Kearney Mesa Division (KMD) ZEB Master Plan

Master Plan Report

San Diego Metropolitan Transit System

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Pacific Railway Enterprises, Inc.

AECOM

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Quality information

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Glossary and List of Acronyms

3D	three-dimensional
AACE	Association for the Advancement of Cost Engineering
AC	alternating current
BEB	battery electric bus
BESS	battery electric storage system
CIDH	Cast-in-drilled-hole
CNG	compressed natural gas
CPUC	California Public Utility Commission
DC	direct current
DG	Distributed generation
ES	Energy Storage
FCEB	fuel cell electric buses
H2	hydrogen
HFCB	Hydrogen Fuel Cell Buses
ICT	Innovations Clean Transit
KMD	Kearny Mesa Division
kW	kilowatt
LC	Large Canopies
LV	low voltage
MED	Major Event Days
MTS	San Diego Metropolitan Transit System
MV	Medium Voltage
MW	Megawatt
PRE	Pacific Rail Enterprise
PV	photovoltaic
ROM	Rough Order of Magnitude
SC	Small Canopies
SDG&E	San Diego Gas and Electric
ZE	Zero Emission
ZEB	Zero Emission Bus

1. Acknowledgements

Pacific Rail Enterprise (PRE) and AECOM would like to thank the following San Diego Metropolitan Transit System (MTS) staff members that participated in the develop of the Kearny Mesa Division (KMD) zero-emission bus Master Plan, whose input was instrumental in the development of the information provided in this report.

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2. Introduction

2.1. Background

In December of 2018, the California Air Resources Board adopted the Innovations Clean Transit (ICT) regulation that requires California's transit agencies to begin purchasing Zero Emission Buses (ZEBs) with a goal of transitioning all transit buses to zero emission technology by 2040. San Diego Metropolitan Transit System (MTS) has begun this transition at their South Bay and Imperial Avenue Divisions and with a battery electric bus (BEB) pilot at their KMD. The KMD currently has a 2028, 2033 and 2035 vehicle procurement plans in place to purchase and deliver twenty-five (25) 40-feet ZEBs in 2027, seven (7) 60-foot ZEBs in 2028, thirty-five (35) 40-foot ZEBs in 2033, and twenty-five (25) 40-foot ZEBs in 2035. MTS's Kearny Mesa Division is located at 4630 Ruffner Street, San Diego, CA 92111 in north San Diego.

MTS operates a bus fleet of approximately 750 buses, which includes standard 40-foot buses, articulated 60-foot buses, and under 25-foot minibuses. The total existing KMD fleet at the time of this report is one hundred and eighteen (118) buses with seventy-four (74) 40-foot compressed natural gas (CNG) buses, forty-two (42) 60-foot articulated buses, and two (2) BEBs. The KMD fleet primarily services the northern San Diego area but operates throughout the San Diego region.

2.2. MTS Objective

The KMD ZEB Master Plan provides a road map for the installation of required charging infrastructure to support the replacement of CNG buses completely with ZEBs over a period of years. Construction of the phase 1 implementation of this ZEB Master Plan is planned to coincide with MTS KMD's planned 2027, 2028, 2033 and 2035 vehicle procurement plans to ensure that when vehicles begin to arrive on site, the required charging equipment and infrastructure is in place, energized, and ready to for use on the first day of operation. The ZEB Master Plan will be developed to support MTS with the following:

- Align with MTS's ZEB vision for the next 10+ years.
- Identity the required site space, infrastructure, and equipment to support:
  - charging the entire KMD fleet of 118 revenue vehicles as BEBs.
  - a partial and full fleet of hydrogen fuel cell buses (HFCB).
- Make ZEB site recommendations that can be implemented in phases and in incremental procurements and in separate construction contracts, based on procurement schedules, available funding, and site constraints, that will culminate in a full ZEB Master Plan buildout when complete.

2.3. Preliminary Engineering Methodology

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

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

Following an initial kick-off project meeting, MTS staff provided the project team with as-builts of the KMD site, facilities and modifications. A Zero Emission (ZE) Facility Checklist was developed to document key existing information and data. The as-builts were used to begin filling out that checklist prior to the site visit, but remaining data pieces were collected during the site visit and subsequent workshop. An in-person site tour was conducted to acquire missing data not ascertainable from the received existing condition documentation and previous operational discussions. Both morning and evening site visits were conducted to observe both the facility and bus movements, both when departing/arriving as well as the facility itself when buses were out on their routes. The night visits were particularly important to understand circulation patterns as buses queue up outside of normal striped bus parking positions including occasional staging in bus circulation aisles waiting to be serviced. The culmination of the data gathering portion of the ZEB Master Plan efforts was the Existing Conditions Report (Appendix A).

The development of the below Master Plan recommendations is the result of the collection of design workshops, concept development, playability/constructability evaluation and physical space to accommodate the ZEB fleet and its required ZE infrastructure. The master plan recommendation is subdivided into implementation 'Phases' needed to fully construct the master plan. Additional phases and stages are possible, and the developed master plan phase and stage concepts are only one of many possible construction and implementation options. Phases were determined by the quantity of MTS's existing 2027, 2028, 2033 and 2035 vehicle procurement and their required supporting infrastructure. There are two master plan phased buildout options included in the report, both of which match achieve the final master plan presented in Section 3.2.1. The phased buildout options will need to be selected during detailed design phase implementation process.

2.4. Existing Conditions Report

The Existing Conditions Report was previously submitted to MTS in June 2023 and is included with this Master Plan as Appendix A. The Existing Conditions Report documented the existing KMD facility and the existing operations on-site to determine site specific limitations and opportunities to work towards a 100% ZEB fleet. Existing utility service is also documented to determine electrical infrastructure improvements necessary to meet the increased power demand associated with a shift to a ZE fleet at the KMD.

2.5. Project Goals in Recommended ZE Master Plan

The following goals were developed through discussions with MTS and its internal stakeholders.

- The project must adhere to the Innovation Clean Transit regulations.
- The master plan site concept for KMD will be developed showing final buildout of BEB supporting infrastructure.
- The design and construction phasing must have the ability to be implemented with limited disruptions to MTS revenue service which will continue to operate from the KMD site during any phased Master Plan implementations.
- Consider both BEBs and HFCBs.
- The solutions must provide charging and fueling resiliency and redundancy to operate the ZEB fleet in the event of power loss.
- Provide for transition to zero-emission vehicles while maintaining, if possible, the same quantity, if not more, vehicles and in the same bus length and type (40-foot and 60-foot) on site as the CNG buses currently operated in 2023 which is a total of 118 count. Once full build-out of Master Plan is complete, bus quantity is expected to be 120 count.
- Maximize the quantity of buses that can be operated on site.
- Review the south driveway entrance off Dagget Street and develop a design that would allow for buses to use this south drive aisle as an entrance / exit to the site from Dagget Street. A regraded design was developed as part of the ZE Master Plan, in addition to the Dagget Street entrance/exit.
- During planned renovation and improvements to the KMD site for ZEB infrastructure, allow for improvements to existing KMD site deficiencies.
- Existing conditions of the bus parking lot's concrete pavement has cracking and is in need of repair – condition allows for concrete replacement within boundaries of ZE site improvements.
- Existing bus parking tracks "Dead Bus" parking across from the exterior chassis wash bay is too narrow to utilize as for daily bus parking spaces for operations and is therefore not proposed within the ZE Master Plan. The existing bus parking and site circulation has been found to be the most efficient layout to maximize parking. Utilizing eight (8) "Dead Bus" parking spaces in daily operations would lower quantity of overall bus parking.
- Consider upgrades to existing parking garage – Not proposed in ZE Master Plan, but the ZE Master Plan does not limit the ability to update and improve car parking garage. Areas of parking garage would not need to be modified to implement the ZE Master Plan.
- Consider removing short southern ramp from car parking garage to lower circulation lane around northeast corner of Maintenance Building – condition is not proposed in ZE Master Plan, but the ZE Master Plan does

not limit the ability to remove ramp. Ramp area does not need to be modified to implement the ZE Master Plan.

- The solution must be cost-efficient. Rough order of magnitude costs estimates were developed for the ZEB Master Plan.

2.6. Project Parameters

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

- The project to accommodate a minimum of 118 count ZEBs.
- The project to allow for the continuous operation of CNG buses during construction and ZEB procurement.
- The project to consider charging technology that is currently available in the market with a focus on matching similar charging and dispensing equipment to match the on-going ZE improvements at the MTS South Bay and Imperial Avenue divisions.
- Provide for incremental resiliency improvements matching on-going South Bay ZE improvements including ability to utilize:
    - Microgrid control charging switchgear
    - Portable trailer generators
    - Fixed generators
    - Battery Energy Storage System(s) (BESS)
    - Solar photovoltaic (PV) on-site generated power
- Provide for hydrogen fuel cell buses operations on site.
- Design to allow for any installed structure protecting impact bollards to be installed closer to structure and not protrude or restrict on-site bus movements.

3. ZEB Master Plans

3.1. Master Planning Approach

Multiple ZE master plan options were developed and presented to MTS and their internal stakeholders for review and comments. MTS selected one of the developed options as the recommend ZE Master Plan and is described in detail below. Appendix B - Considered ZEB Master Plan Concepts includes master plan concepts that were considered (but not ultimately selected); contents of the master plan concepts in Appendix B were able to discern fatal flaws but were not fully developed.

3.2. Recommended Master Plan

3.2.1. Facility Layout

A facility site plan was developed and presented to MTS, which includes the locations of selected charging infrastructure, a new Medium Voltage Switchgear, and a new 1-Megawatt (MW) Natural Gas Generator; Figure 3-1 shows the existing facility site plan and Figure 3-2 shows the full site electrification plan Three open structure overhead steel support frame 'canopies' are proposed to be constructed over the existing parking Lots 1, 2, and 3 (Figure 3-3). Note that most of the canopies are not covered by decking or continuous membrane but open. The canopy structure and configuration are sized to allow for the addition of solar PV panel system that will be installed on top of the canopy structure. Two of these three charging canopies will include portions of the overhead framing covered by a concrete and steel utility platform to support the charging equipment required to power and provide resiliency for MTS's new fleet of incoming BEBs. The charging equipment on these platforms consists of individual charging cabinets, unit substation which serves as the medium to low voltage (480 volt 3-phase) transformer and the low voltage distribution panels (Figure 3-4). Provisions in the unit substation for a tap box would allow direct connection to a trailer mounted portable generator. The nominal 180-kilowatt (kW) charging cabinets connected to the low voltage distribution panels, convert the power from alternating current (AC) to direct current (DC), and output the DC power to the dispensers. Each cabinet can connect to and energize up to three dispensers.

Each canopy will support the selected charging dispenser method of inverted pantographs. The pantographs will be hung directly from the structure of the overhead steel support framing of the canopy or from mounting frames that are suspended down from the bottom framing of the lower members of canopies overhead steel support framing (Figure 3-5), depending on the inverted pantograph type directed by MTS during detail design. While the canopies are similar to the ones located at MTS's South Bay Division and Imperial Division, they are different with respect to the Kearny Mesa parking configuration. Kearny Mesa existing parking is an angled double loaded parking configuration. South Bay and Imperial Divisions both have rectilinear deep track / stacked parking, five to ten (or more) buses deep parked nose to tail. At KMD, the buses are parked at an angle, at a maximum of two-parking spaces deep. The new overhead frame canopies will be constructed at a 45-degree angle to match the parking layout which would remain in place. The new parking spots are similar in size to the existing parking spots, but every fourth spot is separated by an approximate three-foot-wide space for the location of the structural support columns of the canopies.

A new SDG&E Medium Voltage (MV) switch is planned to be set within the grass landscaping strip along the north Opportunity Road property line. Within the same landscaping strip, new MTS owned MV switchgear with new utility meter for new KMD charging electrical service entrance and a 1MW natural gas generators are also located. This area is located outside the existing fence line but within the MTS property boundary. The landscaping area for these equipment item pads will be infilled and raised to the bus parking elevation (which currently exceeds10-feet in elevation drop from east to west) and outfitted with a new retaining wall and security fence. The perimeter concrete retaining wall around the raised electrical pads will provide both additional security from impacts with cars along Opportunity Street but also the raised electrical pads will be level with the existing bus parking pavement allowing at grade access for maintenance and service. New charging MV AC feeder lines for the three-unit switchboards on the overhead fame supported concrete platforms will be run from the new MV switchgear and trenched underground to the first structural column of Canopy 1, will rise up that column to the top of the canopy and traverse from there to the unit substation located on the platforms. MV feeders to the two-unit substations on Canopy 2 will be run overhead and under the connecting overhead bridge from the charging cabinets are also to be located on the canopy supported equipment platforms.

While San Diego Gas and Electric's (SDG&E) existing circuit(s) surrounding the KMD site do not have the sufficient capacity to energize the full proposed KMD fleet, coordination between MTS and SDG&E has already begun to align the site's capacity needs with SDG&E planning.

The ZE Master Plan concrete deck equipment platforms are sized to support either individual charging cabinets (as shown) but are also capable of supporting a combined 'big box' charger which integrates the low voltage (LV)

Switchboard and BEB charging cabinets into a single unit. This big box charging unit has a smaller footprint than the separate individual charging cabinets. By sizing the equipment platforms to support the largest of the two available charger layouts, either can be designed around and used by MTS during subsequent phased ZE Master Plan buildouts.

LV AC circuits from the switchboard to the individual 180kW charging cabinets will be distributed across to the top of the Equipment Platform in open cable trays and run under the charging cabinets. Charging cabinets are installed on raised structural steel platforms to allow LV AC circuits inputs to be run up to the underside of the charging cabinet and DC power and data conductors to be run out of the bottom of the charging cabinets (refer to three-dimensional (3D) view Figure 3-4 and Figure 3-5). The DC power and data charging outputs are collected into separate cable trays and run on the top of the equipment platform until the cable trays reach the edge of the platform. There, the cable trays transition down and become supported from the lower framing members of the open frame canopies. The DC power / data cable trays will run down the length of the canopy supplying charging power and charging controls to the individual BEB pantograph dispensers mounted overhead each BEB parking position. If DC power and data conductors were distributed via conventional conduits in lieu of cable trays, the material costs of conduits would be less expensive than cable trays. However, the cable tray system is more flexible to allow MTS to modify the DC power and data conduits for either upgrades or to change order and location of individual charger outputs to different dispensers. It is AECOM's recommendation that the one-time additional material cost of cable trays over conduit is a benefit to allow for future flexibility for charging system modifications with minimal disassemble and reassembly of conduit rework.

The master plan design concept allows for the continued sequence of operations and existing on-site vehicle flow that MTS currently operates at the KMD site. The fuel/service area and the bus wash will be unaffected by the overhead charging canopies presented in the ZE Master Plan. The site flow of vehicles and pedestrians will remain the same as it is for the existing compressed natural gas (CNG) buses; BEBs will enter the site from Opportunity Road and move directly into the fuel/service lanes. The only difference being that upon full electrification, BEB will not get fueled at the fuel/ service lanes and will only receive their other nightly services in this area – vaulting, interior clean, tire check, etc.

Resiliency and redundancy are important topics when considering an all-electric bus fleet, and several options are discussed in detail in Section 3.2.4.

The addition of a Hydrogen Trailer is an option that is also included in the selected ZE Master Plan. This hydrogen trailer is a fixed liquid hydrogen (H2) fueling trailer that is brought in on wheels but is hardwired in place, 480V circuit, and would be permanently installed. In the future if the trailer is no longer used or replaced by a new larger fixed H2 compression yard, the H2 trailer can be relocated to another MTS property. As shown on Figure 3-2 , the H2 trailer would be placed in the area where existing BEB chargers are currently located. This trailer will have the ability to fuel approximately 10-14 Hydrogen Fuel Cell Buses (HFCB) for a week based on the size of the liquid H2 tank receiving one liquid H2 delivery refill a week. Additional HFCBs could be supported from this H2 trailer but would require additional liquid H2 deliveries.

Upon full electrification of the KMD, the existing CNG yard can be decommissioned, and an overhead canopy can be constructed to charge additional BEBs.

The master plan design concept described in the report is supported by the detailed sheets in Appendix D – Basis of Design Equipment and is based on the following criteria:

- Maximize the available revenue vehicle parking while incorporating ZE infrastructure on site.
- Utilize overhead inverted pantographs charging dispensers.
- Utilize individual DC charging cabinets with a 1:3 charger to dispenser ratio.
- Maintain or improve existing site circulation.
- Minimize ground disturbance.
- Maximize available property.

Minimize disruptions to existing infrastructure and equipment.

Figure 3-1 – Existing Facility Site Plan

STATISTICS

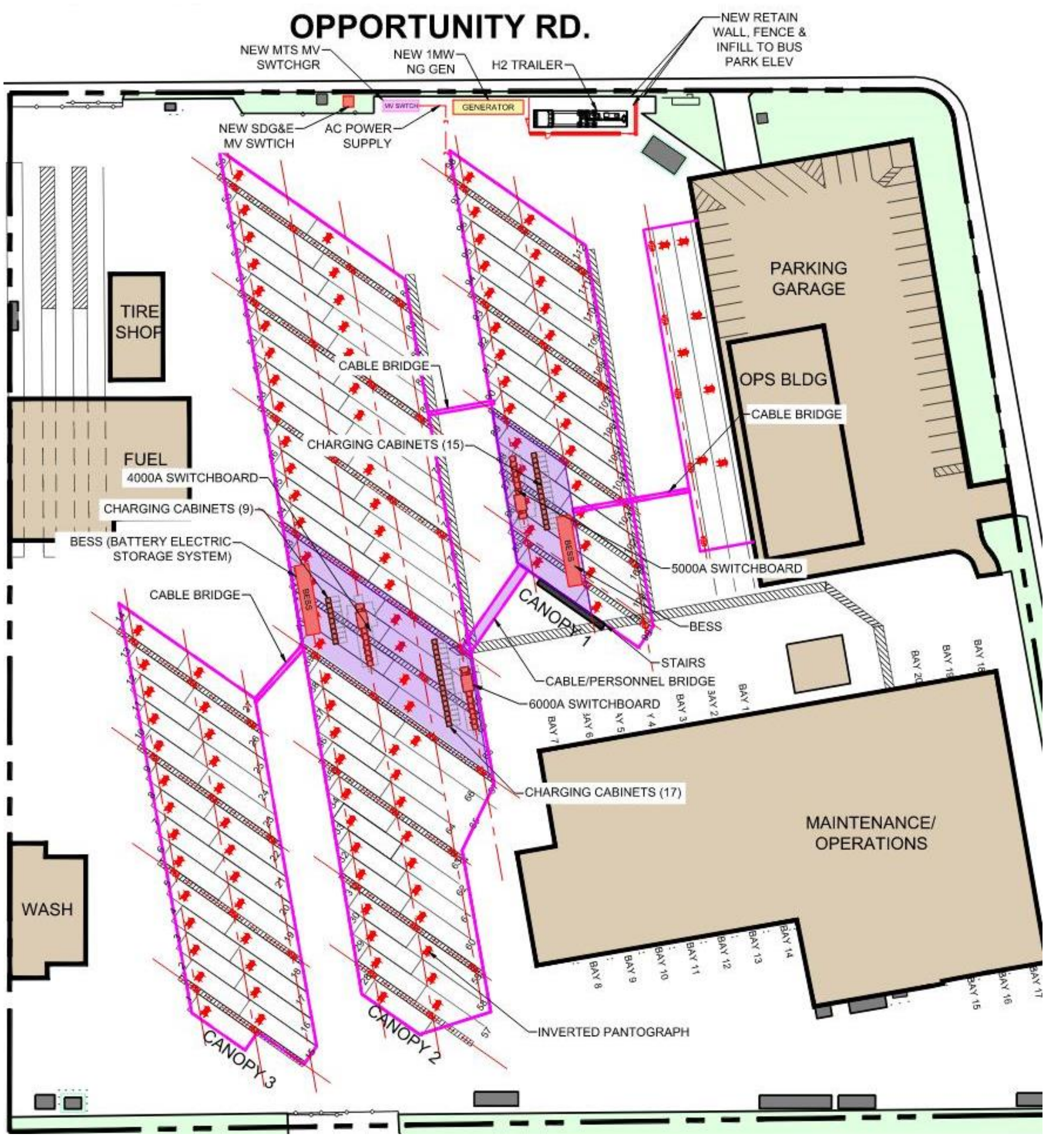
Assigned Buses:		
40' CNG	40' CNG	74
60' ARTICULATED CNG	60' CNG	42
40' BEB	40' BEB	2
60' ARTICULATED BEB	60' BEB	0
TOTAL		118
Open Buses:		
40' OPEN	OPEN	43
60' OPEN	OPEN	5
Total Capacity		166

Figure 3-2 – Full Electrification Site Plan

STATISTICS

Assigned Buses:		
40' CNG	40' CNG	0
60' ARTICULATED CNG	60' CNG	0
40' BEB	40' BEB	77
60' ARTICULATED BEB	60' BEB	42
TOTAL		119
Open Buses:		
40' OPEN	OPEN	45
60' OPEN	OPEN	3
Total Capacity		167

Figure 3-3 – Canopy Plan



Equipment and Infrastructure Quantities

119 – Inverted Pantographs
41 – 180 kW DC charging cabinets
1 – 4000A Unit Substations
1 – 5000A Unit Substations
1 – 6000A Unit Substations
1 – Medium Voltage Switchgear
1 – Natural Gas Generator
1 – H2 Trailer
2 – Battery Electric Storage Systems (BESS)

2 – Equipment Platforms
4 – Overhead Steel Canopies
1 – Access Stair
1 – Personnel/Cable Bridge
3 – Cable Bridge

