SACRAMENTO REGIONAL TRANSIT DISTRICT

ZERO EMISSION BUS (PHASE II)

FACILITIES MASTER PLAN REPORT

February 2022

Final

TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND TERMS

Acronym/Term	Description
BEB	Battery-Electric Bus
BMF	Bus Maintenance Facility
Caltrans	California Department of Transportation
CARB	California Air Resources Board
CMAQ	Congestion Mitigation and Air Quality Improvement Program
CNG	Compressed Natural Gas
EZMT	Energy Zone Mapping Tool
FCEB	Fuel Cell Electric Bus
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
GH2	Gaseous Hydrogen
ICT	Innovative Clean Transit
IIJA	Infrastructure Investments and Jobs Act
kW	Kilowatt
MW	Megawatt
RAISE	Rebuilding America Infrastructure with Sustainability and Equity
SacRT	Sacramento Regional Transit District
SMUD	Sacramento Municipal Utility District
TIFIA	Transportation Infrastructure Finance and Innovation Act
USDOE	United States Department of Energy
USDOT	United States Department of Transportation
ZE(B)	Zero Emission (Bus)

EXECUTIVE SUMMARY

Sacramento Regional Transit District (SacRT) is currently planning for a transition to an all-zero emission bus (ZEB) fleet, pursuant to the California Air Resources Board's (CARB) Innovative Clean Transit (ICT) regulation, which mandates all transit agencies in the state to operate all-zero emission (ZE) fleets by 2040.

The Zero Emission Bus Phase II - Facilities Master Plan Report, this report (Phase II), analyzes and presents design concepts for three new purpose-built ZEB garages in the SacRT service area, including a preliminary analysis of power availability, and construction and procurement schedules. The findings from Phase II provide SacRT with an understanding of the viability of meeting the 2040 goal, as well as reasonable and actionable steps that should be taken in subsequent phases to implement the plan.

ES1 BACKGROUND

SacRT has already deployed several battery-electric buses (BEBs) into revenue service to evaluate the technology for a larger-scale deployment; however, there are several constraints that SacRT must address and mitigate to fully transition its fleet by the ICT regulation's 2040 goal. While all transit agencies in the State are faced with the challenges of limited power availability, technological and range limitations, constrained timelines, and relatively high costs, SacRT must also identify, plan for, design, and construct new bus garages to meet its ZEB goals. Retrofitting SacRT's existing garages would require resolving many administrative and physical challenges.

Retrofitting SacRT's existing bus garages to operate ZEBs is not a viable option at this time. For this reason, SacRT is considering decommissioning them and operating from three new, purpose-built, ZEB garages. The objective of Phase II is to analyze and present design concepts the ZEB garages with consideration to both BEB and fuel cell electric bus (FCEB) strategies.

SacRT has developed two plans to outline a strategy to transition its fleet to ZEBs at its existing garages (Downtown, McClellan, and Hazel), the Zero Emission Fleet Study (Appendix A) and the Zero Emission Bus Rollout Plan (Appendix B) – both of which were developed in partnership with WSP. Both studies identified major issues that would need to be mitigated and addressed to effectively comply with CARB's ICT regulation. The main issues taken into consideration are power limitations, constraints with existing garages, range limitations, and high costs, which are evaluated in Phase II.

ES2 EVALUATION APPROACH

WSP held two workshops[1] with SacRT Staff to identify potential sites and discuss the fleet, service, and operational characteristics that each new site would require to be conducive for future ZEB operations, to include vehicle capacity, site acreage, and site shape. To meet SacRT's operational requirements, it was determined that bus maintenance facilities (BMFs) would be required in the north and south areas of the service area, with a smaller, non-BMF site situated in the east. For the North and East Garages, WSP developed "blank slate" concepts, and for the South Garage, WSP overlaid the garage concept over an area of the site that was determined to be the most suitable for SacRT's future operations. In total, WSP developed five options for implementing a bus facility on each identified site.

Whether BEBs or FCEBs (or a combination of both) are selected for SacRT's future service, it is essential that there is enough installed power to support the fueling or charging infrastructure *before* vehicles are delivered and placed in service. The electrical utility, Sacramento Municipal Utility District (SMUD), serves all of Sacramento County – including all

1 July 20th, 2021, and January 21st and 24th, 2022

of SacRT's existing and proposed garages. It is essential that SacRT has an understanding of the power availability at each site and the power demands of its future fleet. WSP coordinated with SMUD and used Argonne National Laboratory's Energy Zone Mapping Tool (EZMT) to determine the available power at each site and used SacRT's future fleet numbers and charger assumptions to calculate the peak power requirements (connected load).

To develop garage concepts, it is essential to understand the number and type of vehicles that will be relocated to the future garages. These characteristics inform space requirements, power and energy needs, and in a subsequent stage, the service and cost implications of dispatching service from new garages. SacRT provided the minimum vehicle design capacity for each ZEB garages and the specific quantities by service type planned at each future garage.

A preliminary construction and vehicle procurement schedule along with a summary of transition-related considerations were developed for this plan. WSP and SacRT coordinated to develop high-level assumptions for durations based on a design-bid-build delivery method. Based on the information developed for the garage concepts, preliminary construction and vehicle procurement schedules, cost and funding options for vehicles, constructions and utility enhancements were developed, and are presented in the findings section.

ES3 FINDINGS

Phase II presents design concepts for three new bus garages, the construction schedules to implement them, and a vehicle procurement schedule that aligns with the ICT regulations purchase requirements. Based on the analysis, here is a summary of the findings:

— **The presented concepts support the requirements of SacRT.** Each concept meets (or exceeds) the vehicle fleet quantity, the parking configuration, and ZEB type that was requested by SacRT. It should be noted that the East and North Garages are based on a "blank slate" concept – therefore, SacRT would need to ensure that the future site can support the dimensions of the concept.

— **Additional power is needed.** As previously mentioned, the specific amount of power available at each site would have to be reviewed by SMUD. However, based on the analysis, the East Garage would require a connected load of 2.3 MW, the North Garage would require a connected load of 6.8 MW, and the South Garage would require a connected load of 23.3 MW. Per conversations with SMUD, the South Garage may require a new substation to support that load – that could cost as much as $10 million.

— **The transition will be expensive.** Actual cost estimates will come at a later stage; however, the construction and vehicles to support East Garage, not including land acquisition, would cost north of $20 million. The South Garage – also not including land acquisition – is expected to cost roughly 10 times the amount of East Garage.

— **Several refinements and decisions need to be made before proceeding.** At this point, these drawings and concepts, while informative, will have to remain cursory until sites are acquired. At that point, conceptual drawings and schedules can be further developed and more detail planning can be accomplished.

ES4 NEXT STEPS

The following are the recommended steps that SacRT take to further their transition planning efforts:

1. Acquire sites and begin utility coordination and negotiations.
2. Refine conceptual drawings and/or develop 100% designs and a detailed Master Plan.
3. Plan service relocations and identify cost impacts.
4. If necessary, engage CARB to file for exemptions

1 INTRODUCTION

Sacramento Regional Transit District (SacRT) – as with all agencies in the state – is currently planning for a transition to an all-zero emission bus (ZEB) fleet, pursuant to the California Air Resources Board's (CARB) Innovative Clean Transit (ICT) regulation.

SacRT has already deployed several battery-electric buses (BEBs) into revenue service to evaluate the technology for a larger-scale deployment; however, there are several constraints that SacRT must address and mitigate to fully transition its fleet by the ICT regulation's 2040 goal. While all transit agencies in the State are faced with the challenges of limited power availability, technological and range limitations, constrained timelines, and relatively high costs, SacRT must also identify, plan for, design, and construct new bus garages to meet its ZEB goals. Retrofitting SacRT's existing garages would require resolving many administrative and physical challenges – many of which would be too costly or have time implications that threaten meeting the ICT regulation's 2040 goal.

The Zero Emission Bus Phase II - Facilities Master Plan Report, this report (Phase II), analyzes and presents design concepts for three new purpose-built ZEB garages in the SacRT service area, including a preliminary analysis of power availability, and construction and procurement schedules. The findings from Phase II provide SacRT with an understanding of the viability of meeting the 2040 goal, as well as reasonable and actionable steps that should be taken in subsequent phases to implement the plan.

1.1 SACRT'S ZEB BACKGROUND

SacRT has developed two plans to outline a strategy to transition its fleet to ZEBs at its existing garages (Downtown, McClellan, and Hazel), the Zero Emission Fleet Study (Appendix A) and the Zero Emission Bus Rollout Plan (Appendix B) – both of which were developed in partnership with WSP. Both studies identified major issues that would need to be mitigated and addressed to effectively comply with CARB's ICT regulation, including:

- **Power limitations.** The Sacramento Municipal Utility District (SMUD) found that the Downtown Garage had a peak capacity of 11 megawatts (MW), far fewer than the potential peak demand that would be required to support the 197 buses that are parked there (pre-charge management strategies).
- **Constraints with existing garages.**
  - **Downtown Garage:** SacRT leases bus storage parking beneath the Capital City freeway overpass between 28th and 29th street, from Capitol Ave to Q streets, adjacent to its Downtown Garage and main administrative campus at 1400 29th Street. The bus parking lots are leased from the California Department of Transportation (Caltrans), meaning, SacRT lacks the authority to construct infrastructure without Caltrans' approval. Although there are approximately 197 buses currently parked at the Downtown Garage, only 146 charging positions can be supported there due to Caltrans' setback and easement requirements for charging infrastructure – resulting in the required displacement of approximately 50 buses. Hydrogen operations are also not feasible at the Downtown Garage due to code restrictions on hydrogen storage in proximity to the freeway.
  - **Hazel Garage:** The Hazel Garage, under existing conditions consisting of only bus parking and operations support, is not suitable for a sufficient amount of ZEB-supporting infrastructure.
  - **McClellan Garage:** The McClellan Garage is located far from routes that serve downtown and would drastically increase deadhead trip distances if the additional 50 buses were placed there. McClellan would also require costly renovations and retrofits to accommodate a large(r) fleet. There is also concern of environmental ground contamination SacRT would be responsible to clean up if the ground is disturbed.

— **Range Limitations.** Based on previous service modeling, approximately 50% of SacRT's existing blocks could be completed with existing BEB technology. While there have been advancements since this modeling analysis was conducted, dispatching vehicles from a new facility may require restructuring blocks and risk an increase in range requirements.

— **High Costs.** The cost of charging equipment and vehicles was estimated at approximately $189 million. This cost estimate was not inclusive of utility enhancements and/or acquisition of new property.

Based on the findings from these studies, SacRT has determined that the most cost-effective and time-efficient method to meet ZEB requirements would be to acquire property and construct new, purpose-built ZEB maintenance garages.

1.2 REPORT PURPOSE AND STRUCTURE

The purpose of this report is to analyze and present design concepts for the three new purpose-built ZEB garages with consideration to both BEB and fuel cell electric bus (FCEB) strategies. The findings of this report will serve as the foundation for further refinements, evaluation, and the development of SacRT's design criteria for ZEB implementation. It should be noted that this report does not analyze the service or operational impacts that would arise if SacRT were to relocate its garages. These factors, while essential to consider and address, will be analyzed in a subsequent stage of project implementation.

This report is organized into five main sections:

5 **Introduction** – Provides the background on the project, SacRT's previous ZEB studies, and the report's purpose and structure.

6 **Garage Concepts –** Overview of the general background and approach taken to develop garage concepts and estimate power needs, and presents the site-specific design concepts, improvements, and considerations.

7 **ZEB Transition –** Presents the proposed construction schedule and and procurement schedule.

8 **Costs and Funding –** Presents an opinion of probable costs associated with the transition.

9 **Findings and Next Steps –** Summarizes the findings of the report and identifies the next steps in the process of transitioning SacRT's fleet to ZEBs.

2 GARAGE CONCEPTS

The Garage Concepts section provides an overview of the general background and approach taken to develop garage concepts and estimate power needs, and presents the site-specific design concepts, improvements, and considerations.

2.1 BACKGROUND AND APPROACH

2.1.1 GARAGES

As previously mentioned, retrofitting SacRT's existing bus garages to operate ZEBs is not a viable option at this time. For this reason, SacRT is considering decommissioning them and operating from three new, purpose-built, ZEB garages. WSP held two workshops[2] with SacRT Staff to identify potential sites and discuss the fleet, service, and operational characteristics that each site would require to be conducive for future ZEB operations, to include vehicle capacity, site acreage, and site shape.

To meet SacRT's operational requirements, it was determined that bus maintenance facilities (BMFs) would be required in the north and south areas of the service area (hereinafter referred to as "North Garage" and "South Garage"), with a smaller, non-BMF site situated in the east (hereinafter referred to as "East Garage"). The future site for the East Garage has not yet been identified; however, it is assumed that it would generally have many of the same operating characteristics of SacRT's Hazel Division. There are several potential sites that have been identified for the future North and South Garage; however, SacRT's Real Estate Team is still evaluating the viability of these sites.

For the North and East Garages, WSP developed "blank slate" concepts, and for the South Garage, WSP overlaid the garage concept over an area of the site that was determined to be the most suitable for SacRT's future operations. In total, WSP developed five options for implementing a bus facility on each identified site. The specifications and sizing of the facility were calculated using a proprietary space calculator tool developed by WSP. The presented options are high-level schematic layouts which presuppose further design development at a later stage. All concepts can also be found in Appendix C. Table 2-1 summarizes the main takeaways from these workshops as they pertain to the general assumptions for each garage concept.

Table 2-1. Summary of General Garage Concept Assumptions

	East Garage	North Garage	South Garage
Location	TBD	TBD	TBD
Function	Storage and Dispatch	Storage, Dispatch, O&M	Storage, Dispatch, O&M
ZEB Operations*	BEB-only	BEB and/or FCEB	BEB and/or FCEB
Minimum Fleet Vehicle Capacity	35	100	300
Operational Specifications	Herringbone Parking	Herringbone Parking	Herringbone Parking

Source: WSP and SacRT
*Gaseous hydrogen (GH2) for FCEBs is assumed to delivered, not produced on-site.

2 July 20th, 2021, and January 21st and 24th, 2022

2.1.2 UTILITIES

Whether BEBs or FCEBs (or a combination of both) are selected for SacRT's future service, it is essential that there is enough installed power to support the fueling or charging infrastructure *before* vehicles are delivered and placed in service. For BEBs, the electrical infrastructure (transformers, switchgear, circuits, etc.) and supplied power must be able to support all vehicles being charged at once. FCEB operations generally do not require as much power as BEBs; however, power is still needed to vaporize, compress, and dispense the gaseous fuel.

The electrical utility, SMUD, serves all of Sacramento County – including all of SacRT's existing and proposed garages. Since it is likely that new service connections and/or additional power from SMUD will be required to support the new garages' operations, it is essential that SacRT has an understanding of the power availability at each site and the power demands of its future fleet. WSP coordinated with SMUD and used Argonne National Laboratory's Energy Zone Mapping Tool (EZMT) to determine the available power at each site and used SacRT's future fleet numbers and charger assumptions to calculate the peak power requirements (connected load). These data help inform the request(s) that need to be eventually submitted to SMUD to begin the process of installing the required power upgrades.

To determine the peak power demand (MW) of each site, the number of standard buses and cutaways assigned to each site were multiplied by the proposed charger type's rating (kW). While it is highly unlikely that SacRT would meet the peak capacity (based on staggered service schedules, inherent charging inefficiencies, etc.), this provides a conservative power requirement estimate to plan around and optimize from. It should be noted that a FCEB strategy would not need this much power, but for planning purposes the WSP team assumed the worst-case scenario for each garage.

Since the addresses for the prospective South Garage and North Garage(s) were provided by SacRT, WSP was able to utilize the EZMT to identify the characteristics of the power transmission and distribution within the vicinity of these sites. The addresses and an estimated power need (before analysis was conducted) were submitted to SMUD's Distribution Planning Team to validate and determine if capacity was available. For the sites that SMUD found had sufficient power, they assumed that it would take a little over two years for construction (permitting, design, line extensions, etc.). For this reason, WSP is assuming that utility infrastructure enhancements – for any garage – will require at least three years. Table 2-2 summarizes the data that SMUD provided.

Table 2-2. Summary of Power Availability at South and North Sites

Site	Site Location	Estimated Need (MW)	Proposed Connection/Circuit	Available Capacity (Y/N)
South	Site A	15	69 kV	No
North	Site A	5	69 kV	No
	Site B	5	69 kV	No
	Site C	5	69 kV	Yes
	Site D	5	69 kV	Yes
	Site E	5	69 kV	Yes
	Site F	5	69 kV	No

Source: SMUD

2.1.3 FLEET

To develop garage concepts, it is essential to understand the number and type of vehicles that will be relocated to the future garages. These characteristics inform space requirements, power and energy needs, and in a subsequent stage, the service and cost implications of dispatching service from new garages. SacRT provided the minimum vehicle design capacity for each garage (Table 2-1) and the specific quantities by service type planned at each future garage (Table 2-3).

Table 2-3. Summary of Future Fleet Assignments

Site	40-Foot Bus	SacRT GO and E-Van	CBS	Fleet Total
East	5	16	10	31
North	50	24	16	90
South	197	90	37	324
			Total	445

Source: SacRT

2.2 EAST GARAGE

2.2.1 BATTERY-ELECTRIC BUS CONCEPT

The East Garage will be situated on a 5.2-acre site that will have the capacity and capability to charge and store up to 35 fleet vehicles, 30 non-revenue vehicles, and 100 personal vehicles for employees.

The transit fleet will be parked in a double-stacked, single row, herringbone lot under a canopy structure that will support overhead charging. Buses will be charged by pantographs that are connected to 150 kW chargers and cutaways and vans will be charged by plug-in dispensers that are connected to 180 kW chargers. The 150 kW chargers will support two charging positions (1:2) and 180 kW chargers will support three charging positions (1:3). Based on the number of chargers and charger rating(s), the site is expected to have an approximate connected load of 2.3 MW.

The canopy will be supported by columns which are positioned on a two-foot wide raised median between the parking tracks. Charging infrastructure (charging cabinets and low-voltage switchgear) will be consolidated on the paved island at the end of the row. Site construction is expected to be built in a single phase. Specific strategies and locations of equipment to address resilience, such as photovoltaics, battery storage, and redundant circuits will be evaluated in subsequent stages once sites have been acquired.

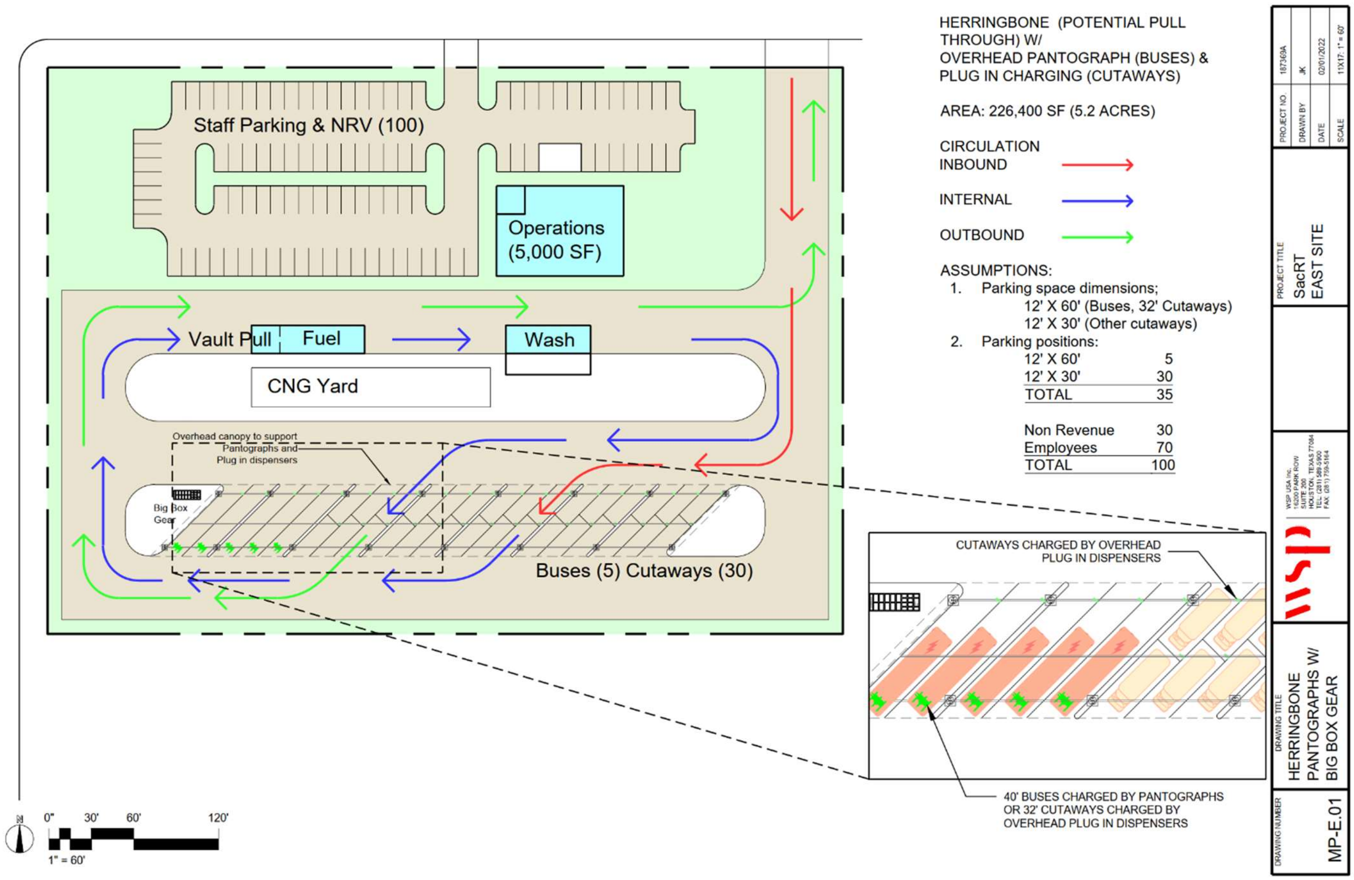
A CNG yard is also presented based on the assumption that SacRT will continue to operate CNG buses after the garage is completed. The CNG yard will be decommissioned once SacRT fully transitions to ZEBs. A summary of the number of planned chargers, charging positions, and required power to support the garage is summarized in Table 2-4 and illustrated in Figure 2-1.

Table 2-4. East Garage BEB Concept Summary

East Garage	Buses	Cutaways + Vans	Total
No. of Chargers	3	10	13
Fleet Charging Positions	5	30	35
Peak Demand (kW)	450	1,800	2,250

Source: WSP

Figure 2-1. East Garage BEB Concept



Source: WSP

2.3 NORTH GARAGE

2.3.1 BATTERY-ELECTRIC BUS CONCEPT

The North Garage will be situated on a 13-acre site that will have the capacity and capability to charge, store, and maintain up to 100 fleet vehicles, 30 non-revenue vehicles, and 150 personal vehicles for employees.

The transit fleet will be parked in a double-stacked, two-row, herringbone lot under canopy structures (one structure per row) that will support overhead charging. Buses will be charged by pantographs that are connected to 150 kW chargers and cutaways and vans will be charged by plug-in dispensers that are connected to 180 kW chargers. The 150 kW chargers will support two charging positions (1:2) and 180 kW chargers will support three charging positions (1:3). Based on the number of chargers and charger rating(s), the site is expected to have a connected load of 6.8 MW.

Parking canopies will be supported by columns which are positioned on two-foot wide raised medians between parking tracks. Charging infrastructure (charging cabinets and low-voltage switchgear) will be consolidated on the paved island at the end of the row. Specific strategies and locations of equipment to address resilience, such as photovoltaics, battery storage, and redundant circuits will be evaluated in subsequent stages once sites have been acquired.

