Redwood Coast Transit Authority
Williams Drive Charging Stations Project – Plans Specs and Estimates (PS&E) RFQ – Addendum #1
April 22, 2025

Format
Questions received are repeated here and addressed individually.
Requests for large amounts of additional data may be referred to in Addendum #1 and posted to the RFP website RCTA Williams Drive Charging Stations - Redwood Coast Transit Authority

**Question**
Will charge management systems be included in the design effort and how will such a system be procured?

**Answer:**
Yes, the term "electric vehicle charging infrastructure" referenced in the Request for Proposals and Appendix A explicitly includes charge management software and all related software systems, controls, and communications infrastructure necessary for the optimal operation and management of electric vehicle charging, as defined by RCTA. This includes infrastructure and software solutions that may be installed concurrently as part of the initial construction project or subsequently after completion of the primary construction project. RCTA anticipates a separate procurement process for charge management software.

Attachments:
1. Site Layout
2. Electric Fleet Transition Study
3. Transit Yard Site Evaluation and Bus Bay Parking and Optimization Study
4. Technical Study – Yard ZEB Improvements


0 10' 20' 40'

N

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## LEGEND

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- EXISTING FENCE
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- PRESUMED EXISTING SITE DRAINAGE

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Author R. PLAZA — Drafting Check F. PENRY — Project Manager F. PENRY

Designer R. PLAZA — Design Check — Project Director K. VEDULA

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Project WILLIAMS DRIVE ELECTRIC BUS CHARGING INFRASTRUCTURE

Title EXISTING CONDITIONS AND CONSTRAINTS

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| 12613489 | 2024-02-27 | 1" = 20' | ANSI D | C-101 | 1 of 5 |


0 10' 20' 40'

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Project **WILLIAMS DRIVE ELECTRIC BUS CHARGING INFRASTRUCTURE**

Title **SITE LAYOUT A**

Size **ANSI D**

| Project No. | Date | Scale | Sheet No. | Sheet |
|---|---|---|---|---|
| 12613489 | 2024-02-27 | 1" = 20' | C-102 | 2 of 5 |

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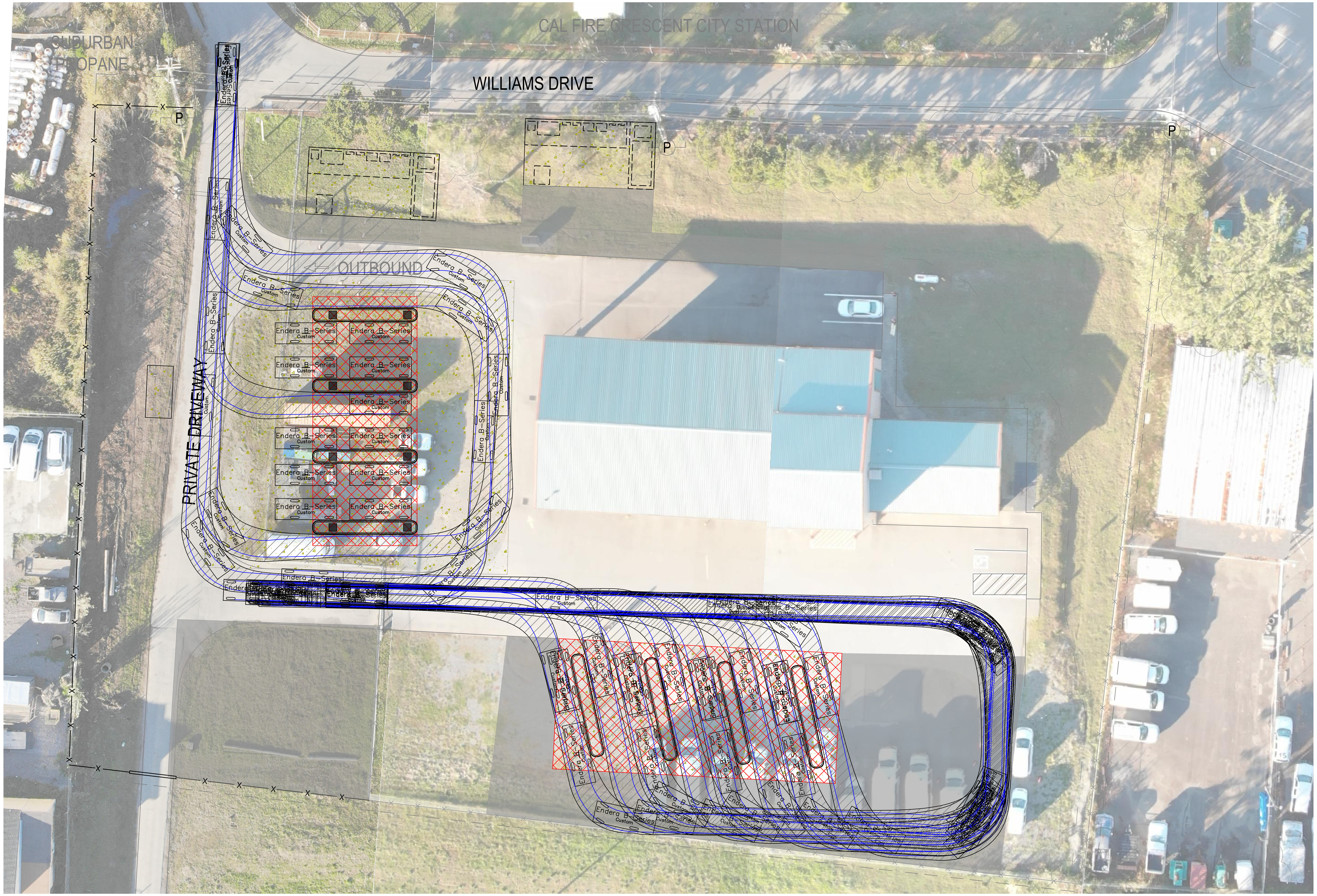


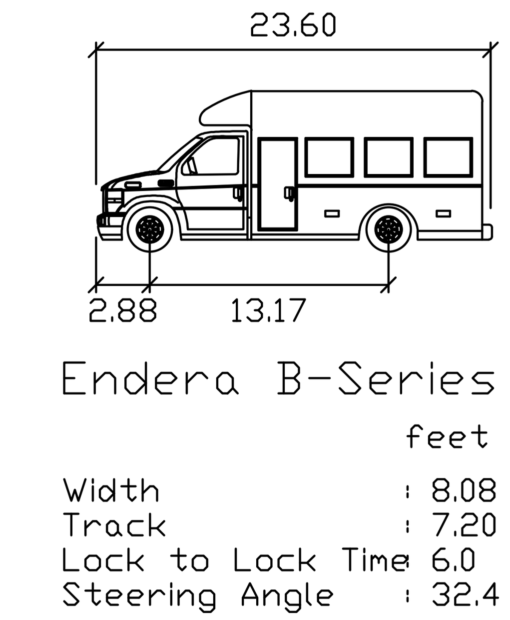


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Project **WILLIAMS DRIVE ELECTRIC BUS CHARGING INFRASTRUCTURE**

Title **SITE LAYOUT A - ENDERA B-SERIES TURNING MOVEMENTS**

Size **ANSI D**

| Project No. | Date | Scale | Sheet No. | Sheet |
|---|---|---|---|---|
| 12613489 | 2024-02-27 | 1" = 20' | C-103 | 3 of 5 |


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Title **SITE LAYOUT B**

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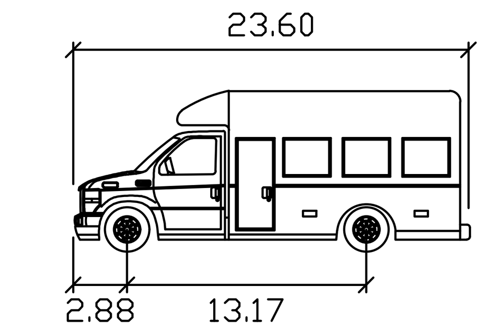
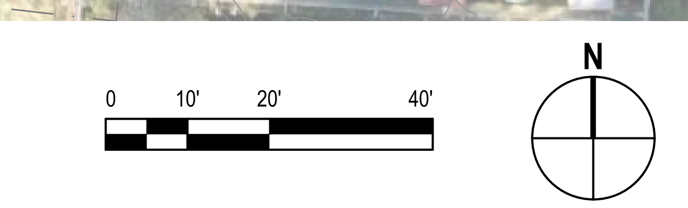



Endera B-Series

feet

Width : 8.08
Track : 7.20
Lock to Lock Time 6.0
Steering Angle : 32.4

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# Redwood Coast Transit Authority

## Electric Fleet Transition Study

Prepared by:

HATCH LTK

March 31, 2021

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# 1. Introduction

Redwood Coast Transit Authority (RCTA), a public transportation authority in Crescent City, California, requested assistance from the Community Transportation Association of America (CTAA) through the National Center of Applied Transit Technology's Strike Team to provide zero-emissions planning and support services. Hatch LTK (formerly LTK Engineering Services) was called on by CTAA to provide the requested technical services to support RCTA's transition to zero-emissions technology.

The California Air Resources Board (CARB) has set a statewide goal for transit agencies to transition to 100 percent zero-emission bus fleets by 2040. Like other California transit agencies, RCTA will be required to transition its current diesel and gasoline fleet to zero-emissions technology. Smaller-sized transit agencies like RCTA must submit a roll-out plan to CARB by 2023, which should include an implementation roadmap that considers fleet replacement, infrastructure improvements, workforce training, and potential funding sources. The work outlined within this document will provide foundational elements to RCTA's roll-out plan.

This report describes the analysis that HATCH LTK performed to understand the current RCTA operations, determine the electric vehicle needs, define suitable battery-electric transit vehicles available in the market, and evaluate the electrical infrastructure requirements to support an electric vehicle fleet. While RCTA has participated in regional discussions around hydrogen fuel cell equipment, Hatch LTK's analysis focuses on battery-electric equipment and the supporting infrastructure. This report also focuses on all RCTA fixed route services except seasonal route 300, which is currently suspended. The scope of this report does not include RCTA's Dial-A-Ride service. The report outlines the findings and provides recommendations and next steps for RCTA to successfully transition its fixed route fleet to battery-electric vehicles.

# 2. Vehicle Requirements

RCTA's current operations were studied to develop a basis for electric vehicle requirements that are closely equivalent to the performance of the current fleet. The goal of this study was to determine the required battery capacity for an equivalent electric vehicle to meet the current fixed route schedules. Figure 1 shows two major factors in the energy consumption of an electric vehicle: 1) the energy required to propel the vehicle; and 2) the energy required for auxiliary loads, such as heating and air conditioning.

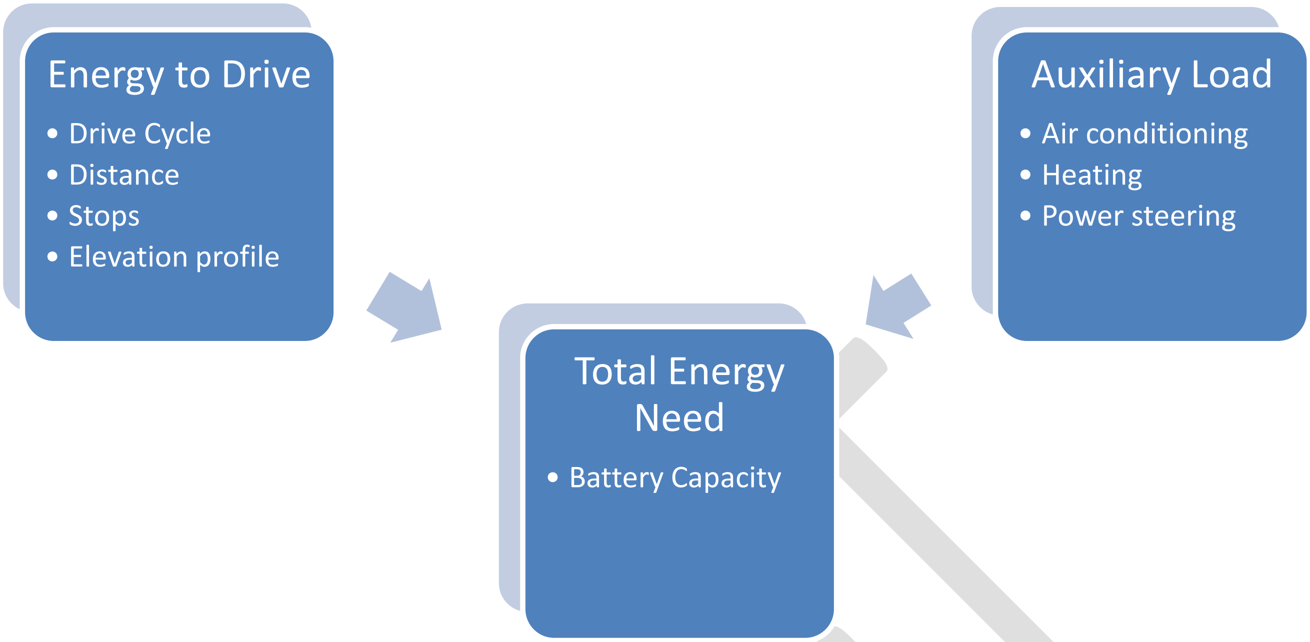


*Figure 1: Battery Sizing Inputs*

Multiple variables were considered in calculating the energy required to complete the routes, including distance traveled, frequency of stopping, elevation changes, speed limits, traffic signs and lights. Using these variables, drive cycles were created for each route. The total auxiliary load was calculated based on average energy needs for each auxiliary components. Finally, unique energy requirement profiles were created for each of the routes.

## Drive Cycle Generation

The necessary energy to complete a route is strongly dependent on the speed profile of the vehicle on its target route, known as its drive cycle. Therefore, the first step in the energy consumption calculation was to obtain the drive cycles for all RCTA routes as accurately as possible within the project constraints.

First, each route was analyzed using Google Earth Pro and Google Maps Street View to identify the bus stops, stop signs, traffic lights, speed limits, and road intersections. Then, the global positions of each traffic element, the distances between them, and the elevation profiles were extracted using a proprietary software tool developed by HATCH LTK. Figures 2 through 4 are screenshots of the Google Earth Pro and Google Maps views for Route 1.