Figure 3-4 – 3D View Canopy 1

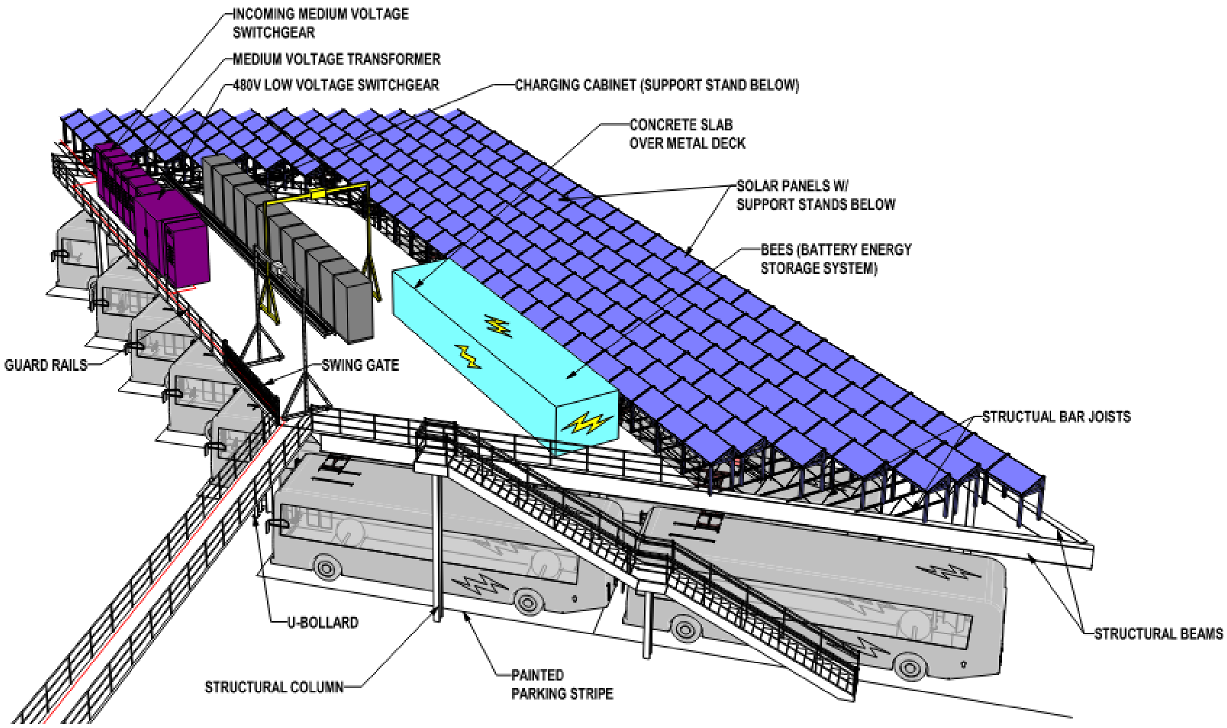


Figure 3-5 – 3D View Canopy 2

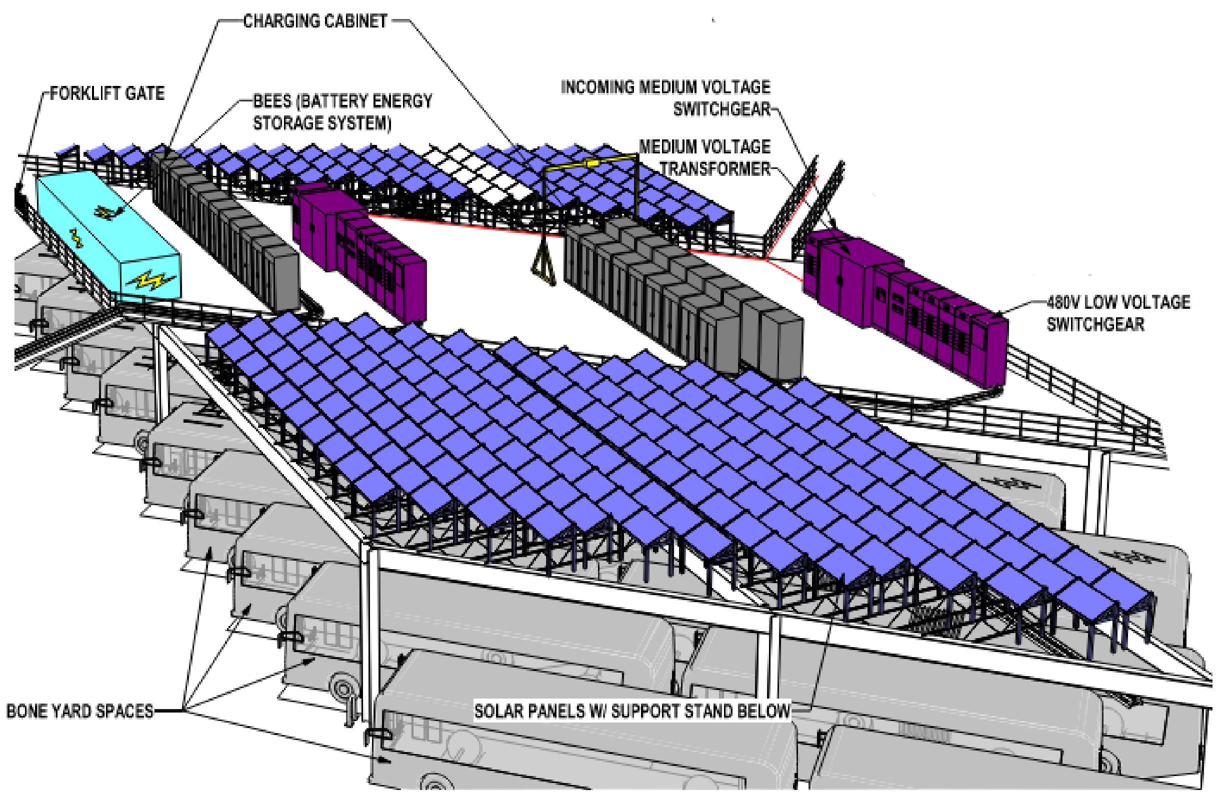
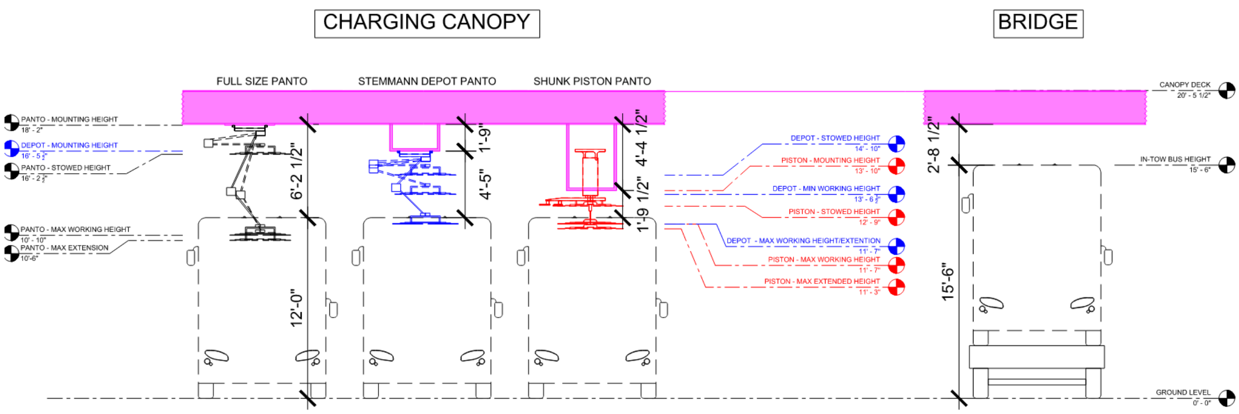


Figure 3-6 is a section view depicting the various inverted pantographs that MTS will have available for them to decide between. Type 1 is a full-size pantograph which has the largest extension and working range of the options, as shown in Figure 3-6. This pantograph can be mounted directly to the overhead steel structure and has the capability of charging a larger range of bus sizes, due to its increased working range. Type 2 is the depot pantograph, which functions similar to the full-size, but with a decreased working and extension range. This type would need to be mounted from a steel mounting frame that would be suspended from the canopy structure. Type 3 is the piston pantograph, which functions differently than the other two types, as it uses a piston to lower the contact bars instead of an extension arm. The piston type will require a larger mounting frame as its working and extensions ranges are much smaller than other two types. All 3 types of pantographs are compatible with the overhead steel structure proposed.

Figure 3-6 – Inverted Pantograph Options



3.2.2. Civil

Existing site conditions were evaluated through a project site visit and the review of available existing as-built records; Including existing pavement, utilities, drainage, and grade. The following section summarizes each of the existing project conditions. Conditions are described in further detail in Appendix A – Existing Conditions Report.

Existing Pavement

The existing pavement on the KMD site is concrete. Sections of the existing concrete pavement have been removed and replaced with thicker concrete pavement sections; however, the majority of the site is comprised of the original, thinner, concrete pavement that is cracked and deteriorated in areas of bus traffic. It is anticipated that the existing concrete pavement in the vicinity of the proposed canopy framing will be further disturbed due to construction of the canopy. To minimize potential impacts to the existing concrete pavement, as-built records were analyzed to determine the existing concrete joint layout to estimate the proposed limits of concrete replacement more accurately.

Existing Utilities

Numerous utilities that service the site (i.e., fire water, domestic water, sanitary sewer) underlie the existing lot in addition to commodity piping (i.e., compressed air, lubricants, fuel). Some abandoned utilities exist, most notably the original diesel fueling system. The proposed canopy framing design would require coordination to avoid conflicts with underground utilities. Conflicts between the proposed canopy column foundations and existing utilities can potentially occur at the north end of Lot 1 and the middle of Lot 2. No underground utilities are located beneath Lot 3. However, recent infrastructure additions for the BEB connections from Transformer 2 run along the eastern-most circulation aisle near Lot 3. The design and construction of the proposed columns in Lot 3 shall consider the original and the recent on-site improvements to avoid potential underground conflicts and utility strikes.

Existing Drainage

The KMD site generally drains from the southeast to northwest – the base of the southeast retaining wall starts at an elevation of 424-feett and conveys to the north gate at the northwest corner at an elevation of 409 -feet. The elevation difference is 15-feet that spans approximately 507-feet in horizontal distance yielding an average grade of 2.9%. The slope is shallow under Lot 3, steeper under Lot 1, and the steepest under Lot 2 and at the main gate. The existing drainage system runs north to south through the western portion of the site.

Existing Grade

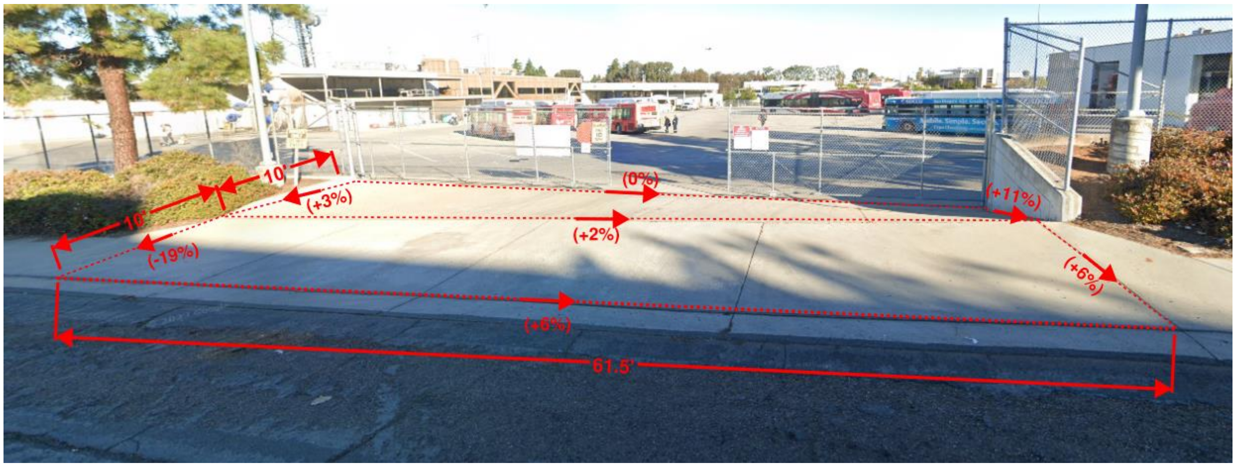
To determine whether the existing grade of the site can accommodate the proposed facility, a preliminary model of the existing surface was developed based on the existing contours from as-built records. Figure 3-7 presents a plan view of the modeled surface with existing contour lines shown in green. The completed model of the existing grades was utilized to determine the maximum longitudinal slope and cross-sectional slope of the existing pavement along the bus parking stalls within the limits of the proposed canopy framing. These values were then compared with the maximum allowable charging angles of the bus charging units. It was concluded that, within the limits of the proposed canopy framing, the existing site slopes do not exceed the tolerances of the proposed charging units and therefore, based on as-built records, the project site would not require re-grading to facilitate the charging of buses. As such, the existing drainage system on site would not require improvements.

Figure 3-7 – KMD Model of Existing Surface

South Entrance Improvements

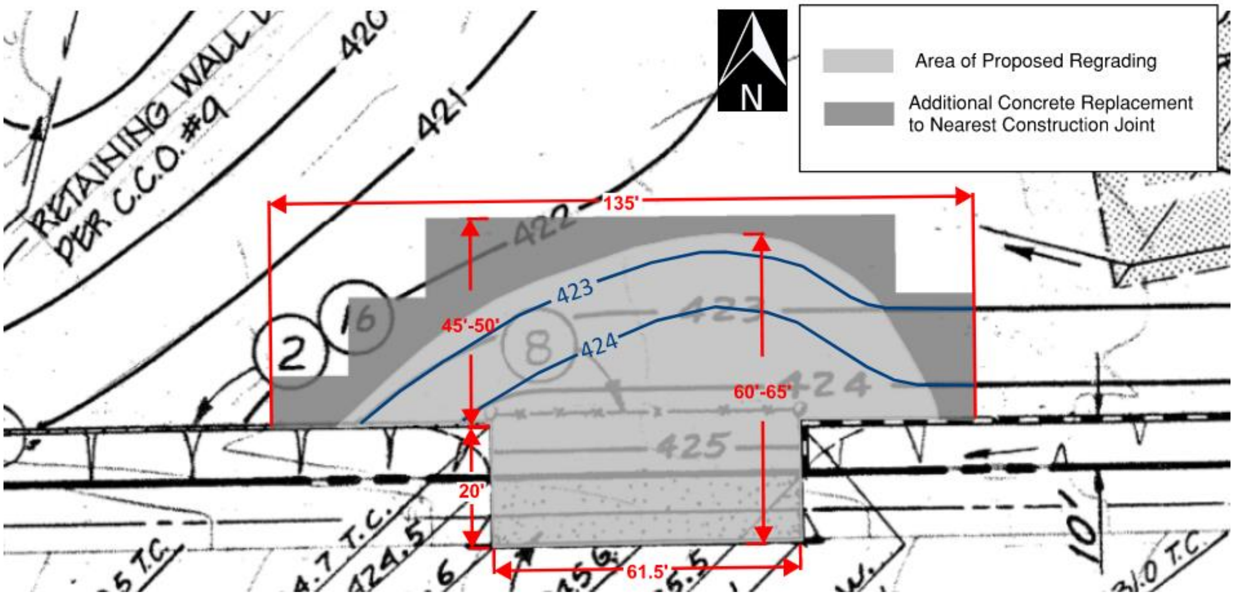
The existing grades of the south entrance for the KMD site are too steep for buses to traverse, to a point where insufficient vertical clearance can cause damage to buses' oil pans. Due to this existing issue, all buses enter and exit the site using the north gate along Opportunity Road. Figure 3-8 presents a street view of the south entrance, which demonstrates these steep grades, which exceed typical driveway entrance standards.

Figure 3-8 – Southern Entrance Existing Conditions



Given the existing limitations of this south entrance, this study determined that adjustment of the existing grades is feasible to provide better bus traffic flow for the site and a smoother transition from the main lot to the driveway. Figure 3-9 presents the approximate limits required for regrading and resurfacing superimposed over the existing site contours and details the proposed approximate contour adjustments. It is estimated that re-grading would be required approximately 45-feet to 50-feet into the main lot from the driveway entrance. The evaluation considered the existing concrete joint pattern when determining the proposed pavement rehabilitation limits at the south entrance. The proposed improvements at the south entrance would not affect the existing drainage patterns from the street or within the site.

Figure 3-9 – South Entrance Area of Proposed Regrading and Resurfacing



3.2.3. Structural

The structural concept proposes three proposed canopies which will serve as platforms for solar panels, placement of all proposed BEB charging infrastructure, PV support, and structures for the bus parking area. Canopies 1 and 2 will feature concrete decks which switchgear, charging cabinets, and battery storage will be mounted upon. Canopy 1 will provide a metal stair for access to the concrete deck. Canopy 2 will provide an elevated bridge for cabling and personnel access to Canopy 1. Access to Canopy 3 is provided by an elevated bridge for cabling only as there is no equipment platform to access on Canopy 3. The non-concrete deck areas of canopies where arrays of solar panels are located would not provide elevated personnel access. All solar PV access for installation, service and maintenance will be from lift truck parked at grade.

Canopies will be supported structurally by a Special Steel Cantilever Column System comprised of cantilevered columns with Cast-In-Drilled-Hole (CIDH) concrete foundations. The Special Steel Cantilever Column System is designed to resist vertical and lateral forces with round pipe columns.

The CIDH concrete foundations will be drilled with the top of the CIDH element placed approximately 10-inches below the proposed finish surface. This will conceal the baseplate connection of the steel column to the CIDH. The diameter of the CIDH will not be visible from the driving surface.

Horizontal framing at canopy areas where solar arrays are located would be supported by wide flange beams in both longitudinal and transverse directions along column lines and steel bar joists spaced at 5-feett on-center between the wide flange beams. The framing will also utilize diaphragm bracing comprised of a steel flat bar placed at the top surface of wide flange beams and steel bar joists. As the top of steel surface is not provided with a closure (metal deck, or roof), bridging will be installed to provide lateral stability of both the top and bottom flanges of the bar joists. The bottom connection of the bar joists will be extended to provide lateral bracing of the bottom flange of wide flange beams. While loading is light, spans are long, and wide flange beams are to be provided with camber to control dead load deflections.

The horizontal framing supporting the concrete deck areas of Canopies 1 and 2 will utilize wide flange beams in both longitudinal and transverse directions along column lines, with spaces between infilled with smaller wide flange beams spaced at 5½ feet on-center between wide flange beams. Infill beams will be welded with full moment continuity across larger intersecting wide flange beams at cantilevered areas (e.g., Canopy 2 battery area). The top deck of the concrete canopies will be constructed with bonded metal deck (1½-inch deck with 4½-inch minimum normal weight concrete fill, sloped to drain with interior drain locations), installed as composite deck (with shear studs). This is required due to the heavy loads and long spans. Camber is required for control of deflections.

Canopies 1, 2, and 3 will not utilize seismic joints. Seismic joints will be required at the cable/personnel bridge between canopies 1 and 2, and at the cable bridge between Canopies 2 and 3.

3.2.4. Electrical

Electrical Service Approach

The electrical concept plan was developed as part of the comprehensive charging facility design with input from MTS. Given the limited availability of space for large electrical infrastructure at the site, locating all the major electrical equipment on the overhead canopies was required.

Reliability and resiliency are crucial factors in designing a fleet charging system, as electricity becomes the fuel to keep the bus fleet in operation. This section will discuss the reliability of the electric utility providing that electricity that will provide power to the charging system that enables a fully functional electric zero-emission bus fleet.

Utility Reliability

Figure 3-10 displays SDG&E's electric power distribution reliability indices, including the measure and units for each index.

Figure 3-10 – Electric Power Distribution Reliability Indices

INDEX	MEASURE	UNITS
System Average Interruption Duration Index (SAIDI)	Average outage duration per customer	Minutes per outage (per customer)
Customer Average Interruption Duration Index (CAIDI)	Average outage duration if an outage is experienced, or average restoration time	Minutes Per Year (per customer)
System Average Interruption Frequency Index (SAIFI)	How often a customer can expect to experience an outage	Number of outages a year (average)
Momentary Average Interruption Frequency Index (MAIFI)	The frequency of momentary interruptions	Number of instantaneous outages (<5 minutes) per year (average)

Source: SDG&E

Reliability Indices

Mitigating the risk of an outage is paramount when considering BEB charging. The first step in mitigation is understanding the data provided for utility reliability. The table above defines how reliability is measured according to the California Public Utility Commission (CPUC) which is charged with regulating all electric utilities in California.

SDG&E Reliability

The reliability metrics vary and are updated every year by utilities in presentations to CPUC (Figure 3-11). This information is publicly available at SDG&E's website and shows that the utility is consistently one of the most reliable providers of electricity in the state.

Figure 3-11 – Historic SDG&E Reliability Metrics (2013-2022)

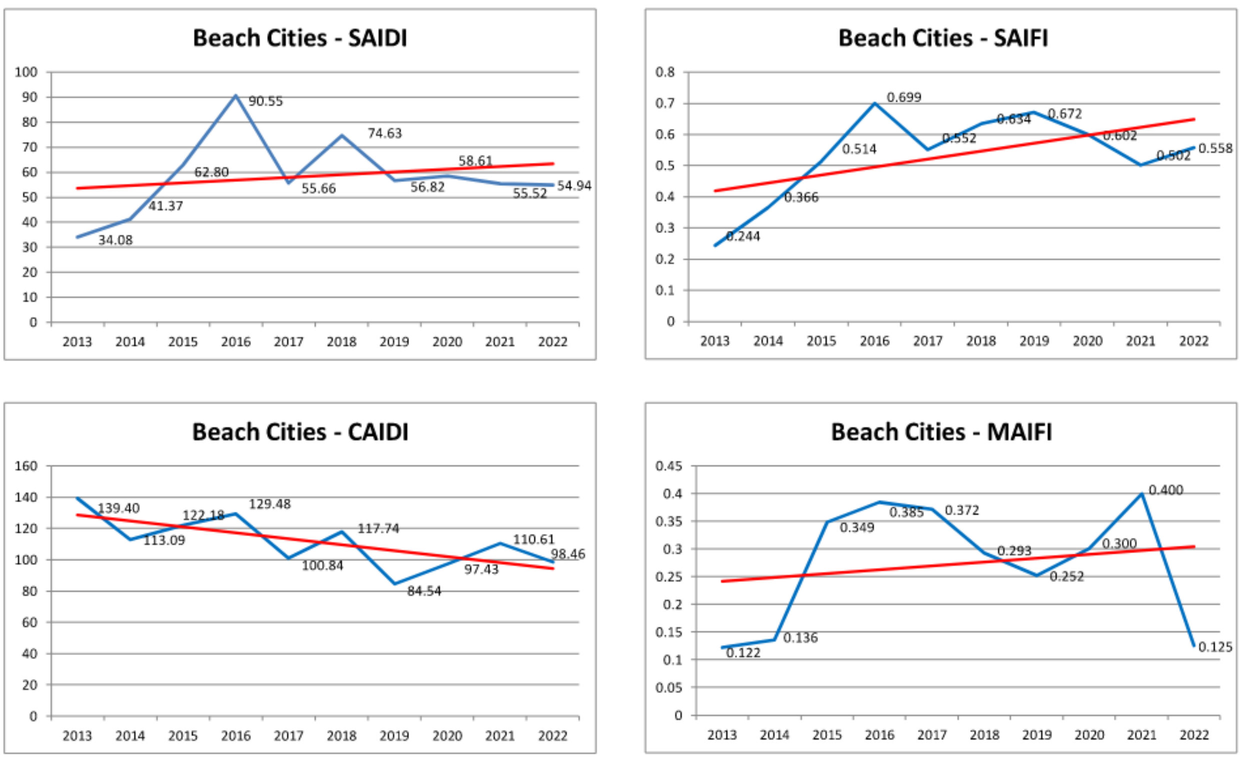
	MED Included					MED Excluded			
Year	SAIDI	SAIFI	CAIDI	MAIFI		SAIDI	SAIFI	CAIDI	MAIFI
2013	34.08	0.244	139.40	0.122		34.08	0.244	139.40	0.122
2014	41.37	0.366	113.09	0.136		38.78	0.357	108.66	0.113
2015	62.80	0.514	122.18	0.349		62.76	0.513	122.28	0.349
2016	90.55	0.699	129.48	0.385		77.04	0.651	118.31	0.385
2017	55.66	0.552	100.84	0.372		49.11	0.470	104.52	0.338
2018	74.63	0.634	117.74	0.293		74.17	0.626	118.49	0.293
2019	56.82	0.672	84.54	0.252		55.75	0.650	85.73	0.252
2020	58.61	0.602	97.43	0.300		54.52	0.578	94.36	0.300
2021	55.52	0.502	110.61	0.400		55.52	0.502	110.61	0.400
2022	54.94	0.558	98.46	0.125		54.94	0.558	98.46	0.125

Note: Major Event Days (MED) are direct result of failures in the California Independent System Operator (CAISO)-controlled bulk power market, or non-SDG&E owned transmission and distribution facilities, or an event caused by earthquake, fire, or storm of sufficient intensity to give rise to a state of emergency being declared by the government, or any other disaster not previously described that affects more than 15% of the system facilities or 10% of the utility's customers, whichever is less for each event. Also, outages involving restricted access by a governmental agency that precluded or otherwise delayed outage restoration times were also considered CPUC Major Events and excluded from reliability results.