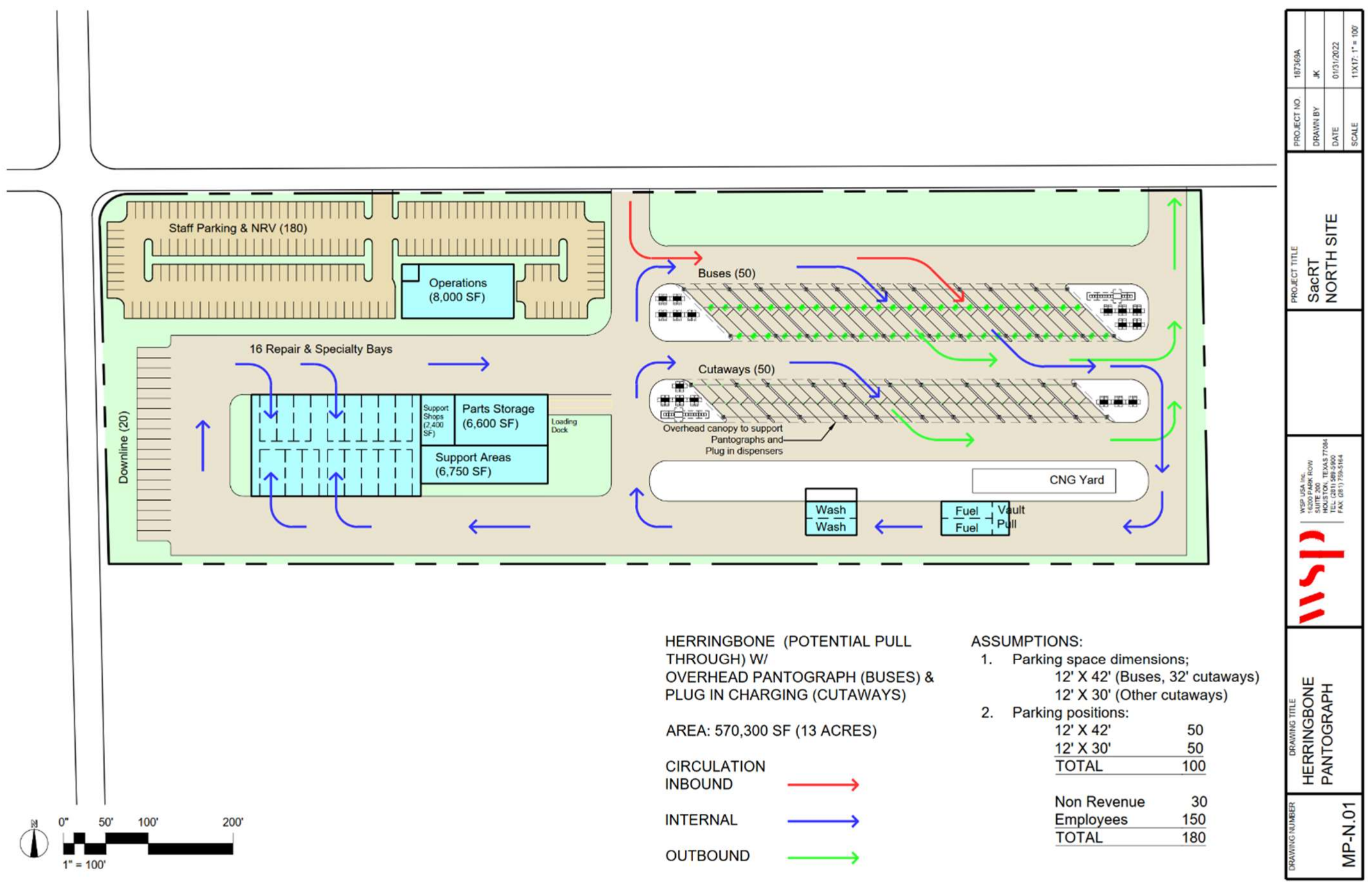
A CNG yard is also presented based on the assumption that SacRT will continue to operate CNG buses after the garage is completed. The CNG yard will be decommissioned once SacRT fully transitions to ZEBs. A summary of the number of planned chargers, charging positions, and required power to support the garage is summarized in Table 2-5 and illustrated in Figure 2-2.

Table 2-5. North Garage BEB Concept Summary

North Garage	Buses	Cutaways + Vans	Total
No. of Chargers	25	17	42
Fleet Charging Positions	50	50	100
Peak Demand (kW)	3,750	3,060	6,810

Source: WSP

Figure 2-2. North Garage BEB Concept



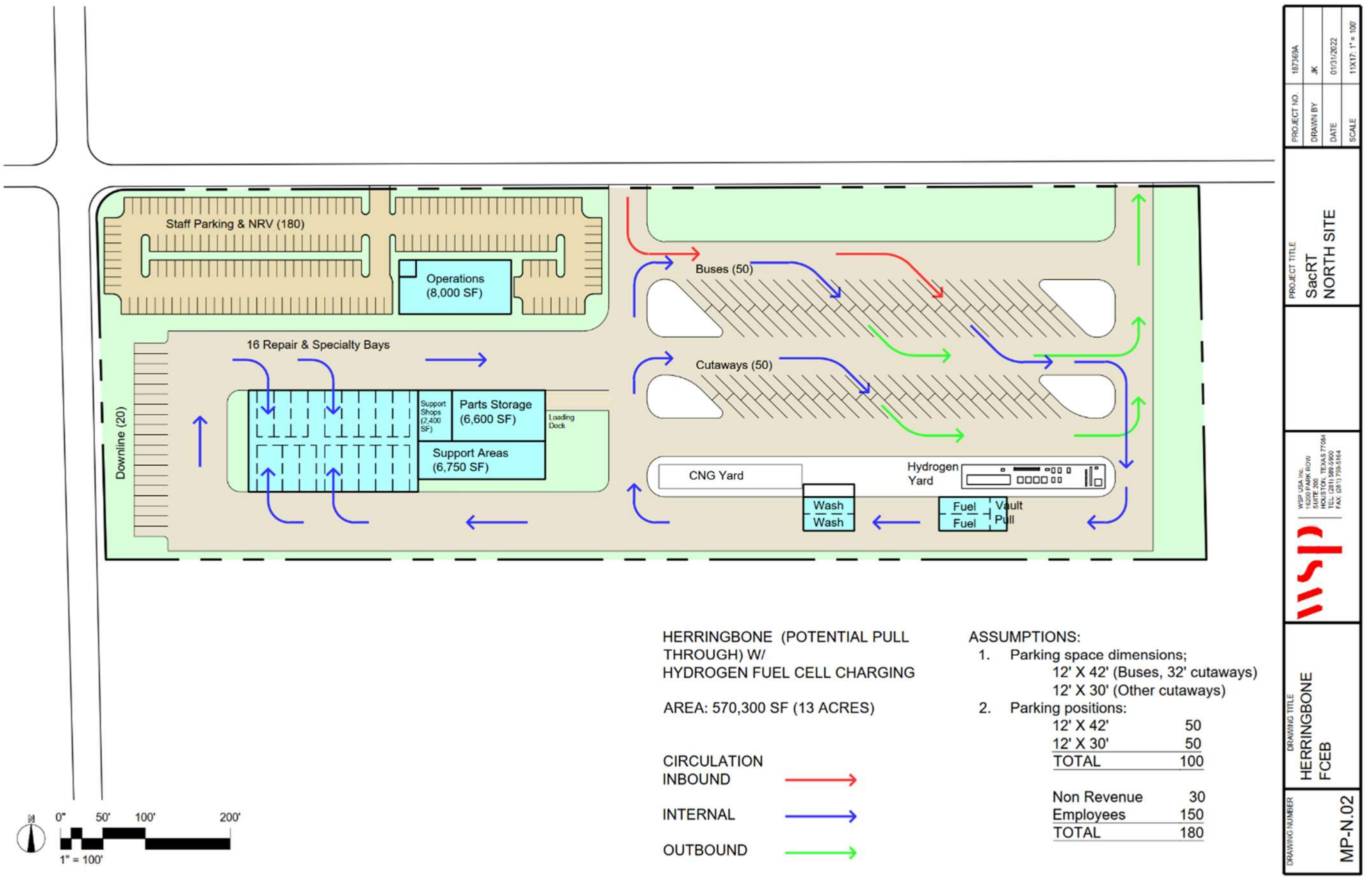
Source: WSP

2.3.2 FUEL CELL ELECTRIC BUS CONCEPT

The North Garage FCEB concept accommodates the same quantity of vehicles as the BEB concept. The exception is that the parking areas in the FCEB concept are clear of any structural columns or canopies because the vehicles are only stored in the area, they are fueled at the proposed hydrogen yard at the southeastern portion of the garage.

The specific sizing of the hydrogen storage tank will be evaluated in a subsequent stage. As with the BEB concept, a CNG yard is also presented based on the assumption that SacRT will continue to operate CNG buses after the garage is completed. The CNG yard will be decommissioned once SacRT fully transitions to ZEBs. The garage's FCEB concept is illustrated in Figure 2-3.

Figure 2-3. North Garage FCEB Concept



Source: WSP

2.4 SOUTH GARAGE

2.4.1 BATTERY-ELECTRIC BUS CONCEPT

The South Garage will be situated on a 28-acre site that will have the capacity and capability to charge, store, and maintain up to 336 fleet vehicles, 20 non-revenue vehicles, and 325 personal vehicles for employees.

The transit fleet will be parked in a double-stacked, six-row, herringbone lot under canopy structures (one structure per row) that will support overhead charging – each row holds 56 vehicles. Buses will be charged by pantographs that are connected to 150 kW chargers and cutaways and vans will be charged by plug-in dispensers that are connected to 180 kW chargers. The 150 kW chargers will support two charging positions (1:2) and 180 kW chargers will support three charging positions (1:3). Based on the number of chargers and charger rating(s), the site is expected to have a connected load of 23.3 MW.

Parking canopies will be supported by columns which are positioned on two-foot wide raised medians between parking tracks. Charging infrastructure (charging cabinets and low-voltage switchgear) will be consolidated on the paved island at the end of the row. Construction of the South Garage can be done in a single (full buildout) phase – supporting up to 336 vehicles or in two separate phases. Specific strategies and locations of equipment to address resilience, such as photovoltaics, battery storage, and redundant circuits will be evaluated in subsequent stages once sites have been acquired.

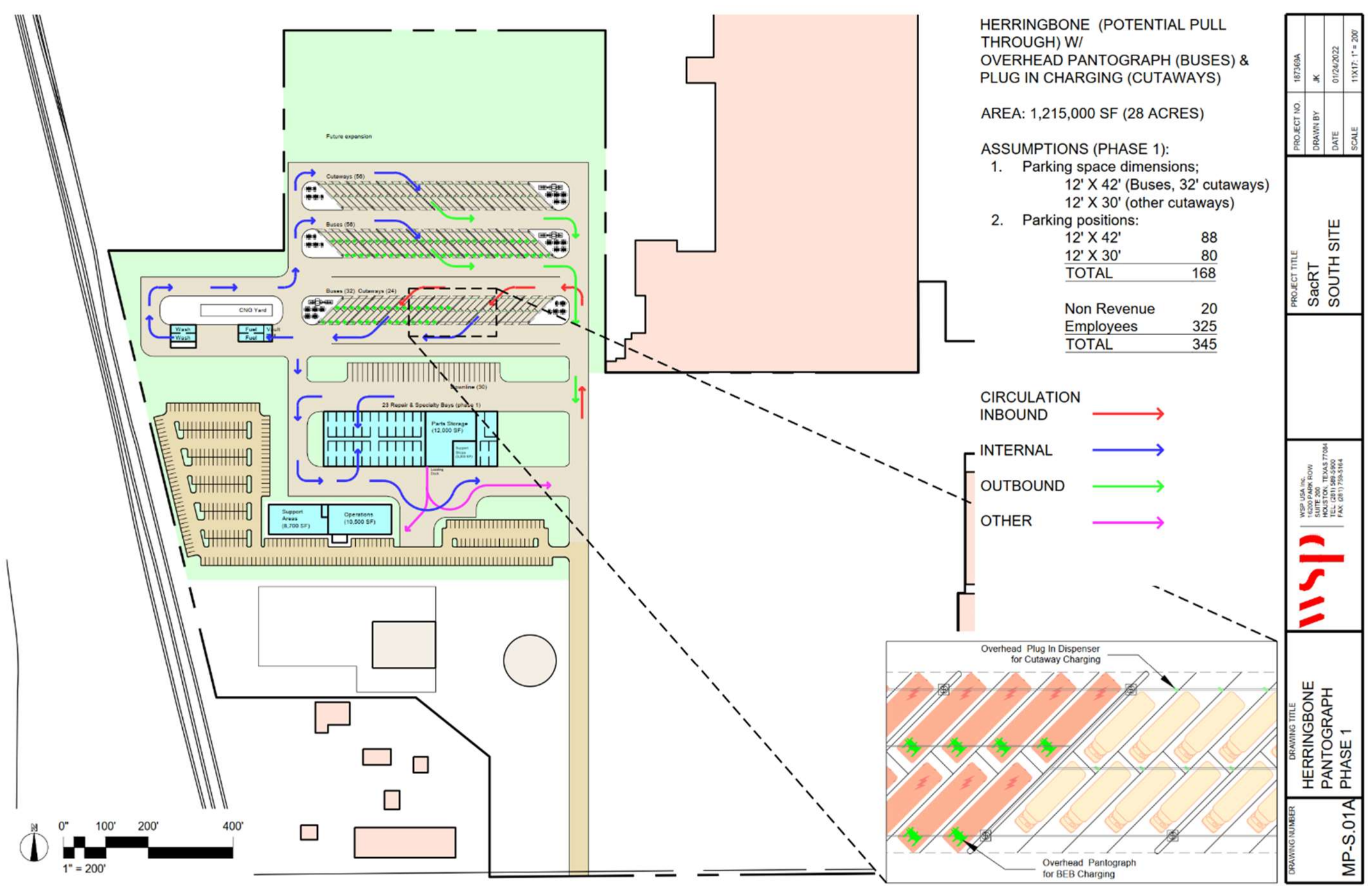
A CNG yard is also presented based on the assumption that SacRT will continue to operate CNG buses after the garage is completed. The CNG yard will be decommissioned once SacRT fully transitions to ZEBs. A summary of the number of planned chargers, charging positions, and required power to support the garage is summarized in Table 2-6 and illustrated in the Phase 1 and Phase 2 drawings, Figure 2-4 and Figure 2-5, respectively.

Table 2-6. South Garage BEB Concept Summary (Full Buildout)

South Garage	Buses	Cutaways + Vans	Total
No. of Chargers	100	46	146
Fleet Charging Positions	200	136	336
Peak Demand (kW)	15,000	8,280	23,280

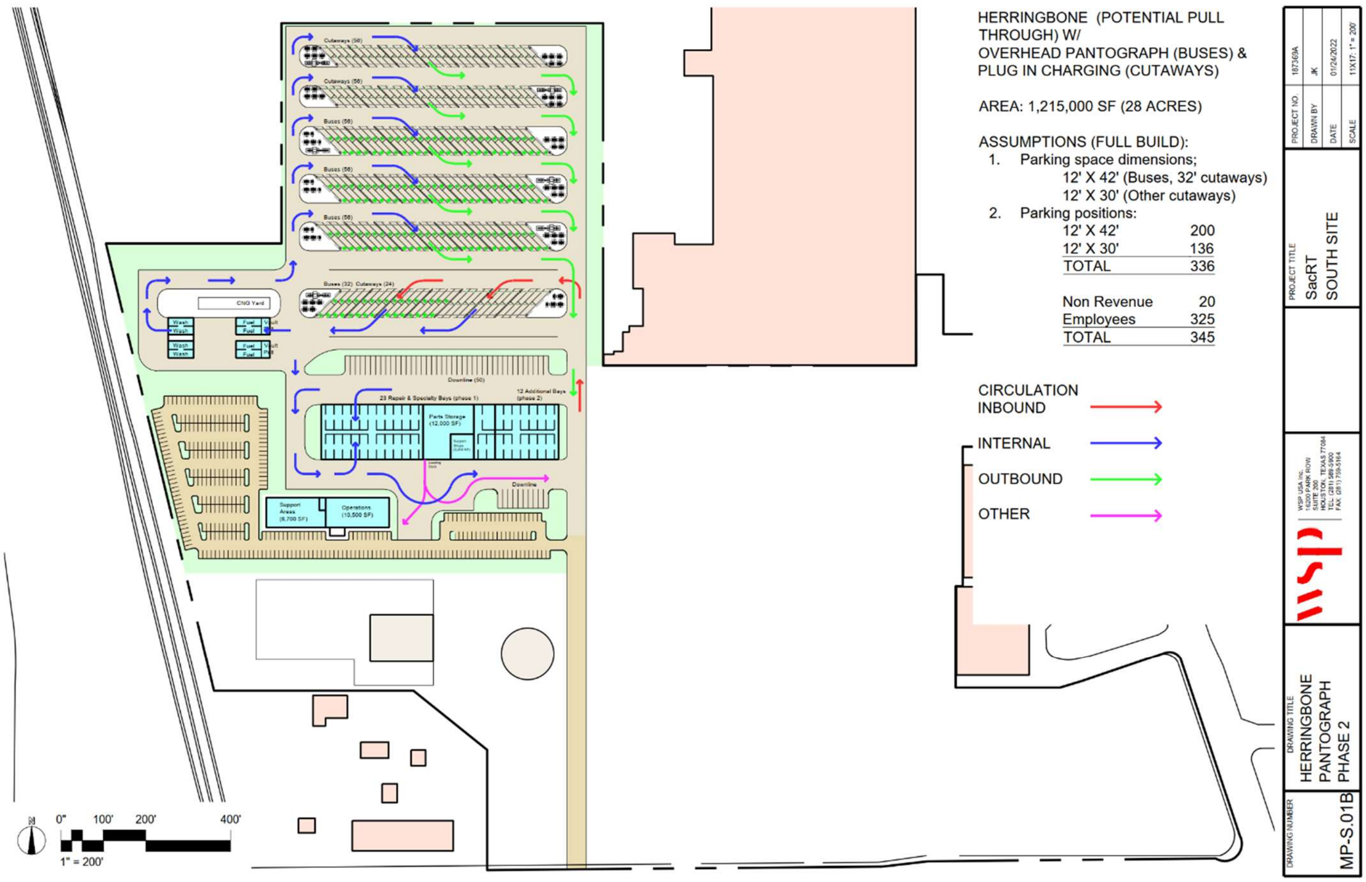
Source: WSP

Figure 2-4. South Garage BEB Concept (Phase 1)



Source: WSP

Figure 2-5. South Garage BEB Concept (Phase 2)



Source: WSP

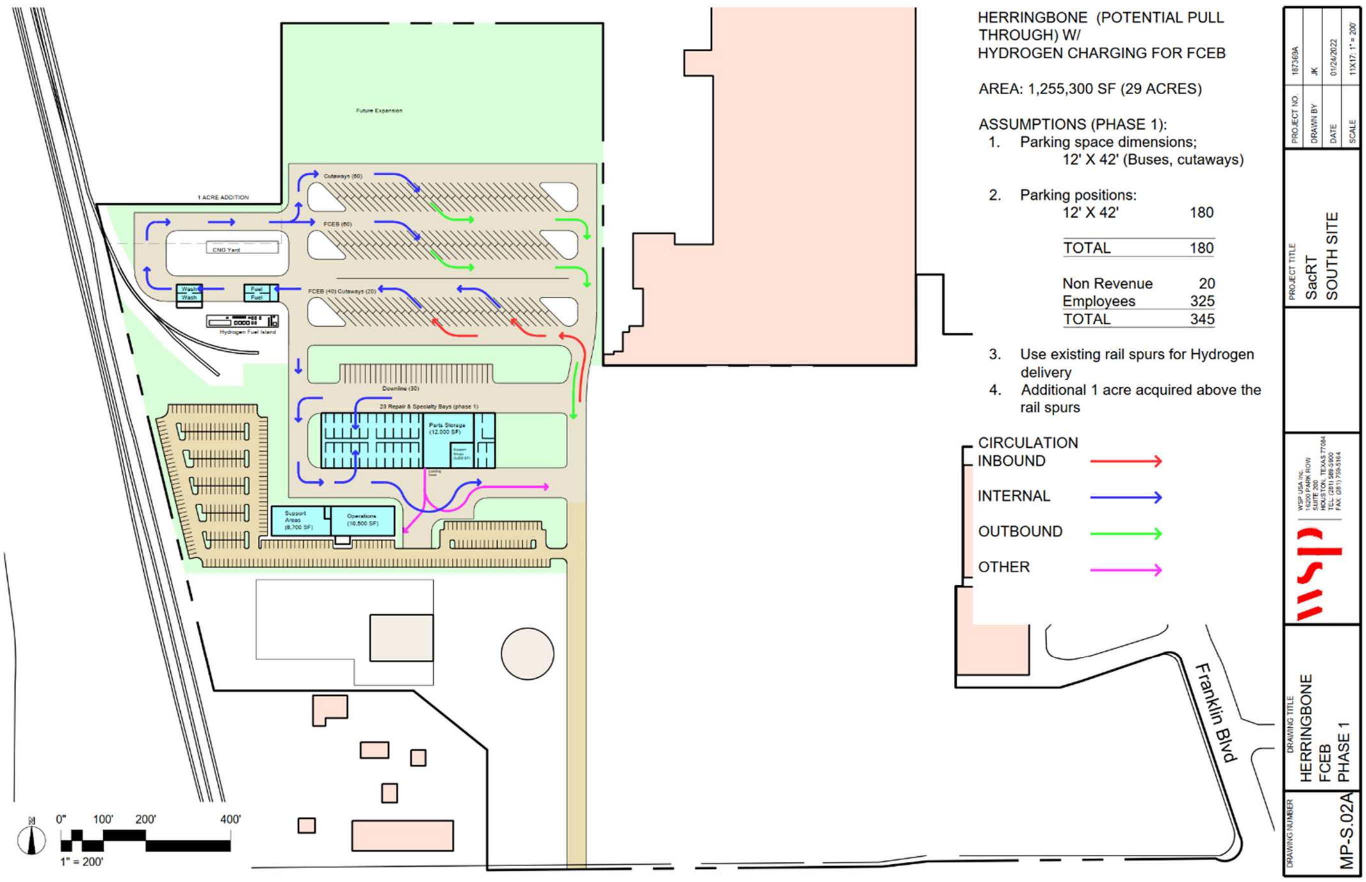
2.4.2 FUEL CELL ELECTRIC BUS CONCEPT

The South Garage FCEB concept accommodates 330 vehicles (six fewer than the BEB concept). The option also occupies an additional acre (29 total) due to the retainment of the existing on-site rail spurs. The team continues to analyze if these tracks can support hydrogen delivery in the future.

At full buildout, the FCEB concept will consist of five rows of double-stacked parking and a single row of single parking. The doubled-stacked rows can store 60 vehicles and the single rows can store 30 vehicles. The parking areas are clear of any structural columns or canopies because the vehicles are only stored in the area, they are fueled at the proposed hydrogen yard to the west.

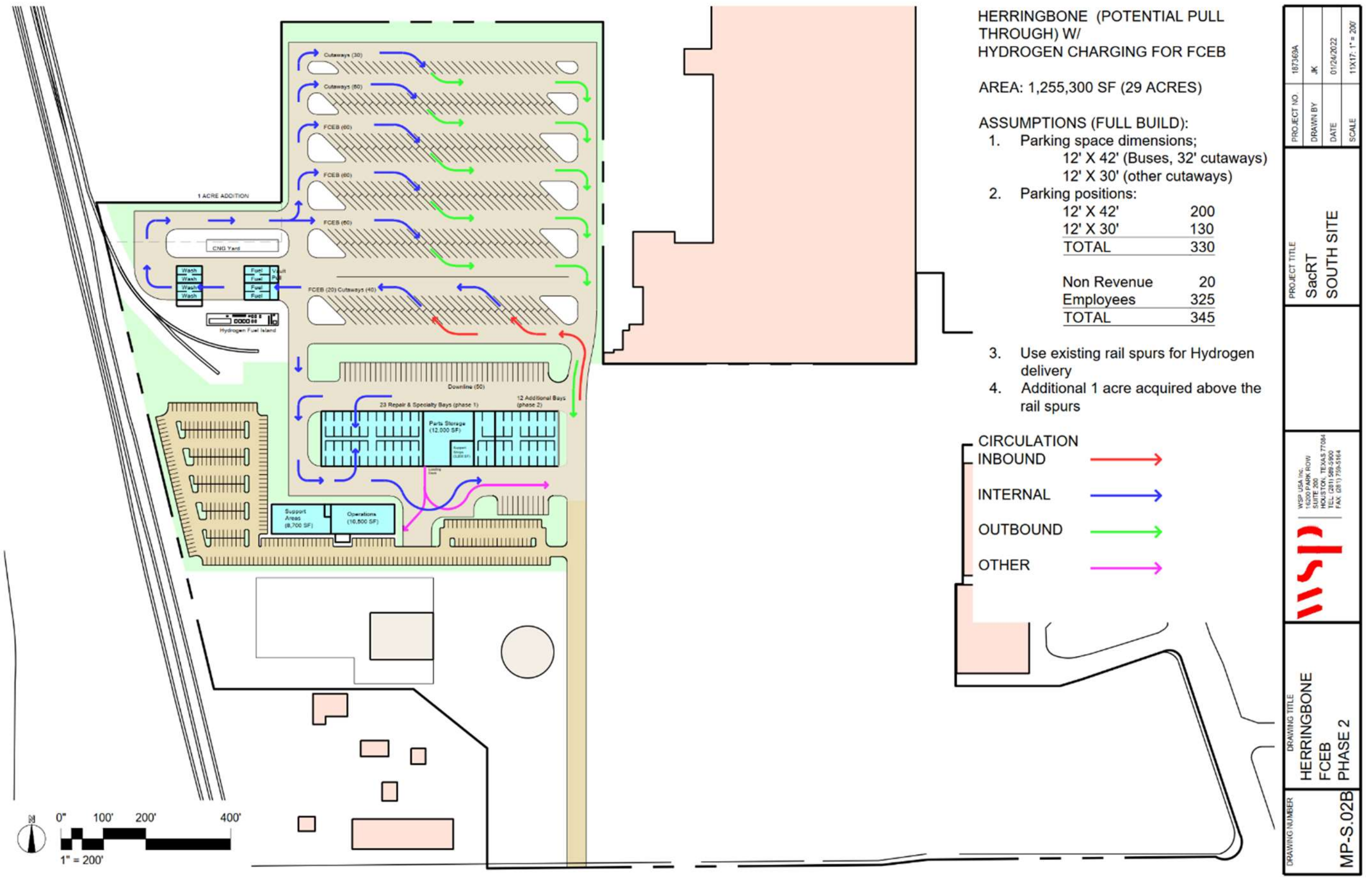
The specific sizing of the hydrogen storage tank will be evaluated in a subsequent stage. As with the BEB concept(s), a CNG yard is also presented based on the assumption that SacRT will continue to operate CNG buses after the garage is completed. The CNG yard will be decommissioned once SacRT fully transitions to ZEBs. The garage's FCEB Phase 1 and Phase 2 concepts are illustrated in Figure 2-6 and Figure 2-7, respectively.

Figure 2-6. South Garage FCEB Concept (Phase 1)



Source: WSP

Figure 2-7. South Garage BEB Concept (Phase 2)



Source: WSP

3 ZEB TRANSITION

The ZEB Transition section presents a preliminary construction and vehicle procurement schedule along with a summary of transition-related considerations that SacRT will have to address, monitor, or mitigate.