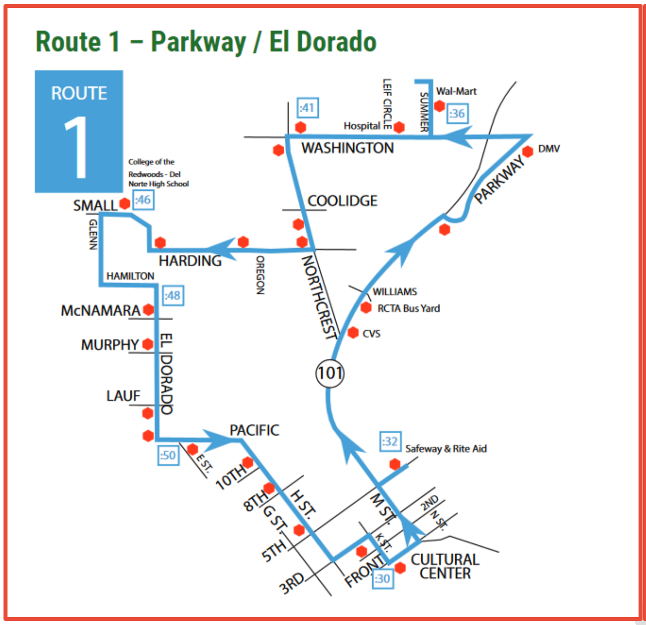



*Figure 2: Digitized Route 1 Using Google Earth Pro*

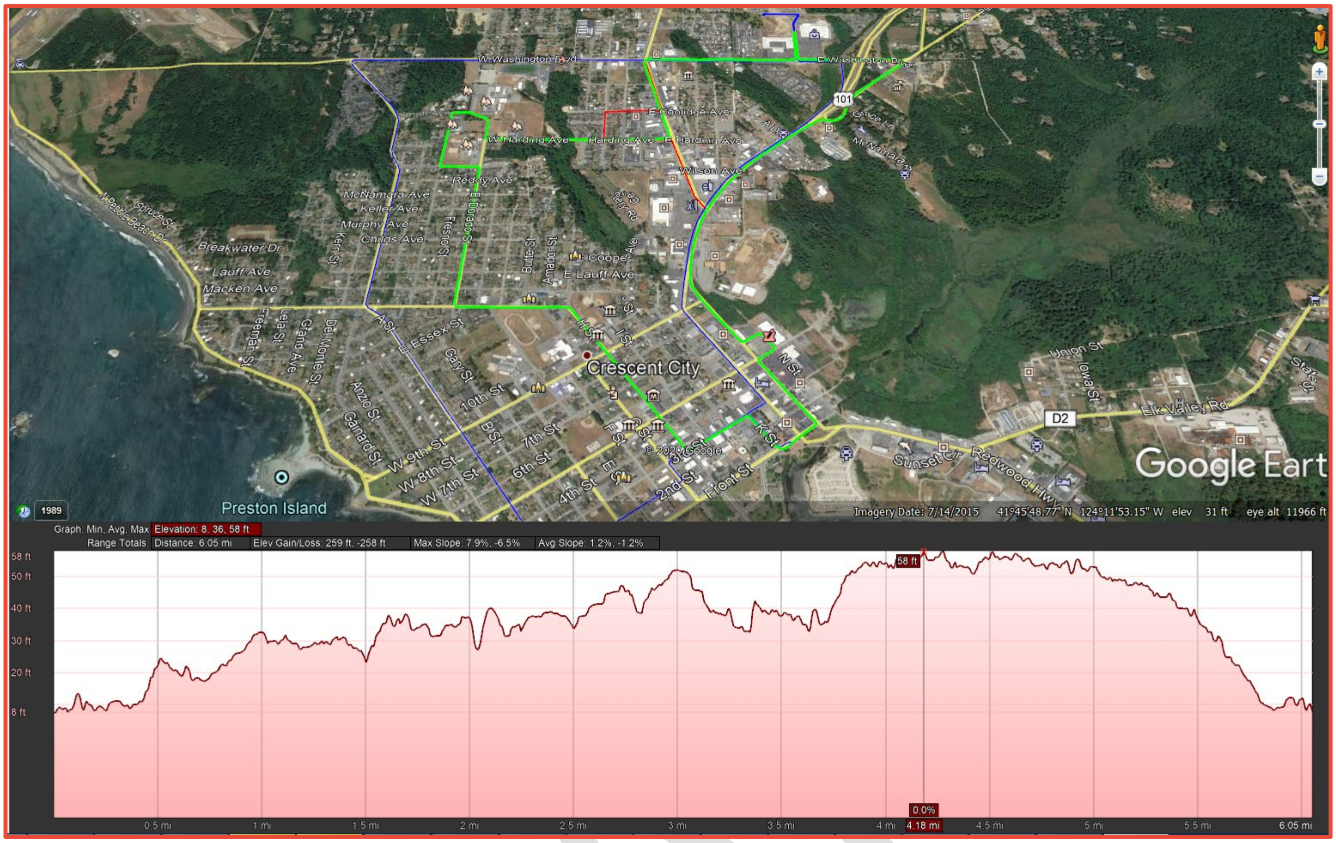


*Figure 3: Elevation Output from Google Earth Pro for Route 1*


*Figure 4: Google Street View Capture for Route 1*

Identifying potential stopping locations and the speed limits on the bus route is necessary but insufficient for generating its drive cycle. To determine the acceleration and deceleration profile of a bus between two stopping points, a bus drive cycle database generated by HATCH LTK was utilized. This database includes available bus drive cycles that represent the speed profiles of buses operating in major cities throughout the world. Assumptions developed specifically for RCTA's drive cycles were then reviewed by RCTA staff.

For each consecutive stopping point on the target route, the drive cycle that most accurately represents that segment of the route was chosen from the drive cycle database. The concatenation of these drive cycle segments created the final drive cycle specific to the target route. This method of developing drive cycles provides a suitable and more cost-effective alternative to collecting real-time data. The current schedule of a route was then compared to the duration of the generated drive cycle to confirm its validity. Figure 5 shows the drive cycle generated for the Route 1.

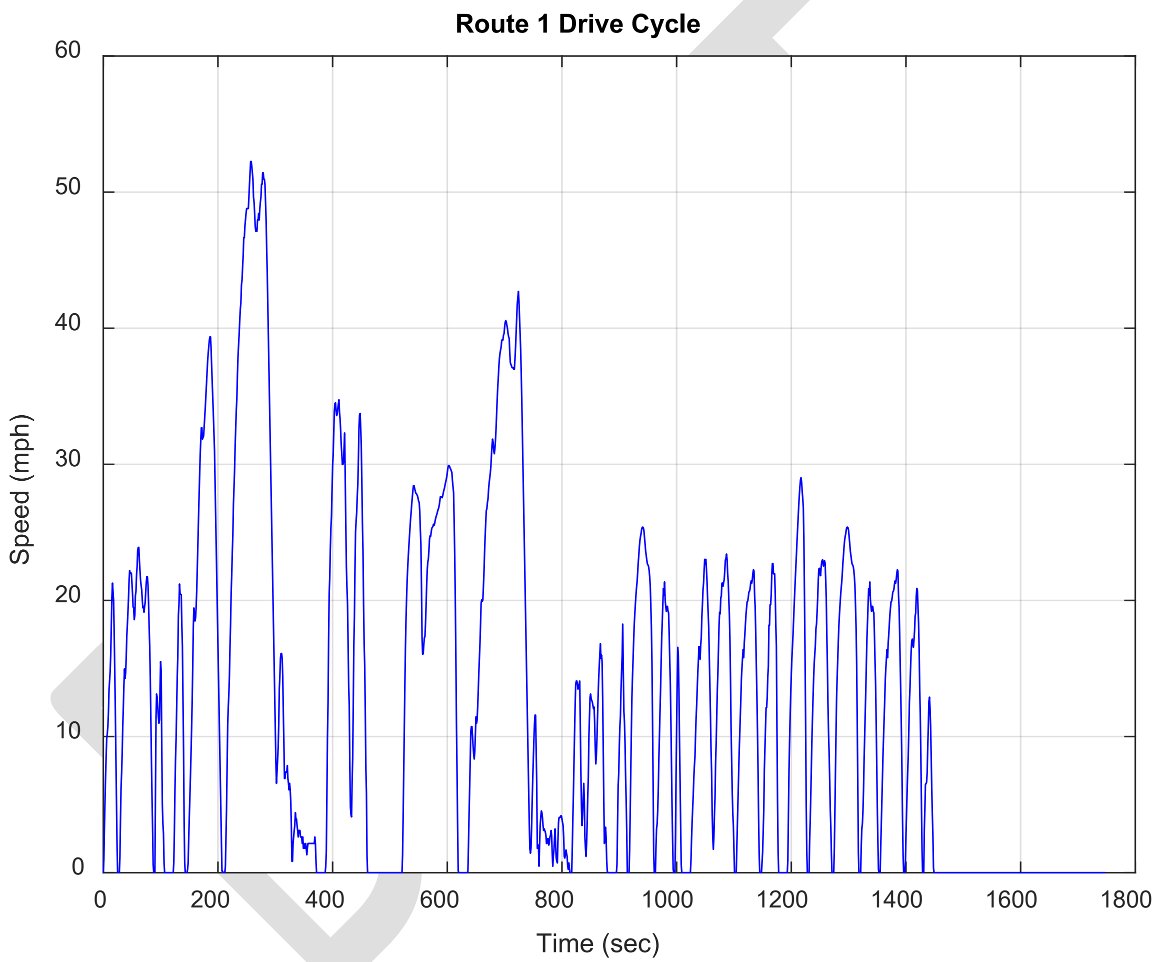


*Figure 5: Drive Cycle for Route 1*

## 2.2 EV Bus Model

RCTA currently uses Ford E-450 chassis-based cutaway shuttles with gasoline engines for its local routes. Therefore, an electric vehicle with the passenger capacity and size of an equivalent gasoline E-450 was designed and used in the simulations to derive the energy consumption profiles. The technical specifications of the designed electric bus are shown in Table 1 below.

The maximum battery capacity that the designed vehicle could hold was calculated while considering the constraint of the gross vehicle weight rating (GVWR). Assuming the vehicle weight with five passengers and one driver as 13,000 lbs. and the battery pack energy density as 150 Wh/kg, the maximum battery capacity that can be placed into the vehicle, without exceeding a GVWR of 14,500 lbs., was calculated to be 165 kWh.

Moreover, market research was conducted to analyze the battery pack capacities in Ford E-450 chassis-based EV buses. It was observed that the battery capacity varies between 120 and 130 kWh, and the advertised ranges are between 105 and 120 miles.

| Chassis | Ford E-450 |
|---|---|
| Gross Vehicle Weight Rating (GVWR) | 14,500 lbs. |
| Maximum Electric Motor Power | 200 kW |
| Maximum Speed | 65 mph |
| Gradeability at 55 mph | 9% |
| Differential Ratio | 6.7 |
| Vehicle Weight in Simulations | 13,000 lbs. |

*Table 1: Electric Shuttle Technical Specifications*

## 2.3 Auxiliary Load

The accessory loads shown in Figure 6 were used in the simulations. We estimated the power load for camera and LED destination display using the consumption data for similar products available in the market. For HVAC and power steering, we used rated power consumption for the systems used in similar sized vehicles:

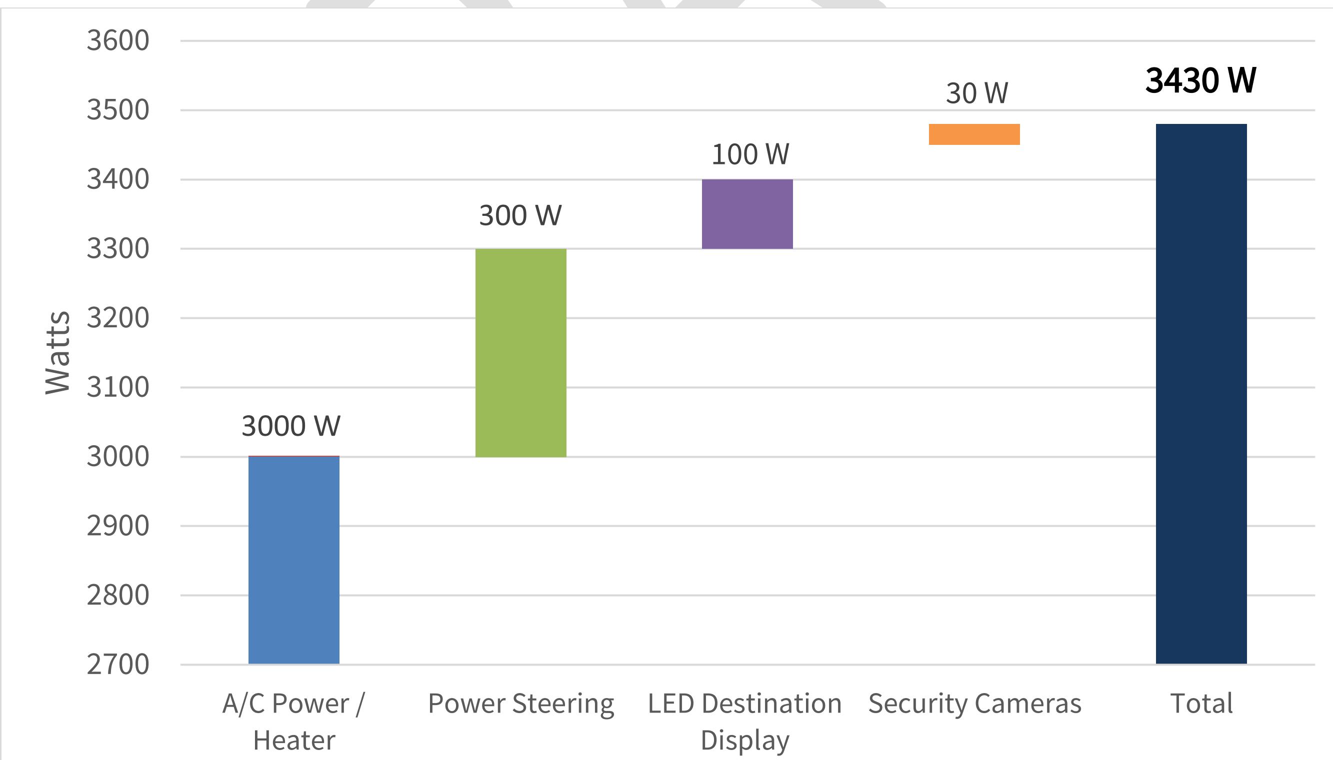


*Figure 6: Auxiliary Load Breakdown*

## 2.4 Simulation

HATCH LTK used its proprietary vehicle simulation tool to determine the battery capacity required for RCTA's local and intercity routes based on the current bus schedules. We simulate the EV bus by taking the drive cycle generated for each route as an input and calculate the energy consumed by the vehicle to complete the entire drive cycle. The tool also considers the auxiliary loads listed in Figure 6 alongside energy captured from regenerative braking.

### 2.4.1 Local Route Analyses

RCTA has four local routes: Routes 1, 2, 3, and 4. Routes 1 and 3 are generally served by one bus, and Routes 2 and 4 are served by another bus. Therefore, in the feasibility analysis, Routes 1 and 3 and Routes 2 and 4 were studied as pairs.

In the analysis, the drive cycle for each segment of the route was fed through the simulation model to calculate the energy consumed by the vehicle to complete one trip. The total energy consumption to complete all trips of the day was then calculated using the number of trips per day from the current schedule. At the final stage, the feasibility of one gasoline E-450 bus being replaced by one E-450 EV bus was analyzed by comparing the total energy consumption per day to the available battery capacities for the E-450 EV buses in the market.

#### Routes 1 & 3

Figure 7 shows the paths and stops on Routes 1 and 3, which are served by the same bus.