Source: SDG&E Electric System Reliability Annual Report 2022.

The charts in Figure 3-12 show a visual representation of the data shown in the above tables for the Beach Cities district in which the KMD site is located.

Figure 3-12 – Beach Cities Reliability Metrics



The loss of electrical power to the MTS Kearny Mesa facility would likely be due a local or area-wide electric utility outage caused by a man-made or natural event including but not limited to utility equipment or line faults, transformer failure, wind or other weather events, mandatory wildfire safety shutoffs, or high-demand load shedding (brown-outs). A recent outage report was requested for the KMD site and the results can be shown in Figure 3-13.

Figure 3-13 – Recent Outage Report at KMD

Outage Category	Begin Date/Time	Duration	General Cause
Unplanned	2/21/2019 03:18 AM	00:01	Device/Equipment Damaged
Unplanned	3/13/2019 12:43 PM	00:06	Animal Contact
Planned	11/5/2019 11:26 AM	00:46	Planned outage
Unplanned	11/20/2019 08:03 AM	00:03	Undetermined
Planned	4/17/2020 07:15 AM	02:00	Planned outage
Unplanned	5/7/2020 09:07 PM	01:02	Device/Equipment Damaged
Unplanned	5/7/2020 10:30 PM	00:28	Device/Equipment Damaged
Unplanned	6/8/2020 05:31 PM	04:14	Device/Equipment Damaged
Unplanned	3/11/2021 02:34 AM	00:00	Undetermined

Resiliency Requirements

KMD Resiliency Approach

For a fully electric bus fleet to remain in operation, the depot must have reliable power. A high-level overview of options for power resiliency and redundancy at this facility has been identified below.

- On-site photovoltaic generation
- Battery energy storage system (BESS)
- Standby CNG generator (fixed and portable)
- Microgrid (which aggregates above resources)

Occasionally redundant power feeds can also increase a site's resiliency, however given that Kearny Mesa is on a radial distribution network that is served by a single substation, it is unlikely that this is a viable solution.

Photovoltaic Generation

Photovoltaic power (PV) is a resiliency option that can provide resiliency to the site in case of outages, in addition to offsetting peak electrical costs and providing financial incentives. The ZE Master Plan Canopies are designed to support PV panels mounted to the top of the overhead steel structural frame that supports the overhead charging dispensers, in areas where charging platforms are not present. If PV panels are desired over the charging platforms, an additional PV elevating structure will be required and considerations made to allow for chargers and switchboards to be maintained, serviced, and replaced in the future without PV panel demounting. The PV system will be connected to the unit substation and be controlled via the Microgrid controller to either energize the chargers directly or can charge a BESS unit that can be mounted to the top of the charging platforms.

Battery Energy Storage Systems (BESS)

BESS can provide immediate backup power to a facility in the event of a complete utility outage. The size and rating of the BES along with the amount of backed-up load will determine how much time the BES will provide power without need for recharging. Current BES systems typically can provide up to 4 hours of power depending on usage.

Based on available space for current BES technology, for a four-hour backup of the charging infrastructure, roughly estimated, a 4140 kWh, 2600kW system could be utilized by the depot. This represents just under 40% of the full buildout load if the entire fleet is comprised of BEB's charging from the Heliox charging cabinets. However, these are estimates and a full analysis of backup needs should be completed in order to correctly size a stationary storage system.

Standby CNG Generator (Fixed and Portable)

A traditional and common option for backup power is providing a socket at the main service or multiple sockets at several major load centers for the connection of one or multiple portable generators. Due to the substantial size of the new services that would serve the cumulative 6800kW of charging load, a large generator rated at 1270kW (see cutsheet in appendix for example) could be utilized to charge buses in the event of a utility outage, as well as supplement any on-site renewables if combined with a microgrid. In addition, the master plan includes generator sockets at each unit substation in order to accommodate smaller trailerized generators that may be utilized as each phase of construction is completed and as charging load increases. There are already existing stationary generators on site which potentially could be incorporated into any future on-site generation.

Microgrid

By definition, a microgrid is a single, controllable, independent power system comprising distributed generation (DG), load, energy storage (ES), and control devices, in which DG and ES are directly connected to the user side in parallel. As a resiliency tool, when BESS systems are combined with on-site generation such as photovoltaic systems or wind turbines and an appropriately-sized emergency generator, a microgrid can not only provide resiliency and redundancy, but assist in meeting net-zero emissions goals and be a proven, cost-saving measure.

With a managed charging profile at each bus-charging site, a smart microgrid controller could perform precise load management of the BES charging loads while utilizing on-site generation through various sources. In addition, during grid up-times, a microgrid can utilize built-in demand response resources to reduce peak-demand usage and reduce electrical utility costs.

Electrical Service Approach and Concept Plan Options

Existing Infrastructure

The site is served by three existing electrical service feeds with three associated meters, all provided by SDG&E.

There is one 750 kVA transformer (ID 772-124) on the southeast corner of the property which provides 480 Volt, three phase power to a switchboard on the south side of the maintenance building. This switchboard supplies power to all loads on the site including the maintenance building, parking structure, bus wash, fuel station, and site lighting (excluding the CNG facility which is discussed below).

There is a second SDG&E-owned 2,000 kVA transformer (ID 772-151) on site just west of the CNG facility which feeds the CNG facility loads and the existing BEB charging stations (which are metered separately). There is one other customer besides MTS that fed from this transformer that is a CNG vendor.

There are two existing ChargePoint CP-250 BEB plug-in type chargers fed from the CNG service by way of a tapped service entrance cabinet on in the metered switchboard that feeds the CNG loads.

The details of the existing electrical conditions can be found in Appendix A.

Based on the anticipated size of the future charging infrastructure, the existing infrastructure does not have enough capacity to support the full buildout of BEB charging and the equipment that will be required. The total maximum connected load of the chargers being 6.84 MW.

ICA data pulled recently indicates circuit capacity however initial conversations with SDG&E personnel indicate otherwise. A utility interconnection study would need to be conducted to understand how MTS might add full charging load over the next decade in order to stay under circuit capacity constraints of circuit #772.

New Infrastructure Conceptual Design

The following presents a summary of the electrical elements for the conceptual design.

Canopy 1

- (15) Heliox 180kW Charging Cabinets
- Unit substation (MV switchgear + transformer + LV distribution)
- BESS
- PV Modules and associated balance of system equipment
- Supporting electrical equipment (lighting, CCTV, power to dispensers)

Canopy 2

- (26) Heliox 180kW Charging Cabinets
- (2) Unit substation (MV switchgear + transformer + LV distribution)
- BESS
- PV Modules and associated balance of system equipment
- Supporting electrical equipment (lighting, CCTV, power to dispensers)

3.3. Phased Implementation

This section discusses the recommended construction phasing that would allow MTS to maintain operations with minimal disruptions to vehicle circulation and parking locations. The yard will remain fully operational during construction with minimal impacts to services at night. Vehicles displaced during construction will be relocated to the available space around the KMD site such as fuel/service lanes, wash lanes, staging areas, open down line parking spaces, circulation aisles and maintenance bays. Two options for phasing construction are described in this section, a Large Canopies option and Small Canopies option. Each option will produce the same master plan concept with the completion of the fourth phase. These options will allow for greater flexibility during detailed design, to better align with construction feasibility, funding, and procurement changes. The following phase descriptions outline the details of how the charging infrastructure can be constructed to meet MTS's procurement schedule, while maintaining revenue operations.

3.3.1. Phase 1 – Large Canopies (LC) Option

Phase 1 will be broken into an A and B phase which represents the procurement schedule of (25) 40-foot BEBs in 2027 and (7) 60-foot BEBs in 2028. At the end of Phase 1, KMD will have the ability to accommodate a total of 34 BEBs, 32 new and 2 existing BEBs.

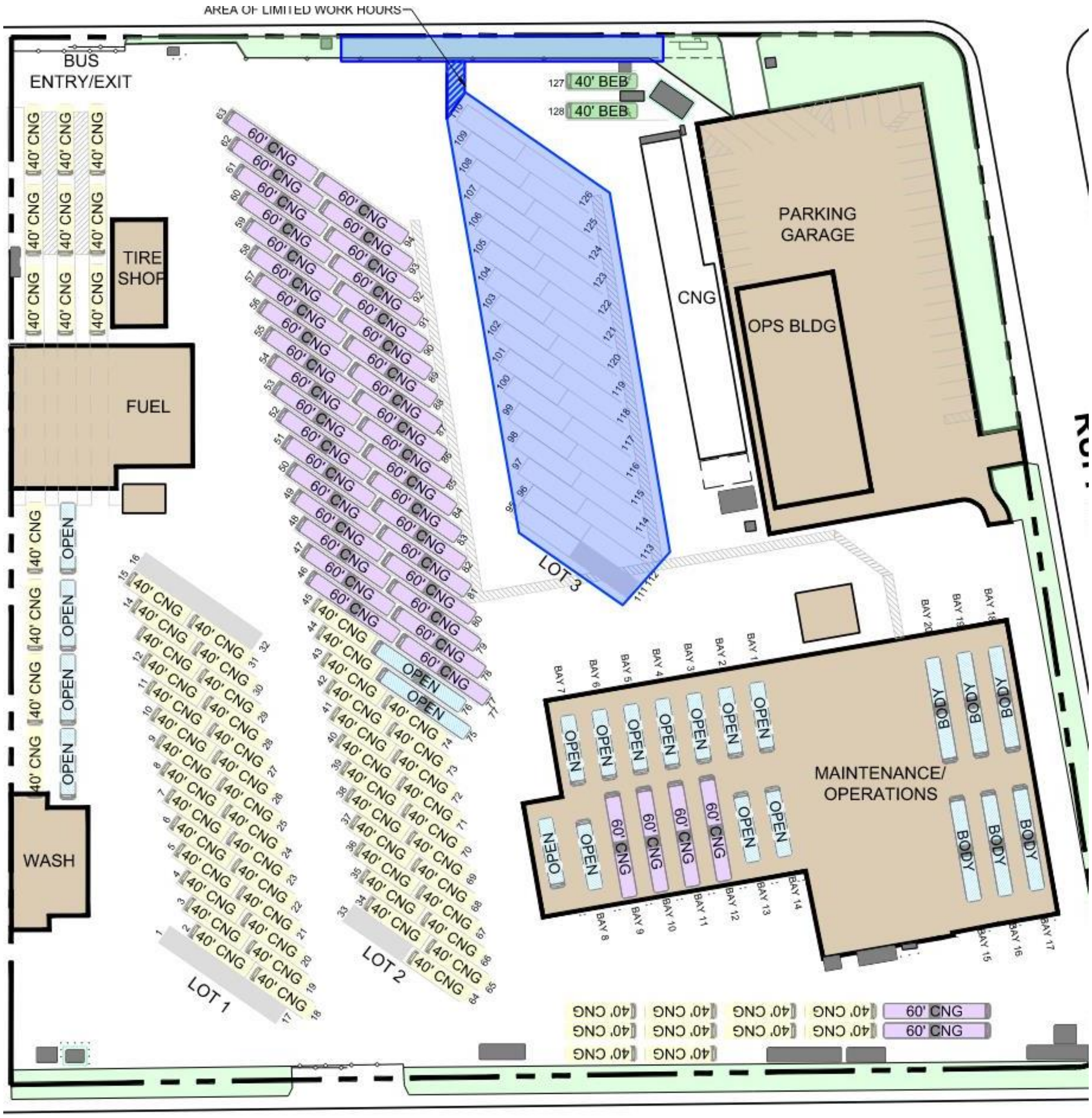
Phase LC 1A will provide the canopy structure over the existing lot 3, which will have the capacity to park 28 buses underneath. Construction phasing plans including Staging (Figure 3-14), Completed (Figure 3-15), and Occupied (Figure 3-16) Plans were developed. Phase LC 1A will feature the following infrastructure and construction practices:

- A new MV switchgear that will be sized to accommodate the full electrification of the KMDs fleet in all phases of construction.
- A new natural gas generator to provide resiliency and redundancy and to accommodate the full electrification of KMDs fleet.
- A new infill and retaining wall will be constructed along Opportunity Rd to provide additional space on site for the two large equipment items listed above. The infill and retaining wall would be located within the site's property boundaries.
- Excavation and laying of duct bank to connect the MV switchgear and natural gas generator to the steel structure. Laying of spare conduits will occur to provide power to the additional canopies that will be constructed in later phases of the project.
- There would be a new overheard steel structure over lot 3. The structure will be sized with equipment to support the Unit Substation #1, eight (8) DC charging cabinets, twenty-five (25) overhead pantograph dispensers and a BESS located on the equipment platform above the southernmost bay. The remaining bays of the canopy, not covered with a platform, will be sized to accommodate the overheard charging dispensers, including the three (3) inverted pantographs dispensers, installed in a future phase and the optional Photovoltaic panels.
- An access staircase will be constructed on the south end of the canopy to allow personnel access to the equipment platform. The area directly around the staircase will be stripped off to mark where buses should not travel.
- Existing striping underneath Canopy 1 will be removed from the pavement.
- New striping underneath Canopy 1 will be painted on the proposed pavement to delineate parking spaces and numbering and reflect the shifting of striping locations to create no circulation zones to house new canopy structural columns.

The inclusion of Figure 3-15 Phase LC 1A Completed Plan represents that upon completion of the Phase LC 1A canopy, the construction contractor vacates the site, and Canopy 1 is completed before the incoming 2027 BEBs arrive on site. The previously relocated CNG buses that were displaced during construction can now resume parking under Canopy 1 until the (25) CNG buses are replaced by the (25) BEBs in 2027.

Upon the completion of Phase LC 1A, MTS will have the charging capacity to meet their current procurement schedule in 2027 with a total of twenty-five (25) 40-foot BEBs capable of being charged on site.

Figure 3-14 – Phase LC 1A Staging Plan



STATISTICS

Assigned Buses:	
40' CNG	74
60' ARTICULATED CNG	42
40' BEB	2
60' ARTICULATED BEB	0
TOTAL	118
Open Buses:	
40' OPEN	13
60' OPEN	6
Total Capacity	137

Figure 3-15 – Phase LC 1A Completed Plan

STATISTICS

Assigned Buses:	
40' CNG	74
60' ARTICULATED CNG	42
40' BEB	2
60' ARTICULATED BEB	0
TOTAL	118
Open Buses:	
40' OPEN	41
60' OPEN	6
Total Capacity	165

Figure 3-16 – Phase LC 1A Occupied Plan

STATISTICS

Assigned Buses:		
40' CNG	40' CNG	49
60' ARTICULATED CNG	60' CNG	42
40' BEB	40' BEB	27
60' ARTICULATED BEB	60' BEB	0
TOTAL		118
Open Buses:		
40' OPEN	OPEN	41
60' OPEN	OPEN	6
Total Capacity		165

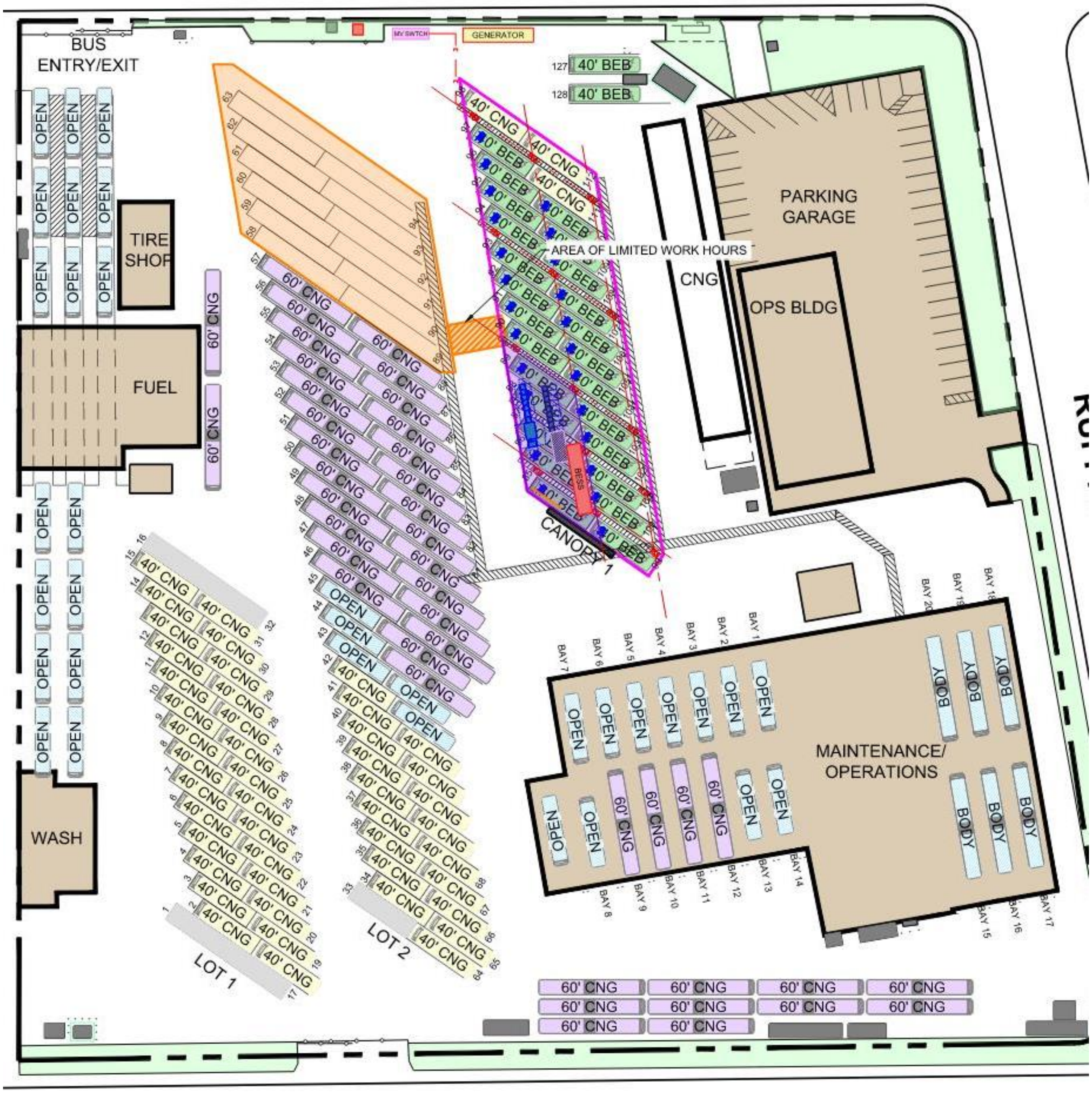
Phase LC 1B will provide a smaller modular canopy that will allow for it to be connected to the future canopy that will be located over the existing lot 2. This canopy will allow for the charging/storage of an additional seven count 60-foot BEBs, which will be powered by the cabinets located on Canopy 1's equipment platform. Three spots under Canopy 2 will continue to park 60-foot CNG buses until later phases are completed. Construction phasing plans including Staging (Figure 3-17), Completed (Figure 3-18), and Occupied (Figure 3-19) Plans were developed. Phase LC 1B will feature the following infrastructure and construction practices.

- A new overhead steel structure, one (1) bay wide, will be constructed to accommodate the seven (7) 60-foot BEBs on the north side of lot 2. This structure will be sized to accommodate ten (10) overheard pantograph dispensers and optional PV panels. The structure will also be built in a modular configuration so that additional bays may be connected in future phases of the project.
- Seven (7) overhead pantograph dispensers will be installed on the overhead structure and three (3) DC charging cabinets will be added to the platform on Canopy 1.
- A cabling bridge from Canopy 1 to this new structure will be required to provide the appropriate DC power supply cables and data/comms cables to the overhead dispensers. This area will be designated as a limited work hours area.
- New parking striping, with numbers, will be painted on the new pavement to delineate the parking positions located underneath Canopy 1.

The inclusion of Figure 3-18 Phase LC 1B Completed Plan represents that upon completion of the Phase LC 1B canopy, the construction contractor vacates the site, and Canopy 2 is completed before the incoming 2028 BEBs arrive on site. The previously relocated CNG buses that were displaced during construction can now resume parking under Canopy 2 until the (7) CNG buses are replaced by the (7) BEBs in 2027.

Upon the completion of Phase LC 1B, MTS will have the charging capacity to meet their current procurement schedule in 2028 with a total of twenty-five (25) 40-foot BEBs and seven (7) 60-foot BEBs capable of being charged on site.

Figure 3-17 – Phase LC 1B Staging Plan



STATISTICS

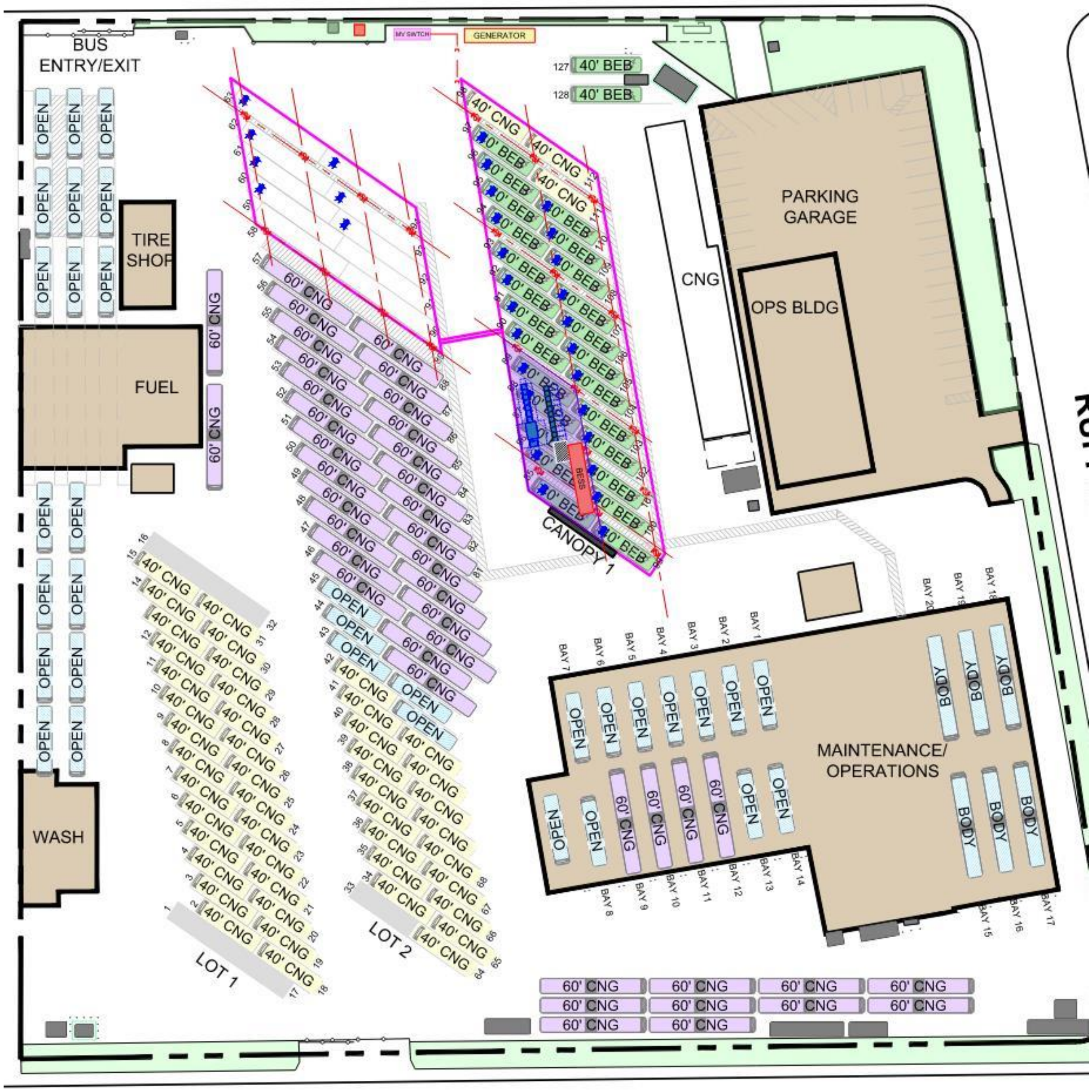
Assigned Buses:

40' CNG	40' CNG	49
60' ARTICULATED CNG	60' CNG	42
40' BEB	40' BEB	27
60' ARTICULATED BEB	60' BEB	0
TOTAL		118

Open Buses:

40' OPEN	OPEN	29
60' OPEN	OPEN	6
Total Capacity		165

Figure 3-18 – Phase LC 1B Completed Plan



STATISTICS

Assigned Buses:		
40' CNG	40' CNG	49
60' ARTICULATED CNG	60' CNG	42
40' BEB	40' BEB	27
60' ARTICULATED BEB	60' BEB	0
TOTAL		118
Open Buses:		
40' OPEN	OPEN	29
60' OPEN	OPEN	6
Total Capacity		165

Figure 3-19 – LC Phase 1B Occupied Plan

STATISTICS

Assigned Buses:		
40' CNG	40' CNG	49
60' ARTICULATED CNG	60' CNG	35
40' BEB	40' BEB	27
60' ARTICULATED BEB	60' BEB	7
TOTAL		118
Open Buses:		
40' OPEN	OPEN	41
60' OPEN	OPEN	6
Total Capacity		165

3.3.2. Phase 2 – Large Canopies (LC) Option

Phase LC 2 can be broken into an A, B, and C phase. This will allow the construction to be confined to a specific area of the yard, but all three can be done concurrently. Phases 2A and 2C will be required to be completed during limited work hours, since the work is being completed in an area of the existing canopies that must remain in operation during construction. Phase 2 will be implemented to meet MTS's procurement of thirty-five (35) BEBs in the year 2033. Construction phasing plans including Staging (Figure 3-20), Completed (Figure 3-21), and Occupied (Figure 3-22) Plans were developed.

