MTS

DOKKEN ENGINEERING
1450 FRAZEE ROAD
SUITE 100
SAN DIEGO, CA 92108
(858) 514-8377

wsp

DRAWING TITLE
OVHD PANTO GROUND EQUIPMENT

DRAWING NUMBER
5.3

DETAILS

6/2/2020 8:53:03 AM

C:\Users\gedda\Documents\2. Projects\12127B MTS San Diego SBBMF BEB\SBBMF OVHD Charger Max Bus Park_PG.rvt

N

0 40' 80' 160'

1"=80'–0"

STATISTICS

Assigned Buses:	
40' CNG	0
40' CNG- DOWN	0
40' BEB	228
60' CNG (Rapid 225)	0
60' CNG (artic transit)	0
60' BEB	27
TOTAL	255

OPTION 2 - NO EMPLOYEE PARKING DECK

PROJECT NO.	12127B
DRAWN BY	CDE
DATE	07/13/2020
SCALE	1" = 80'-0"

PROJECT TITLE

MTS

DOKKEN ENGINEERING

WSP USA Inc.
16200 PARK ROW
SUITE 200
HOUSTON, TEXAS 77084
TEL: (281) 589-5900
FAX: (281) 759-5164

DRAWING TITLE
MASTER PLAN
GRND MTD CABS
HOT PARK BUS

DRAWING NUMBER
5.4

STATISTICS

Assigned Buses:	
40' CNG	0
40' CNG- DOWN	0
40' BEB	228
60' CNG (Rapid 225)	0
60' CNG (artic transit)	0
60' BEB	27
TOTAL	255

OPTION 2 - NO EMPLOYEE PARKING DECK

PROJECT NO.	12127B
DRAWN BY	CDE
DATE	07/13/2020
SCALE	1" = 80'-0"

PROJECT TITLE

DOKKEN ENGINEERING
1450 FRAZEE ROAD
SUITE 100
SAN DIEGO, CA 92108

WSP USA Inc.
16200 PARK ROW
SUITE 200
HOUSTON, TEXAS 77084
TEL: (281) 589-5900
FAX: (281) 759-5164

DRAWING TITLE
MASTER PLAN
GRND MTD CABS
HOT PARK CARS

DRAWING NUMBER
5.5

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CHAPTER 6 – IMPLEMENTATION SCHEDULE & PHASING

IMPLEMENTATION SCHEDULE & PHASING

IMPLEMENTATION SCHEDULE

Exhibit 6.1 is a high-level schedule for the ZEB preferred option for Phase 1 outlining the project milestones from conceptual design, final design, construction, through energizing of the first phase in 2022 when the first 12 buses arrive. Adding the electrical infrastructure to SBMF is statutorily and categorically exempt from environmental review under CEQA as the project is an enhancement of existing facilities. Refer to the Public Resources code section 21080, subdivisions (b)(12), and Class 1 section 15310 of the Public Resource code. In addition, MTS is exempt from building permit requirements from the local agency, City of Chula Vista, therefore that process is not shown. However, MTS will work with the local Fire Marshal to ensure compliance with all the fire and life safety requirements.

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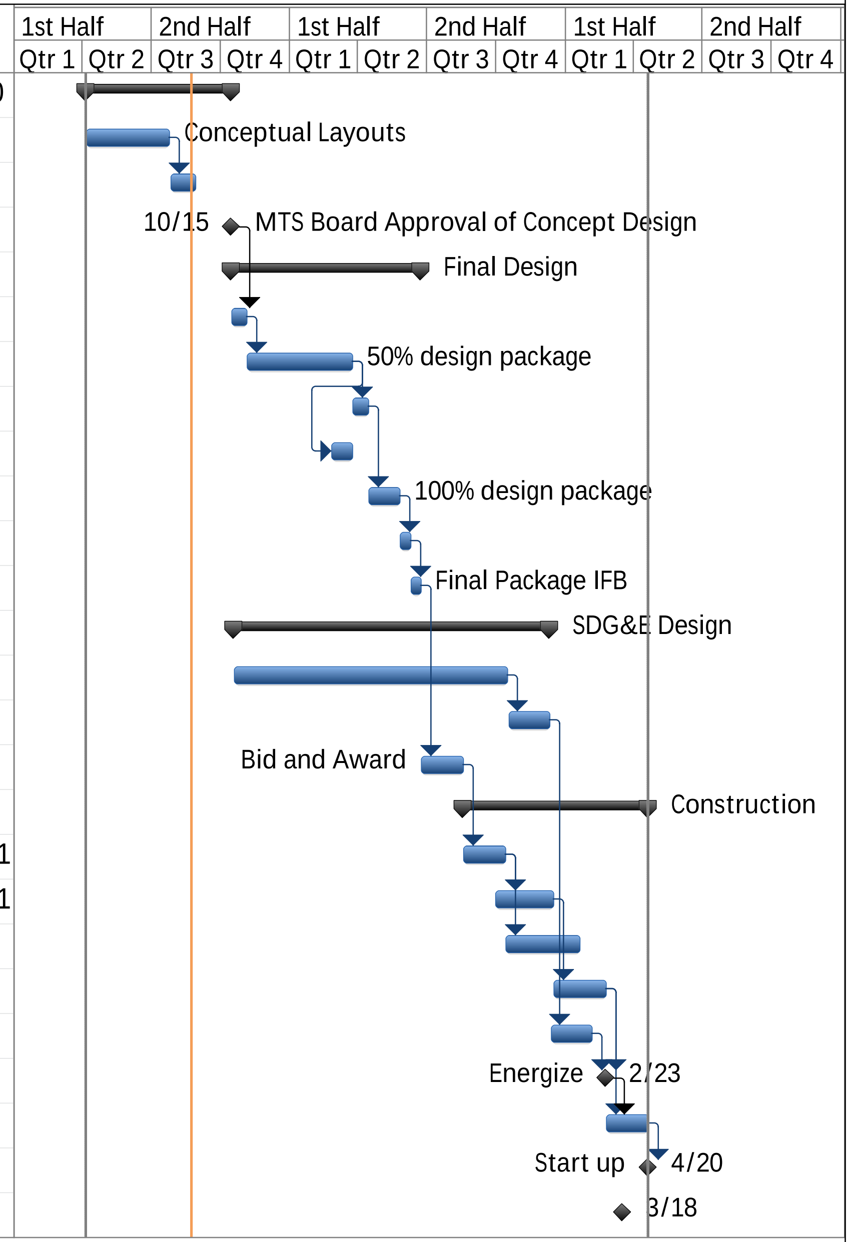
ZEB Preliminary Project Schedule
South Bay Maintenance Facility
August 2020

ID	Task Name	Duration	Start	Finish
1	Conceptual Design	138 days	Mon 4/6/20	Thu 10/15/20
2	Conceptual Layouts	16 wks	Mon 4/6/20	Fri 7/24/20
3	Final Report	5 wks	Mon 7/27/20	Fri 8/28/20
4	MTS Board Approval of Concept Desig	0 days	Thu 10/15/20	Thu 10/15/20
5	Final Design	180 days	Thu 10/15/20	Wed 6/23/21
6	Final Design Contract & Negotiations	15 days	Thu 10/15/20	Wed 11/4/20
7	50% design package	20 wks	Thu 11/5/20	Wed 3/24/21
8	MTS review	3 wks	Thu 3/25/21	Wed 4/14/21
9	City of Chula Vista Fire Marshall reviev	4 wks	Thu 2/25/21	Wed 3/24/21
10	100% design package	6 wks	Thu 4/15/21	Wed 5/26/21
11	MTS Review	2 wks	Thu 5/27/21	Wed 6/9/21
12	Final Package IFB	2 wks	Thu 6/10/21	Wed 6/23/21
13	SDG&E Design	300 days	Mon 10/19/20	Fri 12/10/21
14	Final design	52 wks	Mon 10/19/20	Fri 10/15/21
15	Final Construction Package issued	8 wks	Mon 10/18/21	Fri 12/10/21
16	Bid and Award	8 wks	Thu 6/24/21	Wed 8/18/21
17	Construction	175 days	Thu 8/19/21	Wed 4/20/22
18	Mobilization & Submittals	8 wks	Thu 8/19/21	Wed 10/13/21
19	Utility Install/elevated structure	11 wks	Thu 9/30/21	Wed 12/15/21
20	Secondary Service	14 wks	Thu 10/14/21	Wed 1/19/22
21	Install charging equipment	10 wks	Thu 12/16/21	Wed 2/23/22
22	Install SDG & E infrastructure	8 wks	Mon 12/13/21	Fri 2/4/22
23	Energize	0 days	Wed 2/23/22	Wed 2/23/22
24	Commissioning and testing	8 wks	Thu 2/24/22	Wed 4/20/22
25	Start up	0 days	Wed 4/20/22	Wed 4/20/22
26	First 12 buses arrive	0 days	Fri 3/18/22	Fri 3/18/22



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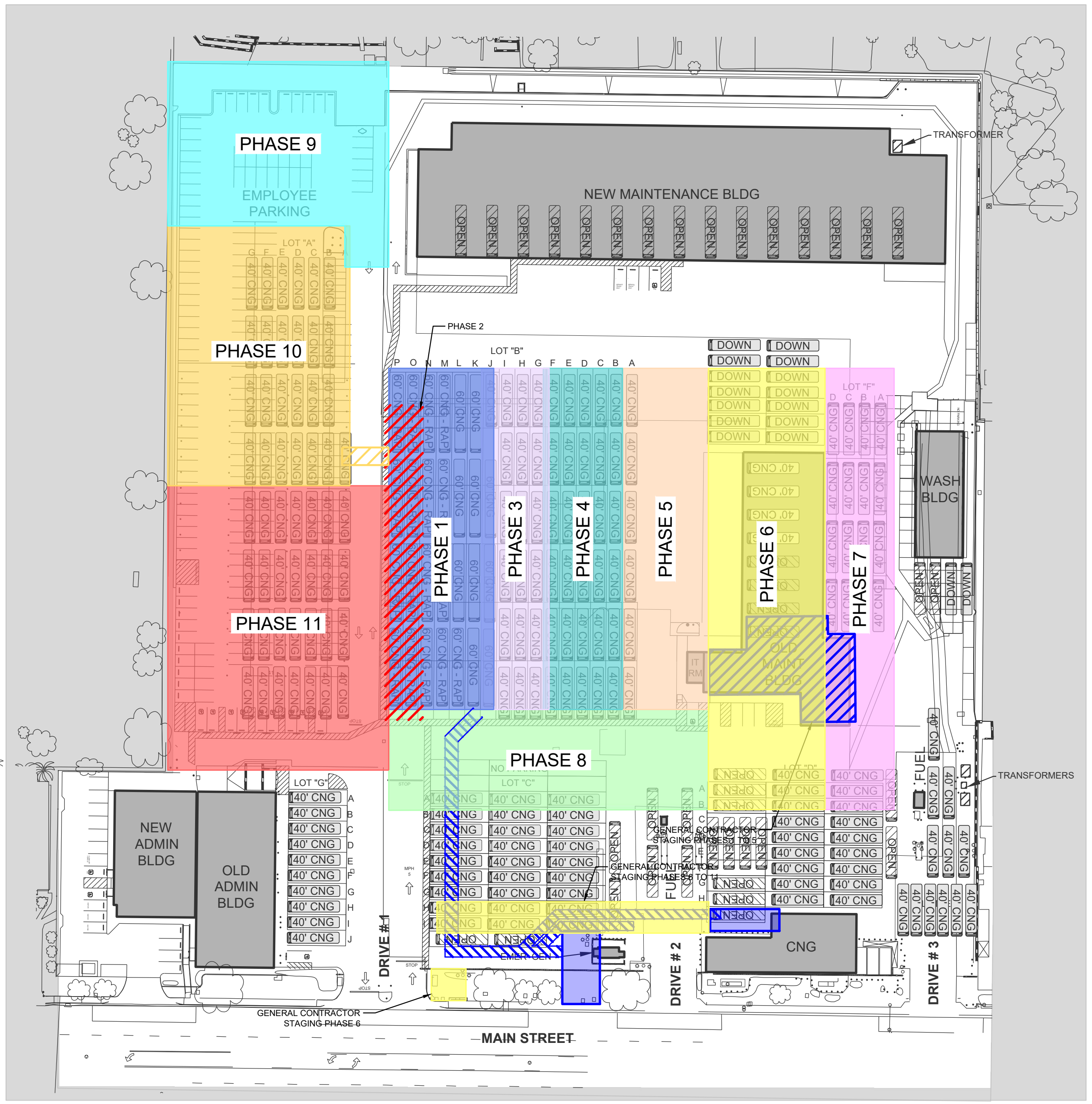
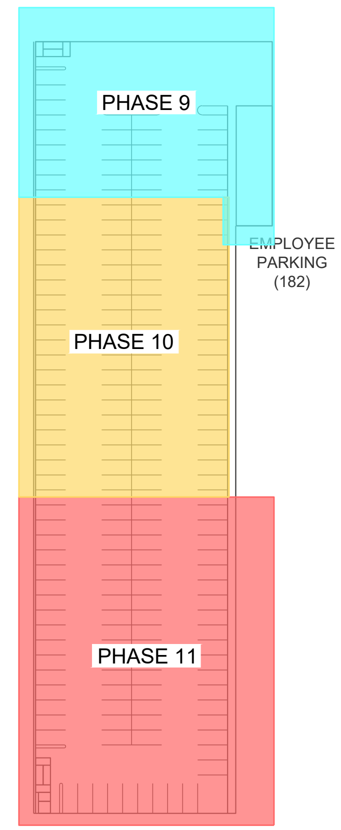
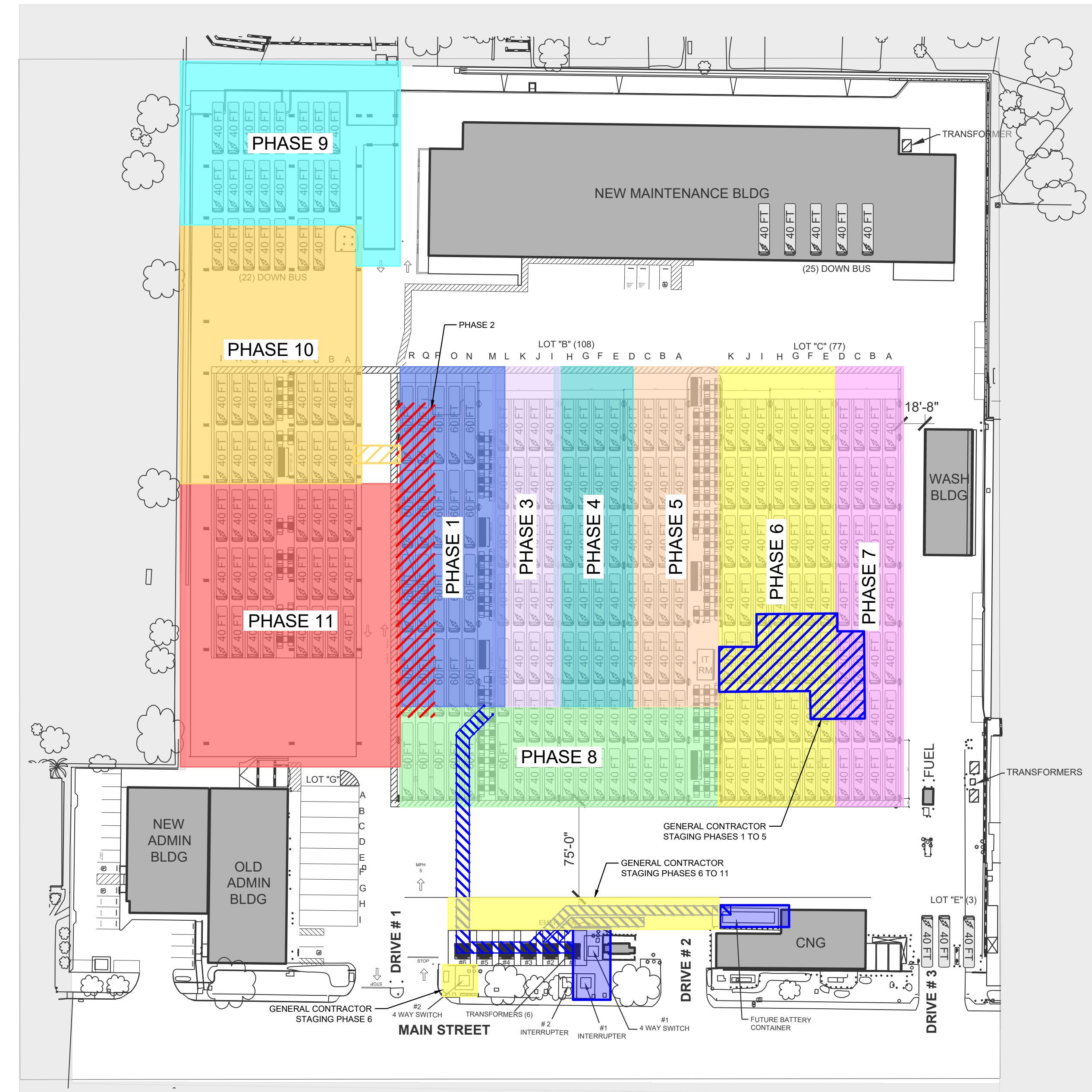


EXISTING SITE PLAN





MASTER PLAN

EXHIBIT 6.2 - PROPOSED PHASING MASTER PLAN

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PHASING

PROPOSED PHASE INTRODUCTION

The MTS selected ZEB master plan design concepts are designed to be implemented over time by a series of smaller localized construction "**Phases**" that limit the construction work and on-site disturbance so that the existing SBMF on-site transit functions can continue. As seen in **Exhibit 6.2 Proposed Phasing Master Plan** there are eleven (11) proposed construction phases represented by a solid color block / shaded area over a portion of the SBMF site. During each individual construction phase the general contractor will have control of this limited phased portion of the site for the main duration of that specific construction phase and the area indicated will not be available for use by MTS and its transit operations contractor for daily transit activities until that individual construction phase is complete.

There are some areas of the site that require construction activities to occur but, due to location, cannot be fully given over to a construction contractor without major disruptions to existing daily on-site operations and vehicle flow. These areas are indicated by the addition of a red diagonal cross hatch across portions of Phase 1 and all of Phase 8 work areas. Construction in these specific **Limited Construction Areas** of the SBMF site would be limited to after AM pull out (approximately 7:00 AM) and before PM pull in (approximately 6:00 PM). All construction materials within the limited construction area would need to be removed daily at the end of the construction day to allow for on-site transit activities to occur upon that area of the SBMF site unimpeded during the approximate hours of 6:00 PM into the next day's morning terminating at 7:00 AM. Additionally, any trenching of pavement or excavations for footings would be required to be covered with steel traffic plate daily at the end of the construction day to allow for on-site transportation activities to occur.

Each of the proposed eleven (11) phases is intended to be a stand-alone facility construction project that corresponds to an upcoming MTS ZEB vehicle procurement. Each area of the proposed phases is achievable to vacate for construction without reducing the current SBMF operating fleet. As shown in the detailed construction phase breakdown drawings and narratives to come later in this chapter, the key aspect of available parking capacity on site allows for the existing MTS bus fleet parked in a Phased Construction Area to be dispersed into existing defined parking positions currently used for temporary and overflow parking for the duration of that particular construction phase. After any one construction phase is complete and before another construction phase begins, the preceding construction phase's work area must be vacated of construction materials and equipment and be turned over to SBMF on-site transit operations for use.

Note that the proposed eleven (11) phases area not meant to strictly limit future on-site facility improvements to the areas indicated but instead to act as an overall road map to facility improvements. Depending on actual planned MTS ZEB vehicle procurements and needs the phases can be combined or further split into more phases. The first near term phases, 1,2, and 3 are shown with individual phased construction staging detail as described below. These first three phases can accommodate 48 BEBs – (12) 60-foot BEBs and (36) 40-foot BEBS. The initial first SDG&E transformer #1, re: **Figure 4.2 SBMF ZEB Master Plan Single Line Diagram,** will support up to 40 BEBs. So, an example of the Proposed Phasing Master Plan's flexibility and variability is that in coordination with the detail design and construction of Phase 3, the actual incoming BEBs to be accommodated should be confirmed based on numerous MTS decision factors including:

a. Phase 3 budget will cover costs of second Transformer #2 and Switchboard #2 which, if installed at Phase 3, would fully support the maximum housed 48 ZEBs. However, the Transformer #1 and Switchboard #1 installed in Phase 1 can only support 40 BEBs so Transformer #2 and Switchboard #2 equipment will be significantly underutilized until Phase 4 and subsequent other phases.
b. Phase 3 facility and ZEB vehicle procurement budgets are tight so while the overhead frame within Phase 3 limits is fully constructed, only the remaining BEBs and chargers are ordered and installed to maximize Transformer #1 and Switchboard #1 full capacity of supporting 40 BEB max. Conventional CNG buses can park beneath the Phase 3 overhead frame in parking spots that do not have a charging dispenser installed.

IMPLEMENTATION SCHEDULE & PHASING

Due to the variability of fleet mix and procurement schedule, the detailed phasing layout of the later phases is increasingly less accurate as more data (fleet type, vehicle size, future budgets, etc....) are assumed. Phase 1 fleet procurement data is known and as such detailed graphic phased layouts have been developed. Similarly, known conditions of the SBMF site after Phase 1 is complete and occupied are also known so a detailed Phase 2 phased layout has been developed as well as a Phase 3. At MTS's request a Phase 6 phase drawing is also provided showing the proposed contractor layout and staging location in Phase 6 where the original Maintenance Building is scheduled to be demolished.

In lieu of individual phase drawings plans based on unknown fleet mixes, the following Proposed Fleet Mix Table was developed. The Proposed Fleet Mix Table indicates the available charging positions created in the developed 11 Phase master plan. This table tracks the potential created 40 foot BEB charging positions in each phase (i.e. the number of 40-foot buses that can be located under the new overhead framing). However, it does not require MTS to procure that many BEBs or provide and install that many charging cabinets or dispensers. Similar to Phase 1, where (30) 40-foot BEB charging spaces are provided for beneath the Phase 1 installed frame, only (12) 60-foot buses are slated to be installed in Phase 1 The extra space under the frame is available to be CNG bus parking, Phase 2 BEBs, or other MTS use. Used as a guideline, MTS can use this Proposed Fleet Mix table to see how many 40-foot equivalent charging positions are available after each proposed construction phase.

PROPOSED FLEET MIX

		Existing 2020	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8	Phase 9	Phase 10	Phase 11
CNG	40 FT CNG	212	200	188	164	144	124	75	47	37	37	14	0
	60 FT CNG RAPID 225	17	17	17	17	17	17	17	17	0	0	0	0
	60 FT CNG	10	10	10	10	10	10	10	10	0	0	0	0
BEB	40 FT BEB	0	0	12	36	56	76	125	153	175	191	214	228
	60 FT BEB	0	12	12	12	12	12	12	12	27	27	27	27
	TOTAL FLEET	**239**	**239**	**239**	**239**	**239**	**239**	**239**	**239**	**239**	**255**	**255**	**255**

	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8	Phase 9	Phase 10	Phase 11
Added 40' BEB charging positions	12	12	24	20	20	49	28	22	16	23	24

PHASE CONSTRUCTION

Each Phase would require a minimum of 4 different on-site activity stages to allow for a typical Phase to be constructed with minimal impact to on-site transit operations.

1. Phase Prep
2. Phase Construction
3. Phase Completion
4. Phase Occupancy and Use

Phase Prep – MTS Operations activity where buses that are normally parked within the area of the upcoming construction phase are parked in available open bus parking spots.

These open bus parking spaces are the portions of the site where currently MTS buses can be parked but are currently not utilized routinely during normal transit nightly parking operations. These open bus parking spaces exist because there are more identified bus parking spaces than current existing fleet count (239) at the SBMF. Refer to **Exhibit 6.3 MTS Operations Parking Blank**. The total of MTS contractor operator numbered / identified parking spaces has been added to each sub-parking area as well as a grand total of available spaces. These available open parking spaces are critical for allowing the various construction phases to be built with minimal impact to on-going site transit operations. In the following Proposed Phase descriptions these open spaces have been indicated to readily identify the open spaces. Note that the MTS contractor operator numbered / identified parking spaces do not account for crush capacity parking (parking in circulation aisles) so there are potentially even more open parking spaces to utilize during phased construction. However, the Proposed Phases do not rely on crush parking and only use the MTS contractor operator numbered / identified parking spaces.

Phase Construction – Activities where Construction Contractor (GC) is now on-site and has occupied a limited portion of the SBMF for construction activities. Unless noted in the phase description, the GC will have full 24 hour / 7 day a week control and occupancy by equipment, materials and construction actives within the identified phase boundaries for the duration of the phase's construction until the transition to the next phase stage. During this stage MTS Operations will continue to utilize the available open parking spaces to park and operate the displaced buses that typically park in the site area now occupied by the GC. Note that Proposed Construction Phasing plans shows one of many potential parking configurations and is not meant to limit MTS or its contract operation to only parking in the identified parking spaces shown.

Phase Completion – GC activities removes all the construction materials, staff and equipment from the previously GC occupied phase construction area to allow for a clear site area to support upcoming use of this area for MTS on-site Operations. MTS, its operator and other MTS direct subcontractor led activities: construction work needed to support BEB operations but not part of the GC construction activities is now performed within the construction phase area limits. Testing and training of the installed chargers and infrastructure is done now prior to next Occupy Phase.

Phase Occupancy – State where the site areas previously under GC control are now fully back and available for MTS operations contractor to park, circulate, charge and operate buses on-site. New incoming BEB buses are parked under the installed overhead charging dispenses and SBMF's displaced conventional fleet moved during the earlier Prep Phase are now able to be parked under the new overhead charger support frame and utilize all site areas previously restricted from use during the earlier phased construction limits.

PROPOSED PHASE 1

Exhibit 6.4 Phase 1 Prep – In Phase 1, (12) 60-foot BEBs will be added to the existing fleet. The current 2020 existing fleet of (239) is shown in their verified typical parking positions. The (40) open parking spaces are shown to indicate alternative potential parking positions which the (28) buses displaced by Phase 1 construction can be relocated. Solid shaded blue area indicates limits of Phase 1 work that will be under GC control fully during the phased construction. GC will have a full control work area in:

- Bus parking yard as shown in bus parking tracts J through P of Lot B.
- A portion of the original maintenance building to be vacated by MTS and MTS operations contractor and be used for on-site GC materials and equipment storage and staging area. This vacated portion of the maintenance building will provide secure, covered and drive in access for the GC and also provide hard wall boundaries from which the GC work and materials are limited from spilling out onto the site and interfering with adjacent on-site transit operations.
- Area on the south of the site near the existing emergency generator to prepare new electrical service entrance and connects the new BEB transformer yard to the future on-site energy storage / battery container when utilized. Future battery storage container location shown.

The solid shaded blue area with diagonal cross hatching indicates the limited access work area for the GC. This irregularly shaped area connects the northern new electrical service entrance to the full transformer yard. The full transformer yard will support the entire anticipated max (255) BEB fleet and the estimated (6) 3000 kVA SDG&E transformers. The trenching, excavation, and put back to get the underground feeders from Transformer #1 to Switchboard #1 would be replicated six times if done separately and would risk damaging installed buried electrical infrastructure from earlier phases to install the later phases. To eliminate this risk and repeatedly trenching the site, all the underground feed work for the entire full ZEB master plan from the transformer yard to an electrical manhole in the southern edge of Phase 1 Lot B work area is proposed to be constructed in Phase 1. This future-proofing underground work would include empty conduits in a single electrical duct bank designed to support a full (255) BEB fleet. Refer to **Exhibit 6.5 SBMF UG BEB Electrical Distribution.**

Exhibit 6.6 Phase 1 Construction
Buses are now removed from the Phase 1 Lot B area and are shown parking and operating in former open parking spaces. Limited open spaces are still available on site even with the shift of buses out from the Phase 1 Lot construction area.

Underground power distribution - as shown on Exhibit 6.5, GC constructs concrete pads for SDG&E's medium voltage 12kV Service #1 interrupter and 4-way pad mounted switch. Empty underground conduit is installed by the GC to connect the interrupter to the 4-way switch then on to Transformer #1. Empty underground feeders are installed from SDG&E Electrical Service #1 to the transformer yard and stub up under Transformer #1 and future Transformers #2 through 6. A tie-in point is created to tie in far future Phase 6 or 7 SDG&E Electrical Service #2 at the Phase 1 installed transformer feeder yard. On-site trenching and concrete encased electrical duct banks are installed from future battery storage area, from existing CNG generator (terminating a pull box for future tie-in) and under all six (6) anticipated pad mounted transformers. Empty conduits only in all duct banks except conductors are pulled to connect Transformer #1 to Switchboard #1.

Main electrical duct bank installed from transformer yard to Phase 1 Lot B work area to support Phase 1 and provide infrastructure future proofing for the other phases. Underground feeders for Switchboard #1, needed for Phase 1, will be routed under and turned up to energize Switchboard #1. Underground feeders to support Switchboard #2, will be routed under the future switchboard's location and turned up and capped on a new concrete BEB equipment support island. This new at-grade raised concrete BEB equipment support island will be constructed to the limits shown and will support the ground-mounted BEB charging cabinets, the surface-mounted wire way runs of Phase 1 and the future equipment for Phase 3.

Three of the main underground duct bank feeders to support the Future Phases 4-8 terminates at a new electrical manhole / pull box at the south edge of Phase's Lot B work area. Future phases will connect to and expand these conduits to systematically construct the trenching of the site on pavement within a GC's full control to allow for construction with limited impact to on-site transit operations. Phase 9-11 underground feeders are routed north and terminate at a new pull box at the northwestern edge of Lot B in alignment with the future Switchboard #6. The empty conduits will be connected to and extended west in Phase 9.

Overhead / Surface-Mounted Power Distribution – in lieu of rigid conduit and its cost and large bending radius at large sizes, power (both AC and DC) will be run between the switchboard to the DC charging cabinets and between the DC cabinets vertically up the overhead frame columns in enclosed, divided (power from data), and exterior-rated wireways. Wireways will allow tighter turning for conductors, allow for accessing the power and communications cabling along the majority of its run while protecting conductors and communications wiring from impact and physical damage while being located at or near grade. The wireways will be surface mounted to the new BEB support island and then run vertically up the overhead frame support columns where the wireways will transition to suspended cable trays. In elevated areas above operators and equipment impact zones suspended cable trays are used to route the conductors to their overhead pantograph dispensers. Conductors and data connections from charger cabinets to overhead pantograph should have sufficient excess length, approximately 6 feet, to allow for the Phase 1 through Phase 5 installed pantographs to be shifted forward at the completion of future Phase 8 to achieve the “Master Plan Alignment” position as shown in Exhibit 6.20.

Overhead Frame – drilled pier footings will be installed to support structural steel columns supporting an overhead structural frame. Perimeter and main frame member span distances are approximately 65-foot max with the majority of spans in the 50-foot range and are intended to be constructed from wide flange structural members. The perimeter frames are infilled with lighter long span open web steel joists approximately 5-foot on center. This joist infill provides overhead structure to support the suspended electrical cable trays used to route the conductors from the DC cabinets to the overhead inverted pantograph charger dispensers. As discussion in Chapters 4 and 5, the infill framing provides the flexibility to relocate suspended pantographs and rework overhead power distribution. Additionally, this in-fill frame will also support solar panel installation.

Pavement / site work – The existing bus track painted striping is removed, and new striping installed. New striping of bus track will accommodate the slight shift of bus parking tracks between new 2-foot wide overhead column zones and the new concrete BEB support island. Bollards are installed on either side of the overhead frame columns.

Exhibit 6.7 Phase 1 Completion – shows completed Phase 1 including new charging equipment and electrical support infrastructure. SDG&E has set their new service interrupter and 4-way switch in the utility right of way along Main Street. SDG&E has also set and energized Transformer #1. Conductors are installed and pulled through the underground feeds supplying Switchboard #1. Switchboard #1 is set and energizes six (6) DC charging cabinets mounted on an elevated open steel frame base. Flexible liquid-tight connections are made from the concrete island-mounted wireways up to and down from the elevated area on a base frame DC charging cabinet. The six (6) DC cabinets, operating in a 1:2 charger to dispenser ratio and will energize the (12) installed overhead pantographs charging dispensers located on the plan. Chargers are tested and staff trained on new charging equipment and related operations.

Exhibit 6.8 Phase 1 Occupancy – Shows the initial added fleet of (12) new 60-foot BEBs parked, charged and operated from dedicated parking spaces with overhead pantographs installed. The overhead frame constructed in Phase 1 covers more bus parking positions than the quantity of BEBs MTS is anticipated to purchase to coincide with the Phase 1 construction project. These now covered but un-energized bus parking spaces are shown supporting conventional fueled buses until Phase 2 begins.

Available Electrical Capacity - at the completion of Phase 1 the installed spare electrical power capacity in Switchboard 1 will be able to support (14) more 150kW chargers / 28 more pantographs.

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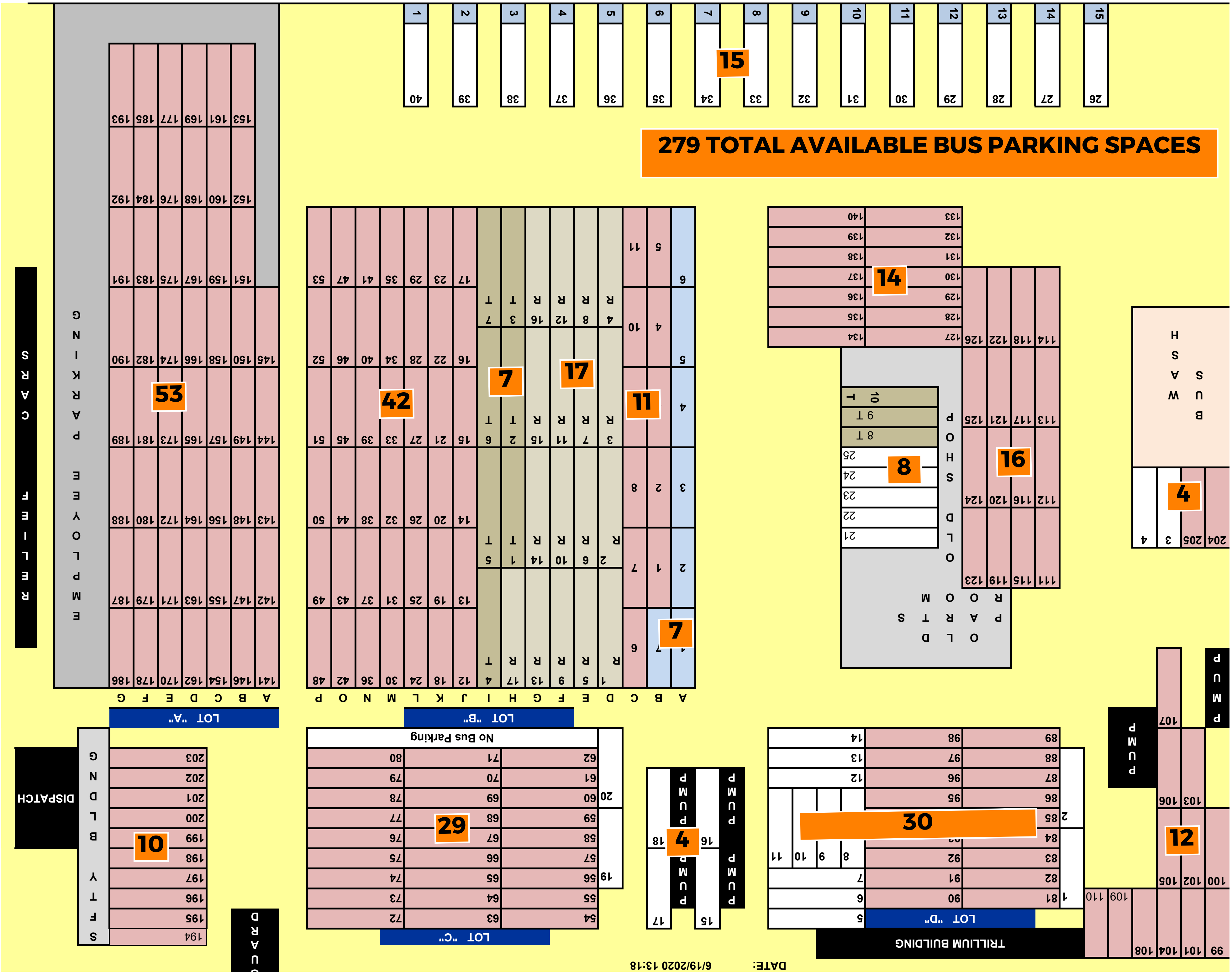
279 TOTAL AVAILABLE BUS PARKING SPACES
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LOT "B"
LOT "C"
LOT "D"
No Bus Parking
DISPATCH
TRILLIUM BUILDING
BUS WASH
SHOP DOOR
PARADOR DOORS
EMPLOYEE PARKING
REFUEL CARS
SHIFT BUILDING
PUMP
DATE: 6/19/2020 13:18
15
53
42
7
17
11
14
8
16
4
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10
29
4
30
12

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Assigned Buses:

40' CNG- READY	40' CNG	164
40' CNG- DOWN	DOWN	48 (20% of total fleet)
40' BEB	BUS	0
CNG (Rapid 225)	60' CNG RAP	17
60' CNG (artic transit)	60' CNG	10
60' BEB	60' CNG	0
TOTAL		239
OPEN BUS PARK	OPEN	40

N

0 20' 40' 80'

1"=40'-0"

PROJECT NO.	12127B
DRAWN BY	JVC
DATE	06/22/20
SCALE	22x34 1"=40'-0" 11 X 17 1"=80-0"

PROJECT TITLE

SOUTH BAY MAINTENANCE FACILITY (SBMF) ELECTRIC BUS CONCEPT LAYOUT

MTS Metropolitan Transit System

DOKKEN ENGINEERING
1450 FRAZEE ROAD SUITE 100 SAN DIEGO, CA 92108
(858) 514-8377

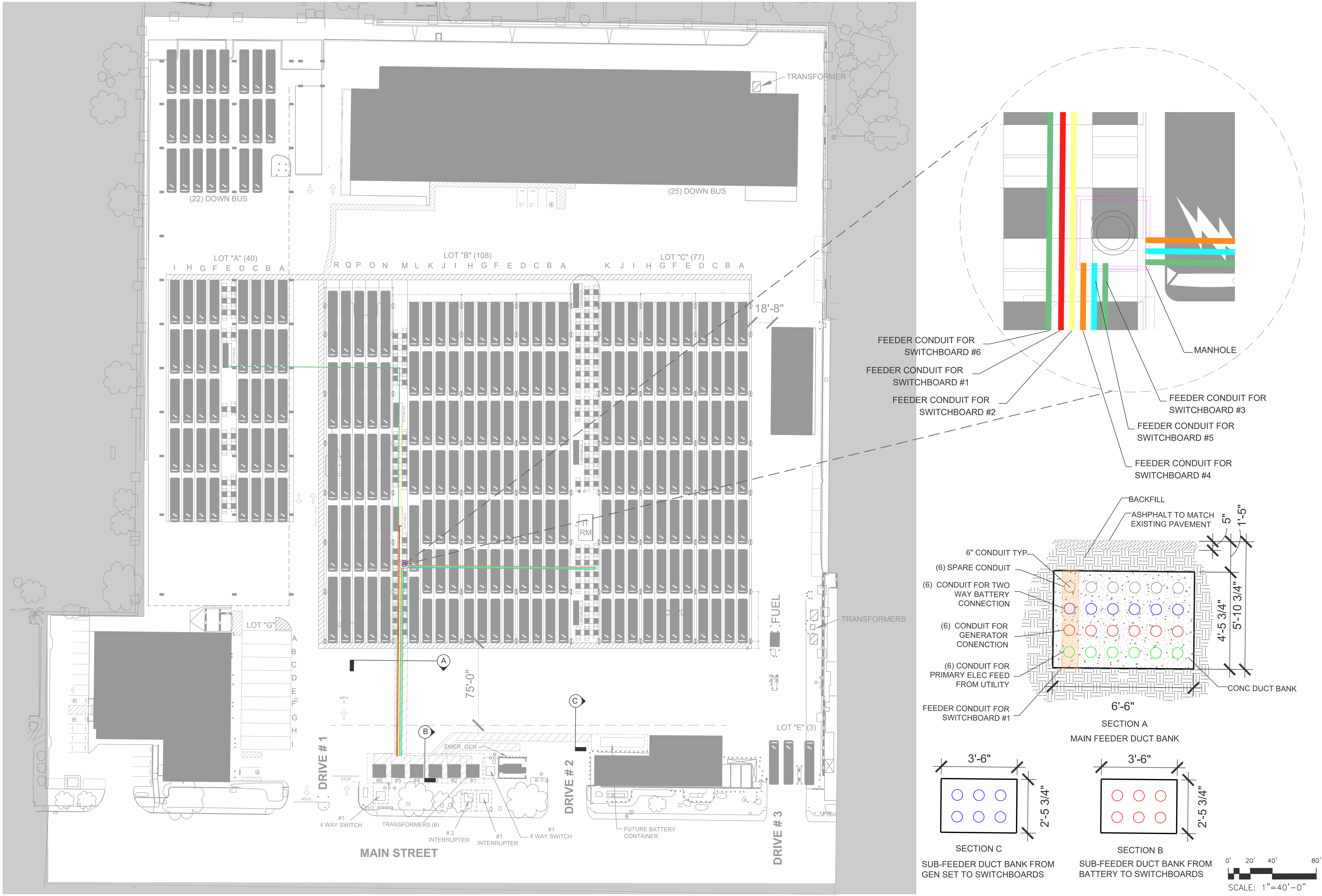
WSP
WSP USA Inc.
WELLS FARGO BLDG
401 B STREET
SUITE 1650
SAN DIEAGO, CA 92101
TEL: (619) 338-9376

DRAWING TITLE

PHASING PLAN
PHASE 1
PREPARATION

DRAWING NUMBER

6.4



PROJECT NO.	12127B
DRAWN BY	
DATE	06/23/20
SCALE	22x34 1"=40'-0" 11 X 17 1"=80'-0"

PROJECT TITLE

SOUTH BAY MAINTENANCE FACILITY (SBMF) ELECTRIC BUS CONCEPT LAYOUT

MTS Metropolitan Transit System

DOKKEN ENGINEERING

wsp

DRAWING TITLE

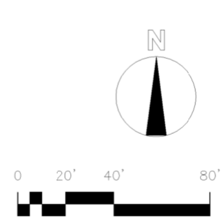
SMBF UG BEB ELECTRICAL DISTRIBUTION

DRAWING NUMBER

6.5

Assigned Buses:

40' CNG- READY	40' CNG	164
40' CNG- DOWN	DOWN	48 (20% of total fleet)
40' BEB	BUS	0
CNG (Rapid 225)	60' CNG RAP	17
60' CNG (artic transit)	60' CNG	10
60' BEB	60' CNG	0
TOTAL		239
OPEN BUS PARK	OPEN	6



PROJECT NO. 12127B
DRAWN BY JVC
DATE 06/22/20
SCALE 22x34 1"=40'-0" 11 X 17 1"=80'-0"

PROJECT TITLE
SOUTH BAY MAINTENANCE FACILITY (SBMF) ELECTRIC BUS CONCEPT LAYOUT

DOKKEN ENGINEERING

WSP

DRAWING TITLE
PHASING PLAN PHASE 1 CONSTRUCTION

DRAWING NUMBER
6.6

Assigned Buses:

40' CNG- READY	40' CNG	164
40' CNG- DOWN	DOWN	48 (20% of total fleet)
40' BEB	BUS	0
CNG (Rapid 225)	60' CNG	17
60' CNG (artic transit)	60' CNG - RAP	10
60' BEB	60' CNG	0
TOTAL		239
OPEN BUS PARK	OPEN	7

0 20' 40' 80'
1"=40'-0"

PROJECT NO. 12127B
DRAWN BY JVC
DATE 06/22/20
SCALE 22x34 1"=40'-0" 11 X 17 1"=80'-0"

PROJECT TITLE
SOUTH BAY MAINTENANCE FACILITY (SBMF) ELECTRIC BUS CONCEPT LAYOUT

DRAWING TITLE
PHASING PLAN PHASE 1 COMPLETION

DRAWING NUMBER
6.7

Assigned Buses:		
40' CNG- READY	40' CNG	152
40' CNG- DOWN	DOWN	48 (20% of total fleet)
40' BEB	BUS	0
CNG (Rapid 225)	60' CNG	17
60' CNG (artic transit)	60' CNG - RAP	10
60' BEB	60' CNG	12
TOTAL		239
OPEN BUS PARK	OPEN	36

N

0 20' 40' 80'
1"=40'-0"

PROJECT NO.	12127B
DRAWN BY	JVC
DATE	06/22/20
SCALE	22x34 1"=40'-0" 11 X 17 1"=80'-0"

PROJECT TITLE
SOUTH BAY MAINTENANCE FACILITY (SBMF) ELECTRIC BUS CONCEPT LAYOUT

DOKKEN ENGINEERING

WSP

DRAWING TITLE
PHASING PLAN
PHASE 1
OCCUPANCY

DRAWING NUMBER
6.8

Assigned Buses:		
40' CNG- READY	40' CNG	140
40' CNG- DOWN	DOWN	48 (20% of total fleet)
40' BEB	BUS	12
CNG (Rapid 225)	60' CNG	17
60' CNG (artic transit)	60' CNG - RAP	10
60' BEB	60' CNG	12
TOTAL		239
OPEN BUS PARK	OPEN	36

N

0 20' 40' 80'

1"=40'-0"

PROJECT NO.	12127B
DRAWN BY	JVC
DATE	06/22/20
SCALE	22x34 1"=40'-0" 11 X 17 1"=80'-0"

PROJECT TITLE
SOUTH BAY MAINTENANCE FACILITY (SBMF)
ELECTRIC BUS CONCEPT LAYOUT

DOKKEN ENGINEERING

WSP

DRAWING TITLE
PHASING PLAN
PHASE 2
CONSTRUCTION

DRAWING NUMBER
6.9

Assigned Buses:

40' CNG- READY	40' CNG	140
40' CNG- DOWN	DOWN	48 (20% of total fleet)
40' BEB	BUS	12
CNG (Rapid 225)	60' CNG	17
60' CNG (artic transit)	60' CNG - RAP	10
60' BEB	60' CNG	12
TOTAL		239
OPEN BUS PARK	OPEN	36

PROJECT NO. 12127B

DRAWN BY JVC

DATE 06/22/20

SCALE 22x34 1"=40'-0" 11 X 17 1"=80'-0"

PROJECT TITLE

SOUTH BAY MAINTENANCE FACILITY (SBMF) ELECTRIC BUS CONCEPT LAYOUT

DRAWING TITLE

PHASING PLAN PHASE 3 PREP

DRAWING NUMBER

6.10

Assigned Buses:

40' CNG- READY	40' CNG	140
40' CNG- DOWN	DOWN	48 (20% of total fleet)
40' BEB	BUS	36
CNG (Rapid 225)	60' CNG	17
60' CNG (artic transit)	60' CNG - RAP	10
60' BEB	60' CNG	12
TOTAL		239
OPEN BUS PARK	OPEN	36

PROJECT NO.	12127B
DRAWN BY	JVC
DATE	06/22/20
SCALE	22x34 1"=40'-0" 11 X 17 1"=80'-0"

PROJECT TITLE

SOUTH BAY MAINTENANCE FACILITY (SBMF) ELECTRIC BUS CONCEPT LAYOUT

DRAWING TITLE

PHASING PLAN PHASE 3 CONSTRUCT

DRAWING NUMBER

6.11

Assigned Buses:		
40' CNG- READY	40' CNG	116
40' CNG- DOWN	DOWN	48 (20% of total fleet)
40' BEB	BUS	36
CNG (Rapid 225)	60' CNG	17
60' CNG (artic transit)	60' CNG - RAP	10
60' BEB	60' BEB	12
TOTAL		239
OPEN BUS PARK	OPEN	36

N

0 20' 40' 80'

PROJECT NO.	12127B
DRAWN BY	JVC
DATE	06/22/20
SCALE	22x34 1"=40'-0" 11 X 17 1"=80-0"

PROJECT TITLE
SOUTH BAY MAINTENANCE FACILITY (SBMF) ELECTRIC BUS CONCEPT LAYOUT

MTS Metropolitan Transit System

DOKKEN ENGINEERING

WSP USA Inc.
WELLS FARGO BLDG
401 B STREET
SUITE 1650
SAN DIEAGO, CA 92101
TEL.: (619) 338-9376

DRAWING TITLE
PHASING PLAN
PHASE 3
OCCUPANCY

DRAWING NUMBER
6.12

PROJECT NO.	12127B
DRAWN BY	JVC
DATE	08/25/20
SCALE	22x34 1"=40'-0" 11 X 17 1"=80'-0"

PROJECT TITLE
SOUTH BAY MAINTENANCE FACILITY (SBMF)
ELECTRIC BUS CONCEPT LAYOUT

DRAWING TITLE
PHASING PLAN
PHASE 6
CONSTRUCTION

DRAWING NUMBER
P6.13

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PROPOSED PHASE 2

Exhibit 6.9 Phase 2 Construction – Phase 2 consists of the additional (12) 40-foot BEB charging pantographs and DC chargers to the overhead frame installed in Phase 1. The (12) added 40-BEBs in this phase are anticipated to replace (12) CNG 40-foot buses. Phase 2 is a limited construction phase as the electrical service infrastructure (Switchboard #1), overhead pantograph support structure, and raised concrete equipment support island were all constructed in Phase 1. This means no trenching and no concrete pouring. Construction activities are limited to surface mounted charging equipment installation.