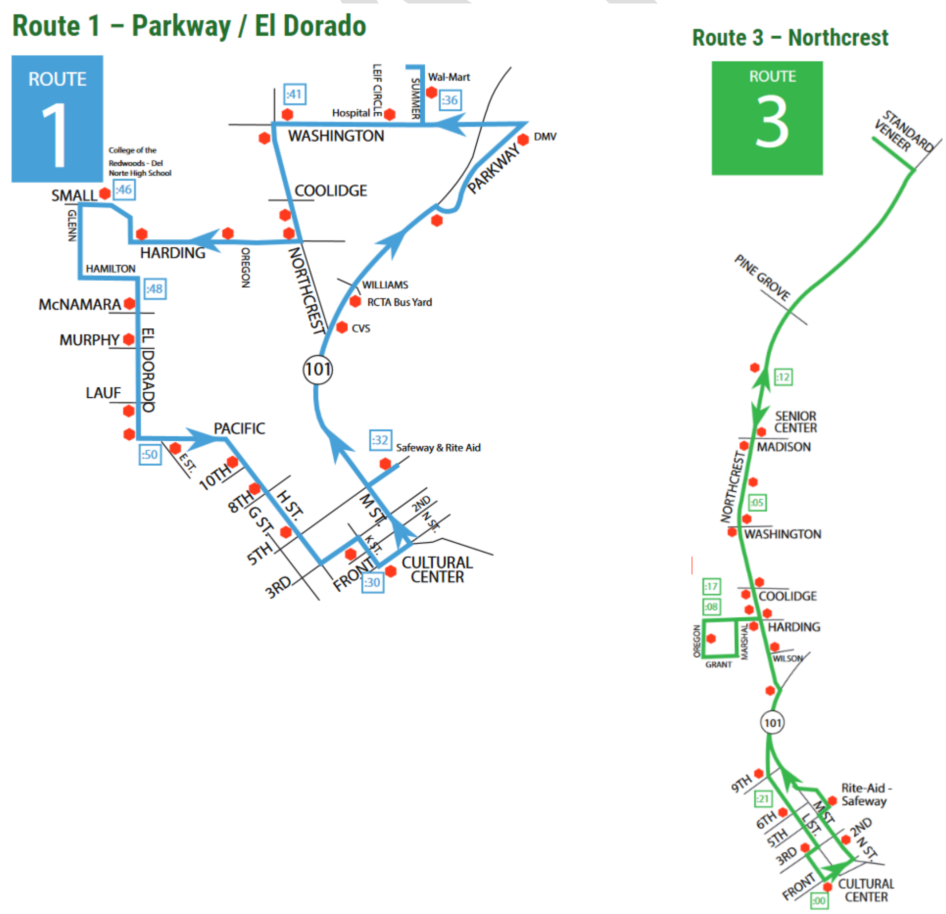


*Figure 7: Routes 1 and 3 in Crescent City*

The drive cycles for these two routes, shown in Figure 8, were generated using the algorithm described in Section 2.1.

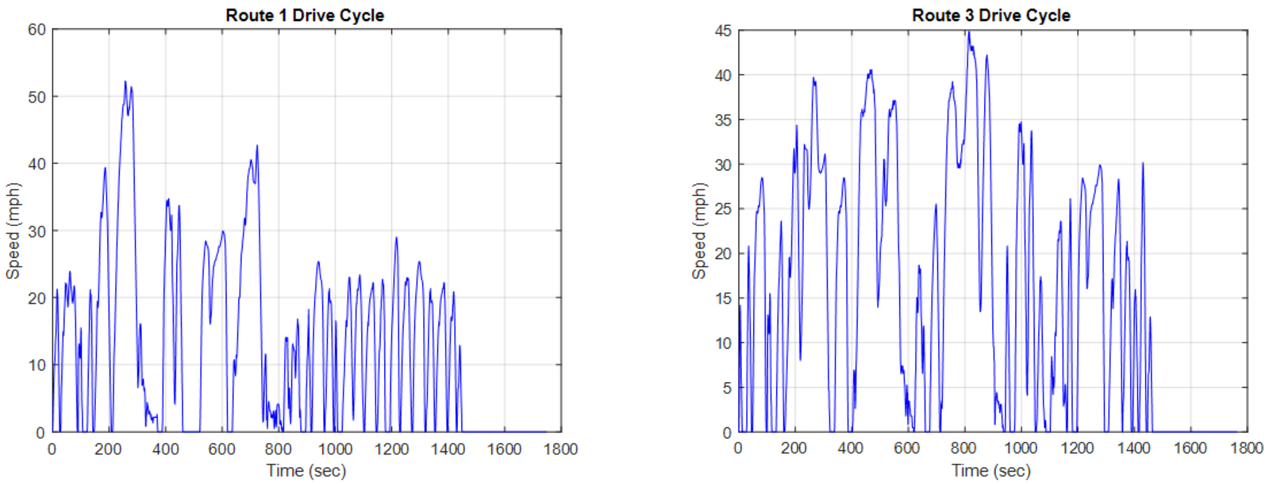


*Figure 8: Drive Cycles for Routes 1 and 3*

Figure 9 shows the distance traveled by the vehicle with respect to trip time. The total distance traveled by the vehicle at the end of trips on Route 1 and Route 3 was determined to be 6.1 miles and 7.3 miles, respectively.

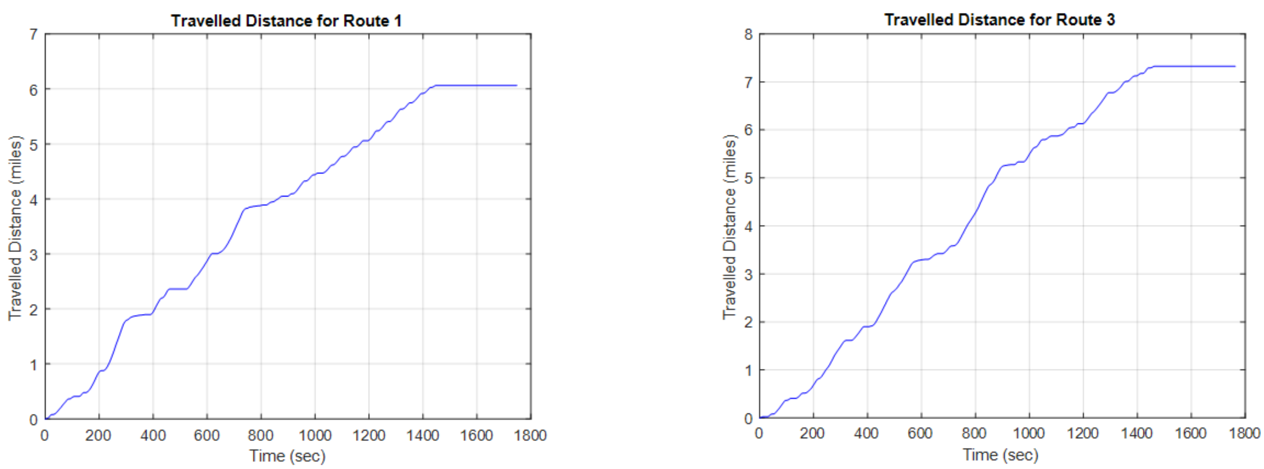


*Figure 9: Traveled Distance in Routes 1 and 3*

The energy consumed by the vehicle with respect to trip time was calculated using the simulation tool and is shown in Figure 10. The total energy consumed by the vehicle at the end of the Route 1 and Route 3 trips was determined to be 6.2 kWh and 7.2 kWh, respectively.

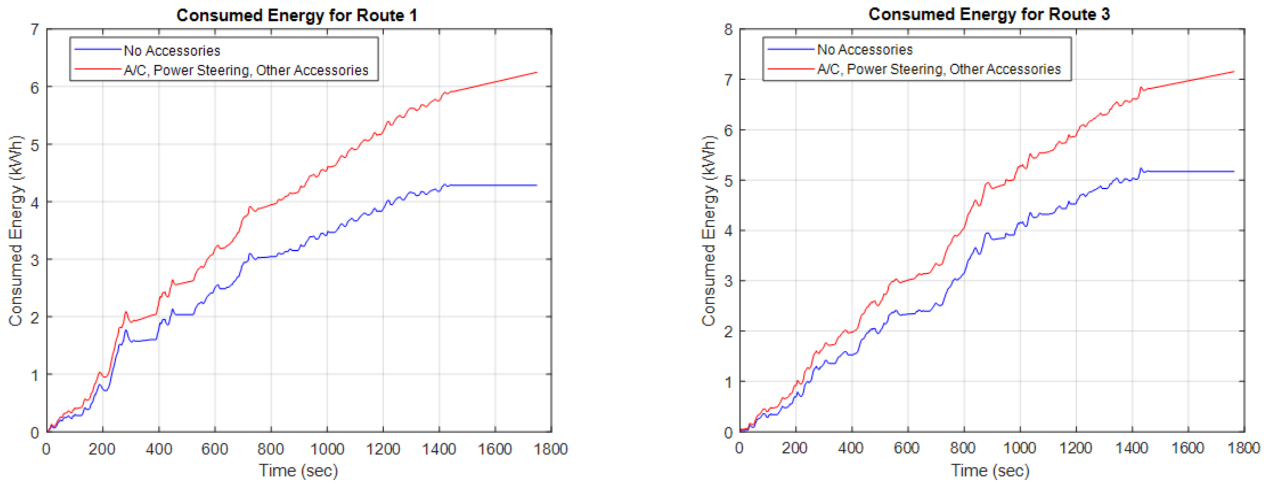


*Figure 10: Consumed Energy to Complete Routes 1 and 3*

According to the schedule of Routes 1 and 3 (as shown in Figure 11), a bus makes 12 trips on Route 1 and 11 trips on Route 3 per day.

| Route 1 – Parkway / El Dorado | | | | | | | |
|---|---|---|---|---|---|---|---|
| Cultural Center | Safeway (5th) | WalMart | Northcrest @ Washington | College of Redwoods / DNHS | El Dorado @ Hamilton | Pacific @ E | Cultural Center |
| 7:00 | 7:02 | 7:06 | 7:11 | 7:16 | 7:18 | 7:20 | 7:25 |
| 7:30 | 7:32 | 7:36 | 7:41 | 7:46 | 7:48 | 7:50 | 7:55 |
| 8:30 | 8:32 | 8:36 | 8:41 | 8:46 | 8:48 | 8:50 | 8:55 |
| 9:30 | 9:32 | 9:36 | 9:41 | 9:46 | 9:48 | 9:50 | 9:55 |
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| 11:30 | 11:32 | 11:36 | 11:41 | 11:46 | 11:48 | 11:50 | 11:55 |
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| **4:30** | **4:32** | **4:36** | **4:41** | **4:46** | **4:48** | **4:50** | **4:55** |
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| Route 3 – Northcrest | | | | | | |
|---|---|---|---|---|---|---|
| Cultural Center | Senior Center | Northcrest at Pine Grove School | C.A.N. Standard Veneer | Oregon Apts. | 101 @ 7th | Cultural Center |
| | | 6:50 | | 6:53 | 6:56 | 7:00 |
| 8:00 | 8:08 | 8:11 | 8:13 | 8:17 | 8:21 | 8:24 |
| 9:00 | 9:08 | 9:11 | 9:13 | 9:17 | 9:21 | 9:24 |
| 10:00 | 10:08 | 10:11 | 10:13 | 10:17 | 10:21 | 10:24 |
| 11:00 | 11:08 | 11:11 | 11:13 | 11:17 | 11:21 | 11:24 |
| **12:00** | **12:08** | **12:11** | **12:13** | **12:17** | **12:21** | **12:24** |
| **1:00** | **1:08** | **1:11** | **1:13** | **1:17** | **1:21** | **1:24** |
| **2:00** | **2:08** | **2:11** | **2:13** | **2:17** | **2:21** | **2:24** |
| **3:00** | **3:08** | **3:11** | **3:13** | **3:17** | **3:21** | **3:24** |
| **4:00** | **4:08** | **4:11** | **4:13** | **4:17** | **4:21** | **4:24** |
| **5:00** | **5:08** | **5:11** | **5:13** | **5:17** | **5:21** | **5:24** |

*Figure 11: Route 1 and 3 Schedules*

Therefore, the total consumed energy by this bus can be calculated in Equation 1.

$$\text{Total Consumed Energy per Day} = (12 \times 6.2\text{ kWh}) + (11 \times 7.2\text{ kWh}) = 154\text{ kWh} \tag{1}$$

In EV applications, battery pack capacity is calculated to include an unused energy margin for both safety and longer cycle life. This margin is generally 20%, meaning 20% of battery capacity is not to be used during operation of the vehicle. Moreover, as the battery ages, its capacity degrades. Therefore, as a general practice, when the battery capacity reaches 80% of its initial capacity, the battery is considered to have reached its end of life as an EV traction battery. As a result, the consumed energy does not directly equate to the required battery capacity. Accounting for these factors and assuming the battery is charged at the end of the day (after the scheduled trips are completed), the battery capacity requirement for an EV bus is calculated to be 241 kWh, as seen in Equation 2.

$$\text{Battery Pack Capacity Requirement} = \frac{154}{(0.8 \times 0.8)} = 241\text{ kWh} \tag{2}$$

As explained in Section 2.2, E-450 chassis-based EV buses have battery capacities ranging between 120 kWh and 130 kWh. Therefore, to replace one gasoline E-450 bus operating on Routes 1 and 3 as currently scheduled, two E-450 electric buses are needed. Thus, the replacement ratio for the fleet conversion from fossil fuel to zero-emission vehicles for Routes 1 and 3 is 1:2.

### Routes 2 & 4

Figure 12 shows the paths and stops on Routes 2 and 4, which are served by the same bus.

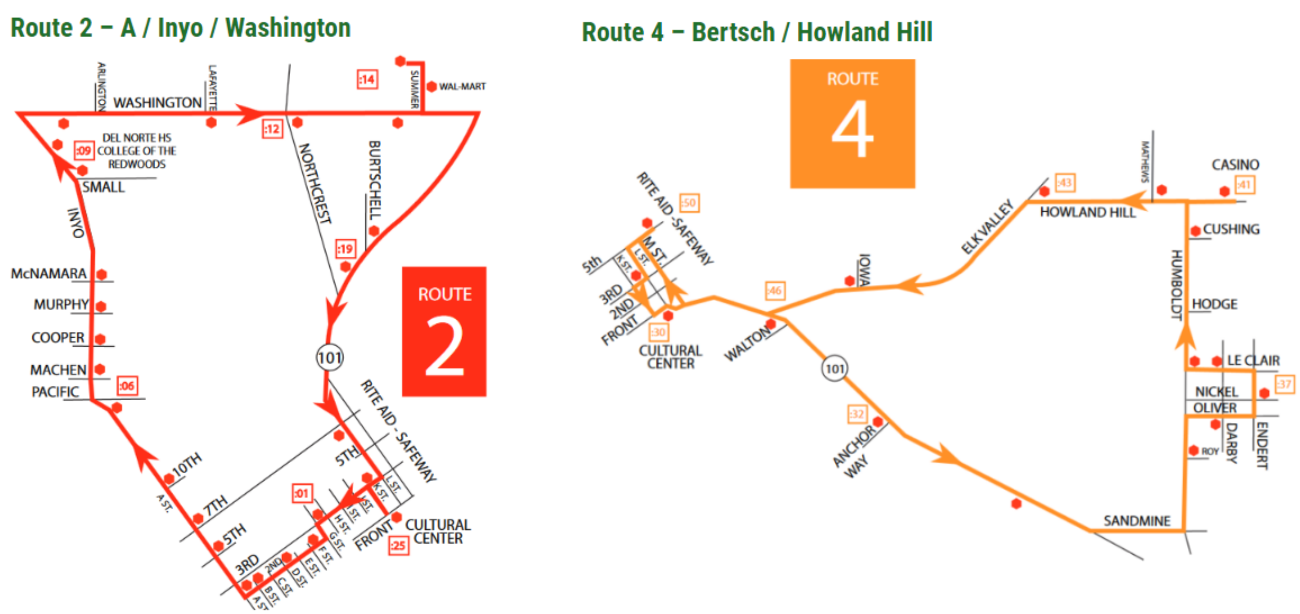


*Figure 12: Routes 2 and 4 in Crescent City*

The drive cycles for these two routes, shown in Figure 13, were generated using the algorithm described in Section 2.1.