3.1 CONSTRUCTION SCHEDULE

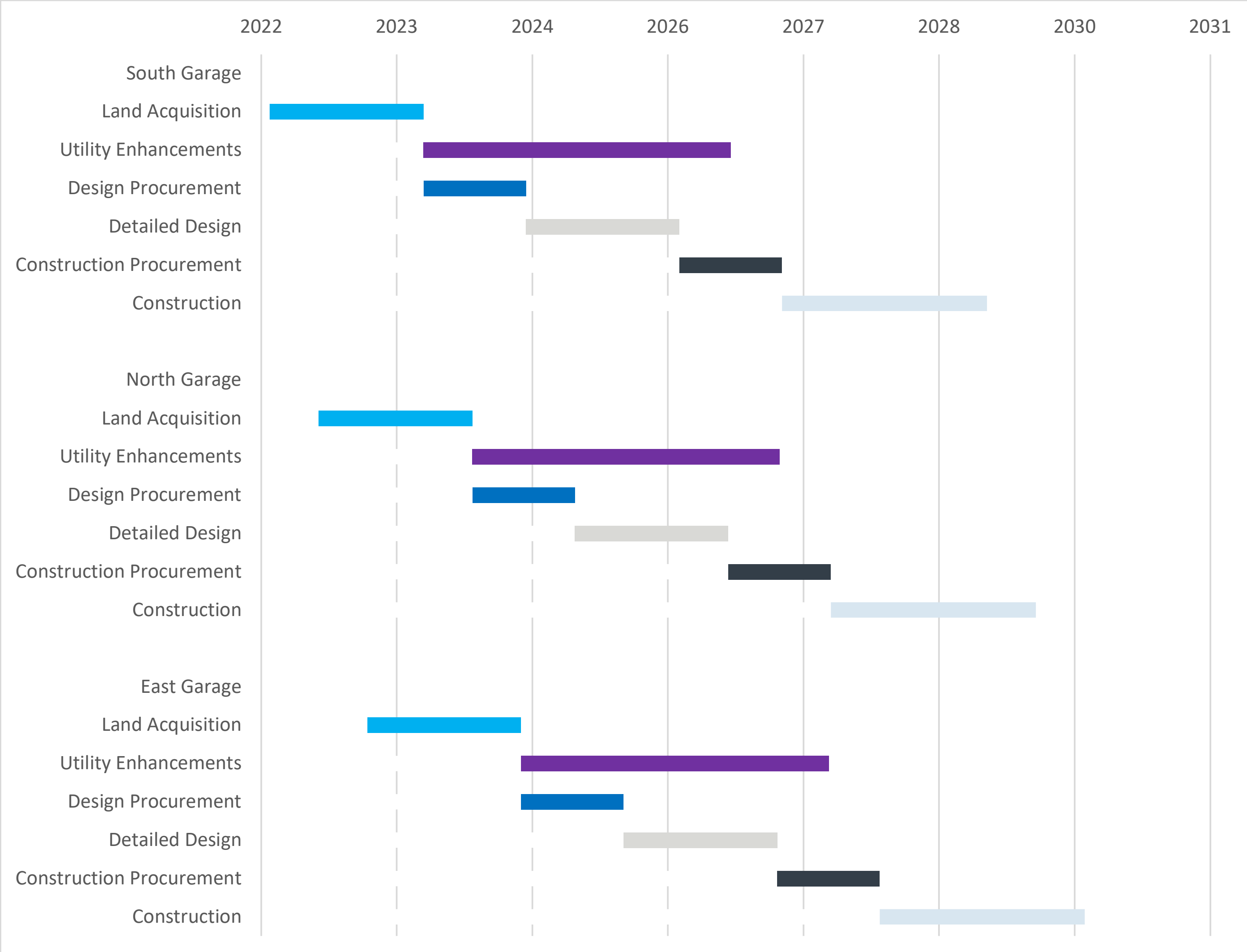
WSP and SacRT coordinated to develop high-level assumptions for durations based on a design-bid-build delivery method. These durations were then used to develop a conceptual schedule that provides some insight into when these garages may be ready to support ZEBs, The scheduling assumptions for each garage's construction process are summarized in Table 3-1 and the conceptual schedule is presented in Figure 3-1.

Table 3-1. Scheduling Assumptions

Responsibility	Stage	Description	Duration (months)
SacRT	Land Acquisition	Identify and acquire land for the new garages. This would include environmental clearance and permitting.	18
SMUD	Utility Enhancements	Plan, design, and construct off-site utility enhancements to support the power needs of each garage.	36
SacRT	Design Procurement	Develop, advertise, and award contract to develop detailed designs for each garage.	12
Designer	Detailed Design	Take conceptual designs to 100%.	18
SacRT	Construction Procurement	Develop, advertise, and award contract to construct infrastructure at each garage.	12
Contractor	Construction	Construction at each garage, including the structure, charging/fueling infrastructure, and supporting connections.	24

Source: WSP

Figure 3-1. Conceptual Construction Schedule



Source: WSP
Note: The South Garage's construction phase is assumed to be the full buildout (336 charging positions). If SacRT decides to pursue a two-phase approach for construction, an additional construction procurement phase will need to be programmed at the conclusion of Phase 1. This, of course, would extend South Garage's full buildout beyond 2030.

The presented schedule is conceptual and in many ways may not capture some of the nuances that have the potential to prolong project delivery, including lag times, environmental clearance, multiple build phases, materials delays, stakeholder engagement and approvals, and review times. On the other hand, there are several optimizations that can be considered and applied to reduce durations and overall schedules. For instance, utility enhancements can begin immediately and occur concurrently for all garages, and design periods can also occur earlier – and potentially at a single time - leading to early construction bids. Design-bid-build is also not the only project delivery method, SacRT may also consider design-build, alternative delivery, or other strategies.

3.2 PROCUREMENT SCHEDULE

To develop a procurement schedule, SacRT must consider several requirements and constraints. First, ZEBs cannot be operated unless infrastructure is in place to charge/fuel them; therefore, it is essential that the delivery of ZEBs occurs after infrastructure is constructed. Second, SacRT's vehicles have several requirements that must be considered – including the useful life and if operated with compressed natural gas (CNG), retanking dates. Lastly, SacRT must also satisfy the purchase requirements of CARB's ICT regulation. SacRT, categorized as a "large transit agency" in the regulation, must ensure that 25% of any new bus deliveries between 2023 and 2025, 50% of its deliveries between 2026 and 2028, and 100% of its deliveries beyond 2029 are ZEBs.

That said, developing a procurement schedule for SacRT's transition is a complex process that is formulated based on many assumptions. The WSP team's conceptual procurement schedule aligns with the conceptual schedule, but also applies many other assumptions:

- The existing Downtown Garage will be vacated when SacRT's existing agreement with Caltrans ends in 2030.
- Additional (temporary) charging will be installed at the Downtown Garage or other SacRT garages to support ZEB deliveries in advance of the construction of the three new garages.
- Any ZEB deliveries before the three new garages are constructed will be stored at SacRT garages with temporary charging capabilities, ICEBs will be relocated to other SacRT garages.
- Minimizing the procurement and delivery of ZEBs prior to garage construction, extending useful life, where applicable.
- A large portion of SacRT's 40-foot CNG buses (approximately 100) are currently eligible for retirement, and many require retanking. To reduce the costs to of providing temporary charging infrastructure, it is assumed that SacRT will replace these vehicles in 2022 with CNG to avoid delaying until 2023 when 26 will need to be ZEBs.
- The first new garage is scheduled to complete construction in late 2028, this will be the critical path for the mass delivery of ZEBs.
- No existing garages can support FCEB fueling infrastructure. For this reason, if FCEBs are desired, SacRT will have to wait until one of the three new garages is constructed to support them.
- SacRT's existing ZE credits (in accordance with the ICT regulation) were not applied or considered.
- While cutaway vehicles, per the ICT regulation, are not subject to be replaced until 2026, the procurement schedule is conservative and attempts to maintain purchase requirements, beginning in 2022.
- Useful Life Assumptions: This exercise assumes useful life in years to approximate retirement. SacRT may also choose to extend the life of vehicles using mileage.
  - 40-foot vehicles: 12 years. We extended the life of many existing CNG vehicles. The vehicles that need to be replaced in 2022 are largely well beyond their useful life. WSP also attempted to spread out procurements to buy buses in larger batches that represented less than a quarter of SacRT's overall fleet.
  - 32-foot vehicles: Seven years. In this schedule, the life of gasoline vehicles may be extended to simplify replacement schedules.
  - 27-foot vehicles: Seven years. In this schedule, the life of gasoline vehicles may be extended to simplify replacement schedules. This schedule assumes that vehicles currently eligible for retirement are replaced in 2022.
  - 25-foot vehicles: Seven years. Existing fleet vehicles have stated useful lives that range from four to seven years. In this schedule, the life of vehicles may be extended to simplify replacement schedules.

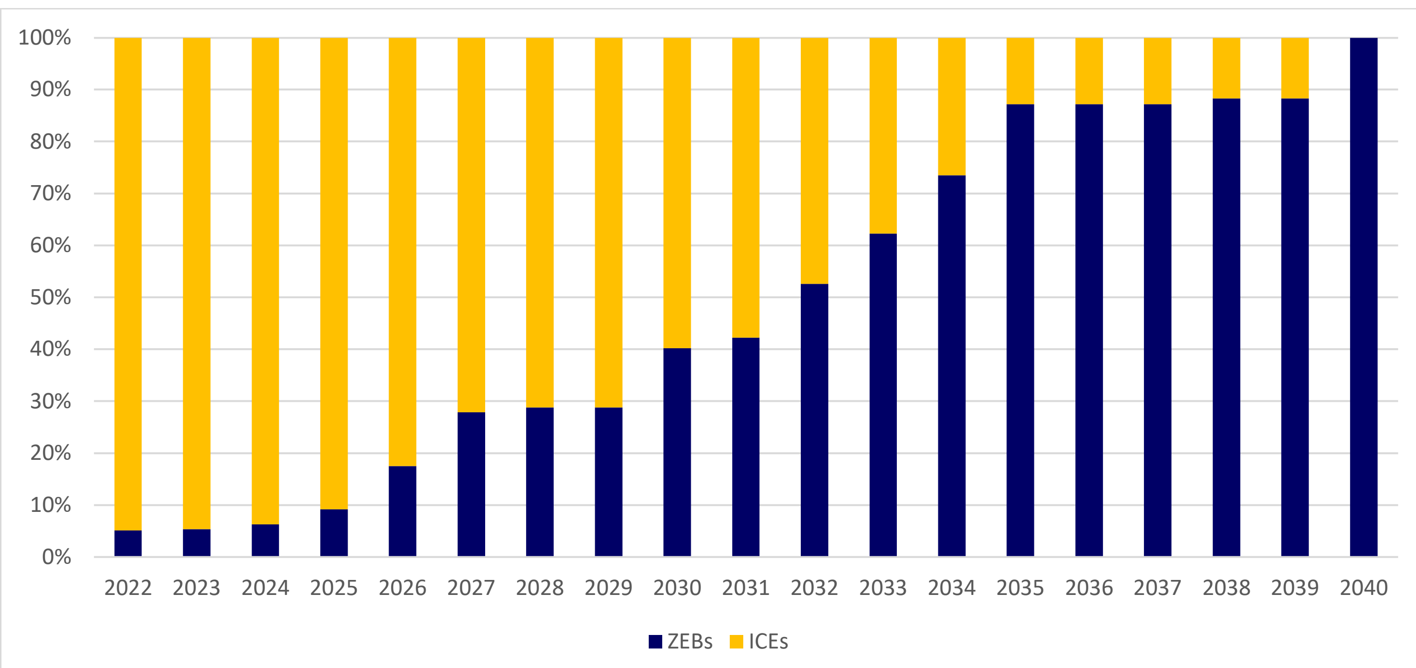
Table 3-2 presents the conceptual procurement schedule.

Table 3-2. Conceptual Procurement Schedule

Year	ICEB Purchases		ZEB Purchases		ZEB %	Total
	Bus	Cutaway	Bus	Cutaway		
2022	103	51	-	-	0%	154
2023	-	-	-	-	0%	0
2024	-	9	-	4	31%	13
2025	-	39	-	13	25%	52
2026	9	37	9	37	50%	92
2027	52	-	52	-	50%	104
2028	-	4	-	4	50%	8
2029	-	-	-	-	0%	0
2030	-	-	-	51	100%	51
2031	-	-	-	13	100%	13
2032	-	-	-	56	100%	56
2033	-	-	22	70	100%	92
2034	-	-	50	-	100%	50
2035	-	-	53	8	100%	61
2036	-	-	-	-	0%	0
2037	-	-	-	40	100%	40
2038	-	-	18	13	100%	31
2039	-	-	52	40	100%	92
2040	-	-	52	68	100%	120

Source: WSP

Figure 3-2. SacRT's Fleet Mix (2022-2040)



Source: WSP

Similar to the conceptual schedule, the conceptual procurement schedule is built on several assumptions that can be changed and refined. While the conceptual schedule maintains compliance with the ICT regulation, there are several factors that may change the quantity of ZEBs that SacRT is expected to procure. For example, the procurement schedule does not consider ZEB credits that SacRT may be eligible for due to the early adoption of ZEBs. There are also ICT regulation exemptions that SacRT may want to consider and apply for to avoid the costs of temporary infrastructure and buses the three garages are being constructed.[3] If an exemption is provided, SacRT may be granted relief on procuring any ZEBs before the garages are commissioned.

3.3 TRANSITION CONSIDERATIONS

As previously discussed, this report focuses primarily on facilities and the vehicle fleet. The specific schedules and implications of service changes and ZEB prioritization, labor impacts, training, vehicle relocations, and CNG and garage decommissioning will need to be further evaluated in subsequent stages of implications. These changes all may have impacts on the construction schedule and vehicle procurement.

3 SacRT may be able to demonstrate a "delay in bus delivery is caused by setback of construction of infrastructure needed for the zero emission bus" This exemption would need to be submitted by November 30th of that year.

4 COSTS AND FUNDING

The Costs and Funding presents an opinion of probable capital costs (vehicles and construction) associated with the transition, as well as a summary of funding opportunities that SacRT may pursue.

4.1 CAPITAL EXPENDITURES

4.1.1 VEHICLES

The cost of ZEB vehicles can vary based on length, ZEB type, required hardware and software customizations, and the size of the order. Unit costs were based on SacRT pricing for the existing GreenPower cutaways and Gillig BEBs and Foothill Transit's recent procurement of New Flyer FCEBs. At this time, there are no market-available FCEB cutaways, therefore a complete cost estimate for the FCEB options is not available.

Based on the assumed costs, it would cost approximately $10.5 million for vehicles to support East Garage, $54.5 million for the North Garage, and $205.2 million for the South Garage. It should note that these vehicles are assumed to be replacements of SacRT's existing fleet – therefore, a portion of these are sunk costs. Table 4-1 summarizes the vehicle costs.

Table 4-1. Summary of Vehicle Costs

Facility	ZEB Type	Number of Vehicles		Unit Cost		Cost		
		Buses	Cutaways	Buses	Cutaways	Buses	Cutaways	Total
East	BEB	5	30	$890,000	$200,000	$4,450,000	$6,000,000	$10,450,000
North	BEB	50	50	$890,000	$200,000	$44,500,000	$10,000,000	$54,500,000
	FCEB	50	50	$1,137,000	TBD	$56,850,000	TBD	TBD
South	BEB	200	136	$890,000	$200,000	$178,000,000	$27,200,000	$205,200,000
	FCEB	200	130	$1,137,000	TBD	$227,400,000	TBD	TBD

Source: SacRT (2019-2020), Foothill Transit (2021)
Note: Unit costs have been rounded to the nearest thousand. There are currently no market-available FCEB cutaways.

4.1.2 CONSTRUCTION COSTS

The opinion of probable cost estimates were developed based on WSP's recent experience with similar projects. The estimate was inclusive of building and equipment costs, parking modifications, maintenance equipment and costs, charging equipment, and CNG equipment. A comprehensive list and units costs for each can be found in Appendix D.

Based on the estimate, the East Garage's construction may cost approximately $11 million, the North Garage may cost between $32 and 40 million (FCEB and BEB, respectively), and the South Garage would cost between $56 and $106 million (FCEB and BEB, respectively). Table 4-2 summarizes the probable cost estimates for each garage and its alternatives.

Table 4-2. Summary of Garage Construction Costs

Facility	ZEB Type	Cost
East	BEB	$11,249,000
North	BEB	$40,308,000
	FCEB	$32,179,000
South	BEB	$105,616,000
	FCEB	$56,330,000

Source: WSP

4.1.3 UTILITY ENHANCEMENTS

The cost of utility enhancements cannot be accurately estimated until an agreement is developed between SacRT and SMUD. At that point, specific construction costs and timelines can also be developed. However, based on conversations with SacRT, it was determined that if the South Garage needed power in excess of 22 MW, a new substation would be required to support the site. Per SMUD, this would cost between $7 and $10 million.

4.2 FUNDING

There are many potential federal, state, local, and project-specific funding and financing sources at SacRT's disposal. With the passage of the Infrastructure Investments and Jobs Act (IIJA) in late 2021, over $15 billion in new funding is available through formula funds and discretionary grant programs to support the transition of the U.S. vehicle fleet to ZE. Funding is provided through a combination of incremental amounts to existing programs and newly created programs through both the U.S. Department of Transportation (USDOT) and the U.S. Department of Energy (DOE).

To implement the ZEB fleet transition program, SacRT can continue to explore funding from federal, state, local, and project-specific sources. Of the funding programs assessed, the most promising federal sources include Rebuilding American Infrastructure with Sustainability and Equity (RAISE) grants, Federal Transit Administration (FTA) Section 5339 Bus and Bus Facilities Discretionary Grants, FTA Section 5339 Low/No Emissions Vehicle program, Federal Highway Administration's (FHWA) Congestion Mitigation and Air Quality Improvement Program (CMAQ), and Environmental Protection Agency's Environmental Justice Collaborative Problem - Solving Cooperative Agreement Program.

To secure federal sources, SacRT will require substantial non-federal funding commitments. The project aligns with the eligibility criteria from all state sources. Additionally, the project-specific funding sources may have the potential to provide the local financial commitment for capital costs.

Finally, Transportation Infrastructure Finance and Innovation Act (TIFIA) program and the California Infrastructure and Economic Development Bank (IBank) through its various programs could be considered for financing, as a means of reducing the upfront financial obligation and spreading out payments over time. Public entities employ several strategies to leverage revenues streams through the capital debt markets. Common examples include Dedicated Revenue Bonds, Lease Revenue Bonds/Certificates of Participation, General Obligation Bonds, and Debt Secured by FTA Formula Funds.

5 FINDINGS AND NEXT STEPS

The following section summarizes the findings and outlines the next steps that SacRT should take to begin its transition to an all-ZEB fleet.

5.1 FINDINGS

The Facilities Master Plan Report presents design concepts for three new bus garages, the construction schedules to implement them, and a vehicle procurement schedule that aligns with the ICT regulations purchase requirements. Based on the analysis, here is a summary of the findings:

— **The presented concepts support the requirements of SacRT.** Each concept meets (or exceeds) the vehicle fleet quantity, the parking configuration, and ZEB type that was requested by SacRT. It should be noted that the East and North Garages are based on a "blank slate" concept – therefore, SacRT would need to ensure that the future site can support the dimensions of the concept.

— **Additional power is needed.** As previously mentioned, the specific amount of power available at each site would have to be reviewed by SMUD. However, based on the analysis, the East Garage would require a connected load of 2.3 MW, the North Garage would require a connected load of 6.8 MW, and the South Garage would require a connected load of 23.3 MW. Per conversations with SMUD, the South Garage may require a new substation to support that load – that could cost as much as $10 million.

— **The transition will be expensive.** Actual cost estimates will come at a later stage; however, the construction and vehicles to support East Garage, not including land acquisition, would cost north of $20 million. The South Garage – also not including land acquisition – is expected to cost roughly 10 times the amount of East Garage.

— **Several refinements and decisions need to be made before proceeding.** At this point, these drawings and concepts, while informative, will have to remain cursory until sites are acquired. At that point, conceptual drawings and schedules can be further developed and more detail planning can be accomplished.

5.2 NEXT STEPS

The following are the recommended steps that SacRT take to further their transition planning efforts:

1. Acquire sites and begin utility coordination and negotiations.
2. Refine conceptual drawings and/or develop 100% designs and a detailed Master Plan.
3. Plan service relocations and identify cost impacts.
4. If necessary, engage CARB to file for exemptions.

A. APPENDIX A – ZERO EMISSION FLEET STUDY (2020)

SACRAMENTO REGIONAL TRANSIT

ZERO EMISSION FLEET STUDY

WSP Project No. 187369A

February 2020

WSP USA Inc.

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March 02, 2020

Craig Norman
Sacramento Rapid Transit (SACRT)
1400 29th St
Sacramento, CA 95816

Subject: SACRT ZEV Fleet Study
Client ref.: 187369WO4

Dear Craig:

Thank you for the opportunity to complete this EV Fleet study and rough-order-of-magnitude cost estimate for your use. Since the kickoff, our team has been focused on getting the key deliverables for you on SACRT route modeling and facility plans.

We look forward to continuing work with SACRT's bus fleet and zero emission bus plans.

Yours sincerely,

John Drayton
Project Manager

WSP ref.: 187396WO4

QUALITY MANAGEMENT

ISSUE/REVISION	FIRST ISSUE	REVISION 1	REVISION 2	REVISION 3
Remarks	Draft	Final		
Date	December 5, 2019	February 28, 2020		

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PRODUCTION TEAM

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TABLE OF CONTENTS

1 EXECUTIVE SUMMARY

1.1 PURPOSE AND BACKGROUND

Sacramento Regional Transit (SacRT) provides public transportation via light rail and bus service. The bus fleet consists of 259 buses, 193 of which are powered by CNG, 53 by gasoline and seven by diesel, as well as six battery electric buses (BEBs). To comply with the California Air Resources Board's (CARB) Innovative Clean Transit (ICT) regulation and further advance sustainability goals, SacRT is looking to transition its fleet to zero emission buses (ZEBs) by 2040.

As a first step in this process, SacRT has partnered with WSP to determine the feasibility of transitioning to a 100% zero-emission (ZE) vehicle fleet. This report, in addition to the route modeling feasibility study, serves as the foundation for subsequent analyses and future implementation. The purpose of this report is to identify initial fleet and facilities needs, develop rough order of magnitude (ROM) costs, and present next steps and considerations for future study.

SacRT faces several significant challenges as it plans for a full transition to ZEB operations. First, current ZEB technology is can only cover 56% of SacRT's current scheduled operation; this may necessitate purchasing additional ZEB's to maintain current service levels. Second, SacRT's main operating facility includes bus parking underneath the I-80 freeway; given limitations on parking and charging at this location, once SacRT transitions to ZEB operation, it will not be feasible to park and charge all of SacRT's ZEB at this location. Given the impacts of these two issues, SacRT may need to seek alternate operating locations for up to 100 additional buses to complete their transition to 100% ZEB operations.

1.2 DATA COLLECTION AND ANALYSIS

To tailor a ZEB phasing plan to SacRT needs, WSP analyzed existing fleet and facilities data provided by SacRT including mileage, vehicle type, route maps, as built designs, and utility service. Battery size, power, and space restrictions play a major role in determining the best possible ZEB solution for SacRT.

Battery electric buses (BEBs) do not currently have the range to replace conventional buses on a 1:1 basis, and a route by route analysis was performed to determine how many BEBs would be required to replace the current fleet. The current bus parking area's maximum available power is 11 MW, which is not enough to charge the entire fleet as is. The current parking area also has space and height restrictions that shrink the available parking with the installation of charging infrastructure. WSP also looked at hydrogen fuel cell buses (FCEBs) for SacRT applications. However, fire safety code and space restriction prevent hydrogen infrastructure installation at the current fueling facility.

SacRT will need to minimize the impact of a ZEB transition to maintain service levels and meet rollout every day for the City of Sacramento. With this in mind, WSP chose the most commonly available buses and charging technology and ran a worst-case scenario analysis.

1.3 FINDINGS

Based on our preliminary analysis, it was determined that a fleet conversion is feasible; however, SacRT will need to find more space to facilitate the charging or hydrogen fueling of its full Zero Emissions fleet. Existing parking and facilities will not support a full fleet conversion to either technology and still meet the agency's bottom line.

In the case of a full BEB fleet, the existing parking's power limit of 11MW will only support charging for 146 of 197 buses. Fifty-one existing buses will need to be charged elsewhere. Additionally, due to range constraints of BEBs, the fleet will need to expand to meet the same service by an additional 50 buses. SacRT will need to find space, power, and facilities for over one hundred 100 buses. It should be noted that SacRT can begin the conversion process now, with existing facilities, and meet early CARB deadlines. New facilities would not be required for at least 5 years, giving SacRT time for sourcing and construction.

In the case of a full FCEB fleet, hydrogen fueling comes with problematic space restrictions. The national fire safety code establishes a minimum perimeter and overhead clearance around hydrogen storage tanks that prevent installation both in the bus parking lot and in the current maintenance facility. Hydrogen fueling cannot be built at SacRT unless more land is found.

It should be noted that these are *initial* findings. Costs and schedule could be further optimized with refined analysis. Considerations such as vehicle-to-grid technology, photovoltaics, midday charging, service changes, etc. are just a few items that could expedite the transition.

1.4 NEXT STEPS

This report is meant to serve as guidance as SacRT begins to make decisions regarding its future ZEB fleet. When we receive Notice to Proceed, WSP will work with SacRT to build a rollout plan to submit to CARB as per its ICT regulation. The Rollout plan will build upon the findings of this report, and lay the groundwork for a successful transition to Zero Emissions.