The southern portion of the original maintenance building will be used for full time GC on-site storage and staging similar to how it was used in Phase 1. The Phase 2 work areas in Lot B, under the Phase 1 installed overhead frame and on the raised concrete BEB equipment island, will be the GC limited work site. Lot B areas are limited to between 7:00 AM. and 6:00 PM. With only surface-mounted equipment installation work in Lot B the parking spaces being electrified during the day are still available for use of daily parking of conventional buses during the evenings.

Six (6) new DC charging cabinets are installed on raised structural platforms and wired via new AC wireways to Switchboard #1. New DC wireways are run from under the DC Chargers and vertically run up the sides of the overhead frame columns. Once above operator and vehicle impact elevations wireways transition to open cable trays and conductors are routed to new installed overhead pantographs.

Available Electrical Capacity - at the completion of Phase 2 the installed spare electrical power capacity in Switchboard 1 will be able to support (8) more 150kW chargers / 16 more pantographs.

PROPOSED PHASE 3

Exhibit 6.10 Phase 3 Prep – Phase 3 is the construction of a new overhead frame in Lot B over 4 tracks, G through J. After Phase 1 and 2 there are 36 open parking spaces on-site. The buses that normally park in tracks G through J are transitioned to daily parking in available open spots. The solid shaded blue area indicates limits of Phase 2 work that will be under GC control fully during the phased construction. GC will have a full control of the following work areas:

- Bus parking yard as shown in bus parking tracts G through J of Lot B.
- Limited portions of the existing raised BEB charging equipment island constructed in Phase 1.
- Southern end of original maintenance building is used as GC staging and storage similar to how that portion of the building was used in Phase 1 and Phase 2.

The solid shaded blue area with diagonal cross hatching indicates limited access work area for the GC. The GC will be tying into existing Switchboard #1 and work inside of the switchboard should not disable the use of the switchboard for daily use in charging the Phase 1 & 2 BEB fleets.

Exhibit 6.11 Phase 3 Construction - Buses are now removed from Phase 3 Lot B work areas and are shown parked in former open parking spaces. Limited open spaces are still available on site even with the shift of buses out from the Phase 3 Lot B construction area.

Underground power distribution – new underground feeder duct bank is constructed from the Phase 1 electrical manhole / pull box to the eastern end of the Phase 3 Lot B work area terminating in another pull box for continued expansion in Phase 4 and other future phases. This main feed duct remains empty conduits only as the feeders to electrify Phase 3 overhead frame were installed in Phase 1 and are under the Phase 1 installed raised concrete BEB charging equipment island.

Overhead Frame – drilled pier footings will be installed to support structural steel columns supporting an overhead structural frame similar to Phase 1. To limit the number of columns on site, the eastern edge of the Phase 1 overhead frame will be tied in to and become the western edge of the Phase 3 overhead frame. This will provide overhead coverage of the Phase 1 constructed raised BEB charging equipment island if and when solar panels are installed on top of the overhead framing system.

Pavement / site work – The existing bus track painted striping is removed, and new striping installed. The new striping of bus tracks accommodates the slight shift of bus parking tracks between new 2-foot wide overhead column zones and the existing Phase 1 concrete BEB charging equipment support island. Bollards are installed on either side of the overhead frame columns.

Overhead / Surface-Mounted Power Distribution – Depending on the quantity of BEBs to be accommodated in Phase 3, twenty-four (24) 40-foot buses spaces will be covered by the Phase 3 overhead frame. Switchboard #1 can support (16) of the new covered (24) parking spaces. To electrify the remaining (8) spaces covered by Phase 3 overhead frame Transformer #2 and Switchboard #2 will be required to be installed. If needed, Switchboard #2 will be set on the existing Phase 1 concrete BEB charging equipment support island. Physically sized to support (20) chargers / (40) pantographs, re: **Figure 4.2 SBMF ZEB Master Plan Single Line Diagram,** Switchboard #2 will fully provide the power for future Phase 4 and partially for Phases 5 and 8. Transformer #2 will be installed in the transformer yard and connect to the underground SDG&E and main electrical duct feeders installed in Phase 1. No new pavement trenching is required but feed conductors will need to be run from Transformer #2 to Switchboard #2.

Phase 3 Completion – New DC charging cabinets are added to existing Phase 1 raised concrete BEB charging equipment island. AC Wireways are connected to Switchboard #1 and #2 (if used) and run to new DC cabinets. DC wireways are used to connect DC Chargers and distribute power vertically up the overhead frame columns then transition to open suspended cable trays. DC conductors and communications cables are tied to new pantographs suspended from the overhead frame. Chargers are tested and staff trained on new charging equipment and related operations.

Exhibit 6.12 Phase 3 Occupancy – Shows full (24) BEB capacity utilizing parking spaces covered by Phase 4 overhead frame. The final quantity of BEBs being procured to utilize Phase 3 construction is unknown but the phasing assumption is that any new BEBs incoming would be CNG bus replacements. With the Phase 4 Lot B area now available for daily on-site transit parking again, there will again be 36 open parking spaces to provide on-site temporary relocations and facilitate future construction phases.

Available Electrical Capacity - at the completion of Phase 3 the available electrical capacity depends on if Switchboard #2 was installed. If installed, the maximum quantity of buses charged in this phase by Switchboard #2 would be (8) leaving a (32) BEB charging capacity at 150kW available for Phase 4.

PROPOSED PHASE 4

Phase 4 is the construction of a new overhead frame in Lot B over tracks B through F. The Phase 4 overhead frame will cover the equivalent area for (30) 40-foot bus parking spaces or (20) 60-foot parking spaces. Tracks B through F are used to park and operate SBMF's 60-foot bus fleet after Phase 1 was constructed. If installed in Phase 3, Switchboard #2 would have capacity for charging the entire Phase 4 with either 40-foot or 60-foot buses.

Similar to Phases 1 through 3, the southern portion of the original maintenance building is used as GC staging and storage during the phase's construction. CNG buses will be relocated out of Lot B tracks B through F and parked in available open parking spaces for the duration of Phase 4.

Underground power distribution – new underground feeder duct bank is constructed from the Phase 3 electrical manhole / pull box to the eastern end of the Phase 4 Lot B work area terminating in another pull box for continued expansion in Phase 5. This main feed duct remains empty conduits only as the power for Phase 4 chargers comes from Switchboard #2 mounted on the Phase 1 installed raised concrete BEB charging equipment island.

Available Electrical Capacity - at the completion of Phase 4 the available electrical capacity depends on the mix of vehicles in Phase 4 and if (20) of the 60-foot bus fleet were replaced. The available capacity range would fall between

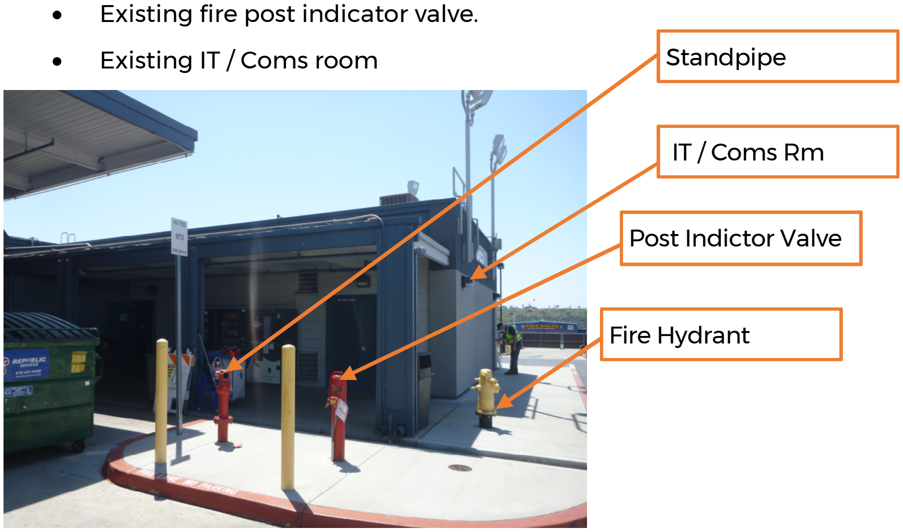
- 2 BEB spare capacity if (30) charging positions were installed for 40-foot BEBs
- 12 BEB spare capacity if (20) charging positions were installed for all 60-foot BEBs

PROPOSED PHASE 5

Phase 5 is the construction of a new overhead frame in Lot B over existing track A and the addition of 3 new tracks in the existing north / south circulation aisle in front of the original maintenance building. The Phase 5 overhead frame will cover (24) 40-foot bus positions. Additionally, a portion of the existing maintenance building is demolished in this phase. There is the potential option to combine Phase 5 with the demolition activities of Phase 6 and take the entire original maintenance building down during Phase 5.

The following critical existing items within the Phase 5 construction area should remain:

- Existing fire hydrant
- Existing fire standpipe
- Existing fire post indicator valve.
- Existing IT / Coms room



GC Staging – depending on if MTS opts to demo only a small southern portion or all of the original maintenance facility the southern portion of the existing maintenance facility could be utilized for GC staging similar to Phases 1 – 4. If the entire maintenance building is demolished, then the GC can stage within the Phase 5 work area and would be required to shift the staging area around during construction – a not-uncommon work site process.

Site paving – the existing maintenance building has drive in maintenance doors on both its west and east face, so the longer portions of the building foundation are level with the surrounding asphalt pavement. If the building is fully demolished in this phase MTS will consider that the concrete floor may be demolished, removed and replaced as new site pavement. If the building is only partially removed in Phase 5, the maintenance building concrete foundation will remain and be utilized as pavement.

Another raised concrete BEB charging equipment support island is Constructed in Phase 5. This island is wider than the Phase 1 island because it will hold more chargers and an additional third switchboard. The Phase 5 island will also encompass and protect the critical existing site items to remain, as noted, from future adjacent vehicle circulation.

Underground power distribution – new underground feeder duct bank is constructed from the Phase 4 electrical manhole / pull box to the three new switchboard positions on the new Phase 5 island. Underground feeder will be run to and raised up under Switchboard #3 and up and capped for future tie in at the future Switchboard #4 and #5 locations.

Transformer #3 will be set in the transformer yard and conductors pulled from it through the existing empty underground electrical duct system installed in Phases 1-4 with no site trenching outside of Phase 5 work area required.

Available Electrical Capacity - at the completion of Phase 5 the available electrical capacity depends on the mix (size of vehicle and quantity) of vehicles procured and charging in Phase 4 and 5 but the spare capacity range would be between 18-28 BEB charging spare capacity.

PROPOSED PHASE 6

Exhibit 6.13 Phase 6 Construction - Phase 6 is the construction an overhead frame over 7 new bus parking tracks over the SBMF site that used to hold the original maintenance building. The Phase 5 frame covers the equivalent of (49) 40-foot bus parking spaces. Whatever remnants of the original maintenance building that was not demolished in Phase 5 is demolished in this phase.

As most of the Phase 6 site is either north / south site circulation space or the original maintenance building footprint there will not be that many existing bus parking spaces to be relocated to the surplus open parking spaces. The few buses that are displaced will be relocated to the open parking spaces prior to Phase 6 construction start.

Note that in Phase 6 the overhead frame is extending down into the existing main east / west circulation aisle used in the evening pull in staging area for incoming buses coming off their route waiting for evening service. This shift of a bus parking lane one bus deeper south than currently parked is based on the final ZEB Master Plan layout. Phase 7 will also extend down and the following Phase 8 will add the southern buses to the previous phases. This southern shift in the master plan is based on not needing all the existing CNG fueling positions and islands as the SBMF slowly shifts from all CNG to about half or more BEB in Phase 6. The ZEB Master Plan has a lower, shifted to the south, east / west main circulation aisle to allow a more homogeneous parking direction on the SBMF site – refer to Chapter 5 for a more detailed description. The two CNG fueling islands between Lot C and Lot D should be considered for removal in Phase 6 to facilitate the southern shift of the east / west circulation aisle. If the quantity of CNG buses at the time of Phase 6 precludes the CNG fuel island removal this removal can be shifted to either Phase 7 or 8.

With the original maintenance building footprint either gone or part of the active work zone of Phase 6 a new GC staging area is needed for this phase. The northern end and edge of the extra wide (27 ft) Phase 5 raised concrete island over the future location of the Switchboard #5 will serve as the GC staging and storage area.

Underground power distribution – with the Phase 6 overhead frame covering (49) 40-foot bus parking spaces either MTS will have a very large BEB procurement to open the Phase 6 as fully electrified or if less BEBs are ordered for the Phase 6 construction the new surplus of bus parking spaces can be used to start transitioning the east / west parked southern buses in Lots C and D. Based on how many BEBs will be operated under the Phase 6 overhead frame between Phase 6 and Phase 7 construction will determine if more underground power is needed. The anticipated available spare power capacity in Switchboard #3 installed in Phase 5 is approximately 18 to 28 BEBs. If more BEBs are needed to operate in the Phase 6 area, then transformer #4 and Switchboard #4 will be needed.

Note that Switchboards #1, 2, and 3 were all powered off of the SDG&E 12 kV electrical service #1. If Transformer #4 and Switchboard #4 are needed, then SDG&E 12kV electrical Service #2 is required. The new Electrical Service #2 would require the GC to construct concrete pads for SDG&E's medium voltage 12kV Service #2 interrupter and a 4-way pad-mounted switch. Empty underground conduit is installed by the GC to connect the interrupter to the 4-way switch then on to the transformer yard Phase 1 installed tie-in point for Transformers #4, 5, and 6.

No new site trenching is anticipated to add transformer #4 and Switchboard #4. The empty conduit feeders connecting the SDG&E service to Transformer #4 and the empty conduit feeders and main electrical bus duct connecting Transformer #4 to Switchboard #4 were installed in Phases 1 through 5. Conductors will need to be pulled in the existing empty conduit to connect transformer #4 to Switchboard #4.

New DC chargers are installed on the Phase 5 raised concrete island with wireways connecting Switchboard #3 and #4 to the overhead frame and transitioning to overhead cable tray and pantograph dispensers suspended beneath the Phase 6 overhead frame.

Available Electrical Capacity - at the completion of Phase 6 the available electrical capacity depends on the mix (size of vehicle and quantity) of vehicles procured and charging in Phase 5 but the spare capacity range is anticipated to be between 5 and 17-BEB charging spare capacity.

PROPOSED PHASE 7

Phase 7 is the construction of an overhead frame over the 4 tracks of Lot F. The Phase 7 overhead frame covers (28) 40-foot bus parking spaces. Depending on how many BEBs were procured and are charging with Phase 6 it is anticipated that (5) to (17) of the Phase 7 charging parking spaces' power can be provided by the Phase 6 installed Switchboard #4. However, to get the remaining (2) to (12) Phase 7 parking spaces energized would require the installation of Transformer #5 and Switchboard #5.

On-site GC staging for Phase 7 will be much smaller than earlier phases. There are no large tracts of unutilized space. With the creation of new parking capacity in Phase 6 there is potential to make a GC staging area north of the transformer yard at the southern end of Lot C.

Underground power distribution – No new site trenching is anticipated to add transformer #5 and Switchboard #5. The empty conduit feeders connecting the SDG&E service to Transformer #5 and the empty conduit feeders and main electrical bus duct connecting Transformer #5 to Switchboard #5 were installed in Phases 1 through 5. Conductors will need to be pulled in the existing empty conduit to connect transformer #4 to Switchboard #4.

Similar to Phase 6, Phase 7's overhead frame is the full master plan compliant (7) 40-foot deep parking track and the 7th parked bus in a parking track extends into the existing east / west circulation. Phase 6 began the transition of moving the east / west bus main circulation aisle down to the south and Phase 7 continues that trend. The two CNG Fueling islands between Lot C and Lot D, if not removed in Phase 6, should be removed in Phase 7. CNG island removal could still be moved to Phase 8 as an MTS decision option.

New DC chargers are installed on the Phase 5 raised concrete island with wireways connecting Switchboard #4 and potentially #5 to the overhead frame and transitioning to overhead cable tray and pantograph dispensers suspended beneath the Phase 7 overhead frame.

Available Electrical Capacity - at the completion of Phase 7 the available electrical capacity depends on the mix (size of vehicle and quantity) of vehicles procured and charging in Phase 6 but the spare capacity range is anticipated to be between 17 and 29-BEB charging spare capacity.

PROPOSED PHASE 8

Phase 8 is the construction of single line of overhead bus frames in front on Phases 1 through 5. Phase 8 overhead frames will add (17) new BEB charging positions. The positions cover tracks set for both 60-foot and 40-foot buses in previous phases.

The Master Plan as shown in this report has all the fronts of the buses lined up along the southern edge of the newly shifted downward east / west circulation aisle Re: Exhibit 6.13. The previous phased installed pantographs inherently kept the buses aligned more to the rear. Once the Phase 8 overhead frame is in place the structure will be assembled to allow for the overhead pantographs to be shifted along the tracks to align perfectly at the front (per the idealized Master Plan Layout) but it would require that all the previously installed pantographs be physically relocated as well. MTS has the option in Phase 8 to include this shifting of pantographs to final alignment or organically move the pantographs as they get taken down for service or replaced over a longer period of time.

Phase 8 will be a limited GC access construction phase as the work is being done at the front of existing electrified charging parking tracks and the tracks cannot be vacated fully and relocated to open parking spots to allow for construction like the previous phases. Phase 8 work will occur approximately from 7:00 AM and all GC work, equipment and materials cleared by to 6:00 PM to allow for on-site traffic movement. Limited GC staging is available in this phase. The area north of the transformer yard or Driveway 2 may be available.

Underground power distribution – No new site trenching is anticipated and the added BEB charging positions are energized by the Phase 6 / 7 installed Switchboard #5. Surface-mounted wireways are added to the Phase 5 island and run between and connecting Switchboard #5 and the new DC chargers installed on stands on the Phase 5 island and up the overhead columns.

Available Electrical Capacity - at the completion of Phase 8 the available electrical capacity, dependent on fleet mix, will be approximately 18 BEB charging spare capacity.

6.13 Master Plan Alignment vs Construction Phase Alignment

PROPOSED PHASE 9, 10, 11

Phases 9, 10, and 11 are the construction of an elevated automotive parking deck over the existing Lot A / Staff parking lot. The bottom of the parking deck structure would be used to support and suspend the overhead electrical distribution (wireways and cable trays) as well as overhead charging pantograph dispensers. As discussed in Chapter 5, the parking deck eliminates the private car vs bus hot parking current parking method and isolates the private vehicles from the bus parking and charging positions. The elevated deck is shown as being constructed in three main phases but it is highly likely that MTS would consider a single construction contract for the entire parking deck with the stipulation that the deck must be built in a minimum of three phases with each phase being complete and re-occupied by MTS Operations for daily transit use before the next construction phase would be complete.

Phase 9 would provide cover for (16) bus parking spaces. The spaces covered have been designated as "Down Line" vehicles awaiting service. Down line vehicles were determined during MTS discussions as not needing charging, so no overhead charging is anticipated in Phase 1 and 8.

Phase 9 Prep - Similar to previous phases the (16) buses currently parked under the Phase 9 work area on a routine basis are relocated to open available parking spaces to facilitate full Phase 9 GC control over the Phase 9 work area. GC staging will be limited to north of the transformer yard and 75' from the south edge of the central bus parking lot.

Phase 9 Construction - The parking deck ramp and first section of deck are constructed. No charging under Phase 9 is expected so no underground electrical or charging equipment is installed. Once the deck is fully completed the displaced buses are brought back to resume parking under the Phase 9 parking deck.

Phase 10 Prep - Similar to previous phases the (16) buses currently parked on a routine basis under the Phase 10 work area are relocated to open available parking spaces to facilitate full Phase 10 GC control over Phase 10 work area. GC Staging area remains from Phase 9.

Phase 10 Construction – the Phase 9 parking deck is extended by 5 structural bays. Below grade, underground Switchboard #6 feeders installed and capped at Phase 1 are extended across the main north / south drive aisle (an area of limited construction access) and turn up under Switchboard #6's location. Transformer #6 is set in the transformer yard and conductors are run inside the empty feeder bus duct installed in Phase 1 and connected to Switchboard #6.
At grade a new raised concrete BEB charging equipment support island is constructed. Switchboard #6 is installed as well as (4) DC charging cabinets on stands located on the Phase 10 island. Surface mounted wireways, suspended cable trays, and conductors are routed from the switchboard to the DC cabinets to the (8) suspended pantographs over the bus parking spaces.

Available Electrical Capacity - at the completion of Phase 10 the available electrical capacity, depending on fleet mix, will be (32) BEB charging spare capacity.

Phase 11 Prep - Similar to previous phases the 24 buses currently parked on a routine basis under the Phase 11 work area are relocated to open available parking spaces to facilitate full Phase 11 GC control over the Phase 11 work area. GC Staging area remains from Phase 9 and 10.

Phase 11 Construction – the Phase 10 parking deck is extended by 4 structural bays. No below grade electrical distribution or trenching is anticipated as all the power to energize the chargers and pantographs in Phase 11 is provide by Switchboard #6 installed in Phase 10. The Phase 10 raised concrete island is expanded. Final (12) DC charging cabinets on stands are located on the Phase 11 expanded raised island. Surface mounted wireways, suspended cable trays and conductors are routed from the switchboard to the DC cabinets to the final (24) suspended pantographs over the bus parking spaces.

While not specifically identified in what phase the additional buses were added to the overall SBMF fleet, at the conclusion of Phase 11 the ready bus parking positions and dedicated downline spaces have increased from the 2020 fleet of 239 to the Master Plan fleet of 255.

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CHAPTER 7 – COST ESTIMATE

COST ESTIMATE

INTRODUCTION

A rough order of magnitude cost estimate was developed based on the Conceptual Site Design for the infrastructure to support the battery electric bus master plan presented in Chapter 5. Costs were developed for each the following options:

- Ground mounted equipment with parking deck
- Ground mounted equipment without parking deck
- Phase 1 buildout for first 12 BEB buses

The general scope of work includes:

- BEB Infrastructure (including electrical components and bus charging)
- Parking Deck for employee parking

EXCLUSIONS

The estimate for design and construction specifically excludes:

- SDG&E Infrastructure Cost and fees
- Environmental permitting
- Additional cost associated with each phasing stage
- Off-site improvements (assumed none would be required)
- Hazardous material investigation and abatement, if any
- Operations and maintenance costs
- Cost for the buses
- Annual energy cost
- Annual staffing cost
- Annual maintenance cost
- One-time training cost

ASSUMPTIONS AND QUALIFICATIONS

1. The work will be done under one general contract during normal working hours.
2. The work will be phased to keep the SBMF operational throughout construction.
3. The estimate is based on prices current as of July 2020 based on the ENR BCI cost index changes and from vendor quotes (Heliox and Schunk).
4. The estimate reflects probable construction costs obtainable in the project locality on the date of this estimate. Pricing assumes competitive bidding for every portion of the construction work for all subcontractors and general contractors, with a minimum of four (4) bidders for all major subcontracted work and four (4) to five (5) general contractor bids.
5. Experience shows fewer bids may result in higher bids, and conversely more bidders may result in lower bids. Therefore, it is important to obtain as many bids as possible.
6. The following is a list of items that may affect the cost estimate:
    a. Modifications to the scope of work or assumptions included in this estimate.
    b. Restrictive technical specifications or excessive contract conditions.
    c. Any specified item of equipment, material, or product that cannot be obtained from at least three different sources.
    d. Any other non-competitive bid situations.

7. Unit costs include cost for materials, labor and equipment, sales tax, and installing contractor's (trade contractor's) mark-up.
8. The estimate is intended to be a determination of fair market value for the project construction. It is not a prediction of low bid. Since the team has no control over market conditions and other factors which may affect bid prices, this estimate cannot and does not warrant or guarantee that bids or ultimate construction cost will not vary from the cost estimate. There are no other warranties, expressed or implied, and the team is not responsible for the interpretation by others of the contents herein.
9. It should be noted that the cost estimate is a "snapshot in time" and that the reliability of this opinion of probable construction cost will inherently degrade over time.
10. This estimate has been prepared based on the conceptual design and should be updated when more detailed project information is available.

FACTORS APPLIED

The following factors have been applied:

- Design Contingency (20%) that reflects the preliminary nature of the design. This factor should be reduced as the detailed design progresses.
- General Contractor's General Conditions (12%)
- Insurance (0.75%)
- Bond (1.5%)
- Overhead and Profit (12.5%)
- Escalation to December 2020 (3 %)
- Pre- and Post-Construction Expenses ("Soft Costs") (1.7%)
- Design Costs (design fees, construction management) (29.5%)

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San Diego, CA
Conceptual Rough Order of Magnitude Estimate
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GROUND MOUNTED EQUIPMENT - PHASE 1

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August 27, 2020

EXECUTIVE SUMMARY

			TOTAL
A	**Charging Equipment, Includes External Funding**		$2,901,600
B	**Charging Infrastructure Support**		$581,011
C	**Support Frame**		$483,795
D	**Deck Over Bus Parking**		$0
E	**Photo-Voltaic System**		$658,168
	Sub-total	**-**	**$4,624,574**
	Design Development Contingency	**20.0%**	$924,915
	Design Contingency sub-total		**$924,915**
	Sub-total Direct Costs		**$5,549,489**
	Markups		
	General Conditions and Requirements	12.0%	$665,939
	Insurance	0.75%	$41,621
	Bond	1.5%	$83,242
	Overhead and Profit	12.5%	$693,686
	Estimated Contract Award, Jan 2020		**$7,033,977**
	Escalation to Dec 2020	3.0%	$211,019
	Estimated Contract Award, Jan 2021		**$7,244,997**
	Pre- and Post-Construction Expenses ("Soft Costs")	1.7%	**$123,165**
	GRAND TOTAL CONSTRUCTION		**$7,368,161**
	For Budgetary Implementation Costs Add:		
	Premilinary Engineering and Environmental	2%	$147,363
	Final Design	12%	$884,179
	Project Management/Construction Management	12.50%	$921,020
	Non-construction Insurance	2%	$147,363
	Other	1%	$73,682
	Sub-total		**$2,173,608**
	TOTAL COSTS INCLUDING IMPLEMENTATION 2020$		**$9,541,769**

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San Diego, CA
Conceputal Rough Order of Magnitude Estimate - GRND MTD PH 1
August 27, 2020

CHARGING EQUIPMENT

LOCATION	QUANTITY	UOM	RATE*	SD Index	ADD
				113%	
CHARGING EQUIPMENT					
DC Charging Cabinets and Pantographs					
DC Charging Cabinet - 150kW (includes DC switch)	6	EA	$121,000.00	$121,000	$726,000
Pantograph (includes depot charge box)	12	EA	$16,000.00	$16,000	$192,000
Energy Storage					
1.5MW Battery Storage**	1	EA	$1,100,000.00	###########	$1,100,000
380kW CNG Generator**	1	EA	$400,000.00	$400,000.00	$400,000
***Price for both options shown. Only one is needed.*					
Installation					
Equipment Install - 20% of Equipment Cost	1		$483,600.00		$483,600
HVIP Funding per Bus (Quantity is total fleet after conversion)	-	EA	($40,000.00)		$0
CALeVIP Funding (Quantity is total number of charging cabinets)	-	EA	($42,000.00)		$0
SDG&E's Power Your Drive - Fleets	-	EA	($25,000.00)		$0
			TO SUMMARY		**$2,901,600**

SBMF ZEB
San Diego, CA
Conceptual Rough Order of Magnitude Estimate - GRND MTD PH 1
August 27, 2020

CHARGING INFRASTRUCTURE SUPPORT

LOCATION	QUANTITY	UOM	RATE*	SD Index	ADD
				113%	
DIVISION 03 - CONCRETE					
033000 Cast-In-Place Concrete (GC)					
Field surveys and verification	16	HRS	$95.00	$107	$1,713
033053 Miscellaneous Cast-In-Place Concrete					
CIP Concrete housekeeping pad					
at utility switch	2	CY	$450.00	$507	$1,126
at 4-way switch	2	CY	$450.00	$507	$1,126
at interrupter	2	CY	$450.00	$507	$1,126
at bus parking	67	CY	$450.00	$507	$33,827
at emergency generator	10	CY	$450.00	$507	$5,072
at battery storage	18	CY	$450.00	$507	$9,306
DIVISION 26 - ELECTRICAL					
260513 Medium Voltage Cables					
AC Power Cable					
from Interrupter to 4-way Switch	24	LF	$39.57	$45	$1,070
from 4-way Switch to Transformer	17	LF	$39.57	$45	$758
260519 Low Voltage Electrical Power Conductors and Cables					
AC Power Cable XFRM to LV SB	210	LF	$80.23	$90	$18,988
AC Power Cable SB to Charging Cabinet	553	LF	$80.23	$90	$50,002
AC Power Cable from Battery Storage to LV SB	375	LF	$80.23	$90	$33,907
AC Power Cable from Generator to LV SB	318	LF	$80.23	$90	$28,753
PE Wire 1x35 mm2 (DC) (CB to Panto)	379	LF	$24.59	$28	$10,488
Interlock Cable 2x1.5 mm2 (Controls) (CB to Panto)	379	LF	$3.86	$4	$1,646
AC Utility Power 4x2.5 mm2 (House Power) (CB to Panto)	379	LF	$4.96	$6	$2,117
260539 Underground raceways for Electrical Systems					
6" Metal conduit from interrupter to 4-way switch	16	LF	$86.20	$97	$1,554
6" Metal conduit 4-way switch to Transformer	16	LF	$86.20	$97	$1,554
6" Metal conduit from XFRM to LV SB	210	LF	$86.20	$97	$20,401
6" Metal conduit from LV SB to Charging Cabinet	553	LF	$86.20	$97	$53,723
6" Metal conduit from Battery Storage to LV SB	375	LF	$86.20	$97	$36,430
6" Metal conduit from Generator to LV SB	318	LF	$86.20	$97	$30,893
260533 Wireways					
12" x 12" Wireway Switchboards to Charging Cabinets to Junction Box	221	LF	$73.50	$83	$18,306
12" x 12" Junction Box on Cable Tray to Pantograph (Cable Tray)	225	LF	$35.00	$39	$8,875
Transformers					
Medium Voltage to Low Voltage Transformers	1	EA	$20,000.00	$22,540	$22,540
Switchgear					
600 Amp 15 KV Load interrupter switch	1	EA	$5,775.00	$6,508	$6,508
100 Amp 208/120V 42 CKT Panel	1	EA	$4,500.00	$5,072	$5,072
800 Amp Nema 3R Panel	4	EA	$7,500.00	$8,453	$33,810
Grounding	1	EA	$7,500.00	$8,453	$8,453
Medium Voltage Switchgear					
4-way switch	1	EA	$25,000.00	$28,175	$28,175
Low Voltage Switchgear					
Low Voltage Switchgear	1	EA	$30,000.00	$33,810	$33,810

DIVISION 27 - COMMUNICATIONS					
271323 Communications Optical Fiber Backbone Cabling					
Communication 8x Glass Fiber (CB to Panto)	379	LF	$10.78	$12	$4,599
DIVISION 31 - EARTHWORK					
Trenching / Excavation					
Main feeder duct bank	403	CY	$47.00	$53	$21,364
Transformer to main feeder duct bank	128	CY	$47.00	$53	$6,754
Generator to main feeder duct bank	94	CY	$47.00	$53	$4,979
Battery storage to main feeder duct bank	194	CY	$47.00	$53	$10,289
Backfill trench					
Main feeder duct bank	67	CY	$46.00	$52	$3,484
Transformer to main feeder duct bank	28	CY	$46.00	$52	$1,467
Generator to main feeder duct bank	18	CY	$46.00	$52	$949
Battery storage to main feeder duct bank	43	CY	$46.00	$52	$2,240
312020 Excavated Material Management and Disposal					
Disposal off site, assume clean but unsuitable	204	CY	$39.00	$44	$8,971
DIVISION 32 - EXTERIOR IMPROVEMENTS					
321313 - Concrete Paving					
Main feeder duct bank	28	SY	$40.00	$45	$1,271
Transformer to main feeder duct bank	12	SY	$40.00	$45	$541
Generator to main feeder duct bank	8	SY	$40.00	$45	$347
Battery storage to main feeder duct bank	18	SY	$40.00	$45	$825
DIVISION 33 - EXTERIOR IMPROVEMENTS					
337119 Electrical Underground Ducts and Manholes					
Handholes, pre-cast concrete, with concrete cover	1	EA	$1,600.00	$1,803	$1,803
			TO SUMMARY		**$581,011**

SBMF ZEB
San Diego, CA
Conceptual Rough Order of Magnitude Estimate - GRND MTD PH 1
August 27, 2020

OVERHEAD SUPPORT STRUCTURE

LOCATION	QUANTITY	UOM	RATE*	SD Index	ADD
				113%	
DIVISION 03 - CONCRETE					
033053 Miscellaneous Cast-In-Place Concrete					
Regular concrete (4000 psi), 6" slab	-	SF	$4.56	$5	$0
DIVISION 05 - METALS					
050001 Miscellaneous and Ornamental Iron					
4" sch 40 pipe bollards	24	EA	$350.00	$394	$9,467
Conduit support rack; galvanized	2,961	LF	$15.00	$17	$50,048
W12x120 Frame Columns	196	LF	$206.00	$232	$45,562
W12x53 K-Bracing	100	LF	$103.00	$116	$11,608
W24x84 Framing	410	LF	$145.00	$163	$67,000
W27X102 Framing	310	LF	$178.00	$201	$62,188
052119 Open Web Steel Joist Framing					
26k12 Subframe Joist for Pantographs	2,294	LF	$17.60	$20	$45,502
053113 Steel Floor Decking					
1.5" Steel Decking, 16 ga.	-	SF	$5.25	$6	$0
DIVISION 09 - FINISHES					
090007 Painting					
Prep columns & framing	14,942	SF	$4.50	$5	$75,776
DIVISION 31 - EARTHWORK					
316326 Drilled Caissons					
Fixed end caisson pile, open, machine drilled, in stable ground, no casings or ground water, 48" diameter	180	LF	$575.00	$648	$116,645
			TO SUMMARY		**$483,795**

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DECK OVER BUS PARKING

LOCATION	QUANTITY	UOM	RATE*	SD Index	ADD
				113%	
DECK OVER BUS PARKING					
Parking Deck	-	SPACE	$22,755.60	$25,646	$0
			TO SUMMARY		**$0**

SBMF ZEB
San Diego, CA
Conceputal Rough Order of Magnitude Estimate - GRND MTD PH 1
August 27, 2020

PHOTO-VOLTAIC SYSTEM

LOCATION	QUANTITY	UOM	RATE*	SD Index	ADD
				113%	
PV SYSTEM					
PV Panels (includes frame)	830	EA	$700.00	$789	$654,787
PV support equipment (inverter / controller)	1	EA	$3,000.00	$3,381	$3,381
DIVISION 05 - METALS					
052119 Open Web Steel Joist Framing					
26k12 Subframe Joist for PV Support (included under Support Frame)	-	LF	$17.60	$20	$0
			TO SUMMARY		**$658,168**

**0.282 MW is generated on a sunny day.

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GROUND MOUNTED EQUIPMENT W/ PARKING DECK

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San Diego, CA
Conceputal Rough Order of Magnitude Estimate - GRND MTD PRK DECK
August 27, 2020

EXECUTIVE SUMMARY

			TOTAL
A	**Charging Equipment, Includes External Funding**		$22,546,800
B	**Charging Infrastructure Support**		$7,003,200
C	**Support Frame**		$3,179,657
D	**Deck Over Bus Parking**		$5,135,739
E	**Photo-Voltaic System**		$6,716,920
	Sub-total	**-**	**$44,582,315**
	Design Development Contingency	**20.0%**	$8,916,463
	Design Contingency sub-total		**$8,916,463**
	Sub-total Direct Costs		**$53,498,778**
	Markups		
	General Conditions and Requirements	12.0%	$6,419,853
	Insurance	0.75%	$401,241
	Bond	1.5%	$802,482
	Overhead and Profit	12.5%	$6,687,347
	Estimated Contract Award, Jan 2020		**$67,809,702**
	Escalation to Dec 2020	3.0%	$2,034,291
	Estimated Contract Award, Jan 2021		**$69,843,993**
	Pre- and Post-Construction Expenses ("Soft Costs")	1.7%	**$1,187,348**
	GRAND TOTAL CONSTRUCTION		**$71,031,341**
	For Budgetary Implementation Costs Add:		
	Premilinary Engineering and Environmental	2%	$1,420,627
	Final Design	12%	$8,523,761
	Project Management/Construction Management	12.50%	$8,878,918
	Non-construction Insurance	2%	$1,420,627
	Other	1%	$710,313
	Sub-total		**$20,954,245**
	TOTAL COSTS INCLUDING IMPLEMENTATION JAN 2021		**$91,985,586**

SBMF ZEB
San Diego, CA
Conceputal Rough Order of Magnitude Estimate - GRND MTD PRK DECK
August 27, 2020

CHARGING EQUIPMENT

LOCATION	QUANTITY	UOM	RATE*	SD Index	ADD
				113%	
CHARGING EQUIPMENT					
DC Charging Cabinets and Pantographs					
DC Charging Cabinet - 150kW (includes DC switch)	113	EA	$121,000.00	$121,000	$13,673,000
Pantograph (includes depot charge box)	226	EA	$16,000.00	$16,000	$3,616,000
Energy Storage					
1.5MW Battery Storage**	1	EA	$1,100,000.00	$1,100,000.00	$1,100,000
380kW CNG Generator**	1	EA	$400,000.00	$400,000.00	$400,000
***Price for both options shown. Only one is needed.*					
Installation					
Equipment Install - 20% of Equipment Cost	1		$3,757,800.00		$3,757,800
CALeVIP FUNDING, HVIP FUNDING, OTHER REBATES					
HVIP Funding per Bus (Quantity is total fleet after conversion)	-	EA	($40,000.00)		$0
CALeVIP Funding (Quantity is total number of charging cabinets)	-	EA	($42,000.00)		$0
SDG&E's Power Your Drive - Fleets	-	EA	($25,000.00)		$0
			TO SUMMARY		**$22,546,800**

SBMF ZEB
San Diego, CA
Conceptual Rough Order of Magnitude Estimate - GRND MTD PRK DECK
August 27, 2020

CHARGING INFRASTRUCTURE SUPPORT

LOCATION	QUANTITY	UOM	RATE*	SD Index	ADD
				113%	
DIVISION 02 - DEMOLITION					
024119 Selective Demolition, Cutout					
Utility Switch to MV Switchgear	100	SF	$36.00	$41	$4,057
DIVISION 03 - CONCRETE					
033000 Cast-In-Place Concrete (GC)					
Field surveys and verification	80	HRS	$95.00	$107	$8,565
033053 Miscellaneous Cast-In-Place Concrete					
CIP Concrete housekeeping pad					
at utility switch	2	CY	$450.00	$507	$1,126
at MV Switchgear	2	CY	$450.00	$507	$1,126
at transformer	13	CY	$450.00	$507	$6,694
at bus parking	313	CY	$450.00	$507	$158,738
at emergency generator	10	CY	$450.00	$507	$5,072
at battery storage	18	CY	$450.00	$507	$9,306
DIVISION 26 - ELECTRICAL					
260513 Medium Voltage Cables					
AC Power Cable					
from Utility Switch to MV Switchgear	75	LF	$39.57	$45	$3,345
from MV Switchgear to Transformer	2,900	LF	$39.57	$45	$129,337
260519 Low Voltage Electrical Power Conductors and Cables					
AC Power Cable XFRM to LV SB	3,130	LF	$80.23	$90	$283,011
AC Power Cable SB to Charging Cabinet	5,343	LF	$80.23	$90	$483,108
AC Power Cable from Battery Storage to LV SB	375	LF	$80.23	$90	$33,907
AC Power Cable from Generator to LV SB	318	LF	$80.23	$90	$28,753
PE Wire 1x35 mm2 (DC) (CB to Panto)	13,533	LF	$24.59	$28	$374,992
Interlock Cable 2x1.5 mm2	13,533	LF	$3.86	$4	$58,835
AC Utility Power 4x2.5 mm2	13,533	LF	$4.96	$6	$75,692
260539 Underfloor Raceways for Electrical Systems					
6" Metal conduit from interrupter to 4-way switch	16	LF	$86.20	$97	$1,554
6" Metal conduit 4-way switch to MV Switchgear	16	LF	$86.20	$97	$1,554
6" Metal conduit from XFRM to LV SB	2,900	LF	$86.20	$97	$281,727
6" Metal conduit Transformer to Switchboards	3,130	LF	$86.20	$97	$304,071
6" Metal conduit Switchboards to DC Charging Cabinets	5,343	LF	$86.20	$97	$519,059
6" Metal conduit DC Charging Cabinets to Pantographs	27,066	LF	$86.20	$97	$2,629,392
260533 Wireways					
12" x 12" Wireway Switchboards to Charging Cabinets to Junction Box	1,355	LF	$73.50	$83	$112,276
12" x 12" Junction Box on Cable Tray to Pantograph (Cable Tray)	3,221	LF	$73.50	$83	$266,769
Transformers					
Medium Voltage to Low Voltage Transformers	6	EA	$20,000.00	$22,540	$135,240
Switchgear					
600 Amp 15 KV Load interrupter switch	1	EA	$5,775.00	$6,508	$6,508
100 Amp 208/120V 42 CKT Panel	6	EA	$4,500.00	$5,072	$30,429
800 Amp Nema 3R Panel	24	EA	$7,500.00	$8,453	$202,860
Grounding	6	EA	$7,500.00	$8,453	$50,715
Medium Voltage Switchgear					
4-way switch	2	EA	$25,000.00	$28,175	$56,350
Low Voltage Switchgear					
Low Voltage Switchgear	6	EA	$30,000.00	$33,810	$202,860