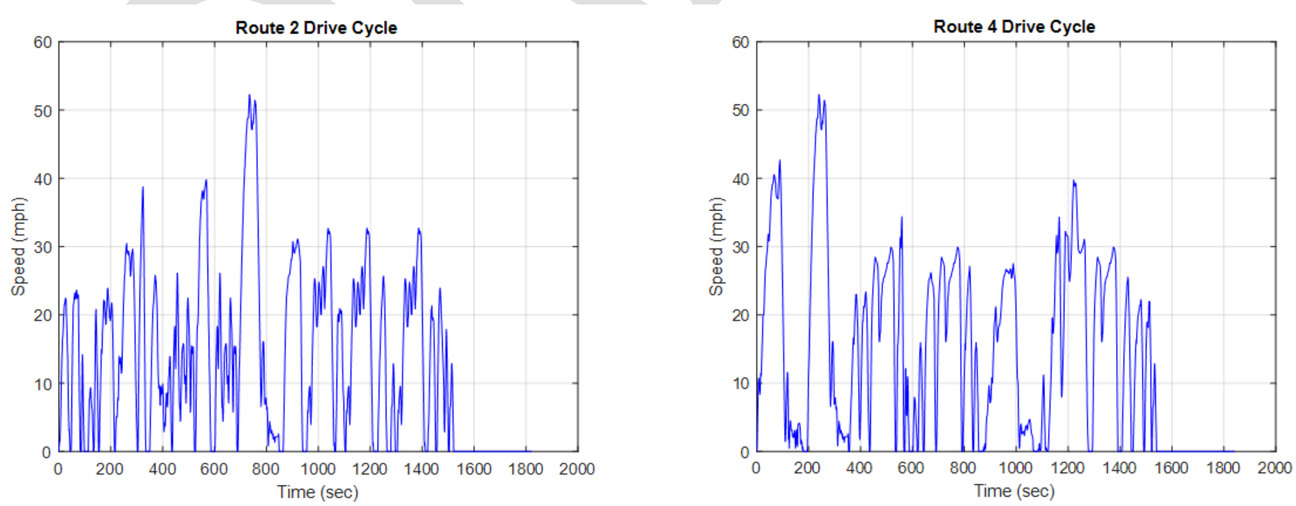


*Figure 13: Drive Cycles for Routes 2 and 4*

Figure 14 shows the distance traveled by the vehicle, with respect to the trip time. The total distance traveled by the vehicle at the end of trips for Route 2 and Route 4 was determined to be 6.6 miles and 7.2 miles, respectively.

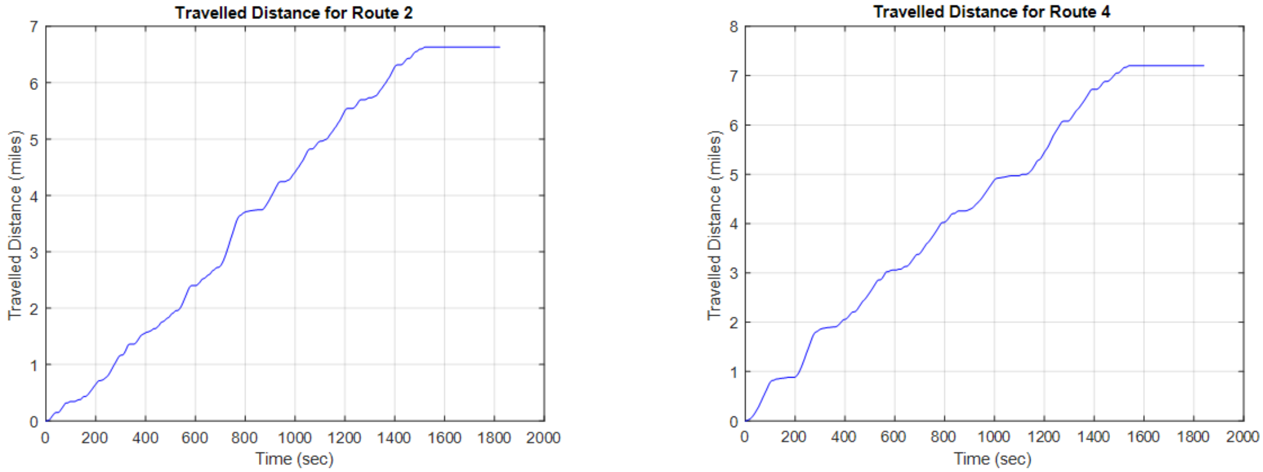


*Figure 14: Traveled Distance in Routes 2 and 4*

The energy consumed by the vehicle with respect to the trip time was calculated using the simulation tool and is shown in Figure 15. The total energy consumed by the vehicle at the end of trips for Route 2 and Route 4 was determined to be 6.8 kWh and 6.9 kWh, respectively.

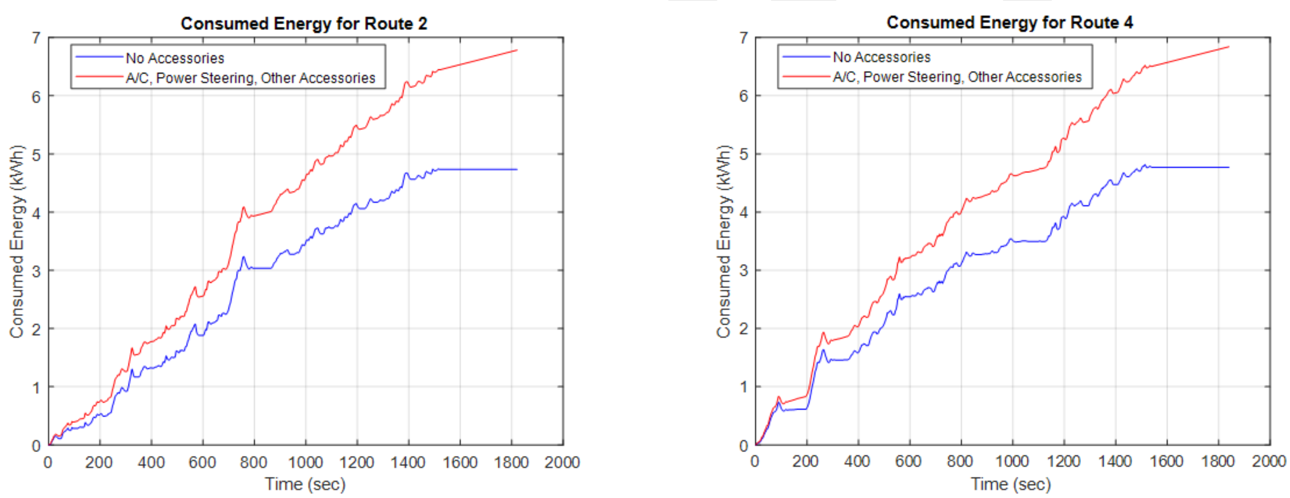


*Figure 15: Consumed Energy to Complete Routes 2 and 4*

According to the schedule of Routes 2 and 4 (shown in Figure 16), a bus makes 11.5 trips (the 0.5 trip is the first trip of the day, which is approximately half of the regular distance) on Route 2 and 11 trips on Route 4 daily.

**Route 2 – A / Inyo / Washington**

| Cultural Center | 3rd & H | A St @ Pacific | College of Redwoods / DNHS | Northcrest @ Washington | WalMart | 101 @ Wilson | Cultural Center |
|---|---|---|---|---|---|---|---|
| | | | | | 6:50 | 6:55 | 6:59 |
| 7:00 | 7:01 | 7:06 | 7:09 | 7:12 | 7:14 | 7:19 | 7:25 |
| 8:00 | 8:01 | 8:06 | 8:09 | 8:12 | 8:14 | 8:19 | 8:25 |
| 9:00 | 9:01 | 9:06 | 9:09 | 9:12 | 9:14 | 9:19 | 9:25 |
| 10:00 | 10:01 | 10:06 | 10:09 | 10:12 | 10:14 | 10:19 | 10:25 |
| 11:00 | 11:01 | 11:06 | 11:09 | 11:12 | 11:14 | 11:19 | 11:25 |
| 12:00 | 12:01 | 12:06 | 12:09 | 12:12 | 12:14 | 12:19 | 12:25 |
| 1:00 | 1:01 | 1:06 | 1:09 | 1:12 | 1:14 | 1:19 | 1:25 |
| 2:00 | 2:01 | 2:06 | 2:09 | 2:12 | 2:14 | 2:19 | 2:25 |
| 3:00 | 3:01 | 3:06 | 3:09 | 3:13 | 3:15 | 3:20 | 3:25 |
| 4:00 | 4:01 | 4:06 | 4:09 | 4:12 | 4:14 | 4:19 | 4:25 |
| 5:00 | 5:01 | 5:06 | 5:09 | 5:12 | 5:14 | 5:19 | 5:25 |

**Route 4 – Bertsch / Howland Hill**

| Cultural Center | 101 @ Anchor Way | Nickel @ Endert | Elk Valley Casino | Howland / Elk Valley | Elk Valley @ 101 | Safeway / Rite Aid on 5th St. | Cultural Center |
|---|---|---|---|---|---|---|---|
| 7:30 | 7:32 | 7:37 | 7:41 | 7:43 | 7:45 | 7:50 | 7:55 |
| 8:30 | 8:32 | 8:37 | 8:41 | 8:43 | 8:45 | 8:50 | 8:55 |
| 9:30 | 9:32 | 9:37 | 9:41 | 9:43 | 9:45 | 9:50 | 9:55 |
| 10:30 | 10:32 | 10:37 | 10:41 | 10:43 | 10:45 | 10:50 | 10:55 |
| 11:30 | 11:32 | 11:37 | 11:41 | 11:43 | 11:45 | 11:50 | 11:55 |
| 12:30 | 12:32 | 12:37 | 12:41 | 12:43 | 12:45 | 12:50 | 12:55 |
| 1:30 | 1:32 | 1:37 | 1:41 | 1:43 | 1:45 | 1:50 | 1:55 |
| 2:30 | 2:32 | 2:37 | 2:41 | 2:43 | 2:45 | 2:50 | 2:55 |
| 3:30 | 3:32 | 3:37 | 3:41 | 3:43 | 3:45 | 3:50 | 3:55 |
| 4:30 | 4:32 | 4:37 | 4:41 | 4:43 | 4:45 | 4:50 | 4:55 |
| 5:30 | 5:32 | 5:37 | 5:41 | 5:43 | 5:45 | 5:50 | 5:55 |

*Figure 16: Route 2 and 4 Schedules*

Therefore, the total consumed energy by this bus was calculated to be 154 kwh, as seen in Equation 3.

$$\text{Total Consumed Energy per day} = (11.5 \times 6.8\ \text{kWh}) + (11 \times 6.9\ \text{kWh}) = 154\ \text{kWh} \qquad (3)$$

In EV applications, battery pack capacity is calculated to include an unused energy margin for both safety and longer cycle life. This margin is generally 20%, meaning 20% of battery capacity is not used during operation of the vehicle. Moreover, as the battery ages, its capacity degrades. Therefore, as a general practice, when the battery capacity reaches 80% of its initial capacity, the battery is considered to have reached its end of life as an EV traction battery. As a result, the consumed energy does not directly equate to the required battery capacity. Accounting for these factors and assuming the battery is charged at the end of the day (after the scheduled trips are completed), the battery capacity requirement for an EV bus is calculated to be 241 kWh, as seen in, as seen in Equation 4.

$$\text{Battery Pack Capacity Requirement} = \frac{154}{(0.8 \times 0.8)} = 241\ \text{kWh} \qquad (4)$$

As explained in the Section 2.2, E-450 chassis-based EV buses have battery capacities ranging between 120 kWh and 130 kWh. Therefore, to replace one gasoline E-450 bus operating on Routes 2 and 4, two E-450 electric buses are needed. Thus, the replacement ratio for the fleet conversion from fossil fuel to zero-emission vehicles for Routes 2 and 4 is 1:2.

### 2.4.2 Intercity Route Analyses

RCTA has two intercity routes: Route 199 and Route 20. Figure 17 and Figure 18 shows the path and stops on Route 199 and Route 20, respectively.

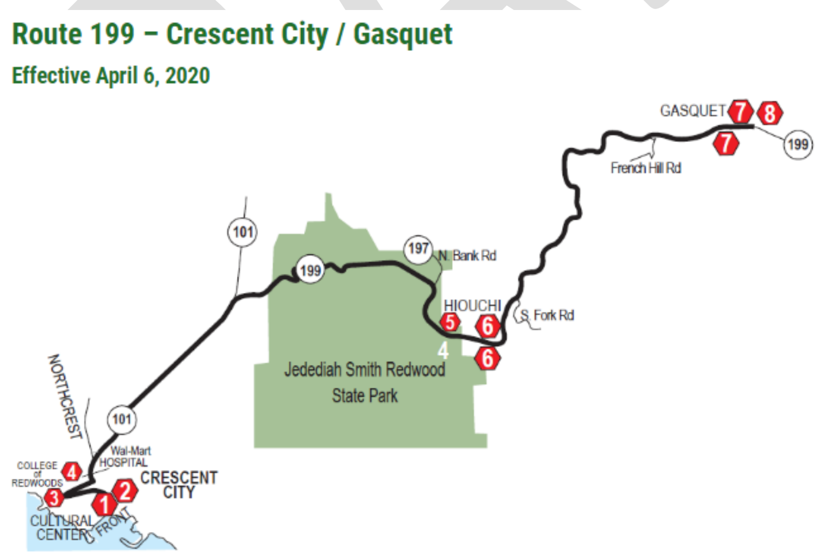


*Figure 17: Route 199*

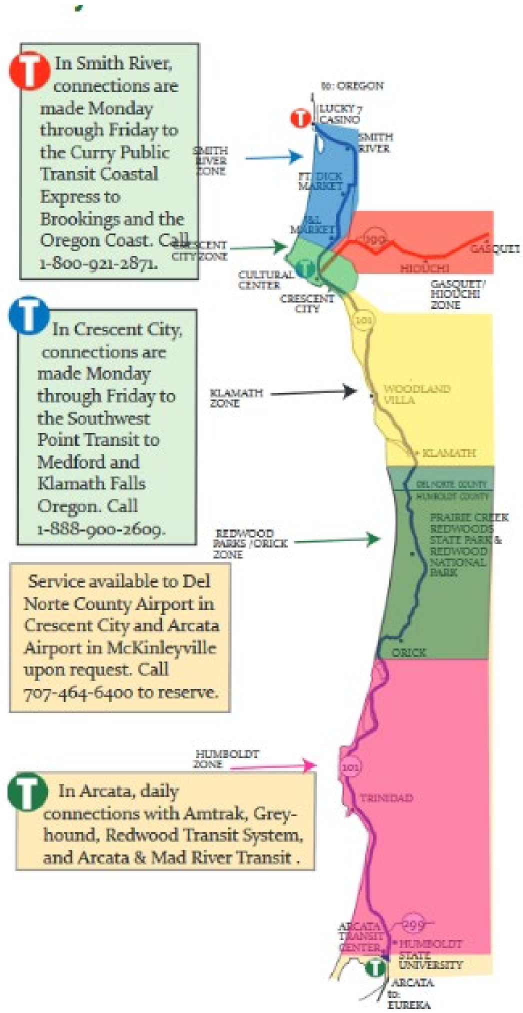


*Figure 18: Route 20*

In this analysis, the unique drive cycle generated for each route was simulated to calculate the energy consumed by the vehicle to complete one trip. Moreover, the layover times of each bus at its destination stops were calculated according to the current schedule to analyze the available time to charge the batteries. The feasibility of deploying an EV bus for these routes was evaluated based on the consumed energy, available battery pack capacities, and available layover times for opportunity charging.