2 EXISTING CONDITIONS

SacRT operates fixed-route, micro transit, dial-a-ride, and light rail service across a 400-square mile service area that includes the cities of Sacramento, Citrus Heights, Elk Grove, Folsom, and Rancho Cordova. SacRT's bus service includes Bus, Community Bus, and SmaRT Ride. Bus service includes fixed-route local and express service that operate daily between 5 a.m. and 11 p.m. every 12 – 60 minutes, depending on the route. Community Bus provides transit for residents and employees; SacRT offers this service in partnership with local agencies. SmaRT Ride is a micro transit service that is similar to other ride-share services where customers can use a smartphone app to request a ride within nine SacRT service areas.

2.1 CURRENT VEHICLES

As of July 2019, SacRT has a vehicle fleet of approximately 259 buses and cutaway buses, 226 of which are dedicated to SacRT's Bus and Community Bus services, 29 are assigned to SmaRT Ride, and four 4 are classified as "historic." The SacRT vehicle fleet may have changed in size since the publication of this document due to newly implemented services (e.g. the Airport express and additional SmaRT Ride service areas) in January 2020. Weekday bus ridership averages approximately 37,000 passengers per day. Buses range in age from one to fifteen years.

2.2 EXISTING FACILITIES

The existing 40' bus parking yard is located under the overpass of 240188L STATE ROUTE 51 SB, located in the city of Sacramento. They have a maintenance and fueling facility directly adjacent at 2803 28th Street. The current bus parking area has a maximum power draw of 11 MW. Smaller cutaway buses and paratransit vans are operated out of the McClellan and Hazel garages.

2.3 OPERATING CONDITIONS

Sacramento County is in California's Climate Zone 12. Sacramento's winter months average a low of 39 degrees, about average for the State. Its temperatures in the summer are typically hotter than the State average (approximately 93 and 87 degrees, respectively). An analysis of the elevation within 0.75 miles of SacRT's fixed-route service showed an average elevation of 102 ft., a low of -0.5 ft., and a high of 1,164 ft. The higher elevations of the service area are in the east in Folsom and most of the service area is under 100 ft. in elevation.[1]

Electrical service in the County is provided by the Sacramento Municipal Utility District (SMUD).

3 FLEET DETAILS AND RECOMMENDATIONS

3.1 INTRODUCTION

WSP conducted a route by route feasibility study for battery electric buses. The study covers electric vehicle type, range, and battery size. Its principle findings are summarized in the sections below, and the full modeling report, including the airport connector service modeling, can be found in the Appendix. It should be noted that WSP did not produce an in-depth analysis for fuel cell bus (FCEB) technology, as current space restrictions at SacRT facilities prevent any fueling installation. Future expansion of facilities could allow for FCEB technology. Data for this analysis were provided between July and December of 2019, and changes in fleet makeup since final submission date are not reflected.

To determine the feasibility of electrifying SacRT's fleet, WSP developed a dynamic, formula-based model to analyze BEB technologies impacts on SacRT's existing service. A number of data were provided by SacRT to provide a comprehensive understanding of their existing fleet and service conditions, including: general transit feed specification (GTFS), garage addresses, fleet inventory, and other related data, including service planning data for the new Airport express route. Automatic vehicle location (AVL) outputs served as the foundation for modeling efforts as these data encompass all vehicle movements. Information related to batteries and chargers were gathered from OEM websites and used as a basis for SacRT's BEB analysis.

Sacramento's fleet, outlined in Table 1, consists primarily of 192 40' CNG buses, currently operating out of SacRT's downtown facilities. SacRT also operates a fleet of cutaway buses and shuttles.

Table 1: SacRT Fleet and Service Summary

Service	Vehicle Type	CNG	Gas	Diesel	BEB	Total
Bus and Community Bus Service	40'	192	0	0	0	**192**
	32'	0	0	5	0	**5**
	Cutaway	0	29	0	0	**29**
	Total	**192**	**29**	**5**	**0**	**226**
SmaRT Ride	25'	0	0	0	6	**0**
	Cutaway	0	23	0	0	**29**
	Total	**0**	**23**	**0**	**6**	**29**
Historic Fleet	40'	1	0	0	0	**1**
	32'	0	0	2	0	**2**
	Cutaway	0	1	0	0	**1**
	Total	**1**	**1**	**2**	**0**	**4**
Total		**193**	**53**	**7**	**6**	**259**

Current battery electric bus technology is range limited; where a conventional bus could run for a 300-mile set of round trips or "blocks," BEBs struggle to reach half that daily mileage. Figure 1, below, displays the daily mileage of each schedule block in the fleet. To overcome range challenges, WSP took an in depth look at SacRT's routes to see which could be covered by BEB technology and replace CNG buses at a 1:1 ratio, and what blocks would need to be split and operated by multiple BEBs at a 2:1 bus replacement ratio.

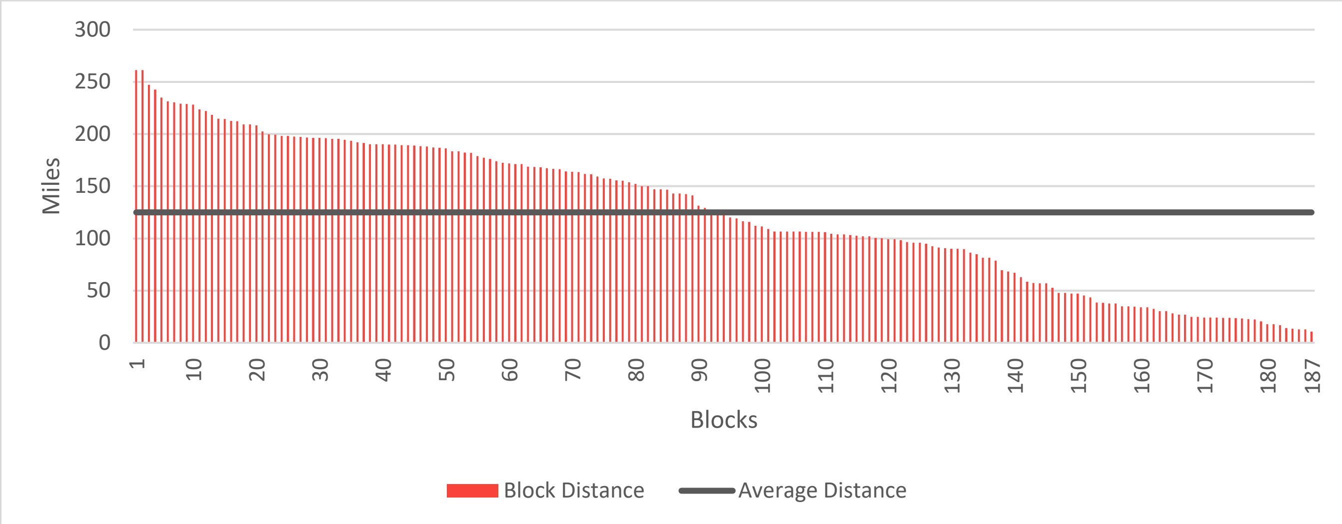


Figure 1: Downtown Garage Weekday Block Ranges

A BEB's performance is typically measured by its range (miles). This is a direct factor of its "efficiency" which is expressed in kilowatt-hours per mile (kWh/mi.). A higher efficiency means that a buses battery will deplete faster, effectively reducing its range, whereas, a lower efficiency results in a longer lasting battery and range. Efficiencies can vary based on several factors, including: battery health, operator behavior, temperature (HVAC usage), speed, weight, etc. An accurate understanding of efficiency on a route can be determined via a pilot or shadow service. However, for the purposes of modeling, we calculated the "base" efficiency for the 35' and 40' bus and battery combinations as advertised by the OEM:

$$Advertised\ Battery\ Capacity\ (kWh) \div\ Advertised\ Range\ (mi.) = Base\ Efficiency\ (kWh/mi.)$$

To account for the variances that can impact the efficiency (as noted above), we added a sensitivity of plus (conservative) and minus (liberal) 25 percent. The liberal, base, and conservative efficiencies provide SacRT with a general understanding of how these buses may operate.

3.2 ZERO EMISSIONS FLEET REQUIREMENTS

Based on our preliminary analysis and assumptions, current battery technology could cover only a portion of existing service. At the Downtown Garage, a 372-kWh operating battery could cover 99 percent of block distances with the liberal efficiency, 73 to 80 percent with the base efficiency, and 38 to 56 percent with the conservative efficiency. At the McClellan Garage, a 94-kWh operating battery could cover 86 percent of all block distances with the liberal efficiency, 67 percent at the base efficiency, and 38 percent of blocks with the conservative efficiency. Blocks out of the Hazel Station Garage can all be electrified assuming an operating battery of 352-kWh.

Table 3-2 summarizes the results for all blocks that can be completed under existing conditions. For further information on incomplete blocks, by garage, please see the attached route modeling report.

Table 3-2 Summarized Garage Blocks Completed

Garage	Day Type	Blocks	Vehicle Type	Blocks Completed		
				Liberal	Base	Conservative
Downtown	Weekday	187	40'	99%	73%	56%
McClellan	Weekday	21	Cutaway	86%	67%	38%
Hazel	Weekday	7	35'	100%	100%	100%
Downtown	Saturday	91	40'	99%	80%	38%
Downtown	Sunday	71	40'	100%	83%	38%

It should be noted that these are *preliminary* findings. Further study should be done to plan for the transition to BEB, including a pilot and/or shadow service. Considerations such as weight restrictions, charging times, vehicle-to-grid technology, photovoltaics, midday charging, service changes, changes in how vehicles are blocked, etc. are just a few items that need to be considered with the transition to BEB.

Assuming a worst-case scenario of vehicles only achieving the conservative efficiency, it is estimated that the vehicle fleet would need to increase by 127 vehicles. This is based off the assumption that if a vehicle block could achieve between 50 to 99 percent of its scheduled range, an additional vehicle would be required to meet service requirements and if a vehicle could achieve 25 to 49 percent of its scheduled range, two additional vehicles would be required to meet service requirements.

3.3 ROM COSTS

WSP market research as shown in Table 3 estimates a cost of between $725,000 to $1,000,000 per bus, depending on the manufacturer and deviations from standard parts. These costs are based on two years of data from procurement contracts around the country.

Table 3: Market Price for 40' BEBs

Model Type	Body Type	USA Manufacturers	Propulsion	Buy America Act Compliant? (Plant Location)	Cost (US$)
40-foot low-floor	Stylized, purpose built for electric	Proterra Green Power New Flyer BYD	Electric (BEB) Electric (BEB) CNG, Electric (BEB) Electric (BEB)	Y (Walnut, CA) Y (Porterville, CA) Y (St. Cloud, MN) Y (Lancaster, CA)	$725,000 to $1,000,000

Costs are forecast to decrease to come more into line with the cost of CNG buses, however, SacRT should base initial decisions off of today's technology and prices. Market research indicates it will cost from $200 Million to $300 Million dollars to purchase the 319 buses required by this analysis. WSP will expand on these costs and create a more comprehensive report in the second phase of this project.

4 INFRASTRUCTURE RECOMMENDATIONS

4.1 INTRODUCTION

The existing bus parking yard is located under the overpass of 240188L STATE ROUTE 51 SB, located in the city of Sacramento. The majority of the total area is covered by the overhead road structure. This bus parking yard is composed of three (3) bus parking lots: North Parking, South Parking and finally Q Street Parking.

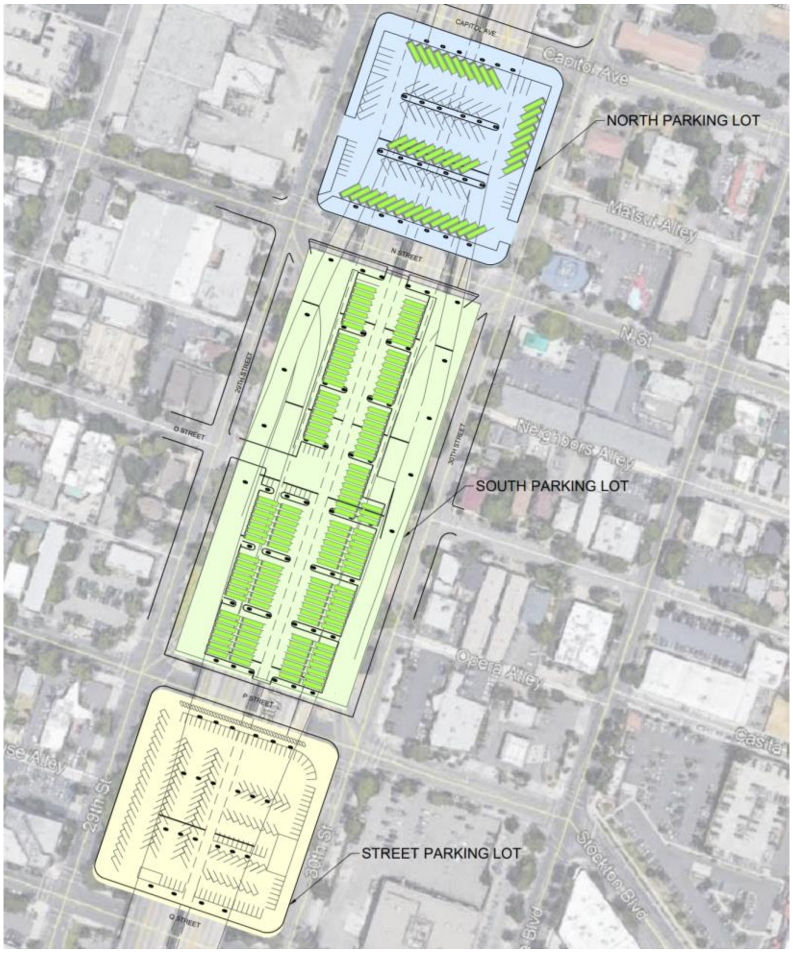


Figure 2: Downtown Bus Parking Facility

Currently, the three parking lots have the following capacities; The North Parking Lot has a capacity of 42 parking spots for forty-foot buses, 39 cutaway buses, and 12 standard vehicle size (approximately 10 foot by 20 foot) parking spots. The South Parking Lot has a capacity of 155 parking spots for forty-foot buses and 12 standard vehicle size parking spots. Finally, Q Street Parking Lot has a capacity for 200 standard sized vehicle parking spots and 42 motorcycle parking spots.

4.2 ZEB CONVERSION INFRASTRUCTURE RECOMMENDATIONS

To meet the full requirements of this project 146 forty-foot battery electric zero emission buses (BEB) with the necessary equipment to provide and distribute electricity to charge and operate the buses (transformers, switchgears, and chargers) needed to be located on the site. Another important consideration was the restrictions and site limitations associated with developing the layout under the existing overpass. These limitations included but were not limited to:

- 20'-0" elliptical clear area around the existing overpass' columns.
- 30'-0" clear area on both sides of the existing overpass's hinge.

The proposed solution for all the developed concepts assumes that 150 kW DC charging cabinets in a 1:2 charger to plug-in dispenser configuration will be utilized to charge the ZEBs while parked in their assigned spot in the yards. Buses will be connected to the charging cabinets with a plug-in dispenser via a charging port located on the center rear of the bus.
To best utilize the site considering the number of ZEBs to be served the following two options were developed. Full schematics for both options are located in Appendix A.

OPTION A

In the North Parking Lot, WSP proposes to utilize the site's east and west perimeters to locate charging positions for 24 ZEBs with the associated charging equipment in a 1:2 charger to dispenser ratio. ZEBs will be backed-in to the existing diagonal parking spaces along the lot's east edge and new diagonal parking on the west edge. The North Parking Lot will include the following new BEB charging equipment located in the unused area behind the bus parking spaces between every two spaces:

- 12 150 kW charging cabinets in the east and west yard edges on the northern and southern edges of the rows of spaces served.
- 24 plug-in dispensers connected to the charging cabinets.

In the South Parking Lot, WSP proposes to utilize the area underneath the exterior edges of the overpass to locate charging positions for 104 ZEBs with the associated charging equipment in a 1:2 charger to dispenser ratio. ZEBs will be backed-in to the existing spaces perpendicular to the yard overpass cover edges on the east and west of the lot. The South Parking Lot will include the following new BEB charging equipment:

- 52 150 kW charging cabinets along the east and west exterior edge of the area covered by the overpass centered behind every two associated bus parking spaces.
- 104 plug-in dispensers connected to the charging cabinets.
- 4 standalone switchboards rated at 4000Amps, 480V.
- 4 transformers rated at 3,000kV laid out to share and overlap their clearance requirements.
- It is also understood that the project can install more than 11 MW of chargers using a diversity factor/charge management control system. However, SMUD can still limit total electric flow to the site to 11MW max.

The Q Street Parking Lot would remain without any modifications under Option A.

Option A is capable of parking, charging, and operating a maximum fleet of 128 ZEBs while maintaining the Q Street Parking Lot unmodified. However, Option A does not meet the full program requirement of 146 forty-foot zero emission buses.

OPTION B

Under Option B the North and South Parking Lots are laid out identically to Option A with 24 and 104 ZEB parking and charging positions respectively. The switchboards and transformers remain located in the northwest corner of the South Parking Lot identical to Option A.

In the Q Street Parking Lot, WSP proposes to utilize the site's east and west perimeters to locate charging positions for 18 ZEBs with the associated charging equipment in a 1:2 charger to dispenser ratio. The existing standard vehicle parking will be vacated and restriped for bus parking use. ZEBs will be backed-in to new diagonal parking spaces along the lot's east and west edges. The Q Street Parking Lot will include the following new BEB charging equipment located in the unused area behind the bus parking spaces between every two spaces:

- Nine 150 kW charging cabinets in the east and west yard edges centered behind every two associated bus parking spaces.
- Eighteen plug-in dispensers connected to the charging cabinets.

Option B is capable of parking, charging, and operating a maximum fleet of 146 forty-foot ZEBs which meets the full project bus parking program requirements However, Option B removes the majority of the Q Street Parking Lot standard parking spaces to achieve bus parking and circulation.

RECOMMENDATIONS

For future land acquisitions it is recommended that any sites considered be entirely free of existing overhead construction in order to avoid possible restrictions, such as those included within this project site. The graphic below reflects analysis of the usable areas which are not encroached by clearance restrictions on the existing site.

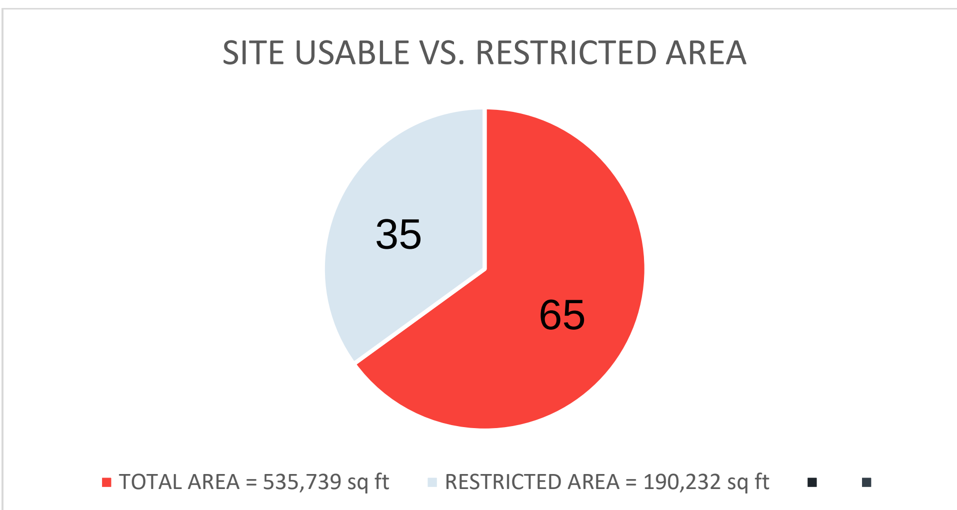


Figure 3: Useable vs. Restricted Parking Area

4.3 COSTS AND FUNDING OPPORTUNITIES

The electric vehicle fleet charging technology is changing rapidly, and new vehicles are entering the market every year. While the initial investment in electric vehicles can be quite costly, there are possibilities for both capital and O&M savings in the future as ZEB technology continues to evolve and mature. Table 4 gives rough order of magnitude for costs for an infrastructure installation to support SacRT's full ZEB fleet.

Table 4: ROM Costs for BEB Infrastructure

Charging Equipment	$100,000	(per bus)
Support Systems	$50,000	(per bus)
Total, for 319 bus fleet	$47,850,000	

This table includes charging equipment, meaning DC cabinets and dispensers, and support systems, including conduit, cabling, trenching, backfilling, switchgear, wiring, and construction needed to make the charging system work. This is estimated on a per-bus basis as BEBs are not easily scalable; every two buses require their own charger. These figures are likely high, but installation costs can vary greatly by site. More accurate costs can be developed as SacRT continues its ZEB conversion.

5 CONCLUSIONS AND NEXT STEPS

Given operational and physical constraints of current SacRT operating facilities, it will not be feasible for SacRT to migrate to 100% ZEB technology at this time in their current facilities. First, the operating range for current BEB's will not allow for a direct 1:1 replacement ratio. Second, the current SacRT operating facilities, particularly the facility under the I-80 freeway adjacent to SacrRT headquarters, is not adequate to operate more than about 150 buses.

Some of these constraints may be temporary. Battery technology is evolving very rapidly, and BEBs with longer range that can replace SacRT's buses on a 1:1 basis may become available within the next ten years. Likewise, staff can work with CALTRANS to determine whether CALTRANS would be willing to waive some of its facility constraints that limit the number of buses that can be parked or charged underneath the freeway. While not considered extensively in this report, hydrogen fuel cell buses would likely be prohibited from being fueled or stored in SacRT's under-freeway parking areas as well.

As a next step in SacRT's ZEB transition plans, SacRT should consider whether there are options for acquiring alternative locations that would be suitable for operating up to 100 additional buses. Ideally, such a location would be within SacRT's current service area, and in an area that is near existing bus lines and would not require significant deadheading.

B. PPENDIX B – ZERO-EMISSION BUS ROLLOUT PLAN (2021)

FINAL

MARCH 2021

SACRAMENTO REGIONAL TRANSIT DISTRICT

ZERO-EMISSION BUS ROLLOUT PLAN

TABLE OF CONTENTS

1. ROLLOUT PLAN SUMMARY

AGENCY BACKGROUND

Transit Agency's Name	Sacramento Regional Transit District
Mailing Address	1400 29th St., Sacramento, CA 95816
Transit Agency's Air District	Sacramento Air Quality Management District
Transit Agency's Air Basin	Sacramento Valley Air Basin
Total number of buses in Annual Maximum Service[1]	246
Urbanized Area	Sacramento
Population of Urbanized Area[2]	1.1 Million
Contact information of general manager, chief operating officer, or equivalent	Henry Li | HLi@sacrt.com
Rollout Plan Content	
Is your transit agency part of a Joint Group[3]	No
Is your transit agency submitting a separate Rollout Plan specific to your agency, or will one Rollout Plan be submitted for all participating members of the Joint Group?	N/A
Please provide a complete list of the transit agencies that are members of the Joint Group (optional)	N/A
Contact information of general manager, chief operating officer, or equivalent staff member for each participating transit agency member	N/A
Does Rollout Plan have a goal of full transition to ZE technology by 2040 that avoids early retirement of conventional transit buses?	Yes
Rollout Plan Development and Approval	
Rollout Plan's approval date	9/14/2020
Resolution No.	20-10-0117
Is copy of Board-approved resolution attached to the Rollout Plan?	Yes (Appendix A)
Contact for Rollout Plan follow-up questions	James Boyle, Director of Planning
Who created the Rollout Plan?	Consultant
Consultant	WSP

[1]The ICT regulation defines "Annual Maximum Service" (13 CCR § 2023(b)(3)) as the number of buses in revenue service that are operated during the peak season of the year, on the week and day that maximum service is provided but excludes demand response buses.

[2]As last published by the Census Bureau before December 31, 2017

[3]The ICT regulation defines a Joint ZEB Group or Joint Group (13 CCR § 2023.2) as two or more transit agencies that choose to form a group to comply collectively with the ZEB requirements of section 2023.1 of the ICT regulation.

2. INTRODUCTION

In accordance with the California Air Resource Board's Innovative Clean Transit regulation (CARB ICT regulation), the following report serves as Sacramento Regional Transit District (SacRT) Rollout Plan to transition its bus fleet to 100 percent zero-emission (ZE) by 2040.

2.1 BACKGROUND

2.1.1 CALIFORNIA AIR RESOURCE BOARD'S INNOVATIVE CLEAN TRANSIT REGULATION

The CARB's ICT regulation requires all public transit agencies in the State of California to transition from conventional buses (compressed natural gas, diesel, etc.) to zero-emission buses (battery-electric or fuel cell electric) by 2040. The regulation requires a progressive increase of an agency's new bus purchases to be zero-emission buses (ZEBs) based on their fleet size. By 2040, CARB expects all transit agencies in the state to be operating only ZEBs.

To ensure that each agency has a strategy to comply with the 2040 requirement, the ICT regulation requires each agency, or a coalition of agencies ("Joint Group"), to submit a ZEB Rollout Plan ("Rollout Plan") before purchase requirements take effect. The Rollout Plan is considered a living document and is meant to guide the implementation of ZEB fleets and help transit agencies work through many of the potential challenges and explore solutions. Each Rollout Plan must include a number of required components (as outlined in the Rollout Plan Guidelines) and must be approved by the transit agency's governing body through the adoption of a resolution, prior to submission to CARB.

According to the ICT regulation, each agency or Joint Group's requirements are based on its classification as either a "Large Transit Agency" or a "Small Transit Agency". The ICT defines a Large Transit Agency as an agency that operates in the South Coast or the San Joaquin Valley Air Basin and operates more than 65 buses in annual maximum service or it operates outside of these areas, but in an urbanized area with a population of at least 200,000 and has at least 100 buses in annual maximum service. A Small Transit Agency is an agency that doesn't meet the above criteria.