DIVISION 27 - COMMUNICATIONS					
271323 Communications Optical Fiber Backbone Cabling					
Communication 8x Glass Fiber	13,533	LF	$10.78	$12	$164,441
DIVISION 31 - EARTHWORK					
Trenching / Excavation					
Main feeder duct bank	403	CY	$47.00	$53	$21,364
Transformer to main feeder duct bank	128	CY	$47.00	$53	$6,754
Generator to main feeder duct bank	94	CY	$47.00	$53	$4,979
Battery storage to main feeder duct bank	194	CY	$47.00	$53	$10,289
Transformer to switchgear	1,786	CY	$47.00	$53	$94,603
Backfill trench					
Main feeder duct bank	67	CY	$46.00	$52	$3,484
Transformer to main feeder duct bank	28	CY	$46.00	$52	$1,467
Generator to main feeder duct bank	18	CY	$46.00	$52	$949
Battery storage to main feeder duct bank	43	CY	$46.00	$52	$2,240
Transformer to switchgear	1,786	CY	$46.00	$52	$92,590
312020 Excavated Material Management and Disposal					
Disposal off site, assume clean but unsuitable	1,786	CY	$39.00	$44	$78,500
DIVISION 32 - EXTERIOR IMPROVEMENTS					
321313 - Concrete Paving					
Main feeder duct bank	28	SY	$40.00	$45	$1,271
Transformer to main feeder duct bank	12	SY	$40.00	$45	$541
Generator to main feeder duct bank	8	SY	$40.00	$45	$347
Battery storage to main feeder duct bank	18	SY	$40.00	$45	$825
Transformer to switchgear	903	SY	$40.00	$45	$40,707
DIVISION 33 - EXTERIOR IMPROVEMENTS					
337119 Electrical Underground Ducts and Manholes					
Handholes, pre-cast concrete, with concrete cover	6	EA	$1,600.00	$1,803	$10,819
			TO SUMMARY		**$7,003,200**

SBMF ZEB
San Diego, CA
Conceptual Rough Order of Magnitude Estimate - GRND MTD PRK DECK
August 27, 2020

OVERHEAD SUPPORT STRUCTURE

LOCATION	QUANTITY	UOM	RATE*	SD Index	ADD
				113%	
DIVISION 03 - CONCRETE					
033053 Miscellaneous Cast-In-Place Concrete					
Regular concrete (4000 psi), 6" slab	-	SF	$4.56	$5	$0
DIVISION 05 - METALS					
050001 Miscellaneous and Ornamental Iron					
4" sch 40 pipe bollards	126	EA	$350.00	$394	$49,701
051200 Structural Steel					
Conduit support rack; galvanized	2,961	LF	$15.00	$17	$50,048
W12x120 Frame Columns	1,376	LF	$206.00	$232	$319,455
W12x53 K-Bracing	1,000	LF	$103.00	$116	$116,081
W24x84 Framing	2,700	LF	$145.00	$163	$441,221
W27X102 Framing	2,450	LF	$178.00	$201	$491,485
052119 Open Web Steel Joist Framing					
26k12 Subframe Joist for Pantographs	16,976	LF	$17.60	$20	$336,722
053113 Steel Floor Decking					
1.5" Steel Decking, 16 ga.	-	SF	$5.25	$6	$0
DIVISION 09 - FINISHES					
090007 Painting					
Prep columns & framing	110,112	SF	$4.50	$5	$558,433
DIVISION 31 - EARTHWORK					
316326 Drilled Caissons					
Fixed end caisson pile, open, machine drilled, in stable ground, no casings or ground water, 48" diameter	1,260	LF	$575.00	$648	$816,512
			TO SUMMARY		**$3,179,657**

SBMF ZEB
San Diego, CA
Conceputal Rough Order of Magnitude Estimate - GRND MTD PRK DECK
August 27, 2020

DECK OVER BUS PARKING

LOCATION	QUANTITY	UOM	RATE*	SD Index	ADD
				113%	
DECK OVER BUS PARKING					
Parking Deck	217	SPACE	$22,755.60	$25,646	$5,565,087
			TO SUMMARY		**$5,565,087**

SBMF ZEB
San Diego, CA
Conceputal Rough Order of Magnitude Estimate - GRND MTD PRK DECK
August 27, 2020

PHOTO-VOLTAIC SYSTEM

LOCATION	QUANTITY	UOM	RATE*	SD Index	ADD
				113%	
PV SYSTEM					
PV Panels (includes frame)**	8,480	EA	$700.00	$789	$6,689,872
PV support equipment (inverter / controller)	8	EA	$3,000.00	$3,381	$27,048
DIVISION 05 - METALS					
052119 Open Web Steel Joist Framing					
26k12 Subframe Joist for PV Support (included under Support Frame)	-	LF	$17.60	$20	$0
			TO SUMMARY		**$6,716,920**

**2.9 MW is generated on a sunny day.

SBMF ZEB
San Diego, CA
Conceptual Rough Order of Magnitude Estimate
August 27, 2020

MTS

GROUND MOUNTED EQUIPMENT - NO PARKING DECK

SBMF ZEB
San Diego, CA
Conceputal Rough Order of Magnitude Estimate - GRND MTD NO DECK
August 27, 2020

EXECUTIVE SUMMARY

			TOTAL
A	**Charging Equipment, Includes External Funding**		$22,546,800
B	**Charging Infrastructure Support**		$7,003,200
C	**Support Frame**		$3,986,964
D	**Deck Over Bus Parking**		$0
E	**Photo-Voltaic System**		$7,959,438
	Sub-total	**-**	**$41,496,401**
	Design Development Contingency	**20.0%**	$8,299,280
	Design Contingency sub-total		**$8,299,280**
	Sub-total Direct Costs		**$49,795,681**
	Markups		
	General Conditions and Requirements	12.0%	$5,975,482
	Insurance	0.75%	$373,468
	Bond	1.5%	$746,935
	Overhead and Profit	12.5%	$6,224,460
	Estimated Contract Award, Jan 2020		**$63,116,026**
	Escalation to Dec 2020	3.0%	$1,893,481
	Estimated Contract Award, Jan 2021		**$65,009,507**
	Pre- and Post-Construction Expenses ("Soft Costs")	1.7%	**$1,105,162**
	GRAND TOTAL CONSTRUCTION		**$66,114,669**
	For Budgetary Implementation Costs Add:		
	Premilinary Engineering and Environmental	2%	$1,322,293
	Final Design	12%	$7,933,760
	Project Management/Construction Management	12.50%	$8,264,334
	Non-construction Insurance	2%	$1,322,293
	Other	1%	$661,147
	Sub-total		**$19,503,827**
	TOTAL COSTS INCLUDING IMPLEMENTATION JAN 2021		**$85,618,496**

SBMF ZEB
San Diego, CA
Conceptual Rough Order of Magnitude Estimate - GRND MTD NO DECK
August 27, 2020

CHARGING EQUIPMENT

LOCATION	QUANTITY	UOM	RATE*	SD Index	ADD
				113%	
CHARGING EQUIPMENT					
DC Charging Cabinets and Pantographs					
DC Charging Cabinet - 150kW (includes DC switch)	113	EA	$121,000.00	$121,000	$13,673,000
Pantograph (includes depot charge box)	226	EA	$16,000.00	$16,000	$3,616,000
Energy Storage					
1.5MW Battery Storage**	1	EA	$1,100,000.00	$1,100,000.00	$1,100,000
380kW CNG Generator**	1	EA	$400,000.00	$400,000.00	$400,000
***Price for both options shown. Only one is needed.*					
Installation					
Equipment Install - 20% of Equipment Cost	1		$3,757,800.00		$3,757,800
CALeVIP FUNDING, HVIP FUNDING, OTHER REBATES					
HVIP Funding per Bus (Quantity is total fleet after conversion)	-	EA	($40,000.00)		$0
CALeVIP Funding (Quantity is total number of charging cabinets)	-	EA	($42,000.00)		$0
SDG&E's Power Your Drive - Fleets	-	EA	($25,000.00)		$0
			TO SUMMARY		**$22,546,800**

SBMF ZEB
San Diego, CA
Conceptual Rough Order of Magnitude Estimate - GRND MTD NO DECK
August 27, 2020

CHARGING INFRASTRUCTURE SUPPORT

LOCATION	QUANTITY	UOM	RATE*	SD Index	ADD
				113%	
DIVISION 02 - DEMOLITION					
024119 Selective Demolition, Cutout					
Utility Switch to MV Switchgear	100	SF	$36.00	$41	$4,057
DIVISION 03 - CONCRETE					
033000 Cast-In-Place Concrete (GC)					
Field surveys and verification	80	HRS	$95.00	$107	$8,565
033053 Miscellaneous Cast-In-Place Concrete					
CIP Concrete housekeeping pad					
at utility switch	2	CY	$450.00	$507	$1,126
at MV Switchgear	2	CY	$450.00	$507	$1,126
at transformer	13	CY	$450.00	$507	$6,694
at bus parking	313	CY	$450.00	$507	$158,738
at emergency generator	10	CY	$450.00	$507	$5,072
at battery storage	18	CY	$450.00	$507	$9,306
DIVISION 26 - ELECTRICAL					
260513 Medium Voltage Cables					
AC Power Cable					
from Utility Switch to MV Switchgear	75	LF	$39.57	$45	$3,345
from MV Switchgear to Transformer	2,900	LF	$39.57	$45	$129,337
260519 Low Voltage Electrical Power Conductors and Cables					
AC Power Cable XFRM to LV SB	3,130	LF	$80.23	$90	$283,011
AC Power Cable SB to Charging Cabinet	5,343	LF	$80.23	$90	$483,108
AC Power Cable from Battery Storage to LV SB	375	LF	$80.23	$90	$33,907
AC Power Cable from Generator to LV SB	318	LF	$80.23	$90	$28,753
PE Wire 1x35 mm2 (DC) (CB to Panto)	13,533	LF	$24.59	$28	$374,992
Interlock Cable 2x1.5 mm2	13,533	LF	$3.86	$4	$58,835
AC Utility Power 4x2.5 mm2	13,533	LF	$4.96	$6	$75,692
260539 Underfloor Raceways for Electrical Systems					
6" Metal conduit from interrupter to 4-way switch	16	LF	$86.20	$97	$1,554
6" Metal conduit 4-way switch to MV Switchgear	16	LF	$86.20	$97	$1,554
6" Metal conduit from XFRM to LV SB	2,900	LF	$86.20	$97	$281,727
6" Metal conduit Transformer to Switchboards	3,130	LF	$86.20	$97	$304,071
6" Metal conduit Switchboards to DC Charging Cabinets	5,343	LF	$86.20	$97	$519,059
6" Metal conduit DC Charging Cabinets to Pantographs	27,066	LF	$86.20	$97	$2,629,392
260533 Wireways					
12" x 12" Wireway Switchboards to Charging Cabinets to Junction Box	1,355	LF	$73.50	$83	$112,276
12" x 12" Junction Box on Cable Tray to Pantograph (Cable Tray)	3,221	LF	$73.50	$83	$266,769
Transformers					
Medium Voltage to Low Voltage Transformers	6	EA	$20,000.00	$22,540	$135,240
Switchgear					
600 Amp 15 KV Load interrupter switch	1	EA	$5,775.00	$6,508	$6,508
100 Amp 208/120V 42 CKT Panel	6	EA	$4,500.00	$5,072	$30,429
800 Amp Nema 3R Panel	24	EA	$7,500.00	$8,453	$202,860
Grounding	6	EA	$7,500.00	$8,453	$50,715
Medium Voltage Switchgear					
4-way switch	2	EA	$25,000.00	$28,175	$56,350
Low Voltage Switchgear					
Low Voltage Switchgear	6	EA	$30,000.00	$33,810	$202,860

DIVISION 27 - COMMUNICATIONS					
271323 Communications Optical Fiber Backbone Cabling					
Communication 8x Glass Fiber	13,533	LF	$10.78	$12	$164,441
DIVISION 31 - EARTHWORK					
Trenching / Excavation					
Main feeder duct bank	403	CY	$47.00	$53	$21,364
Transformer to main feeder duct bank	128	CY	$47.00	$53	$6,754
Generator to main feeder duct bank	94	CY	$47.00	$53	$4,979
Battery storage to main feeder duct bank	194	CY	$47.00	$53	$10,289
Transformer to switchgear	1,786	CY	$47.00	$53	$94,603
Backfill trench					
Main feeder duct bank	67	CY	$46.00	$52	$3,484
Transformer to main feeder duct bank	28	CY	$46.00	$52	$1,467
Generator to main feeder duct bank	18	CY	$46.00	$52	$949
Battery storage to main feeder duct bank	43	CY	$46.00	$52	$2,240
Transformer to switchgear	1,786	CY	$46.00	$52	$92,590
312020 Excavated Material Management and Disposal					
Disposal off site, assume clean but unsuitable	1,786	CY	$39.00	$44	$78,500
DIVISION 32 - EXTERIOR IMPROVEMENTS					
321313 - Concrete Paving					
Main feeder duct bank	28	SY	$40.00	$45	$1,271
Transformer to main feeder duct bank	12	SY	$40.00	$45	$541
Generator to main feeder duct bank	8	SY	$40.00	$45	$347
Battery storage to main feeder duct bank	18	SY	$40.00	$45	$825
Transformer to switchgear	903	SY	$40.00	$45	$40,707
DIVISION 33 - EXTERIOR IMPROVEMENTS					
337119 Electrical Underground Ducts and Manholes					
Handholes, pre-cast concrete, with concrete cover	6	EA	$1,600.00	$1,803	$10,819
			TO SUMMARY		**$7,003,200**

SBMF ZEB
San Diego, CA
Conceputal Rough Order of Magnitude Estimate - GRND MTD NO DECK
August 27, 2020

OVERHEAD SUPPORT STRUCTURE

LOCATION	QUANTITY	UOM	RATE*	SD Index	ADD
				113%	
DIVISION 03 - CONCRETE					
033053 Miscellaneous Cast-In-Place Concrete					
Regular concrete (4000 psi), 6" slab	-	SF	$4.56	$5	$0
DIVISION 05 - METALS					
050001 Miscellaneous and Ornamental Iron					
4" sch 40 pipe bollards	176	EA	$350.00	$394	$69,423
051200 Structural Steel					
Conduit support rack; galvanized	2,961	LF	$15.00	$17	$50,048
W12x120 Frame Columns	1,727	LF	$206.00	$232	$400,944
W12x53 K-Bracing	1,300	LF	$103.00	$116	$150,905
W24x84 Framing	3,294	LF	$145.00	$163	$538,289
W27X102 Framing	3,110	LF	$178.00	$201	$623,885
052119 Open Web Steel Joist Framing					
26k12 Subframe Joist for Pantographs	21,376	LF	$17.60	$20	$423,997
053113 Steel Floor Decking					
1.5" Steel Decking, 16 ga.	-	SF	$5.25	$6	$0
DIVISION 09 - FINISHES					
090007 Painting					
Prep columns & framing	138,618	SF	$4.50	$5	$703,001
DIVISION 31 - EARTHWORK					
316326 Drilled Caissons					
Fixed end caisson pile, open, machine drilled, in stable ground, no casings or ground water, 48" diameter	1,584	LF	$575.00	$648	$1,026,472
			TO SUMMARY		**$3,986,964**

SBMF ZEB
San Diego, CA
Conceputal Rough Order of Magnitude Estimate - GRND MTD NO DECK
August 27, 2020

DECK OVER BUS PARKING

LOCATION	QUANTITY	UOM	RATE*	SD Index	ADD
				113%	
DECK OVER BUS PARKING					
Parking Deck	-	SPACE	$22,755.60	$25,646	$0
			TO SUMMARY		**$0**

SBMF ZEB
San Diego, CA
Conceputal Rough Order of Magnitude Estimate - GRND MTD NO DECK
August 27, 2020

PHOTO-VOLTAIC SYSTEM

LOCATION	QUANTITY	UOM	RATE*	SD Index	ADD
				113%	
PV SYSTEM					
PV Panels (includes frame)**	10,085	EA	$700.00	$789	$7,956,057
PV support equipment (inverter / controller)	1	EA	$3,000.00	$3,381	$3,381
DIVISION 05 - METALS					
052119 Open Web Steel Joist Framing					
26k12 Subframe Joist for PV Support (included under Support Frame)	-	LF	$17.60	$20	$0
			TO SUMMARY		**$7,959,438**

**3.4 MW is generated on a sunny day.

APPENDIX A – EXISTING CONDITIONS REPORT

SOUTH BAY MAINTENANCE FACILITY (SBMF) ELECTRIC BUS CONCEPT LAYOUT

Final Existing Facility Conditions Report

Metropolitan Transit System

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Final

Existing Conditions Report

Prepared for:

Prepared by:

Dokken Engineering & WSP

May 27, 2020

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TABLES

FIGURES

GLOSSARY OF TERMS AND ACRONYMS

AC	Alternating Current – multi-directional current flow, good for distributing power over long distances.
ATS	Automatic Transfer Switch
Amp	Ampere – a unit of electrical current
BEB	Battery-Electric Bus – a type of bus that produces no emissions.
CNG	Compressed Natural Gas – a fuel type that produces fewer emissions than diesel.
DC	Direct Current – One-way current flow, used to charge batteries, less efficient over long distances.
Diesel	A fuel type for buses. This fuel type results in more emissions than hybrid or CNG buses.
Hostler	Staff member of the nightly service crew who move the buses through the nightly fare collection / fuel / interior clean / exterior wash / park cycle.
hp	Horsepower – Unit of power equivalent to 0.7457 kW.
kW	Kilo-Watt – A unit of power, which is the rate at which energy is transferred
kWh	Kilo-Watt-Hour – A unit of energy.
kVA	Kilo-Volt Amps
kVARH	Kilo-Volt Amps Reactive Hours
MW	Mega-Watt – A unit of power equal to 1000 kW
MWh	Mega-Watt-Hour – A unit of energy equal to 1000 kWh
MTS	San Diego Metropolitan Transit System
Nightly Service	The process of a bus returning to a bus garage and being serviced (fares collected, interior cleaned, fueled/charged) to be ready for AM pull out the next day.
NRV	Non-Revenue Vehicle
PCC	Portland Concrete Cement
Tracks	A long open parking aisle in which buses are parked facing the same direction in a stacked row nose-to-tail (front of one bus pointed at the rear of another bus).
ZEB	Zero Emission Bus – Vehicle which uses electricity to power its motor.

1 INTRODUCTION

1.1 Report Purpose and Structure

This report documents the existing site and utility conditions present at the San Diego Metropolitan Transit System's (MTS) South Bay Maintenance Facility (SBMF). The information outlined in this report establishes a baseline for the decisions made in subsequent tasks and will ultimately inform MTS on how to gradually implement a scalable and modular zero emission bus charging system at the SBMF.

The goals of this Existing Conditions Report are to:

1. Develop an understanding of the existing Compressed Natural Gas (CNG) bus fleet and maintenance facilities, parking configurations, and site flow at the SBMF.
2. Identify physical and infrastructure constraints associated with the implementation of Zero Emission Buses (ZEBs).
3. Analyze existing facilities to determine the need for infrastructure upgrades and modifications required to existing vehicle maintenance and vehicle support facilities to support ZEBs.
4. Identify existing utility capacities, limitations, and availability as a baseline prior to the implementation of ZEBs.
5. Provide a basis for selecting charging infrastructure technology types that can be feasibly installed and phased into the SBMF.

This report examines the existing facilities and electrical service at the SBMF and recommends the improvements needed to implement a scalable and modular bus charging system. This document also assesses the existing utility services to determine how the existing electrical infrastructure will need to be improved to meet the additional power demand of a scalable battery-electric bus (BEB) operation.

This report is organized into the following sections:

- Section 2: Existing Conditions
- Section 3: Summary Findings & Next Steps

1.2 Background and Approach

The project team began the site assessment process with a kickoff meeting with MTS and Transdev staff to discuss the proposed methodology, schedule, and goals. A check list of existing pertinent data was assembled and reviewed with MTS key ZEB and SBMF operations staff. The check list was filled out based on received as-built and operational data as received from MTS. Data not able to be confirmed by information contained in the as-builts was collected during an in-person site tour. This report details the findings of both the as-built existing data review and the on-site Site Assessment.

On April 27, 2020, the project team performed a field site assessment, met with key operations staff to discuss the existing facility. and documented the existing conditions of the SBMF. The site assessment observations and supporting data provided by MTS are provided in Section 2 of this report.

MTS currently operates and maintains 239 compressed natural gas (CNG) buses at the SBMF. The SBMF operates throughout the San Diego region, primarily servicing the South Bay, including 9 routes within the City of Chula Vista. Figure 2-1 provides an overview of the current service routes operating within the City of Chula Vista and City of National City.

Figure 1-1. MTS Transit Map

1.3 Summary of Documents Referenced

In order to develop an understanding of the SBMF's bus operations and existing infrastructure, the project team worked with MTS and Transdev staff to gather information relating to the layout, condition, power consumption, and use of existing facilities. The following documents were provided by MTS for review:

1. As-built construction drawings of existing facilities addressed by this report:
   - South Bay Maintenance Facility Improvements – New Maintenance Facility – Electrical Site Plan Dated June 03, 2015
   - South Bay Maintenance Facility Improvements – New Maintenance Facility - Single Line Diagram Dated June 03, 2015
   - South Bay Maintenance Facility Improvements – New Administration Building - Single Line Diagram Dated June 03, 2015
   - South Bay Maintenance Facility Improvements – New Maintenance Facility – Photovoltaic Single Line Dated June 03, 2015
   - South Bay Maintenance Facility – Utilities Exhibit – Dated March 1, 2013
   - South Bay Depot AT&T Wireless Design Report – Dated December 14, 2019
   - South Bay Maintenance Facility Bus Parking Layout – Dated November 15, 2019
2. Full Site CAD Drawings of existing facilities:
   - South Bay Maintenance Facility Improvements – New Administration Building
   - South Bay Maintenance Facility Improvements – New Maintenance Facility
   - South Bay Maintenance Facility Improvements – Existing Maintenance Building Repairs
   - South Bay Maintenance Facility Improvements – New Bus Wash Building
3. Historic electric-utility and gas-utility usage information provided by MTS
4. MTS South Bay Division Fleet Inventory List

2 Existing Conditions

This section provides an understanding of the existing conditions at the SBMF. The following topics are covered in this report: fleet parking, operations, facilities, siting, planned improvements, power conditions and consumption, site circulation, and fleet utilization.

2.1 Site Location

The SBMF is located at 3650 Main St., in the City of Chula Vista (Figure 2-1). According to the California Environmental Protection Agency (CalEPA), the SBMF is not located in a state-designated disadvantaged community[1].

Figure 2-1. SBMF Aerial View

[1] Disadvantaged communities are defined as the top 25 percent scoring census tracts using results of the California Communities Environmental Health Screening Tool (CalEnviroScreen) along with other areas with high amounts of pollution and low population.

2.2 Fleet Parking, Operations, and Existing Facilities

The following structures are present at the SBMF: A two-story maintenance building (New Maintenance Building), one-story maintenance building (Old Maintenance Building), two-story administration building (New Administration Building), one-story administration building (Old Administration Building), stand-alone dual bus wash building, five stand-alone CNG fueling stations, a direct current (DC) charging station, and an approximately 4,000-square-foot CNG compressor yard. Table 2-1 and Figure 2-2 provide an overview of the existing site facilities and parking lot designations.

Buses enter and exit the site from Main St. via Driveway 1 and proceed to the fuel staging lanes located adjacent to the CNG compressor yard. Following fuel and wash, buses are returned to the bus parking area. Buses remain parked until the following business day unless maintenance is required.

Bus parking is provided on-site in Parking Lots “A”, “B”, “C”, “D”, “E”,“F” and “G”. Parking Lot “B” accommodates 60-foot Rapid 225 and Artic Transit buses and 40-foot buses. The remaining parking lots are used exclusively for 40-foot buses. Parking Lot “A” is reserved for employee parking during daytime hours and is converted into a bus parking area during the evening. Buses are generally parked nose-to-tail in unnumbered stalls. Additional parking for down fleet vehicles is provided adjacent to the bus wash area. The existing Portland Concrete Cement (PCC) and Asphalt Concrete (AC) paving are in good condition. No drainage issues were identified during the site assessment.

The New Maintenance Building appears to have adequate clearances, above 17’-0” clear, to accommodate future BEBs for both ground mounted charges and overhead chargers. The existing flooring is epoxy-coated concrete and is in good condition. The Old Maintenance Building appears to have adequate clearances to accommodate BEBs. The existing flooring is concrete and is in acceptable condition. The Old Maintenance Building is used for tire storage and serves as the central hub for the site’s wireless access point (WAP).

Table 2-1. Existing CNG Fleet and Facilities Inventory

CNG Fleet Overview	
Buses and Service Type	
40’ CNG	**205**
60’ CNG (Rapid 225)	**17**
60’CNG (Artic Transit)	**10**
Total	**239**
Facilities	
Bays Capable of Servicing 60'	4
Total Maintenance Bays	21*
Tire Bays	-
Paint Booths	-
DC Charging Positions	4
CNG Fueling Positions	5
CNG Compressor Yards	1
Diesel Fueling Positions	-
Unleaded Fueling Positions	-
Dyno Bays	-
NRV Bays	-
Body shops	-
Bus Wash Lanes	2
Chassis Wash Bays/Steam Cleaning Bays	2

*New Maint Bldg: (1) Chassis Wash, (4) 60', (10) 40'
Old Maint Bldg: (1) Chassis Wash, (5) 40'

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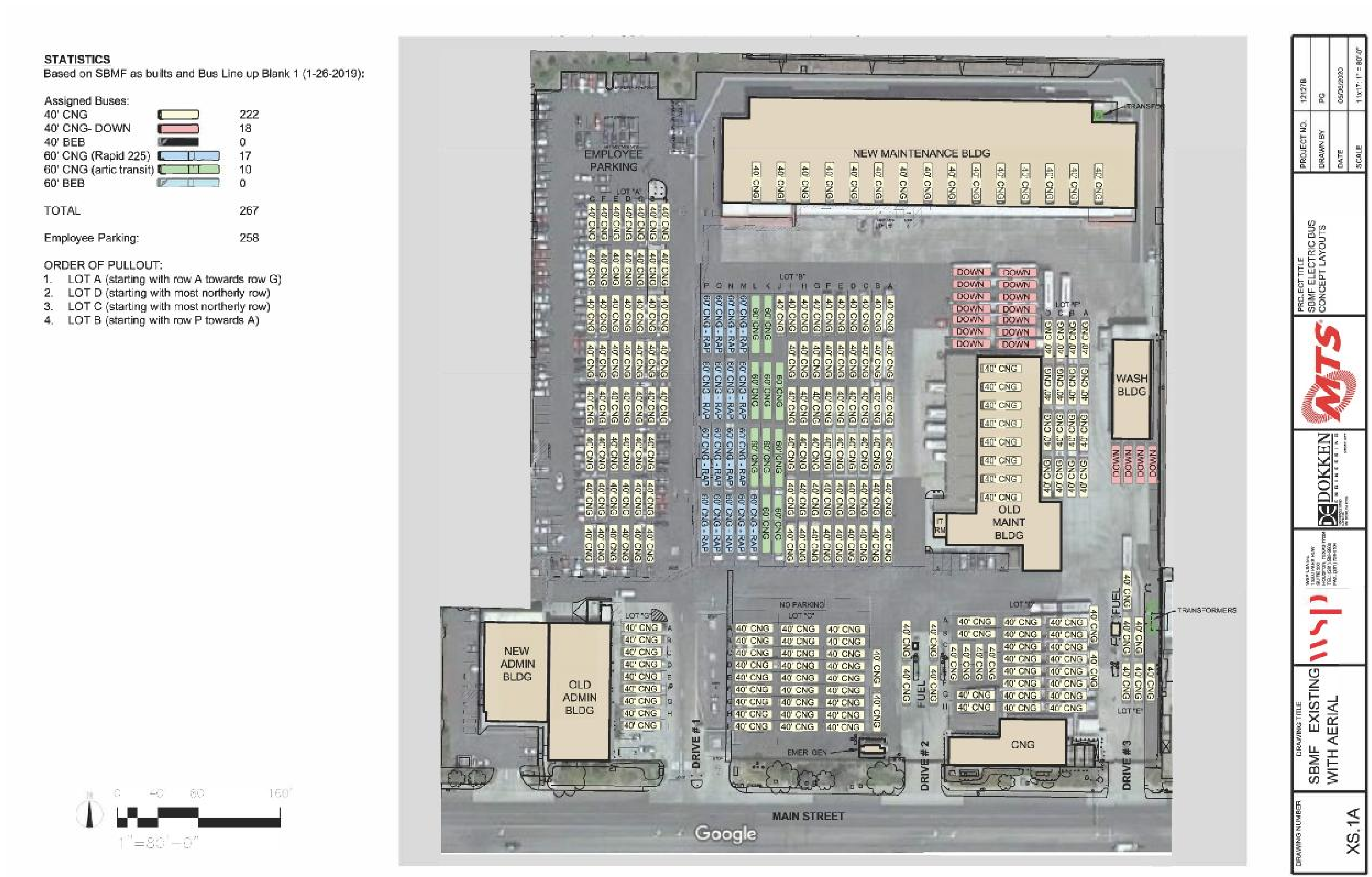
Figure 2-2. Existing Site Plan with Aerial



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2.3 Siting

The SBMF is bordered by residential homes to the north, commercial storage facilities to the east, Main St. to the south, and an elementary school and recreation center to the west. Electrical service enters the site via Main St. at Driveway 3. There are no known onsite easements constraining the site. The existing site is very constrained with limited space available for future electric bus charging equipment and ground level expansion.

2.4 Characteristics and Planned Improvements

In 2014, MTS completed the expansion and renovation of the existing site. These improvements included a new administration building, a new bus maintenance building, alterations to the existing maintenance building, a dual bus wash facility, and additional on-site bus parking.

MTS is scheduled to replace 37 of their existing 239 CNG vehicles in August 2021. No additional major capital improvement projects or planned renovations are programmed for the SBMF.

2.5 Existing Power Conditions and Usage

Building and CNG Electrical Facilities

The site's existing electrical service is provided by SDG&E from Main St. to SDG&E owned transformers. The lines go to two different transformers and are split between the Old Maintenance Building and the New Maintenance Building. Figure 2-3 highlights key electrical infrastructure at the SBMF. The transformer that powers the New Maintenance Building is a 12.47 kV to 480/277 V transformer that feeds into 1200A switchgear. The CNG system has a 250A breaker off of this switchgear that goes to an automatic Transfer Switch (ATS) that connects to a 200 kW backup generator for the CNG systems. This is shown in Figure 2-5.

The New Administration Building also has an SDG&E provided transformer to 600A switch gear. There is a backup generator also connected to this bus via an ATS. This is shown in Figure 2-6.

The CNG Compression yard is powered by "**Meter: 6697164 – CNG Compression Yard**." No single-line diagram was provided for this service.

There also appears to be electrical service to a four (4) bus BEB Pilot that is not identified on the electrical one-line drawings and the path was unverified during the site visit since the service is underground.

Photovoltaic Electrical Facilities

Photovoltaic cells are present on the roof of the New Maintenance building with associated equipment located in the building's electrical room. The system is rated for 100 kW AC and reduces the loads seen at "**Meter 6704704 - New Maintenance Facility**." The connection is also shown in Figure 2-7 and ties into the main bus of the 1200A switch gear.

Figure 2-3. Key Electrical Infrastructure

Clockwise starting from top left: New Maintenance Facility main disconnect and meter; New Maintenance Facility generator; site emergency backup generator

Table 2-2. Historical SBMF Power Consumption (2019/2020)

Date	Billed kW	kWh	Cost ($)
3650 Main St., Chula Vista CA 91911			
Meter: 6704704 – New Maintenance Facility			
2/12/2019	**-**	**25,131**	**$4,000**
3/14/2019	**-**	**21,342**	**$3,850**
415/2019	**-**	**19,725**	**$3,799**
5/14/2019	**-**	**18,856**	**$3,698**
6/13/2019	**-**	**18,945**	**$3,517**
7/15/2019	**-**	**18,088**	**$3,453**
8/13/2019	**-**	**23,722**	**$4,198**
9/12/2019	**-**	**25,667**	**$4,019**
10/13/2019	**-**	**21,495**	**$3,808**
11/12/2019	**-**	**28,093**	**$4,396**
12/12/2019	**-**	**31,983**	**$4,573**
1/14/2020	**-**	**29,322**	**$4,696**
Meter: 6697164 - CNG Compression Yard			
2/28/2019	**-**	**82,588**	**$18,759**
3/31/2019	**-**	**79,751**	**$18,645**
4/30/2019	**-**	**87,605**	**$18,827**
5/31/2019	**-**	**81,935**	**$20,119**
6/30/2019	**-**	**87,353**	**$20,201**
7/31/2019	**-**	**90,618**	**$20,331**
8/31/2019	**-**	**90,042**	**$20,247**
9/30/2019	**-**	**88,265**	**$20,364**
10/31/2019	**-**	**85,121**	**$19,988**
11/30/2019	**-**	**85,971**	**$20,242**
12/31/2019	**-**	**87,056**	**$21,021**
1/31/2020	**-**	**79,173**	**$21,176**
Other Meters Monthly Cost			
Meter: 6688065 – Old Maintenance Building			
-	**-**	**18,310**	**$4,070**
Meter: 6697868 – 3650 Main St. D			
-	**-**	**101,514**	**$25,814**
Total Averages	**-**	**228,812**	**$35,884**
CNG Usage	**______- therms**		

"Total Averages" are the sum of the yearly averages of each individual meter

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Figure 2-4. New Maintenance Facility Electrical Site Plan

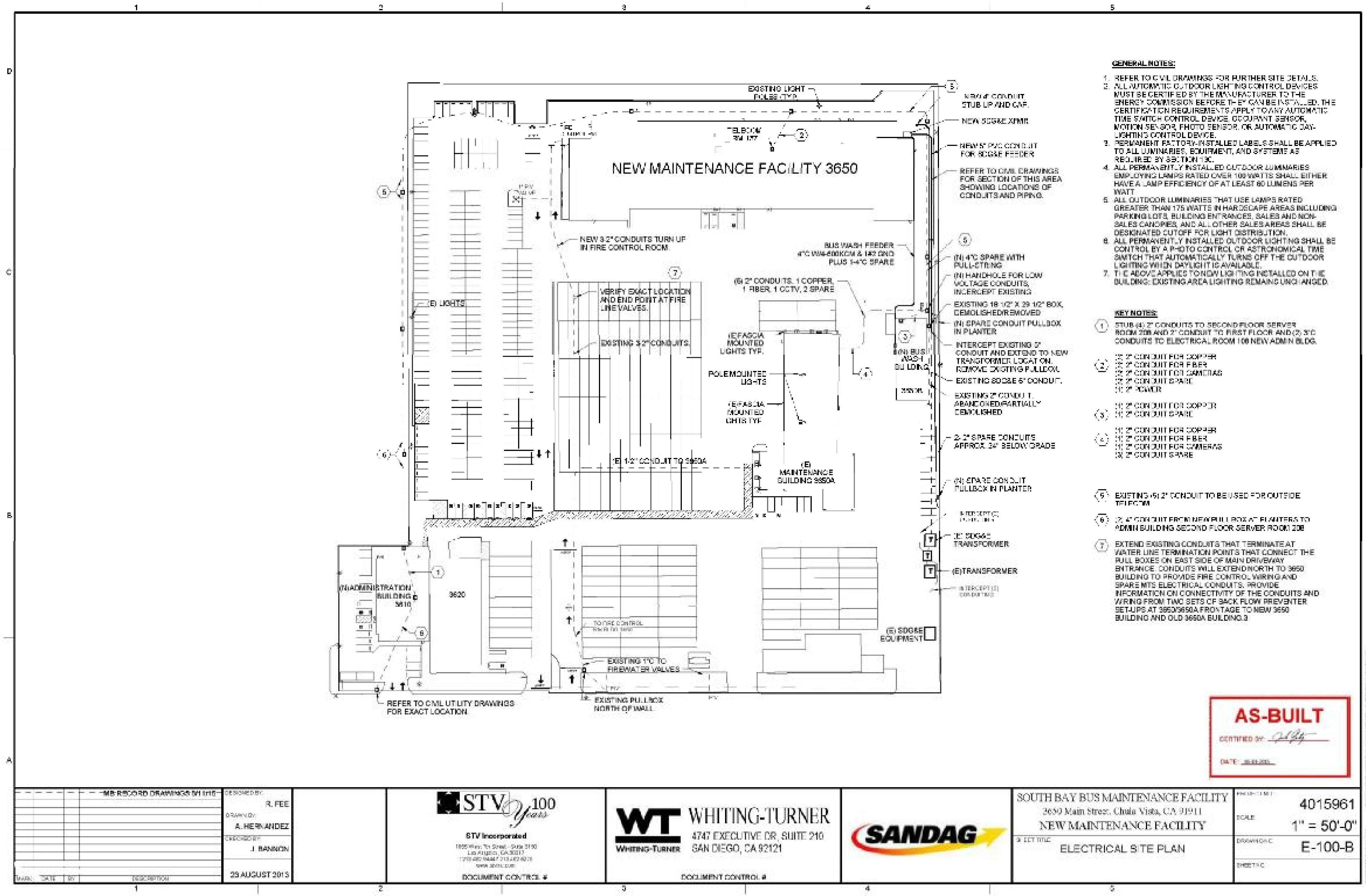

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Figure 2-5. New Maintenance Facility Single Line Diagram

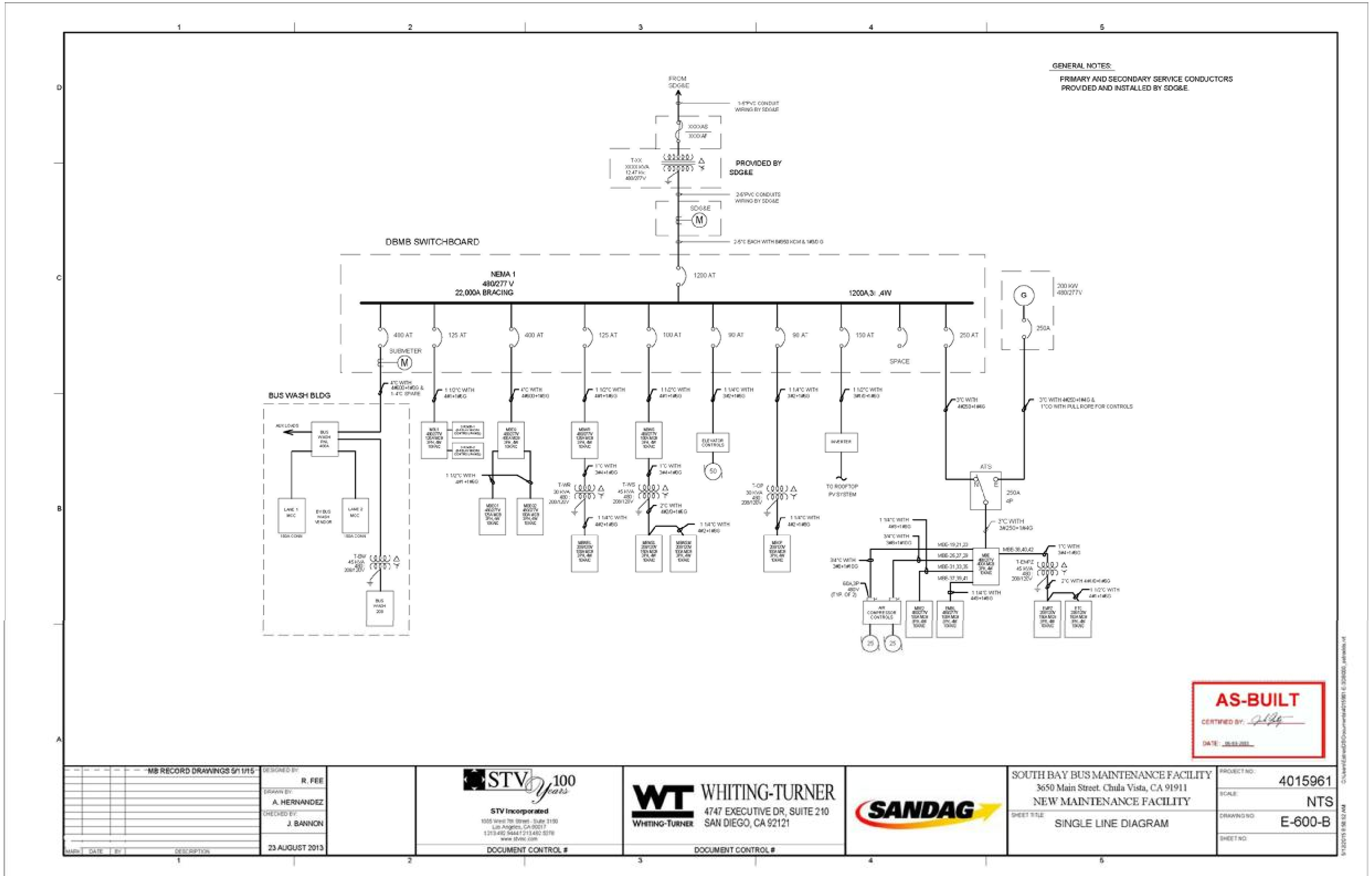

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Figure 2-6. New Administration Building Single Line Diagram

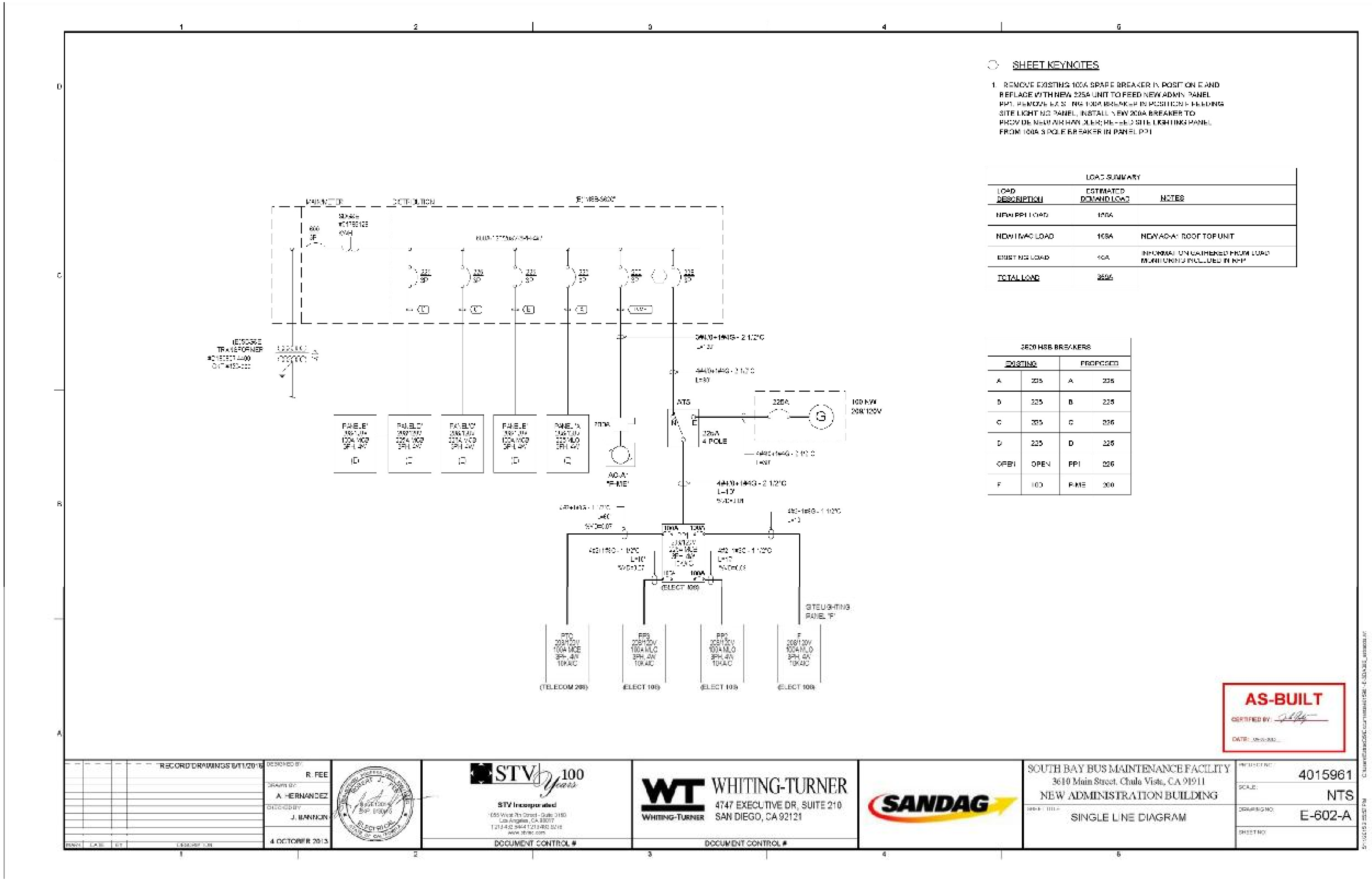

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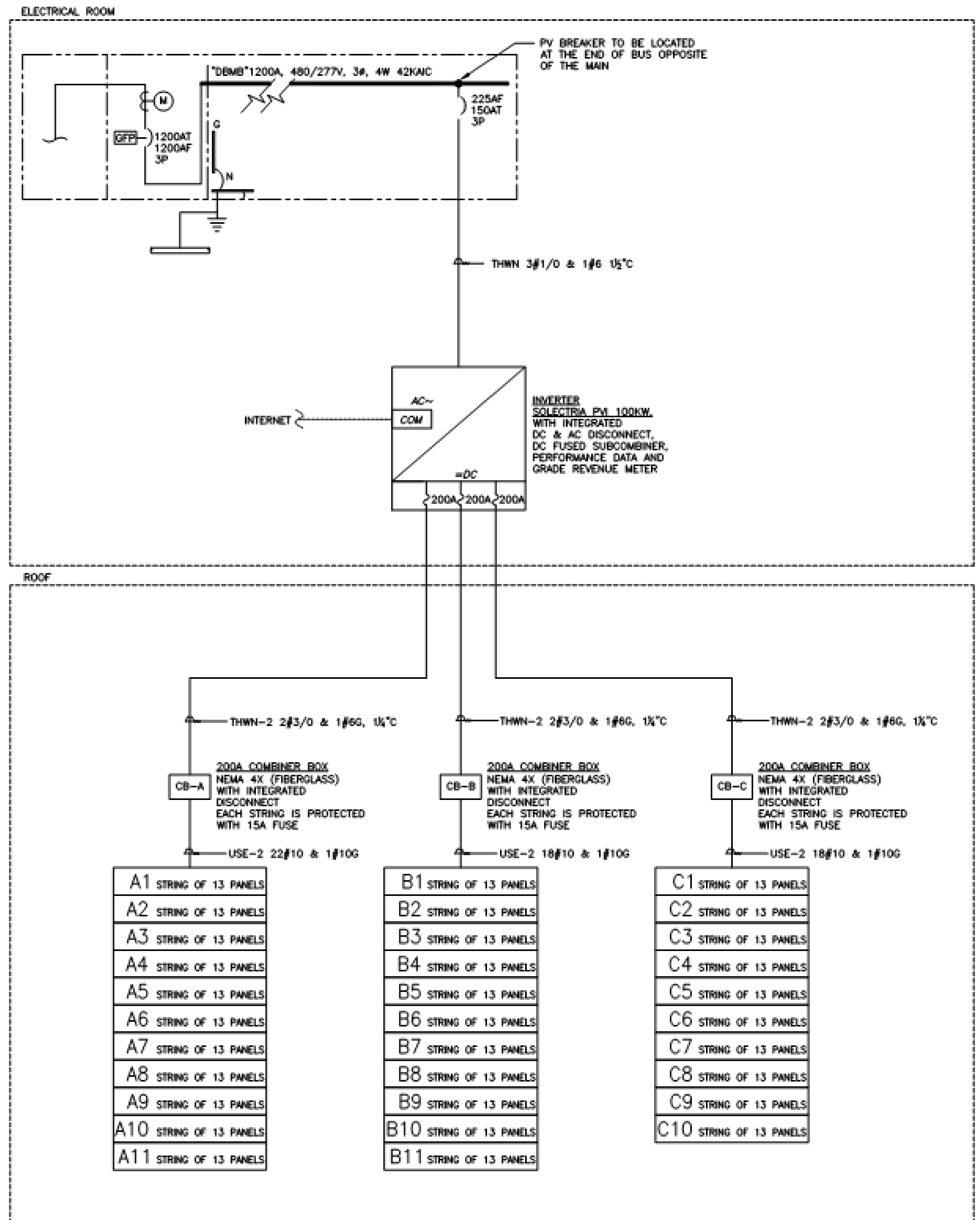
Figure 2-7. PV One-Line Connection Diagram



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2.6 Site Circulation

The description below coupled with the SBMF Existing Site Circulation Plan (Figure 2-8) provide a general overview of current site circulation and daily operations at the SBMF:

1. Bus operator arrives on site and parks in the designated on-site employee parking lot.
2. Operator clocks-in at the Administration Building and obtains vehicle and route assignment.
3. Operator retrieves vehicle and performs a pre-trip inspection prior to parking pullout.
4. Upon successful completion of the pre-trip inspection buses exit the site to Main St. via Driveway 1.
5. Buses that do not pass pre-trip inspection are parked in the down fleet area for maintenance.
6. Following peak morning service, a portion of the buses return to the site in the early afternoon.
7. As peak PM service is ramping up buses are inspected and discharged from the facility.
8. Upon completion of daily service, buses return to the site for nightly service.
9. Operator clocks-out and exits the site.
10. Hostler pulls buses to be serviced and proceeds to the CNG fuel lanes.
11. After fueling, buses are taken through the bus wash area for cleaning.
12. Buses requiring servicing are parked in the down fleet area until retrieved by maintenance for service.
13. If no issues are reported then buses are returned to the designated parking areas facing nose-to-tail and staged for efficient morning discharge. Figure 2-8 illustrates the existing parking configuration and bus discharge order.