## Route 199

The drive cycle for the in-city section of the route 199 was generated by leveraging the segments of drive cycles generated for local Routes 1 through 4, since the intercity sections of Route 199 overlaps with the local routes. The drive cycle for the intercity section of the Route 199 was generated using some parts of the cruise section of Heavy-Duty Diesel Truck (HDDT) drive cycle. The distance and speed limits between consecutive bus stops were also considered while generating the intercity drive cycle. Figure 19 shows the generated drive cycles for Route 199 in both directions. The duration of the trips is 40 minutes from Cultural Center to Gasquet and 45 minutes from Gasquet to Cultural Center, while the traveled distances are 21.2 miles from Cultural Center to Gasquet and 22.4 miles from Gasquet to Cultural Center.

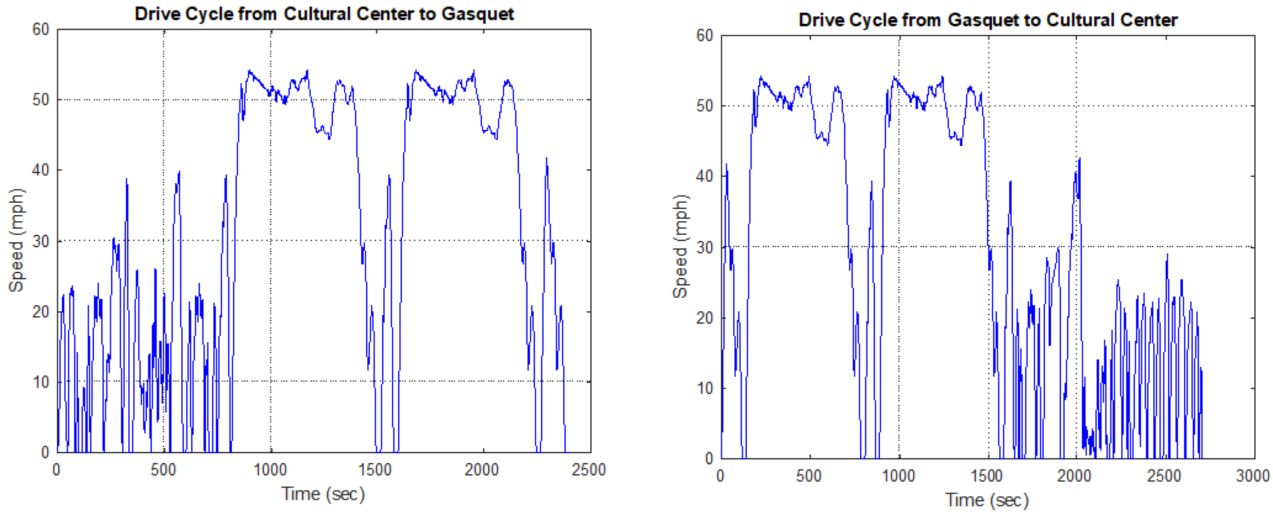


*Figure 19: Drive Cycle for Route 199*

As shown in Figure 20, the vehicle consumes 23.0 kWh of energy during its trip from Cultural Center to Gasquet and 20.7 kWh of energy during its return trip from Gasquet to Cultural Center.

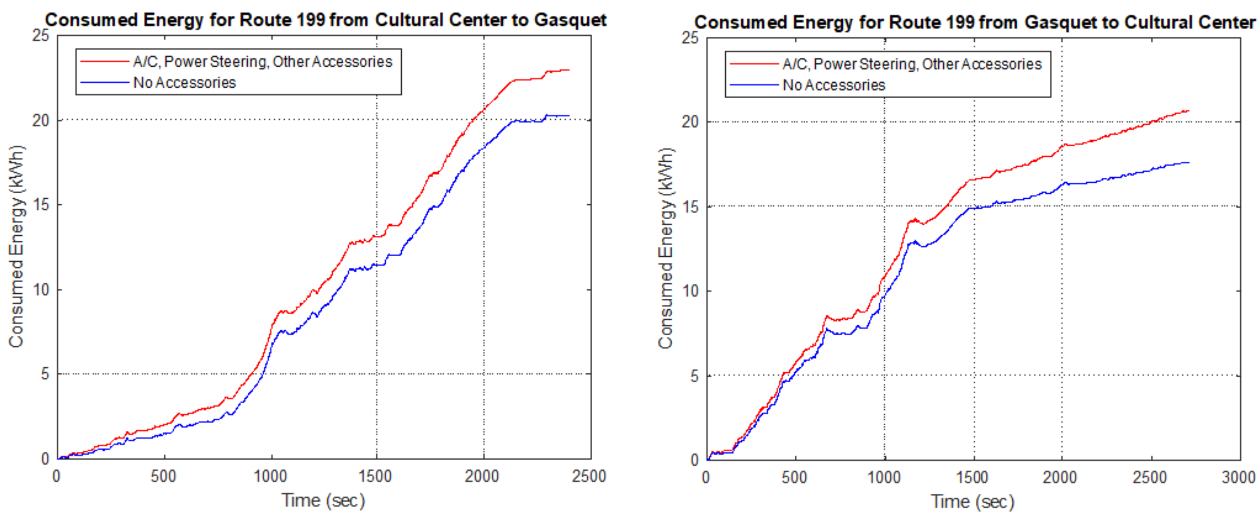


*Figure 20: Consumed Energy to complete Route 199 Trips*

According to the schedule of Route 199 in Figure 21, a bus makes two trips from Cultural Center to Gasquet and two trips from Gasquet to Cultural Center per day.

| Crescent City – Gasquet (Eastbound) MON – FRI | AM | Mid | PM |
|---|---|---|---|
| Crescent City | | | |
| 1 Cultural Center | 6:53 | 12:30 | — |
| 2 5th @ 101 (Safeway) | 6:55 | 12:32 | — |
| 3 College of the Redwoods | 7:02 | 12:39 | — |
| 4 Sutter Hospital / Crescent City Wal-Mart | 7:06 | 12:43 | — |
| Jedediah Smith Redwood S.P. | | | |
| 5 Visitor's Center | 7:18 | 12:55 | — |
| Hiouchi | | | |
| 6 Hiouchi Café | 7:20 | 12:57 | — |
| Gasquet | | | |
| 7 Mobile Home Park EB | 7:32 | 1:09 | — |
| 8 Smith River NRA V.C. | 7:33 | 1:10 | — |

| Gasquet – Crescent City (Westbound) MON – FRI | AM | Mid | PM |
|---|---|---|---|
| Gasquet | | | |
| 8 Smith River NRA V.C. | 7:34 | 1:11 | — |
| 10 Gasquet Market | 7:37 | 1:14 | — |
| Hiouchi | | | |
| 6 199 @ Hiouchi Cafe | 7:49 | 1:26 | — |
| Jedediah Smith Redwood S.P. | | | |
| 5 Visitor's Center | 7:52 | 1:29 | — |
| Crescent City | | | |
| 4 Sutter Hospital / Crescent City Wal-Mart | 8:04 | 1:41 | — |
| 3 College of the Redwoods | 8:09 | 1:46 | — |
| 2 6th Street @ L | 8:16 | 1:54 | — |
| 1 Cultural Center – Front St @ 101 | 8:18 | 1:56 | — |

*Figure 21: Route 199 Schedule*

Therefore, the total consumed energy by this bus can be calculated in Equation 5.

$$\text{Total Consumed Energy per day} = (2 \times 23.0 \text{ kWh}) + (2 \times 20.7 \text{ kWh}) = 87.4 \text{ kWh} \quad (5)$$

In EV applications, battery pack capacity is calculated to include an unused energy margin for both safety and longer cycle life. This margin is generally 20%, meaning 20% of battery capacity is not to be used during operation of the vehicle. Moreover, as the battery ages, its capacity degrades. Therefore, as a general practice, when the battery capacity reaches 80% of its initial capacity, the battery is considered to have reached its end of life as an EV traction battery. As a result, the consumed energy does not directly equate to the required battery capacity. Accounting for these factors and assuming the battery is charged at the end of the day (after the scheduled trips are completed), the battery capacity requirement for an EV bus is calculated to be 137 kWh, as seen in Equation 6.

$$\text{Battery Pack Capacity Requirement} = \frac{87.4}{(0.8 \times 0.8)} = 137 \text{ kWh} \quad (6)$$

According to the schedule of Route 199 in Figure 21, there are four hours between consecutive trips from Cultural Center to Gasquet. Therefore, an electric bus operating on Route 199 has some time for charging between trips at the bus depot during the day. This practice is also referred to as opportunity charging. The goal of opportunity charging is to sufficiently charge the battery so that vehicle can finish the remainder of its trip for the day. The intent is not to maximize the charge because of the higher time-of-use cost of electricity during the daytime. As such, a lower (10 kW) power transfer rate is assumed in this analysis instead of 19.2 kW, which is the maximum rated capacity for the suggested Level 2 chargers. At 10 kW, the battery will be sufficiently charged without incurring additional costs. Since the distance between Cultural Center and bus depot is minimal, we can also assume that the round trip between the Cultural Center and bus depot will be no more than half an hour. This would give 3.5 hours for opportunity charging at the bus depot. Based on these assumptions, 35 kWh of energy can be restored in the battery pack, which reduces the net total consumed energy per day in Equation 5 to 52.4 kWh. Based on the net total consumed energy per day, the battery pack capacity requirement in Equation 6 decreases to 82 kWh. As explained in Section 2.2, E-450 chassis-based EV buses in the market have battery capacities ranging between 120 kWh and 130 kWh. Since the battery energy requirement is less than the standard battery capacities for vehicle available in the market, one gasoline E-450 bus operating on Route 199 can be replaced by one E-450 electric bus. Thus, the replacement ratio for the fleet conversion from fossil fuel to zero-emission vehicles for Route 199 is 1:1.

## Route 20

As it will be shown, due to the distance traveled and the short layover times, utilizing an EV bus on the entirety of Route 20 is not feasible. However, it was observed that the Route 20 has two parts: 1) North – Cultural Center to Lucky 7 Casino (North leg) and 2) South – Cultural Center to Arcata (South leg). The South leg is serviced twice while the North leg is services four time a day. The North leg is currently independently operated 50% of the time. Thus, we analyzed the two parts separately and explored the possibility of partially electrifying the Route 20. This exercise was deemed sensible because operating an EV on even one parts of Route 20 can still contribute towards RCTA's emissions goals.

### Cultural Center and Arcata (South Leg)

The drive cycle for the South leg of Route 20 was generated using parts of the cruise section of the Heavy-Duty Diesel Truck (HDDT) drive cycle. The distance and speed limits between consecutive bus stops were also considered while generating the drive cycle. Figure 22 shows the generated drive cycles for South leg of Route 20 between Cultural Center and Arcata in both directions. The duration of the trips is 1 hour and 57 minutes between Cultural Center and Arcata, and the distance traveled is 77 miles.

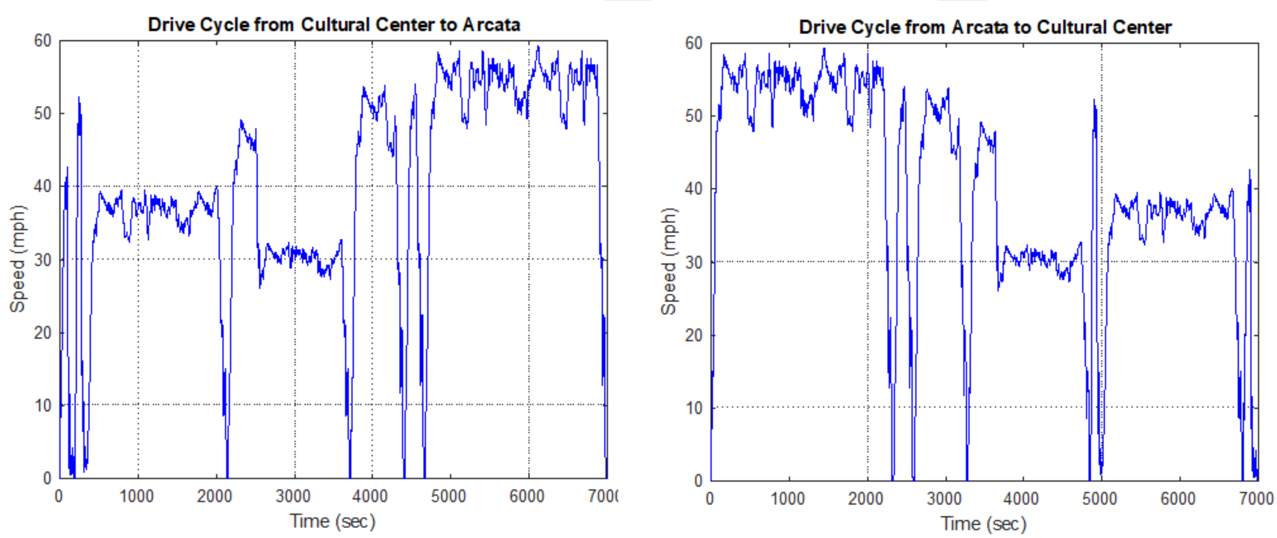


*Figure 22: Drive Cycles between Cultural Center and Arcata on Route 20*

As shown in Figure 23, the vehicle consumes 72.6 kWh from Cultural Center to Arcata while consuming 72.1 kWh on the way back.