SacRT is categorized as a "Large Transit Agency" under the ICT regulation and must comply with the following requirements:

- July 1, 2020 – Board-approved Rollout Plan must be submitted to CARB.[4]
- January 1, 2023 – 25 percent of all new bus purchases must be ZE
- January 1, 2026 – 50 percent of all new bus purchases must be ZE
- January 1, 2029 – 100 percent of all new bus purchases must be ZE
- January 1, 2040 – 100 percent of fleet must be ZE
- March 2021 – March 2050 – Annual compliance report due to CARB

2.1.2 SACRAMENTO REGIONAL TRANSIT DISTRICT

SacRT operates 30 fixed routes, 19 commuter routes, and 17 seasonal routes in addition to SmaRT Ride on-demand transit, SacRT Go paratransit, eTran Elk Grove (seven fixed routes and 10 commuter routes), Airport Express bus service, Causeway Connection bus service to UC Davis, and 43 miles of light rail that covers a 400-square-mile service area. Buses and light rail operate 365 days a year using 97 light rail vehicles, 232 buses powered by compressed natural gas (CNG), 62 vans, 107 paratransit vehicles, and 9 electric shuttle buses, and 9 40' electric buses.

Passenger amenities include 52 light rail stations, 30 bus and light rail transfer centers, and 22 park-and-ride lots. SacRT also serves over 3,100 bus stops throughout Sacramento County.

Annual ridership has fluctuated recently on both bus and light rail systems and has grown from 14 million passengers in 1987 to over 20.8 million passengers in FY 19. Weekday light rail and bus ridership averages approximately 37,500 and 35,000, respectively.

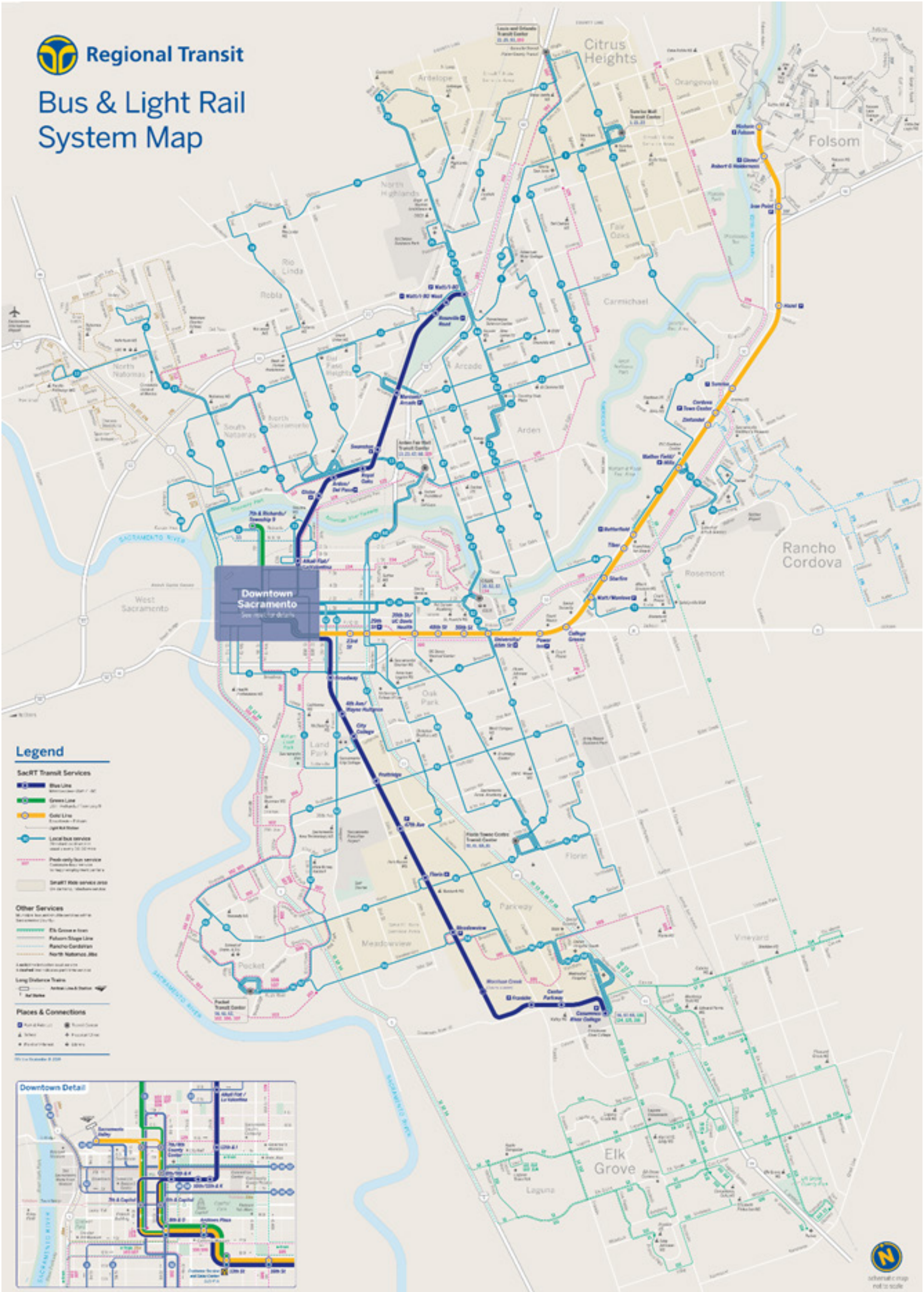
SacRT's SmaRT Ride on-demand transit provides smaller circulator buses to the communities of Arden, Carmichael, Citrus Heights, Downtown-Midtown-East Sacramento, Folsom, Franklin-South Sacramento, Gerber-Calvine, North Sacramento, and Rancho Cordova.

Airport Express bus service operates from Downtown Sacramento to the Sacramento International Airport every 20-30 minutes, seven days a week. The Causeway Connection electric bus operates Monday through Friday from 5:30 a.m. to 8:50 p.m. between the cities of Davis and Sacramento.

SERVICE AREA

[4] Due to the impacts of COVID-19, CARB granted agencies an extension on their Rollout Plan upon request. SacRT requested an extension on May 29th that was granted on June 2nd.

Figure 2-1. SacRT Transit Map | Source: SacRT, September 2019



SacRT's service district covers nearly 400-square miles spanning the entirety of Sacramento County that includes the cities of Sacramento, Citrus Heights, Elk Grove, Folsom, and Rancho Cordova.

ENVIRONMENTAL FACTORS

Sacramento County is in California's Climate Zone 12. Sacramento's winter months average a low of 39 degrees, about average for the State. Its temperatures in the summer are typically hotter than the State average (approximately 93 and 87 degrees, respectively). An analysis of the elevation within 0.75 miles of SacRT's fixed-route service showed an average elevation of 102 ft., a low of -0.5 ft., and a high of 1,164 ft. The higher elevations of the service area are in the east in Folsom and most of the service area is under 100 ft. in elevation.

SCHEDULE AND OPERATIONS

SacRT's bus service includes Bus, Community Bus, and SmaRT Ride. Bus service includes fixed-route local and express service. Community Bus provides transit for residents and employees, SacRT offers this service in partnership with local agencies. SmaRT Ride is a microtransit service that is similar to other ride-share services where customers can use a smartphone application to request a ride within nine SacRT service areas.

SacRT operates 63 bus routes on weekdays and 26 on Saturday and Sunday. Service is primarily available between 5 a.m. to 11 p.m. every 12 to 60 minutes, depending on the route. Weekday bus ridership averages approximately 37,000 passengers per day. Fixed-route service operates out of two permanent and one temporary garage: Downtown Garage, McClellan Garage, and Hazel Station Garage.

2.2 EXISTING ZEB EFFORTS

2.2.1 PURCHASES AND PROCUREMENTS

SacRT is already a leader in the adoption and transition to ZEBs. As early as 2018, SacRT awarded a contract to GreenPower to provide nine EV Stars for their award-winning SmaRT Ride microtransit service (all of which are now in service). In partnership with Electrify America (EA) and the City of Sacramento, SacRT purchased six Proterra 40' buses for Causeway Connection service and three Gillig buses for Airport service.

2.2.2 ZERO-EMISSION BUS FACILITY TRANSITION STUDY

In 2019, SacRT partnered with WSP to produce the Zero-Emission Bus Facility Transition Study, a study to determine the feasibility of transitioning SacRT's existing fleet to ZEB. The study includes route and facilities analysis to develop preliminary plans and strategies to accomplish a 100% fleet transition to ZEBs. The initial findings of this

study were used to inform the Rollout Plan. It should be noted that this study is still ongoing and will ultimately inform SacRT's next steps towards implementation.

2.3 ROLLOUT PLAN APPROACH

Pursuant to the ICT regulation, the Rollout Plan identifies a strategy for SacRT to procure and operate all ZEBs by 2040. Due to the rapidly-evolving nature of ZEB technologies, it is possible that the findings and recommended approaches in this report will be outdated when it is time for implementation. For that reason, a number of generous assumptions were included to account for technological advancements. For example, current BEB technology is not sufficient to meet the range requirements of all of SacRT's service blocks. To account for potential future improvements, the Rollout Plan assumes that battery technology will eventually meet the requirements of SacRT, therefore, a 1:1 (conventional bus to ZEB) replacement ratio was used to account for future ZEB bus procurements and facility enhancements. This approach ensures that SacRT is planning for the future and not conforming to or purchasing infrastructure that will only be compatible with existing technologies. To account for potential fleet increases, facilities are planned and designed for maximum build-out to ensure that enough ZEB infrastructure is in place for fleet expansion.

However, in some areas, SacRT is still evaluating technologies and strategies beyond 2030. Those areas of current study will be indicated, where applicable.

It should also be noted that this Rollout Plan is based on December 2019 data. This dataset is used because it represents the fleet in typical operations. Since then, COVID-19 has impacted SacRT's service, and future routes and plans may be impacted. SacRT has applied for and received an extension to the filing deadline for this plan to account for these changes.

The ***Start-Up and Scale-Up Challenges*** section identify the barriers that may prohibit or make these full-buildout scenarios difficult to achieve. These challenges will serve as the springboard for refinements and strategies in the next stages of implementation.

2.4 ROLLOUT PLAN PURPOSE AND STRUCTURE

In accordance with CARB's Rollout Plan Guidance, the District's Rollout Plan includes all required elements. The required elements and corresponding sections are detailed below:

- Transit Agency Information (Section 1: Rollout Plan Summary)
- Rollout Plan General Information (Section 1: Rollout Plan Summary)
- Current Bus Fleet Composition and Future Bus Purchases (Section 3: Fleet Acquisitions)
- Technology Portfolio (Section 3.2: ZEB Technology Application)
- Facilities and Infrastructure Modifications (Section 4: Facilities and Infrastructure Modifications)
- Providing Service in Disadvantaged Communities (Section 5: Disadvantaged Communities)
- Workforce Training (Section 6: Workforce Training)
- Potential Funding Sources (Section 7: Costs and Funding Opportunities)
- Start-up and Scale-up Challenges (Section 8: Start-up and Scale-up Challenges)

3. FLEET AND ACQUISITIONS

The following section provides an overview of SacRT's existing bus fleet, justification for ZEB technology, and a procurement schedule through 2040 that meets the CARB ICT regulation's requirements.

3.1 EXISTING BUS FLEET

The SacRT fleet includes CNG, diesel, gasoline, and battery-electric (BEB)-powered buses and shuttles. As of August 1, 2020, SacRT operates an active fleet of 246 40-foot buses and 190 shuttles and cutaways that range from 25 to 32 feet in length. SacRT's fleet is operated from three "garages" – Downtown, McClellan, and Hazel. Table 3-1 provides a detailed overview of SacRT's fixed route bus fleet.

In July 2021, the City of Elk Grove's transit services were successfully transitioned under SacRT. SacRT has been operating e-tran and e-van services under a service contract since July 2019, under the annexation agreement, SacRT will provide fixed-route local, commuter and paratransit services and maintenance operations for Elk Grove.

MANUFACTURER	MODEL	FUEL TYPE	LENGTH	IN SERVICE YEAR	BUS TYPE	NO. OF BUSES
Orion	7.501	CNG	40′	2008	Standard	90
	VII			2008		8
Gillig	G27D102N4	CNG	40′	2014	Standard	1
				2015		29
				2016		66
	Battery Electric	Battery Electric	40′	2021		3
El Dorado	EZ Rider II	Diesel	32′	2015	Standard	4
				2016		1
	Aero Elite	CNG	27′	2015	Shuttle	11
				2017		11
		Gas		2019		12
	AeroTech	CNG		2018		4
	Aerotech 220	Gas	25′	2014		6
Proterra	Catalyst E2	Battery Electric	40′	2019	Standard	6
New Flyer	C40LF	CNG	40′	2010	Standard	8
				2011		6
	Xcelsior			2014		3
				2015		8
				2018		5
				2020		8
GreenPower	EV Star	Battery Electric	25′	2018	Shuttle	6
				2019		3
Starcraft	Allstar	Gas	27′	2010	Shuttle	20
				2012		19
		CNG	25′	2017		2
		CNG		2018		4
		Gas	27′	2018		40
		Gas	32′	2018		8
		CNG	25′	2019		4
		Gas	27′	2020		40
					Total Buses	**436**

Table 3-1 Summary of SacRT's Existing Fleet | Source: SacRT, March 26, 2021

3.2 ZEB TECHNOLOGY APPLICATION

Previous and ongoing SacRT ZEB analysis has found that BEBs are more suitable than fuel cell electric buses (FCEBS) for SacRT's existing operations. This is based on BEBs' rate of technological advancement, costs, and availability. Electricity is a reliable and readily-available fuel source and a variety of OEMs have entered the market and produced BEB models that are currently entering pilot or service phases around the country.

While FCEB technology is promising and has many potential benefits (as compared to both CNG and BEB), buses that serve SacRT's main bus division are stored under a freeway, where, according to fire safety regulations, hydrogen fuel storage is prohibited. Additionally, hydrogen fuel is more expensive than both electricity and natural gas and is currently a limited and potentially inconsistent resource. Furthermore, SacRT's facilities are space-constrained, a hydrogen solution could potentially require substantial footprints that are not currently feasible.

However, SacRT will continue to explore options to resolve space constraints. In doing so, as FCEBs become more affordable, SacRT will consider integrating them in the fleet (as indicated in Table 3-2).

3.2.1 BATTERY-ELECTRIC BUS TECHNOLOGIES

As mentioned, based on SacRT's conditions and service needs at this time, it is recommended that a ground mounted plug-in charging strategy be implemented

[5] These five buses are used for training purposes only.

Table 3-2. Summary of SacRT's Future Bus Purchases (through 2040) | Source: WSP | Useful life assumptions: 40' bus - 12 years; 32' bus - 10 years; 27' bus - 7 years; 25' bus - 5 years. The "Replacing ICE" column indicates where ZEB buses have replaced buses with internal combustion engines.

		ZERO-EMISSION BUSES				CONVENTIONAL BUSES		
YEAR	TOTAL BUSES	TOTAL ZEB	PCT.	REPLACING ICE	BUS TYPE	TOTAL ICE	PCT.	BUS TYPE
2021	-	-	-	-	-	-	-	-
2022	63	-	-	-	-	63	100%	40'/25'
2023	69	18	26%	12	27'/25'	51	74%	40'/25'
2024	57	15	26%	12	27'/25'	42	74%	40'/25'
2025	47	12	26%	12	32'/ 27'/25'	35	74%	27'/25'
2026	59	32	54%	32	27'/25'	27	46%	40'/32'/25'
2027	55	28	51%	28	40'/25'	27	49%	25'
2028	117	59	50%	46	40'/32'/25'	58	50%	40'
2029	7	7	100%	4	25'			
2030	44	44	100%	35	40'/27'/25'			
2031	60	60	100%	22	40'/27'/25'			
2032	47	47	100%	40	40'/27'/25'			
2033	46	46	100%		40'/27'/25'			
2034	48	48	100%	41	40'/25'			
2035	71	71	100%	33	40'/32'/25'			
2036	81	81	100%	39	40'/32'/25'			
2037	35	35	100%		27'/25'			
2038	55	55	100%	4	40'/32'/27'/ 25'			
2039	41	41	100%		40'/27'/25'			
2040	124	124	100%	58	40'/27'/25'			

to support BEBs at all three garages. SacRT's future BEBs are expected to have specifications that are compatible with the Society of Automotive Engineers' (SAE) J1772 (plug-in) charging standards. In the future, depending on available space, SacRT may consider overhead pantograph or ground-mounted inductive charging.

The proposed facility layouts for each garage are based on utilizing a 150-kW DC charging cabinet in a 1:2 charging orientation (one DC charging cabinet energizes two separate dispensers/buses). This charger to dispenser ratio maximizes space utility, reduces infrastructure costs, and meets the requirements to charge the fleet during servicing and dwell time on the site while minimizing the peak electrical demand.

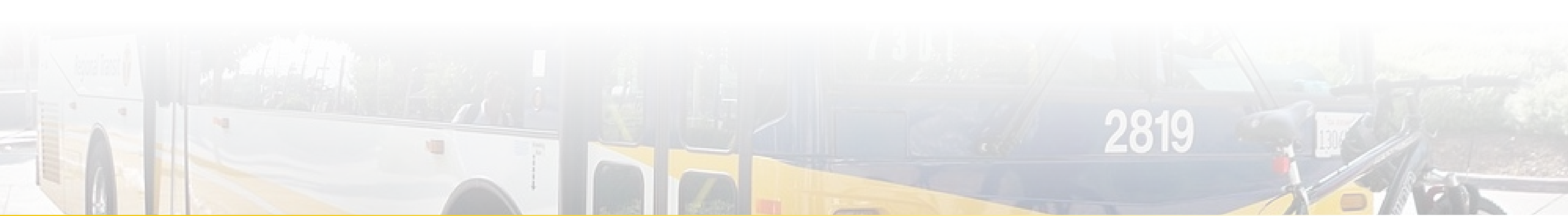
Figure 3-1 shows an example of a ground-mounted plug-in charging bus yard.

3.3 PROCUREMENT SCHEDULE

In accordance with the ICT regulation, SacRT will prioritize ZEB purchases and progressively increase the percentage of ZEB purchases over time. Based on initial analysis, the last conventional bus is expected to be purchased in 2028.

Early retirement should not be an issue pursuant to the ICT regulation (2040) based on SacRT's future purchases. One potential strategy is to place newly acquired buses on SacRT's longest (distance) blocks. This will ensure that these buses meet the Federal Transit Administration's (FTA) 500,000-mile requirement ("useful life") more rapidly.

Table 3-2 presents a summary of SacRT's anticipated bus and shuttle procurements through 2040. By 2023, 25% of purchases must be ZEB; by 2026, 50% of purchases must be ZEB; and from 2029 onward 100 percent of purchases must be ZEB. Figure 3-2 illustrates the fleet mix of conventional and ZEBs through 2040.



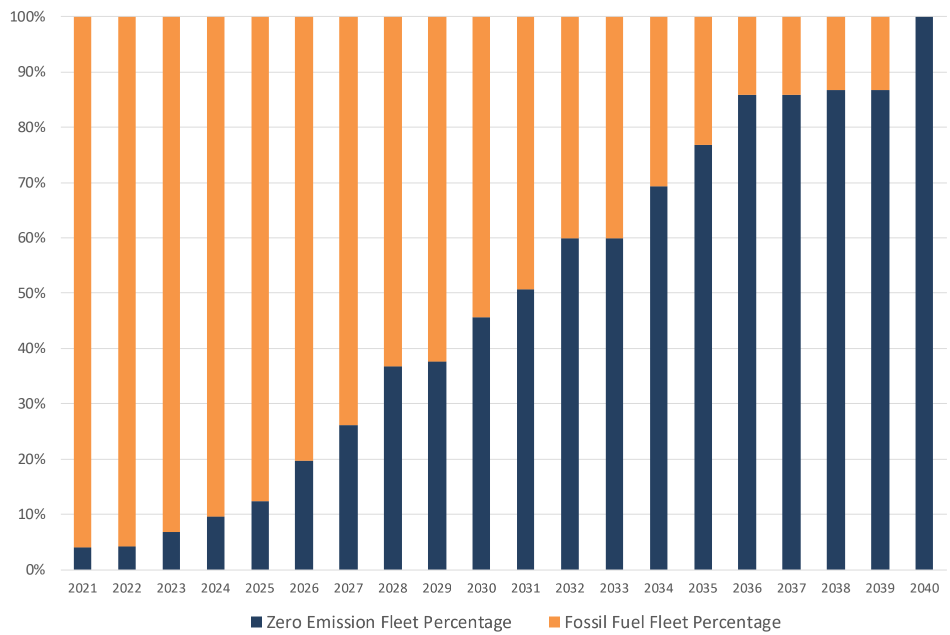


Figure 3-2. ZEB Fleet Percentage 2021 - 2040 | Source: WSP

3.3.1 ZEB CONVERSIONS

Conventional bus conversions to ZEB technologies are not currently being considered at this time. However, SacRT will remain open to conversions if they are deemed financially feasible and align with ZEB adoption goals.

4. FACILITIES AND INFRASTRUCTURE MODIFICATIONS

The following section details the planned charging strategies, infrastructure, detailed garage improvements, and construction and phasing schedule.

4.1 METHODOLOGY

Since ZEB technology continues to evolve, it is difficult to commit to a costly strategy that may become outdated or obsolete in the future. However, it is also pertinent to ensure that strategies are future-ready. For this reason, the recommended facility and infrastructure modifications are based on what can physically be accommodated at each garage. This provides SacRT with a ceiling for what can physically be constructed and worst-case scenario for electric utility planning. Since service changes and bus movements may occur multiple times a year, by establishing a full-build scenario, SacRT can optimize, and tailor strategies based on existing (or anticipated) service.

4.2 FACILITY MODIFICATIONS

SacRT's transition to a BEB fleet will require a number of modifications and changes to existing infrastructure and operations. This will include the enhancements and expansions of electrical equipment, additional electrical capacity, and the installation of chargers, dispensers, and other components. These modifications will occur at all three of SacRT's garages, and, if viable and required, at layover facilities for on-route charging operations.

During preliminary concept discussions, the feasibility of both conductive (overhead inverted pantographs, and ground-mounted or overhead plug-in) and inductive (in-ground wireless) charging dispensers were analyzed based on efficacy, costs, and spatial requirements. Due to spatial constraints, it was found that ground-mounted plug-in chargers are the most viable, at this time.

Proposed layouts are based on utilizing a 150-kW DC charging cabinet in a 1:2 charging orientation (one DC charging cabinet energizes two separate dispensers/buses). This charger to dispenser ratio would meet the requirements to charge SacRT's fleet overnight and minimize peak electrical demand.

As previously mentioned, the proposed facilities and modifications are based on what is feasible under existing conditions. If conditions change, SacRT will reanalyze the ZEB strategy to possibly include FCEBs and supporting infrastructure.

Figure 4-1 illustrates the location of SacRT's garages and Table 4-1 summarizes the modifications and schedule of each garage.

The following sections detail the process of each garage's transition from existing conditions to BEB-readiness.

Figure 4-1. SacRT's Garage Locations | Source: WSP; Google Earth

GARAGE	ADDRESS	MAIN FUNCTIONS	PLANNED INFRASTRUCTURE	SERVICE CAPACITY	UPGRADE REQ'D?	TIMELINES
Downtown	1323 28th St Sacramento, CA	Parking/ Storage	Plug-in Charging	146	Yes	2022-2035
McClellan	3701 Dudley Ave. McClellan, CA	O&M	Plug-In Charging	23+	Yes	2022-2035
Hazel	12500 Folsom Blvd. Rancho Cordova, CA	Parking/ Storage	Plug-In Charging	5+	Yes	2022-2035

Table 4-1. SacRT's Garage Summary | Source: WSP

Note: The construction timeline represents the span of time that each garage will be upgraded. Ongoing analysis will determine specific timelines and milestones.

4.2.1 DOWNTOWN GARAGE

EXISTING CONDITIONS

SacRT's Downtown Garage is split over multiple blocks in Sacramento. Buses are stored under the Capitol City Freeway between Q Street and Capitol Avenue with electrical utility service provided by the Sacramento Municipal Utility District (SMUD). The Downtown Garage's fuel, wash, and maintenance facilities are located at 1323 28th St adjacent to the storage area. Currently, 196 CNG 40-foot buses are stored, maintained, fueled, and serviced at the downtown garage.

Figure 4-2 presents Downtown Garage under existing conditions.

Figure 4-2. Downtown Garage (Bus Storage) - Existing Conditions | Source: WSP

PLANNED ZEB MODIFICATIONS

It is recommended that the Downtown Garage adopts a ground-mounted plug-in charging solution. The associated charging, switchgear, and transformer cabinets will be arranged within the parking area as space allows. Due to Caltrans' setback requirements, BEB-supporting infrastructure cannot be placed within 20 feet of the freeway's supporting columns. For this reason, the Downtown Garage can only accommodate 146 buses (net loss of 51 buses from existing) with 146 charging positions in a 1:2 charger to bus dispenser ratio. SacRT is currently assessing where these 51 buses will be relocated to.

Table 4-2 summarizes the ZEB infrastructure planned at Downtown Garage.