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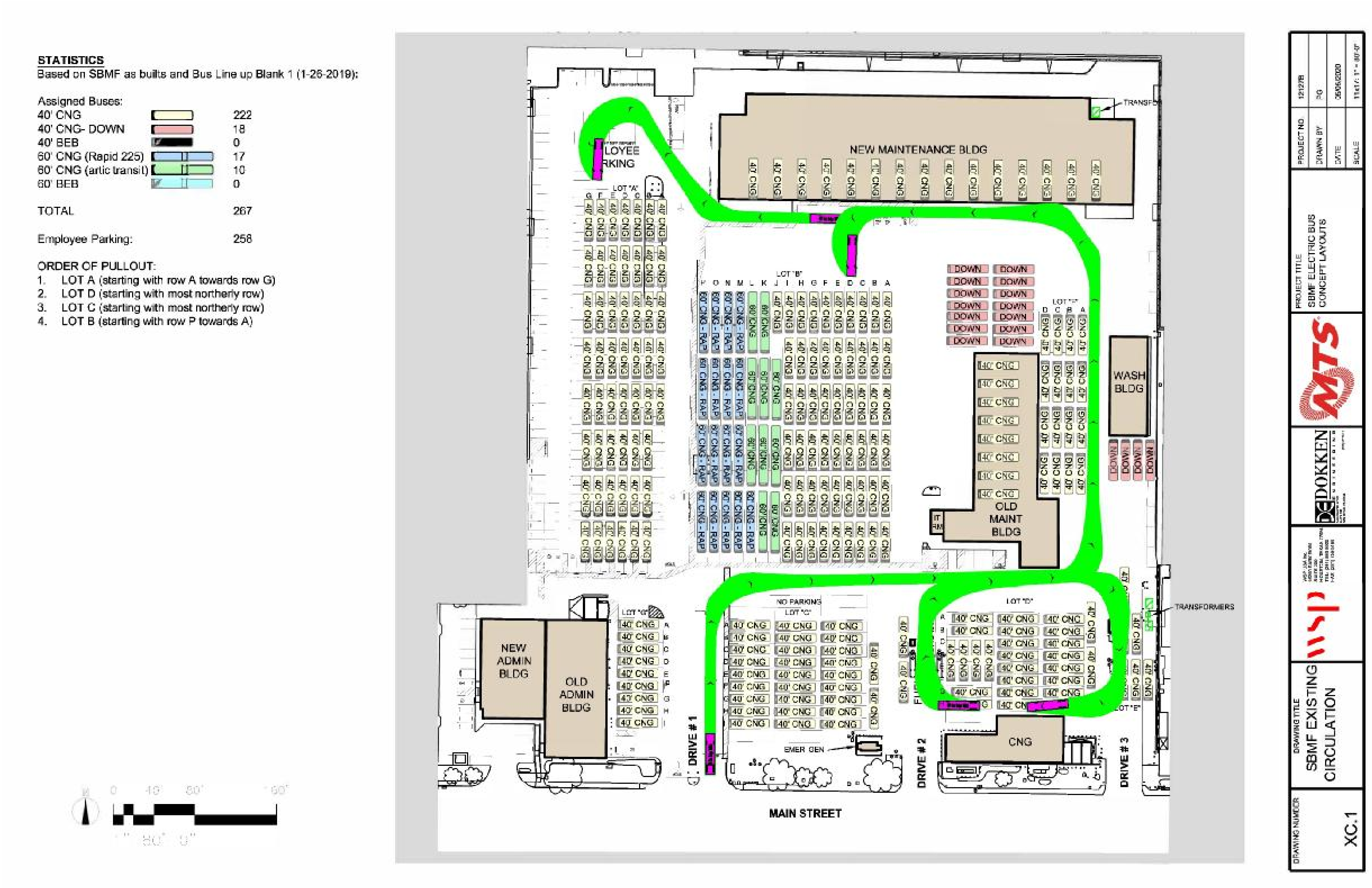
Figure 2-8. SBMF Existing Circulation Plan



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2.7 Fleet Utilization

The SBMF begins dispatching buses for revenue service between 4:00 AM and 7:00 AM. During peak AM service there are approximately 200 buses in circulation. Following PM peak service, buses begin to return to the yard at 6:00 PM with most buses returning between 10:00 PM and 11:00 PM.

The SBMF also maintains 70 Non-Revenue Vehicles (NRV) on site. MTS has indicated that these vehicles will not be upgraded to electric vehicles in the near future and are therefore not analyzed as part of this report.

3 Findings and Next Steps

This section provides a summary of the existing conditions analyzed in this report and the recommended action required to implement a scalable BEB operation.

3.1 Findings

The existing SBMF facility has adequate power to electrify the current on-site operations, equipment and buildings, and the electrical system, although varied in age, is in good working order. However, there is not enough spare capacity to support either initial near-term ZEB battery electric bus pilot of (12) twelve BEBS charging with 150kW chargers or future full fleet BEBs. It is anticipated that new electrical service will be needed to support both the near term BEB pilot and the future full fleet BEB.

3.2 Next Steps

After MTS has reviewed, confirmed, and accepted the findings contained in this Existing Facility Condition Report, the project team will form a set of parameters and assumptions with MTS to generate multiple conceptual solutions for both near term limited BEBs and full fleet BEB. All of these conceptual solutions will be analyzed for operational efficiency, ability to be constructed and operated on site while traditional fueled CNG transit buses and transit operations are on-site and on-going. Analysis will drive the selection of the technologies and phasing options to be conceptually studied and tested in subsequent tasks. These concept BEB operations plans will be graded on:

- Efficiency of BEB on-site circulation
- Comparison of BEB on-site circulation in conjunction with on-going traditional CNG transit operations
- Cost of improvements
- Ability to support / maintain identified full fleet count and break down as provided by MTS.

These are just examples of the items that will be discussed and analyzed in subsequent tasks of the SBMF Electric Bus Concept Layout project.

APPENDIX: Final Facility Tour Checklist for South Bay Maintenance Facility Program Master Plan

FACILITY TOUR CHECKLIST FOR SOUTH BAY MAINTENANCE FACILITY PROGRAM MASTER PLAN

OPERATIONS

Current Fleet Size – 239 CNG 40ft transit buses includes 27 60’

(17) 60’ Rapid 225

(10) 60’ artic transit

(7) 40’ airport buses

(205) 40’ transit (includes 7 40 ft airport buses)

Near term fleet size / capacity to plan around. 239 includes

(17) 60’ CNG Rapid 225

(10) 60’ CNG artic transit

(7) 40’ CNG airport buses

(193) CNG 40ft transit buses

(12) BEB 60ft articulated buses [12 BEB buses replace (12) 40ft buses not existing 60ft buses]

Anticipated maximum fleet size at SBMF (226) 40ft BEB + (27) 60ft BEB = 253 total BEB Fleet including same sub-fleet mix as existing fleet

Parking – Interior / Exterior, Tracks / Stacks / Dedicated Positions

- Active Fleet – quantity and location – Buses shown on existing site plan in current parking configuration.
- Down Fleet – 20% downline
    - Will downline parking spaces need charging? -No
- Size of existing spaces / tracks 12 ft wide x 45 ft long for 40’ transit buses and 12’x 65’ for 60’ articulated buses
- Four existing curb cuts from Main Street onto SBMF site. MTS Confirmed as noted
    1. Operations Drive - no transit bus access
    2. Bus Western Drive (main drive) only entry / exit drive that is used
    3. Middle Bus Drive – not used as either exit or entry drive
    4. Eastern Bus Drive – not used as either exit or entry drive

WSP USA
401 B Street
Suite 1650
San Diego, CA 92101

Tel.: +1 619 338.9376
wsp.com

- Four major groupings of permanently striped bus parking plus two non-striped bus parking areas identified as shown on existing parking layout. Note plan shows 271 identified potential parking spaces (documentation of received SBMF Operator Excel parking configuration) in which the assigned 239 buses are dispersed.
- Morning pre-check positions, quantity and location identified as happening in front of Operations building prior to leaving site.

Diagram existing site flow of:

- Daily morning pull out of buses. 4 am – 7 am
- How buses are currently dispatched? Lot A goes first starting with row A working towards row G. Lot D is next -starting with the most northerly row first, then the next southerly row and so on. Lot D is third, starting with the most northerly row first, then the next southerly row and so on. Lot B is last. Start with row P ending with Row A. the artic busses (60 foot long rows D thru I) will pull out depending on route
  - Is MTS currently using or piloting any automated yard management systems? Paper.
- Daily mid-day returns (60-65 buses)
  - Diagram mid bus entry to site, where parked. – in middle bus yard only
- Daily evening pull-in of buses
  - Hours of first bus & quantities 6:00 pm. Bulk of peak fleet in 10-11 pm (100 buses)
  - Hours of last bus & quantities 11 pm -3:15 am (150)
- Nightly service cycle
  - Hours of PM fuel / wash bus servicing 6 pm – 3:30 am
- On-Site Vehicle Maintenance
  - First shift hours Assumed 7:00 AM to 4:00 PM
  - Second shift hours Assumed 4:00 PM to Midnight
  - Third shift hours None
- Third Party Vendors
  - Fuel delivery – assumed none
  - On-site third party operator / maintainers assumed tire shop at Operations Building Container and at original maintenance building and CNG yard. Identify any others on site. - none
  - Lubricant delivery – daytime week day only
  - Parts – daytime weekday only
  - Trash – daytime weekday only

Staff parking Count private car spaces on plan and note. – 258 spaces

- What percentage, if any, should be planned for private EV charging in staff parking lot? – None at this time
- NRV– 70 NRVs – car type. Not need to be EV in future but consider when sizing electrical BEB feasibility infrastructure.

Location of existing fueling system – as on received as-builts

- Assumed no legacy diesel / unleaded dispensers or tanks on site

Fuel dispensers – as on received as-builts

Underground fuel piping – as on received as-builts

Document type of fuel management system

- How tracked - Existing System Ron Turly, Fuelmaster – tie to future charge management system
- CNG system owned and operated by Trillium
- Localized fuel monitoring

CIVIL

Surrounding street names - as on received as-builts

Confirm property lines and available land for development as on received as-builts

- Confirm if any available adjacent property available for potential MTS use. Assumed none
- Any on-site existing structures able to be removed / relocated off site – original maintenance building, CNG pumps, CNG compressor stations (some CNG compressing / dispensing capacity must remain until all CNG buses are removed from site.)
- Assume private vehicle parking can be elevated on raised parking deck to increase bus parking in one concept.
- Should vaulting remain as is for incoming evening pull stacked buses or is MTS' plan to phase out cash? yes
- Confirm setbacks and easements – As-built site plans received showing utility type and routing. No easements (aerial or UG) labeled on received as-builts. Request existing parcel / survey / plats / titles showing easements and land use restrictions (i.e. appears to be two separate parcels making up main site with new maintenance building fully on eastern parcel. What if any easements to be respected or noted to be replatted out for full build out for concept with overhead charging frame over bus parking.) – MTS to review plats / titles and provide to WSP. Concepts to assume no easements to respect in middle of yard between parcels.

Confirm pavement types in bus parking area

- Condition of pavement (i.e good condition, ready for replacement) – good except for entry pavement on West / Main bus entrance where buses turn.

Location of any existing on-site storm water detention / retention as on received as-builts

Location of existing on-site storm water system

- Site drains as on received as-builts
- Main trunk lines as on received as-builts
- Tie-in location(s) to city storm water system as on received as-builts

Location of existing on-site sanitary water system as on received as-builts

- On-site buildings and areas sanitary exit to site system points as on received as-builts
- Main trunk lines as on received as-builts
- Tie-in location(s) to city sanitary water system as on received as-builts

Location of existing on-site domestic / fire water system as on received as-builts

- Site entry point(s) as on received as-builts
- Main site trunk / distribution lines as on received as-builts
- On-site buildings and areas tie-in points as on received as-builts

Location of existing on-site natural gas as on received as-builts

- Site entry point(s) as on received as-builts
- Main site trunk / distribution lines as on received as-builts
- On-site buildings and areas tie-in points as on received as-builts
- Get CNG compressor yard plans or note major equipment items on plans and photograph by contacting Trillium. Who owns CNG compressor yard generator(s) – MTS or 3rd party.
    - Who maintains CNG yard – MTS, Operator or third party

Document from discussions with MTS if any site areas have issues with flooding / retaining water currently. If yes approximate elevation of property from sea level or standard chula vista flood plain. none

Confirm if any seismic issues are on-site greater than the general Chula Vista region that need to be addressed / accommodated for in any planned improvements. none

ELECTRICAL - SITE

Location of existing electrical service entry to site

- Electrical utility provider SDG&E
- Size of service as on received as-builts
- Service entry type – (overhead, undergrounds, etc…) as on received as-builts.
- Voltage of service as on received as-builts
- Transformer size – photographed during tour. Size being determined.
    - Spare capacity of service WSP power to calculate

Mark location of existing site electrical distribution equipment, if any. as on received as-builts

Mark on site plan route of electrical:

- Entry as on received as-builts
- Site gear as on received as-builts
- Distribution to on-site buildings as on received as-builts

Location of existing backup generator

- Physical size and capacity of generator
    - 200kW as on received as-builts for new maintenance facility.
    - 100 kW as on received as-builts for Operations building.
    - Diagram route to existing gear and on-site buildings / areas as on received as-builts

- What does generator backup (equipment, spaces, panels) as on received as-builts

- Reliability (i.e. frequency and hours down in the last 5-7 years) no historic issues. MTS to request from SDG&E

Locate site lighting

- Method (perimeter poles, yard poles) assumed perimeter, building mounted, with limited yard poles at fueling islands

ELECTRICAL – BUS PARKING & MAINTENANCE BUILDING

Location of existing electrical service entry into buildings as on received as-builts

- Type of entry (underground, overhead) as on received as-builts.
- Main switchgear as on received as-builts
    - Spare capacity – photograph taken of meter sections, main breakers and breaker / switch sections in MSB in
        - Original Maintenance Building
        - New Maintenance Building
        - CNG Compressor Yard(s) if multiple
        - Operations Building
        - Wash Building
- Meter location - noted
- Confirm if buildings are sub-metered or all tie back to a single meter / single bill. – No multiple bills, multiple meters. Cross check with received power bills to confirm existing usage.
- Spare power conduits noted on east side of SBMF lot line to serve Wash and New Maintenance 3650 building – confirm if still empty spare or subsequently used. MTS believes spare. No visible entry (stub ups with caps / cover) of spares found during tour.

Location of MTS agency communication connection

- Type of connection (copper, fiber) if any as on received as-builts
- Document MTS's opinion of communications capacity / reliability- no known issues
- Where does local facility communication tie-back too for MTS central coms system? Fuel system ties into original existing maintenance building before going to new Ops and Maintenance building
    - Tel/Com Rm 137 at New Maintenance Building
    - Tel/Com Rm 208 at Ops building
    - New BEB charge management server rack tie-in preferred in new maintenance building?

BUILDING STRUCTURE

- Roof structure type as on received as-builts.
    - Confirm if BEB concepts to include charging in maintenance bays or non-bus parking position. – Not for this project
- Overhead door bus entry / exit opening clear height & width New Maintenance Building 14ft wide x 16ft tall

- Flooring type – not required info with no work in new Maintenance Building
- Flooring condition– not required info with no work in new Maintenance Building

Document from discussions with MTS if buildings / areas have any known structural issues currently. – None.

BEB FEASIBILITY / LOOKING FOR

Open space land for expanded / new electrical service – assume no new adjacent property available, any new electrical service must fit on or above existing site boundaries.

Near term 12 BEB 60ft additions.

Did MTS have any preconceived locations for the 12 BEBs? – No real space but was thinking first 12 would be in middle parking

All new concepts planned around 150kW BEB charges.

- WSP to provide estimated power needs for 1:1, 1:2, and 1:3 charging based on near term and full fleets.

Proposed BEB concepts / layouts

1. Near term 12 BEB addition
2. Full fleet with induction with existing maintenance building removed and lot re-striped. Ground mounted new electric service, distribution infrastructure and charging equipment.
3. Full fleet with overhead frame and inverted pantograph charging and or plug-in charger with retractor / reels with existing maintenance building remaining. Ground mounted new electric service, overhead distribution infrastructure and charging equipment.
4. Full fleet with overhead frame and inverted pantograph charging plug-in charger with retractor / reels with existing maintenance building removed and lot re-striped. Ground mounted new electric service, overhead distribution infrastructure and charging equipment.
5. Full fleet with overhead frame and inverted pantograph charging plug-in charger with retractor / reels with existing maintenance building removed and lot re-striped. Private car parking on elevated deck and ground mounted new electric service, overhead distribution infrastructure and charging equipment.

Available space to add charging stations to bus parking area

- Plug-in stations
- Overhead frames to support overhead plug-in dispensers
- Overhead pantographs (clear height) supports
- Induction equipment (Primary Power Modules / Cooling)
- Conceptual footprint of hydrogen compression yard.
- Any current SBMF site or building improvement projects or repair projects either in planning or construction that should be factored in the near and full BEB designs? - none

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APPENDIX B -BEB CHARGING TECHNOLOGY MEMO

BEB CHARGING TECHNOLOGY OVERVIEW

INTRODUCTION

There are multiple charging technologies for battery electric buses available for depot charging, based on bus Original Equipment Manufacturer (OEM) compatibility and availability in the current US market. The four depot charging types are:

- Plug-In AC Charging
- Plug-In DC Automatic Charging
- Overhead Inverted Pantograph DC Charging
- Inductive Charging

The common elements of all charging systems are discussed first in this section, followed by an overview of the four types and individual sections explaining each technology.

CHARGING SYSTEM COMPONENTS

Regardless of the specific charging technology, all charging systems require an enhanced utility-provided electrical service to the site, on-site electrical distribution, the actual battery electric bus charging equipment, and a charge management system. The basics for each of these components are described in the following sections. Exhibit 1 is a representation of a battery electric bus charging system.

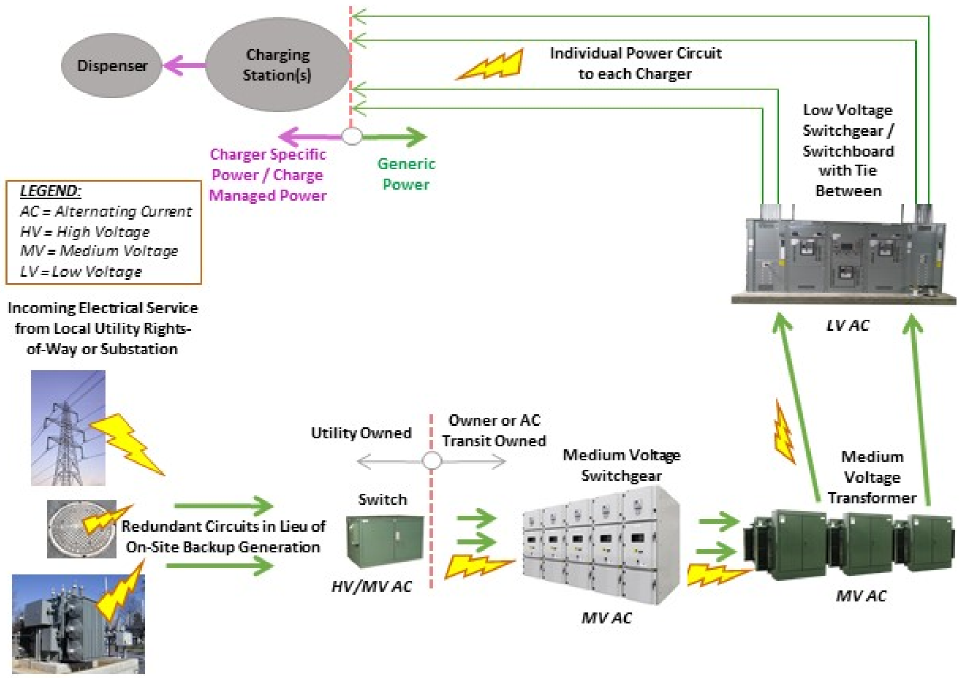

Exhibit 1: BEB Charging System

ELECTRIC SERVICE FROM LOCAL UTILITY

Due to the large electrical power demand for charging electric buses and the small amount of available spare capacity left in the existing service at the site, expanded or new electrical service will be required to serve the incoming battery electric buses.

Depending upon the load to be served, a local utility provides two types of service – high tension (HT) which is above 1000 Volts (such as 2,400 V, or 4,160 V or 13.8 kV or 115 kV) or low tension which is below 600 Volts (480 volts or 208 Volts). High tension service tariffs are typically much less expensive than the low-tension service rates. Given the significant loads required for battery electric bus charging, high tension service will most likely be brought to the site at either 13.8 kV (referred to as medium voltage, or MV) or 115 kV (referred to as high voltage or HV). Utility metering would be located at the service entrance point to the site with utility-owned and maintained transformers converting the higher voltage power to the end user voltage.

If the customer's load to be served is large and needs high reliability, utility companies usually meet these customer requirements by providing two or three service feeders from different utility substations. This way, if one of the feeders is out for any reason (such as ground fault), the second or third feeder would be able to carry the entire load. To allow anything on the site to be fed by any of the service feeders, the main breakers are arranged in what is referred to as a main-tie-main configuration. This type of redundancy arrangement on the HV/MV side is called primary-selective.

The feeder breakers connect typically to medium voltage (MV) i.e. 13.8 kV to 480 Volt 3-phase transformers located as close to the loads as possible. From these MV transformers, low voltage power, typically at 480 Volts 3-Phase, is distributed to the loads through Low Voltage (LV) Switchgear or Switchboards. If redundancy is required, the main breakers of two of these LV switchgears or switchboards would be tied together in a main-tie-main configuration. This type of arrangement on the low voltage side is called secondary-selective. Depending upon the requirements, the equipment could be primary-selective or secondary-selective only or could be both primary and secondary selective.

For large proposed battery electric bus facilities (possibly 100 buses or more), the local utility may opt to bring the redundant high-tension service feeders to the site at even higher voltages than a standard 13.8 kV circuit. In this case, additional utility-provided and installed transformers would be required to step the voltage down to 13.8 kV. This setup is commonly referred to as a substation and would consist of primary switches, step-down transformers, secondary MV switchgear with protective relay and other components. To provide redundancy, a double-ended substation, with two service feeders and two sets of transformers, would be used. All this equipment would require a large fenced or wall enclosed area (in the range of 60 feet by 30 feet) on the customer's site. While the initial capital expense of constructing an electrical substation and providing and installing the equipment is borne by the local utility, if used solely to provide power to the customer's property the cost of the substation would be passed on to the customer either through a one-time charge or amortized on the monthly electrical bill.

ON-SITE ELECTRICAL DISTRIBUTION

On-site electrical distribution includes the step-down (13.8 kV to 480 Volt) MV transformers, low voltage switchgears/ switchboards with feeder circuit breakers, and a raceway distribution system to bring power to the charging stations. This equipment can be customer-owned and maintained, which provides flexibility in choosing transformer size and equipment location but adds cost.

On-site MV transformers will step down the incoming 13.8 kV electrical service to 480 Volts, the voltage end user buildings and vehicle electric charging equipment utilize. The number of transformers required will depend on the number of chargers and the size of the transformers. Two or more of these transformers can operate in parallel and feed into a 480 Volt collector bus through spot network protectors (NWP) that can accommodate larger ampacities. The network protectors have circuit breakers and relays that do not let current flow in the reverse direction (i.e. to protect the utility grid from the customer's distribution network). The number of transformers for each electrical service feeder is set at one greater than the number needed to support all the chargers at the facility (referred to as an N-1 configuration). By operating transformers in an (N-1) configuration, even if one transformer fails the other(s) should be able to carry the entire load.

Switchgear vs. Switchboards – The 480v 3-phase AC power is fed from the secondary side of the MV transformers to two low voltage switchgears or switchboards. These switchgears or switchboards are tied in a main-tie-main configuration so that power can be delivered to all feeder breakers through the tie breaker, even if one of the main breakers trips for any reason. Regardless of whether switchgear or a switchboard is used, they both distribute 480 Volt power to each of the individual bus charging cabinets through smaller sized breakers. Typical switchboards are shown in Exhibit 2.

Exhibit 2: Interior switchboard & exterior switchboard

AC power distribution to switchboards – Because the switch is the connection point between the utility and customer-owned service, the switch is typically located at the property line so that the utility can gain access without entering the facility. Power must then be carried from the switch to the on-site medium voltage transformers. MTS-owned transformers could be located anywhere on the site as long as they are outdoors in an accessible location for installation and servicing. This could include locations on the roofs of buildings as well as at ground level. Higher, rooftop elevations are preferable in any areas subject to flooding. Switchboards, on the other hand, may be located either indoors or outdoors but should be located as close as possible to the chargers they serve to reduce cost of distributing power, due to the large number of connections to the chargers that are needed. Because switchboards can be located indoors or outdoors, the location may be determined by the availability of interior space, especially in existing facilities. The location of the transformers relative to the switch and the switchboards is not critical, as there are just a few connections to and from the transformers and no significant distance restrictions with distribution of AC power.

AC power distribution to chargers – A separate AC power circuit is required for power distribution from the LV switchgear equipment to each individual charging cabinet. Depending on the number of charging cabinets installed on a site, the AC power distribution circuits can be sizable both in quantity (125 conduits for a 250-bus garage utilizing 1:2 shared charging) and in space. For example, a 250-bus facility using shared 1:2 charging requires an AC distribution bundle of (125) 3.5-inch conduits, stacked 5 deep, and would be approximately 7 feet wide by 2 feet deep. Because of this large space impact, the path of the AC power distribution should be coordinated with the structure of a building, and the length should be minimized by locating the switchboards as close to the chargers as is feasible.

There are different possible routes for distributing the power from the switchgear/switchboard to the charging stations / charging cabinets. The first is to distribute the power underground. Distributing the power underground ensures that the conduit cannot be damaged by any buses. Phasing for this option, however, becomes difficult, as the existing slab needs to be cut, meaning that circulation around the site will be limited during installation, as buses cannot move across the torn-up slab and concrete without extensive plating after each day of construction. The other alternative to distribute power is overhead. In this scenario, conduit is suspended from either existing overhead structure or new overhead framing to allow an individual power dropdown to each charging station / charging cabinet. This makes phasing simpler, limiting disturbances to the existing pavement and slab so that buses can continue to circulate around the entire site unimpeded.

CHARGING EQUIPMENT

Battery electric bus charging equipment takes AC power fed from the LV switchgears, converts it to DC power and charges the battery on one or more buses. The configuration of the charging system's components varies somewhat among the four types of charging systems. However, for each type of charging system, charging equipment typically comprises the following components:

- Charging cabinet (or charging station)
- Rectifier
- Charger
- One or more dispensers
- Distribution network to connect them, which in some systems may entail a distribution panel to allow multiple dispensers to be operated by a single charger

The charging cabinet (or charging station with AC systems) is equipment that monitors and manages the charging process. It is provided by a charging equipment OEM, and it has either manual and/or automated controls. The charging cabinet takes generic AC power and distributes charger specific power to the bus through one or more dispensers that are connected to the bus(es).

While batteries need to be charged with DC power, electricity is distributed as AC power due to the limitations on the distance over which DC power can be distributed. The incoming AC power is converted to DC power by a rectifier. The rectifier can either be located on the bus or within the charging cabinet. If the rectifier is located on the bus, the charging system is considered an AC Charger (AC power is brought to the rectifier on the bus from a charging station). If the rectifier is located off the bus (within the charging cabinet), it is considered a DC Charger (DC power is brought to the bus from the rectifier). Both types are shown in Exhibit 3.

The dispenser is the equipment that physically connects the charging cabinet to the bus. The type of dispenser varies by charging system type, manufacturer, and agency preference. Exhibit 4 illustrates the different types of dispensers for the four types of charging systems, and how each connects to the bus. AC systems lack a separate dispenser, as the charging station, cord and gun serve as the dispenser. Power is carried to the dispenser through underground or overhead conduits. The number and size of conduits required, and the maximum length of the connections vary with the type of system and manufacturer.

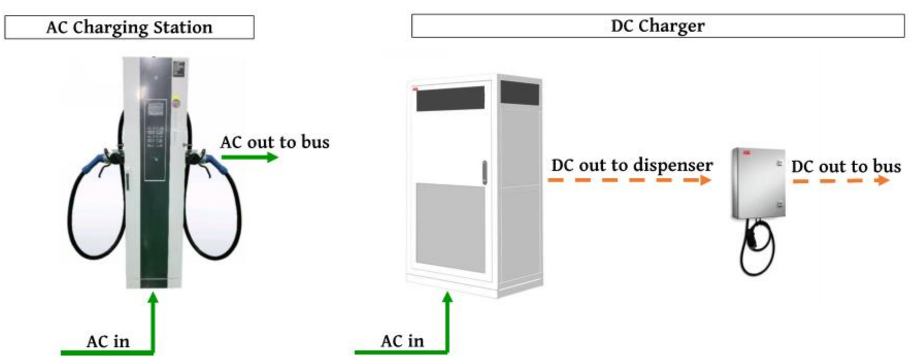

Exhibit 3:AC and DC Charging Stations

Some OEM's DC charging systems may provide, or allow for, a distribution panel. This is an electrical power bar or "bus" with a single DC input from the charger and multiple outputs to allow a single charger to distribute power to multiple dispensers. A distribution panel can be contained within the DC charging cabinet or it can be a separate standalone panel near the charging cabinet, depending on the OEM.

It is also possible to have a centralized rectifier, located between the transformer and the switchboards, to feed DC power to the charging cabinets via DC switchboards. However, charging cabinets would still be required because DC charging cabinets regulate the voltage provided to each dispenser and they start, stop and monitor the bus charging process. These functions cannot be done by a centralized DC rectifier.

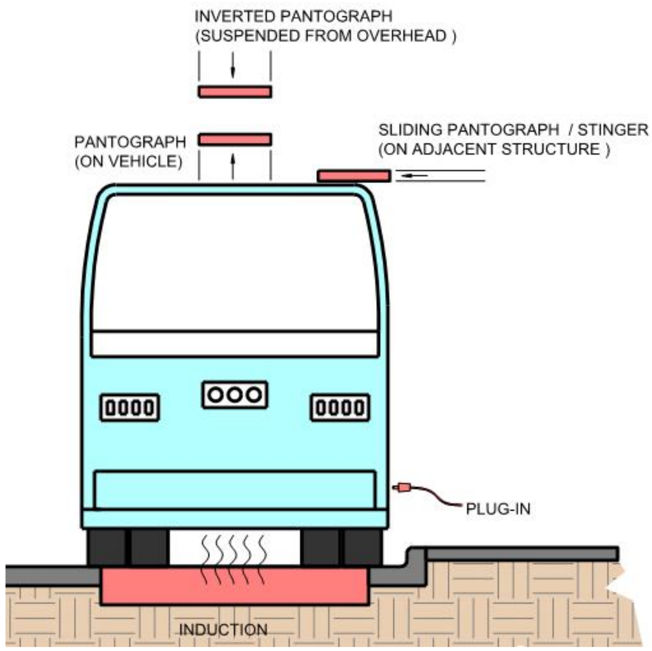

Exhibit 4: Dispenser Types and Locations

CHARGE MANAGEMENT SYSTEM

Charge management is the hardware or software system that monitors and controls the installed bus charging stations/cabinets on a site. Using a charge management system, an on-site night time service manager would be able to:

- View the status of the various individual charger stations/cabinets (e.g. open, in-use, offline).
- View state of charge (SOC) of a specific battery electric bus connected to a specific charger on site.
- Control prioritization of connected chargers (i.e. in a 1 charger to 2+ dispenser shared charging system, control which dispenser gets power and how much power).
- Monitor the total amount of power used by the site for charging, adjust charging rates and time of charging to keep daily maximum use under a desired maximum power usage.

The importance of charge management overlay upon installed chargers cannot be overstated. The charge management system on a site should be able to control chargers from multiple OEMs and various OEM's buses. The ability to remotely monitor and control the charge management system at various sites from a central location can provide for optimal monitoring of the nighttime depot charging process, including centralized charging oversight and assessment of the status of the electrical infrastructure at each facility.

DEDICATED VS. SHARED CHARGING

Dedicated charging (1:1) refers to a charging system configuration when a single charger is connected to a single dispenser and can charge a single battery electric bus at any given time. For example, if Bus 1 pulled into a charging position and began charging at full 150 kW power, Bus 2 could pull into a second position and receive the full amount of 150 kW power from its own charger without interfering with the charging rate of Bus 1.

Shared charging (1:2, 1:3, etc.) refers to a charging system configuration when a single charger is connected to multiple dispensers. Depending on the manufacturer of the charging system and the charge management software installed for the site, some 150 kW shared chargers can potentially charge multiple buses at a time, although not at the same rate as a dedicated charger. For example, if a dedicated 150 kW charging system could charge a single bus in one hour, a shared charging system could charge a single bus in one hour, or two buses in two hours, etc. Once the single charging cabinet is connected to multiple buses via multiple dispensers, there are three main ways the system can charge the buses depending on the charger OEM's hardware capabilities:

1. First in / first out charging. In this system, the first bus to connect to a dispenser connected to a shared charging cabinet would also be the first bus to be fully charged. For example, if Bus 1 pulled into a spot and connects to a dispenser connected to shared charging cabinet, Bus 2 could pull into another parking space that has another dispenser connected to the same shared charging cabinet. However, the shared charging cabinet would continue to send all the available power to the Bus 1 until it is fully charged, and only then would the charging cabinet begin to charge Bus 2 via the other shared dispenser. If Bus 3 pulled in and plugged in to another dispenser connected to the same shared charging cabinet, the system would continue to charge Bus 2 until fully charged before charging Bus 3.
2. Simultaneous Split Shared Charging. In this system, if Bus 1 and Bus 2 were parked and plugged into two separate dispensers that shared the same 150 kW charging cabinet, the charging cabinet would split the power such that both buses received power from the charger at the same time. However, neither Bus 1 nor Bus 2 would be receiving the full 150 kW but would instead receive a portion of the power. Depending on the manufacturer, that power may not necessarily be split evenly. For example, a ChargePoint 150 kW (156 kW) charging cabinet would send 2/5ths of the power (62.4 kW) to a Bus 1, and 3/5ths (93.6 kW) to Bus 2, due to the specific power rectifying system inside the charger.
3. Staggered Shared Charging. In this system, the charging cabinet would send full power to its connected shared dispensers but in alternating timed intervals. For instance, if Bus 1 and Bus 2 are plugged into two separate dispenser that shared the same 150 kW charging cabinet, the charger would send full power to Bus 1 for a short, specified amount of time, and then full power to the Bus 2 for the same short amount of time, and then alternate between them until one bus was fully charged. When Bus 1 is fully charged, full power would go into Bus 2 until either Bus 2 becomes fully charged, or Bus 3 takes the place of Bus 1, and the alternating would begin again, until either bus obtained a full charge.

There are many pros and cons for each charging method, but the main differentiating factors between the methods are shown in Table 1:

DEDICATED CHARGING

Pros	**Cons**
• Any battery electric bus parked and connected to a dispenser will receive a full amount of power available from the charger until fully charged, regardless of the number of other buses being charged on the site. • A bus plugging into any dispenser will not alter or impede the charging rate of another bus currently plugged into the system. • The plan for charging the buses is straightforward. Any track can be used for any purpose and a bus can pull into any charging position. Pre-specified charging positions are not required. • Numerous battery electric bus manufacturers and third-party charger manufacturers produce 1:1 chargers	• More space is required to accommodate a complete set of charging cabinets, in addition to higher costs for a 1:1 charging cabinet set • Larger or more transformers and switchgear to support more chargers mean higher infrastructure costs and more space than shared charging. • Potential higher electricity costs due to potential higher peak demand usage.

SHARED CHARGING

Pros	Cons
• The required electrical service is smaller than for a dedicated 1:1 charging system. • Smaller or fewer transformers and switchgear means lower infrastructure cost, and a smaller space requirement. • Reduced rates of charge to a battery may extend bus battery life.	• Any bus that pulls in and begins charging is not guaranteed to receive the full or any amount of power from a charger, as the power may be being directed to another bus. • 1:2 charging is not commercially available from every manufacturer. (Two of the noted manufacturers in this report, ABB and ChargePoint, can currently achieve a charging ratio of 1:2+.) • Dispenser locations must be carefully considered and coordinated to establish which parking positions are expected to be filled in what order and at what time so that all battery electric buses assigned to the facility can receive a full charge in the requisite amount of time.

DEPOT CHARGING SYSTEM TECHNOLOGY OPTIONS

A summary of the technical differences and requirements of the four types of charging systems is presented in Exhibit 5. The definition of each column heading is described below:

Bus OEMs – Which battery electric bus original equipment manufacturers (OEM) and rebuilders currently natively support each charging system type.

Charger OEMs – Which third party bus charging system manufacturers and bus OEMs manufacture charging systems.

Bus OEM Fleet Compatibility – Ability of the bus charging system (charger, dispenser and charge management software) to be compatible (charge, monitor charging, record charging) with buses manufactured by other OEMs.

Bus Charger Ratio at 150 kW – The ratio between a single 150 kW charging cabinet and the number of dispensers it can support. (Note that some bus and charger OEMs make higher voltage cabinets that can support multiple dispensers at 150 kW. For purposes of consistency, this assessment only addresses the single 150 kW charging cabinets and not the larger voltage cabinets.)

Concurrent Charging from Shared Charger – Ability for multiple dispensers connected to a single charging cabinet to receive bus charging simultaneously through all connected dispensers.

Charging Cabinet Location – Required location of the charging cabinet in relation to the bus and the maximum distance from the bus.

Dispenser Location – Location of the dispenser in relation to the bus (as illustrated in Figure 4 in the previous section).

Ground Level Space Requirements – Amount of physical, grade-level space (mounted to pavement or raised island) next to the bus required for the charging dispensing system. Width includes space for the charging dispensing equipment and clearances for service and operation. This determines the minimum amount of space between tracks of parked buses.

Ground Level Equipment – The charging equipment, if any, that is required to be located adjacent to or near the bus at grade-level.

Operator Interaction – The actions a person would perform to charge a bus with each charging system type. This is an important distinction to know as chargers requiring limited or no interaction can be remotely located (on the roof, understructure, or not directly adjacent to bus parking) whereas chargers requiring more operator interaction may require the charger and/or dispenser to be directly adjacent to the bus being charged.

Distribution to Dispenser – The location of the power and charge management wiring from the charging cabinet to the dispenser.

Electrical Yard Needs – How much area would be needed for a new electrical yard to support each charging type system

Rectifier Location – The rectifier that converts AC to DC can either be located on the bus or within the charging cabinet. The difference is whether the space and weight for the rectifier is located on the bus (reducing passenger capacity) or outside in the charging cabinet at the depot (taking up depot space and potentially reducing parking capacity in bus parking areas.)

Degree of Initial Commitments – When retrofitting battery electric bus charging into existing garages and parking areas, installation of electrical distribution infrastructure for charging raises the issue of complete buildout of infrastructure conduits and ductbanks for future phases. That is, if an existing concrete slab is being trenched to install under-slab or in-pavement conduits for an initial phase, it may make sense economically and logistically to install all the empty conduits and ductbanks for the full build out to eliminate the need to re-trench and put back slabs and pavements later.

Commercially Available – Indicates whether charging systems described are currently available.

Charge Station Costs 1:1 – Estimated capital cost per bus for charging equipment and material only, assuming one bus per charger. Installation of the charging equipment is not included in these costs. Includes material cost for a single charging cabinet and dispenser set or induction support equipment per pad and single receiver on bus. The cost for the upgraded electrical service is also not included.

BYD – Bus Manufacturer

CCW – Bus Manufacturer

Exhibit 5: Types of Charging Systems

	Bus OEMs	Charger OEMs	Bus OEM Fleet Compatibility		Bus:Charger Ratio at 150 kW			Concurrent Charging from Shared Charger			Charging Cabinet Location
Plug-In AC Charging	BYD, CCW	BYD, CCW, Custom	Not compatible across OEMs		1:1			No			Directly adjacent to bus
Plug-In DC Automatic Charging	All but BYD and CCW	ABB, Chargepoint, Proterra	ABB, Chargepoint: All bus OEMs	Proterra: all (charge management works for Proterra only)	ABB: up to 3:1	Chargepoint: up to 2:1	Proterra: 2:1	ABB, Proterra: no	Chargepoint: yes		May be up to 450 feet from dispenser
Overhead Pantograph DC Charging	All but CCW	ABB, Ebus, Heliox, Proterra, Siemens	All		ABB, Proterra, Siemens: 1:1	Heliox: up to 2:1	Ebus: up to 7:1	No			May be up to 450 feet from pantograph dispenser
Inductive Charging	All	Momentum, Wave	All		Wave: up to 3:1	Momentum: up to 2:1		No			Within 75' of charging pad dispenser

Exhibit 5: Types of Charging Systems Cont.