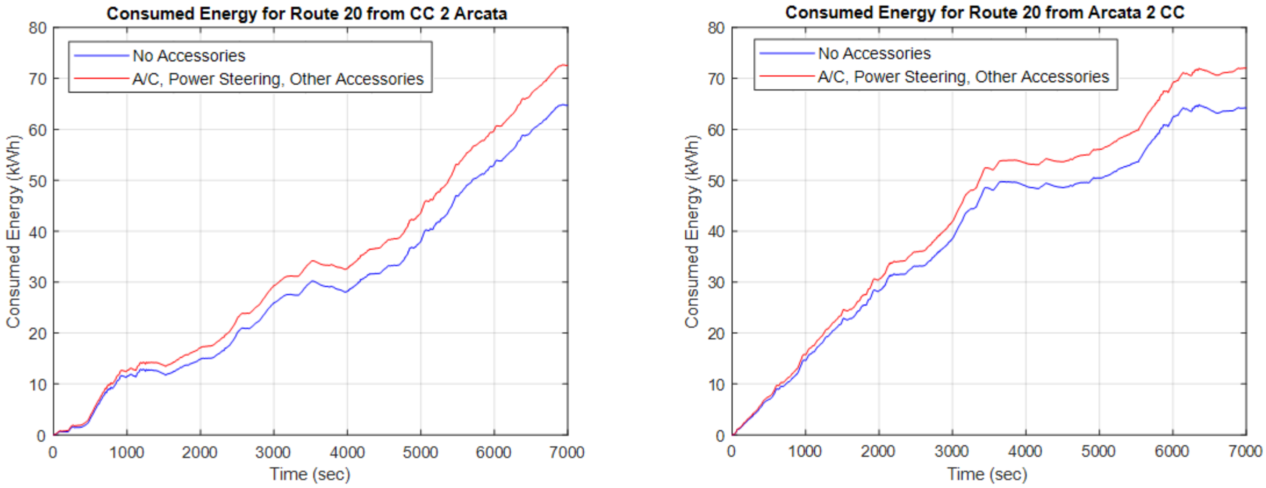


*Figure 23: Consumed Energy to Complete Trips between Cultural Center and Arcata on Route 20*

According to the schedule of Route 20 (seen in Figure 24), a bus makes 2 trips from Cultural Center to Arcata and 2 trips from Arcata to Cultural Center per day.

**Smith River / Arcata (Southbound)**

| Stop | | | | | |
|---|---|---|---|---|---|
| **Smith River** | | | | | |
| Lucky 7 Store (Departs) | 6:45 | 9:20 | 2:15 | 6:30 | — |
| Old Ray's Foods | 6:50 | 9:25 | 2:20 | 6:32 | — |
| Ft. Dick Market | 6:58 | 9:33 | 2:28 | 6:40 | — |
| Pelican Bay State Prison | 7:00 | — | — | — | — |
| J & L Market | 7:05 | 9:40 | 2:35 | 6:47 | — |
| **Crescent City** | | | | | |
| College of Redwoods | 7:13 | 9:48 | 2:43 | 6:55 | — |
| Cultural Center | 7:30 | 10:00 | 3:00 | 7:05 | — |
| Klamath (Pem-Mey) | 8:05 | — | 3:35 | — | — |
| Klamath Glen | — | — | 3:45 | — | — |
| Prairie Creek S.P. | 8:28 | — | 4:16 | — | — |
| Orick Redwood N.P. Office | 8:38 | — | 4:26 | — | — |
| Visitor Ctr – R.N.P. | 8:42 | — | 4:30 | — | — |
| **Arcata** | | | | | |
| Arcata Transit Center (Arrive) | 9:22 | — | 5:10 | — | — |

**Arcata / Smith River (Northbound)**

| Stop | | | | | | |
|---|---|---|---|---|---|---|
| **Arcata** | | | | | | |
| Arcata Transit Center (Departs) | — | — | 10:00 | — | 5:50 | — |
| Redwood N.P. Visitor Center | — | — | 10:40 | — | 6:30 | — |
| Orick – N.P. Office | — | — | 10:44 | — | 6:34 | — |
| Prairie Creek S.P. | — | — | 10:54 | — | 6:44 | — |
| Klamath Glen | — | — | 11:27 | — | — | — |
| Klamath (Pem-Mey) | — | — | 11:37 | — | 7:07 | — |
| **Crescent City** | | | | | | |
| Cultural Center | 6:05 | 8:30 | 12:12*/ 1:30 | 6:00 | 7:42 | — |
| College of Redwoods | — | 8:38 | 1:38 | — | — | — |
| J & L Market | 6:15 | 8:45 | 1:45 | 6:10 | — | — |
| Pelican Bay State Prison | — | — | — | — | — | — |
| Ft. Dick Market | 6:22 | 8:52 | 1:52 | 6:17 | — | — |
| **Smith River** | | | | | | |
| Ray's Food Place | 6:30 | 9:00 | 2:00 | 6:25 | — | — |
| Lucky 7 Casino (Arrives) | 6:35 | 9:05 | 2:05 | 6:30 | — | — |

*Figure 24: Schedule of Route 20*

Therefore, the total energy consumed by this bus is calculated to be 289.4 kWh, as seen in Equation 7.

$$\text{Total Consumed Energy per Day} = (2 \times 72.6\ \text{kWh}) + (2 \times 72.1\ \text{kWh}) = 289.4\ \text{kWh} \tag{7}$$

As explained in Section 2.2, E-450 chassis-based EV buses in the market have battery capacities ranging between 120 kWh and 130 kWh. Since the total consumed energy per day from Equation 7 exceeds the battery capacities available in the market, an EV bus needs to be charged right after it completes a trip in any direction on the South leg of Route 20. According to the schedule in Figure 24, the layover time at Arcata is 40 minutes. These 40 minutes are not sufficient to recharge the batteries enough for the return trip to Cultural Center, even with a 60 kW DC Fast Charger. 60 kW is the maximum charging rate for the suggested EV. Also, the bus stops along the route are too short timewise to consider any additional on-route charging opportunity.

Moreover, a bus that arrives in Arcata may occasionally take a different path back to the Cultural Center due to weather-related road closures. Figure 25 shows this alternative 400-mile return trip on the map.

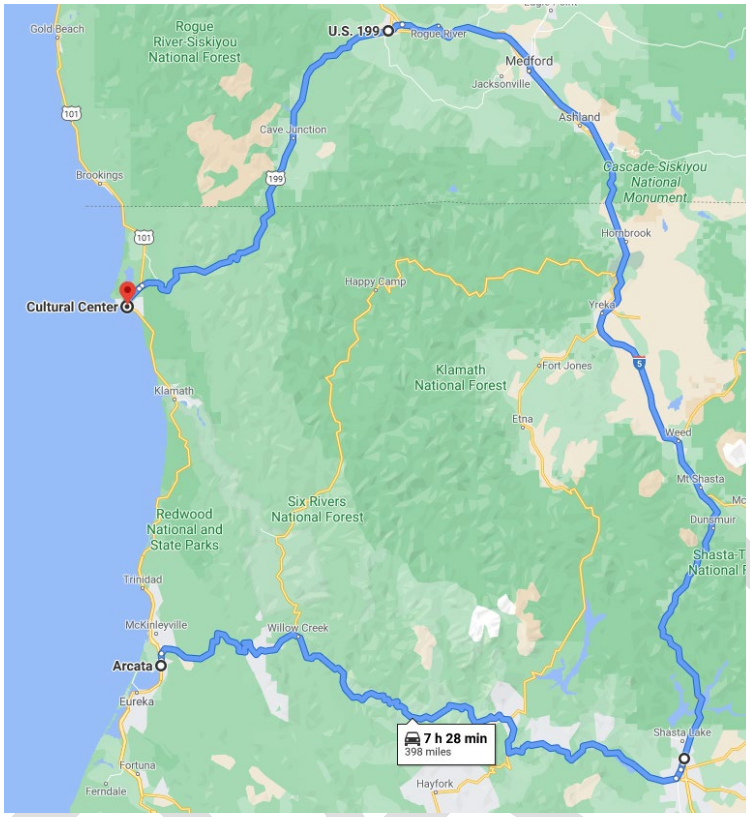


Figure 25: Alternative Return Path from Arcata to Cultural Center

This alternative path can take up to 8 hours and is much longer than the regular return trip. If an EV bus is deployed to perform this alternative trip, it would take 48 hours to complete, assuming 80 miles of range with fully charged batteries and 6- to 8-hour charge time. Thus, an EV bus does not have the same resilience as a conventional bus for these emergency cases. As a result, replacing conventional buses with electric buses is infeasible for the Cultural Center and Arcata section of Route 20.

## Cultural Center and Lucky 7 Casino (North Leg)

The drive cycle for the North leg of Route 20 was generated by using parts of the cruise section of the Heavy-Duty Diesel Truck (HDDT) drive cycle. The distance and speed limits between consecutive bus stops were also considered while generating the drive cycle. Figure 26 shows the generated drive cycles for North leg of Route 20 between Cultural Center and Lucky 7 Casino in both directions. The duration of the trips is 35 minutes between Cultural Center and Lucky 7 Casino, with the distance traveled at approximately 18.1 miles.

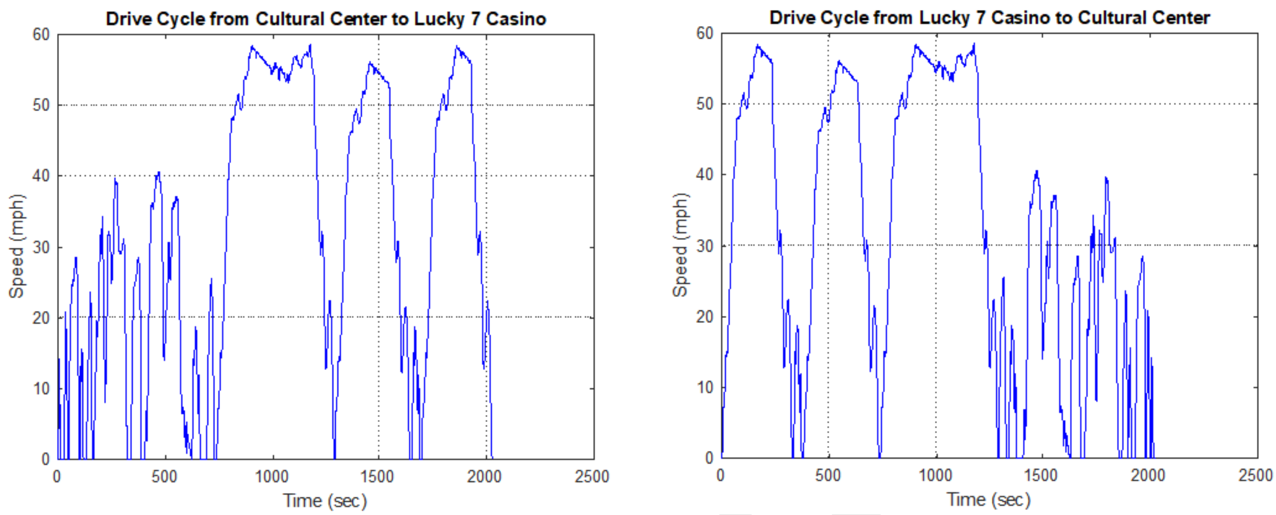


*Figure 26: Drive Cycles between Cultural Center and Lucky 7 Casino on Route 20*

As shown in Figure 27, the vehicle consumes 17.5 kWh from Cultural Center to Lucky 7 Casino while consuming 17.0 kWh on the way back.

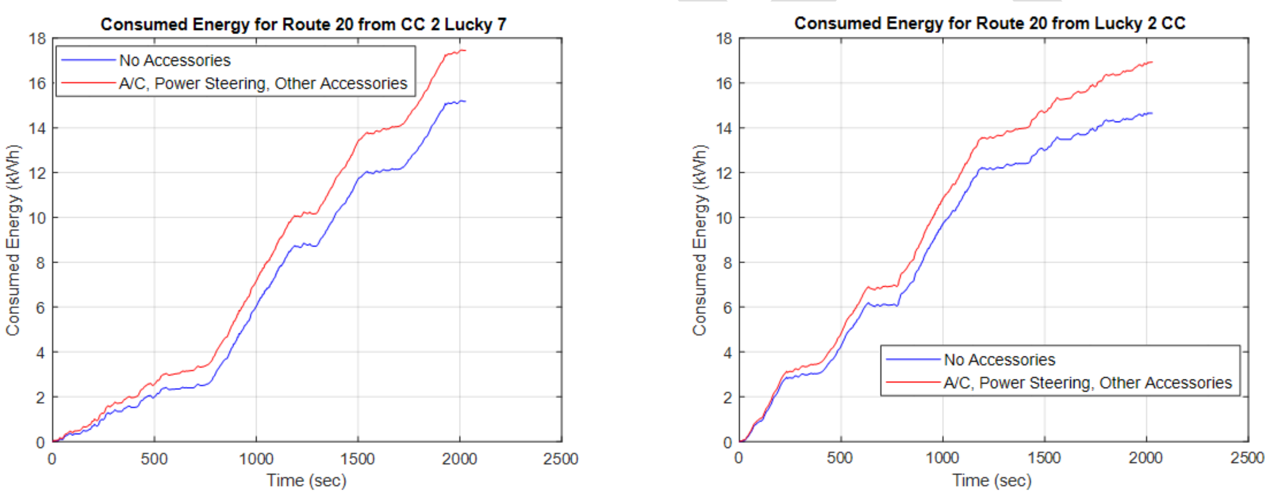


*Figure 27: Consumed Energy to Complete Trips between Cultural Center and Lucky 7 Casino on Route 20*

According to the schedule in Figure 24, a bus makes 4 trips from Cultural Center to Lucky 7 Casino and 4 trips from Lucky 7 Casino to Cultural Center per day. Therefore, the total consumed energy by this bus can be calculated in Equation 8.

$$\text{Total Energy Consumed per Day} = (4 \times 17.5\ \text{kWh}) + (4 \times 17.0\ \text{kWh}) = 138\ \text{kWh} \qquad (8)$$

In EV applications, battery pack capacity is calculated to include an unused energy margin for both safety and longer cycle life. This margin is generally 20%, meaning 20% of battery capacity is not to be used during operation of the vehicle. Moreover, as the battery ages, its capacity degrades. Therefore, as a general practice, when the battery capacity reaches 80% of its initial capacity, the battery is considered to have reached its end of life as an EV traction battery. As a result, the consumed energy does not directly equate to the required battery capacity. Accounting for these factors and assuming the battery is charged at the end of the day (after the scheduled trips are completed), the battery capacity requirement for an EV bus is calculated to be 216 kWh, as seen in Equation 9.

$$\text{Battery Pack Capacity Requirement } = \frac{138}{(0.8\times0.8)} = 216 \text{ kWh} \quad (9)$$

When we consider the North leg of the Route 20 operating independently, according to the schedule in Figure 24, we can see that there are three layover slots at Cultural Center throughout the day (1 hour, 3 hours, and 3.5 hours) between the consecutive trips. Therefore, an electric bus operating on North leg of Route 20 has time for charging between trips at bus depot during the day. This practice is also referred to as opportunity charging. The goal of the opportunity charging is to sufficiently charge the battery so that vehicle can finish the remaining part of its trip for the day. The intent is not to maximize the charge due to the higher time-of-use cost of electricity during the daytime. As such, a lower (10 kW) power transfer rate is assumed in this analysis instead of 19.2 kW, which is the maximum rated capacity for the suggest Level 2 chargers. At 10 kW, the battery will be sufficiently charged without incurring additional costs. Since the distance between Cultural Center and the bus depot is minimal, we can also assume that the round trip between the Cultural Center and the bus depot will be no more than half an hour. This would give the bus 6 hours for the opportunity charging throughout the day at the bus depot. Based on these assumptions, 60 kWh of energy can be restored in the battery pack, which reduces the net total consumed energy per day in Equation 8 to 78 kWh. Based on the net total consumed energy per day, the battery pack capacity requirement in Equation 9 decreases to 122 kWh. As explained in Section 2.2, E-450 chassis-based EV buses in the market have battery capacities ranging between 120 kWh and 130 kWh. Since the battery pack capacity requirement is below the battery capacities available in the market, an E-450 based EV bus can be deployed on the North leg of the Route 20. The South leg of the Route 20 between Cultural Center and Arcata will need to continue to be served with legacy fossil fuel vehicles.