Phase LC 2A will be the addition of 3 charging positions to Canopy 1, that was constructed in Phase 1A. The following infrastructure will be constructed in this phase:

- Three (3) overhead pantograph dispensers will be added to Canopy 1, and one (1) DC charging cabinet will be added to the platform.
- All associated cabling will be installed during this phase.

Phase LC 2B will construct 4 additional bays over the south side of lot 2. The following infrastructure will be constructed in this phase:

- Overheard steel structure to support the charging equipment platform, overhead charging dispensers, and the optional PV panels. The additional steel structure will include four (4) bays.
- Unit Substation #2, eleven (11) DC charging cabinets, thirty-one (31) overhead pantograph dispensers, and the second BESS will be installed on top of the new charging platform. The pantographs will be mounted on eight spots located underneath the platform, with the remaining twenty-three being mounted on the southern-most section of this phase of the canopy. 5 spots on the east parking row will have the pantographs mounted in such a location that allows for future 60-foot BEBs to be parked in these positions.
- An area of limited work hours will be established between Canopy 1 and the new concrete platform that is part of Canopy 2 being constructed. This area will be the location of the cabling and personnel bridge that will allow the AC power supply cabling to access the unit substation in addition to providing a means of access to the equipment platform atop Canopy 2.
- New parking stripes will be painted, with numbers, to delineate the new parking positions located under the canopy.

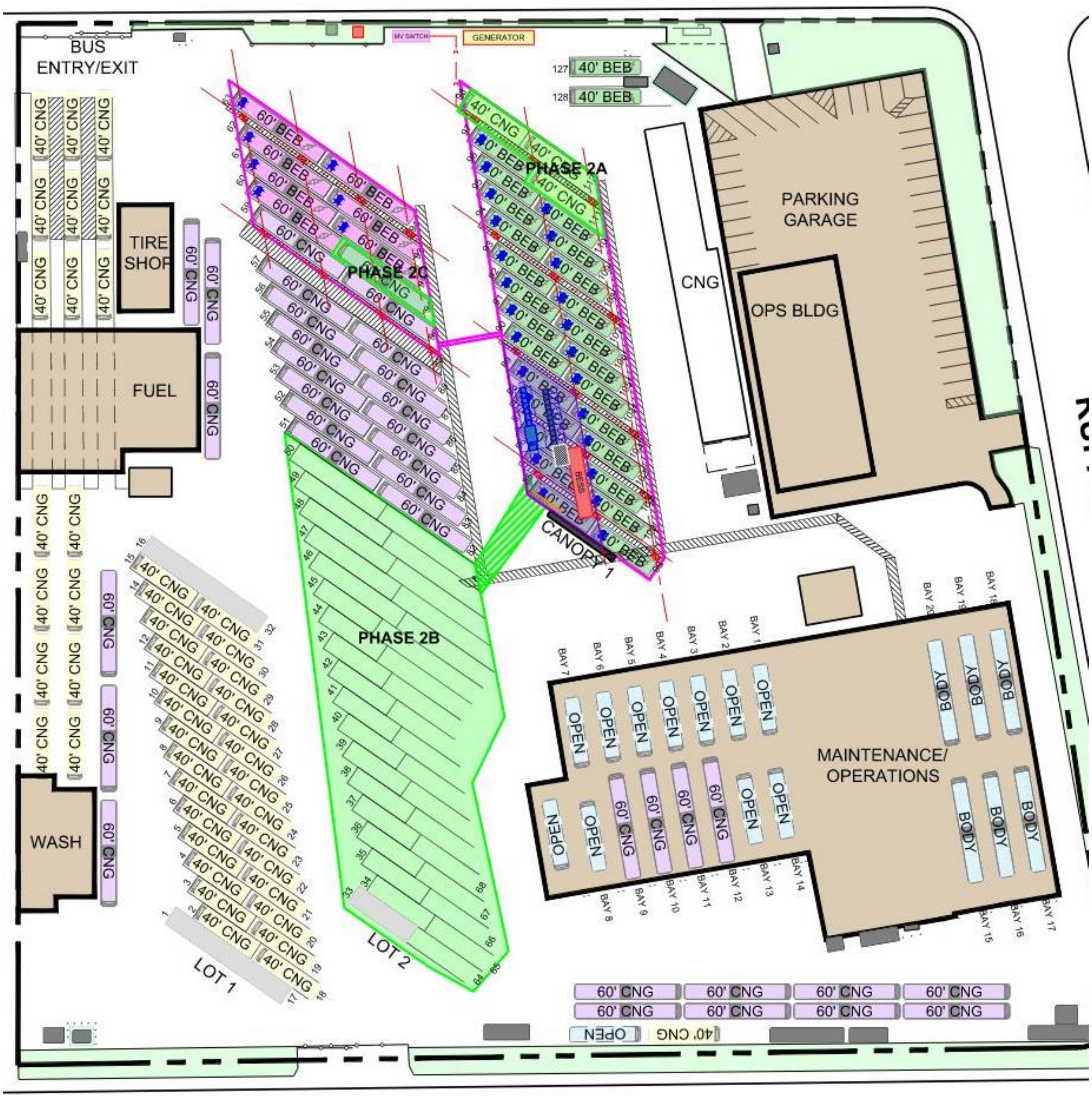
Phase LC 2C will include the addition of 1 charging position to the north section of Canopy 2, that was constructed in Phase 1B. This space will temporarily park a 40-foot BEB until the completion of Phase 4, when additional 40-foot spaces will be available. The following infrastructure will be constructed in this phase:

- One (1) overhead pantograph dispenser, connected to Unit Substation #1 on Canopy 1's platform.
- All associated cabling will be installed during this phase.

The inclusion of Figure 3-21 Phase LC 2 Completed Plan represents that upon completion of the Phase LC 2 canopy, the construction contractor vacates the site, and the southern section of Canopy 2 is completed before the incoming 2033 BEBs arrive on site. The previously relocated CNG buses that were displaced during construction can now resume parking under Canopy 2 until the (35) CNG buses are replaced by the (35) BEBs in 2033.

Upon the completion of Phase LC 2, MTS will have the charging capacity to meet their current procurement schedule in 2033 with a total of sixty-two (62) 40-foot BEBs and seven (7) 60-foot BEBs capable of being charged on site.

Figure 3-20 – Phase LC 2 Staging Plan



STATISTICS

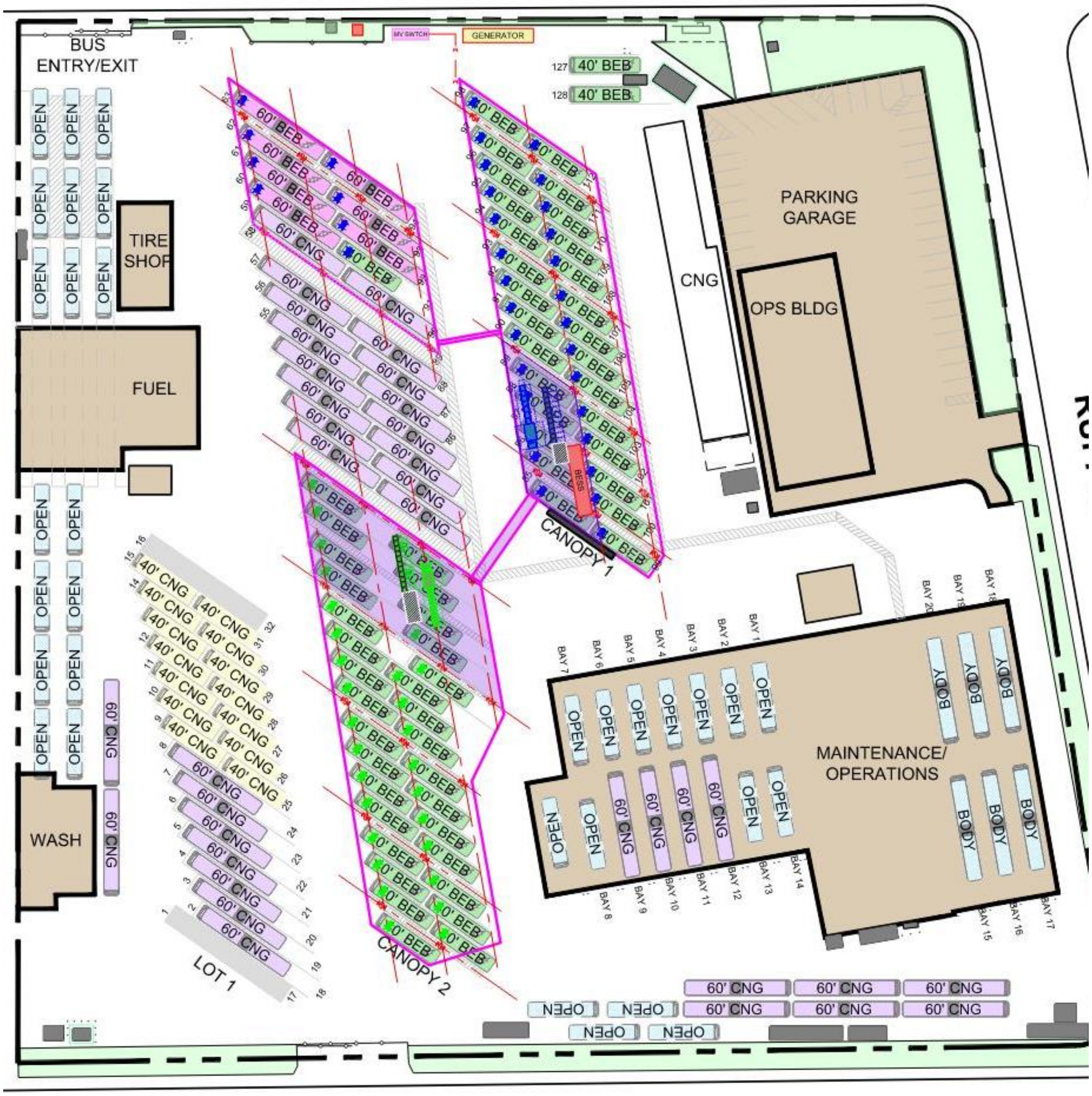
Assigned Buses:	
40' CNG	49
60' ARTICULATED CNG	35
40' BEB	27
60' ARTICULATED BEB	7
TOTAL	118
Open Buses:	
40' OPEN	12
60' OPEN	0
Total Capacity	130

Figure 3-21 – Phase LC 2 Completed Plan

STATISTICS

Assigned Buses:		
40' CNG	40' CNG	49
60' ARTICULATED CNG	60' CNG	35
40' BEB	40' BEB	27
60' ARTICULATED BEB	60' BEB	7
TOTAL		118
Open Buses:		
40' OPEN	OPEN	12
60' OPEN	OPEN	0
Total Capacity		130

Figure 3-22 – Phase LC 2 Occupied Plan



STATISTICS

Assigned Buses:		
40' CNG	40' CNG	14
60' ARTICULATED CNG	60' CNG	35
40' BEB	40' BEB	62
60' ARTICULATED BEB	60' BEB	7
TOTAL		118
Open Buses:		
40' OPEN	OPEN	32
60' OPEN	OPEN	0
Total Capacity		150

3.3.3. Phase 3 – Large Canopies (LC) Option

Phase LC 3 will encompass the construction of Canopy 3 over existing lot 1 and be completed to meet MTS's procurement schedule of 25 BEBs in the year 2035. Construction phasing plans including Staging (Figure 3-23), Completed (Figure 3-24), and Occupied (Figure 3-25) Plans were developed.

The following infrastructure will be constructed in this phase:

- Overheard steel structure to support the overhead charging dispensers and the optional PV panels. The steel structure will include three (3) bays and a cantilevered area on both the north and south sides.
- Unit Substation #3, nine (9) DC charging cabinets will be adding the platform on Canopy 2, constructed during Phase 2, and twenty-six (26) overhead pantograph dispensers will be added to the new overhead structure.
- New parking stripes will be painted, with numbers, to delineate the new parking positions located under the canopy.
- The 40-foot BEB that is located in the northern section of Canopy 2 will be relocated to Canopy 3.
- The existing BEB charging equipment on the northeast corner of the site will be removed to allow for a potential hydrogen trailer to be installed.

The inclusion of Figure 3-24 Phase LC 3 Completed Plan represents that upon completion of the Phase LC 3 canopy, the construction contractor vacates the site, and Canopy 3 is completed before the incoming 2035 BEBs arrive on site. The previously relocated CNG buses that were displaced during construction can now resume parking under Canopy 2 until the (25) CNG buses are replaced by the (25) BEBs in 2035.

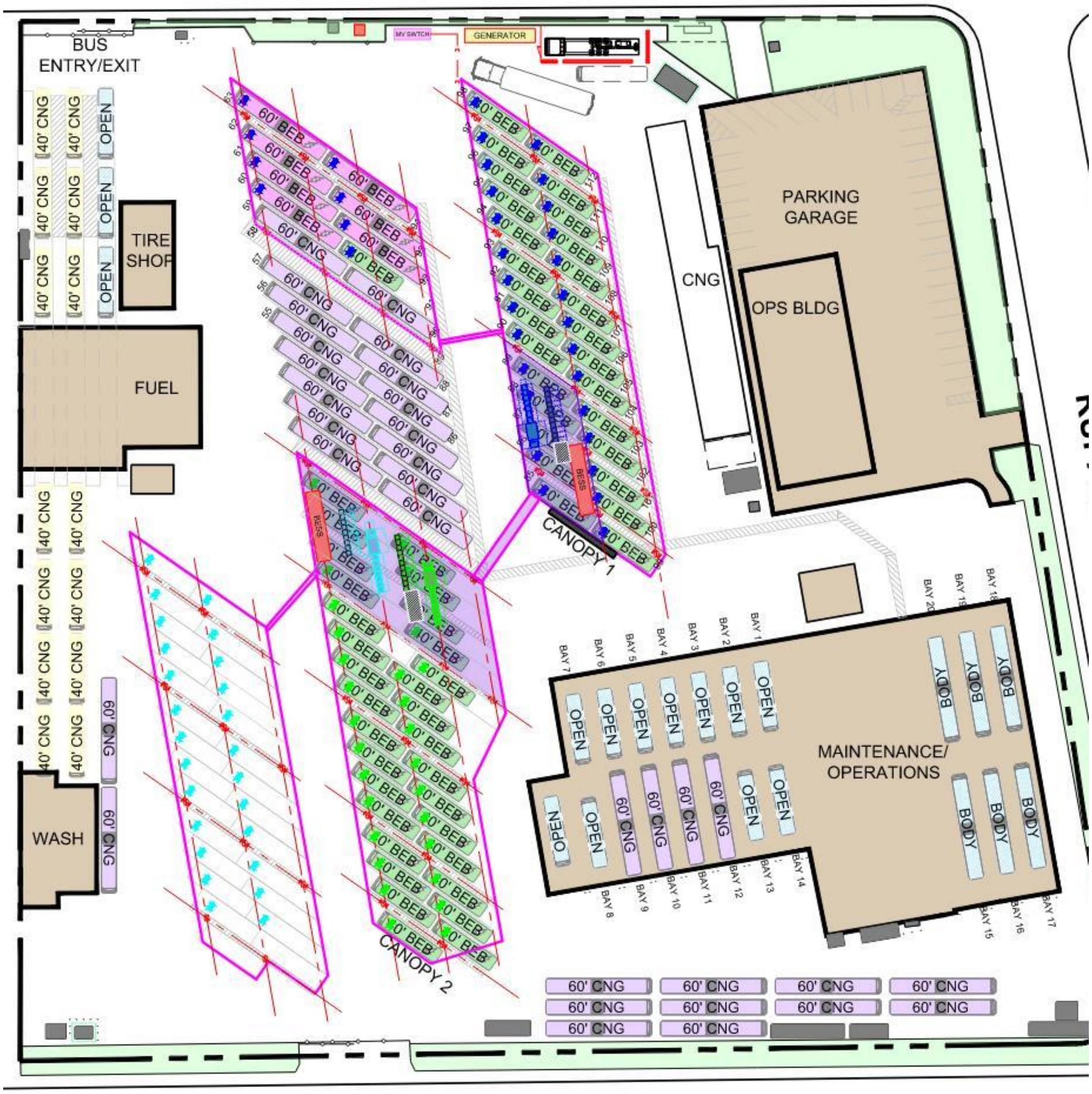
Upon the completion of Phase 3, MTS will have the charging capacity to meet their current procurement schedule with a total of eighty-five (85) 40-foot BEBs and seven (7) 60-foot BEBs.

Figure 3-23 – Phase LC 3 Staging Plan

STATISTICS

Assigned Buses:		
40' CNG	40' CNG	14
60' ARTICULATED CNG	60' CNG	35
40' BEB	40' BEB	62
60' ARTICULATED BEB	60' BEB	7
TOTAL		118
Open Buses:		
40' OPEN	OPEN	15
60' OPEN	OPEN	0
Total Capacity		133

Figure 3-24 – Phase 3 LC Completed Plan



STATISTICS

Assigned Buses:	
40' CNG	14
60' ARTICULATED CNG	35
40' BEB	62
60' ARTICULATED BEB	7
TOTAL	118
Open Buses:	
40' OPEN	15
60' OPEN	0
Total Capacity	133

Figure 3-25 – Phase LC 3 Occupied Plan

STATISTICS

Assigned Buses:		
40' CNG	40' CNG	0
60' ARTICULATED CNG	60' CNG	35
40' BEB	40' BEB	85
60' ARTICULATED BEB	60' BEB	7
TOTAL		127
Open Buses:		
40' OPEN	OPEN	33
60' OPEN	OPEN	0
Total Capacity		160

3.3.4. Phase 4 – Large Canopies (LC) Option

Phase LC 4 of the Master Plan is the final phase of the Master Plan and features the electrification of the remaining revenue buses on site at MTS's Kearny Mesa Division. This phase assumes that the remainder of KMD's BEB procurement will be for thirty-five (35) 60-foot BEBs and that the eight (8) excess 40-foot BEBs will be relocated to make room. If less 60-foot BEBs are part of the next procurement and excess 40-foot BEBs are to remain on site or be procured, the design of the canopies allows for this. Phase LC 4 will be broken into an A, B, and C phase similar other phases in this master plan. During this phase, the existing CNG yard will be decommissioned to make room for additional charging positions and 40-foot BEBs parking in 60-foot spaces will be relocated to new positions added during this phase. Construction phasing plans including Staging (Figure 3-26), Completed (Figure 3-27), and Occupied (Figure 3-28) Plans were developed.

The following Infrastructure will be constructed in Phase LC 4A:

- The remaining two (2) overhead steel structure bays will be added to Canopy 2 to join the canopy sections constructed during Phase 1B and Phase 2B. The structure, similar to all other canopies, will be built to support the overhead charging dispensers and the optional PV panels.
- Eighteen (18) overhead pantograph dispensers will be installed, along with all associated cabling to connect to the DC charging cabinets.
- Five (5) additional DC charging cabinets will be installed on Canopy 2's platform and connected to the Unit Substation #2.

The following infrastructure will be constructed in Phase LC 4B:

- One (1) overhead pantograph dispenser will be added to the south cantilevered area of Canopy 3.

The following infrastructure will be constructed in Phase LC 4C:

- Overhead steel structure, in the location of the decommissioned CNG yard, will be constructed in similar to the existing canopy structures located at other MTS divisions.
- Three (3) additional DC charging cabinets will be installed on Canopy 1's platform.
- Seven (7) overhead pantograph dispensers will be installed, along with all associated cabling to connect to the DC charging cabinets.

The inclusion of Figure 3-27 Phase LC 4 Completed Plan represents that upon completion of the Phase LC 4 canopy, the construction contractor vacates the site, and Canopy 2 is completed before the incoming BEBs arrive on site. The previously relocated CNG buses that were displaced during construction can now resume parking under Canopy 2 until the (35) CNG buses are replaced by the (35) BEBs in 2035. At the end of this phase there will be (9) additional 40-foot BEBs on site, these BEBs will be relocated to another MTS facility to provide room for the new 60-foot BEBs required at KMD.

At the end of Phase LC 4, MTS will have a full electrified fleet at their Kearny Mesa Division. The fleet make up at the end of this phase will consist of charging positions for seventy-seven (77) 40-foot BEBs and forty-two (42) 60-foot BEBs for a total of 119 charging positions on site. This will allow MTS to operate a fleet more than 125 BEBs when accounting for a 15-20% spare ratio of buses that will either be out service or set aside in reserve.