	Dispenser Location	Ground-Level Space Requirements	Ground Level Equipment	Operator Interaction	Distribution to Dispenser	Electrical Yard Needs	Rectifier Location	Degree of Initial Commitments		Commercial Availability	Charging Station Cost 1:1
Plug-In AC Charging	Directly adjacent to bus	3' min. charging aisle every 2 tracks	One charging station per bus in charging aisles	Plug in and push button on dispenser to start	In ground or overhead	1:1 requires maximum size yard	On bus	High		Yes	Included with bus
Plug-In DC Automatic Charging	Above or adjacent to bus	2'-4' charging aisle every 2 tracks if ground mounted	One stanchion or hanging cable per bus in charging aisles	Plug in	In ground or overhead	Size depends on bus:charger ratio	In Charging Cabinet	In ground: High	Overhead: Low	Yes	Approx. $90-110k/bus
Overhead Pantograph DC Charging	Above bus	None	None	None	Set bus parking brake	Size depends on bus:charger ratio	In Charging Cabinet	Low		Yes	Pantograph: approx. $80-110k/bus
Inductive Charging	Under bus	10' equipment aisle every 6 tracks	1 power box, 1 control box, and 1 cooling box per charger in equipment aisle	None	In ground	Size depends on bus:charger ratio	In Charging Cabinet	In ground: High	Overhead: Low	Yes	Not available

PLUG-IN AC CHARGING

An AC charging system is provided by bus manufacturers BYD and CCW; a BYD unit is shown in Exhibit 6. The cabinet or building mounted unit that holds the cord and charging controls for an AC charging system is called a “charging station” and not a “charger” because the actual charger and rectifier are located on the bus. The charging stations provided by these AC charging bus manufacturers are only compatible with buses from the same manufacturer. This means that a CCW bus cannot be charged by a BYD charging system, and vice versa. Due to this limitation, the initial phase selection of a specific AC charging manufacturer can be more restrictive than with the other charging technologies. For example, once a BYD charging station is installed on a site at a space, only BYD buses can be charged there.

Exhibit 6: 200 kW AC Charging Station

With AC charging, the rectifier is located on the bus, which can increase bus weight and potentially limit passenger capacity over other charging options. The charging stations include the dispenser and the charging control panel as a single unit that must be located close to the bus, with the controls within reach of the driver or technician.

The charging station is connected to the bus with a short cord. The plug at the end of the cord that is inserted into the charging port of the bus is referred to as a “charging gun.” Once the charging gun is fully inserted into the port, signal wires inside the gun complete a circuit and the operator can start the charging process by activating the charging controls from the charging station control panel. Unlike DC Automatic Plug-In Charging or Overhead Pantograph, current AC charging technologies and standards requires user interaction with a charger control panel to start the charging process. It is this required user charger control panel access that necessitates that the charging station be directly adjacent to the bus it is charging; it does not allow for a charging station to remotely located or located overhead.

AC chargers vary in size and space requirements. The BYD 200 kW Fast Charging Station, shown in Exhibit 6, has a large space requirement. It has a 2’5” wide by 1’4” deep footprint, and also requires a three-foot space behind it to allow for electrical service access. This means that a pair of charging stations must be placed three feet apart back to back or be placed side by side to allow for this access.

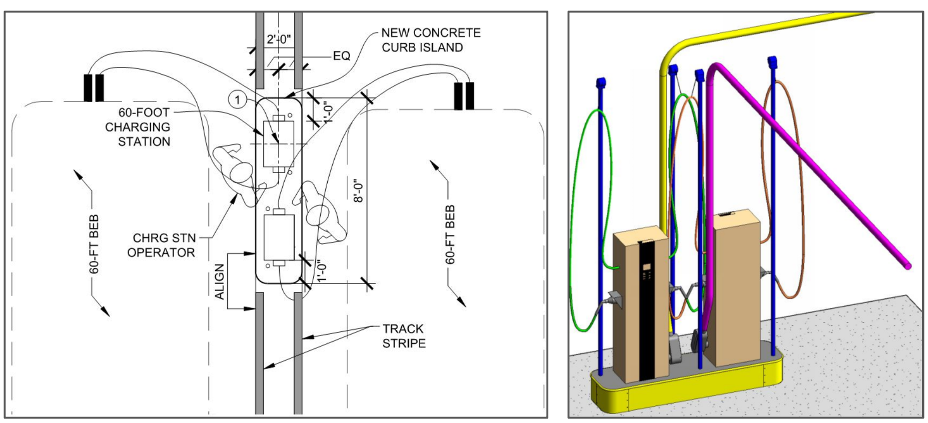

Exhibit 7: AC Charing Stations on Raised Concrete Island

For facilities which have constrained physical layouts, placing the chargers back to back would result in displacement of existing bus parking. This charging technology would therefore result in a loss of bus storage capacity at the facility. In addition to the charging station footprint, grade-level mounted charging stations adjacent to or within the bus parking area should be placed on a concrete curb to mitigate the risk of damage from bus movements.

The charging ratio for this type of charging station is 1:1, meaning that a single charging station can only connect to a single bus at any given time. The BYD 200kW charging station shown in Exhibit 6 has two charging cords and guns per station, and two ports per bus, which allow the operator to plug in either one or two cords to the same bus. Two cords are provided to reduce the size and weight that a single 200kW cord would require. By plugging in only one cord, the bus can be charged at half the rate, allowing for manual power usage limiting. This does not mean, however, that the other charging gun can be plugged into another adjacent bus. A single two cord charging station can only charge one bus at a time.

The AC charging option also requires more interaction from the operator than the other options presented later. The operator plugs in the bus and must interact with the console on the charger to initiate charging, and then the operator may walk away without any further steps. Once the bus is fully charged, the charger will stop on its own. The next driver must unplug the bus before operating it. The staff removing the cord also needs to store the cord in its holder / cord management rack to prevent cord damage.

A charge management system can provide oversight and controls to an AC charging system including: 1) delayed start of charging even after operator initiates charging by control operation, 2) turning off charging stations and staggering charging stations to limit power demand peak usage, and 3) allowing monitoring of charging station status and connected vehicle information. However, a separate secure wifi communication network would be needed to serve the charge management system.

As a ground-mounted unit, a charging station receives its AC distributed power from the switchboards. If this AC distributed power comes from overhead, there is a vertical power drop to each charging station, as shown

Exhibit 8 ChargePoint Charging Cabinet & Remote Dispenser

in the above figure (note the 3-1/2” conduits, colored yellow and magenta, dropping from above and tying into the side of the charging stations.). If the AC distributed power comes from underground, it can be run under pavement and / or concrete slabs and stub up under the charging station. Note that installing under-slab distributed power in an existing facility would require extensive saw cutting and trenching of the existing parking garage slabs.

PLUG-IN AC CHARGING PROS AND CONS

Pros:	Cons:
• Charging stations come at no extra cost with the provided battery electric buses (typical for BYD, negotiable with CCW). • Does not require extra rectifying equipment taking up floor space. • Power distribution to the charging station is generic single conduit AC power circuit, not charger manufacturer-specific DC power with additional control and data wiring.	• Chargers are limited to a specific bus manufacturer • Requires the operator to interact with the charging station panel. • Requires floor mounting of the charging station close to the bus • Adds weight to bus by having the rectifier on the bus. • Current BYD charging stations are electrically bottom-fed-only units. This limits power to either underfloor or an overhead power drop that ties into the unit’s base. • There is no hard-wired data connection to a charge management controller station. A secure wifi connection would be needed in the garage to transmit data back from charging stations.

PLUG-IN DC AUTOMATIC CHARGING

A Plug-in DC Automatic charging system is currently available from several sources, including several battery electric bus OEMs like GreenPower and Proterra, in addition to third party vendors such as ABB and ChargePoint (a ChargePoint cabinet is shown in Exhibit 8). A DC charger consists of a charging cabinet that contains an integrated rectifier, plus a separate dispenser. Separating the dispenser from the charger and remotely locating the charging cabinet away from the bus reduces space requirements and provides additional spatial flexibility, an advantage over current AC charging systems. (A ground mounted DC charger with an integral dispenser would have very similar space requirements to the AC chargers.) In addition, a plug-in DC automatic charging dispenser can be located overhead, which would eliminate the need for allocation of scarce floor space in the bus parking area. However, if the dispenser is located overhead, additional cord management features, such as a cord retractor with retractor power and controls, are required to access the remote cord.

The third party charging systems with CCSI SAE Level 2 / 3 J1772 DC compliant charging cords and guns (Exhibit 9) are compatible with multiple battery electric buses produced by various OEMs as long as they are specified with CCSI SAE Level 2 / 3 J1772 DC compliant charging plug-in ports. This includes battery electric bus OEMs who do not produce their own plug-in charging equipment such as Gillig, New Flyer, and Ebus. Following this standard can reduce initial phase commitments to a single bus manufacturer, as opposed to Plug-In AC systems, which currently only allow for buses from the same manufacturer to use that manufacturer's charger.

Exhibit 9: Example of J1772 Plug & Port

The size, weight, configuration, conduit entry and exit points, and electrical inputs and outputs of these chargers vary by manufacturer. Even the orientation of the equipment has not been standardized. The layouts shown later in this report represent the worst-case scenario dimensions and therefore can account for all the various charging system OEMs. For instance, while a ChargePoint dispenser may be wider than dispensers from the other manufacturers, it is not as tall, deep, or heavy as an ABB charger. Taking the worst-case width from ChargePoint and worst-case depth, height, and weight from ABB, a design can be made that can accommodate any available DC charging cabinet and dispenser.

The floor space requirements for DC charging systems can vary depending on where the DC charger is positioned. The DC dispenser would take up floor space similar to an AC charging station, but DC charging cabinets can be placed remotely, overhead on roofs or on the edge of a parking garage, so that the floor space required to accommodate the charging cabinets is not in the bus parking area. Due to DC power distribution constraints, there is a limit to how far the charging cabinets can be from the dispenser – between 350 and 500 feet maximum from the DC charging cabinet to a remote dispenser, depending on charger OEM. This distance would include any vertical drops or risers.

With most manufacturers, this charging system allows for both 1:1 dedicated charging and shared charging. Multiple OEM's chargers mentioned in this report can utilize shared charging (ABB, ChargePoint, & Proterra). ABB can achieve a charging ratio of up to 1:3, and the ChargePoint and Proterra systems can currently achieve a ratio of 1:2, although they can achieve a higher charging ratio using distribution panels. The only operator interaction required with a DC charging system is that an operator needs to plug and unplug the bus. Once the bus is plugged in, automatically the charge management software dictates when the bus begins charging and stops charging, monitors energy usage and battery state of charge, and provides status reports.

There are multiple options for distributing the power from the charging cabinet to the dispensers, and these options can vary by manufacturer. The ABB charging system allows for the dispensers sharing a charger to be "daisy-chained" with one another from a single circuit, whereas a ChargePoint cabinet has separate conduits to each of its two connected dispensers. Depending on the location of the dispensers relative to the charger, the total amount of conduit required can be minimized by having a daisy-chained connection to the dispensers. However, balancing the spatial distribution of shared dispensers with fleet charging needs based on arrival / exit times may require separate DC power conduits from a charging cabinet to each of its shared dispensers.

At the 150 kW range being considered for MTS SBMF, the conduit size for a single power connection between a charger and a dispenser is 3 to 4 inches. Additionally, a low voltage signal wire and data control wiring would also have to be installed between each charger and dispenser in parallel and in a separate conduit from the DC power conduits. These multiple conduits to each dispenser (two to three conduits per dispenser, so up to 750 conduits for a 250-bus facility) create a sizeable quantity of conduits to route and organize either underground or overhead.

The number of conduits required for a Plug-in DC Automatic Charging system is therefore significantly greater than for an AC charging system, which only requires one conduit per AC charger. This represents a tradeoff between the DC charging system's greater ability to remotely monitor and control charging and the DC charging system's demand for additional conduits. The distribution path of this DC connected power and control wiring must be carefully coordinated with any existing structure. An additional limitation to DC power is distance. AC power is not affected by distance while DC power has a relatively short distance limit of between 350 and 500 feet.

The amount of power that can be delivered to a bus using commercially available cords and charging guns ranges from 50 kW to 156 kW. Manufacturers are currently in a rapid improvement phase, with alterations and benefits to systems being introduced at a rapid rate. While manufacturers are currently working to develop a charger capable of delivering power at up to 350 kW, the voltages needed to deliver this much power require cooling systems (internally liquid cooled cords) for the dispenser cords, increasing the weight of the cord. Given these challenges, the remainder of this report assumes the current 150 kW limit. Furthermore, charging batteries at rates higher than 150 kW can lead to more rapid battery degradation, reducing the useful life of the battery.

PLUG-IN DC CHARGING PROS AND CONS

Pros:	Cons:
• DC charging equipment is compatible with multiple bus OEMs if both the chargers and the bus adhere to the J1772 standard. • DC charging cabinets can be remotely located overhead or away from the immediate bus parking areas. • Dispensers can be remotely located overhead to eliminate the need for any ground mounted space taken up by charging equipment • DC chargers save weight on the bus because the rectifier is located within the charging cabinet. • Currently the DC charging cabinets are available with bottom electrical AC feed in and DC Controls out. However, if cabinets are located on the roof / overhead this feed allows for more direct overhead DC power distribution from the cabinet to the dispenser, which is important given that DC power diminishes quickly with distance of transmission. • Depending on manufacturer, shared charging may be feasible. • The same DC charging cabinet can support overhead pantograph charging as well as plug-in dispensers (see next section)	• Substantial cost for DC charging system – approximately $110,000 per charging cabinet and single dispenser. • If charging cabinets are located remotely, DC power diminishes quickly with distance of transmission. • Charging cabinets are larger than AC systems due to the need to accommodate the rectifier. • DC power from the charging cabinet to the dispensers requires vendor-specific controls and data wiring. • Remote charging cabinets require three separate conduits between the charging cabinet and each dispenser. • Cord management can be a challenge, especially if the dispenser is located overhead. Additional cord retractor, power and controls are required.

OVERHEAD INVERTED PANTOGRAPGH DC CHARGING

An Overhead Inverted Pantograph DC charging system is much like a DC Plug-In Charging system; in that it comprises a DC charging cabinet and a DC connection to charge the bus. However, in the Inverted Pantograph system, the dispenser is a pantograph that is hung from the underside of the bus garage roof structure or structural framing over the bus parking areas. A pantograph is an articulating arm, moved by either compressed air or an electric motor, that has exposed copper bus bars that are lowered onto charging bars located on a battery electric bus's roof (see Exhibit 10). One pantograph is required for each bus parking position.

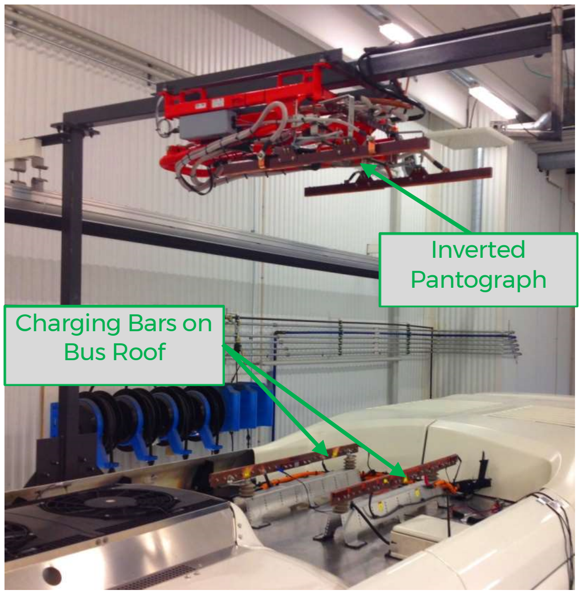

Exhibit 10 Inverted Pantograph & Charging Bars on Bus Roof

Traditional "pantographs arms" were located on the top of a bus and extended up and connected to overhead catenary lines similar to those on a light rail car or electric trolleybus. An inverted pantograph is located on the building and extends down to the bus. Commercially available from ABB, Ebus, Heliox, Proterra, and Siemens, inverted pantographs are currently used extensively for en-route (off-depot) charging of battery electric buses. En-route inverted pantographs are larger, more expensive models typically outputting 250-500 kW and are designed for heavy frequent duty cycles to extend and retract multiple times in an hour. To dispense 150 kW from a DC charging cabinet in the depot to a parked bus in a parking space once a day overnight (and possibly once in the mid-day if mid-day top offs are utilized), a depot inverted pantograph (Exhibit 11) is a smaller, less robust and less expensive charging unit.

Using an overhead pantograph can allow for much higher charging rates, up to 500 kW, as the voltage is not limited by a plug as it is with DC plug-in charging. All battery electric bus manufacturers can utilize an overhead pantograph charger either as a native option or custom order. A major advantage of this system is that buses from different manufacturers can parked and charged in the same facility, by the same pantograph charging system. This is due to the basic "open source" character of the DC connection by copper charging bars, which eliminates restrictions associated with the bus manufacturer-specific plug technology of the AC or some DC plug-in systems. While pantographs are available that can charge at the 150 kW rate used by plug-in systems, higher power pantographs are available; however, charging batteries at rates higher than 150 kW can lead to more rapid battery degradation, reducing the useful life of the battery.

Exhibit 11: Depot Charging with Inverted Pantographs

The 150 kW DC charging cabinets that can be used for this system are the same as for the Plug-in DC Automatic Charging and can be installed remotely from the pantographs, with the same conduit length limitations, so no floor space is required for the charging cabinets in the bus parking area. The pantographs are installed suspended from the existing roof structure or a new custom overhead framing system. Since the pantographs are overhead, the power would also be distributed overhead, and would require the same number of conduits as the DC Plug-in systems. Unlike plug-in systems, pantograph systems would use a local wireless connection to transfer data between the bus and the pantograph, but data would be transmitted from the pantograph to the charge management system using the same data conduit that plug-in systems use. Overhead power and data distribution means that that there are no ground level conduits for buses to hit and no new obstacles introduced. In an outdoor facility, the only new obstacles would be the support columns required for a new overhead support system. The standard location of the charging bars on the roof of the bus is centered over the front axle. If the fleet to be charged is parked in tracks the spacing of the pantographs in these tracks will be located by the size of the vehicle (i.e. every sixty-five feet for artics or every forty-five feet for forty-foot buses).

This charging system requires limited operator interaction. The specific charging process depends on the manufacturer, but in general the operator uses painted marking on pavement to determine where to stop, and a dashboard or cockpit light illuminates indicating that an RFID receiver on the bus roof has detected an RFID transmitter on the pantograph. The operator either engages the pantograph or the pantograph is controlled by automated software. When the charging is complete, the pantograph disengages and retracts to a raised position. Pantographs typically have an installed spring system to “fail safe” (retract away back to a raised position) when power or compressed air is lost.

OVERHEAD INVERTED PANTOGRAPH DC CHARGING PROS AND CONS

Pros:	**Cons:**
• Minimal operator intervention is required at the charging position. • There is no need for cord management. • DC charging by copper charging bars on the pantograph is compatible with any bus OEM charging bar set. • DC charging cabinets can be remotely located overhead or to the side of the bus parking areas. • The overhead pantograph eliminates the need for floor space for ground-mounted charging dispensers. • A pantograph can deliver higher power than 150 kW for faster charging if connected to a higher-power charging cabinet.	• Pantographs cost more than plug-in dispensers. • Pantographs require adequate space under existing enclosed garage roof structures or new overhead frame support structures at exterior bus parking areas. • There is currently no standard for low power pantograph depot charging. Currently depot pantographs fall under the same SAE J3105 Overhead High Power standards as high-power en-route chargers. • Suspending equipment from the roof would require a manlift or catwalk for maintenance and service. • Mixed fleet requires different spacing when in tracks. • Optional higher power charging could increase peak demand usage, increase the cost of charging and could also result in more rapid battery degradation. • Low power pantographs for depot charging are not currently available.

INDUCTION CHARGING

Induction charging is wireless charging through a magnetic field, much like the wireless charging of a cell phone when placed on a charging pad. Energy is transferred between a transmitter sending "pad" located in the pavement or building slab and a receiver on the underside of the bus (Exhibit 12). A bus pulls into a designated charging position aided by both external stop striping for alignment and a tone or light on the bus indicating correct positioning over the charging pad. Once positioned, and the charging begins as controlled by the charge management software.

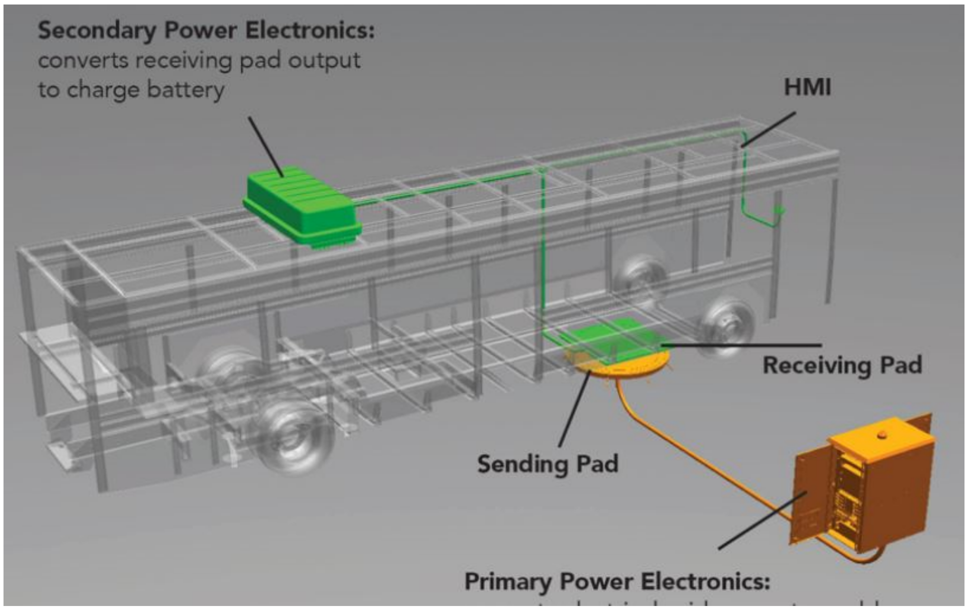

Exhibit 12: Induction Charging Schematic

This ground-based transmission system consists of an above-ground primary power module, a cooling module, and a controls module. These above ground modules are contained within either a single charging cabinet or multiple cabinets depending on the manufacturer. The above-ground transmission support equipment is connected to the recessed transmission pad by underground conduits containing both power and control wiring. Heat is generated within the recessed pad during the induction energy transfer. This heat is removed via coolant surrounding the power cable connecting the pad with the above-ground cooling unit. The above-ground cooling unit uses an ambient air heat exchanger to dissipate the collected heat and send chilled coolant back down to the transmission pad. The induction receiver pad is surface mounted to the underside of the bus and connected to the on-board battery charge controller and batteries. The position of the receiver pad on the bus varies depending on the bus OEM and the location and configuration of the batteries.

Induction charging systems are commercially available from two vendors, Momentum and Wave, with additional charging OEMs expressing interest in developing their version of induction charging. The induction charging system is a third-party after-market component that is installed on the underside of a bus chassis, so it is compatible with all bus manufacturers and can be used by either native AC charged or DC charged buses. This makes the initial procurement phase commitment to a specific bus OEM minimal, as any bus can be outfitted with the proper equipment required to be charged via induction. Addition of an induction charging pad to a bus does not prohibit the inclusion of a plug-in port or roof mounted charging rails on a bus. The induction charging on a bus can be used for both the 150 kW charging at a depot and, if desired, for higher powered en-route charging outside of the depot.

The charging ratio for induction systems can be a dedicated 1:1 charging system, or it can be a shared charging system up to 1:3, with multiple transmitting pads connected to a single set of above ground modules. A significant limitation of the induction system is the distance a transmitter pad can be from the above ground modules: 60 to 75 feet depending on the manufacturer. This distance includes the 90 degree turns from both the above ground modules and the recessed transmitter pad. Because of this short distance limitation, the above-ground modules are typically installed directly adjacent to the parked bus's charging position. If shared charging is being utilized, the above ground modules can power up to three pads in three directly adjacent parking tracks – see Exhibit 13 for a graphic of a shared induction system. The distance limitations do not allow for shared charging of three buses within the same track.

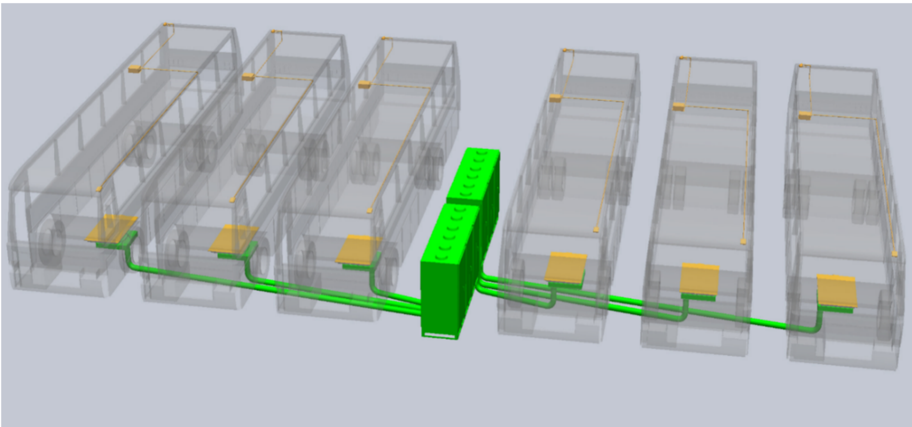

Exhibit 13 Shared Induction Charging System

The above ground modules should be located on a raised concrete island to protect against impact from the adjacent buses. When retrofitting into an existing parking lot or garage, substantial space is required to accommodate the above ground equipment islands. Another issue is the need to atmospherically vent the charging heat to the surrounding air. In an enclosed bus parking garage, an induction system requires adequate air changes per hour and proper spacing of the cooling modules to allow for ambient air cooling and heat dissipation. Induction charging requires other special conditions to successfully charge: proper position of the bus mounted receiver over the ground mounted transmitting pad, proper air gap between the receiver and the transmitter, and, depending on the charger manufacturer, certain maximum and minimum height limitations.

The recessed transmitting pad is de-energized until a bus with a receiving pad is stationary and properly positioned over the transmitting pad. The charging automatically stops, and the transmitting pad is de-energized when the batteries are either fully charged or the charging process is interrupted by the charge management software. There are no decoupling or other procedures to remove bus from its charging position. The bus can simply be driven away from the parking space.

This charging system has no moving parts (no pantograph arm or charging cord) and no repetitive physical connections (plugging in charging gun or pantograph connecting to charging bars) to the bus, which make induction charging the mechanically simplest charging option available.

INDUCTION CHARGING PROS AND CONS

Pros:	**Cons:**
• Requires no mechanical moving parts. • Very limited operator interaction required during charging process. • Induction systems can support shared charging of up to 1:3. • Receiving pads can be retrofitted or installed as part of original OEM equipment to any battery electric bus.	• Distance between the above-ground modules and the transmitter pad(s) is limited to 60-75 feet. Therefore, the above-ground modules cannot be remotely installed away from bus parking. • Above-ground modules require ground space in the parking area for the full length and width of a parking track. • Above-ground modules vent heat into the bus parking enclosure.

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APPENDIX C – SBMF ZEB CHARGER PROJECT PHASE II DRAWINGS

METROPOLITAN TRANSIT SYSTEM
ZERO EMISSION BUS CHARGER PROJECT PHASE II

INDEX OF DRAWINGS

SHT NO	DWG NO	DESCRIPTION
1	G000	TITLE SHEET, LOCATION MAP AND INDEX OF DRAWINGS
2	G001	GENERAL NOTES
3	G002	LEGEND, ABBREVIATIONS, SYMBOLS, AND BASIS OF COORDINATES
4	C101	CIVIL SITE ACCESS AND EROSION CONTROL PLAN KEARNY MESA DIVISION
5	C102	CIVIL SITE PLAN KEARNY MESA DIVISION
6	C201	CIVIL SITE ACCESS AND EROSION CONTROL EAST COUNTY DIVISION
7	C202	CIVIL SITE PLAN EAST COUNTY DIVISION
8	C301	CIVIL SITE ACCESS AND EROSION CONTROL SOUTH BAY DIVISION
9	C302	CIVIL SITE PLAN SOUTH BAY DIVISION
10	C401	CIVIL DETAIL PLAN SHEET 1 OF 2
11	C402	CIVIL DETAIL PLAN SHEET 2 OF 2
12	E101	ELECTRICAL SINGLE LINE DIAGRAM KEARNY MESA DIVISION
13	E102	ELECTRICAL SITE PLAN KEARNY MESA DIVISION
14	E201	ELECTRICAL SINGLE LINE DIAGRAM EAST COUNTY DIVISION
15	E202	ELECTRICAL SITE PLAN EAST COUNTY DIVISION
16	E301	ELECTRICAL SINGLE LINE DIAGRAM SOUTH BAY DIVISION
17	E302	ELECTRICAL SITE PLAN SOUTH BAY DIVISION
18	E401	ELECTRICAL DETAILS

IMPORTANT NOTICE

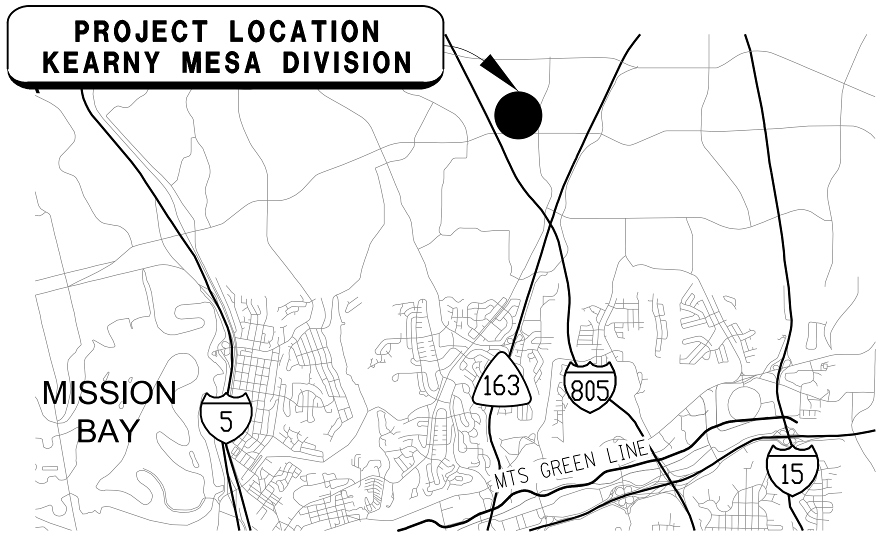
SECTION 4216/4217 OF THE GOVERNMENT CODE REQUIRES A DIG ALERT IDENTIFICATION NUMBER BE ISSUED BEFORE A "PERMIT TO EXCAVATE" WILL BE VALID. FOR YOUR DIG ALERT I.D. NUMBER CALL UNDERGROUND SERVICE ALERT TOLL FREE 1-800-422-4133 TWO WORKING DAYS BEFORE YOU DIG.

WORK TO BE DONE

IN ACCORDANCE WITH THESE PLANS, THE STANDARD SPECFICATIONS, SPECIAL PROVISIONS AND STANDARD DRAWINGS, INSTALL TWO OWNER-FURNISHED ELECTRIC VEHICLE CHARGERS AT EACH OF THE THREE FACILITIES AS SHOWN.

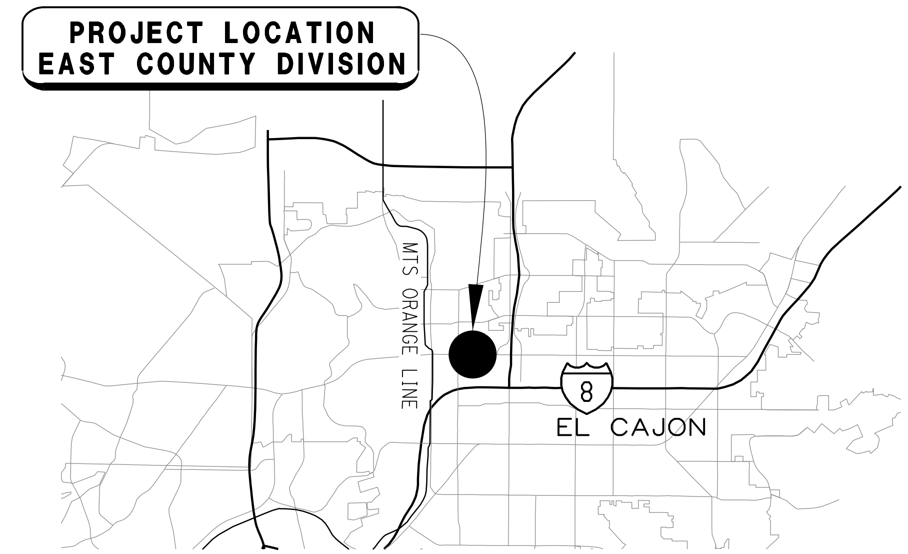
STANDARD SPECIFICATION:
STATE OF CALIFORNIA, DEPARTMENT OF TRANSPORTATION, STANDARD SPECIFICATIONS, 2018 EDITION

STANDARD PLANS FOR PUBLIC WORKS CONSTRUCTION (GREENBOOK) CURRENT VERSION



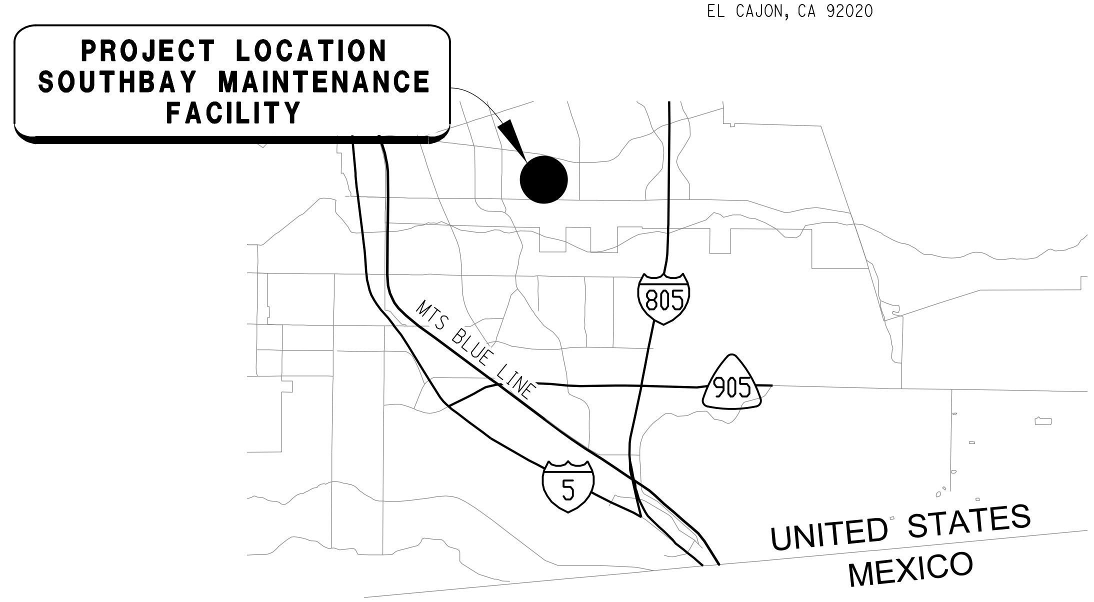
SITE ADDRESSES

KEARNY MESA DIVISION
4630 RUFFNER STREET
SAN DIEGO, CA 92111



SITE ADDRESSES

EAST COUNTY DIVISION
544 VERNON WAY
EL CAJON, CA 92020



SITE ADDRESSES

SOUTH BAY DIVISION
3650A MAIN STREET
CHULA VISTA, CA 91911

NO.	DATE	REVISIONS	BY	CHK	APRV

HDR

REGISTERED PROFESSIONAL ENGINEER LEONARDO HERNANDEZ No. C67141 Exp. 09/30/20 CIVIL STATE OF CALIFORNIA

	DATE
DESIGNED BY L. HERNANDEZ	08/19
DRAWN BY J.R. GRANADO	08/19
CHECKED BY M. SHAVER	08/19
PRJ. ENG. R. BOLEY	08/19

MTS Metropolitan Transit System

ZERO EMISSION BUS CHARGER PROJECT-PHASE II

TITLE SHEET, LOCATION MAP AND INDEX OF DRAWINGS

SCALE NTS
CONTRACT NO. G1947.0-17
DRAWING NO. G000
SHEET NO. 1 OF 18

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

9/16/2019 c:\pwworking\west01\d1080278\10160437-G00.dgn $PENTBLL$ $PLTDRVL$

MTS GENERAL NOTES:

1. PERMITTEE SHALL ADHERE TO CONSTRUCTION AND SAFETY STANDARDS REQUIRED BY MTS OR THEIR CONTRACTORS WHEN WORKING WITHIN THE PROJECT SITE.
2. PERMITTEE SHALL PERFORM ALL WORK IN ACCORDANCE WITH APPLICABLE CALIFORNIA OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (CAL-OSHA) REGULATIONS, MTS DESIGN CRITERIA, AND MTS OPERATIONS AND SAFETY POLICIES.
3. PERMITTEE TO OBTAIN APPROVAL OF PROJECT PHASING AND IMPACTS TO BUS OPERATIONS WITH MTS STAFF PRIOR TO COMMENCEMENT OF CONSTRUCTION.
4. PERMITTEE SHALL NOT USE OR STORE HAZARDOUS SUBSTANCES, AS DEFINED BY THE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT, AS AMENDED ("CERCLA") OR PETROLEUM OR OIL AS DEFINED BY APPLICABLE ENVIRONMENTAL LAWS ON MTS PROPERTY.

GENERAL NOTES:

1. THE CONTRACTOR SHALL REVIEW EXISTING CONDITIONS ON THE SITE DURING THE BIDDING AND SHALL VERIFY ALL SITE CONDITIONS AND DIMENSIONS PRIOR TO STARTING WORK. THE CONTRACTOR SHALL NOTIFY THE ENGINEER OF ANY DISCREPANCIES OR INCONSISTENCIES BETWEEN THE PLANS AND THE ACTUAL SITE CONDITIONS.
2. THE CONTRACTOR'S WORK SHALL CONFORM TO ALL REQUIREMENTS SPECIFIED IN THE SPECIAL PROVISION AND AS SHOWN HEREIN.
3. ALL DIMENSIONS SHALL TAKE PRECENDENCE OVER SCALE SHOWN ON PLANS, SECTIONS AND DETAILS.
4. NOTES AND DETAILS ON THE DRAWINGS SHALL TAKE PRECENDENCE OVER GENERAL NOTES AND TYPICAL DETAILS.
5. THE CONTRACTOR DOCUMENTS AND SPECIFICATIONS PRESENT THE FINISHED CONDITION. UNLESS OTHERWISE INDICATED, THEY DO NOT INDICATE THE METHOD OF CONSTRUCTION.
6. THE CONTRACTOR SHALL, AT HIS OWN EXPENSE, DESIGN CONSTRUCT AND MAINTAIN ALL SAFETY DEVICES, INCLUDING SHORING AND BRACING AND SHALL BE SOLELY RESPONSIBLE FOR CONFORMING TO ALL LOCAL, STATE AND FEDERAL SAFETY AND HEALTH STANDARDS, LAW AND REGULATIONS.
7. WHERE NO CONSTRUCTION DETAILS ARE SHOWN OR NOTED FOR ANY PART OF THE WORK, THE DETAILS SHALL BE THE SAME AS FOR OTHER SIMILAR WORK.
8. ALL REINFORCING STEEL SHALL CONFORM TO ASTM A615 GRADE 60.
9. CONCRETE SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF 3000 psi AT 28 DAYS.
10. ALL EXPOSED EDGES OF CONCRETE SHALL HAVE A 3/4" CHAMFER.
11. ALL STEEL SHALL BE HOT DIPPED GALVANIZED CONFORMING TO ASTM A123.

UTILITY NOTES:

THE EXISTENCE AND LOCATION OF ANY UNDERGROUND UTILITY PIPES OR STRUCTURES SHOWN ON THE PLANS WERE OBTAINED BY A SEARCH OF THE AVAILABLE RECORDS AND ARE NOT NECESSARILY IN THE LOCATION SHOWN ON THE PLANS. CONTRACTOR SHALL VERIFY THE LOCATION OF ANY UTILITY SHOWN ON THE PLANS PRIOR TO CONSTRUCTION. CONTRACTOR IS ALSO DIRECTED TO THE GENERAL NOTES SHOWN HEREON FOR ADDITIONAL INFORMATION/INSTRUCTION REGARDING UTILITIES.

CIVIL IMPROVEMENT NOTES:

1. CONTRACTOR SHALL USE SURVEY CONTROL POINT, INCLUDING BENCH MARKS, WHERE AVAILABLE.
2. CONTRACTOR SHALL DEMOLISH AND DISPOSE OF EXISTING ASPHALT PAVEMENT, CONCRETE AND ANY OTHER MATERIAL NOT USED.
3. WHERE EXISTING CURB OR GUTTER IS TO REMAIN AND AT JOINTS TO EXISTING AC PAVEMENT AN AC PAVEMENT CAP IS TO BE APPLIED ADJACENT THERETO, THE CONTRACTOR SHALL FIRST REMOVE PAVEMENT BY COLD PLANING TO ALLOW MINIMUM 1 1/2 INCH OVERLAY THICKNESS.
4. CONTRACTOR SHALL REPLACE EXISTING STRIPING AND PAVEMENT MARKERS IN AREAS OF NEW PAVEMENT IN SAME LOCATION AND IN KIND.
5. IN AREAS WHERE THE CONTRACTOR APPLIES AC CAP OR CONSTRUCTS A NEW STRUCTURAL SECTION, THE CONTRACTOR SHALL ADJUST TO GRADE ALL EXISTING VALVE BOXES, MANHOLES, AND ANY OTHER SIMILAR UTILITY SYSTEM APPURTENANCE.

ELECTRICAL GENERAL NOTES:

1. ALL WORK SHALL COMPLY WITH THE LATEST CALIFORNIA ELECTRICAL CODE (CEC) REQUIREMENTS.
2. WORK SHALL BE IN ACCORDANCE WITH LATEST APPLICABLE NATIONAL AND LOCAL CODES AND SHALL COMPLY WITH REQUIREMENTS OF ALL AUTHORITIES HAVING JURISDICTION.
3. THE DRAWINGS INDICATE IN DIAGRAMMATIC FORM THE DESIRED ARRANGEMENT OF PRINCIPAL APPARATUS, PIPING, ETC., AND SHALL BE FOLLOWED AS CLOSELY AS POSSIBLE. SCALED AND FIGURED DIMENSIONS ARE APPROXIMATE AND ARE GIVEN FOR ESTIMATING PURPOSES ONLY. BEFORE PROCEEDING WITH WORK, VERIFY EXISTING CONDITIONS, DIMENSIONS, SIZES AND ASSUME FULL RESPONSIBILITY FOR FITTING-IN OF EQUIPMENT AND MATERIALS, INCLUDING OFFSETS, BENDS, ETC., WHICH MAY BE REQUIRED.
4. CUT STEEL CONDUIT ENDS SQUARE, REAM SMOOTH. PAINT MALE THREADS OF FIELD THREADED CONDUIT WITH GRAPHITE BASE PIPE COMPOUNDS. DRAW UP TIGHT WITH CONDUIT COUPLINGS.
5. LEAVE WIRE SUFFICIENTLY LONG TO PERMIT MAKING FINAL CONNECTIONS.
6. COVERS OF JUNCTION AND PULL BOXES SHALL BE ACCESSIBLE.
7. PROVIDE PULL BOXES AND MANHOLES AS INDICATED AND WHENEVER NECESSARY TO FACILITATE CABLE PULL. COORDINATE EXACT LOCATIONS WITH OTHER TRADES.
8. FOR EMPTY RACEWAY RUNS, PROVIDE PULL BOXES EVERY 100 FEET AND AS INDICATED. COORDINATE EXACT LOCATIONS WITH OTHER TRADES.
9. SUPPORT PANEL, JUNCTION AND PULL BOXES INDEPENDENTLY FROM STRUCTURE WITH NO WEIGHT BEARING ON CONDUITS.
10. SUPPLEMENTARY JUNCTION AND PULL BOXES IN ADDITION TO THOSE INDICATED ON THE CONTRACT DRAWINGS AND AS REQUIRED BY APPLICABLE CODES. PROVIDE AND INSTALL SUPPLEMENTARY JUNCTION AND PULL BOXES AS FOLLOWS:
    1. WHEN REQUIRED TO FACILITATE INSTALLATION OF WIRING.
    2. AT EVERY FOURTH 90 DEGREE TURN.
    3. AT INTERVALS NOT EXCEEDING 200 FEET FOR RACEWAY SIZES OVER 1 INCH.
11. ALL ELECTRICAL UNDERGROUND CONDUITS SHALL BE 1 INCH MINIMUM.
12. CONTRACTOR SHALL FURNISH ALL MATERIAL, LABOR, EQUIPMENT, PERMITS, INSPECTIONS, FEES AND OTHER EXPENSES REQUIRED FOR THE EXECUTION OF THE WORK SHOWN ON THE CONSTRUCTION DRAWINGS.
13. REPAIR AND REPLACE LANDSCAPE/ASPHALT AND CONCRETE PAVEMENT TO MATCH EXISTING. CONTRACTOR TO REFILL AND COMPACT SOIL, AND FINISH THE SURFACE SUCH THAT IT MATCHES THE SURROUNDING SURFACE AND GROUND LAYERS, AS APPROVED BY THE ENGINEER.
14. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL CUTTING, TRENCHING, BACKFILLING AND PATCHING REQUIRED TO COMPLETE THE WORK. ALL EXPOSED FINISHED AREAS THAT ARE DAMAGED AS A RESULT OF THIS WORK SHALL BE REPAIRED TO MATCH THE EXISTING CONDITIONS AT NO ADDITIONAL COST TO THE OWNER.
15. BEFORE SUBMITTING BIDS FOR THE WORK, CONTRACTOR SHALL MAKE A THOROUGH FIELD INSPECTION OF THE PROJECT AREA TO DETERMINE ANY EXISTING CONDITIONS THAT MAY AFFECT THE WORK.
16. AREA CLASSIFICATION: OUTDOOR/WET UNLESS OTHERWISE NOTED.
17. COORDINATE ALL UNDERGROUND RUN WORK WITH OTHER UTILITIES ON THE SITE.
18. ELECTRICAL CONTRACTOR SHALL DEWATER TRENCHES PRIOR TO INSTALLATION OF CONDUITS. PROVIDE WATER-TIGHT FITTINGS ON ALL UNDERGROUND CONDUITS.
19. CONTRACTOR SHALL CALL 811 AND HAVE UNDERGROUND UTILITIES IN EXCAVATION AREAS MARKED PRIOR TO DIGGING.
20. ALL EQUIPMENT SHOWN IS NEW UNLESS NOTED OTHERWISE.
21. IN AREAS WHERE THERE ARE NO ALTERATIONS INDICATED, THE EXISTING FACILITIES SHALL BE RETAINED IN SERVICE. IN CASE OF DOUBT, ASSUME THAT THE EXISTING ELECTRICAL WIRING IS TO REMAIN IN OPERATION THROUGHOUT THE CONSTRUCTION PERIOD AND THEREAFTER.