GARAGE	CHARGING STRATEGY	NO. OF EXISTING BUSES	NO. OF BUSES SUPPORTED	NO. OF CHARGERS	NO. OF DISPENSERS	CHARGER RATING
Downtown	Ground-mounted plug-in	197	146	73	146	150 kW

Table 4-2. Downtown Garage Supporting Infrastructure Summary | Source: WSP

The following BEB equipment is proposed:

- 73 DC charging cabinets located at the end of bus parking rows that will distribute to 146 plug-in charging positions spaced every two buses.
- Four standalone switchboards rated at 4000 Amps, 480V.
- Four transformers rated at 3,000 kV

Figure 4-3 illustrates the Downtown Garage at full build-out.

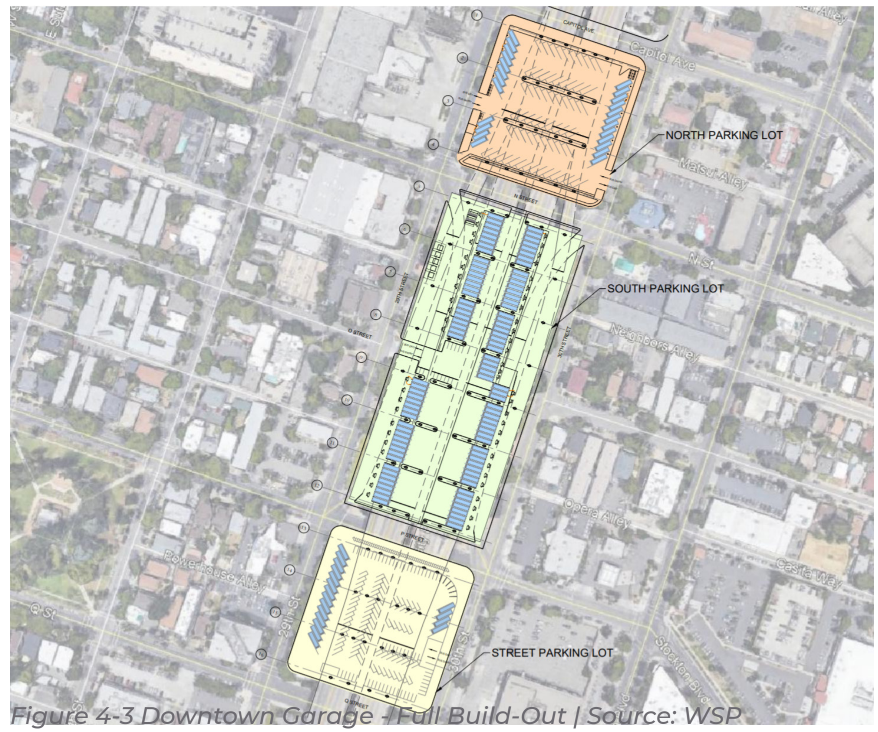


Figure 4-3 Downtown Garage - Full Build-Out | Source: WSP

4.2.2 MCCLELLAN GARAGE

EXISTING CONDITIONS

The McClellan Garage is located at 3701 Dudley Avenue in McClellan, CA. It is currently used to store, service and operate 23 gasoline-powered cutaway shuttles. The site includes a single-story maintenance building, and a combined fuel and wash building. Figure 4-4 presents McClellan Garage under existing conditions.

Figure 4-4 McClellan Garage - Existing Conditions | Source: WSP

PLANNED ZEB MODIFICATIONS

It is recommended that the McClellan garage adopt a ground-mounted plug-in charging solution. The associated charging, switchgears, and transformer cabinets will also be mounted on platforms adjacent to dispensers. The future ZEB infrastructure for this site is currently study, but it has the potential to store and charge over 80 buses.

Table 4-3 summarizes the ZEB infrastructure planned at McClellan Garage.

GARAGE	CHARGING STRATEGY	NO. OF EXISTING BUSES	NO. OF BUSES SUPPORTED	NO. OF CHARGERS	NO. OF DISPENSERS	CHARGER RATING
McClellan	Ground-mounted plug-in	23	23+	12+	23+	150 kW

Table 4-3. McClellan Garage Supporting Infrastructure Summary | Source: WSP

4.2.3 HAZEL GARAGE

EXISTING CONDITIONS

The Hazel Garage is located at 12500 Folsom Boulevard in Rancho Cordova, CA. It is used to store, service, and operate five diesel-powered 32-foot buses.

Figure 4-5 presents Hazel Garage under existing conditions.

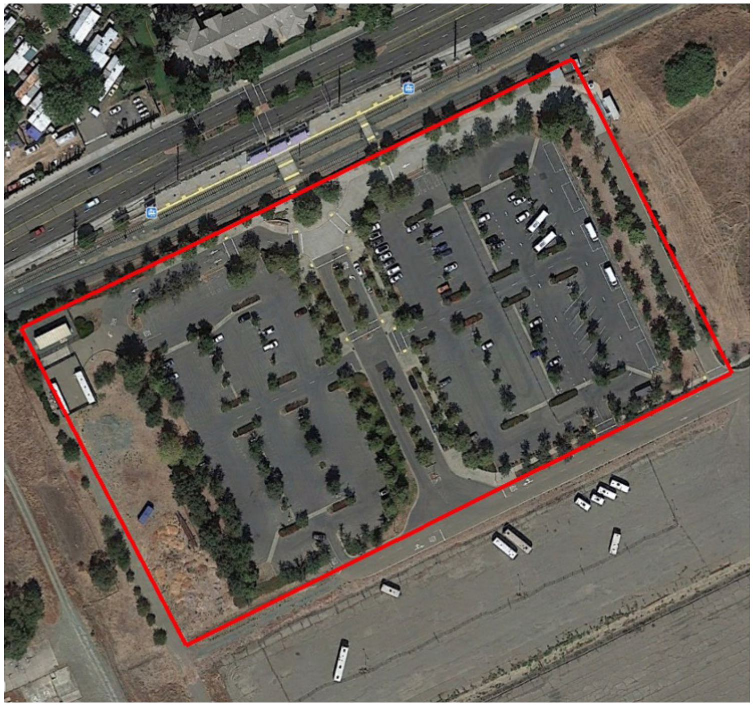


Figure 4-5 Hazel Garage - Existing Conditions

PLANNED ZEB MODIFICATIONS

Hazel Garage will likely adopt a ground mounted plug-in charging strategy. The associated charging cabinets, switchgears, and transformers will be located adjacent to the charging area. Charging type, future site layout, and utility connection are currently under study.

Table 4-4 summarizes the ZEB infrastructure planned at Hazel Garage.

GARAGE	CHARGING STRATEGY	NO. OF EXISTING BUSES	NO. OF BUSES SUPPORTED	NO. OF CHARGERS	NO. OF DISPENSERS	CHARGER RATING
Hazel	Ground-mounted plug-in	5	5+	3+	5+	150 kW

Table 4-4. Hazel Supporting Infrastructure Summary | Source: WSP

4.3 PHASING AND CONSTRUCTION STRATEGY

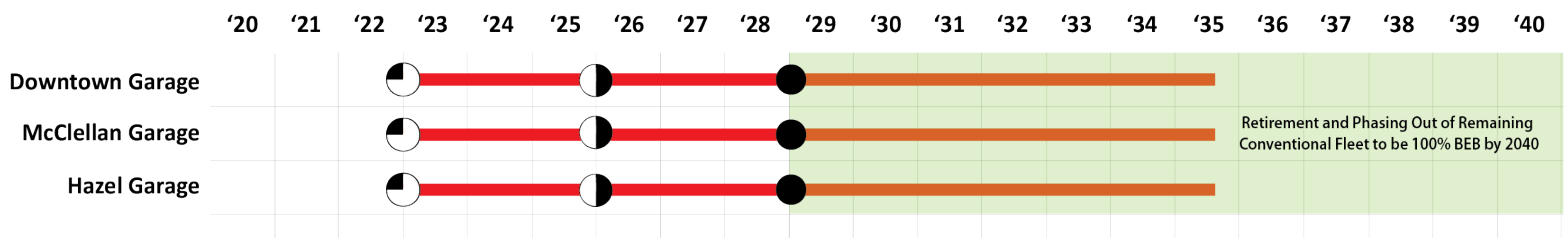
The process of integrating BEBs into SacRT's fleet will broken down into a number of important tasks and phases related to construction of supporting facilities. The assumed approach is a design-bid-build strategy. Multiple requests for proposals (RFPs) need to be developed and put out for bid, with accompanying design and construction activities taking place. Utility upgrades, onsite (phased) construction, and other activities are expected to last approximately five years, for each garage. This five-year assumption is a conservative estimate based on the amount of time it may take the utility to provide upgraded electrical equipment outside of the garage. The onsite upgrades and construction of BEB supporting infrastructure can be done concurrently.

To minimize or avoid operational or service impacts, it is recommended that onsite construction be implemented in phases. This method essentially segments the garage and ensures that construction continues without impacting SacRT's service.

Since BEBs cannot be operated unless infrastructure is in place to energize them, it is pertinent to meet construction deadlines because it has the ability to impact both service and ICT regulation compliance. It is assumed that buses can be procured 18 months before the conclusion of the facilities construction.

Figure 4-7 presents a conceptual schedule for SacRT's fleet transition. The Harvey Balls indicate the percentage of newly purchased that have to be ZEB. Note, the phasing and specific construction schedules are still being analyzed, however, it is anticipated that construction for each garage will be completed during this time frame (2022-2035).

Figure 4-6. Potential Phasing and Construction Schedule | Source: WSP



5. DISADVANTAGED COMMUNITIES

Disadvantaged communities (DACs) refer to the areas that suffer the most from a combination of economic, health, and environmental burdens. The California Environmental Protection Agency (CalEPA) and California's Senate Bill 535, define a "disadvantaged" community as a community that is located in the top 25th percentile of census tracts identified by the results of the California Communities Environmental Health Screening Tool (CalEnviroScreen). CalEnviroScreen uses environmental, health, and socioeconomic data to measure each census tract (community) in California. Each tract is assigned a score to gauge a community's pollution burden and socioeconomic vulnerability. A higher score indicates a more disadvantaged community, whereas a lower score indicates fewer disadvantages.

The replacement of conventional buses with ZEBs can yield many benefits in the communities they serve, including a reduction of noise and harmful pollutants. DACs are disproportionately exposed to these externalities, thus, should be prioritized and considered during initial deployments of ZEBs. In phasing and deployment, SacRT will ensure that DACs and equity are a driving factor in determining which garages and routes are first served with ZEBs.

5.1 DISADVANTAGED COMMUNITY ANALYSIS

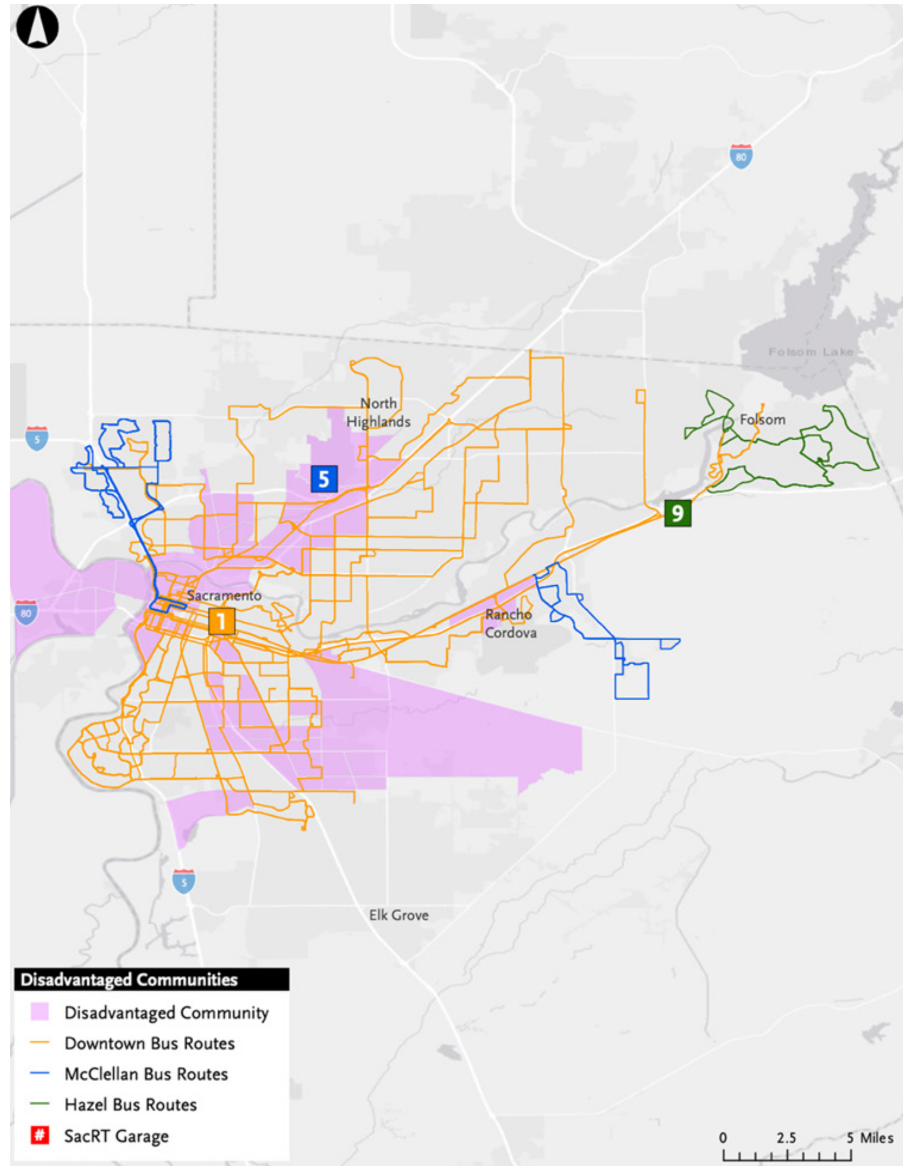
To understand ZEBs impacts on SacRT's service area, it was pertinent to establish if (1) a garage is located in a DAC, and (2) if its routes traverse DACs.

Based on analysis, McClellan is the only garage located in a DAC, meaning, it may be given priority in the transition due to the residents in that census tract potentially benefitting from the reduction of noise and emissions as a result of transitioning to ZEBs. McClellan-based blocks of service and routes also provide the largest percentage of DACs of any garage (30 percent), 22 percent of Downtown garage's communities served are DAC, and Hazel has none. Future analysis will provide more detail on route and block-specific DAC information, however, at this time, SacRT will continue to monitor these communities and consider and align them with their ZEB procurement schedule to ensure that vulnerable communities are properly served.

GARAGE	IN DAC?	NO. EXEMPT AREA?	COMMUNITIES SERVED	DACs SERVED	PCT. OF DACs SERVED
Downtown	No	No	240	44	22%
McClellan	Yes	No	26	6	30%
Hazel	No	No	17	0	0%

Table 5-1. SacRT's Disadvantaged Communities Summary | Source: CalEnviroScreen 3.0

Figure 5-1. SacRT's Disadvantaged Communities | Source: WSP; CalEnviroScreen3.0



5.2 ADDITIONAL EQUITY-FOCUSED EFFORTS

5.2.1 SACRAMENTO SUSTAINABLE COMMUNITIES RESOURCE PRIORITIES NEEDS MAP

SacRT has also recently supported and engaged in the development of Sacramento's Sustainable Communities Resource Priorities Needs Map which was spearheaded by Sacramento Municipal Utility District (SMUD), University of California, Davis, Sacramento Metro Air Quality Management District, Sacramento Area Council of Governments, and a variety of local agencies and non-profits. The Map uses data to indicate the local areas most likely to be underserved or in distress by lack of community development, income, housing, employment opportunities, and transportation. The map can then be used to develop targeted strategies to provide and promote a healthy environment, social well-being, mobility, and prosperous economy for Sacramento County most vulnerable populations. SacRT's ZEB implementation plays a key role in further pursuing a sustainable and equitable approach to transportation and development.

Additionally, the map includes a number of other GIS layers including education, tree canopy, EV charging, food deserts, and public transportation information in order to maximize and improve the equity of regional decision-making. The map is regularly monitored and interactive in a manner that allows customized searching and evaluation. The interactive storyboard format of the map allows for each section to reveal a different view of a specific map layer while explaining the nature of the vulnerability being examined.

SacRT will work with SMUD to leverage the mapping tool to improve decision-making as it relates to resource allocation, while empowering community members to take an active role in providing positive impact in their communities. The information will be used to help inform regional strategies including local, state, regional, and federal grant funding opportunities.

5.2.2 SMART RIDE ON-DEMAND MICROTRANSIT

SacRT's also serves its most disadvantaged communities by providing mobility, connectivity, health access, and overall quality of life, through cleaner forms of transportation. Since 2018, SacRT's SmaRT Ride On-Demand Microtransit service - the nation's largest mixed-ZEV on-demand fleet of its kind - provides more affordable services than traditional ride-hailing options (Lyft, Uber, etc.), which could cost riders more than five times the amount for a similar trip.

5.2.3 BUS RAPID TRANSIT

SacRT is actively progressing its planning phase of pursuing high-capacity bus services through Bus Rapid Transit, with a goal of focusing on supplementing or enhancing services in DACs. Preliminary research has concluded that multi-modal users and pedestrians are more unsafe in DACs due to the high levels of traffic and infrastructure that allows for more interactions between motorized vehicles and pedestrians. SacRT's goal is to develop BRT service that improves the safety of the community, to include exclusive rights of way and signal prioritization for buses. These BRT services will be targeted along areas that lack the infrastructure, investment, and safety, such as the Stockton Boulevard, Florin Road, Sunrise Boulevard, Arden Way and Watt Avenue corridors.

6. WORKFORCE TRAINING

The following section provides an overview of SacRT's plan and schedule to train personnel on the impending transition.

6.1 TRAINING REQUIREMENTS

The transition to ZEBs will significantly alter SacRT's service and operations. Converting to ZEBs from CNG is an arduous endeavor and will impact all ranks of the organization. This will require extensive change management and training which will be provided by the OEMs and SacRT. Training will need to be conducted after buses are procured and in advance of the delivery of the first buses. Therefore, it is expected that all personnel will be sufficiently trained before the buses arrive. Training for the buses will be included in the purchase price and facilitated by the OEM. If other OEM-provided buses are procured in the future and/or if new components, software, or protocols are implemented, it is expected that SacRT's staff will be trained well in advance of the commissioning of these additions. Since battery technology is rapidly evolving, it is likely that buses and their supporting battery chemistries and software will change between 2020 and 2040, therefore, SacRT's future procurements/deliveries will require refresher or updated trainings for relevant staff.

The following provides a list of personnel and positions that will need to be retrained upon adoption of ZEBs (this list is not exhaustive):

- Bus Operators and Supervisors
  - Bus operators and field supervision will need to be familiarized with the buses, safety, bus operations, and plug-in charging operations.
- Facilities Maintenance Staff and Maintenance
  - Maintenance staff will need to be familiarized with scheduled and unscheduled repairs, high-voltage systems, and the specific maintenance and repair of equipment.
- First Responders
  - Local fire station staff will need to be familiarized with the new buses and supporting facilities.
- Tow Truck Service Providers
  - Tow truck providers will need to be familiarized with the new buses and proper procedures for towing ZEBs.
- Mechanics
  - Mechanics will need to be familiarized with the safety-related features and other components of ZEBs.
- Instructors
  - Maintenance and Bus Operator instructors will need to understand all aspects of the transition of ZEBs to train others.
- Utility Service Workers
  - Staff will become familiarized with proper charging protocol and procedures that are ZEB-specific.
- Management Staff
  - Maintenance and Operations managerial staff will be familiarized with ZEB operations and safety procedures.

7. COSTS AND FUNDING OPPORTUNITIES

The following section identifies preliminary capital costs and potential funding sources that SacRT may pursue in its adoption of ZEBs.

7.1 PRELIMINARY CAPITAL COSTS

While costs for a full fleet transition are still being analyzed, it is estimated that capital, alone, would be in excess of $200M. The specifics of which are dependent on what and when the technology is adopted (BEBs or FCEBs). The following provides a ROM for a full fleet conversion for both BEBs and FCEBs. A mixed fleet solution is still under consideration.

For BEBs, recent quotes from a variety of OEMs indicate that the average base purchase price is approximately $900K and $250K for a 40-foot (standard bus) and 25-foot cutaway, respectively. Chargers vary based on power output, however, a 150-kW plug-in charger with garage buildout costs amortized on a per-charger basis, are expected to cost $150K. Using these unit costs as a baseline, it would cost $201.4M for buses and chargers (alone). This does not account for the trenching, utility infrastructure, soft costs, or other costs related to the transition.

The costs of a FCEB transition are a bit more complex due to the variable unit costs of FCEB-supporting infrastructure (tanks, compressors, reformers, dispensers, etc.). However, based on ROM costs, a transition with the same number of buses is expected to start at $246.9M. This is based on the assumption of $1.2M per FCEB and two hydrogen tanks, one 15,000 gallon and one 9,000 gallon, based on the needs of SacRT's fleet size (estimated at $700K and $500K, respectively). It should be noted that this price does not include the price of the compressors, reformers, etc. that are necessary to operate hydrogen. The total estimate also includes a one-for-one replacement for cutaway/shuttle vehicles and chargers with BEBs since there are currently no FCEB cutaways on the market.

Tables 7-1 summarizes the number of buses and supporting equipment required at each division. Tables 7-2 and 7-3 present the ROM capital costs for a BEB and FCEB transition, respectively.

				BCB	FCEB
GARAGE	NO. OF 40 FT BUSES	NO. OF CUTAWAYS	TOTAL BUSES	NO. OF CHARGERS	NO. OF H2 TANKS
Downtown*	197	-	197	99	2
McClellan	-	23	23	12	-
Hazel	-	5	5	3	-
Total	197	28	225	114	2

Table 7-1. ROM Vehicle and ZEB Equipment for ZEB Conversion | Source: SacRT, August 2020

GARAGE	40-FT BUS COSTS	CUTAWAY BUS COSTS	TOTAL BUS COSTS	TOTAL CHARGER COSTS	TOTAL COSTS
Downtown*	$177.3M	-	$177.3M	$14.9M	$192.2M
McClellan	-	$5.8M	$5.8M	$1.8M	$7.6M
Hazel	-	$1.3M	$1.3M	$450K	$1.7M
Total	$177.3M	$7M	$184.3M	$17.1M	$201.4M

Table 7-2. ROM Capital Costs for BEB Conversion | Source: SacRT, August 2020

*Note: * Approximately 51 buses at Downtown would have to be relocated to another location. Assuming that SacRT maintains their existing fleet size, these 51 buses and associated chargers (26) would cost an additional $45.9M and $3.9M, respectively.*

GARAGE	40-FT BUS COSTS	CUTAWAY BUS COSTS	TOTAL BUS COSTS	TOTAL CHARGER COSTS	TOTAL TANK COSTS	TOTAL COSTS
Downtown*	$237.6M	-	$236.4M	-	$1.2M	$237.6M
McClellan	-	$5.8M	$5.8M	$1.8M	-	$7.6M
Hazel	-	$1.3M	$1.3M	$450K	-	$1.7M
Total	$237.6M	$7M	$243.4M	$2.3M	$1.2M	$246.9M

Table 7-3. ROM Capital Costs for FCEB Conversion | Source: SacRT, August 2020

*Note: * It is assumed that 15,000 and 9,000 gallon tanks would be needed to fuel 197 standard buses*

7.2 POTENTIAL FUNDING RESOURCES

There are a number of potential federal, state, local, and project-specific funding and financing sources at SacRT's disposal. To date, SacRT has applied for and been awarded for various elements of their ZE inventory, as indicated in Table 7-4.

SacRT will also continue to leverage funds from its local tax measure and pursue other strategies to meet it electrification goals, such as public-private partnerships, another grant opportunities.

TYPE	AGENCY	FUNDING MECHANISM
Federal	United States Department of Transportation (USDOT)	Better Utilizing Investments to Leverage Development (BUILD) Grants
	Federal Transportation Administration (FTA)	Capital Investment Grants – New Starts
		Capital Investment Grants – Small Starts
		Bus and Bus Facilities Discretionary Grant
		Low- or No-Emission Vehicle Grant
		Metropolitan & Statewide Planning and Non-Metropolitan Transportation Planning
		Urbanized Area Formula Grants
		State of Good Repair Grants
		Flexible Funding Program – Surface Transportation Block Grant Program
	Federal Highway Administration (FHWA)	Congestion Mitigation and Air Quality Improvement Program
	Environmental Protection Agency (EPA)	Environmental Justice Collaborative Program-Solving Cooperative Agreement Program
	Department of Energy (DOE)	Design Intelligence Fostering Formidable Energy Reduction and Enabling Novel Totally Impactful Advanced Technology Enhancements
State	California Air Resources Board (CARB)	Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP)
		State Volkswagen Settlement Mitigation
		Carl Moyer Memorial Air Quality Standards Attainment Program
		Cap-and-Trade Funding
	California Transportation Commission (CTC)	Solution for Congested Corridor Programs (SCCP)
	California Department of Transportation (Caltrans)	Low Carbon Transit Operations Program (LCTOP)
		Transportation Development Act
		Transit and Intercity Rail Capital Program
		Transportation Development Credits
		New Employment Credit
Local and Project-Specific		Joint Development
		Parking Fees
		Tax Rebates and Reimbursements
		Enhanced Infrastructure Financing Districts
		Opportunity Zones

Table 7-4. ZEB Funding Opportunities

8. START-UP AND SCALE-UP CHALLENGES

There are a number of challenges and opportunities that SacRT faces in converting to an all-ZEB fleet, especially in accordance with CARB ICT regulation purchasing requirements and schedule. The following briefly describes some of the challenges that SacRT faces for its transition:

Downtown Garage Space Constraints: SacRT leases its current Downtown Garage from the California Department of Transportation (Caltrans), meaning, **SacRT lacks autonomy and authority to construct or implement infrastructure without Caltrans' approval.** Of the 197 buses currently parked at the Downtown Garage, which is largely underneath a freeway, only 146 can be charged and stored given the setback and easement limitations for infrastructure.