Figure 3-26 – Phase LC 4 Staging Plan

STATISTICS

Assigned Buses:	
40' CNG	0
60' ARTICULATED CNG	35
40' BEB	85
60' ARTICULATED BEB	7
TOTAL	127
Open Buses:	
40' OPEN	11
60' OPEN	0
Total Capacity	138

Figure 3-27 – Phase LC 4 Completed Plan

STATISTICS

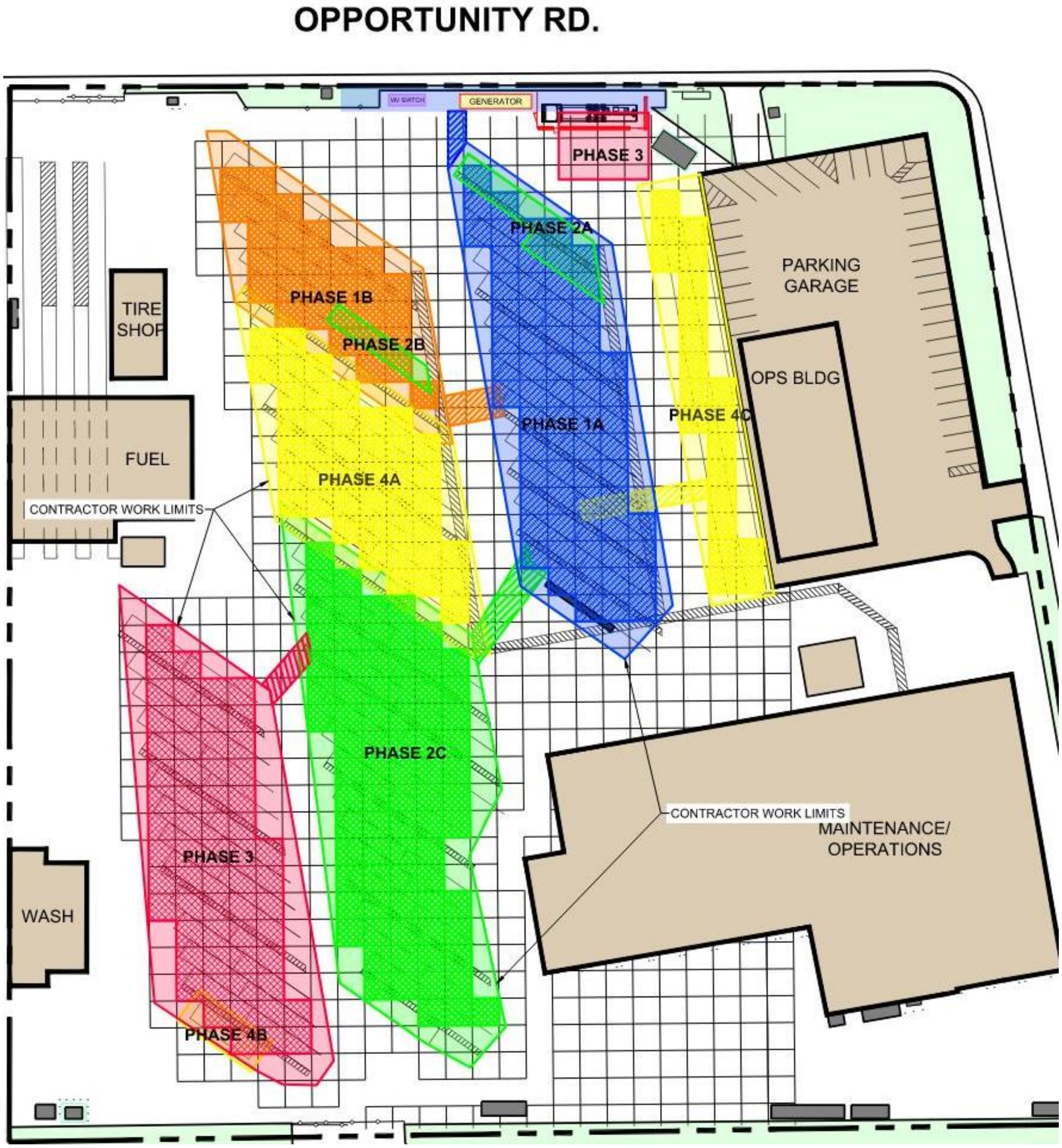
Assigned Buses:		
40' CNG	40' CNG	0
60' ARTICULATED CNG	60' CNG	35
40' BEB	40' BEB	85
60' ARTICULATED BEB	60' BEB	7
TOTAL		127
Open Buses:		
40' OPEN	OPEN	11
60' OPEN	OPEN	0
Total Capacity		138

Figure 3-28 – Phase 4 LC Occupied Plan

STATISTICS

Assigned Buses:		
40' CNG	40' CNG	0
60' ARTICULATED CNG	60' CNG	0
40' BEB	40' BEB	77
60' ARTICULATED BEB	60' BEB	42
TOTAL		119
Open Buses:		
40' OPEN	OPEN	35
60' OPEN	OPEN	3
Total Capacity		157

Figure 3-29 – LC Overall Staging and Pavement Reconstruction Plan



Pavement Reconstruction Quantities Estimate

Phase 1A: 14,859 square feet
Phase 1B: 6,750 square feet
Phase 2: 17,787 square feet
Phase 3: 15,614 square feet
Phase 4A: 9,661 square feet
Phase 4B: 4,730 square feet

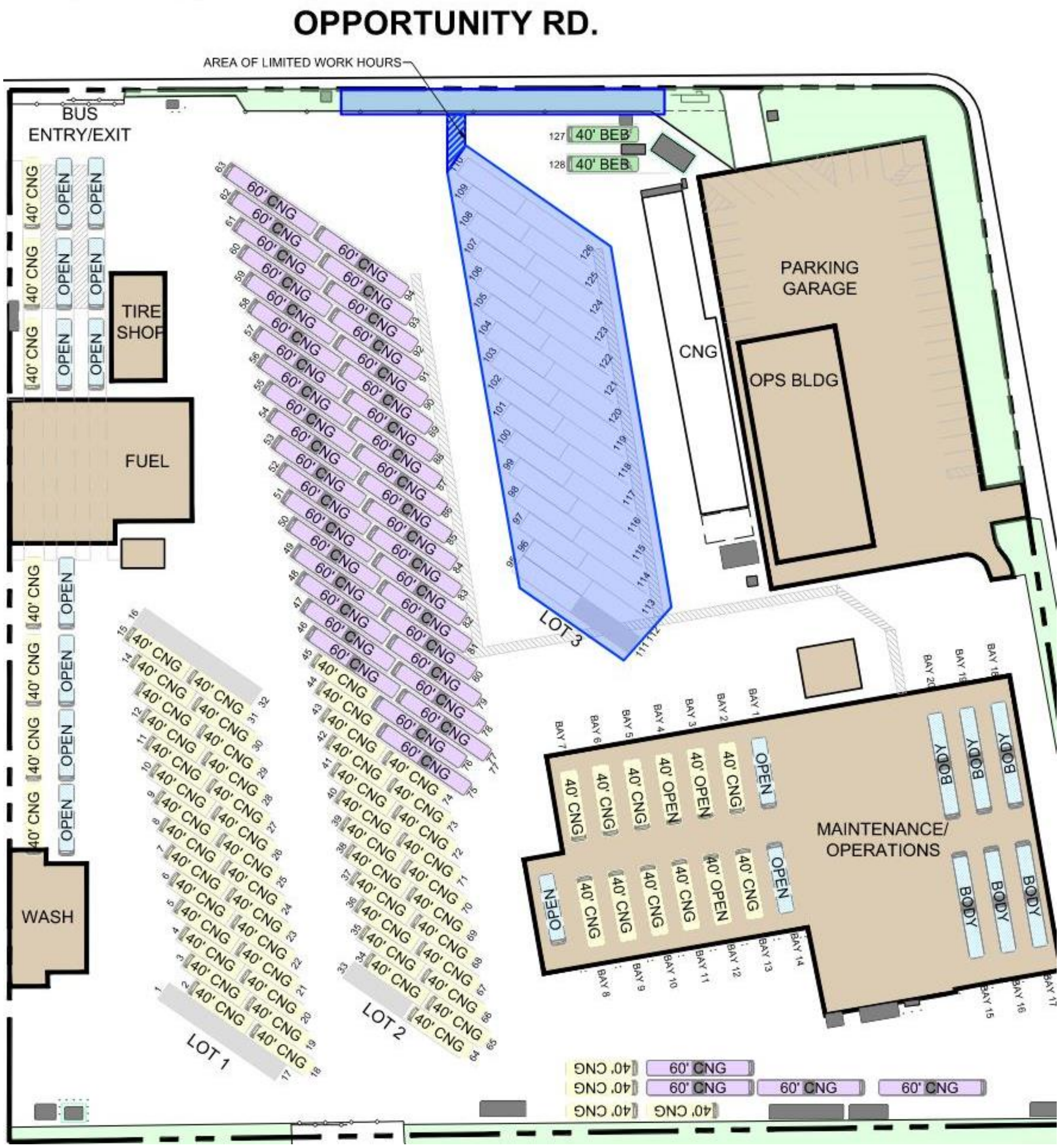
3.3.5. Phase 1 – Small Canopies (SC) Option

Phase SC 1 will be broken into an A and B phase which represents the procurement schedule of 25 40-foot BEBs in 2027 and 7 60-foot BEBs in 2028. At the end of Phase SC 1, KMD will have the ability to accommodate a total of 34 BEBs, 32 new and 2 existing BEBs.

Phase SC 1A will provide the canopy structure over the existing lot 3, which will have the capacity to park 28 buses underneath. Construction phasing plans including Staging (Figure 3-30), Completed (Figure 3-31), and Occupied (Figure 3-32) Plans were developed. Phase SC 1A will feature the following infrastructure and construction practices:

- A new MV switchgear that will be sized to accommodate the full electrification of the KMDs fleet in all phases of construction.
- A new natural gas generator to provide resiliency and redundancy and to accommodate the full electrification of KMDs fleet.
- A new infill and retaining wall will be constructed along Opportunity Rd to provide additional space on site for the two large equipment items listed above. The infill and retaining wall would be located within the site's property boundaries.
- Excavation and laying of duct bank to connect the MV switchgear and natural gas generator to the steel structure. Laying of spare conduits will occur to provide power to the additional canopies that will be constructed in later phases of the project.
- There would be a new overheard steel structure over lot 3. The structure will be sized with equipment to support the Unit Substation #1, eight (8) DC charging cabinets, twenty-five (25) overhead pantograph dispensers and a BESS located on the equipment platform above the southernmost bay. The remaining bays of the canopy, not covered with a platform, will be sized to accommodate the overheard charging dispensers, including the remaining three (3) inverted pantographs dispensers and the optional Photovoltaic panels.
- An access staircase will be constructed on the south end of the canopy to allow personnel access to the equipment platform. The area directly around the staircase will be stripped off to mark where buses should not travel.
- New striping underneath Canopy 1 will be painted on the proposed pavement to delineate parking spaces and numbering.
- The inclusion of Figure 3-31 Phase SC 1A Completed Plan represents that upon completion of the Phase SC 1A canopy, the construction contractor vacates the site, and Canopy 1 is completed before the incoming 2027 BEBs arrive on site. The previously relocated CNG buses that were displaced during construction can now resume parking under Canopy 1 until the (25) CNG buses are replaced by the (25) BEBs in 2027.
- Upon the completion of Phase SLC 1A, MTS will have the charging capacity to meet their current procurement schedule in 2027 with a total of twenty-five (25) 40-foot BEBs capable of being charged on site.

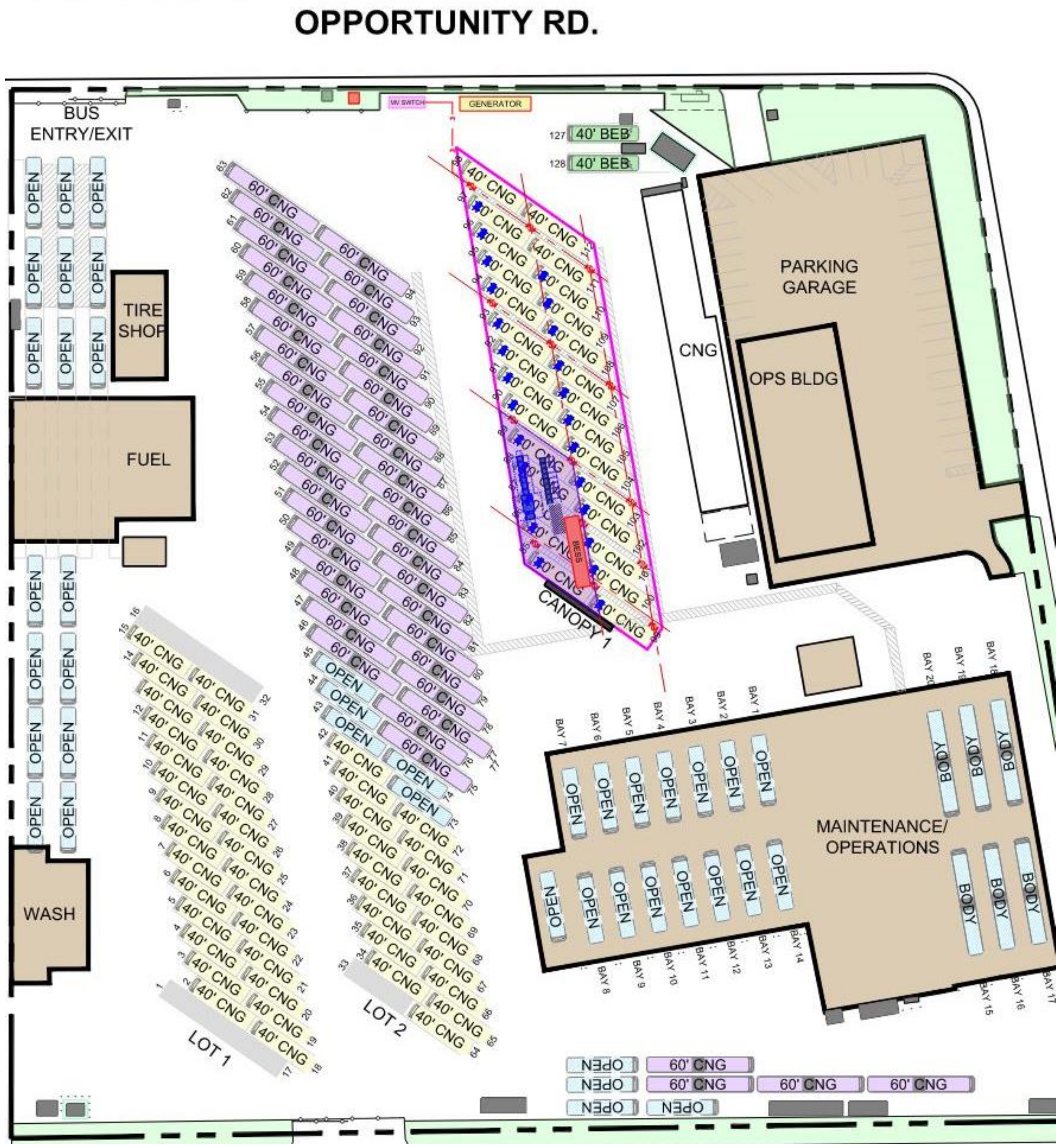
Figure 3-30 – Phase SC 1A Staging Plan



STATISTICS

Assigned Buses:		
40' CNG	40' CNG	74
60' ARTICULATED CNG	60' CNG	42
40' BEB	40' BEB	2
60' ARTICULATED BEB	60' BEB	0
TOTAL		118
Open Buses:		
40' OPEN	OPEN	13
60' OPEN	OPEN	6
Total Capacity		137

Figure 3-31 – Phase SC 1A Completed Plan



STATISTICS

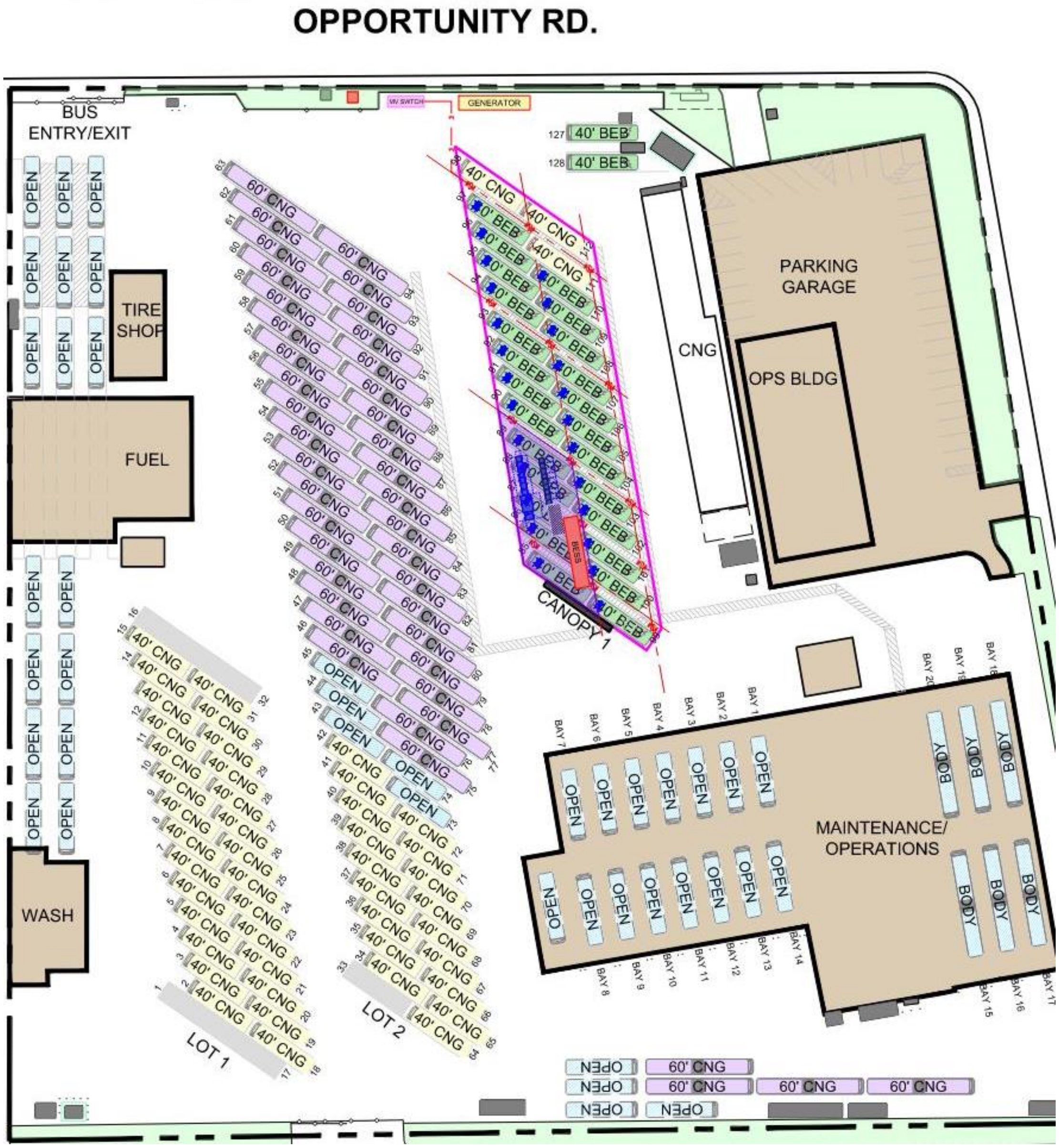
Assigned Buses:

40' CNG	40' CNG	74
60' ARTICULATED CNG	60' CNG	42
40' BEB	40' BEB	2
60' ARTICULATED BEB	60' BEB	0
TOTAL		118

Open Buses:

40' OPEN	OPEN	41
60' OPEN	OPEN	6
Total Capacity		165

Figure 3-32 – Phase SC 1A Occupied Plan



STATISTICS

Assigned Buses:		
40' CNG	40' CNG	49
60' ARTICULATED CNG	60' CNG	42
40' BEB	40' BEB	27
60' ARTICULATED BEB	60' BEB	0
TOTAL		118
Open Buses:		
40' OPEN	OPEN	41
60' OPEN	OPEN	6
Total Capacity		165

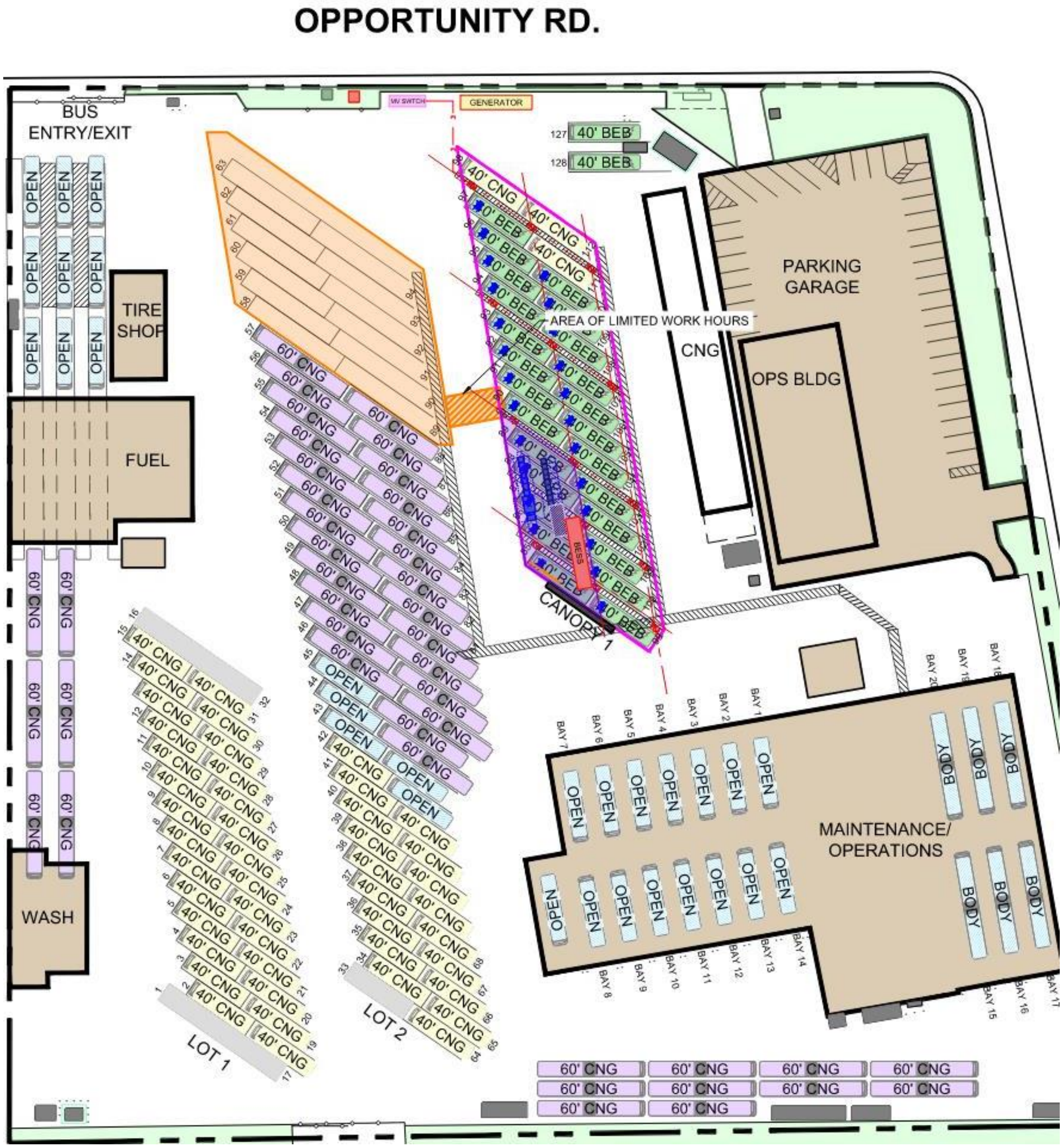
Phase SC 1B will provide a smaller modular canopy that will allow for it to be connected to the future canopy that will be located over the existing lot 2. This canopy will allow for the charging/storage of the additional seven (7) 60-foot BEBs, which will be powered by the cabinets located on Canopy 1's equipment platform. Three spots under this canopy will continue to park 60-foot CNG buses until later phases are completed. Construction phasing plans including Staging (Figure 3-33), Completed (Figure 3-34), and Occupied (Figure 3-35) Plans were developed. Phase SC 1B will feature the following infrastructure and construction practices.