HATCH LTK understands that splitting the route in this manner will introduce operational challenges. The most notable impact will be to the ridership. Currently, the riders travelling from Lucky 7 Casino can continue their journey south towards Arcata in the same bus. With the split operation, these riders will need to switch buses at Cultural Center. Moreover, the operator operating the electric vehicle will no longer continue operating the vehicle toward the south. Instead, the vehicle will be diverted to the depot for opportunity charging after offboarding the riders at the Cultural Center. It will be a similar case for the Northbound operation. However, as mentioned previously, HATCH LTK performed this analysis because we recognized an opportunity for RCTA to further reduce its fossil fuel mileage. Should RCTA decide to operate an electric bus on the North leg of Route 20, further analysis of its impact on ridership and operations planning is recommended by HATCH LTK to ensure minimum disruption.

## 1.1. Conversion Matrix

| Routes | Electrification | Replacement Ratio |
|---|---|---|
| 1 Parkway/El Dorado<br>3 Northcrest | √ | 1-2 |
| 2 A/Inyo/Washington<br>4 Bertsch/Howland Hill | √ | 1-2 |
| 199 Crescent City | √ | 1-1 with mid-day depot charging |
| 20 Smith River/Arcata (South - Between Cultural Center and Arcata) | × | Not possible |
| 20 Smith River/Arcata (North - Cultural Center to Lucky 7 Casino) | √ | 1:1 with mid-day depot charging |

*Table 2: Route Conversion Matrix*

# 3. Energy and Infrastructure Analysis

## 3.1 Existing Electrical Infrastructure

Pacific Power provides electric utility service to the Crescent City RCTA maintenance building. They are a critical partner in the planning process. For RCTA to transition to an all-electric fleet successfully, it is important that Pacific Power understands RCTA's future energy needs and has a plan in place to be able to meet these requirements.

Existing electrical equipment is in an electrical closet and is accessible from outside through double doors. This equipment is primarily being used to feed the maintenance shop and the office space. Pictures of the meter switch, provided by the RCTA staff, were used to assess the electrical capacity on site. The nameplate data in Figure 28 indicates a 600 AMP, 120/240 Volt, 1 Phase 3 Wire service. Therefore, the maximum existing electrical capacity is determined to be 144 KW. As will be discussed in the following part of this report, this infrastructure is not adequate to support the charging stations proposed in this report.

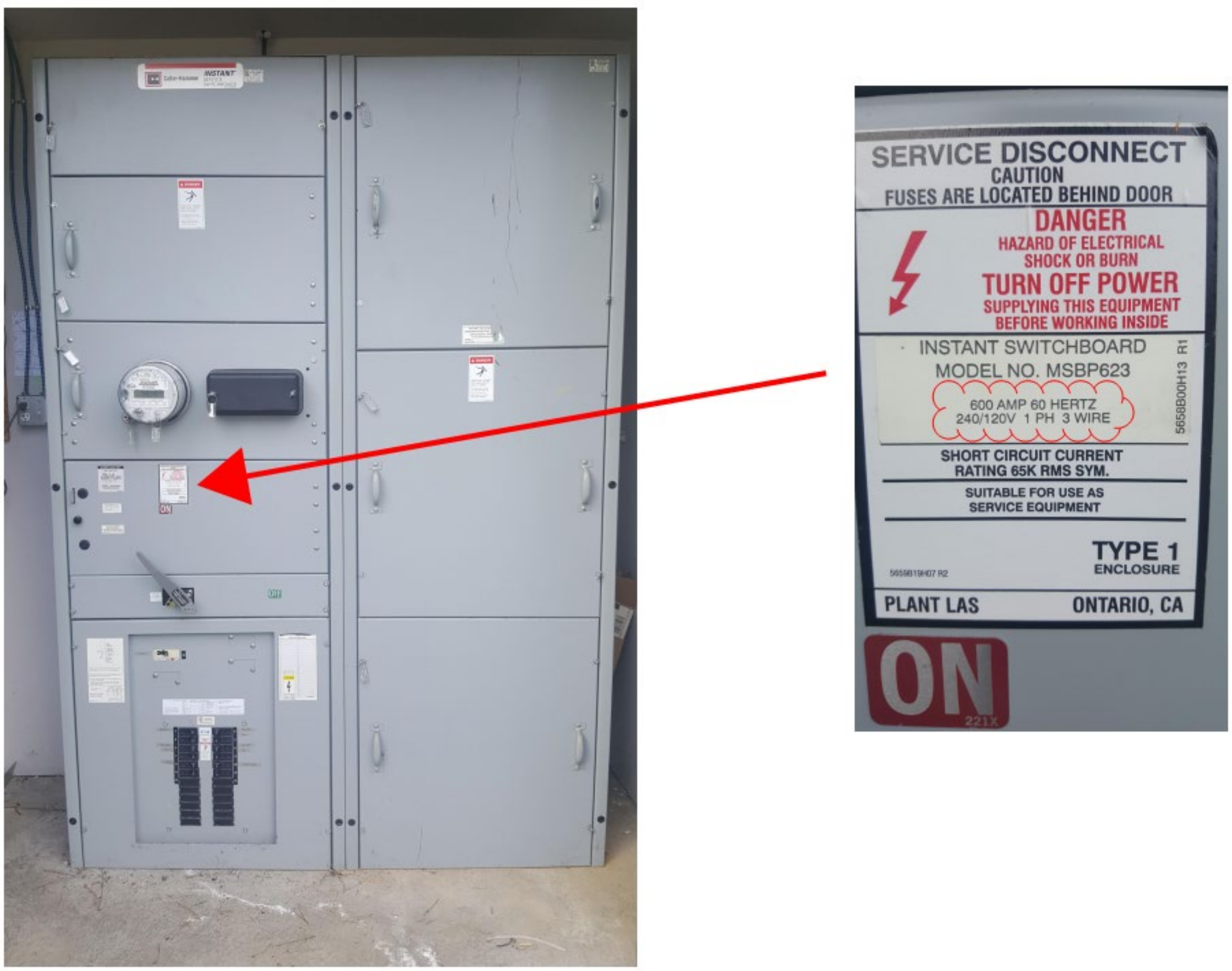


*Figure 28: Switchgear at RCTA depot facility*

Figure 29 shows a picture of the existing utility pole on Williams Drive that is being used to feed the RCTA facility.

*Figure 29: Utility Pole on Williams drive*

This picture shows a single transformer case on top of the pole, which provides also indication that the supplied service is single-phase service..

RCTA has verified during a meeting that a site visit was conducted by Pacific Power personal and that the existing service is verified to be a single-phase service by Pacific Power. This information is consistent with the pictures of the electrical equipment (Figure 28) and the pole mount transformer (Figure 29).

A request has been made to Pacific Power to share one year of peak demand data for the current RCTA facility to determine the spare electrical capacity at site. Spare capacity can be determined using one of the two options listed below, which are based on the National Electrical Code (NEC):

- Option 1 – Review of peak demand (kW) data provided by the utility. At minimum, one year of peak demand data should be evaluated to determine the maximum electric usage and available spare capacity.
- Option 2 – Maximum demand continuously recorded over a minimum 30-day period using a recording ammeter or power meter connected to the main service equipment.

Analysis of the peak demand can be completed after the requested data is provided. Alternatively, RCTA can choose to install a power meter and gather data for 30-day period to calculate existing peak demand.

Available spare capacity can be used to partially support charging needs of the electric buses, therefore reducing the size of required new service.

## 3.2 Charging

There are two different strategies for charging electric buses: 1) depot charging; and 2) on-route charging. Depot charging is easier and cheaper to deploy as it does not require agency to acquire new space along the route for charging station installation. In addition, maintenance and repairs are easier since the equipment is located at the depot and the crew does not require traveling off-site.

From the route analysis, we determined that most of the RCTA routes can be served by an equivalent EV bus with a single charge, meaning that the buses only need to be charged after the full day of service. In the case of intercity Routes 199 and North leg of the Route 20 (Cultural Center and Arcata), there is a requirement for charging the vehicles during the downtime between trips, referred to as opportunity charging. The vehicles on both Route 199 and Route 20 North leg have downtime at the Cultural Center which is a short 10-minute drive from the depot. So, the vehicles can easily be brought back to the depot for the opportunity charging. Hence, depot charging is the recommended option for RCTA's operations.

The charging speed is determined based on the time available for charging the vehicles. Figure 30 shows the scheduled vehicle trips and the downtime when the vehicle can be charged. In the schedule, half-hour slots were left available to account for the travel time to the facility as well as other variables.

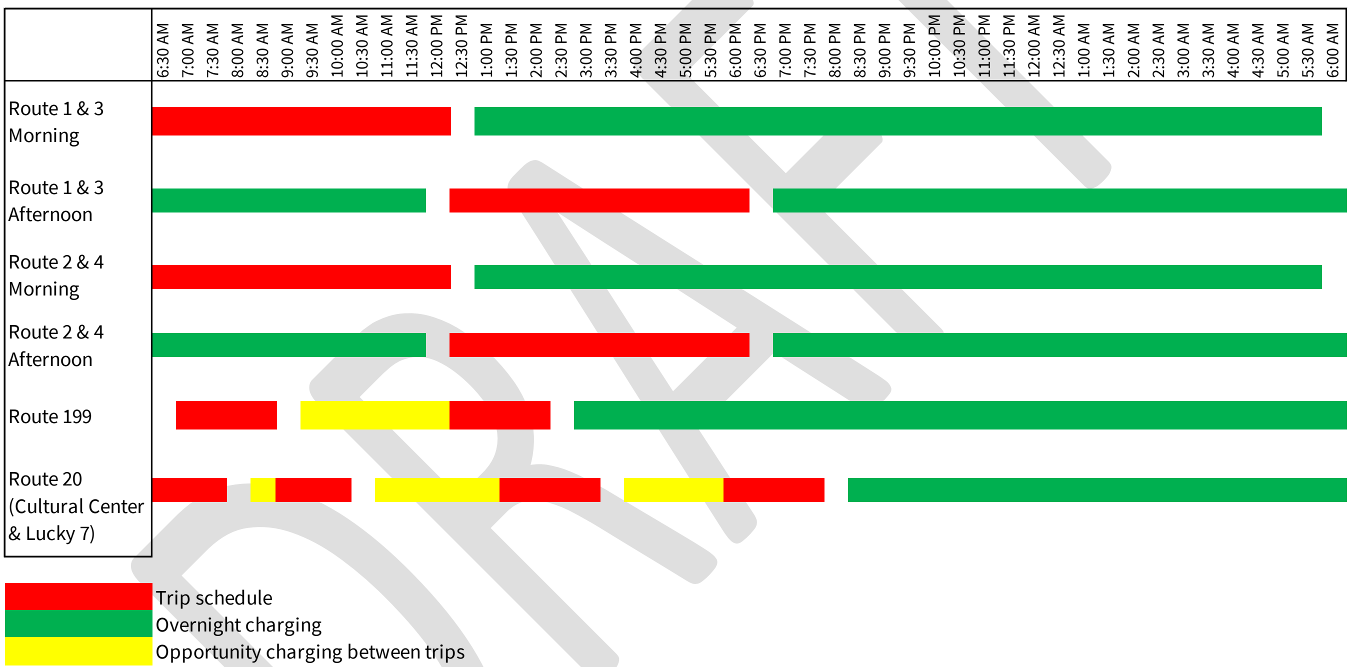


*Figure 30: Charging Schedule*

As illustrated in Figure 30, the vehicles have plenty of time between their last trip of the day and their first trip of the following day for charging. Route 20 has the shortest available time for overnight charging of approximately 10 hours. Out of the 10 hours of downtime, we can realistically expect to charge the bus for 8 hours. In order to calculate the charging requirement, we have used the Route 20 available charge time, which represents the worst case scenario, and a 125 kWh battery pack size, which is the average of the available battery capacities (120kWh to 130 kWh) for the suggested E-450 chassis-based EV bus. Using these assumptions, in order to ensure that the battery can be fully charged from 0% state of charge (SoC) in eight hours, an average required power transfer rate can be calculated using Equation 10.

$$\text{Average Power Transfer Rate} = \frac{\text{Battery capacity}}{\text{Charge time}} = \frac{125\text{ kWh}}{8\text{ h}} = 15.6\text{ kW} \tag{10}$$

This is a worst-case scenario assumption as the battery, in most cases, will have some charge when the vehicle is plugged into the charger. Furthermore, the rate of charge is variable as it decreases when the battery approaches 100% SoC to avoid overheating. The EV suggested also has a maximum rating for charging with Level 2 chargers of 19.2 kW. Hence, 19.2 kW Level 2 chargers are most suitable for RCTA's application.

Furthermore, since all the vehicles need overnight charging to ensure a fully charged battery pack next morning, one 19.2 kW Level 2 charging stations per electric bus will be required to fulfill the charging requirements of the suggested fixed routes electrification.

Various charging strategies and power management software can be employed to reduce the charger rating requirement and upstream electrical equipment size. For example, because the vehicles are sitting idle for long periods of time, not all vehicles need to be charged in parallel at night. Some vehicles can be charged in sequence to reduce the charger/electrical infrastructure capacity. Intelligent power management software can make this task easier by automatically scheduling the charging in sequence or by controlling the amount of power that is transferred to each of the vehicles at any given time. Figure 31 shows a typical energy management system dashboard that provides a full overview of the bus charging operations while intelligently managing the charging. The availability of such management software, cost and its functionality vary between charging station manufacturers and is typically bundled with the cost of the charging system. A full in-depth technical evaluation is recommended to ensure that a correct system for RCTA's needs is procured.