STANDARD SPECIFICATIONS:

1. STATE OF CALIFORNIA, DEPARTMENT OF TRANSPORTATION, STANDARD SPECIFICATIONS 2018 EDITION.

STANDARD PLANS:

1. 2018 STANDARD PLAN FOR PUBLIC WORKS CONSTRUCTION (SPPWC) STANDARD PLAN 132-3, CONCRETE PAVEMENT REPLACEMENT.

NO.	DATE	REVISIONS	BY	CHK	APRV

HDR

REGISTERED PROFESSIONAL ENGINEER
LEONARDO HERNANDEZ
No. C67141
Exp. 09/30/20
CIVIL
STATE OF CALIFORNIA

DESIGNED BY	L. HERNANDEZ	DATE 08/19
DRAWN BY	J.R. GRANADO	08/19
CHECKED BY	M. SHAVER	08/19
PRJ. ENG.	R. BOLEY	08/19

MTS® Metropolitan Transit System

ZERO EMISSION BUS CHARGER PROJECT-PHASE II

GENERAL NOTES

SCALE	NTS
CONTRACT NO.	G1947.0-17
DRAWING NO.	G001
SHEET NO.	2 OF 18

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES

0 1 2 3

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$PLTDRVL$

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CONVENTIONS

1 KEYNOTES

DETAIL REFERENCE:
DETAIL DESIGNATION
SHEET NUMBER REFERENCE

1 / EXXXX

POWER

CONTROL PANEL WITH MAIN DISCONNECT

ELECTRICAL EQUIPMENT ENCLOSURE: SWITCHBOARD, MOTOR CONTROL CENTER, CONTROL PANEL, TRANSFORMER OR OTHER EQUIPMENT AS INDICATED. ESTIMATE SIZE AS INDICATED. SURFACE OR FLUSH MOUNTED.

ELECTRICAL MOTOR CONNECTION

E ELEC. PULL BOX DEPTH AS REQUIRED, UNO.

J JUNCTION OR PULL BOX

C CONDULET

NON-FUSED SAFETY DISCONNECT SWITCH, 3 POLE UNO

F FUSED SAFETY DISCONNECT SWITCH, 3 POLE UNO

CONNECTION TO EQUIPMENT PROVIDED UNDER OTHER DIVISIONS OR BY OWNER

EXOTHERMIC WELD

RACEWAYS

#10 WIRE SIZE AS NOTED

CONDUIT AND WIRE RUN CONCEALED IN WALL OR CEILING SPACE, OR RUN EXPOSED IN UNFINISHED SPACE.

CONDUIT AND WIRE RUN CONCEALED IN SLAB, UNDER SLAB OR UNDERGROUND

CONDUIT TURNING UP

CONDUIT TURNING DOWN

REINFORCED CONCRETE ENCASED DUCTBANK

SINGLE LINE

GF GROUND FAULT SENSOR AND RELAY

300AT 300AF 3P CIRCUIT BREAKER, TRIP SIZE, FRAME SIZE, AND NO. OF POLES AS INDICATED.

FUSE, SIZE, AND NUMBER OF FUSES AS NOTED

FUSED SWITCH

TRANSFORMER, KVA RATING AS SHOWN ON DRAWING

GROUND CONNECTION

POWER SWITCH (SHOW NORMALLY OPEN)

SPD LOW VOLTAGE SURGE PROTECTIVE DEVICE

G GENERATOR

ATS TRANSFER SWITCH, CURRENT RATING, AND NUMBER OF POLES AS NOTED
ATS - AUTOMATIC
MTS - MANUAL

100 KVA NON-MOTOR LOAD WITH DESIGN KVA, KW, OR AMP

THERMAL OVERLOAD ELEMENT

CPT CONTROL POWER TRANSFORMER (CPT)

ETM ELAPESED TIME METER

NORMALLY OPEN CONTACT (N.O.)

NORMALLY CLOSED CONTACT (N.C.)

CURRENT TRANSFORMER (CT)

WH UTILITY WATT-HOUR METER PER UTILITY REQUIREMENTS

DMP DIGITAL METERING PACKAGE

MOTOR CONTROLLER AND SEPARATELY MOUNTED MOTOR CONTROLLER WITH SHORT CIRCUIT PROTECTION AND DISCONNECT.

MOTOR STARTER AND CONTROLLER SUBSCRIPTS:

A - MAGNETIC STARTER NEMA SIZE

B - STARTER TYPE
NONE - FULL VOLTAGE NON-REVERSING (FVNR)
FVR - FULL VOLTAGE REVERSING
2S - TWO SPEED
RVAT - REDUCED VOLTAGE AUTO TRANSFORMER

C - CONTROL DIAGRAM OR CONTROLS SCHEDULE NUMBER (IF REQUIRED)

D - CONTROLLER TYPE
VFD - VARIABLE FREQUENCY DRIVE
RVSS - REDUCED VOLTAGE SOFT STARTER
CONT - CONTACTOR

ABBREVIATIONS

AGENCIES

AASHTO	AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
A.S.T.M.	AMERICAN SOCIETY FOR TESTING MATERIALS
AT&T	AMERICAN TELEPHONE AND TELEGRAPH COMPANY
MTS	METROPOLITAN TRANSIT SYSTEM
SDG&E	SAN DIEGO GAS AND ELECTRIC COMPANY
SDRS/SDRSD	SAN DIEGO REGIONAL STANDARDS DRAWINGS

LEGEND

e	EXISTING ELECTRICAL
gs	EXISTING GAS
w	EXISTING WATER
LITE	EXISTING STREET LIGHT
SS	EXISTING ABANDONED SEWER
SS	EXISTING ABANDONED SEWER
s	EXISTING SEWER
sd	EXISTING STORM DRAIN
COMM	EXISTING COMMUNICATION LINE
E	EXISTING ABANDONED ELECTRICAL
TEL	EXISTING TELEPONE
111	CONTROL POINTS (SEE DWG NO. C01)

NOTE:

HORIZONTAL CONTROL FOR KMD WILL BE LAID OUT ON SITE BY THE CONTRACTOR MEASURED OFF EXISTING SURFACE FEATURES LOCATED DURING DESIGN PHASE.

GENERAL

AC	ASPHALT CONCRETE
A, AMP	AMPERE
AF	AMP FRAME
AT	AMP TRIP
ATS	AUTOMATIC TRANSFER SWITCH
AVE	AVENUE
BKR	BREAKER
BLDG	BUILDING
C	CONDUIT
CKT	CIRCUIT
CAL OSHA	CALIFORNIA DIVISION OF SAFETY AND HEALTH
CAT	CATEGORY
CEC	CALIFORNIA ELECTRICAL CODE
CNG	COMPRESSED NATURAL GAS
CONT'D	CONTINUED
CPT	CONTROL POWER TRANSFORMER
CR	CONTROL RELAY
CT	CURRENT TRANSFORMER
CU	COPPER
DC	DIRECT CURRENT
DIA	DIAMETER
DISC	DISCONNECT
DMP	DIGITAL METERING PACKAGE
DP	DEFINITE PURPOSE RELAY/ DISTRIBUTION PANEL
DR	DRIVE
DWG	DRAWING
E/ELEC	ELECTRICAL
ECD	EAST COUNTY DIVISION
ENG	ENGINEER
ETC	ETCETERA
EV	ELECTRICAL VEHICLE

GENERAL

(E), EXIST	EXISTING
EV	ELECTRICAL VEHICLE
FDR	FEEDER
G	GENERATOR
GALV	GALVANIZED
GF	GROUND FAULT PROTECTION
GND	GROUND, GROUNDING
HH	HANDHOLE
HMI	HUMAN MACHINE INTERFACE
IAD	IMPERIAL AVENUE DIVISION
ID	IDENTIFICATION
KMD	KEARNY MESA DIVISION
KV	KILOVOLT
KVA	KILO VOLTAGE
KW	KILOWATT
L	LENGTH
L	CLIGHTING CONTRACTOR
M	MOTOR STARTER
MAG	MAGNETIC
MH	MANHOLE
MIN/MIN.	MINIMUM
MSB	MAIN SERVICE SWITCHBOARD
MTS	MANUAL TRANSFER SWITCH
(N)	NEW
NEMA	NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
NF	NON FUSED
N.C.	NORMAL CLOSED CONTACT
NO/No.	NUMBER
N.O.	NORMAL OPEN CONTACT
NP	NAMEPLATE
NTS	NOT TO SCALE

GENERAL CONT'D

P	POWER OR POLE
PB	PULL BOX
PC	PHOTO CELL
PH	PHASE
PNL	PANEL
PRJ	PROJECT
PWR	POWER
QTY	QUANTITY
SBD	SOUTH BAY DIVISION
STD	STANDARD
SHT	SHEET
ST	STREET
SWBD	SWITCHBOARD
TC	TIME CLOCK
TR	TIMING RELAY
TYP	TYPICAL
UG	UNDERGROUND
UNO	UNLESS NOTED OTHERWISE
UV	ULTRA VIOLET
V	VOLT
Vd	VOLTAGE DROP
VAC	VOLTS ALTERNATING CURRENT
W	WATT, WIRE
WH	WATT-HOUR
WP	WEATHERPROOF
XMFR	TRANSFORMER
ZE	ZERO EMISSION
ZEB	ZERO EMISSION BUS
#/No.	NUMBER
Ø	DIAMETER

EAST COUNTY DIVISION
BASIS OF COORDINATES: (NAD 83)

THE BASIS OF COORDINATES FOR THIS SURVEY IS THE NORTH AMERICAN DATUM OF 1983 (NAD83) CALIFORNIA STATE PLANE COORDINATE SYSTEM OF 1983 (CCS83) ZONE 6 (EPOCH 1991.35) BASED LOCALLY UPON THE FOLLOWING CONTROL POINTS PER RECORD OF SURVEY 14492 AND RECORD OF SURVEY 16652:

STATION	NORTHING	EASTING	EASTING
23	1878209.269	6340538.326	BD "COUNTY ENG GF 23" IN 2" IP PER ROS 16652
54	1880624.38	6342863.18	BD "USC&GS G 281" IN CONC MON PER ROS 14492

GRID BEARING BETWEEN #23 AND #54 = N 43°54'33" E.

VERTICAL CONTROL: (NGVD29)

ELEVATIONS SHOWN HEREON ARE IN TERMS OF THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29) BASED LOCALLY UPON THE FOLLOWING CITY OF EL CAJON BENCH MARK:

BENCHMARK	ELEVATION	DESCRIPTION
#329	493.486'	STD BD S'LY TOP CURB VERNON WAY, E 40' +/- E PCR SE COR JOHNSON AVE & VERNON WAY.

SUPPLEMENTAL CONTROL:

AS ESTABLISHED FOR THIS PROJECT

NOTE: SUPPLEMENTAL CONTROL POINTS WERE ESTABLISHED HORIZONTALLY BY RTK GPS SURVEY WITH REDUNDANCY ANDVERTICALLY BY RTK GPS SURVEY WITH REDUNDANCY PLUS TRIG LEVELING.

SUPPLEMENTAL CONTROL				
PT#	NORTHING	EASTING	ELEVATION	DESCRIPTION
7005	1876278.74	6340193.05	393.50	CP X
7006	1876414.41	6340405.91	395.62	CP X
7007	1876153.89	6340514.15	394.72	CP X
7009	1876149.11	6340183.82	392.51	CP X
7010	1876149.11	6340280.31	394.03	CP MAG
7011	1876160.79	6340180.60	394.56	CP X

SOUTH BAY DIVISION
BASIS OF COORDINATES: (NAD 83)

THE BASIS OF COORDINATES FOR THIS SURVEY IS THE NORTH AMERICAN DATUM OF 1983 (NAD 83) CALIFORNIA STATE PLANE COORDINATE SYSTEM OF 1983 (CCS83) ZONE 6 (EPOCH 1991.35) BASED LOCALLY UPON THE FOLLOWING CONTROL POINTS PER RECORD OF SURVEY 14841:

STATION	NORTHING	EASTING	EASTING
5029	1796043.061	6317705.077	BD CV GPS 5029 IN CURB INLET
1383	1796389.727	6311762.199	L&D CITY ENG IN CONC CROSS GUTTER

GRID BEARING BETWEEN #5029 AND #1383 = N 86°39'42" W.

VERTICAL CONTROL: (NGVD29)

ELEVATIONS SHOWN HEREON ARE IN TERMS OF THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29) BASED LOCALLY UPON THE FOLLOWING CONTROL POINT PER ROS 14841:

BENCHMARK	ELEVATION	DESCRIPTION
CP 5029	106.765'	BD CV GPS 5029 IN CURB INLET

SUPPLEMENTAL CONTROL:

AS ESTABLISHED FOR THIS PROJECT

NOTE: SUPPLEMENTAL CONTROL POINTS WERE ESTABLISHED HORIZONTALLY BY RTK GPS SURVEY WITH REDUNDANCY AND VERTICALLY BY RTK GPS SURVEY WITH REDUNDANCY PLUS TRIG LEVELING.

SUPPLEMENTAL CONTROL				
PT#	NORTHING	EASTING	ELEVATION	DESCRIPTION
6003	1797326.73	6314105.65	91.66	CP MAG
6004	1797154.40	6314075.58	87.42	CP X
6005	1797213.92	6314115.02	89.94	CP MAG

NO.	DATE	REVISIONS	BY	CHK	APRV

HDR

REGISTERED PROFESSIONAL ENGINEER LEONARDO HERNANDEZ No. C67141 Exp. 09/30/20 CIVIL STATE OF CALIFORNIA

DESIGNED BY L. HERNANDEZ	DATE 08/19
DRAWN BY R. GRANADO	08/19
CHECKED BY M. SHAVER	08/19
PRJ. ENG. R. BOLEY	08/19

MTS Metropolitan Transit System

ZERO EMISSION BUS CHARGER PROJECT-PHASE II

LEGEND, ABBREVIATIONS, SYMBOLS, AND BASIS OF COORDINATES

SCALE NTS
CONTRACT NO. G1947.0-17
DRAWING NO. G002
SHEET NO. 3 OF 18

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES
0 1 2 3

9/16/2019
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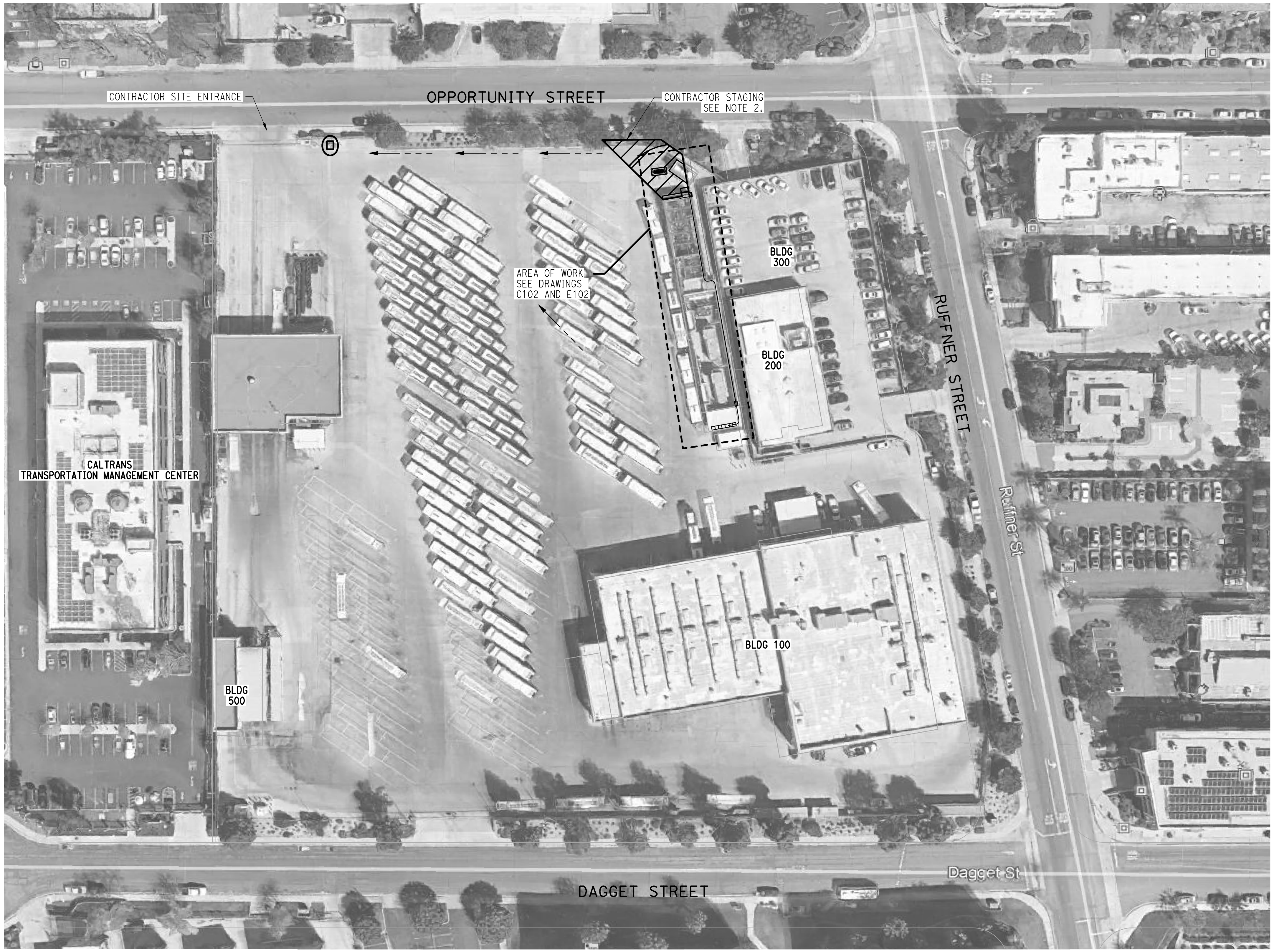


NOTES:

1. REFER TO MTS STORM WATER STANDARDS FOR DEVELOPMENT AND IMPLEMENTATION OF WATER POLLUTION CONTROL PLAN. SEE ALSO SECTION 5.26 TEMPORARY STORM WATER POLLUTION CONTROL.
2. CONTRACTOR SHALL COORDINATE WITH SITE FACILITIES MANAGER AND PROVIDE ACCESS TO MTS FACILITIES AS NEEDED.

N

LEGEND:

SE-10, INLET PROTECTION

DRAINAGE DIRECTION

119 CONTROL POINTS

NO.	DATE	REVISIONS	BY	CHK	APRV

HDR

REGISTERED PROFESSIONAL ENGINEER
LEONARDO HERNANDEZ
No. C67141
Exp. 09/30/20
CIVIL
STATE OF CALIFORNIA

DESIGNED BY L. HERNANDEZ	DATE 08/19
DRAWN BY R. GRANADO	08/19
CHECKED BY M. SHAVER	08/19
PRJ. ENG. R. BOLEY	08/19

MTS Metropolitan Transit System

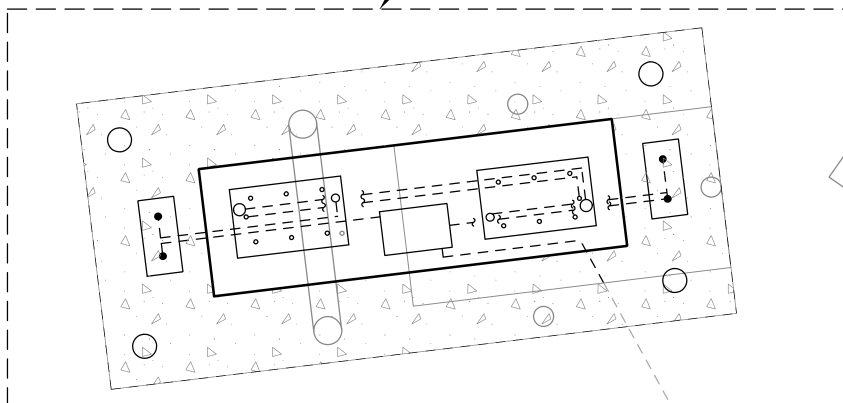
ZERO EMISSION BUS CHARGER PROJECT-PHASE II

CIVIL SITE ACCESS KEARNY MESA DIVISION

SCALE 1"=50'	
CONTRACT NO. G1947.0-17	
DRAWING NO. C101	SHEET NO. 4 OF 18

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES

0 1 2 3



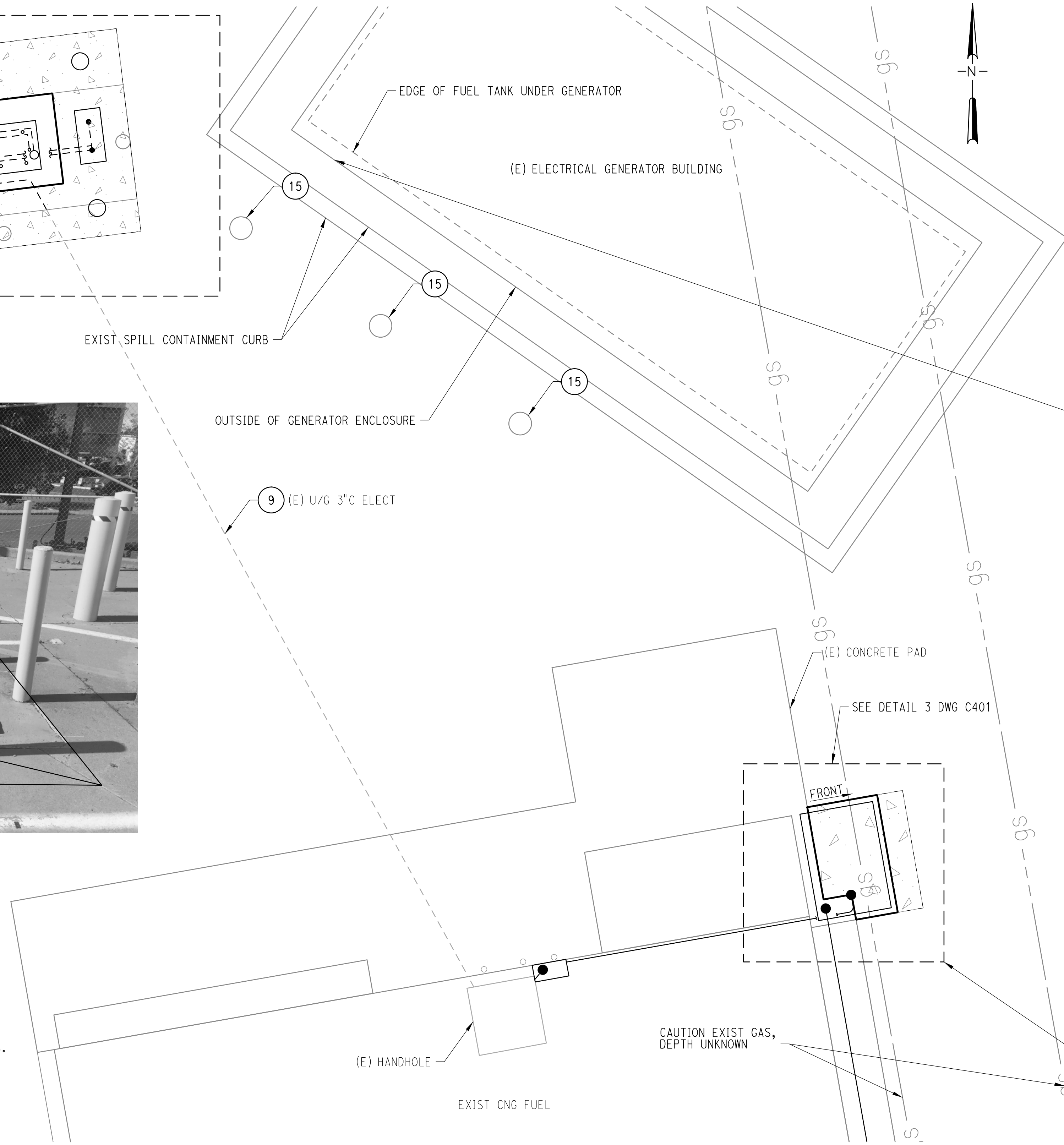


PHOTO SHOWING GENERATOR NEAR CHARGER LOCATION

PHOTO SHOWING REMOVAL LIMITS AT CHARGER LOCATION

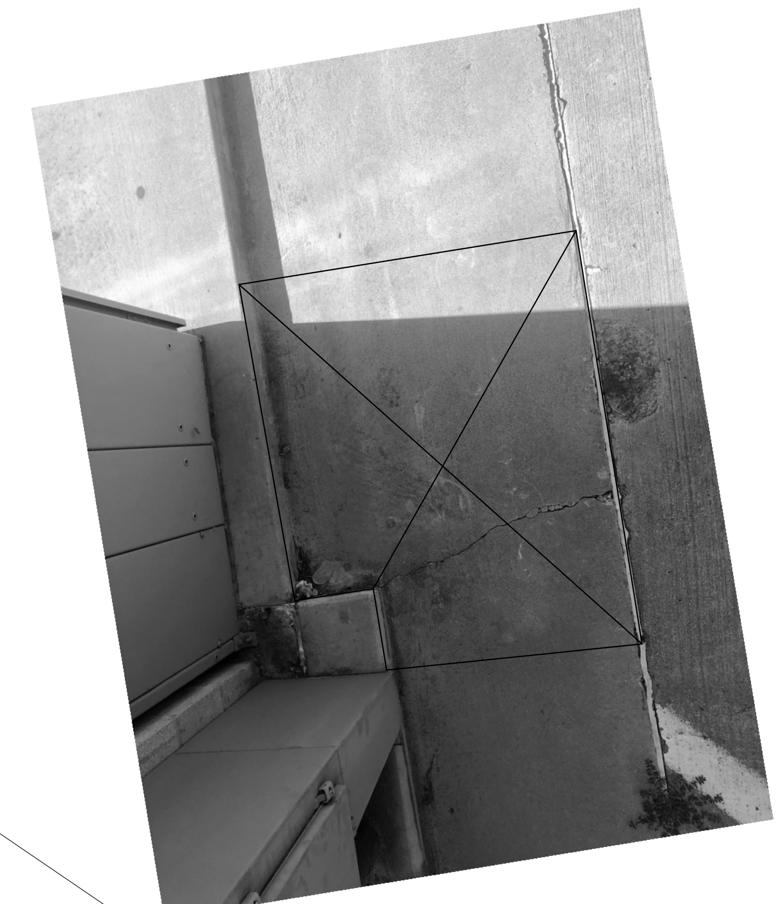


PHOTO SHOWING REMOVAL LIMITS AT SWITCHBOARD LOCATION

NOTES:

1. THERE ARE SHALLOW UTILITIES LOCATED ONSITE, CONTRACTOR TO VERIFY LOCATION AND DEPTH OF EXISTING UTILITIES PRIOR TO EXCAVATION. NO SUBSURFACE INVESTIGATION (POTHOLE) WAS PERFORMED DURING DESIGN. EXISTING UTILITIES SHOWN HEREON WERE LOCATED BY UTILITY MARK-OUT SERVICE.
2. SLOPE CONCRETE IN EXISTING SWALE AREAS TO MATCH EXISTING ELEVATIONS.
3. REFER TO MTS STORMWATER STANDARDS FOR DIRECTION REGARDING STORM WATER POLLUTION CONTROL DURING CONSTRUCTION. SEE ALSO SECTION 5.

CONSTRUCTION NOTES:

9 PROTECT EXISTING UTILITY, CONTRACTOR TO POTHOLE AND VERIFY EXACT LOCATION.

15 PROTECT EXIST BOLLARD

SITE PLAN

SCALE: 1" = 2'-0"

NO.	DATE	REVISIONS	BY	CHK	APRV

HDR

REGISTERED PROFESSIONAL ENGINEER LEONARDO HERNANDEZ No. C67141 Exp. 09/30/20 CIVIL STATE OF CALIFORNIA

	DATE
DESIGNED BY L. HERNANDEZ	08/19
DRAWN BY D.R. GRANADO	08/19
CHECKED BY M. SHAVER	08/19
PRJ. ENG. R. BOLEY	08/19

MTS Metropolitan Transit System

ZERO EMISSION BUS CHARGER PROJECT-PHASE II

CIVIL SITE PLAN KEARNY MESA DIVISION

SCALE AS NOTED	
CONTRACT NO. G1947.0-17	
DRAWING NO. C102	SHEET NO. 5 OF 18

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

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NOTES:

1. EXISITNG CURB CUT(ONSITE). RUNOFF DRAINS TO BACK OF CURB INLET IN STREET.
2. REFER TO MTS STORM WATER STANDARDS FOR DEVELOPMENT AND IMPLEMENTATION OF WATER POLLUTION CONTROL PLAN. SEE ALSO SECTION 5.26 TEMPORARY STORM WATER POLLUTION CONTROL.
3. CONTRACTOR SHALL COORDINATE WITH SITE FACILITIES MANAGER AND PROVIDE ACCESS TO MTS FACILITIES AS NEEDED. CONTRACTOR SHALL NOT INTERFERE WITH BUS WASH OPERATIONS.

CONSTRUCTION NOTES:

17 INSTALL TRENCH DRAIN FILTER FABRIC FOR INLET PROTECTION. ANCHOR IN PLACE WITH TRENCH GRATE.

N

LEGEND:

SE-10, INLET PROTECTION

DRAINAGE DIRECTION

119 CONTROL POINTS

NO.	DATE	REVISIONS	BY	CHK	APRV

HDR

REGISTERED PROFESSIONAL ENGINEER
LEONARDO HERNANDEZ
No. C67141
Exp. 09/30/20
CIVIL
STATE OF CALIFORNIA

	DATE
DESIGNED BY L. HERNANDEZ	08/19
DRAWN BY R. GRANADO	08/19
CHECKED BY M. SHAVER	08/19
PRJ. ENG. R. BOLEY	08/19

MTS Metropolitan Transit System

ZERO EMISSION BUS CHARGER PROJECT-PHASE II

CIVIL SITE ACCESS EAST COUNTY DIVISION

SCALE	
1"=30'	
CONTRACT NO.	
G1947.0-17	
DRAWING NO.	SHEET NO.
C201	6 OF 18

FOR REDUCED PLANS
ORIGINAL SCALE IS IN INCHES
0 1 2 3

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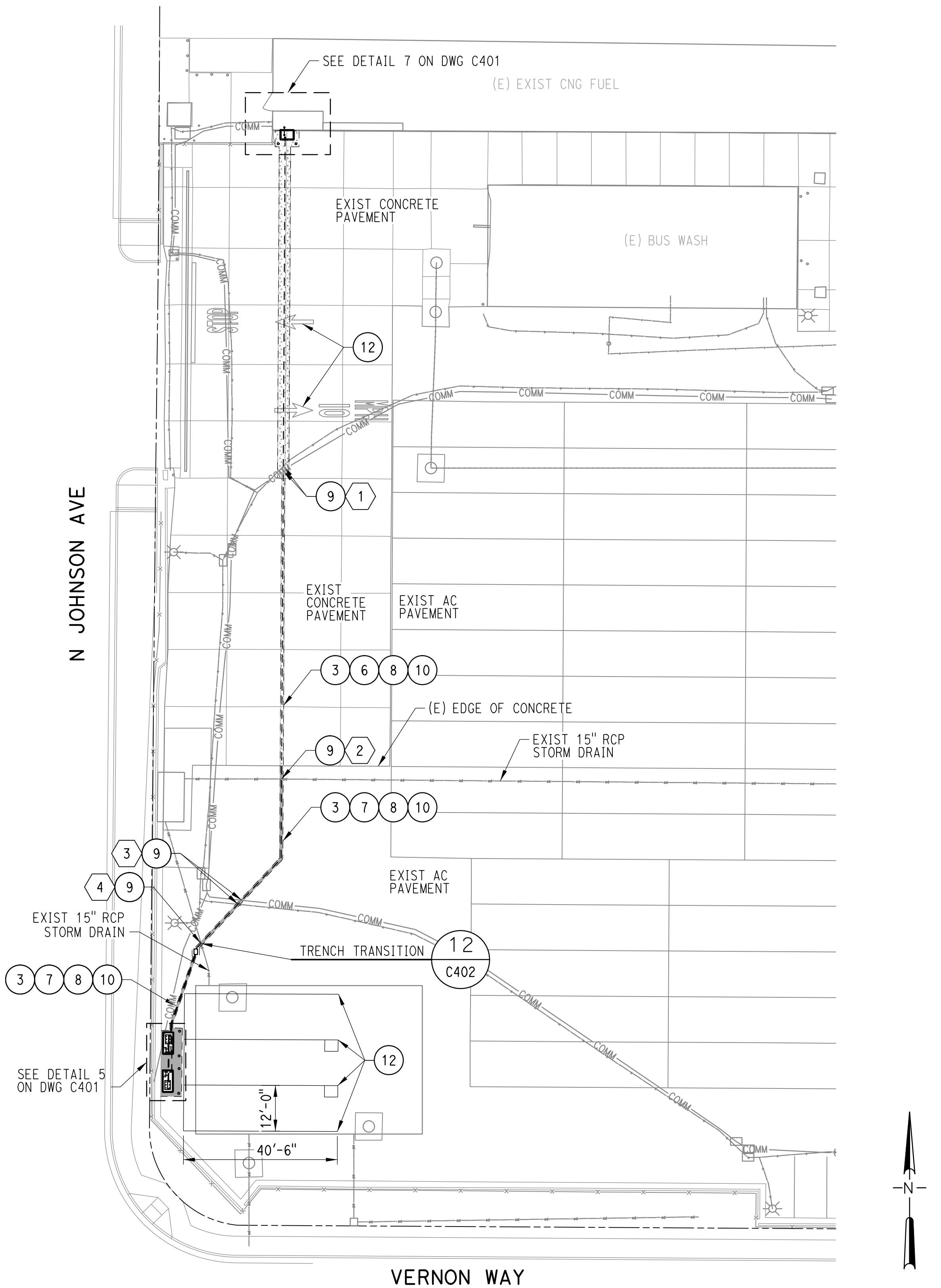

SITE PLAN

SCALE: 1" = 20-0"

NOTES:

1. THERE ARE SHALLOW UTILITIES LOCATED ONSITE, CONTRACTOR TO VERIFY LOCATION AND DEPTH OF EXISTING UTILITIES PRIOR TO EXCAVATION.
2. SLOPE CONCRETE IN EXISTING SWALE AREAS TO MATCH EXISTING ELEVATIONS.
3. BE ADVISED, DOWEL BASKETS WERE USED WHEN LAYING THE EXISTING CONCRETE PAVEMENT.

CONSTRUCTION NOTES:

3 SAWCUT EXISTING PAVEMENT

6 CONCRETE PAVEMENT SEE DETAIL 5, DWG C402

7 ASPHALT PAVEMENT SEE DETAIL 7, DWG C402

8 INSTALL CONDUIT, SEE ELECTRICAL SHEET, DWG E202 FOR SIZE AND LAYOUT

9 PROTECT EXISTING UTILITY, CONTRACTOR TO POTHOLE AND VERIFY EXACT LOCATION

10 TRENCH PER DUCT BANK DETAILS, SEE DWG C402

12 INSTALL STRIPING REPLACE TYPE-I 10'-0" ARROWS PER CALTRANS STANDARD PLAN A24A WITH THERMOPLASTIC

CROSSING UTILITY TABLE

⬡	NORTHING	EASTING	UTILITY DESCRIPTION	UTILITY DEPTH
1	1876334.867	6340211.090	COMMUNICATION LINE	4'-3"
2	1876253.816	6340210.654	STORM DRAIN	3'-4"
3	1876220.906	6340199.215	ELECTRICAL LINE	3'-6"
4	1876210.612	6340189.476	STORM DRAIN	1'-10.8"

*EXISTING UTILITY DEPTH COLLECTED FROM UTILITY LOCATOR

NO.	DATE	REVISIONS	BY	CHK	APRV

HDR

REGISTERED PROFESSIONAL ENGINEER LEONARDO HERNANDEZ No. C67141 Exp. 09/30/20 CIVIL STATE OF CALIFORNIA

DESIGNED BY	L. HERNANDEZ	08/19
DRAWN BY	J.R. GRANADO	08/19
CHECKED BY	M. SHAVER	08/19
PRJ. ENG.	R. BOLEY	08/19

MTS Metropolitan Transit System

ZERO EMISSION BUS CHARGER PROJECT-PHASE II

CIVIL SITE PLAN EAST COUNTY DIVISION

SCALE: AS NOTED
CONTRACT NO.: G1947.0-17
DRAWING NO.: C202
SHEET NO.: 7 OF 18

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

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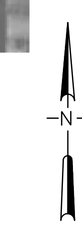

NOTES:

1. REFER TO MTS STORM WATER STANDARDS FOR DEVELOPMENT AND IMPLEMENTATION OF WATER POLLUTION CONTROL PLAN.
2. CONTRACTOR SHALL COORDINATE WITH SITE FACILITIES MANAGER AND PROVIDE ACCESS TO MTS FACILITIES AS NEEDED. CONTRACTOR SHALL NOT INTERFERE WITH BUS OPERATIONS.
3. SW ENTRANCE ON MAIN ST IS CLOSED AND NOT IN USE BY MTS.

LEGEND:

- SE-10, INLET PROTECTION
- DRAINAGE DIRECTION
- 119 CONTROL POINTS

NO.	DATE	REVISIONS	BY	CHK	APRV

HDR

REGISTERED PROFESSIONAL ENGINEER
LEONARDO HERNANDEZ
No. C67141
Exp. 09/30/20
CIVIL
STATE OF CALIFORNIA

	DATE
DESIGNED BY L. HERNANDEZ	08/19
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PRJ. ENG. R. BOLEY	08/19

MTS Metropolitan Transit System

ZERO EMISSION BUS CHARGER PROJECT-PHASE II

CIVIL SITE ACCESS SOUTH BAY DIVISION

SCALE 1"=20'
CONTRACT NO. G1947.0-17
DRAWING NO. C301
SHEET NO. 8 OF 18

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES
0 1 2 3

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$PLTDRVL$

NOTES:

1. SHALLOW UTILITIES LOCATED ONSITE, CONTRACTOR TO VERIFY LOCATION AND DEPTH OF EXISTING UTILITIES PRIOR TO EXCAVATION.
2. SLOPE CONCRETE IN EXISTING SWALE AREAS TO MATCH EXISTING ELEVATIONS.