- A new overhead steel structure, one (1) bay wide, will be constructed to accommodate the seven (7) 60-foot BEBs on the north side of lot 2. This structure will be sized to accommodate ten (10) overheard pantograph dispensers and optional PV panels. The structure will also be built in a modular configuration so that additional bays may be connected in future phases of the project.
- Seven (7) overhead pantograph dispensers will be installed on the overhead structure and three (3) DC charging cabinets will be added to the platform on Canopy 1.
- A cabling bridge from Canopy 1 to this new structure will be required to provide the appropriate DC power supply cables and communications cables to the overheard dispensers. This area will be designated as a limited work hours area.
- New parking striping, with numbers, will be painted on the new pavement to delineate the parking positions located underneath Canopy 1.

The inclusion of Figure 3-34 Phase SC 1B Completed Plan represents that upon completion of the Phase SC 1B canopy, the construction contractor vacates the site, and Canopy 2 is completed before the incoming 2028 BEBs arrive on site. The previously relocated CNG buses that were displaced during construction can now resume parking under Canopy 2 until the (7) CNG buses are replaced by the (7) BEBs in 2027.

Upon the completion of Phase SC 1B, MTS will have the charging capacity to meet their current procurement schedule in 2028 with a total of twenty-five (25) 40-foot BEBs and seven (7) 60-foot BEBs capable of being charged on site.

Figure 3-33 – Phase SC 1B Staging Plan



STATISTICS

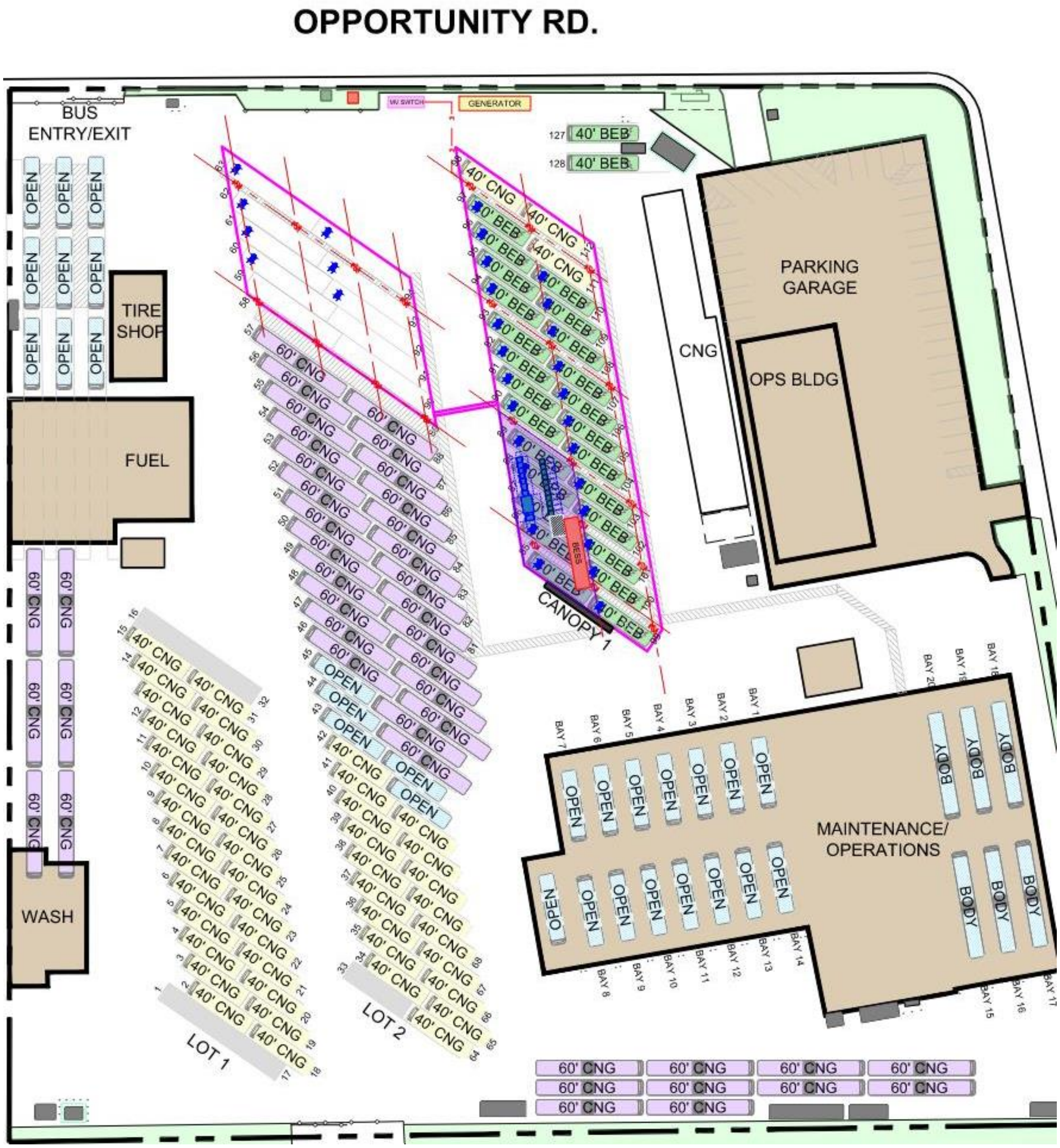
Assigned Buses:

40' CNG	40' CNG	49
60' ARTICULATED CNG	60' CNG	42
40' BEB	40' BEB	27
60' ARTICULATED BEB	60' BEB	0
TOTAL		118

Open Buses:

40' OPEN	OPEN	29
60' OPEN	OPEN	6
Total Capacity		165

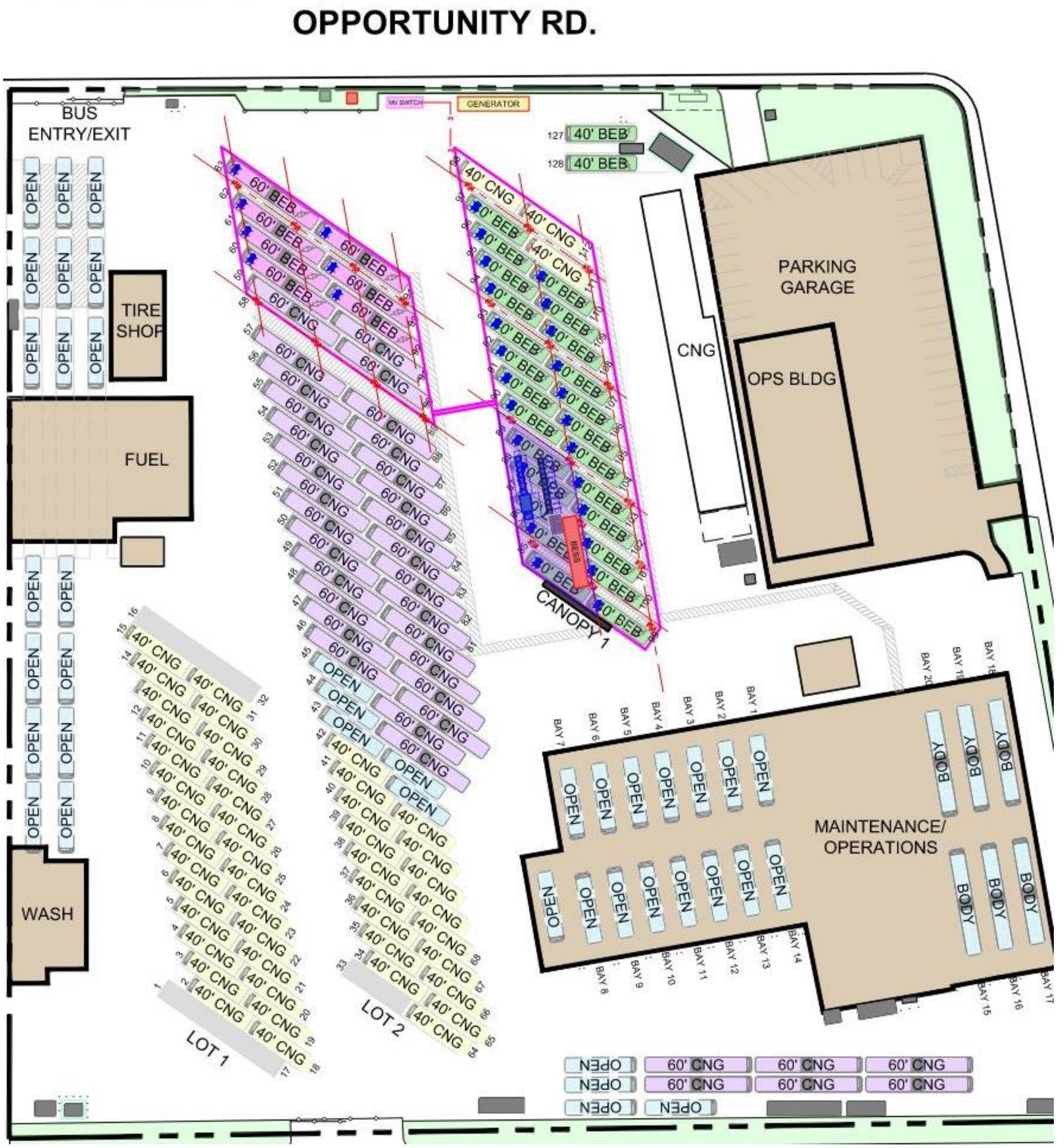
Figure 3-34 – Phase SC 1B Completed Plan



STATISTICS

Assigned Buses:	
40' CNG	49
60' ARTICULATED CNG	42
40' BEB	27
60' ARTICULATED BEB	0
TOTAL	118
Open Buses:	
40' OPEN	29
60' OPEN	6
Total Capacity	165

Figure 3-35 – Phase SC 1B Occupied Plan



STATISTICS

Assigned Buses:	
40' CNG	49
60' ARTICULATED CNG	35
40' BEB	27
60' ARTICULATED BEB	7
TOTAL	118

Open Buses:	
40' OPEN	41
60' OPEN	6
Total Capacity	165

3.3.6. Phase 2 – Small Canopies (SC) Option

Phase SC 2 can be broken in an A, B, and C phase which will allow construction to the confined to a specific area of the yard and displace less revenue vehicles. However, all three could be constructed concurrently if preferred. Phase 2A will have to be completed during limited work hours because it involves work to be done in an area of the site that must remain operations during construction. Phase SC 2 will be implemented to meet MTS's procurement of 35 BEBs in the year 2033. Construction phasing plans including Staging (Figure 3-36), Completed (Figure 3-37), and Occupied (Figure 3-38) Plans were developed.

Phase SC 2A will be the addition of 3 charging positions to canopy 1, that was constructed in phases 1A. The following infrastructure will be constructed in this phase:

- Three (3) overhead pantograph dispensers will be added to Canopy 1, and one (1) DC charging cabinet will be added to the platform.
- All associated cabling will be installed during this phase.

Phase SC 2B will construct 2 charging bays in the center of Lot 2. The following infrastructure will be constructed in this phase:

- Overheard steel structure to support the charging equipment platform, overhead charging dispensers, and the optional PV panels. The additional steel structure will include two (2) bays. The northern most bay of this canopy section will include a concrete equipment platform.
- Unit Substation #2, five (5) DC charging cabinets, and fifteen (15) overhead pantograph dispensers. The six northern parking lanes will have the pantographs mounted in such a location that will allow for future 60-foot BEBs to be charged in these parking positions.
- An area of limited work hours will be established between Canopy 1 and the new concrete platform that is part of Canopy 2 that is being constructed. This area will be the location of the cabling and personnel bridge that will allow the AC power supply cabling to access the unit substation in addition to providing a means of access to the equipment platform atop Canopy 2.
- New parking striping, with numbers, will be painted on the new pavement to delineate the parking positions located underneath.

Phase SC 2C will construct 2 charging bays over the north side of existing Lot 1. The following infrastructure will be constructed in this phase:

- Overheard steel structure to support the charging equipment platform, overhead charging dispensers, and the optional PV panels. The steel structure will include two (2) bays with a cantilevered area over the northern side.
- Unit Substation #3, six (6) DC charging cabinets, and seventeen (17) overhead pantographs dispensers.
- An area of limited work hours will be established between Canopy 2 and the new Canopy 3. This area will be the location of the cabling bridge that will allow the DC power supply and data/comms cables to connect to the dispensers.

The inclusion of Figure 3-37 Phase SC 2 Completed Plan represents that upon completion of the Phase SC 2 canopy, the construction contractor vacates the site, and the southern section of Canopy 2 is completed before the incoming 2033 BEBs arrive on site. The previously relocated CNG buses that were displaced during construction can now resume parking under Canopy 2 until the (35) CNG buses are replaced by the (35) BEBs in 2033.

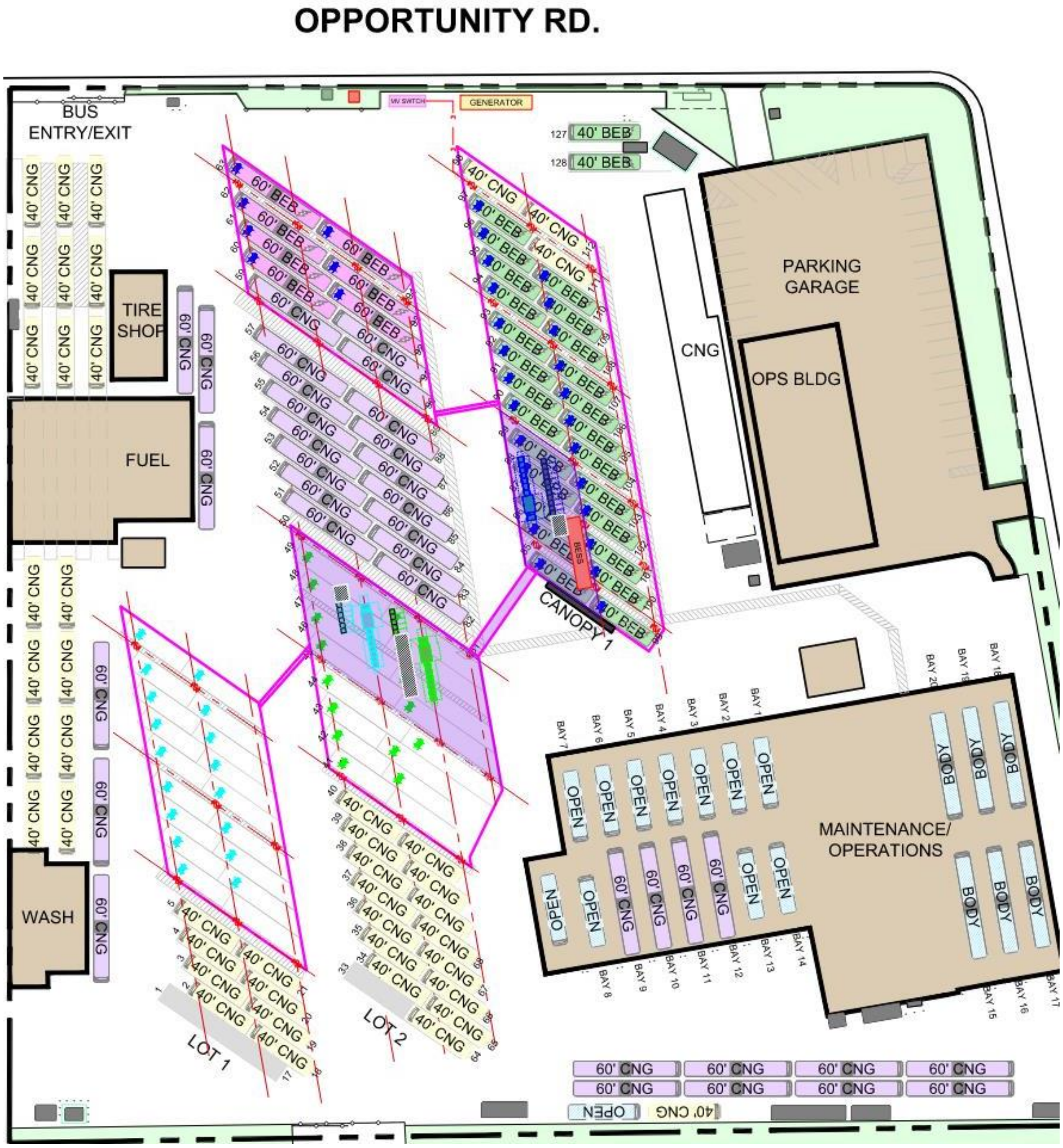
Upon the completion of Phase SC 2, MTS will have the charging capacity to meet their current procurement schedule in 2033 with a total of sixty-two (62) 40-foot BEBs and seven (7) 60-foot BEBs.

Figure 3-36 – Phase SC 2 Staging Plan

STATISTICS

Assigned Buses:		
40' CNG	40' CNG	49
60' ARTICULATED CNG	60' CNG	35
40' BEB	40' BEB	27
60' ARTICULATED BEB	60' BEB	7
TOTAL		118
Open Buses:		
40' OPEN	OPEN	12
60' OPEN	OPEN	0
Total Capacity		130

Figure 3-37 – Phase SC 2 Completed Plan

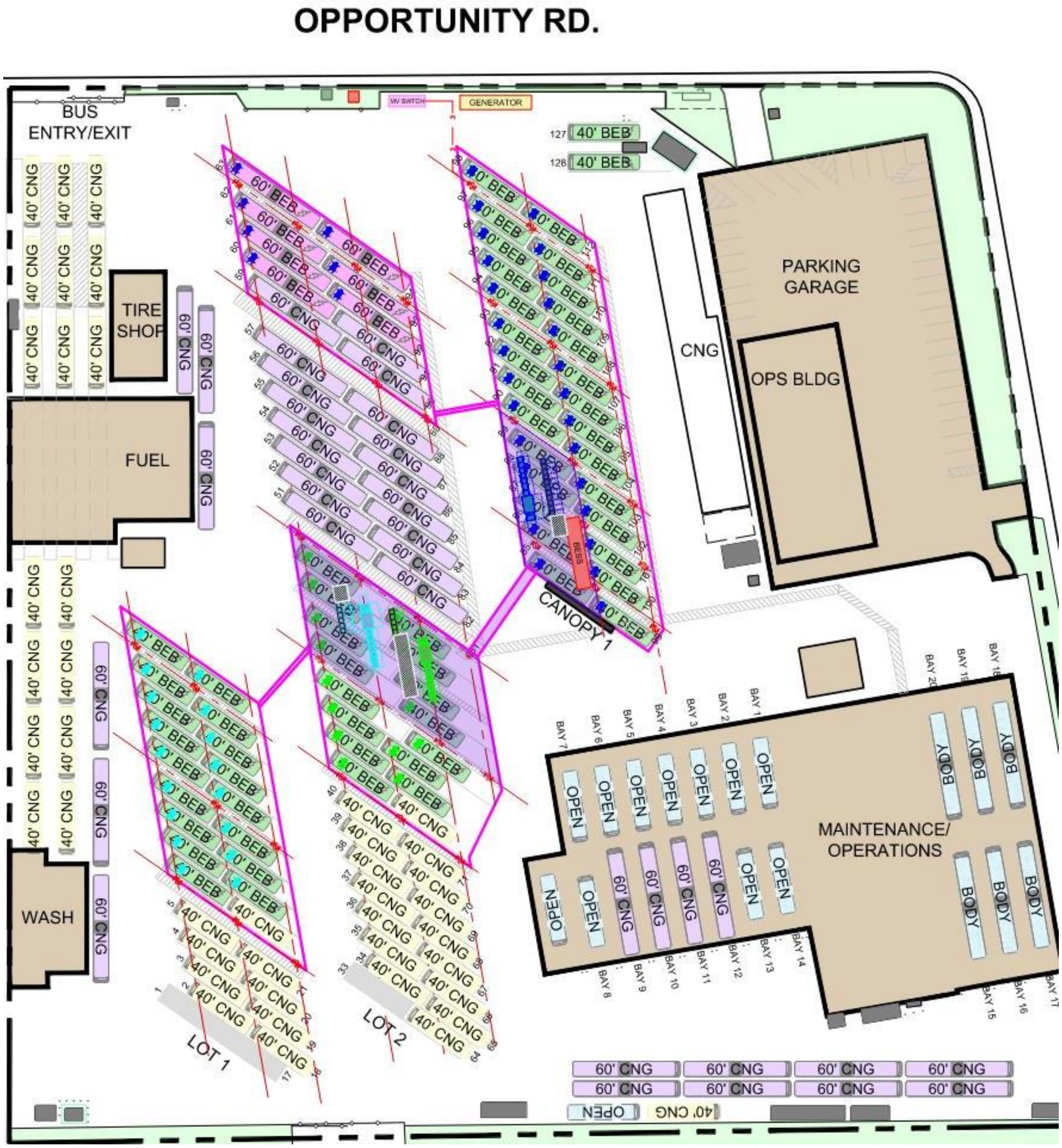


STATISTICS

Assigned Buses:		
40' CNG	40' CNG	49
60' ARTICULATED CNG	60' CNG	35
40' BEB	40' BEB	27
60' ARTICULATED BEB	60' BEB	7
TOTAL		118

Open Buses:		
40' OPEN	OPEN	12
60' OPEN	OPEN	0
Total Capacity		130

Figure 3-38 – Phase SC 2 Occupied Plan



STATISTICS

Assigned Buses:		
40' CNG	40' CNG	14
60' ARTICULATED CNG	60' CNG	35
40' BEB	40' BEB	62
60' ARTICULATED BEB	60' BEB	7
TOTAL		118
Open Buses:		
40' OPEN	OPEN	32
60' OPEN	OPEN	0
Total Capacity		150

3.3.7. Phase 3 – Small Canopies (SC) Option

Phase SC 3 will encompass the constructions of the final section of Canopy 3 and three (2) bays to the south side of Canopy 2. This phase can be broken into an A and B phase, but both phases can be constructed concurrently if desired. The completion of this phase will be constructed to meeting the MTS's final stage of BEB scheduled procurement of 25 40-foot BEBs in the year 2035. Construction phasing plans including Staging (Figure 3-39), Completed (Figure 3-40), and Occupied (Figure 3-41) Plans were developed.

Phase SC 3A will see the addition of sixteen (16) charging positions to Canopy 2. The following infrastructure will be constructed in this phase:

- Overhead steel structure to support the overhead charging dispensers and the optional PV panels. The steel structure will add two (2) bays and the cantilevered charging position on the south side. This section will be connected to the section of canopy built during Phase 2B.
- Six (6) DC charging cabinets will be added to the Canopy 2 platform and connected to Unit Substation #2. Sixteen (16) overhead pantographs dispensers with one (1) of those dispensers being added to the section of canopy built in Phase 2B.
- New parking strips will be painted to delineate the new parking positions located under the canopy.
- The existing BEB charging equipment on the northeast corner of the site will be removed to allow for a potential hydrogen trailer to be installed.