McClellan Site Issues: The McClellan Garage can possibly accommodate the 51 buses displaced from the Downtown Garage's transition. However, it comes with many challenges. Firstly, McClellan is located far from downtown routes and would drastically increase deadhead trip distance and thus, operating costs. Additionally, McClellan is located on land formerly part of an Air Force base and is a "brownfield". Any construction onsite would require soil remediation and excessive permitting to bring buildings up to code. **These problems would incur exorbitant costs for SacRT.**

Utility Limitations: SMUD has established that a maximum of 11MW can be supplied to the Downtown Garage. This translates to a maximum of 73 150 kW charging cabinets being installed onsite, **far fewer than are required to charge the entire fleet**. This data is based on preliminary analysis and technological advancements and charge management solutions may reduce the amount of power required, however, utility enhancements would still be required.

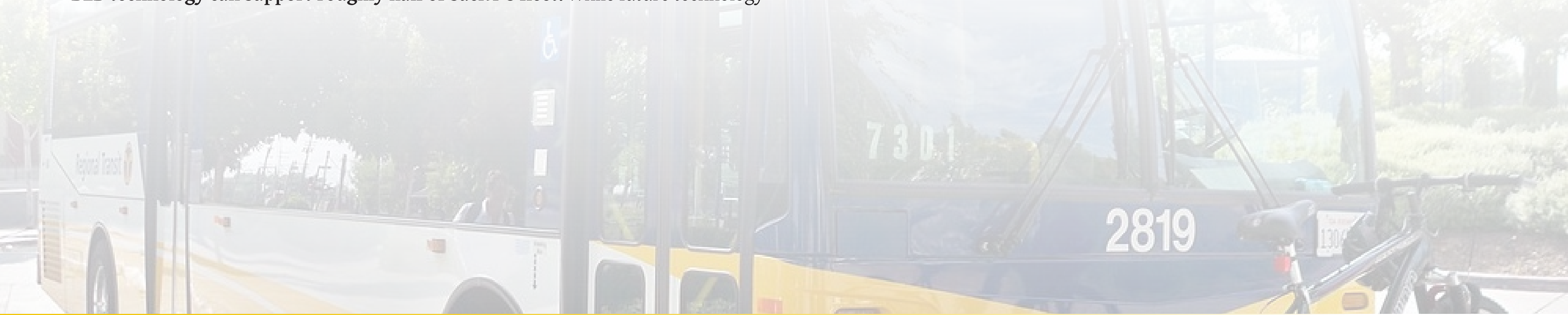
Technological Adaptation: Currently, SacRT is modeling and planning for a transition based on existing service and ZEB technology. **Due to range limitations, current BEB technology can support roughly half of SacRT's fleet.** While future technology advancements are expected, SacRT needs to plan for what already exists. To maintain current service with today's BEB technology, SacRT would need to expand the fleet by up to 100 additional vehicles. SacRT has neither the capital budget nor the space required for these extra buses.

Costs: Adoption of ZEBs has many benefits, including potential lifecycle cost savings. However, the investment required for capital and change management will be very expensive. As previously discussed, **buses and chargers at existing fleet levels could cost $189M.** SacRT will have to be creative with funding mechanisms and sources to ensure that the transition to ZEB will not be detrimental to its operations and service. Even after capital funding is secured, the temporary relocation of buses will require deadheading that is likely not funded by grants.

Market Production Factors: The ICT regulation will put a lot of pressure on OEMs to produce ZEBs at unprecedented rates. However, it is not only California that is interested in converting to ZEBs. These monumental policy changes will have a great impact on these transitions, **making it challenging to meet ZEB goals for agencies if the supply of buses cannot meet demand**.

Phasing and Transition: Transitioning to ZEBs without any service interruptions will be very challenging due to the **limited space for temporary construction and bus relocation,** and hard deadlines.

COVID-19 Considerations: The ongoing pandemic has impacted SacRT ridership and the bus industry at large. **It is unclear of the long-term impacts to funding and public transit as a whole.** This Rollout Plan is based on pre-COVID conditions, however, due to the volatile nature of transit (even before COVID), ambitious goals will have to be flexible and adaptable based on new data and trends.

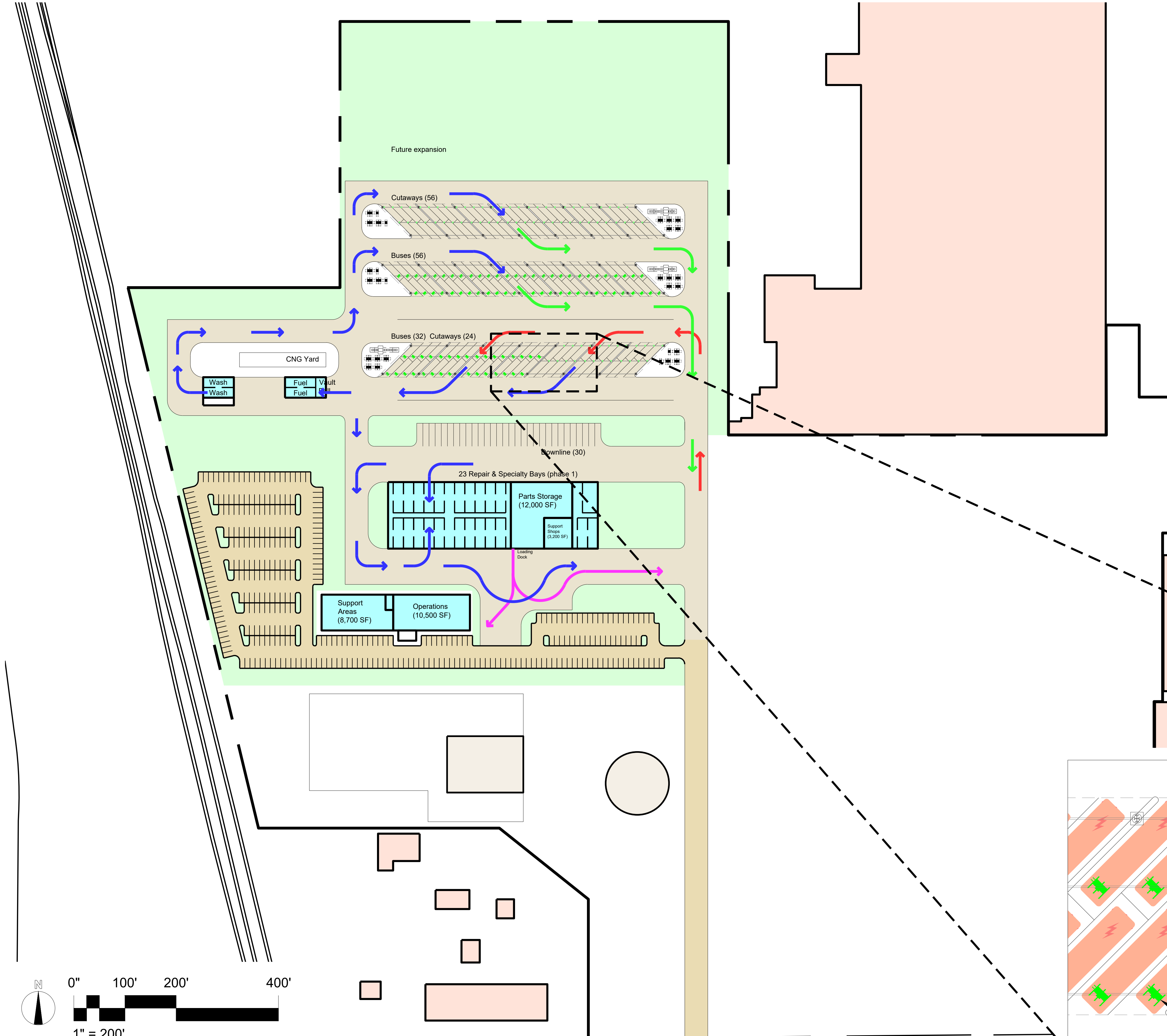


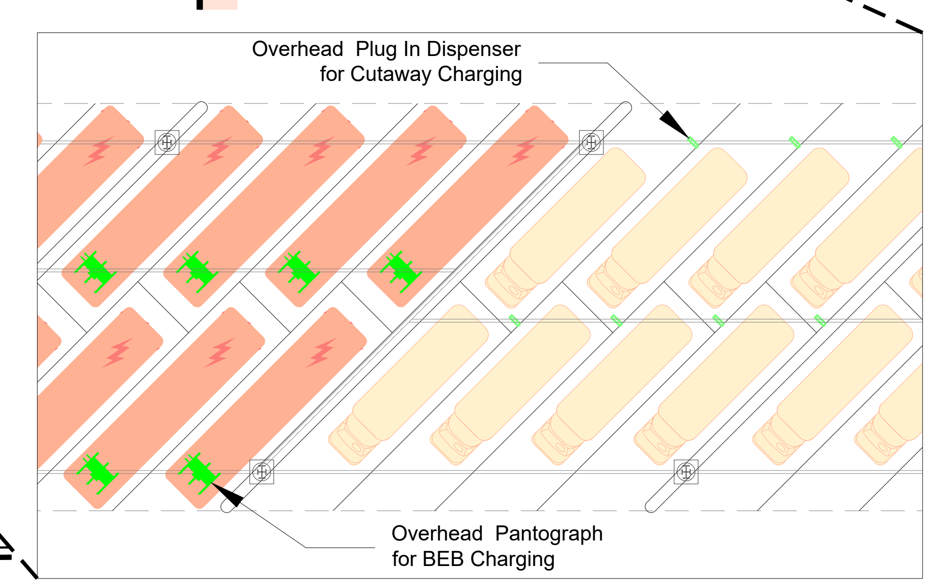
APPENDIX A

BOARD RESOLUTION

C. APPENDIX C – CONCEPTUAL DRAWINGS

SOUTH SITE





HERRINGBONE (POTENTIAL PULL THROUGH) W/ OVERHEAD PANTOGRAPH (BUSES) & PLUG IN CHARGING (CUTAWAYS)

AREA: 1,215,000 SF (28 ACRES)

ASSUMPTIONS (PHASE 1):

1. Parking space dimensions;
   - 12' X 42' (Buses, 32' cutaways)
   - 12' X 30' (other cutaways)
2. Parking positions:

12' X 42'	88
12' X 30'	80
TOTAL	168
Non Revenue	20
Employees	325
TOTAL	345

CIRCULATION

INBOUND

INTERNAL

OUTBOUND

OTHER

PROJECT NO. 187369A

DRAWN BY JK

DATE 01/24/2022

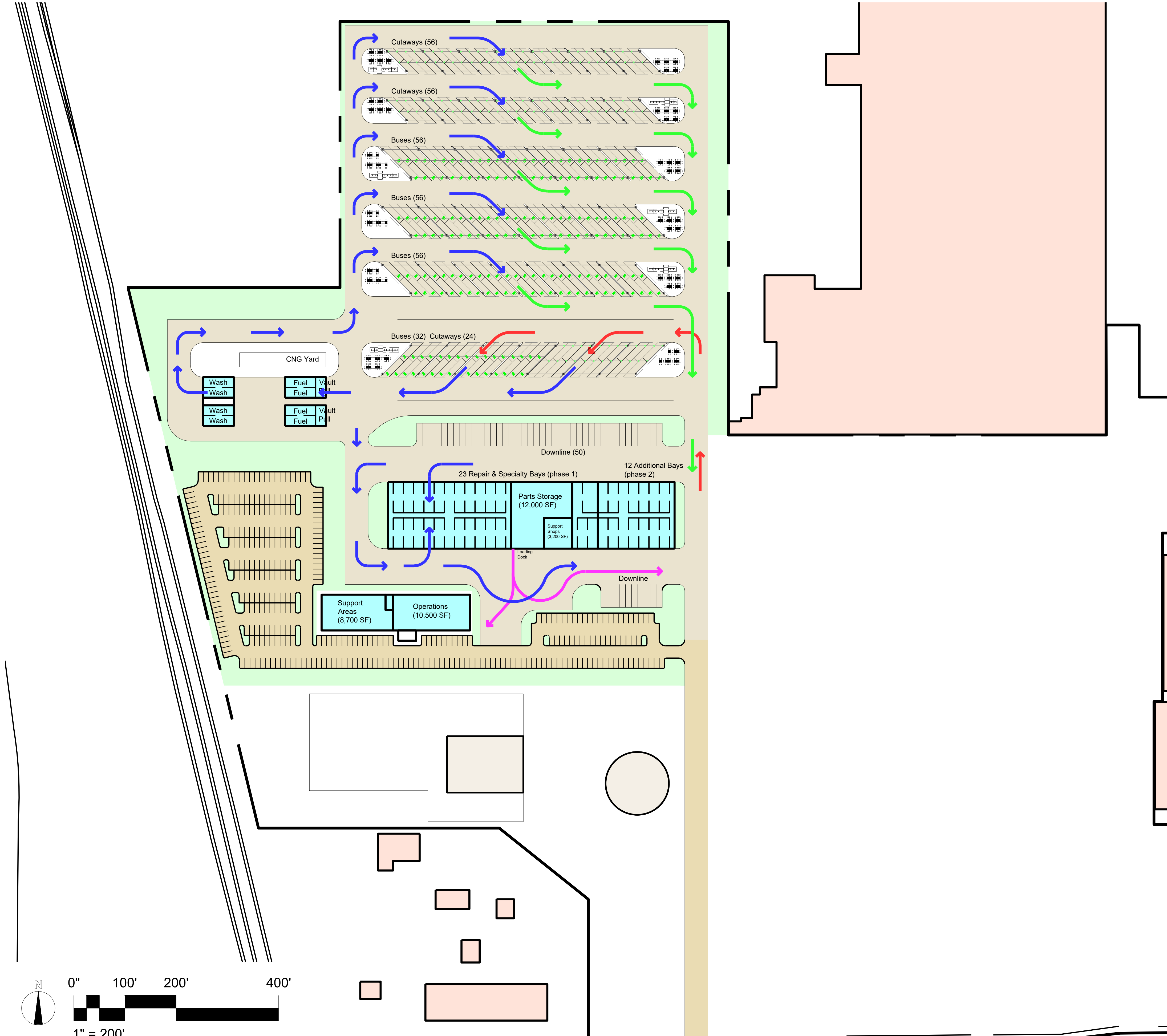
SCALE 11X17: 1" = 200'

PROJECT TITLE SacRT SOUTH SITE

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

DRAWING TITLE HERRINGBONE PANTOGRAPH PHASE 1

DRAWING NUMBER MP-S.01A



HERRINGBONE (POTENTIAL PULL THROUGH) W/
OVERHEAD PANTOGRAPH (BUSES) &
PLUG IN CHARGING (CUTAWAYS)

AREA: 1,215,000 SF (28 ACRES)

ASSUMPTIONS (FULL BUILD):

1. Parking space dimensions;
   12' X 42' (Buses, 32' cutaways)
   12' X 30' (Other cutaways)
2. Parking positions:

12' X 42'	200
12' X 30'	136
TOTAL	336
Non Revenue	20
Employees	325
TOTAL	345

CIRCULATION
INBOUND →

INTERNAL →

OUTBOUND →

OTHER →

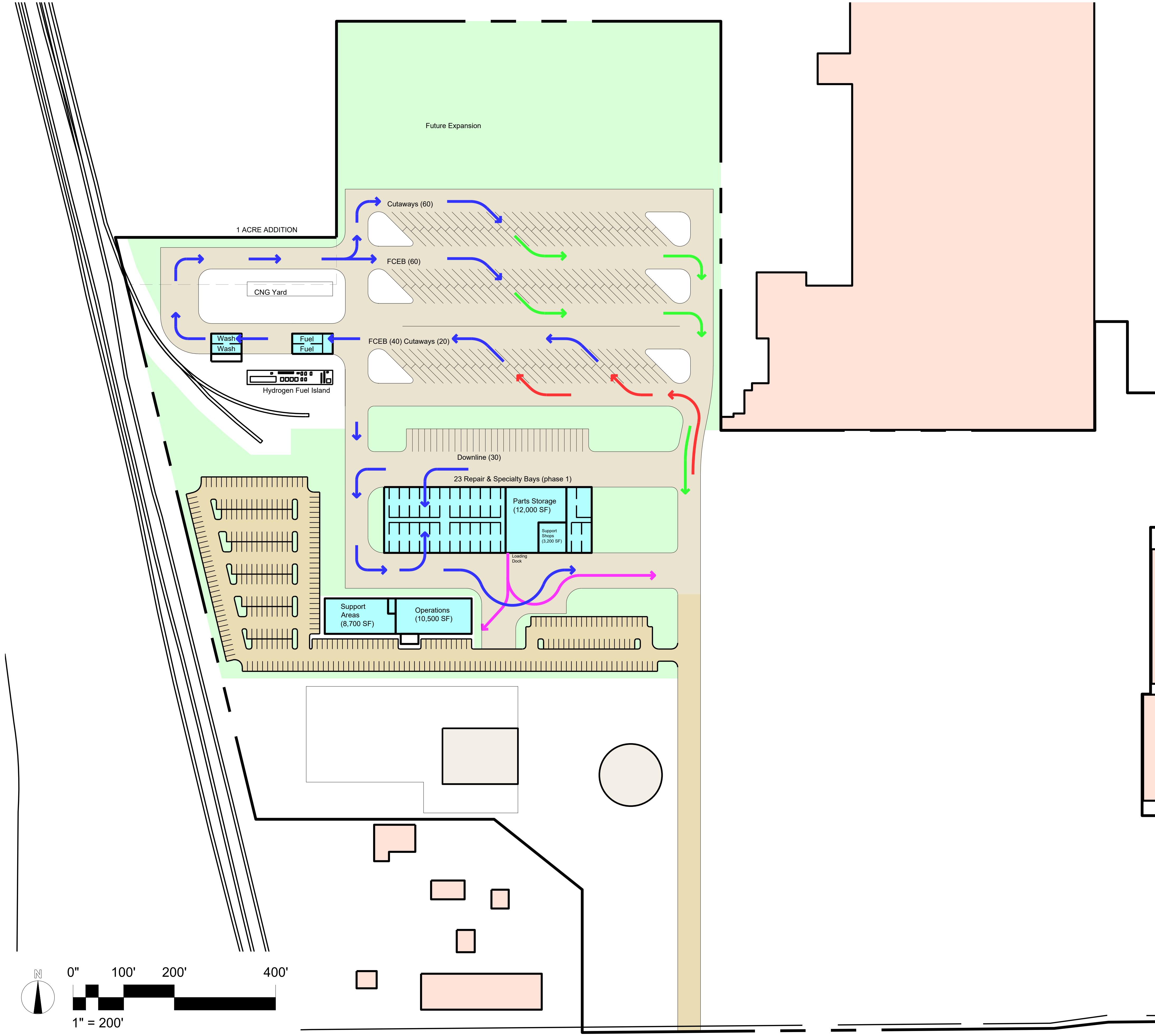
PROJECT NO.	187369A
DRAWN BY	JK
DATE	01/24/2022
SCALE	11X17: 1" = 200'

PROJECT TITLE
SacRT
SOUTH SITE

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

DRAWING TITLE
HERRINGBONE
PANTOGRAPH
PHASE 2

DRAWING NUMBER
MP-S.01B



HERRINGBONE (POTENTIAL PULL THROUGH) W/ HYDROGEN CHARGING FOR FCEB

AREA: 1,255,300 SF (29 ACRES)

ASSUMPTIONS (PHASE 1):

1. Parking space dimensions;
   12' X 42' (Buses, cutaways)

2. Parking positions:

12' X 42'	180
TOTAL	180
Non Revenue	20
Employees	325
TOTAL	345

3. Use existing rail spurs for Hydrogen delivery
4. Additional 1 acre acquired above the rail spurs

CIRCULATION

INBOUND →

INTERNAL →

OUTBOUND →

OTHER →

PROJECT NO.	187369A
DRAWN BY	JK
DATE	01/24/2022
SCALE	11X17: 1" = 200'

PROJECT TITLE
SacRT
SOUTH SITE

WSP USA Inc.
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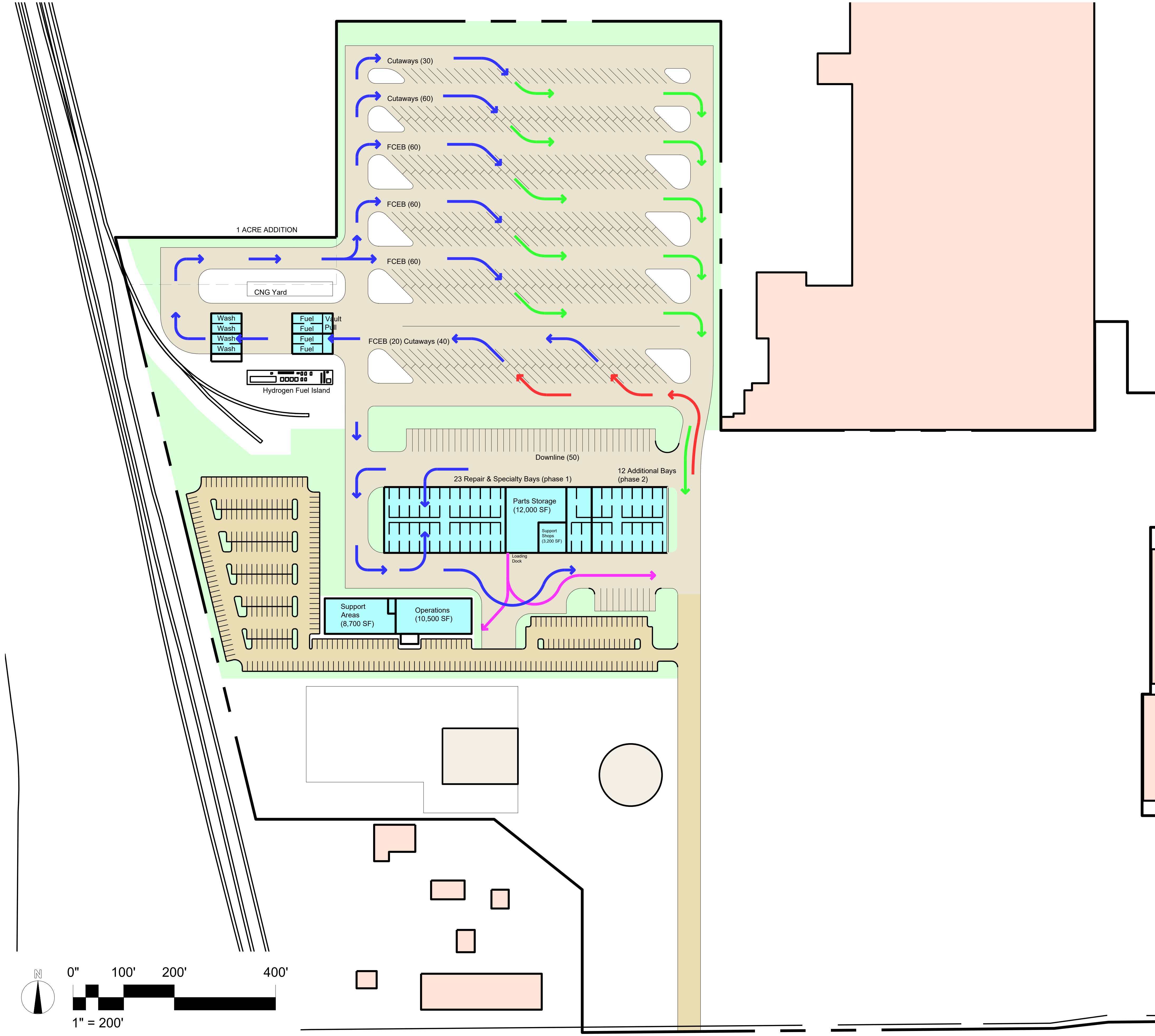
FAX: (281) 759-5164

DRAWING TITLE
HERRINGBONE
FCEB
PHASE 1

DRAWING NUMBER
MP-S.02A



HERRINGBONE (POTENTIAL PULL THROUGH) W/
HYDROGEN CHARGING FOR FCEB

AREA: 1,255,300 SF (29 ACRES)

ASSUMPTIONS (FULL BUILD):

1. Parking space dimensions;
   12' X 42' (Buses, 32' cutaways)
   12' X 30' (other cutaways)
2. Parking positions:

12' X 42'	200
12' X 30'	130
TOTAL	330
Non Revenue	20
Employees	325
TOTAL	345

3. Use existing rail spurs for Hydrogen delivery
4. Additional 1 acre acquired above the rail spurs

CIRCULATION

INBOUND

INTERNAL

OUTBOUND

OTHER

PROJECT NO.	187369A
DRAWN BY	JK
DATE	01/24/2022
SCALE	11X17: 1" = 200'