CONSTRUCTION NOTES:

3 SAWCUT EXISTING PAVEMENT

6 CONCRETE PAVEMENT SEE DETAIL 5, DWG C402

7 ASPHALT PAVEMENT SEE DETAIL 7, DWG C402

8 INSTALL CONDUIT, SEE ELECTRICAL SHEET, DWG. No. E302 FOR SIZE AND LAYOUT

9 PROTECT EXISTING UTILITY, CONTRACTOR TO POTHOLE AND VERIFY EXACT LOCATION

10 TRENCH PER DUCT BANK DETAILS, SEE DWG C402

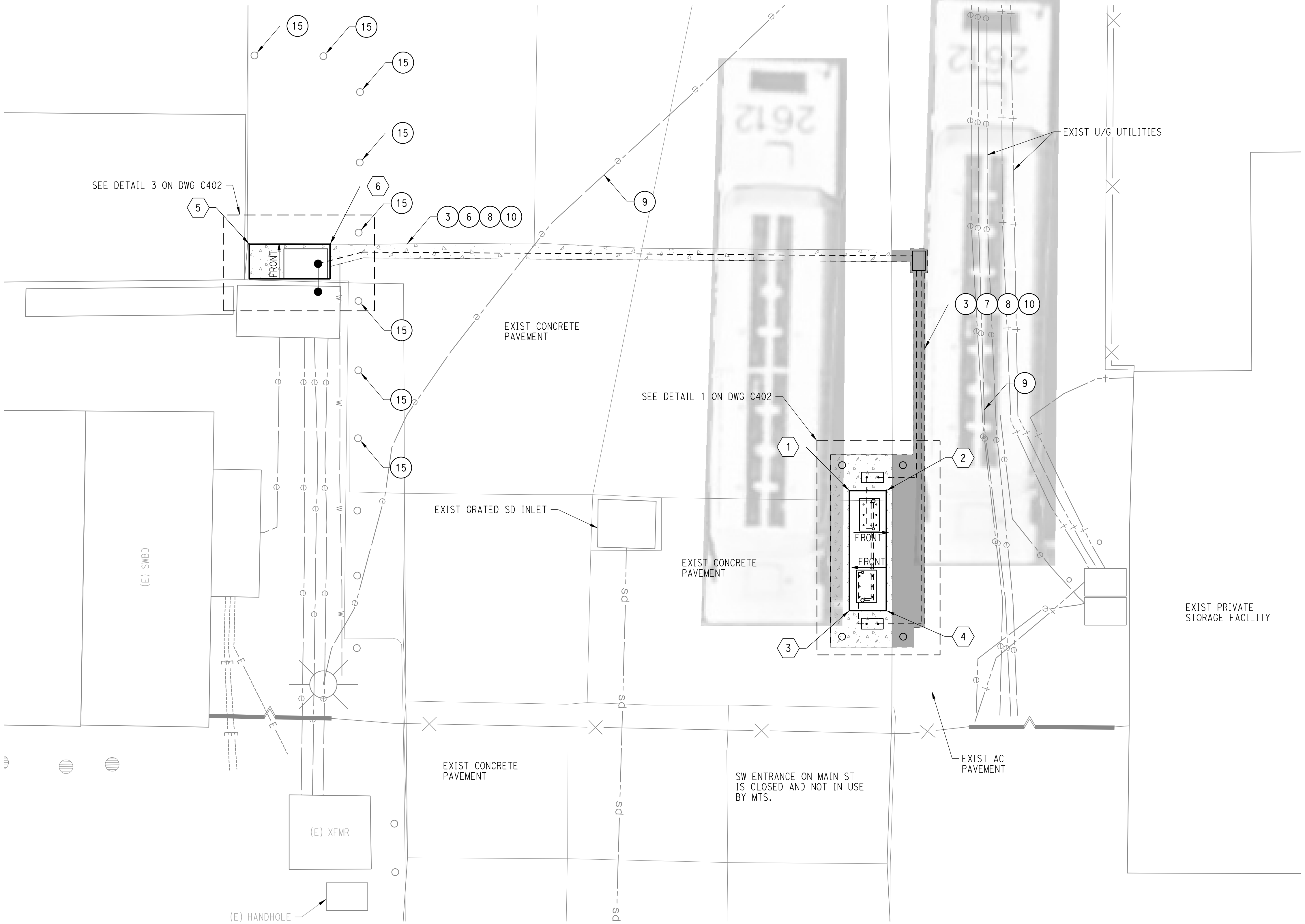
15 PROTECT EXIST BOLLARD

SBD CHARGER PAD LAYOUT DATA

⬡	NORTHING	EASTING	ELEVATION	DESCRIPTION
1	1797205.402	6314099.998	-	NW PAD CORNER
2	1797205.402	6314102.665	-	NE PAD CORNER
3	1797196.733	6314099.998	-	SW PAD CORNER
4	1797196.733	6314102.655	-	SE PAD CORNER

SBD SWITCHBOARD PAD LAYOUT DATA

⬡	NORTHING	EASTING	ELEVATION	DESCRIPTION
5	1797223.212	6314056.649	-	NW PAD CORNER
6	1797223.212	6314062.482	-	NE PAD CORNER



SITE PLAN

SCALE: 1" = 4'-0"

NO.	DATE	REVISIONS	BY	CHK	APRV

HDR

REGISTERED PROFESSIONAL ENGINEER LEONARDO HERNANDEZ No. C67141 Exp. 09/30/20 CIVIL STATE OF CALIFORNIA

DESIGNED BY L. HERNANDEZ	DATE 08/19
DRAWN BY D.R. GRANADO	08/19
CHECKED BY M. SHAVER	08/19
PRJ. ENG. R. BOLEY	08/19

MTS Metropolitan Transit System

ZERO EMISSION BUS CHARGER PROJECT-PHASE II

CIVIL SITE PLAN SOUTH BAY DIVISION

SCALE AS NOTED

CONTRACT NO. G1947.0-17

DRAWING NO. C302

SHEET NO. 9 OF 18

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

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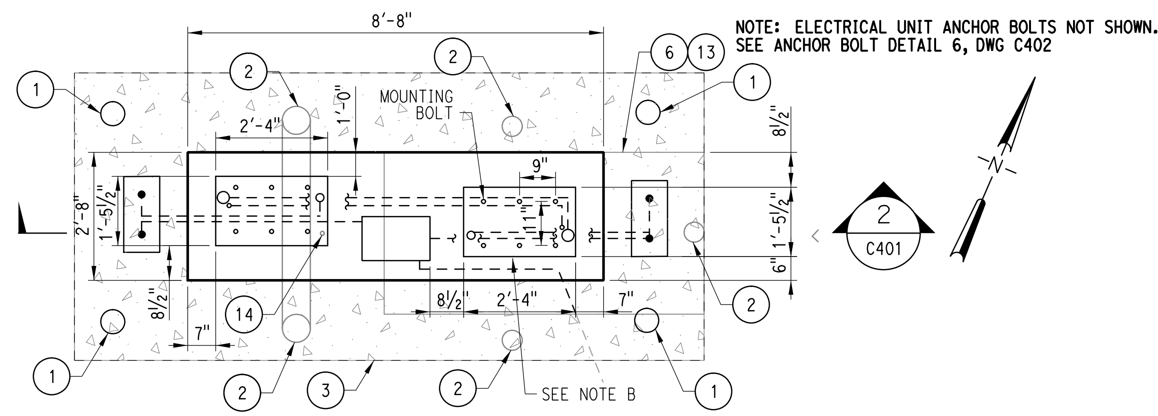
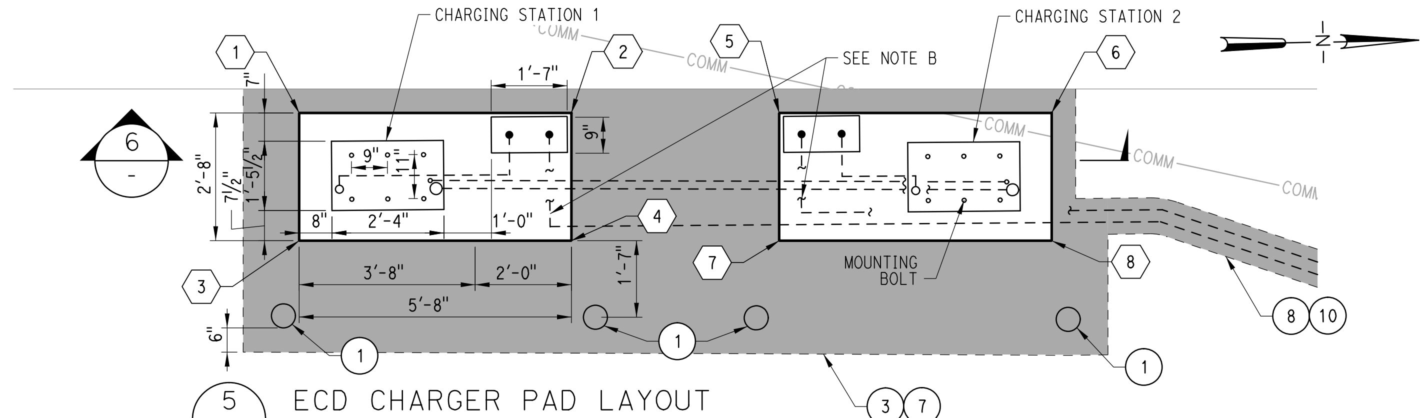
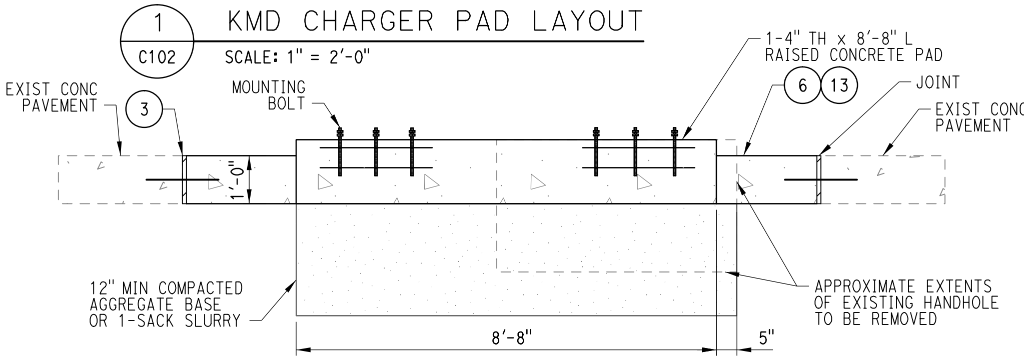


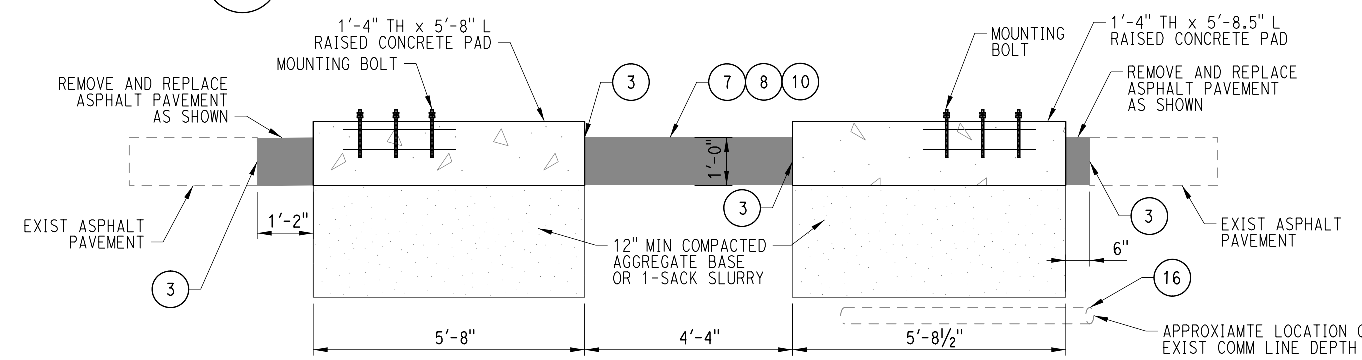
1 KMD CHARGER PAD LAYOUT
C102 SCALE: 1" = 2'-0"



5 ECD CHARGER PAD LAYOUT
SCALE: 1" = 2'-0"

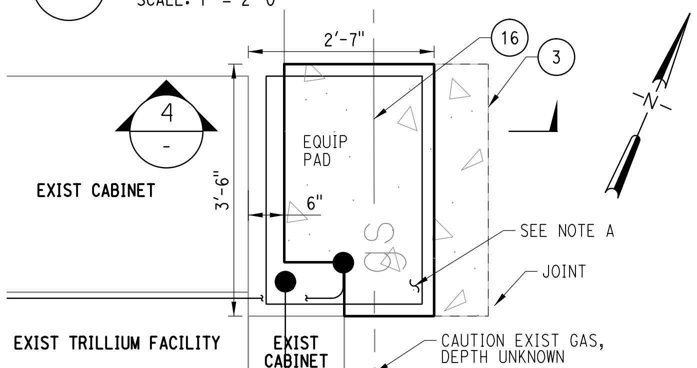


2 KMD CHARGER PAD DETAIL
- SCALE: 1" = 2'-0"

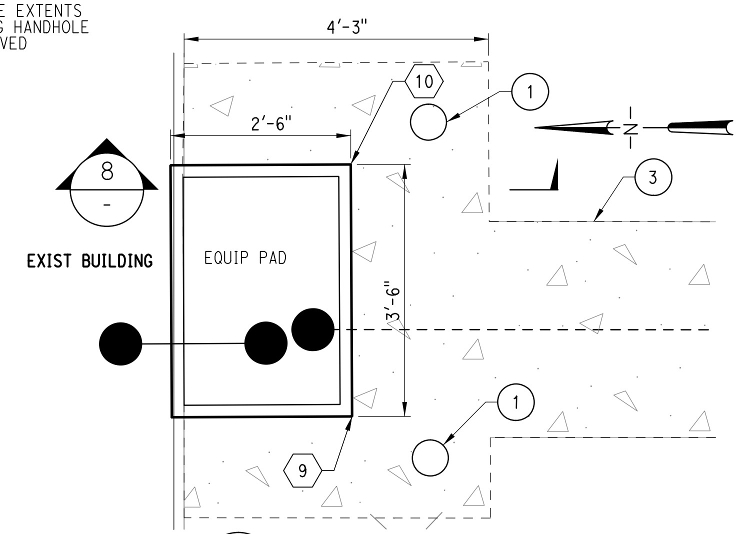


6 ECD CHARGER PAD DETAIL
SCALE: 1" = 2'-0"

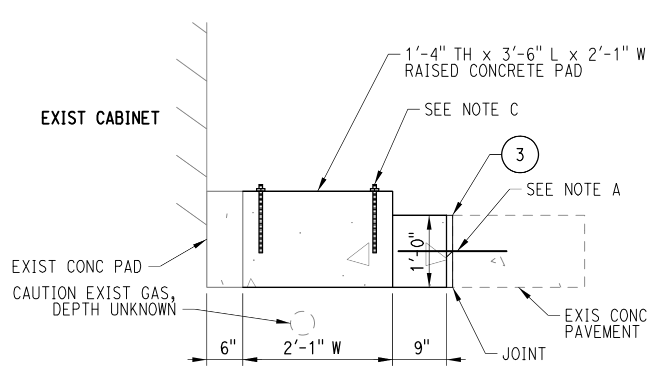
*NOTE: SLURRY NEEDED IN DUCT BANK AREAS ONLY.



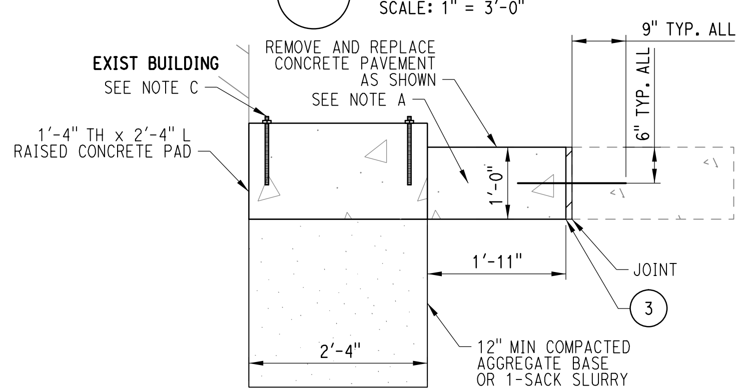
3 KMD SWITCHBOARD LAYOUT
SCALE: 1" = 3'-0"



7 ECD SWITCHBOARD LAYOUT
SCALE: 1" = 3'-0"



4 KMD SWITCHBOARD DETAIL
SCALE: 1" = 3'-0"



8 ECD SWITCHBOARD DETAIL
SCALE: 1" = 3'-0"

ECD CHARGER PAD LAYOUT DATA				
⬡	NORTHING	EASTING	ELEVATION	DESCRIPTION
1	1876171.591	6340179.382	-	SW PAD CORNER
2	1876177.261	6340179.427	-	NW PAD CORNER
3	1876171.571	6340182.049	-	SE PAD CORNER
4	1876177.240	6340182.094	-	NE PAD CORNER
5	1876181.594	6340179.462	-	SW PAD CORNER
6	1876187.273	6340179.508	-	NW PAD CORNER
7	1876181.573	6340182.129	-	SE PAD CORNER
8	1876187.252	6340182.174	-	NE PAD CORNER

ECD SWITCHBOARD PAD LAYOUT DATA				
⬡	NORTHING	EASTING	ELEVATION	DESCRIPTION
9	1876421.838	6340210.352	-	SW PAD CORNER
10	1876421.838	6340213.852	-	SE PAD CORNER

CONSTRUCTION NOTES:

1. INSTALL BOLLARD PER DETAIL 6, DWG. No. C401
2. REMOVE BOLLARD
3. SAWCUT EXISTING PAVEMENT
6. CONCRETE PAVEMENT SEE DETAIL 5, DWG 402
7. ASPHALT PAVEMENT SEE DETAIL 7, DWG C402
8. INSTALL CONDUIT, SEE ELECTRICAL SHEET, DWG. E401 FOR SIZE AND LAYOUT
10. TRENCH PER DUCT BANK DETAILS, SEE DETAILS 8, 9, & 10 DWG C402
13. REMOVE EXISTING HANDHOLE AND CONCRETE PAVEMENT
14. REMOVE EXISTING RISER
15. PROTECT EXISTING BOLLARD
16. PROTECT EXISTING UTILITY

GENERAL NOTES:

1. FINAL LOCATION AND CONFIGURATION OF CHARGER UNITS AND DISCONNECT SWITCHES SHALL BE ADDRESSED IN CONTRACTOR PROVIDED SHOP DRAWINGS, AND ANY DEVIATION FROM THE CURRENT CONFIGURATION SHALL BE INCLUDED IN THE COST OF INSTALLATION.

NOTES:

A. CONTRACTOR TO COORDINATE SPACING AND LOCATION OF DOWELS WITH LOCATION OF MOUNTING BOLTS FOR CHARGING UNITS AND SWITCHBOARDS. 3/4" DIAMETER SMOOTH STEEL DOWELS AT 12" CENTERS. DRILL AND EPOXY GROUT 9" INTO EXISTING CONCRETE PAVEMENT. (TYP.)

B. FOR INSTALLATION OF DISCONNECTS, SEE DETAIL 2, DWG. NO E401.

C. CONTRACTOR TO FOLLOW MANUFACTURERS DATA FOR LOCATION AND INSTALLATION GUIDELINES OF ANCHOR BOLTS.

F. FINAL BOLLARD LOCATIONS ARE TO BE SHOWN ON CONTRACTOR'S SHOP DRAWINGS FOR ELECTRICAL EQUIP INSTALLATION AND SHALL FOLLOW MANUFACTURER'S INSTALLATION GUIDELINES/INSTRUCTIONS FOR MINIMUM CLEARANCES AROUND EQUIPMENT.

G. CONTRACTOR TO PROVIDE TEMPORARY GENERATOR FOR ANY SHUT DOWNS/CUTOVERS, TYPICAL, ALL SITES.

NO.	DATE	REVISIONS	BY	CHK	APRV

REGISTERED PROFESSIONAL ENGINEER
LEONARDO HERNANDEZ
No. C67141
Exp. 09/30/20
CIVIL
STATE OF CALIFORNIA

DESIGNED BY	L. HERNANDEZ	08/19
DRAWN BY	J.R. GRANADO	08/19
CHECKED BY	M. SHAVER	08/19
PRJ. ENG.	R. BOLEY	08/19

Metropolitan Transit System

ZERO EMISSION BUS CHARGER PROJECT-PHASE II

CIVIL DETAIL PLAN SHEET 1 OF 2

SCALE	NTS
CONTRACT NO.	G1947.0-17
DRAWING NO.	C401
SHEET NO.	10 OF 18

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES
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9/16/2019
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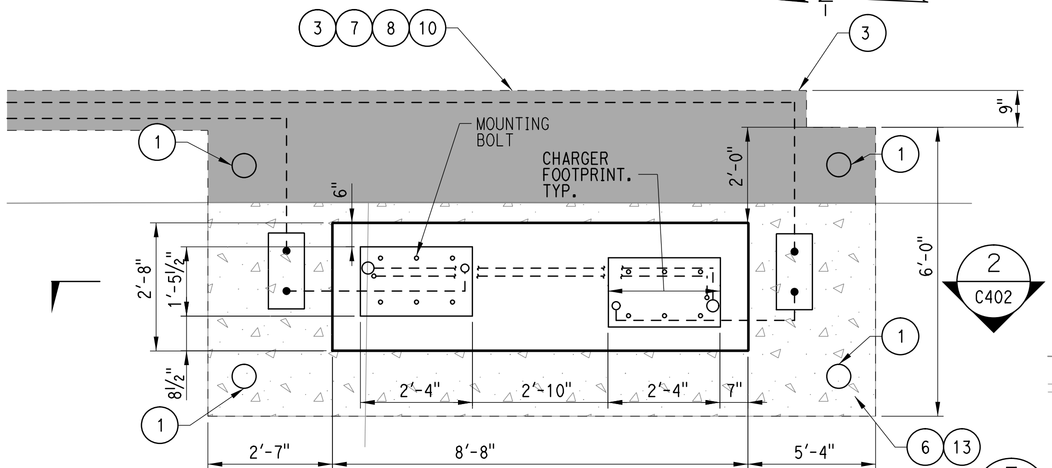
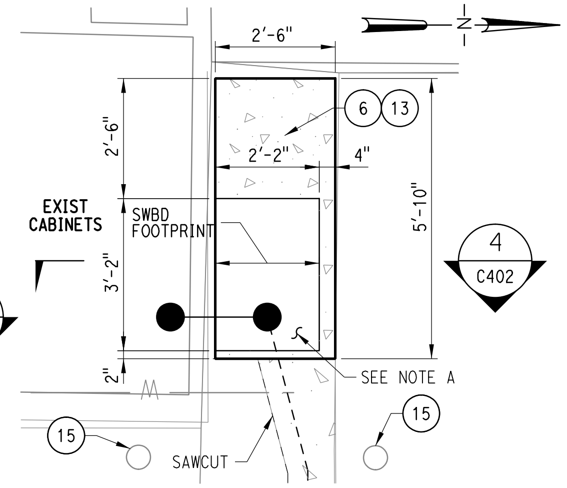
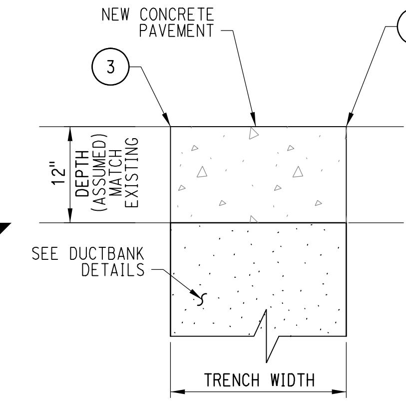


1 SBD CHARGER PAD LAYOUT
SCALE: 1" = 2'-0"



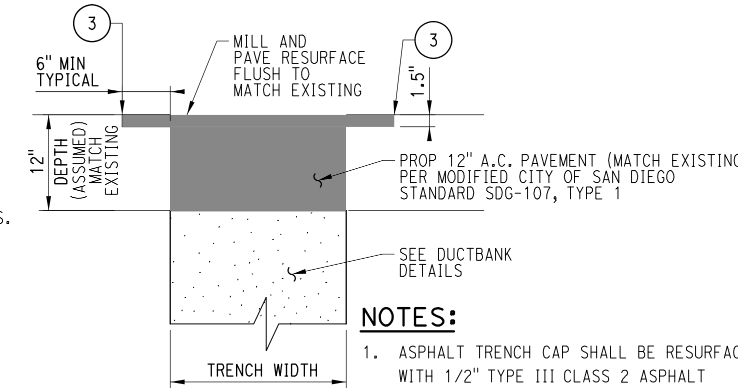
3 SBD SWITCHBOARD LAYOUT
SCALE: 1" = 2-0"



NOTES:

1. EXISTING CONCRETE PAVEMENT SHALL BE REMOVED AROUND THE PERIMETER OF THE EXCAVATION AS SHOWN ON THE PLANS.
2. PRIOR TO PLACING CONCRETE PAVEMENT, EDGES SHALL BE TRIMMED TO NEAT HORIZONTAL AND VERTICAL LINES.
3. SEE NOTE 'A' THIS SHEET.

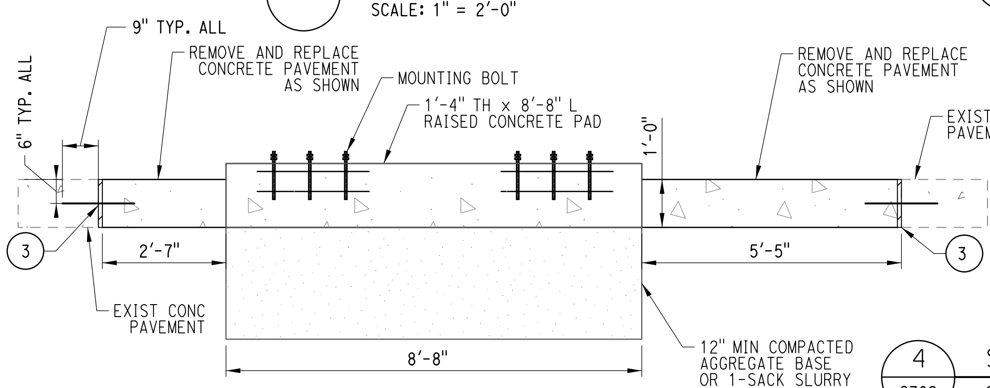
5 CONCRETE PAVEMENT DETAIL
SCALE: NTS



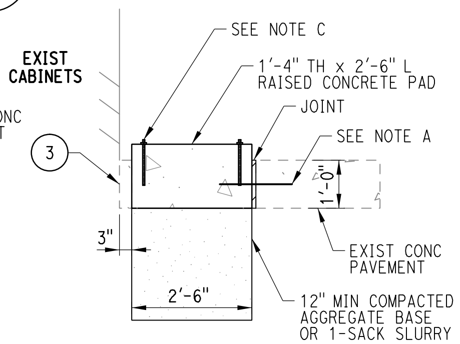
NOTES:

1. ASPHALT TRENCH CAP SHALL BE RESURFACED WITH 1/2" TYPE III CLASS 2 ASPHALT

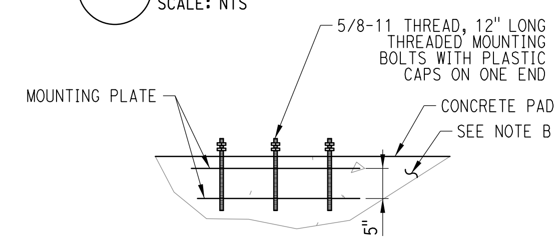
7 ASPHALT CONCRETE PAVEMENT DETAIL
SCALE: NTS



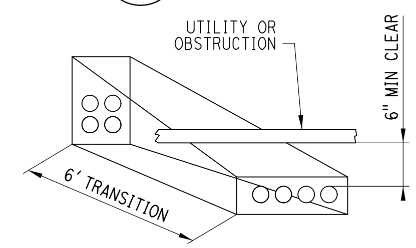
2 SBD CHARGER PAD DETAIL
SCALE: 1" = 2'-0"



4 SBD SWITCHBOARD DETAIL
C302
SCALE: 1" = 2'-0"



6 ANCHOR BOLT DETAIL
SCALE: NTS



12 TRENCH TRANSITION TO AVOID CONFLICT WITH UTILITY/OBSTRUCTION
SCALE: NTS

CONSTRUCTION NOTES:

1. INSTALL BOLLARD PER DETAIL 11, DWG. No. C402
2. REMOVE BOLLARD
3. SAWCUT EXISTING PAVEMENT
6. CONCRETE PAVEMENT SEE DETAIL DWG. No. C402
7. ASPHALT PAVEMENT SEE DETAIL DWG. No. C402
8. INSTALL CONDUIT, SEE ELECTRICAL SHEET, DWG. No. E401 FOR SIZE AND LAYOUT
10. TRENCH PER DUCT BANK DETAILS, SEE SHEET C04
13. REMOVE CONCRETE PAVEMENT
14. NOT USED THIS SHEET
15. PROTECT EXISTING BOLLARD
16. NOT USED THIS SHEET

NOTES:

A. CONTRACTOR TO COORDINATE SPACING AND LOCATION OF DOWELS WITH LOCATION OF MOUNTING BOLTS FOR CHARGING UNITS AND SWITCHBOARDS. 3/4" DIAMETER SMOOTH STEEL DOWELS AT 12" CENTERS. DRILL AND EPOXY GROUT 9" INTO EXISTING CONCRETE PAVEMENT. (TYP.)

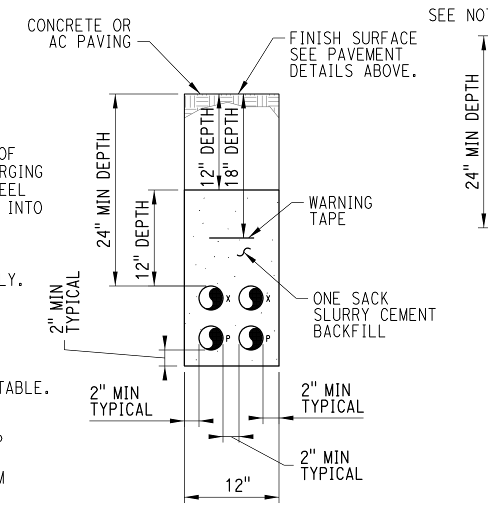
B. REFER TO MANUFACTURERS GUIDELINES FOR INSTALLATION OF MOUNTING PLATE AND BOLT ASSEMBLY.

C. CONTRACTOR TO FOLLOW MANUFACTURERS DATA FOR LOCATION AND INSTALLATION GUIDELINES OF ANCHOR BOLTS.

D. SEE DWG C302 FOR SBD CHARGER PAD LAYOUT DATA TABLE.

F. FINAL BOLLARD LOCATIONS ARE TO BE SHOWN ON CONTRACTOR'S SHOP DRAWINGS FOR ELECTRICAL EQUIP INSTALLATION AND SHALL FOLLOW MANUFACTURER'S INSTALLATION GUIDELINES/INSTRUCTIONS FOR MINIMUM CLEARANCES AROUND EQUIPMENT.

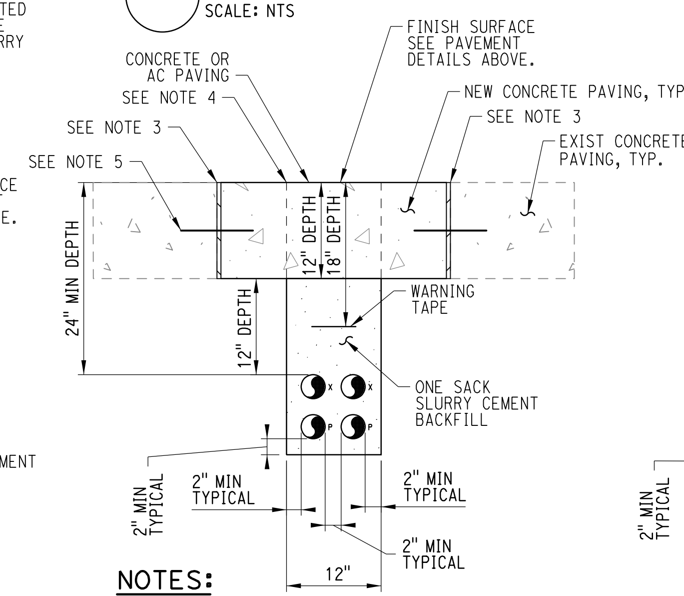
G. CONTRACTOR TO PROVIDE TEMPORARY GENERATOR FOR ANY SHUT DOWNS/CUTOVERS, TYPICAL, ALL SITES.



NOTES:

1. P SUBSCRIPT 2" ELECTRICAL VAC POWER CONDUIT.
2. X SUBSCRIPT 2" SPARE CONDUIT.

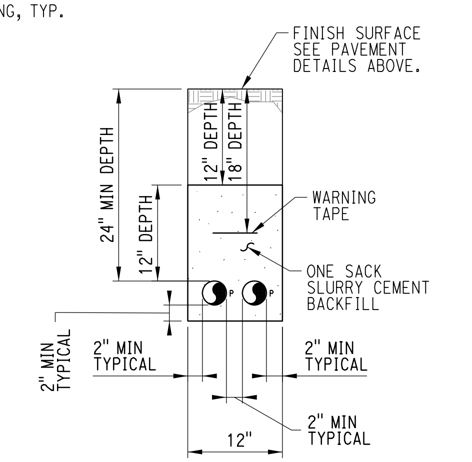
8 DUCTBANK DETAIL
SCALE: NTS



NOTES:

1. P SUBSCRIPT 2" ELECTRICAL VAC POWER CONDUIT.
2. X SUBSCRIPT 2" SPARE CONDUIT.
3. DO NOT SAWCUT HERE UNTIL AFTER TRENCH IS BACKFILLED; AT BEGINNING OF CONCRETE PAVING OPERATIONS.
4. SAWCUT FOR TRENCHING OPERATIONS AND DUCTBANK INSTALLATION. FINAL 3FT CONCRETE TRENCH CAP SHALL BE SINGLE MONOLITHIC POUR.
5. 3/4" DIAMETER SMOOTH STEEL DOWELS AT 12" CENTERS. DRILL AND EXPOXY GROUT 9" INTO EXISTING CONCRETE PAVEMENT, TYP.

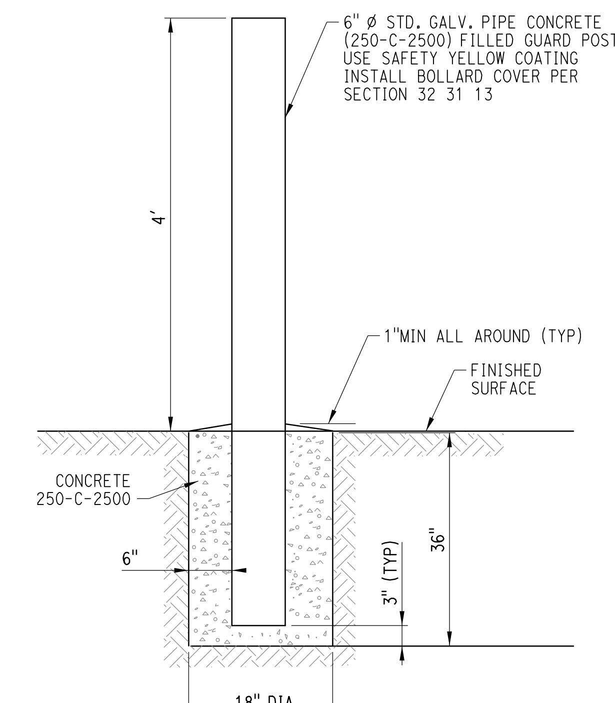
9 DUCTBANK DETAIL
SCALE: NTS



NOTES:

1. P SUBSCRIPT 2" ELECTRICAL VAC POWER CONDUIT.

10 DUCTBANK DETAIL
SCALE: NTS



11 FIXED BOLLARD DETAIL
SCALE: NTS

NO.	DATE	REVISIONS	BY	CHK	APRV

HDR

REGISTERED PROFESSIONAL ENGINEER LEONARDO HERNANDEZ No. C67141 Exp. 09/30/20 CIVIL STATE OF CALIFORNIA

DESIGNED BY	L. HERNANDEZ	08/19
DRAWN BY	R. GRANADO	08/19
CHECKED BY	M. SHAVER	08/19
PRJ. ENG.	R. BOLEY	08/19

MTS Metropolitan Transit System

ZERO EMISSION BUS CHARGER PROJECT-PHASE II

CIVIL DETAIL PLAN SHEET 2 OF 2

SCALE	NTS
CONTRACT NO.	G1947.0-17
DRAWING NO.	C402
SHEET NO.	11 OF 18

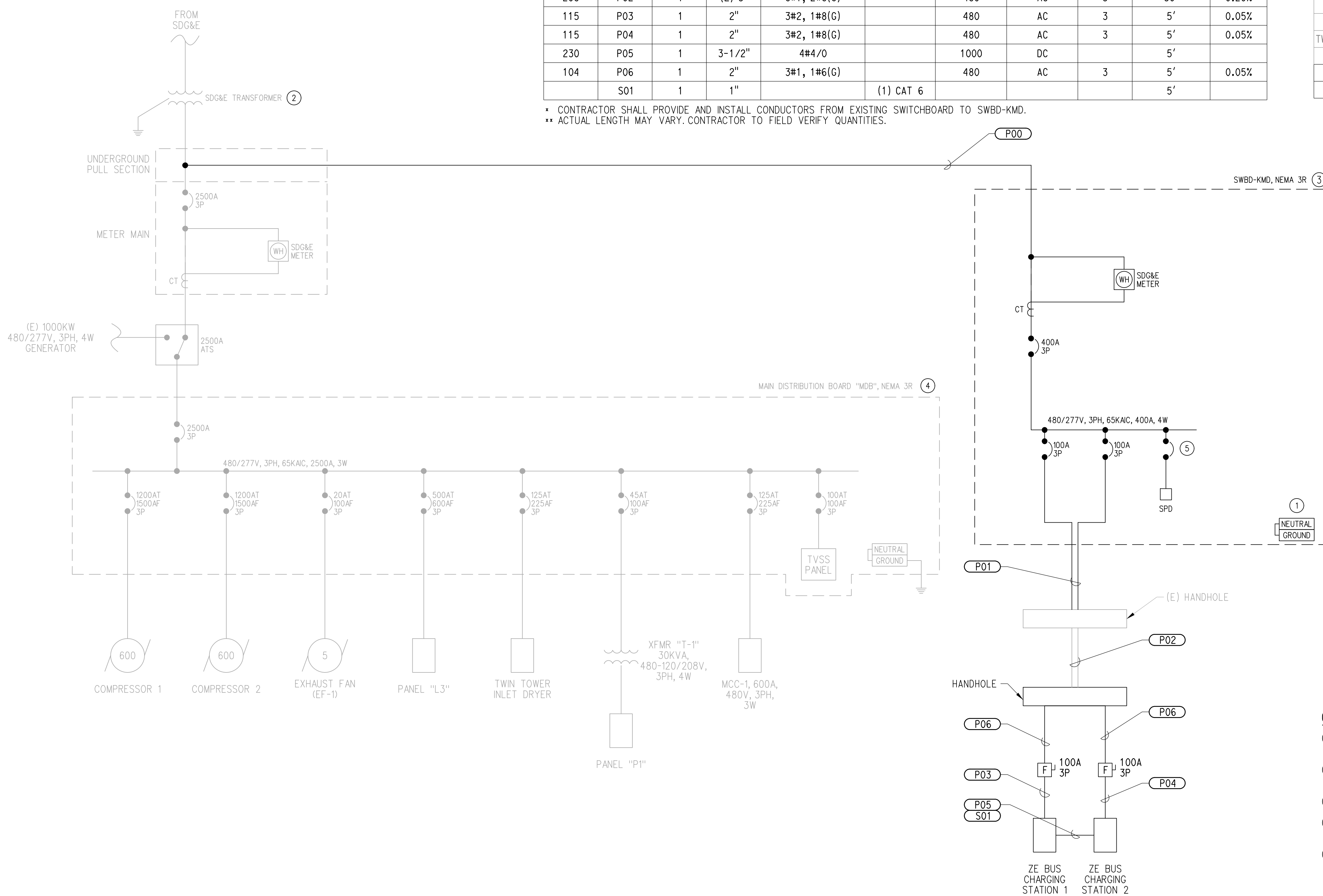
FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

9/16/2019 c:\pwworking\west01\d1080278\0160437-C402.dgn $PENTBLL$ $PLTDRVL$

FEEDER SCHEDULE											
TOTAL AMPS	CONDUIT			POWER	SIGNAL	VOLTAGE	CURRENT	PHASE	ESTIMATED LENGTH**	VOLTAGE DROP
	TAG	QTY	SIZE							
200	P00*	1	2"	4#3/0, 1#3(G)		480	AC	3	200'	1.25%
208	P01	1	2"	6#1, 2#6(G)		480	AC	3	20'	0.15%
208	P02	1	(E) 3"	6#1, 2#6(G)		480	AC	3	30'	0.20%
115	P03	1	2"	3#2, 1#8(G)		480	AC	3	5'	0.05%
115	P04	1	2"	3#2, 1#8(G)		480	AC	3	5'	0.05%
230	P05	1	3-1/2"	4#4/0		1000	DC		5'	
104	P06	1	2"	3#1, 1#6(G)		480	AC	3	5'	0.05%
	S01	1	1"		(1) CAT 6				5'	

* CONTRACTOR SHALL PROVIDE AND INSTALL CONDUCTORS FROM EXISTING SWITCHBOARD TO SWBD-KMD.
** ACTUAL LENGTH MAY VARY. CONTRACTOR TO FIELD VERIFY QUANTITIES.

EXISTING TRILLIUM SWBD					
EQUIPMENT	MOTOR HP	CONNECTED		DEMAND	
		FLA	KVA	FLA	KVA
COMPRESSOR 1	600	669.0	556.2	669.0	556.2
COMPRESSOR 2	600	669.0	556.2	669.0	556.2
PANEL "P-1"	-	100.0	83.1	16.6	13.8
MCC-1	-	600.0	498.8	112.8	93.8
EXHAUST FAN EF-1	5	3.0	2.5	3.0	2.5
TWIN TOWER INLET DRYER	-	48.0	39.9	48.0	39.9
PANEL "L-3"	-	500.0	415.7	200.0	415.7
SWBD-KMD	-	200.0	166.3	200.0	166.3
TOTAL LOAD		2789.0	2318.7	1918.4	1567.6



SWBD-KMD				
EQUIPMENT	CONNECTED		DEMAND	
	FLA	KVA	FLA	KVA
ZE BUS CHARGING STATION 1	80.0	66.5	80.0	66.5
ZE BUS CHARGING STATION 2	80.0	66.5	80.0	66.5
25% CONTINUOUS LOAD PER NEC 210.20(A)	40.0	33.3	40.0	33.3
TOTAL LOAD	200.0	166.3	200.0	166.3

CONSTRUCTION NOTES:

1. CONTRACTOR TO BOND NEUTRAL AND GROUND OF SWBD-KMD TO GROUND BUS OF EXISTING SWITCHBOARD.
2. LETTER STATING SHORT CIRCUIT CURRENT VALUE FROM SDG&E SHALL BE PROVIDED AT THE JOB SITE FOR INSPECTION. SHORT CIRCUIT CURRENT VALUE SHALL MEET SG 006.1 TABLE 2.
3. PROVIDE ARC FLASH LABELS AS REQUIRED BY NFPA 70E AND CALCULATED PER IEEE1584.
4. PARTIAL SINGLE LINE DIAGRAM OF EXISTING SWITCHBOARD SHOWN. SEE AS-BUILTS FOR COMPLETE SINGLE-LINE DIAGRAM.
5. SIZE DISCONNECT FOR SURGE PROTECTION DEVICE PER MANUFACTURER'S RECOMMENDATION.

$PENTBLL$
$PLTDRVL$

9/16/2019
c:\pwworking\west01\d1080278\10160437-E101.dgn

NO.	DATE	REVISIONS	BY	CHK	APRV

HDR

REGISTERED PROFESSIONAL ENGINEER
No. E22688
Exp. 03-31-21
ELECTRICAL
STATE OF CALIFORNIA

DESIGNED BY J. LEE	DATE 08/19
DRAWN BY M.R. GRANADO	08/19
CHECKED BY A. NICHOLS	08/19
PRJ. ENG. R. BOLEY	08/19

MTS Metropolitan Transit System

ZERO EMISSION BUS CHARGER PROJECT-PHASE II

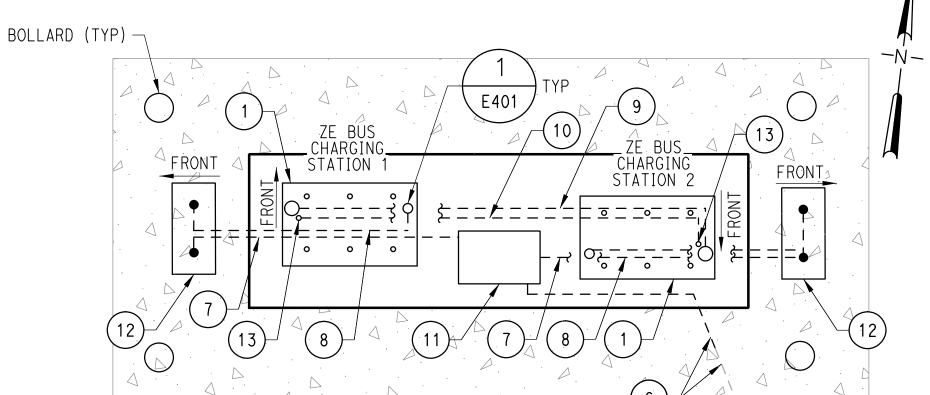
ELECTRICAL SINGLE LINE DIAGRAM KEARNY MESA DIVISION

SCALE NTS
CONTRACT NO. G1947.0-17
DRAWING NO. E101
SHEET NO. 12 OF 18

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES
0 1 2 3

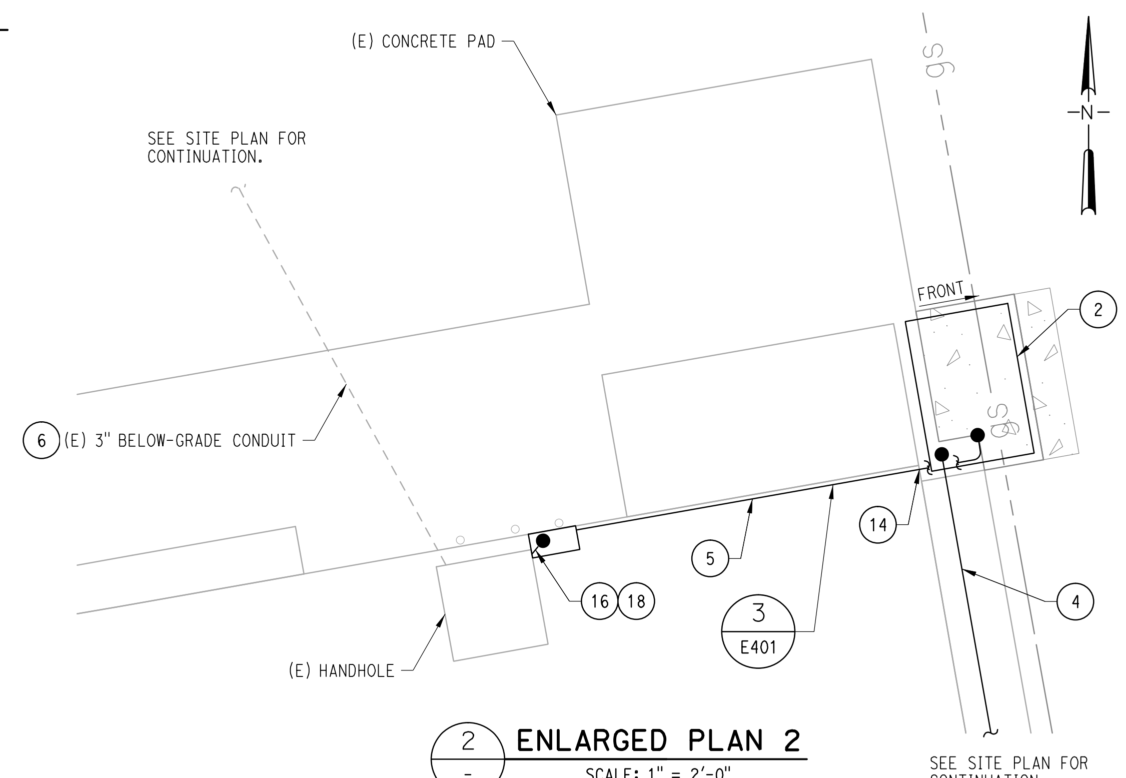
SITE PLAN

SCALE: 1" = 10'-0"



1 ENLARGED PLAN 1

NO SCALE



2 ENLARGED PLAN 2

SCALE: 1" = 2'-0"

CONSTRUCTION NOTES:

1. CONTRACTOR TO INSTALL OWNER FURNISHED CHARGEPOINT EXPRESS 250 STATION, 480V, 3PH, 66.5KW WITH UV AND GLARE RESISTANT HMI SCREEN AND POWER PLUG FOR CONNECTION TO EV BUSES. SEE DETAIL 1 ON C401.
2. SWBD-KMD, 400A, 480/277V, 3PH, 4W.
3. LOCATED UNDER CANOPY
4. CONTRACTOR SHALL INSTALL THE FOLLOWING CONDUITS TO TOP FEED SWBD-KMD FROM EXISTING UNDERGROUND PULL SECTION: 2"C - 4#3/0, 1#3(G).
5. 2"C - 6#1, 2#6(G) TO (E) HANDHOLE.
6. CONTRACTOR TO EXTEND (E) 3" CONDUIT AND ROUTE 6#1, 2#6(G) THROUGH (E) 3" CONDUIT TO HANDHOLE.
7. 2"C - 3#1, 1#6(G).
8. 2"C - 3#2, 1#8(G).
9. 3-1/2"C - 4#4/0 FOR DC POWER.
10. 1"C - (1) CAT6. CONDUIT SHALL MAINTAIN 6" MINIMUM SPACING FROM 480V AND DC POWER CONDUITS PER CONSTRUCTION NOTES 7, 8 AND 9.
11. CONTRACTOR TO PROVIDE AND INSTALL 11"X17"X24" CONCRETE HANDHOLE. HANDHOLE COVER TO HAVE "ELECTRICAL" LOGO UNLESS OTHERWISE NOTED.
12. CONTRACTOR TO PROVIDE AND INSTALL STANCHION MOUNTED 100A, 3P FUSIBLE DISCONNECT SWITCH FOR ZE BUS CHARGING STATION. SEE DETAIL 2 ON E401.
13. CONTRACTOR TO PROVIDE AND INSTALL A 1" TO 3/4" REDUCER AT CONNECTION OF CONDUIT TO MOUNTING PLATE.
14. CONTRACTOR SHALL CORE DRILL THROUGH (E) WALL FOR ROUTING OF 2" CONDUIT.
15. CONTRACTOR SHALL PROVIDE UL FIELD EVALUATION OF THE EXISTING METERING SECTION AND RECERTIFY UL RATING FOR EXISTING SWITCHBOARD AFTER COMPLETION OF CONSTRUCTION NOTE 17.
16. CONTRACTOR SHALL CORE DRILL THROUGH EXISTING CONCRETE SLAB AND HANDHOLE AND INSTALL CONDUIT AND CONDUCTORS THROUGH BOTH DRILLED ENDS PER CONSTRUCTION NOTE 5.
17. CONTRACTOR SHALL COORDINATE WITH SDG&E FOR SHUTDOWN OF SERVICE TO COMPLETE WORK. CONTRACTOR SHALL TAP THE BUS BAR ON THE LINE SIDE OF THE EXISTING METER, INSTALL LUGS, AND TERMINATE CONDUCTORS TO NEW SWBD-KMD.
18. CONTRACTOR TO PROVIDE AND INSTALL WALL-MOUNTED 12" X 12" X 6" NEMA 4 PULL BOX.