Phase SC 3B will see the addition of eight (8) charging positions to Canopy 3. The following infrastructure will be constructed in this phase:

- Overhead steel structure to support the overhead charging dispensers and the optional PV panels. The steel structure will add one (1) bay and the cantilevered charging position that will be added in phase 4 on the south side. This section will be connected to the section of canopy built during Phase 2C.
- Three (3) DC charging cabinets will be added to the platform on Canopy 2 and connected to Unit Substation #3. Nine (9) overhead pantograph dispensers with one (1) of those dispensers being added to the section of canopy built in Phase 2C.
- New parking strips will be painted to delineate the new parking positions located under the canopy.

The inclusion of Figure 3-40 Phase SC 3 Completed Plan represents that upon completion of the Phase SC 3 canopy, the construction contractor vacates the site, and Canopy 3 is completed before the incoming 2035 BEBs arrive on site. The previously relocated CNG buses that were displaced during construction can now resume parking under Canopy 2 until the (25) CNG buses are replaced by the (25) BEBs in 2035.

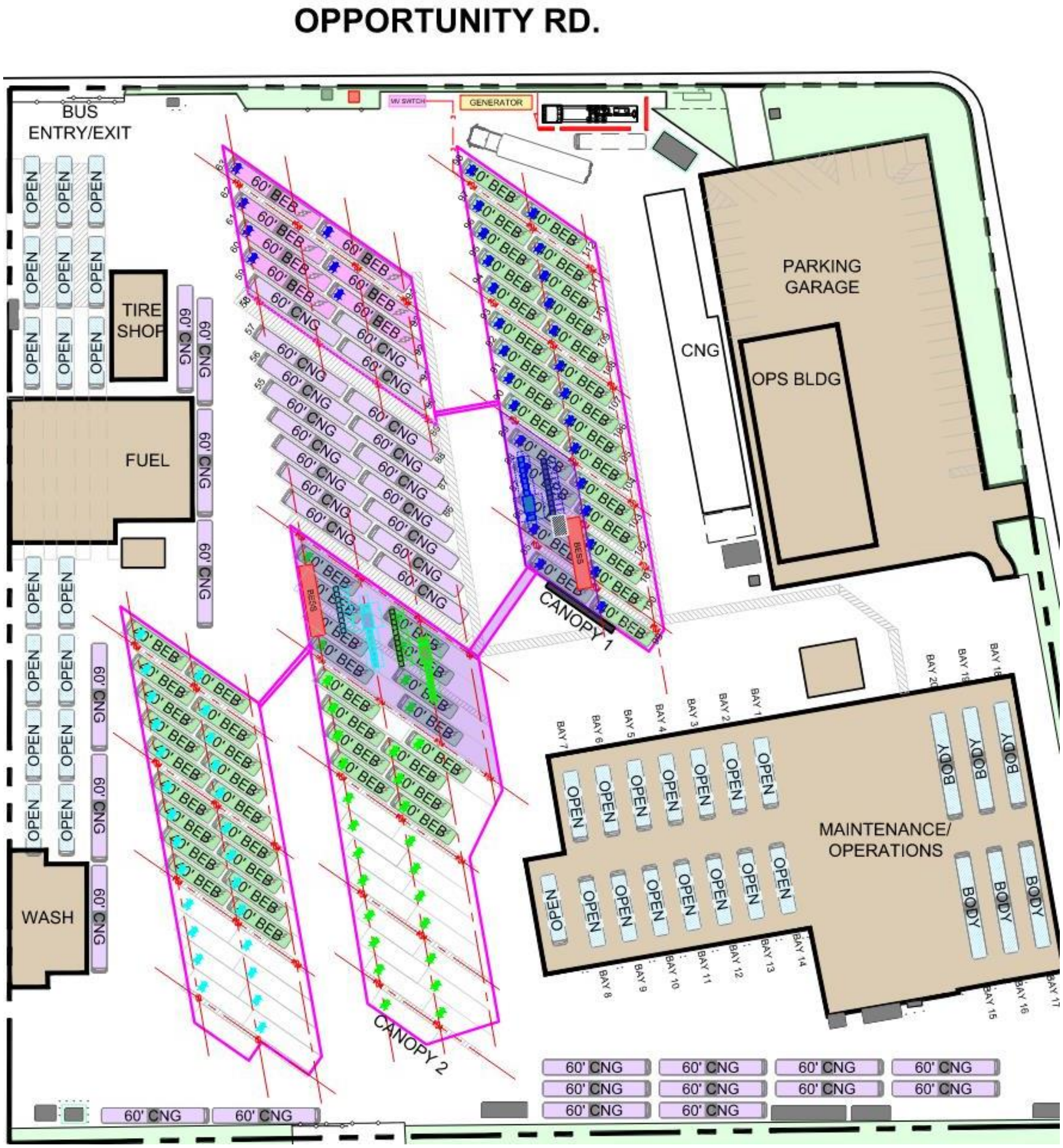
Upon the completion of Phase SC 3, MTS will have the charging capacity to meet their current procurement schedule with a total of eighty-five (85) 40-foot BEBs and seven (7) 60-foot BEBs.

Figure 3-39 – Phase SC 3 Staging Plan

STATISTICS

Assigned Buses:		
40' CNG	40' CNG	14
60' ARTICULATED CNG	60' CNG	35
40' BEB	40' BEB	62
60' ARTICULATED BEB	60' BEB	7
TOTAL		118
Open Buses:		
40' OPEN	OPEN	15
60' OPEN	OPEN	0
Total Capacity		133

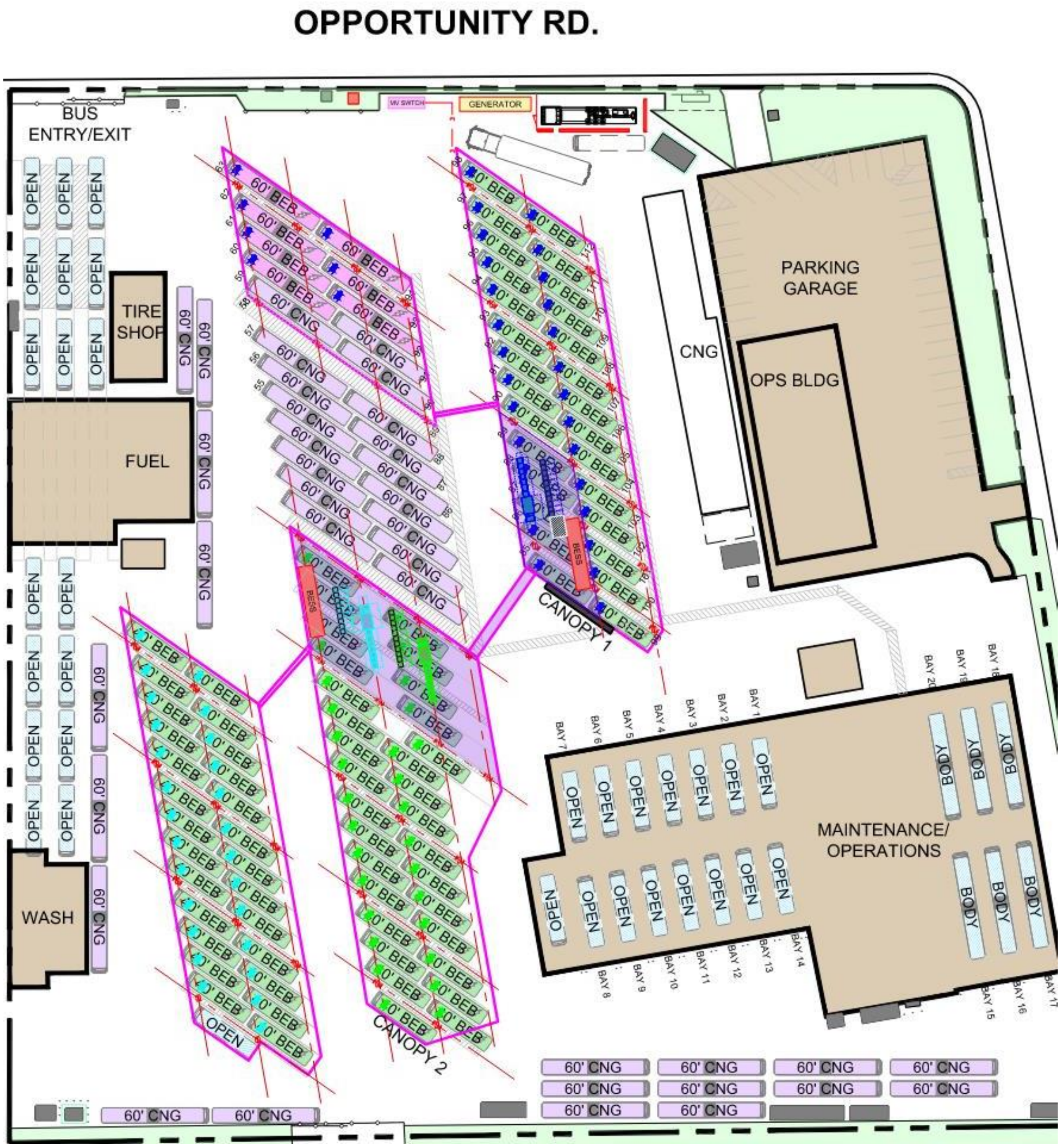
Figure 3-40 – Phase SC 3 Completed Plan



STATISTICS

Assigned Buses:		
40' CNG	40' CNG	14
60' ARTICULATED CNG	60' CNG	35
40' BEB	40' BEB	62
60' ARTICULATED BEB	60' BEB	7
TOTAL		118
Open Buses:		
40' OPEN	OPEN	15
60' OPEN	OPEN	0
Total Capacity		133

Figure 3-41 – Phase SC 3 Occupied Plan



STATISTICS

Assigned Buses:		
40' CNG	40' CNG	0
60' ARTICULATED CNG	60' CNG	35
40' BEB	40' BEB	85
60' ARTICULATED BEB	60' BEB	7
TOTAL		127
Open Buses:		
40' OPEN	OPEN	33
60' OPEN	OPEN	0
Total Capacity		160

3.3.8. Phase 4 – Small Canopies (SC) Option

Phase SC 4 of the Master Plan is the final phase of the Master Plan and features the electrification of the remaining revenue buses on site at MTS's Kearny Mesa Division. This phase assumes that the remainder of KMD's BEB procurement will be for thirty-five (35) 60-foot BEBs and that the eight (8) excess 40-foot BEBs will be relocated to make room. If less 60-foot BEBs are part of the next procurement and excess 40-foot BEBs are to remain on site or be procured the design of the canopies does allow for this. It will be broken into an A, B and C phase similar other phases in this master plan. During this phase, the existing CNG yard will be decommissioned to make room for additional charging positions. Construction phasing plans including Staging (Figure 3-42), Completed (Figure 3-43) and Occupied (Figure 3-44) Plans were developed.

The following infrastructure will be constructed in Phase SC 4A:

- The remaining two (2) overhead steel structure bays will be added to canopy 2 to join the canopy sections constructed during Phase 1B and Phase 2B. The structure, similar to all other canopies, will be built to support the overhead charging dispensers and the optional PV panels.
- Eighteen (18) overhead pantograph dispensers will be installed, along with all associated cabling to connect to the DC charging cabinets on Canopy 2's platform.
- Five (5) additional DC charging cabinets will be installed on Canopy 2's platform and connected to the Unit Substation #2.
- One (1) overhead pantograph dispenser will be installed on the canopy built during Phase 1B and will be connected to a DC charging cabinet on Canopy 1's platform.

The following infrastructure will be constructed in Phase SC 4B:

The following infrastructure will be constructed in Phase SC 4C:

- Overhead steel structure, in the location of the decommissioned CNG yard, will be constructed in similar to the existing canopy structures located at other MTS divisions.
- Three (3) additional DC charging cabinets will be installed on Canopy 1's platform.
- Seven (7) overhead pantograph dispensers will be installed, along with all associated cabling to connect to the DC charging cabinets.

The inclusion of Figure 3-43 Phase SC 4 Completed Plan represents that upon completion of the Phase SC 4 canopy, the construction contractor vacates the site, and Canopy 2 is completed before the incoming BEBs arrive on site. The previously relocated CNG buses that were displaced during construction can now resume parking under Canopy 2 until the (35) CNG buses are replaced by the (35) BEBs in 2035. At the end of this phase there will be (9) additional 40-foot BEBs on site, these BEBs will be relocated to another MTS facility to provide room for the new 60-foot BEBs required at KMD. At the end of Phase SC 4, MTS will have a full electrified fleet at their Kearny Mesa Division. The fleet make up at the end of this phase will consist of charging positions for seventy-seven (77) 40-foot BEBs and forty-two (42) 60-foot BEBs for a total of 119 charging positions on site. This will allow MTS to operate a fleet more than 125 BEBs when accounting for a 15-20 percent spare ratio of buses that will either be out service or set aside in reserve.

Figure 3-42 – Phase SC 4 Staging Plan

STATISTICS

Assigned Buses:

40' CNG	40' CNG	0
60' ARTICULATED CNG	60' CNG	35
40' BEB	40' BEB	85
60' ARTICULATED BEB	60' BEB	7
TOTAL		127

Open Buses:

40' OPEN	OPEN	11
60' OPEN	OPEN	0
Total Capacity		138

Figure 3-43 – Phase SC 4 Completed Plan

STATISTICS

Assigned Buses:

40' CNG	40' CNG	0
60' ARTICULATED CNG	60' CNG	35
40' BEB	40' BEB	85
60' ARTICULATED BEB	60' BEB	7
TOTAL		127

Open Buses:

40' OPEN	OPEN	11
60' OPEN	OPEN	0
Total Capacity		138

Figure 3-44 – Phase SC 4 Occupied Plan

STATISTICS

Assigned Buses:		
40' CNG	40' CNG	0
60' ARTICULATED CNG	60' CNG	0
40' BEB	40' BEB	77
60' ARTICULATED BEB	60' BEB	42
TOTAL		119
Open Buses:		
40' OPEN	OPEN	35
60' OPEN	OPEN	3
Total Capacity		157

Figure 3-45 – SC Overall Staging and Pavement Reconstruction Plan

Pavement Reconstruction Quantities Estimate

Phase 1A: 14,859 square feet
Phase 1B: 6,750 square feet
Phase 2: 18,017 square feet
Phase 3: 10,217 square feet
Phase 4A: 9,661 square feet
Phase 4B: 4,730 square feet

4. Cost Estimate

4.1. Introduction

A Rough Order of Magnitude (ROM) Estimate was developed in adherence to the Association for the Advancement of Cost Engineering (AACE) Estimate Classification 4 standards for study or feasibility end usage and is intended as an approximation of an anticipated construction award value based on the current design of the project. The cost estimate is based on discussions with the design team, preliminary site plans dated July 14, 2023 and preliminary phasing sketches provided August 23, 2023. The complete Cost Estimate was submitted on June 28, 2023 and includes detailed breakdowns for the Master Plan Options and additional detail for generator, energy storage systems, and photovoltaic systems and these are included in Appendix C- Cost Estimate Detailed Spreadsheets. Figure 4-1 is an example of the estimate summary found in Appendix C- Cost Estimate Detailed Spreadsheets. Option 2 presented in the Cost Summary is for reference purposes only. Option 2 was evaluated but not considered and more detail about this option can be found in Appendix B - BEB Master Plan Drawings. Figure 4-2 includes a breakdown of the phased construction total presented on Figure 4-1.

4.2. Inclusions, Exclusions, and Assumptions

- The estimate is based on initial drawings dated July 14, 2023, phased drawing sketches dated August 23, 2023, various email communications with the design team, and multiple collaborative meetings between the estimator and the project manager/design team.
- The estimate includes infrastructure for phases 1A/1B/2A/2B/3A/3B including vehicle canopy structures and associated equipment platforms, and a total 36 charging cabinets and 102 pantographs.
- The estimate includes a 25-percent design contingency commensurate with the level of detail contained within the current design.
- The estimate includes a 12-percent markup for General Contractor Field Office Overhead, which captures costs associated with general conditions and general requirements for the project (contractor mobilization/demobilization, construction supervision staff, temporary offices/restrooms, dumpsters, etc.).
- The estimate assumes that approximately 65-percent of the work will be performed by subcontractors, with 35-percent self-performed by a general contractor. Roughly 65-percent of the direct subtotal is equivalent to the Electrical scope being subcontracted, with the remainder of the work being self-performed.
- The unit rates contained within the estimate are base year 2023 dollars and are inclusive of current material, labor, and equipment costs.
- The estimate includes a markup for escalation to the mid-point of construction from the date of the estimate, assumes a March 2025 start and approximately 16 months of construction at 5.5-percent per annum to an approximate mid-point date of November 2025.
- Materials pricing for charging cabinets and pantographs is based on budgetary pricing from Heliox, provided March 15, 2023.
- In addition to the assumed base bid for construction (Option 1), the estimate is inclusive of several additional options, including:
  - An option to add a ground mounted generator and all additional associated infrastructure.
  - An option to mount the generator at the platform along with the remainder of the electrical gear and charging cabinets. This option is priced as an increase to the cost of the ground mounted generator option.
  - An option to add a BESS.
  - An option to add a Photovoltaic system to the canopies.
- The estimate assumes that the work will be performed during normal working hours as a singular general contract.
- The estimate assumes that the work will be performed in phases to maintain operation of the facility through construction.
- The estimate assumes that the construction will be competitively bid, with a minimum of four general contractor bids and four bids for all subcontracted work.

- Construction market conditions are currently highly volatile. Select materials that will be required for the project, including but not limited to structural steel and electrical gear have seen recent spikes in unit pricing and extensive lead times for procurement. There are likely to be significant fluctuations in unit pricing between now and the time of construction award. It is recommended that this estimate be considered as a snapshot of the fair market value of the project as the design currently depicts. Due to the volatile nature of the current construction market, this estimate should not be considered valid for use beyond this master planning exercise, and the cost of the project should be re-evaluated as the design progresses.
- The estimate excludes costs associated with the following:
  - Design costs, including any delegated design that may occur during construction.
  - Construction Management or Owners Representation.
  - Costs associated with local utility infrastructure improvements that may be required for the project.
  - Permitting.
  - Site Improvements not currently depicted within the design.
  - Costs associated with operations and maintenance, training, bus procurement/upgrades, annual staffing, or energy usage costs.
  - Hazardous material abatement or contaminated soils remediation.
  - Off-site parking/contractor staff transportation.
  - Off-site material laydown/staging areas.
  - Additional owner soft costs or owner construction contingencies.
  - Any item of work not explicitly described within the cost estimate.

Figure 4-1 – Cost-Estimate of Proposed Regrading of South Entrance Area, Phasing Total with Options

Estimate Summary - Options

Division	Description		Phasing Total	Ground Mounted Generator (Included w/ Phasing Total in Phase 1A)	Platform Mounted Generator (Delta from Ground Mounted)	Add Battery Energy Storage System	Add Photovoltaic System
			Total	Total	Total	Total	Total
02	Existing Conditions		$ 359,551	$ -	$ 8,246	$ -	$ -
03	Concrete		$ 437,163	$ -	$ 43,974	$ 2,195	$ -
05	Metals		$ 6,012,292	$ -	$ 105,656	$ -	$ 127,871
09	Finishes		$ 51,946	$ -	$ -	$ -	$ -
11	Equipment		$ 15,919	$ -	$ -	$ -	$ -
26	Electrical		$ 16,690,480	$ -	$ 236,102	$ 2,781,409	$ 364,242
27	Communications		$ 318,287	$ -	$ -	$ -	$ -
31	Earthwork		$ 938,871	$ -	$ 5,406	$ -	$ -
32	Exterior Improvements		$ 333,412	$ -	$ (7,107)	$ -	$ -
33	Utilities		$ 254,383	$ -	$ 186,467	$ -	$ -
Subtotal			**$ 25,412,354**	**$ -**	**$ 578,743**	**$ 2,783,604**	**$ 492,113**
General Contractor Field Office Overhead		*12.00%*	*$ 3,049,482*	*$ -*	*$ 69,449*	*$ 334,032*	*$ 59,054*
Sales Tax on Materials		*Assumes Tax Exempt*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*
Subtotal			$ 28,461,837	$ -	$ 648,192	$ 3,117,636	$ 551,166
Mid Project Escalation, Assumes 3/1/25 Start and 16 Months of Construction at 5.5% Average per year		*10.60%*	*$ 3,017,077*	*$ -*	*$ 68,711*	*$ 330,483*	*$ 58,426*
Escalated Subtotal			**$ 31,478,914**	**$ -**	**$ 716,904**	**$ 3,448,119**	**$ 609,592**
General Contractor Self Performed Work (35%) Subtotal			$ 11,017,620	$ -	$ 250,916	$ 1,206,842	$ 213,357
General Contractor Overhead		*3.00%*	*$ 330,529*	*$ -*	*$ 7,527*	*$ 36,205*	*$ 6,401*
General Contractor Profit		*10.00%*	*$ 1,101,762*	*$ -*	*$ 25,092*	*$ 120,684*	*$ 21,336*
Subcontracted Work (65%) Subtotal			$ 20,461,294	$ -	$ 465,987	$ 2,241,278	$ 396,235
Subcontractors Overhead		*5.00%*	*$ 1,023,065*	*$ -*	*$ 23,299*	*$ 112,064*	*$ 19,812*
Subcontractors Profit		*10.00%*	*$ 2,046,129*	*$ -*	*$ 46,599*	*$ 224,128*	*$ 39,624*
General Contractor Markup on Subcontractor		*5.00%*	*$ 1,176,524*	*$ -*	*$ 26,794*	*$ 128,873*	*$ 22,784*
Subtotal with Contractor Overhead & Profit			**$ 37,156,923**	**$ -**	**$ 846,215**	**$ 4,070,074**	**$ 719,548**
Bonds		*1.50%*	*$ 557,354*	*$ -*	*$ 12,693*	*$ 61,051*	*$ 10,793*
Subtotal			**$ 37,714,277**	**$ -**	**$ 858,908**	**$ 4,131,125**	**$ 730,341**
Design Contingency		*25.00%*	*$ 9,428,569*	*$ -*	*$ 214,727*	*$ 1,032,781*	*$ 182,585*
Total Contract Cost			**$ 47,142,846**	**$ -**	**$ 1,073,635**	**$ 5,163,906**	**$ 912,926**

Figure 4-2 – Cost-Estimate of Proposed Regrading of South Entrance Area, Phasing Breakdown