PROJECT TITLE
SacRT
SOUTH SITE

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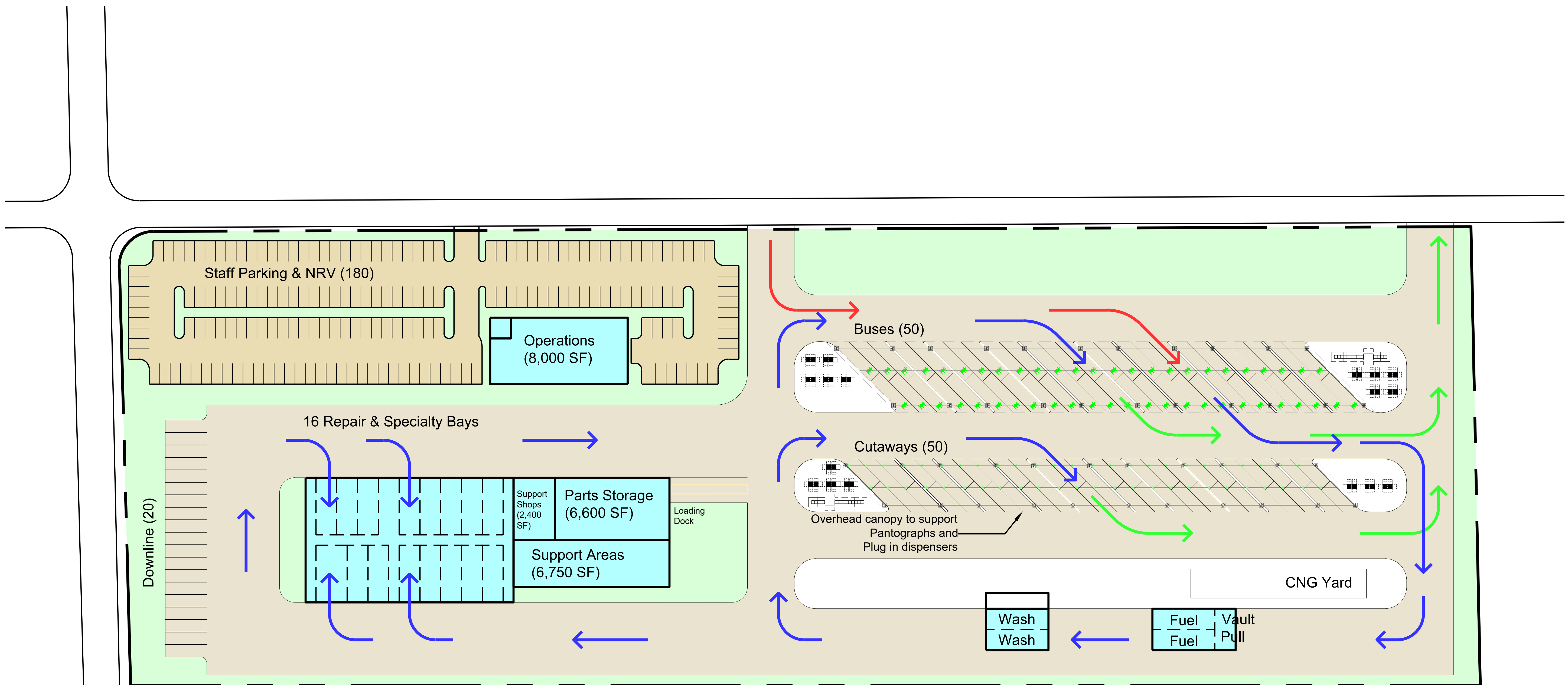
HOUSTON, TEXAS 77084
TEL: (281) 589-5900
FAX: (281) 759-5164

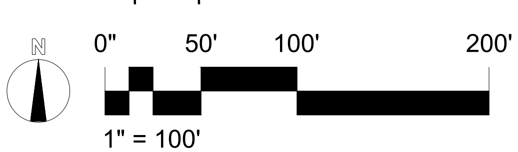
DRAWING TITLE
HERRINGBONE
FCEB
PHASE 2

DRAWING NUMBER
MP-S.02B

NORTH SITE

HYPOTHETICAL 13 ACRE SITE





HERRINGBONE (POTENTIAL PULL THROUGH) W/
OVERHEAD PANTOGRAPH (BUSES) &
PLUG IN CHARGING (CUTAWAYS)

AREA: 570,300 SF (13 ACRES)

CIRCULATION
INBOUND
INTERNAL
OUTBOUND

ASSUMPTIONS:

1. Parking space dimensions;
   12' X 42' (Buses, 32' cutaways)
   12' X 30' (Other cutaways)
2. Parking positions:

12' X 42'	50
12' X 30'	50
TOTAL	100
Non Revenue	30
Employees	150
TOTAL	180

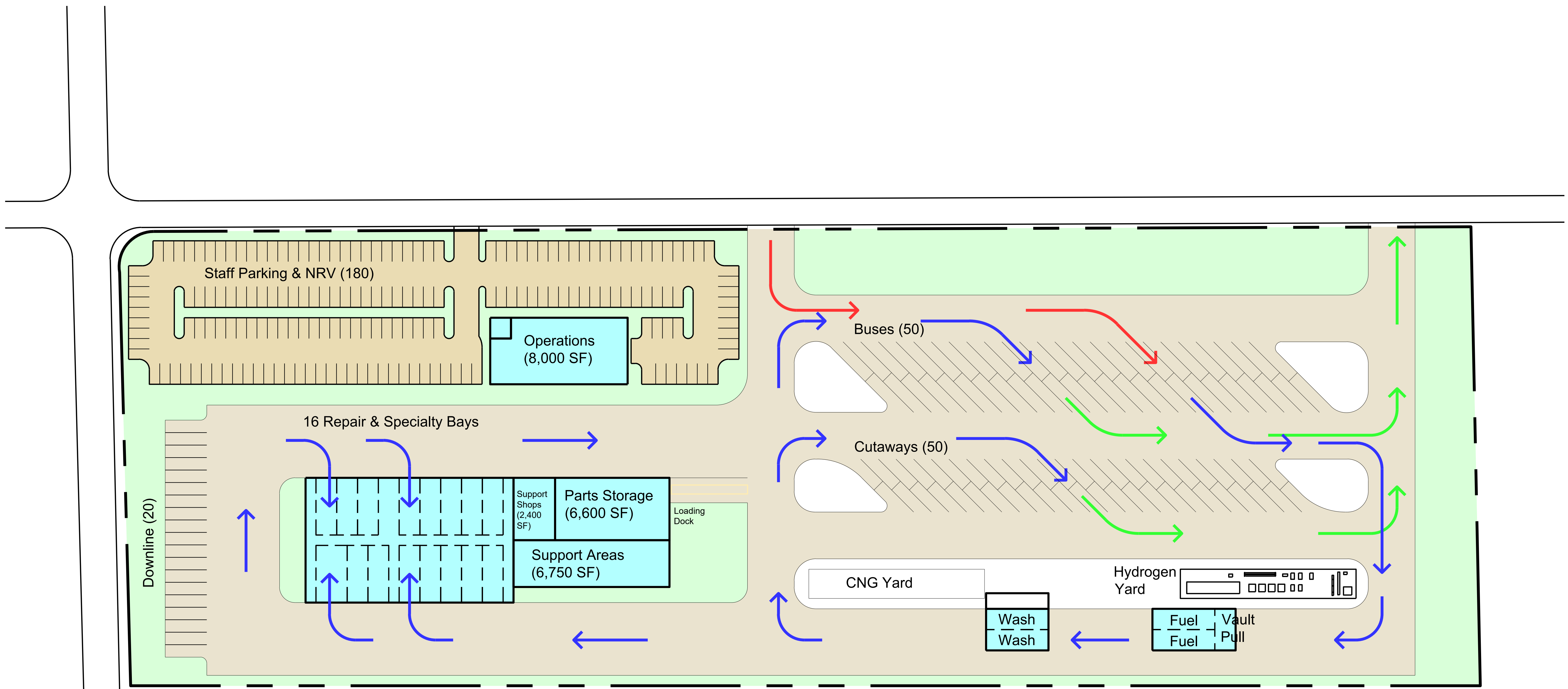
PROJECT NO.	187369A
DRAWN BY	JK
DATE	01/31/2022
SCALE	11X17: 1" = 100'

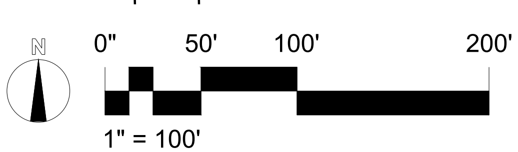
PROJECT TITLE
SacRT
NORTH SITE

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

DRAWING TITLE
HERRINGBONE
PANTOGRAPH

DRAWING NUMBER
MP-N.01





HERRINGBONE (POTENTIAL PULL THROUGH) W/ HYDROGEN FUEL CELL CHARGING

AREA: 570,300 SF (13 ACRES)

CIRCULATION
INBOUND →
INTERNAL →
OUTBOUND →

ASSUMPTIONS:

1. Parking space dimensions;
   - 12' X 42' (Buses, 32' cutaways)
   - 12' X 30' (Other cutaways)
2. Parking positions:

12' X 42'	50
12' X 30'	50
TOTAL	100
Non Revenue	30
Employees	150
TOTAL	180

PROJECT NO.	187369A
DRAWN BY	JK
DATE	01/31/2022
SCALE	11X17: 1" = 100'

PROJECT TITLE
SacRT NORTH SITE

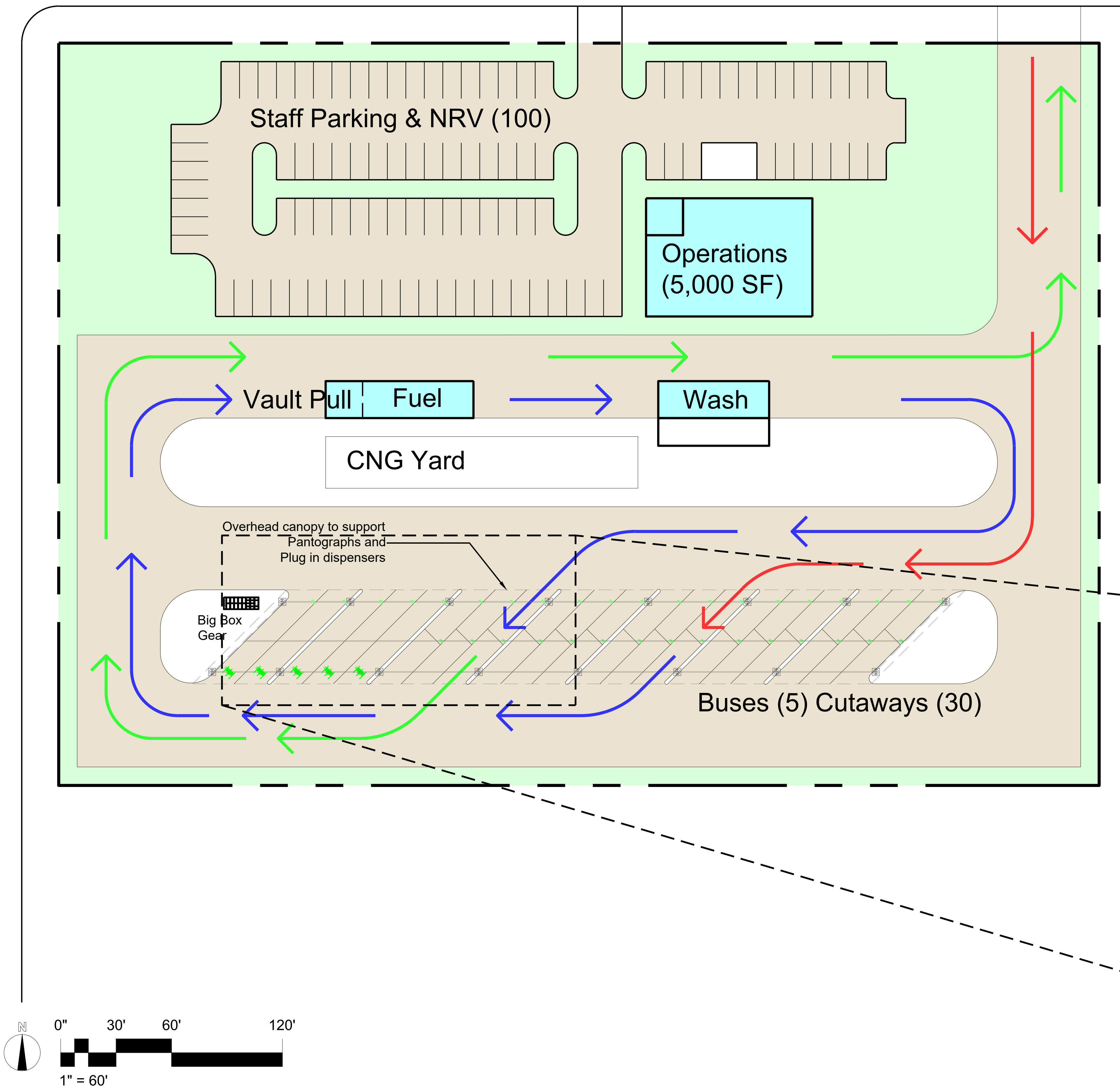
WSP USA Inc.
16200 PARK ROW
SUITE 200
HOUSTON, TEXAS 77084
TEL: (281) 589-5900
FAX: (281) 759-5164

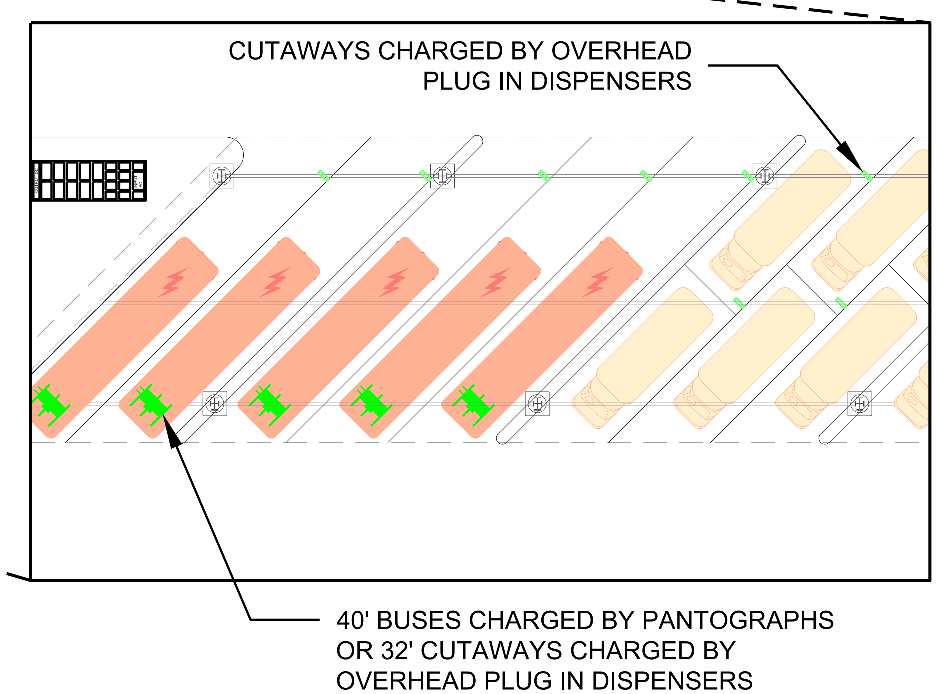
DRAWING TITLE
HERRINGBONE FCEB

DRAWING NUMBER
MP-N.02

EAST SITE

HYPOTHETICAL 5.2 ACRE SITE





HERRINGBONE (POTENTIAL PULL THROUGH) W/ OVERHEAD PANTOGRAPH (BUSES) & PLUG IN CHARGING (CUTAWAYS)

AREA: 226,400 SF (5.2 ACRES)

CIRCULATION
INBOUND
INTERNAL
OUTBOUND

ASSUMPTIONS:
1. Parking space dimensions;
   12' X 60' (Buses, 32' Cutaways)
   12' X 30' (Other cutaways)
2. Parking positions:

12' X 60'	5
12' X 30'	30
TOTAL	35

Non Revenue	30
Employees	70
TOTAL	100

PROJECT NO. 187369A
DRAWN BY JK
DATE 02/01/2022
SCALE 11X17: 1" = 60'

PROJECT TITLE
SacRT
EAST SITE

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

DRAWING TITLE
HERRINGBONE
PANTOGRAPHS W/
BIG BOX GEAR

DRAWING NUMBER
MP-E.01

D. APPENDIX D – OPINION OF PROBABLE COSTS

WSP put together an opinion of probable costs for each of the 5 layouts. The rates are based on WSP's experience on similar projects.

The following items (not exhaustive) are not included;

- Design Services before and during construction
- Design contingency factors
- Construction Management services
- Utility Infrastructure costs and fees
- Environmental permitting
- Building permitting
- Off-site improvements
- On-site earth/siteworks works and landscaping
- Operations and maintenance costs
- Costs of the buses and cutaways
- Backup power equipment such as generators and batteries
- Annual energy costs
- Annual staffing costs
- Training costs
- Hazardous material investigation and abatement if any
- Additional costs associated with phasing if any
- General Contractor's costs such as
    - General Conditions
    - Insurance
    - Bond
    - Mobilization
    - Overhead and profit
    - Escalation
    - Pre and Post-construction Expenses ("Soft Costs")
- Repair to existing rail spurs for delivering Hydrogen (South Facility FCEB option)

The table below summarizes the costs for each layout (Total costs are rounded up to thousands):

Item	Name	Key Highlights	Capacity (Total Revenue Vehicles)	Amount (USD)
1	South Facility BEB	Battery Electric Bus and Cutaway facility with Maintenance Buildings	330	105,616,000
2	South Facility FCEB	Fuel Cell Electric Bus and Cutaway facility with Maintenance Buildings	330	56,330,000
3	North Facility BEB	Battery Electric Bus and Cutaway facility with Maintenance Buildings	100	40,308,000
4	North Facility FCEB	Fuel Cell Electric Bus and Cutaway facility with Maintenance Buildings	100	32,179,000
5	North Facility BEB	Battery Electric Bus and Cutaway facility without Maintenance Buildings	35	11,249,000

Itemized costs for each facility are appended.

South Site Facility - BEB Layout (Approx. 330 Buses and Cutaways)
Opinion of Probable Construction Costs

Date: 2/7/2022

No.	Item Description	Quantity	Unit	Unit Cost	Cost
	Building and Equipment Cost				
	A. Main Building and canopy				
1	Main Building, Admin / Operations Portion	20,300	SF	$255.00	$5,177,000
2	Main Building, Maintenance Portion	72,800	SF	$225.00	$16,380,000
3	Fuel/Service & Wash Buildings	13,300	SF	$225.00	$2,993,000
4	Overhead Canopy	187,820	SF	$70.00	$13,147,000
5	PV System	187,820	SF	$40.00	$7,513,000
	Buildings Subtotal				$45,210,000
	B. Parking and Circulation				
6	Buses	810,600	SF	$10.00	$8,106,000
7	Employee/Visitor Parking	136,800	SF	$8.00	$1,094,000
	Parking Subtotal				$9,200,000
	C. Shop Equipment				
8	Total, Maintenance - Shops Equipment	1	LS	$6,815,000.00	$6,815,000
9	Total, Maintenance - Storage Equipment	1	LS	$180,000.00	$180,000
	Equipment Subtotal				$6,995,000
	D. Charging Equipment				
10	Pantographs	200	EA	$35,000.00	$7,000,000
11	Plug-in dispensers	136	EA	$12,400.00	$1,686,000
12	Charging Cabinets	146	EA	$124,000.00	$18,104,000
13	LV Switchgear	8	EA	$172,500.00	$1,380,000
14	MV Switchgear	2	EA	$70,000.00	$140,000
15	Transformer	2	EA	$119,000.00	$238,000
	Charging Equipment Subtotal				$28,548,000
	E. Equipment Installation (30% of Shop & Charging Equipment Subtotals)				$10,663,000
	F. CNG Equipment				
16	CNG Equipment including installation	1	LS	5,000,000.00	5,000,000
	CNG Equipment Subtotal				$5,000,000
	TOTAL				$105,616,000

South Site Facility - FCEB Layout (Approx. 330 Buses and Cutaways)
Opinion of Probable Construction Costs

Date: 2/7/2022

No.	Item Description	Quantity	Unit	Unit Cost	Cost
	Building and Equipment Cost				
	A. Main Building and canopy				
1	Main Building, Admin / Operations Portion	20,300	SF	$255.00	$5,177,000
2	Main Building, Maintenance Portion	72,800	SF	$225.00	$16,380,000
3	Fuel/Service & Wash Buildings	13,300	SF	$224.00	$2,979,000
	Buildings Subtotal				$24,536,000
	B. Parking and Circulation				
4	Buses	810,600	SF	$10.00	$8,106,000
5	Employee/Visitor Parking	136,800	SF	$8.00	$1,094,000
	Parking Subtotal				$9,200,000
	C. Shop Equipment				
6	Total, Maintenance - Shops Equipment	1	LS	$6,815,000.00	$6,815,000
7	Total, Maintenance - Storage Equipment	1	LS	$180,000.00	$180,000
	Equipment Subtotal				$6,995,000
	D. Equipment Installation (30% of Shop Equipment Subtotal)				$2,099,000
	F. CNG Equipment				
8	CNG Equipment including installation	1	LS	5,000,000.00	5,000,000
	CNG Equipment Subtotal				$5,000,000
	E. Hydrogen Equipment				
9	Liquid Hydrogen Delivered Facility including installation	1	LS	$8,500,000.00	$8,500,000
	Hydrogen Equipment Subtotal				$8,500,000
	TOTAL				$56,330,000

North Site Facility - BEB Layout (100 Buses and Cutaways)
Opinion of Probable Construction Costs

Date: 2/7/2022

No.	Item Description	Quantity	Unit	Unit Cost	Cost
	Building and Equipment Cost				
	A. Main Building and canopy				
1	Main Building, Admin / Operations Portion	15,210	SF	$255.00	$3,879,000
2	Main Building, Maintenance Portion	33,000	SF	$225.00	$7,425,000
3	Fuel/Service & Wash Buildings	6,500	SF	$224.00	$1,456,000
4	Overhead Canopy	54,730	SF	$70.00	$3,831,000
5	PV System	54,730	SF	$40.00	$2,189,000
	Buildings Subtotal				$18,780,000
	B. Parking and Circulation				
6	Buses	340,345	SF	$10.00	$3,403,000
7	Employee/Visitor Parking	63,350	SF	$8.00	$507,000
	Parking Subtotal				$3,910,000
	C. Shop Equipment				
8	Total, Maintenance - Shops Equipment	1	LS	$3,760,000.00	$3,760,000
9	Total, Maintenance - Storage Equipment	1	LS	$99,000.00	$99,000
	Equipment Subtotal				$3,859,000
	D. Charging Equipment				
10	Pantographs	25	EA	$35,000.00	$875,000
11	Plug-in dispensers	17	EA	$12,400.00	$211,000
12	Charging Cabinets	42	EA	$124,000.00	$5,208,000
13	LV Switchgear	3	EA	$172,500.00	$518,000
14	MV Switchgear	1	EA	$70,000.00	$70,000
15	Transformer	1	EA	$119,000.00	$119,000
	Charging Equipment Subtotal				$7,001,000
	E. Equipment Installation (30% of Shop & Charging Equipment Subtotals)				$3,258,000
	F. CNG Equipment				
16	CNG Equipment including installation	1	LS	3,500,000.00	3,500,000
	CNG Equipment Subtotal				$3,500,000
	TOTAL				$40,308,000

North Site Facility - FCEB Layout (100 Buses and Cutaways)
Opinion of Probable Construction Costs

Date: 2/7/2022

No.	Item Description	Quantity	Unit	Unit Cost	Cost
	Building and Equipment Cost				
	A. Main Building and canopy				
1	Main Building, Admin / Operations Portion	15,210	SF	$255.00	$3,879,000
2	Main Building, Maintenance Portion	33,000	SF	$225.00	$7,425,000
3	Fuel/Service & Wash Buildings	6,500	SF	$224.00	$1,456,000
	Buildings Subtotal				$12,760,000
	B. Parking and Circulation				
4	Buses	327,000	SF	$10.00	$3,270,000
5	Employee/Visitor Parking	63,350	SF	$8.00	$507,000
	Parking Subtotal				$3,777,000
	C. Equipment				
6	Total, Maintenance - Shops Equipment	1	LS	$3,760,000.00	$3,760,000
7	Total, Maintenance - Storage Equipment	1	LS	$99,000.00	$99,000
	Equipment Subtotal				$3,859,000
	D. Equipment Installation (30% of Equipment Subtotal)				$1,158,000
	E. CNG Equipment				
8	CNG Equipment including installation	1	LS	3,500,000.00	3,500,000
	CNG Equipment Subtotal				$3,500,000
	F. Hydrogen Equipment				
9	Liquid Hydrogen Delivered Facility including installation	1	LS	$7,125,000.00	$7,125,000
	Hydrogen Equipment Subtotal				$7,125,000
	TOTAL				$32,179,000

East Site Facility - BEB Layout (35 Buses and Cutaways)
Opinion of Probable Construction Costs

Date: 2/7/2022

No.	Item Description	Quantity	Unit	Unit Cost	Cost
	Building and Equipment Cost				
	A. Main Building and canopy				
1	Main Building, Admin / Operations Portion	5,760	SF	$255.00	$1,469,000
2	Fuel/Service & Wash Buildings	3,700	SF	$224.00	$829,000
3	Overhead Canopy	18,700	SF	$70.00	$1,309,000
4	PVSystem	18,701	SF	$40.00	$748,000
	Buildings Subtotal				$4,355,000
	B. Parking and Circulation				
4	Buses	131,450	SF	$10.00	$1,315,000
5	Employee/Visitor Parking	37,600	SF	$8.00	$301,000
	Parking Subtotal				$1,616,000
	C. Charging Equipment				
6	Pantographs	5	EA	$35,000.00	$175,000
7	Plug-in dispensers	30	EA	$12,400.00	$372,000
8	Charging Cabinets	13	EA	$124,000.00	$1,612,000
9	LV Switchgear	1	EA	$172,500.00	$173,000
10	MV Switchgear	1	EA	$70,000.00	$70,000
11	Transformer	1	EA	$119,000.00	$119,000
	Charging Equipment Subtotal				$2,521,000
	D. Equipment Installation (30% of Equipment Subtotal)				$757,000
	F. CNG Equipment				
12	CNG Equipment including installation	1	LS	2,000,000.00	2,000,000
	CNG Equipment Subtotal				$2,000,000
	TOTAL				$11,249,000