GENERAL NOTES:

1. AREA CLASSIFICATION: OUTDOOR, WET.

NO.	DATE	REVISIONS	BY	CHK	APRV

HDR

REGISTERED PROFESSIONAL ENGINEER · No. E22688 · Exp. 03-31-21 · ELECTRICAL · STATE OF CALIFORNIA

		DATE
DESIGNED BY	J. LEE	08/19
DRAWN BY	M.R. GRANADO	08/19
CHECKED BY	A. NICHOLS	08/19
PRJ. ENG.	R. BOLEY	08/19

MTS Metropolitan Transit System

ZERO EMISSION
BUS CHARGER PROJECT-PHASE II

ELECTRICAL
SITE PLAN
KEARNY MESA DIVISION

SCALE	AS NOTED
CONTRACT NO.	G1947.0-17
DRAWING NO.	E102
SHEET NO.	13 OF 18

FOR REDUCED PLANS
ORIGINAL SCALE IS IN INCHES
0 1 2 3

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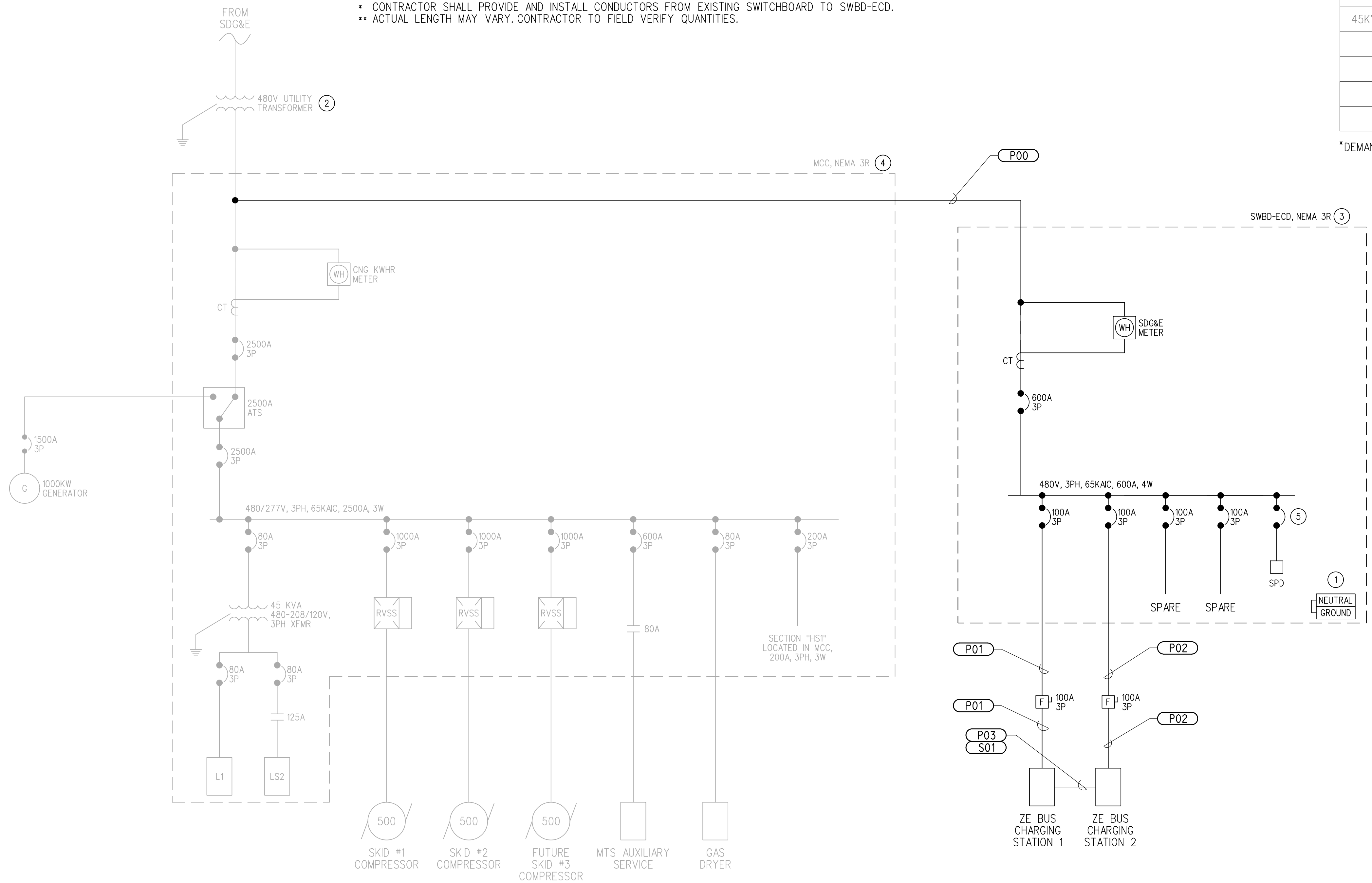
FEEDER SCHEDULE										
TOTAL AMPS	CONDUIT			POWER	SIGNAL	VOLTAGE	CURRENT	PHASE	LENGTH	VOLTAGE DROP
	TAG	QTY	SIZE							
400	P00*	2	2"	4#3/0, 1#3(G)		480	AC	3	5'	0.03%
115	P01	1	2"	3#2, 1#8(G)		480	AC	3	240'	1.63%
115	P02	1	2"	3#2, 1#8(G)		480	AC	3	10'	0.07%
230	P03	1	3-1/2"	4#4/0		1000	DC		10'	
-	S01	1	1"		(1) CAT 6				10'	

* CONTRACTOR SHALL PROVIDE AND INSTALL CONDUCTORS FROM EXISTING SWITCHBOARD TO SWBD-ECD.
** ACTUAL LENGTH MAY VARY. CONTRACTOR TO FIELD VERIFY QUANTITIES.

EXISTING TRILLIUM CNG MCC					
EQUIPMENT	MOTOR HP	CONNECTED		DEMAND	
		FLA	KVA	FLA	KVA
SKID #1 COMPRESSOR	500	584.6	486.0	584.6	486.0
SKID #2 COMPRESSOR	500	584.6	486.0	584.6	486.0
SKID #3 COMPRESSOR (F)	500	584.6	486.0	-	-
MTS AUXILIARY SERVICE	-	501.6	417.0	501.6	417.0
25% OF LARGEST MOTOR		69.8	58.0	69.8	58.0
45KVA TRANSFORMER / 120/208V 3PH	-	54.1	45.0	40.9	34.0
BREAKER HS1	-	125.1	104.0	125.1	104.0
GAS DRYER	-	58.1	48.3	58.1	48.3
SWBD-ECD	-	200.0	166.3	200.0	166.3
TOTAL LOAD		2762.4	2296.6	1839.9*	1529.6*

*DEMAND LOAD ASSUMES AN 85% DIVERSITY FACTOR.



SWBD-ECD				
EQUIPMENT	CONNECTED		DEMAND	
	FLA	KVA	FLA	KVA
ZE BUS CHARGING STATION 1	80.0	66.5	80.0	66.5
ZE BUS CHARGING STATION 2	80.0	66.5	80.0	66.5
25% CONTINUOUS LOAD PER NEC 210.20(A)	40.0	33.3	40.0	33.3
TOTAL LOAD	200.0	166.3	200.0	166.3

CONSTRUCTION NOTES:

1. CONTRACTOR TO BOND NEUTRAL AND GROUND OF SWBD-ECD TO GROUND BUS OF EXISTING SWITCHBOARD.
2. LETTER STATING SHORT CIRCUIT CURRENT VALUE FROM SDG&E SHALL BE PROVIDED AT THE JOB SITE FOR INSPECTION. SHORT CIRCUIT CURRENT VALUE SHALL MEET SG 006.1 TABLE 2.
3. PROVIDE ARC FLASH LABELS AS REQUIRED BY NFPA 70E AND CALCULATED PER IEEE1584.
4. PARTIAL SINGLE LINE DIAGRAM OF EXISTING TRILLIUM CNG MCC SHOWN. SEE AS-BUILTS FOR COMPLETE SINGLE-LINE DIAGRAM.
5. SIZE DISCONNECT FOR SURGE PROTECTION DEVICE PER MANUFACTURER'S RECOMMENDATION.

NO.	DATE	REVISIONS	BY	CHK	APRV

HDR

REGISTERED PROFESSIONAL ENGINEER
ADAM W. NICHOLS
No. E22688
Exp. 03-31-21
ELECTRICAL
STATE OF CALIFORNIA

DESIGNED BY	J. LEE	08/19
DRAWN BY	M.R. GRANADO	08/19
CHECKED BY	A. NICHOLS	08/19
PRJ. ENG.	R. BOLEY	08/19

MTS Metropolitan Transit System

ZERO EMISSION BUS CHARGER PROJECT-PHASE II

ELECTRICAL SINGLE LINE DIAGRAM EAST COUNTY DIVISION

SCALE: NTS
CONTRACT NO.: G1947.0-17
DRAWING NO.: E201
SHEET NO.: 14 OF 18

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES
0 1 2 3

9/16/2019
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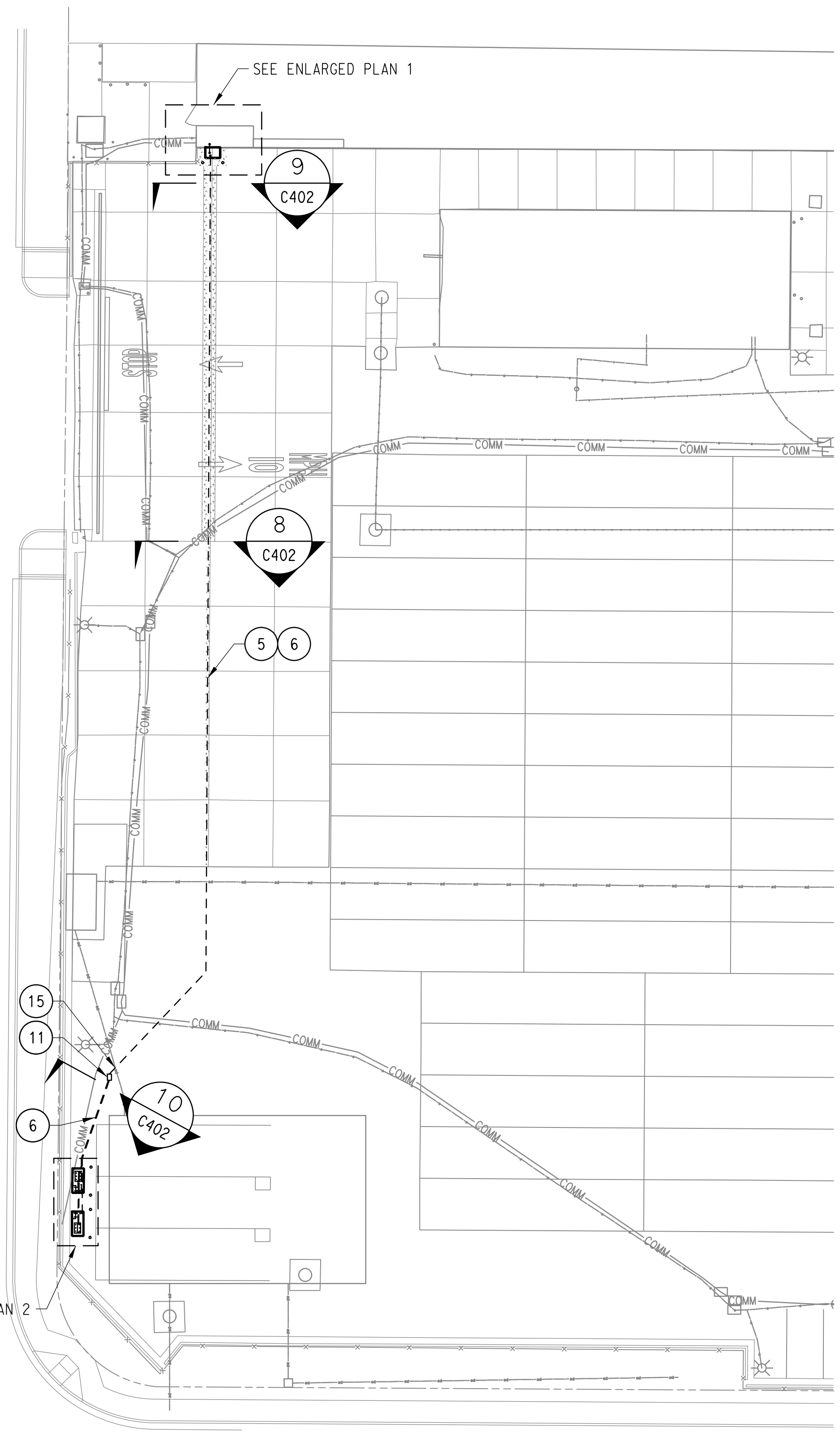
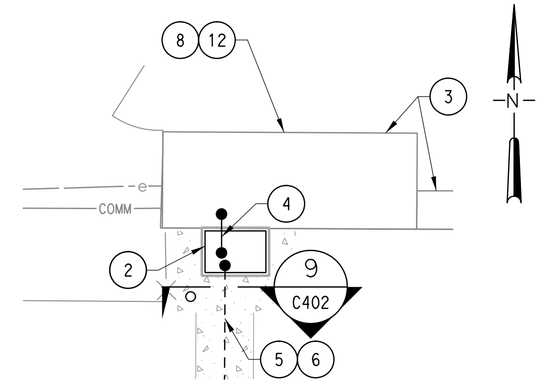


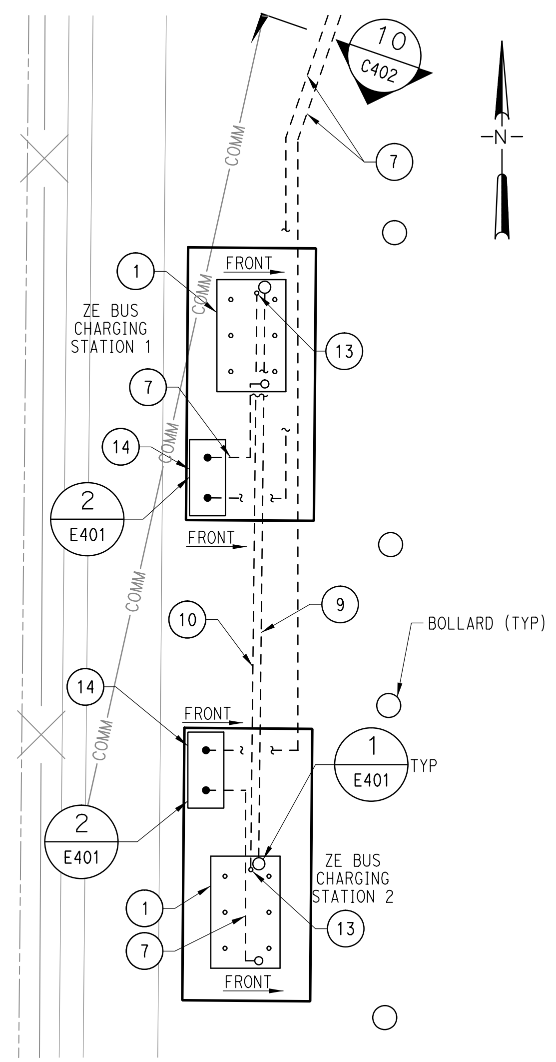
SITE PLAN

SCALE: 1" = 20'-0"



1 ENLARGED PLAN 1

SCALE: 1" = 4'-0"



2 ENLARGED PLAN 2

SCALE: 1" = 10'-0"

GENERAL NOTES:

1. AREA CLASSIFICATION: OUTDOOR, WET.
2. REFER TO DETAIL 12 ON DRAWING C402 FOR TRENCH TRANSITION TO AVOID CONFLICT WITH UTILITY/OBSTRUCTION.

CONSTRUCTION NOTES:

1. CONTRACTOR TO INSTALL OWNER FURNISHED CHARGEPOINT EXPRESS 250 STATION, 480V, 3PH, 66.5KW WITH UV AND GLARE RESISTANT HMI SCREEN AND POWER PLUG FOR CONNECTION TO EV BUSES. SEE DETAIL 5 ON C401.
2. SWBD-ECD, 600A, 480V, 3PH, 4W.
3. (E) MCC, 2500A, 480V, 3PH, 3W.
4. CONTRACTOR SHALL CORE DRILL THROUGH EXISTING WALL FOR ROUTING OF THE FOLLOWING CONDUITS AND CONDUCTORS TO TOP FEED SWBD-ECD FROM EXISTING METERING SECTION: (QTY: 2) 2"C - 4#3/0, 1#3(G).
5. (QTY: 2) 2"C - PULLROPE.
6. (QTY: 2) 2"C - 3#2, 1#8(G).
7. 2"C - 3#2, 1#8(G).
8. CONTRACTOR SHALL COORDINATE WITH SDG&E FOR SHUTDOWN OF SERVICE TO COMPLETE WORK. CONTRACTOR SHALL TAP THE BUS BAR ON THE LINE SIDE OF THE EXISTING METER, INSTALL LUGS, AND TERMINATE CONDUCTORS TO SWBD-ECD.
9. 3-1/2"C - 4#4/0 FOR DC POWER.
10. 1"C - (1) CAT6.
11. CONTRACTOR TO PROVIDE AND INSTALL 11"X17"X36" CONCRETE HANDHOLE. HANDHOLE COVER TO HAVE "ELECTRICAL" LOGO UNLESS OTHERWISE NOTED.
12. CONTRACTOR SHALL PROVIDE UL FIELD EVALUATION OF THE (E) METERING SECTION AND RECERTIFY UL RATING FOR (E) MCC AFTER COMPLETION OF CONSTRUCTION NOTE 8.
13. CONTRACTOR TO PROVIDE AND INSTALL A 1" TO 3/4" REDUCER AT CONNECTION OF CONDUIT TO MOUNTING PLATE.
14. CONTRACTOR TO PROVIDE AND INSTALL STANCHION MOUNTED 100A, 3P FUSIBLE DISCONNECT SWITCH FOR ZE BUS CHARGING STATION. SEE DETAIL 2 ON E401.
15. SEE C202 FOR UTILITY LOCATION AND DEPTH OF 15" RCP STORM DRAIN CONTRACTOR SHALL ROUTE DUCT BANK BELOW STORM DRAIN AT CROSSING WITH A MINIMUM OF 6 INCH SEPARATION BETWEEN TOP OF CONDUIT AND BOTTOM OF STORM DRAIN PIPE.

NO.	DATE	REVISIONS	BY	CHK	APRV

HDR

REGISTERED PROFESSIONAL ENGINEER ADAM V. NICHOLS No. E22688 Exp. 03-31-21 ELECTRICAL STATE OF CALIFORNIA

DESIGNED BY J. LEE	DATE 08/19
DRAWN BY M.R. GRANADO	08/19
CHECKED BY A. NICHOLS	08/19
PRJ. ENG. R. BOLEY	08/19

MTS Metropolitan Transit System

ZERO EMISSION BUS CHARGER PROJECT-PHASE II

ELECTRICAL SITE PLAN EAST COUNTY DIVISION

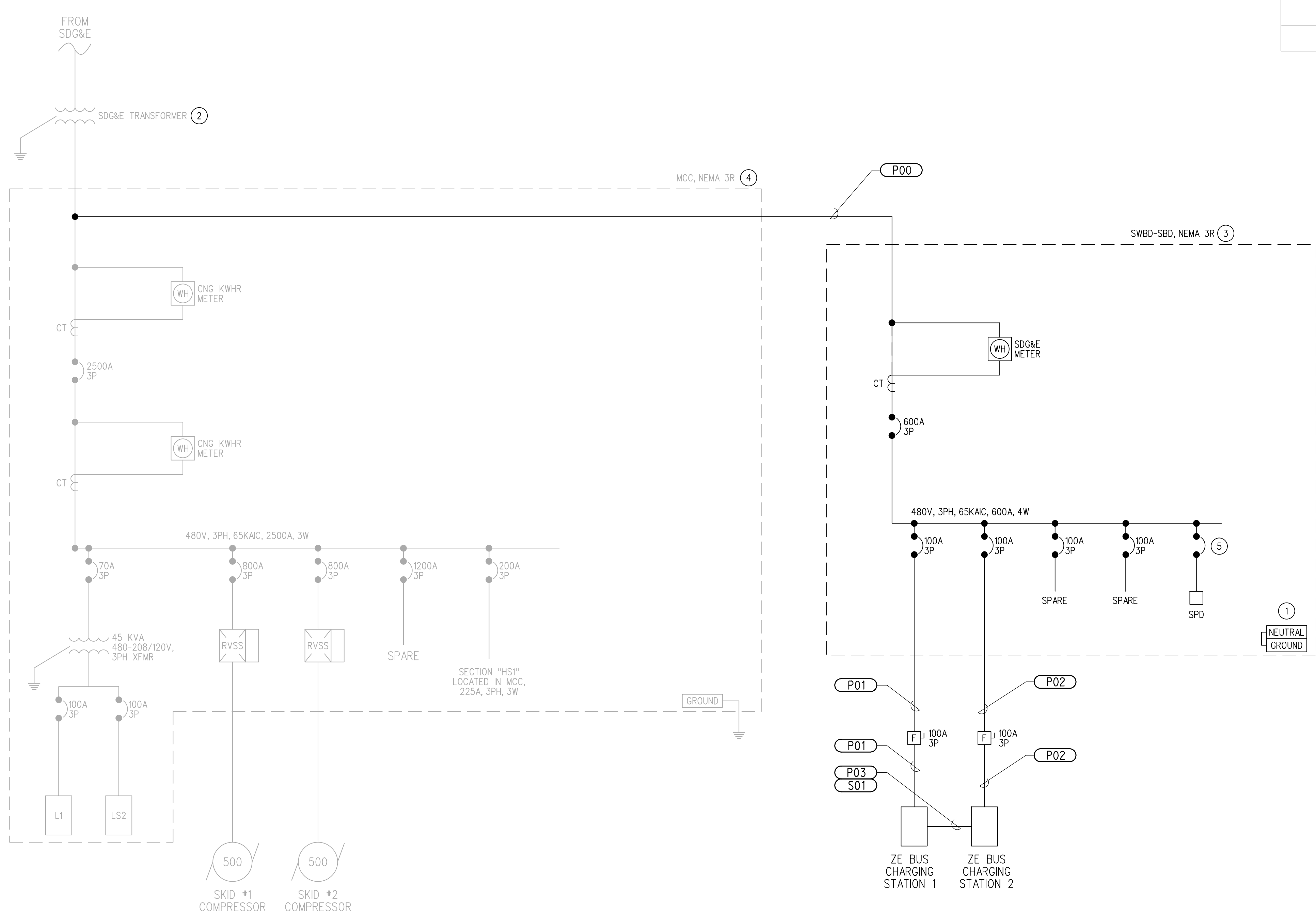
SCALE	AS NOTED
CONTRACT NO.	G1947.0-17
DRAWING NO. E202	SHEET NO. 15 OF 18

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

FEEDER SCHEDULE										
TOTAL AMPS	CONDUIT			POWER	SIGNAL	VOLTAGE	CURRENT	PHASE	LENGTH	VOLTAGE DROP
	TAG	QTY	SIZE							
400	P00*	2	2"	4#3/0, 1#6(G)		480	AC	3	5'	0.03%
115	P01	1	2"	3#2, 1#8(G)		480	AC	3	75'	0.59%
115	P02	1	2"	3#2, 1#8(G)		480	AC	3	5'	0.05%
230	P03	1	3-1/2"	4#4/0		1000	DC		10'	
-	S01	1	1"		(1) CAT 6				10'	

* CONTRACTOR SHALL PROVIDE AND INSTALL CONDUCTORS FROM EXISTING SWITCHBOARD TO SWBD-SBD.
** ACTUAL LENGTH MAY VARY. CONTRACTOR TO FIELD VERIFY QUANTITIES.

EXISTING TRILLIUM CNG MCC					
EQUIPMENT	MOTOR HP	CONNECTED		DEMAND	
		FLA	KVA	FLA	KVA
SKID #1 COMPRESSOR	500	584.6	486.0	584.6	486.0
SKID #2 COMPRESSOR	500	584.6	486.0	584.6	486.0
25% OF LARGEST MOTOR		146.7	122.0	146.7	122.0
45KVA TRANSFORMER / 120/208V 3PH	-	54.1	45.0	32.5	27.0
BREAKER HS1	-	132.3	110.0	132.3	110.0
SWBD-SBD	-	200.0	166.3	200.0	166.3
TOTAL LOAD		1702.4	1415.3	1680.7	1397.3



SWBD-SBD				
EQUIPMENT	CONNECTED		DEMAND	
	FLA	KVA	FLA	KVA
ZE BUS CHARGING STATION 1	80.0	66.5	80.0	66.5
ZE BUS CHARGING STATION 2	80.0	66.5	80.0	66.5
25% CONTINUOUS LOAD PER NEC 210.20(A)	40.0	33.3	40.0	33.3
TOTAL LOAD	200.0	166.3	200.0	166.3

CONSTRUCTION NOTES:

1. CONTRACTOR TO BOND NEUTRAL AND GROUND OF SWBD-SBD TO GROUND BUS OF EXISTING SWITCHBOARD.
2. LETTER STATING SHORT CIRCUIT CURRENT VALUE FROM SDG&E SHALL BE PROVIDED AT THE JOB SITE FOR INSPECTION. SHORT CIRCUIT CURRENT VALUE SHALL MEET SG 006.1 TABLE 2.
3. PROVIDE ARC FLASH LABELS AS REQUIRED BY NFPA 70E AND CALCULATED PER IEEE1584.
4. PARTIAL SINGLE LINE DIAGRAM OF EXISTING TRILLIUM CNG MCC SHOWN. SEE AS-BUILTS FOR COMPLETE SINGLE-LINE DIAGRAM.
5. SIZE DISCONNECT FOR SURGE PROTECTION DEVICE PER MANUFACTURER'S RECOMMENDATION.

NO.	DATE	REVISIONS	BY	CHK	APRV

HDR

REGISTERED PROFESSIONAL ENGINEER · ADAM M. NICHOLS · No. E22688 · Exp. 03-31-21 · ELECTRICAL · STATE OF CALIFORNIA

	DATE
DESIGNED BY J. LEE	08/19
DRAWN BY M.R. GRANADO	08/19
CHECKED BY A. NICHOLS	08/19
PRJ. ENG. R. BOLEY	08/19

MTS Metropolitan Transit System

ZERO EMISSION BUS CHARGER PROJECT-PHASE II

ELECTRICAL SINGLE LINE DIAGRAM SOUTH BAY DIVISION

SCALE NTS
CONTRACT NO. G1947.0-17
DRAWING NO. E301
SHEET NO. 16 OF 18

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

$PENTBLL$ $PLTDRVL$
9/16/2019 c:\pwworking\west01\d1080278\10160437-E301.dgn

GENERAL NOTES:

1. AREA CLASSIFICATION: OUTDOOR, WET.
2. REFER TO DETAIL 12 ON DRAWING C402 FOR TRENCH TRANSITION TO AVOID CONFLICT WITH UTILITY OBSTRUCTION.

CONSTRUCTION NOTES:

(1) CONTRACTOR TO INSTALL OWNER FURNISHED CHARGEPOINT EXPRESS 250 STATION, 480V, 3PH, 66.5KW WITH UV AND GLARE RESISTANT HMI SCREEN AND POWER PLUG FOR CONNECTION TO EV BUSES. SEE DETAIL 1 ON C402.

(2) SWBD-SBD, 600A, 480V, 3PH, 4W.

(3) (E) MCC, 2500A, 480V, 3PH, 3W.

(4) CONTRACTOR SHALL INSTALL THE FOLLOWING CONDUITS AND CONDUCTORS TO TOP FEED SWBD-SBD FROM EXISTING METERING SECTION: (QTY: 2) 2"C - 4#3/0, 1#3(G).

(5) (QTY: 2) 2"C - 3#2, 1#8(G).
(QTY: 2) 2"C - PULLROPE.

(6) CONTRACTOR TO PROVIDE AND INSTALL STANCHION MOUNTED 100A, 3P FUSIBLE DISCONNECT SWITCH FOR ZE BUS CHARGING STATION. SEE DETAIL 2 ON E401.

(7) 2"C - 3#2, 1#8(G).

(8) 3-1/2"C - 4#4/0 FOR DC POWER.

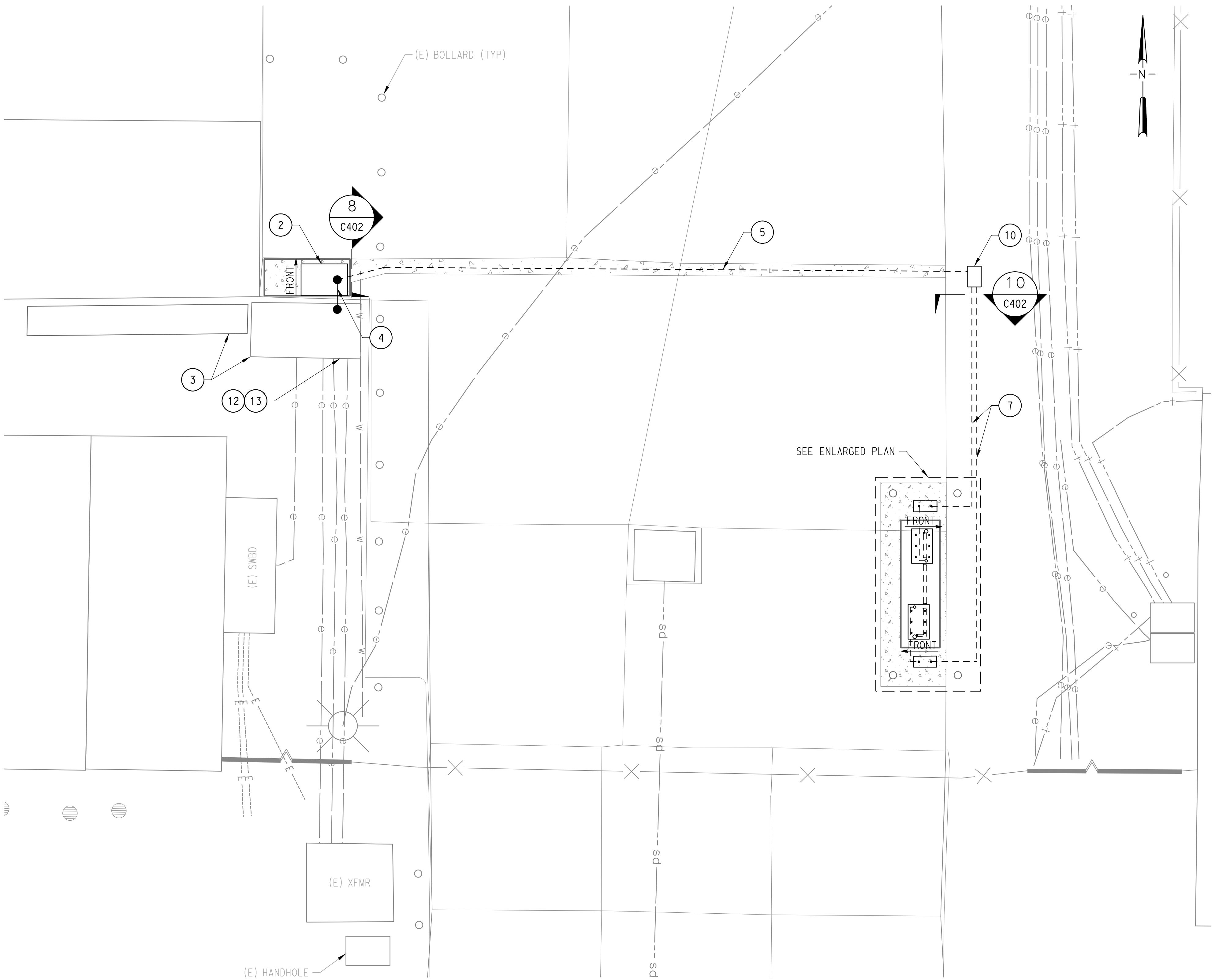
(9) 1"C - (1) CAT6.

(10) CONTRACTOR TO PROVIDE AND INSTALL 11"X17"X24" CONCRETE HANDHOLE. HANDHOLE COVER TO HAVE "ELECTRICAL" LOGO UNLESS OTHERWISE NOTED.

(11) CONTRACTOR TO PROVIDE AND INSTALL A 1" TO 3/4" REDUCER AT CONNECTION OF CONDUIT TO MOUNTING PLATE.

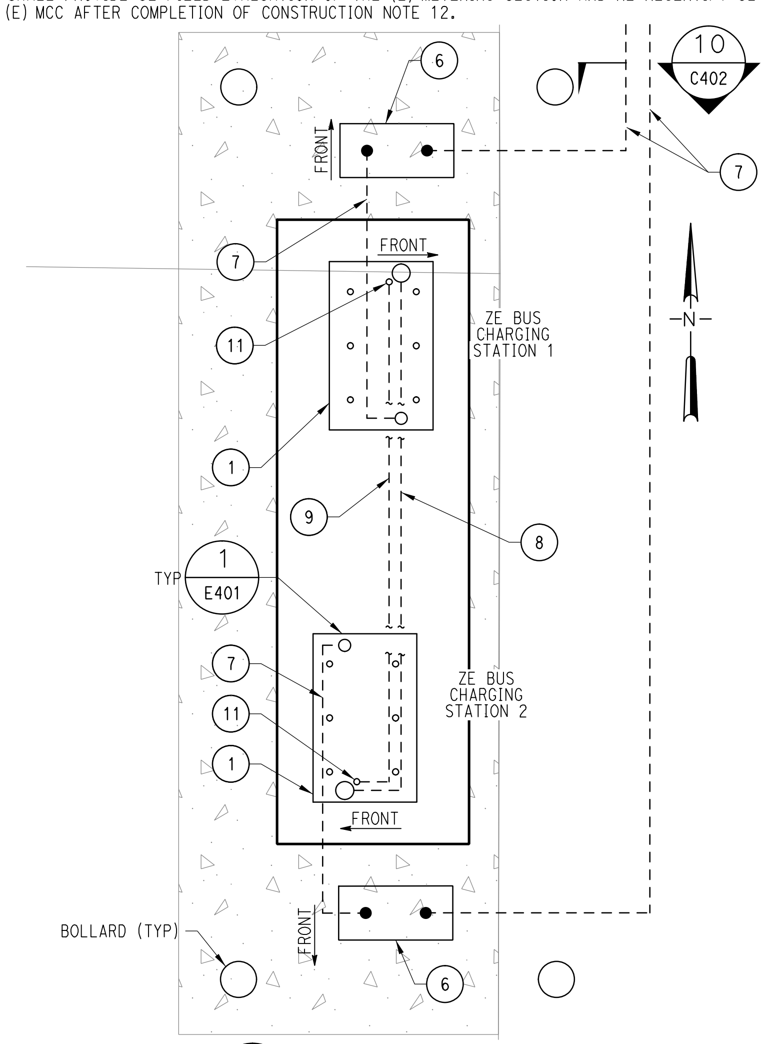
(12) CONTRACTOR SHALL COORDINATE WITH SDG&E FOR SHUTDOWN OF SERVICE TO COMPLETE WORK. CONTRACTOR SHALL TAP THE BUS BAR ON THE LINE SIDE OF THE EXISTING METER, INSTALL LUGS, AND TERMINATE CONDUCTORS TO SWBD-SBD.

(13) CONTRACTOR SHALL PROVIDE UL FIELD EVALUATION OF THE (E) METERING SECTION AND RE RECERTIFY UL RATING FOR (E) MCC AFTER COMPLETION OF CONSTRUCTION NOTE 12.



SITE PLAN

SCALE: 1" = 4'-0"



1 - ENLARGED PLAN

SCALE: 1" = 3'-0"

NO.	DATE	REVISIONS	BY	CHK	APRV

HDR

REGISTERED PROFESSIONAL ENGINEER ADAM NICHOLS No. E22688 Exp. 03-31-21 ELECTRICAL STATE OF CALIFORNIA

DESIGNED BY	J. LEE	08/19
DRAWN BY	M.R. GRANADO	08/19
CHECKED BY	A. NICHOLS	08/19
PRJ. ENG.	R. BOLEY	08/19

MTS Metropolitan Transit System

ZERO EMISSION BUS CHARGER PROJECT-PHASE II

ELECTRICAL SITE PLAN SOUTH BAY DIVISION

SCALE: AS NOTED
CONTRACT NO. G1947.0-17
DRAWING NO. E302
SHEET NO. 17 OF 18

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

9/16/2019
c:\pwworking\west01\d1080278\10160437-E302.dgn
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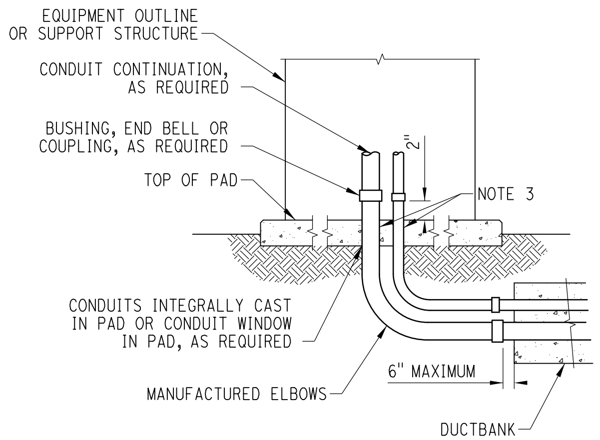
$PLTDRV$

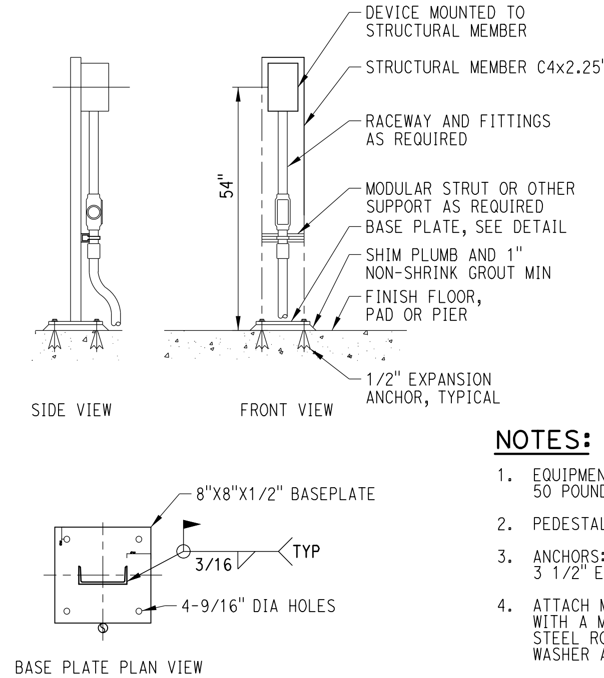


NOTES:

1. SEE DUCTBANK SECTIONS ON DRAWING C402 FOR ADDITIONAL REQUIREMENTS.
2. SEE OTHER CONTRACT DRAWINGS C401 AND C402 FOR PAD REQUIREMENTS.
3. PROVIDE TAPE WRAP ON CONDUIT WHERE IT PASSES THROUGH CONCRETE.

1 / - CONDUIT TRANSITION TO ABOVE GRADE (EXTERIOR)

SCALE: NTS

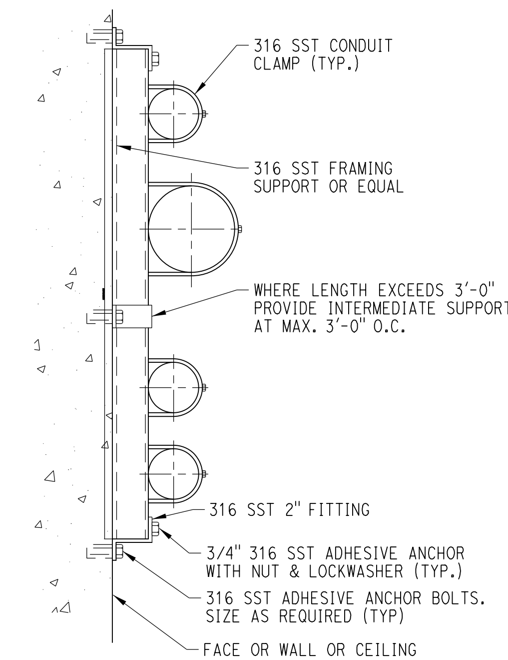


NOTES:

1. EQUIPMENT LOAD SHALL NOT EXCEED 50 POUNDS.
2. PEDESTAL ASSEMBLY MATERIAL TYPE: ALUMINUM.
3. ANCHORS: STAINLESS STEEL, 1/2" DIAMETER, 3 1/2" EMBEDMENT.
4. ATTACH MODULAR STRUT TO STRUCTURAL MEMBER WITH A MINIMUM OF TWO 3/8" DIAMETER STAINLESS STEEL ROUND HEAD MACHINE SCREWS WITH LOCK WASHER AND NUT.
5. PROTECT SURFACES WITH DISSIMILAR MATERIALS ONE PRIME COAT, 5 MILS, SERIES L69 EPOXOLINE AND 1 COAT, 2.5 MILS, SERIES 1080 ENDURA-SHIELD WATERBORNE ACRYLIC POLYURETHANE.

2 / - SINGLE DEVICE PEDESTAL

SCALE: NTS

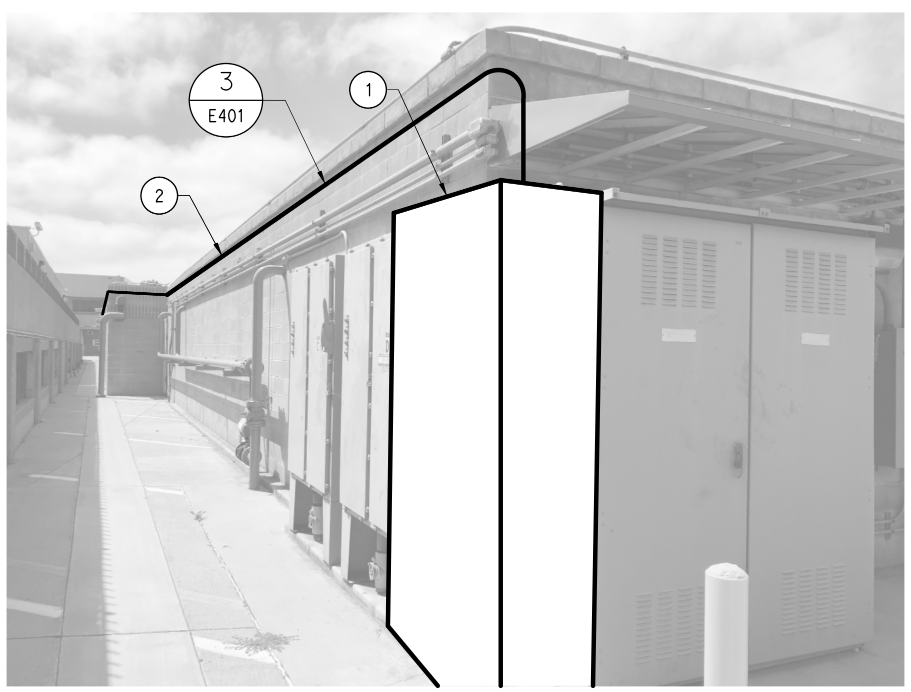


NOTES:

1. THIS DETAIL TYPICAL FOR BOTH VERTICAL AND HORIZONTAL MOUNTING - FOR HORIZONTAL MOUNTING, PLACE 1"± NON- SHRINK GROUT UNDER THE SUPPORT.
2. MODULAR STRUT AND PREFORMED CHANNEL, FITTINGS AND CLAMPS SHALL BE STAINLESS STEEL. FIELD COAT ALL CUTS.
3. CHANNELS TO BE SPACED AT 5'-0" OC MAXIMUM.

3 / - WALL MOUNTED CONDUIT SUPPORT

SCALE: NTS



NOTES:

1. SWBD-KMD, 480/277V, 3PH, 4W.
2. 2"C - 4#3/0, 1#3(G).

4 / - CONDUIT ROUTING ON CNG FACILITY EAST WALL TO SWBD-KMD

SCALE: NTS

NO.	DATE	REVISIONS	BY	CHK	APRV

HDR

REGISTERED PROFESSIONAL ENGINEER
ADAM W. NICHOLS
No. E22688
Exp. 03-31-21
ELECTRICAL
STATE OF CALIFORNIA

DESIGNED BY J. LEE	DATE 08/19
DRAWN BY M.R. GRANADO	08/19
CHECKED BY A. NICHOLS	08/19
PRJ. ENG. R. BOLEY	08/19

MTS Metropolitan Transit System

ZERO EMISSION
BUS CHARGER PROJECT-PHASE II

ELECTRICAL
ELECTRICAL DETAILS

SCALE NTS	
CONTRACT NO. G1947.0-17	
DRAWING NO. E401	SHEET NO. 18 OF 18

FOR REDUCED PLANS
ORIGINAL SCALE IS IN INCHES
0 1 2 3

9/16/2019
c:\pwworking\west01\d1080278\10160437-E401.dgn
$PENTBLL$
$PLTDRVL$