Estimate Summary - Phasing			Phase 1A	Phase 1B	Phase 2A	Phase 2B	Phase 2C	Phase 3	Phase 4A	Phase 4B	Total
Division	**Description**		**Total**	**Total**	**Total**	**Total**	**Total**	**Total**	**Total**	**Total**	**Total**
02	Existing Conditions		$ 75,658	$ 50,367	$ -	$ 67,941	$ -	$ 73,548	$ -	$ 92,037	$ 359,551
03	Concrete		$ 136,327	$ 67,515	$ -	$ 100,892	$ -	$ 83,385	$ 12,470	$ 36,574	$ 437,163
05	Metals		$ 1,364,583	$ 730,675	$ -	$ 1,462,694	$ -	$ 1,243,637	$ 642,200	$ 568,503	$ 6,012,292
09	Finishes		$ 11,128	$ 6,107	$ -	$ 13,061	$ -	$ 10,979	$ 6,101	$ 4,570	$ 51,946
11	Equipment		$ 15,919	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 15,919
26	Electrical		$ 5,879,904	$ 731,124	$ 355,278	$ 4,479,856	$ 57,276	$ 2,613,532	$ 1,719,438	$ 854,073	$ 16,690,480
27	Communications		$ 74,306	$ 34,160	$ 5,344	$ 76,491	$ 624	$ 61,686	$ 39,573	$ 26,102	$ 318,287
31	Earthwork		$ 207,803	$ 117,071	$ -	$ 231,045	$ -	$ 194,242	$ 107,894	$ 80,816	$ 938,871
32	Exterior Improvements		$ 58,270	$ 14,999	$ -	$ 44,309	$ -	$ 72,437	$ 71,798	$ 71,598	$ 333,412
33	Utilities		$ 177,837	$ 76,546	$ -	$ -	$ -	$ -	$ -	$ -	$ 254,383
Subtotal			**$ 8,001,735**	**$ 1,828,567**	**$ 360,627**	**$ 6,476,292**	**$ 57,903**	**$ 4,353,459**	**$ 2,599,487**	**$ 1,734,284**	**$ 25,412,354**
General Contractor Field Office Overhead		*12.00%*	*$ 960,208*	*$ 219,428*	*$ 43,275*	*$ 777,155*	*$ 6,948*	*$ 522,415*	*$ 311,938*	*$ 208,114*	*$ 3,049,482*
Sales Tax on Materials		*Assumes Tax Exempt*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*
Subtotal			$ 8,961,943	$ 2,047,995	$ 403,903	$ 7,253,446	$ 64,852	$ 4,875,874	$ 2,911,425	$ 1,942,398	$ 28,461,837
Mid Project Escalation, Assumes 3/1/25 Start and 16 Months of Construction at 5.5% Average per year		*10.60%*	*$ 950,005*	*$ 217,096*	*$ 42,815*	*$ 768,897*	*$ 6,875*	*$ 516,864*	*$ 308,624*	*$ 205,903*	*$ 3,017,077*
Escalated Subtotal			**$ 9,911,948**	**$ 2,265,091**	**$ 446,718**	**$ 8,022,343**	**$ 71,726**	**$ 5,392,738**	**$ 3,220,049**	**$ 2,148,300**	**$ 31,478,914**
General Contractor Self Performed Work (35%) Subtotal			$ 3,469,182	$ 792,782	$ 156,351	$ 2,807,820	$ 25,104	$ 1,887,458	$ 1,127,017	$ 751,905	$ 11,017,620
General Contractor Overhead		*3.00%*	*$ 104,075*	*$ 23,783*	*$ 4,691*	*$ 84,235*	*$ 753*	*$ 56,624*	*$ 33,811*	*$ 22,557*	*$ 330,529*
General Contractor Profit		*10.00%*	*$ 346,918*	*$ 79,278*	*$ 15,635*	*$ 280,782*	*$ 2,510*	*$ 188,746*	*$ 112,702*	*$ 75,191*	*$ 1,101,762*
Subcontracted Work (65%) Subtotal			$ 6,442,766	$ 1,472,309	$ 290,367	$ 5,214,523	$ 46,622	$ 3,505,280	$ 2,093,032	$ 1,396,395	$ 20,461,294
Subcontractors Overhead		*5.00%*	*$ 322,138*	*$ 73,615*	*$ 14,518*	*$ 260,726*	*$ 2,331*	*$ 175,264*	*$ 104,652*	*$ 69,820*	*$ 1,023,065*
Subcontractors Profit		*10.00%*	*$ 644,277*	*$ 147,231*	*$ 29,037*	*$ 521,452*	*$ 4,662*	*$ 350,528*	*$ 209,303*	*$ 139,640*	*$ 2,046,129*
General Contractor Markup on Subcontractor		*5.00%*	*$ 370,459*	*$ 84,658*	*$ 16,696*	*$ 299,835*	*$ 2,681*	*$ 201,554*	*$ 120,349*	*$ 80,293*	*$ 1,176,524*
Subtotal with Contractor Overhead & Profit			**$ 11,699,816**	**$ 2,673,657**	**$ 527,295**	**$ 9,469,373**	**$ 84,664**	**$ 6,365,453**	**$ 3,800,865**	**$ 2,535,800**	**$ 37,156,923**
Bonds		*1.50%*	*$ 175,497*	*$ 40,105*	*$ 7,909*	*$ 142,041*	*$ 1,270*	*$ 95,482*	*$ 57,013*	*$ 38,037*	*$ 557,354*
Subtotal			**$ 11,875,313**	**$ 2,713,762**	**$ 535,204**	**$ 9,611,414**	**$ 85,934**	**$ 6,460,935**	**$ 3,857,878**	**$ 2,573,837**	**$ 37,714,277**
Design Contingency		*25.00%*	*$ 2,968,828*	*$ 678,441*	*$ 133,801*	*$ 2,402,853*	*$ 21,483*	*$ 1,615,234*	*$ 964,469*	*$ 643,459*	*$ 9,428,569*
Total Contract Cost			**$ 14,844,141**	**$ 3,392,203**	**$ 669,005**	**$ 12,014,267**	**$ 107,417**	**$ 8,076,168**	**$ 4,822,347**	**$ 3,217,296**	**$ 47,142,846**

Appendix A – Existing Conditions Report

Appendix B – Considered ZEB Master Plan Concepts

(Two design options were created as part of the ZEB Master Plan. These options feature the same charging equipment and similar infrastructure. As shown above in Section 3.2 Recommended Master Plan, Option 1 features three overhead steel structures with one cabling bridge and one personnel/cabling bridge.

The study included the analysis of a second option which was considered but not selected. Option 2 which is shown below as part of Appendix B (Figure B1 and Figure B2) features four overhead steel structures with two cabling bridges and one personnel/cabling bridge. This option separates the canopies over lot 2 and leaves the “Bone Yard” without any means of installing overhead charging infrastructure. This option will decrease costs but will minimize the flexibly of the site to park BEBs during full electrification of the fleet.

The following presents a summary of the electrical elements for the conceptual design for Option 2:

Canopy 1

12 Charging Cabinets

36 Charging positions (dispensers)

1 Unit substation

BESS

Solar

Supporting electrical equipment (lighting, CCTV, power to dispensers)

Canopy 2

16 Charging Cabinets

5000A switchboard and unit substation

10 Charging Cabinets

4000A switchboard and unit substation

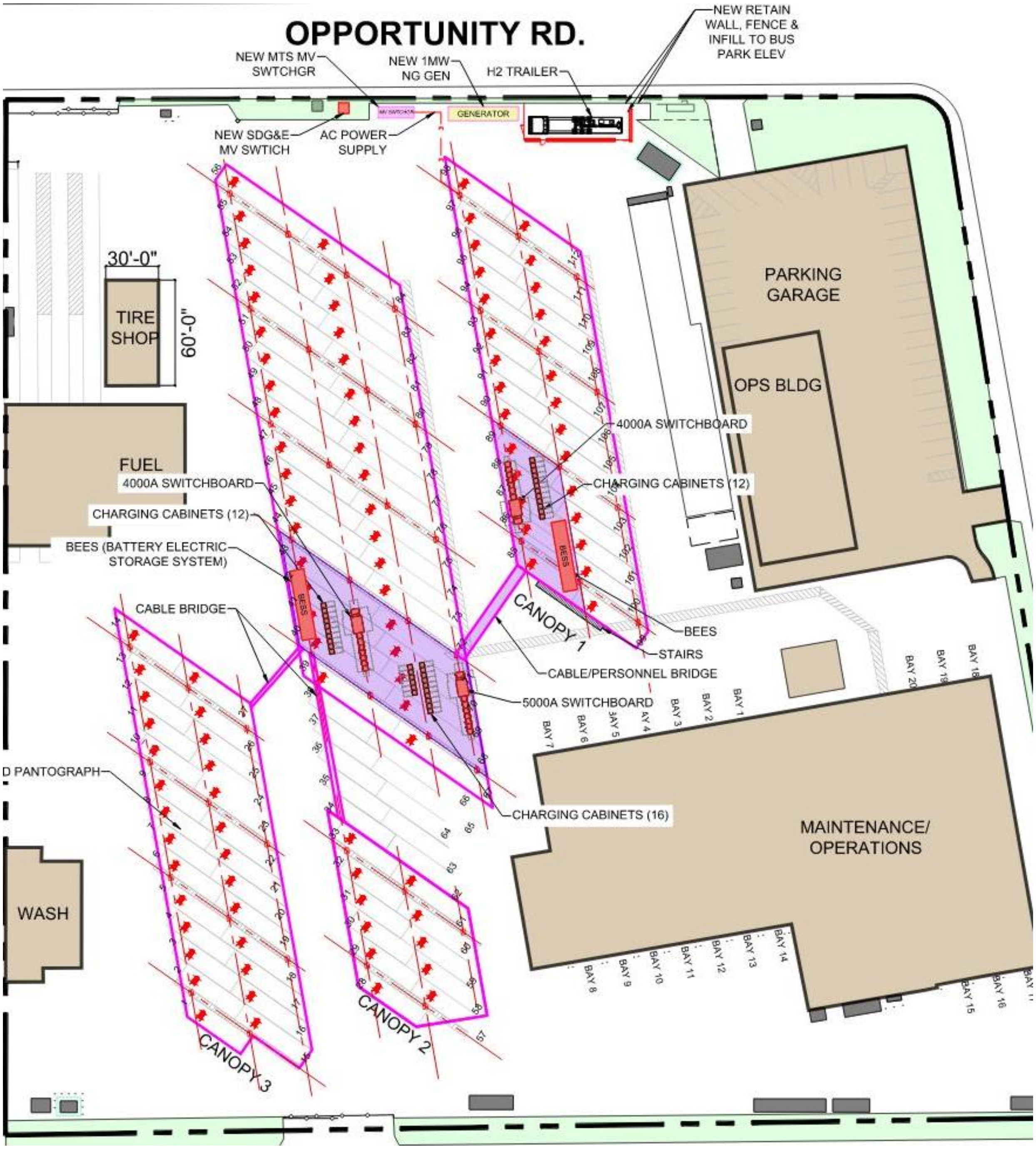
BESS

Solar

Supporting electrical equipment (lighting, CCTV, power to dispensers)

Figure B1 - Pavement Plan - Option 2

Figure B2 - Canopy Plan - Option 2



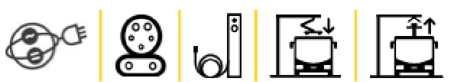
Appendix C – Cost Estimate Detailed Spreadsheets

Appendix D – Basis of Design Equipment

Figure D1 – Heliox Flex 180 kW DC Charging Cabinet

heliox

FLEX 180 kW HPC
3 x 60 kW UL

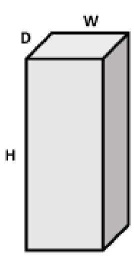


Charge any CCS compatible EV in flexible configurations with up to 180 kW. Performing at industry's highest efficiency of up to 95.5%. A fast and high-efficiency solution for a single vehicle, or a 3-vehicle fleet simultaneously. Covering the complete CharIN high power charging (HPC) required power, voltage and current ranges. Two HPC DC 180 kW chargers can be combined to exceed the HPC350 power class.

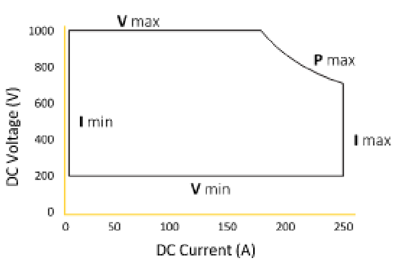
Industry highest component reliability and system redundancy keeps your fleets' battery charged at all times. Charger systems are designed according to the IEC 61851 / UL 2202, communicate according to ISO 15118 / DIN70121 and connect with a CCS-plug (SAE J1772, UL 2251) or alternatively with automated connection device (SAE J3105). This secures all vehicle manufacturer compatibility.

Dimensions

H: 95"
W: 32"
D: 32"



Power Curve



Specifications

General	Charger
Charging standard	SAE J1772 / SAE J3105
Communication standard	DIN70121 / ISO15118-1/2/3 ed1 (incl. V2ICP/VDV261 support)
Compliance and safety	UL 2202 / UL 2231
Output DC voltage range	200 - 1000 V
Rated DC output power	Single output: 180 kW Triple outputs: 60 kW each in parallel OR 180 kW sequential charge mode
Maximum DC output current	Single output: 250 A Triple outputs: 80 A each
Input connections	3P + G
Input power rating; full load / idle	205 kVA / 100 VA
Input line-line voltage range	480 V AC +6/-13 %, 60 Hz
Input maximum AC current per phase	283 A, inrush current limited
Power factor above 50 % rated	> 0.98
Peak efficiency	95.5%
Dielectric withstand	3000 V
Network cellular back office	4G modem, LAN OCPP 1.6J/2.0, ChargeSight
Temperature range	-22 to 113 °F, derating may apply
Operational noise level	<60 dB(A) @ 40"
System weight	1300 lb
Protection	NEMA 3R
Environment operating	ISO 12944: C4 H, optional C5 H

Figure D2 – Heliox Flex 540 kW DC Charging Cabinet

heliox

Flex 540 kW

Versatility. Flexibility. Scalability.

The Heliox Flex 540 kW is a fast and efficient solution for single vehicle opportunity charging. Boasting one of the industry's highest component efficiency ratings, the Flex 540 kW will always have your fleet ready to go.

96.2% Efficiency

General

Charging standard:	SAE J3105-1
Communication standard:	DIN70121 / ISO15118-1/2/3
Compliance and safety:	UL 2202 / UL 2231
Power factor above 50% rated:	>0.98
Peak efficiency:	96.2%
Dielectric withstand:	3000 V
Network cellular:	4G modem, LAN
Back office:	OCPP 1.6J, OCPP 2.0.1 ready
Temperature range:	-22 to 113 °F (derating may apply)
Operational noise level:	<60 dB(A) @ 40"
System weight:	4000 lbs.
Dimensions:	H: 98.5", W: 94.5", D 31.5"
Protection	NEMA 3R
Environment operating:	ISO 12944

Input

Input connections, Frequency	480 V / 60 Hz (3P + GND)
Full load / idle input power	569 kVA / 200 VA
Input line-line voltage range:	480 V AC +6/-13%
Input max. AC phase current:	788 A, no inrush

Output

Output DC voltage range:	150 - 1000 V
Rated DC output power:	540 kW
Maximum DC output current:	750 A

Figure D3 – Pantograph Type 1 – Full Size Pantograph

02 Technical data

Mechanical lifetime of the lifting/lowering system	400.000 cycles
Contact force ¬ Upper/lower limit	500 N ±20 %
Resting force	40 ÷ 50 N
Raising time (from resting position)	~ 17 sec
Lowering time (from resting position)	~ 17 sec
Environmental conditions ¬ Protection Class o Drive unit	 IP 65
¬ Working temperature (min. ÷ max.)	-30 °C ÷ +65 °C

03 Electrical configuration

Inverted Pantograph SLS 201

Number of poles	4
Contact sequence	1. PE 2. DC+ / DC- 3. CP

Main-Power (electronic load)

Nominal operating votlage ¬ Upper limit	750 V DC 1.500 V DC
Charge current ¬ Fast charging ¬ Fast charging max	 500 A (non-stop) 600 A (10 min)

Lowering drive

Operating voltage ¬ Upper / lower limit	24 V DC +30 % ÷ -15 %
Max. operating current	10,3 A
Max. power-on time	20 % at 25 °C
Limit switches	S1 - middle position
Fail-Safe-Function	Yes (additional capacitor packet)

Contact rails

Number of poles	4

Figure D4 – Pantograph Type 2 – Depot Charger

DepotPANTO™

Specifications	DepotPANTO
Nominal Voltage:	1500 VDC
Nominal Current:	400 A
Lowering Time:	≤ 15 seconds
Raising Time:	≤ 15 seconds
Weight:	Approx 187 lbs / 86 kg
Operating Temp:	-13º F to +167º F / -25º C to +75º C
Application:	Indoor

Figure D5 – Pantograph Type 3 – Piston Pantograph

02 Technical data

Mechanical lifetime of the lifting/lowering system	15.000 cycles
Contact force ¬ Upper / lower limit	440 N [99 lbf] ± 10%
Resting lock	self-locking spindle
Raising time (from resting position)	~ 12 sec (dependig on the distance contacts to the vehicle connector)
Lowering time (in resting position)	~ 12 sec (dependig on the distance contacts to the vehicle connector)
Environmental conditions ¬ Protection Class ○ Drive unit (inside column) ○ HV/LV-Box ¬ Working temperature (min. ÷ max.)	 IP 67 IP 66 -20 °C ÷ +60 °C [-4 °F ÷ +140 °F] **For use in covered depots or only with special cover around the Depot-Charger to protect against snow and ice. Additional heating must be discussed.*

03 Electrical configuration

General

Number of Poles	4
Contact sequence	1. PE 2. DC+ / DC- 3. CP

High-voltage (electronic load)

Nominal operating votlage ¬ Upper limit	750 V DC 1.000 V DC
Charge current ¬ Continuous charging	 250 A

Lowering drive

Operating voltage ¬ Upper / lower limit	24 V DC +10 % ÷ -10 %
Max. operating current	13A for 1sec / 10,4A in further operation
Max. power-on time	20 % at 25 °C [77 °F] 17 % at 60 °C [140 °F]
Limit switches	Internal (Software) / *Signal not required for control of Pantograph; The external sensor signals are to be used!*

Figure D6 – Battery Electric Storage System

ABB eStorage Flex 40

Fully integrated Energy Storage System

The state-of-the-art ABB eStorage Flex is a compact, fully integrated, pre-engineered energy storage system designed to maximize the return of investment with an industrialized solution that reduces installation time and complexity as well as transportation costs. The solution is optimized for functionality featuring digital intelligence that improves solution performance and operating costs.

Technical data

1500Vdc

Description	eStorage Flex-40-1035	eStorage Flex-40-1380	eStorage Flex-40-1725	eStorage Flex-40-2070
Electrical specifications				
Maximum Output power (S) [1]	1000kVA	1500kVA	1500kVA	1500kVA
Typical Output power (P) [1,2]	950kW	1300kW	1300kW	1300kW
Installed Energy	1035kWh	1380kWh	1725kWh	2070kWh
Max C-rate	<1C	<1C	<1C	<1C
Nominal voltage	LV: up to 690Vac MV: up to 40.5kV	LV: up to 690Vac MV: up to 40.5kV	LV: up to 690Vac MV: up to 40.5kV	LV: up to 690Vac MV: up to 40.5kV
Frequency	50/60Hz	50/60Hz	50/60Hz	50/60Hz
Power factor range	4-quadrant, 0 to 1	4-quadrant, 0 to 1	4-quadrant, 0 to 1	4-quadrant, 0 to 1
Connection method	3-phase	3-phase	3-phase	3-phase
DC Voltage range	1100-1465Vdc	1100-1465Vdc	1100-1465Vdc	1100-1465Vdc
Equipment				
Enclosure	ABB EcoFlex	ABB EcoFlex	ABB EcoFlex	ABB EcoFlex
Inverter operations modes	VSI Vf, CSI PQ, Islanding, Black-start	VSI Vf, CSI PQ, Islanding, Black-start	VSI Vf, CSI PQ, Islanding, Black-start	VSI Vf, CSI PQ, Islanding, Black-start
Battery chemistry	NMC	NMC	NMC	NMC
Transformer type	Oil-filled, dry-type	Oil-filled, dry-type	Oil-filled, dry-type	Oil-filled, dry-type
AC switchgear	Low-voltage: ABB MNS / Medium-voltage: ABB SafeRing/SafePlus	Low-voltage: ABB MNS / Medium-voltage: ABB SafeRing/SafePlus	Low-voltage: ABB MNS / Medium-voltage: ABB SafeRing/SafePlus	Low-voltage: ABB MNS / Medium-voltage: ABB SafeRing/SafePlus
Ambient temp. range (nom. ratings)	-20°C to +50°C	-20°C to +50°C	-20°C to +50°C	-20°C to +50°C
Relative humidity	5% to 95% non-condensing	5% to 95% non-condensing	5% to 95% non-condensing	5% to 95% non-condensing
General specifications				
Overall dimensions (LxWxH)	12000x2450x2900mm (ISO 40ft)	12000x2450x2900mm (ISO 40ft)	12000x2450x2900mm (ISO 40ft)	12000x2450x2900mm (ISO 40ft)
Weight (maximum)	30460kg	35640kg	38640kg	41460kg
Product compliance				
system	IEEE1547, CA Rule 21, VDE-AR-N 4110/4120	IEEE1547, CA Rule 21, VDE-AR-N 4110/4120	IEEE1547, CA Rule 21, VDE-AR-N 4110/4120	IEEE1547, CA Rule 21, VDE-AR-N 4110/4120
Batteries	IEC 62619, UL1973, UN 38.3, UL9540A	IEC 62619, UL1973, UN 38.3, UL9540A	IEC 62619, UL1973, UN 38.3, UL9540A	IEC 62619, UL1973, UN38.3, UL9540A
Transformer	IEC 60076	IEC 60076	IEC 60076	IEC 60076
Low-voltage distribution	IEC 61439	IEC 61439	IEC 61439	IEC 61439
Fieldbus connectivity (predefined option)	Modbus, for control and monitoring	Modbus, for control and monitoring	Modbus, for control and monitoring	Modbus, for control and monitoring
Local user interface (upgrade package)	ABB local control panel and embedded ABB Energy Management System	ABB local control panel and embedded ABB Energy Management System	ABB local control panel and embedded ABB Energy Management System	ABB local control paneland embedded ABB Energy Management System
Remote connectivity (upgrade package)	Advanced SCADA and cloud connection, IEC 62443	Advanced SCADA and cloud connection, IEC 62443	Advanced SCADA and cloud connection, IEC 62443	Advanced SCADA and cloud connection, IEC 62443

Figure D7 – Natural Gas Generator

Containerized KTA50 series generator set

1000 kVA-1675 kVA 50 Hz
1120 kW-1270 kW 60 Hz

Model	Standby rating		Prime rating			Datasheet	
	50 Hz kVA (kW)	60 Hz kW (kVA)	50 Hz kVA (kW)	60 Hz kW (kVA)	Controller	50 Hz	60 Hz
C1400 D5	1400 (1120)		1250 (1000)		PC3.3	GLD-6126-EN	
C1675 D5	1675 (1340)		1400 (1120)		PC3.3	GLD-6127-EN	
C1675 D5A	1675 (1340)		1500 (1200)		PC3.3	GLD-6128-EN	
C1250 D6		1270 (1588)		1120 (1400)	PC3.3		GLD-6129-EN

Available voltage

50 Hz Line-Neutral/Line-Line	60 Hz Line-Neutral/Line-Line
• 240/416 • 230/400 • 220/380	• 277/480 • 255/440 • 240/416

Generator set features*

Engine and alternator

- Heavy duty air cleaner
- Manual oil drain pump
- Coolant heater
- Alternator heater
- PMG excitation system

Fuel system

- 1000 L fuel tank
- 2000 L fuel tank
- Fuel level warning (high and low)
- Fuel pre-filter with water separator
- Electric fuel pump with external fuel connection

Control panel

- PowerCommand 3.3 with Masterless Load Demand (MLD)
- Motorized 4 pole circuit breaker, fixed type
- 2000 A circuit breaker, 3 pole/4 pole, fixed type
- 2500 A circuit breaker, 3 pole/4 pole, fixed type
- External access to bus bar connection
- Re-connectable neutral/earth link
- Earth leakage protection
- Fuel leakage warning
- Low fuel level warning and shutdown
- Low coolant level shutdown
- Door limit switch on bus bar compartment

Warranty

- 2 years for Standby application
- 1 year for Prime application

Battery

- Easy to access heavy duty maintenance-free battery
- Battery charger
- Battery isolator

*Note: Some options may not be available on all models - consult factory for availability.

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