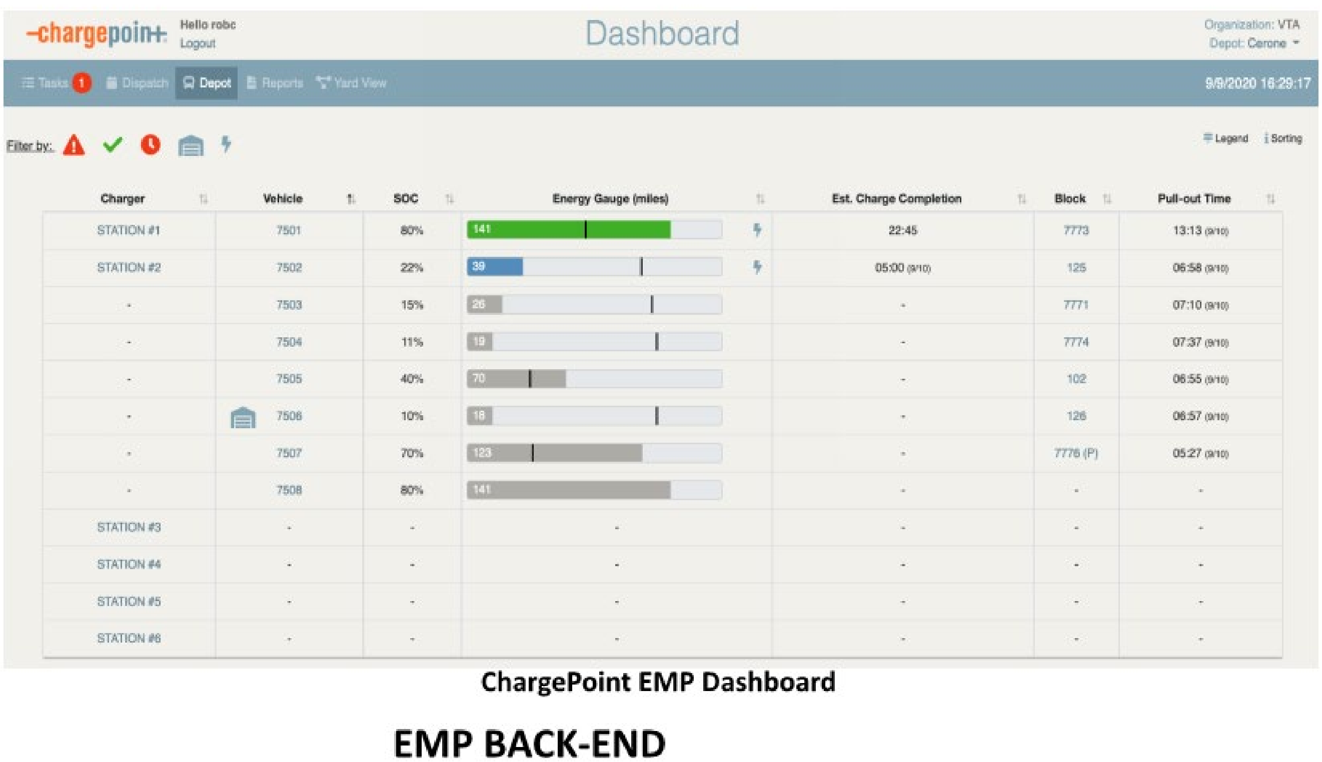


*Figure 31: Sample Charge Management Dashboard*

Charging strategies can also help RCTA reduce its utility costs by reducing demand charges and taking advantage of Time-of-Use (TOU) rates. Pacific Power is developing a new TOU schedule to be implemented in 2023. Further study should be done to incorporate the new EV charging TOU rates once it is rolled out by the Pacific Power to further optimize the charging costs.

It is recommended that RCTA perform a further in-depth analysis on the available options to optimize the charging infrastructure while minimizing costs. Information, such as time-of-use (TOU) charges and peak demand charges, should be obtained from Pacific Power and incorporated into the analysis.

The optimal location for the charging stations is determined by several factors: quantity of vehicles, layout of the vehicles, distance of the charging station from electrical service equipment, and electric utility service tie-in location. Figure 32 shows potential locations for the vehicle chargers in blue. The corresponding vehicle charging spaces for a maximum of 11 vehicles are shown in red.

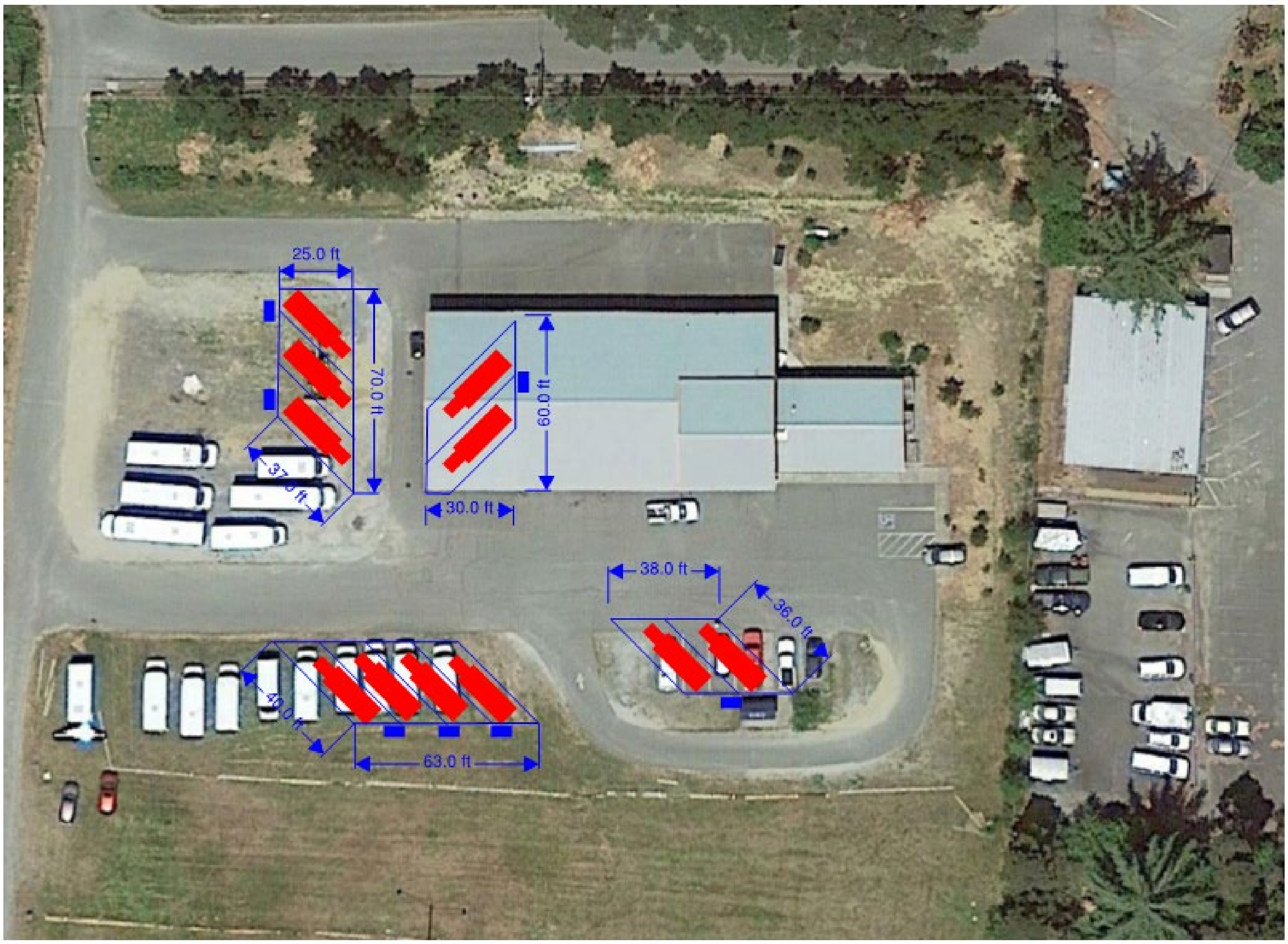


*Figure 32: Parking and Charger Location*

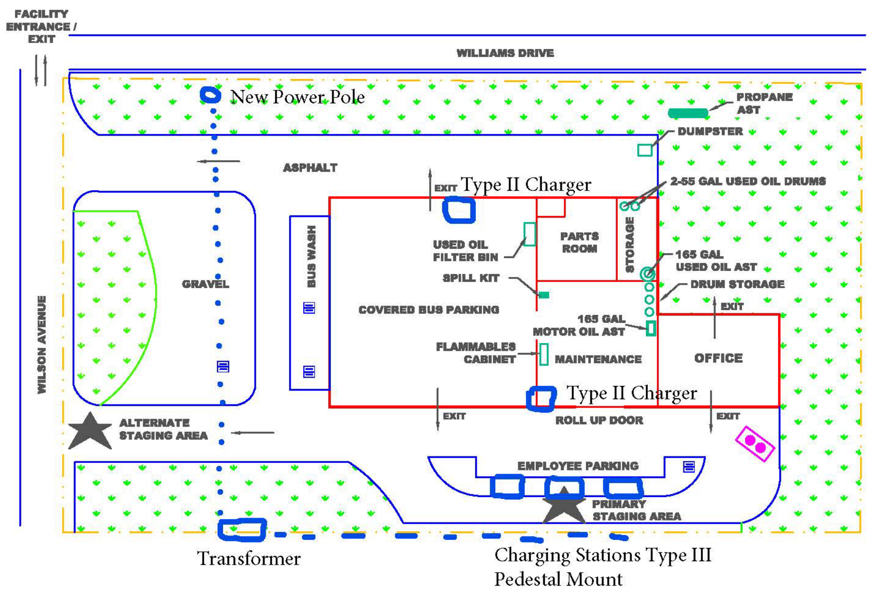


*Figure 33 Proposed Site Map for Electric Bus Charging*

A Level 2 charging station can cost anywhere from $5,000 to $12,000 while a DCFC starts at $50,000. The price points of these charging stations are highly dependent on the ratings and functionality. There are also ongoing service charges that need to be considered for the operations cost analysis. The installation cost for the stations can vary drastically as well, depending on proximity to the power panel, the needs for infrastructure upgrades, installation type (wall mount/pedestal mount) and whether civil/structural work is required. A preliminary engineering design would be the next step to obtain a more accurate estimate for capital costs and budgetary planning.

## 3.3 Infrastructure Upgrade

The maximum battery capacity and energy consumption for each vehicle are based on the results shown in Section 2.4. Hatch LTK's analysis of electrical infrastructure only included depot charging as this would be the most immediate infrastructure improvement required.

The current 144 kW 1-phase service is not adequate to feed the entire electric loads of the EV charging stations suggested in this report. As a result, an electrical infrastructure upgrade with a new 240V three-phase metered service is recommended for the charging infrastructure while the existing electric service continues to serve the existing facility. The required new service capacity can be reduced if the available spare capacity of the existing service can support 1 or 2 charging stations. However, because the existing load data for past one year was not available for the analysis, , HATCH LTK calculated the new service size to support the full EV charging station load.

Table 4 below shows electrical service size requirements for different levels of electrification. As shown, depending on how many EVs are introduced to the operation, the required service capacity increases.

| | Charger rating (kW @ 240V) | Number of EVs in Operation | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| **Route 1 & 3 Morning** | 19.2 | 19.2 | 19.2 | 19.2 | 19.2 | 19.2 | 19.2 |
| **Route 1 & 3 Afternoon** | 19.2 | | 19.2 | 19.2 | 19.2 | 19.2 | 19.2 |
| **Route 2 & 4 Morning** | 19.2 | | | 19.2 | 19.2 | 19.2 | 19.2 |
| **Route 2 & 4 Afternoon** | 19.2 | | | | 19.2 | 19.2 | 19.2 |
| **Route 199** | 19.2 | | | | | 19.2 | 19.2 |
| **Route 20 North leg** | 19.2 | | | | | | 19.2 |
| **Power needed (kW)** | | 19.2 | 38.4 | 57.6 | 76.8 | 96 | 115.2 |
| **Required Service Capacity (kVA)** | | 24 | 48 | 72 | 96 | 120 | 144 |

*Table 3: New Electrical Load Calculation*

Additionally, RCTA also indicated interest in installing DC fast chargers during one of the review calls. To support the above fleet, three 50kW charging cabinets with two dispenser each will be adequate. The chargers will allow sequential charging for the six vehicles overnight. This charging configuration would require a new 188 kVA service at minimum. If RCTA wishes to include spare capacity for future expansion to support up to 10 vehicles, five 50kW charging cabinets with two dispenser each will be required. This changes the new service capacity requirement to 313 kVA at minimum.

Even if RCTA plans to roll out the EVs for the recommended routes in stages over the years, it is recommended that the electrical infrastructure for full electrification be installed under a single project. The cost of adding more capacity in a single construction project is very minimal when compared to cost of incremental upgrades through multiple construction projects.

As mentioned previously, the new electrical service requirement might be reduced if there is enough spare capacity available through existing service to support some charging units. The service can also be reduced by optimizing charging through charge management software. HATCH LTK recommends exploring these options to reduce capital costs in service upgrades.

The location for the new electrical infrastructure must be coordinated with RCTA. A detailed layout power distribution equipment will be influenced by the desired capacity and the existing interior space availability. Based on field pictures and building floor plan drawings, the existing electrical room does not have the space to accommodate new equipment. The electrical infrastructure upgrade will require installation and space for typical equipment, such as:

- Electric meters and current/potential transformer enclosures
- Fused disconnect switches, a main circuit breaker, power distribution switchgears, panelboards
- Cables, conduits, and grounding

The location of the new equipment should be coordinated with Pacific Power. The electrical equipment should be located such that it is close to both the battery charger and the incoming utility feed in order to reduce installation cost. As is the case with charging stations, the installation cost for the upstream electrical equipment installation is also dependent on various factors, including the extent of civil improvements required, trenching and conduit runs, concrete foundations for equipment, parking lot development, etc. A preliminary engineering design would be the next step to obtain a more accurate estimate for capital costs and budgetary planning.

### 3.4 Resiliency Options

Since transit operation will rely on electrical infrastructure with the adoption of electric vehicles, it is highly recommended that there is a contingency plan in place and on-site backup power available during power outages. The power can be stored on-site using battery storage systems or other energy storage methods, or it can be generated through a portable diesel generator. Cleaner generation technology, such as hydrogen fuel cell or compressed natural gas (CNG), can also be explored for this purpose. Further, a higher spare ratio can provide resiliency in the form of fully charged standby vehicles in an event of the primary vehicle being unable to charge for any number of reasons. Additionally, legacy fossil fuel vehicles can also be used for contingency in cases of emergencies. Further analysis is required to determine the best resiliency option for RCTA's needs.

## 4. Zero-Emissions Vehicles Market Assessment

Hatch LTK evaluated zero-emissions vehicles to determine market availability of zero-emissions vehicles consistent with RCTA's services and its current fleet inventory. Our assessment considered medium duty equipment, which is more suitable for regional intercity service, and light duty equipment, which would be more suitable for local fixed route and demand response services.

### 4.1 Regional Intercity Service

| Fleet No. | Year | Chassis Make | Body Make | Fixed Seats | Folding Seats | Wheelchair Positions | Length | Mileage |
|---|---|---|---|---|---|---|---|---|
| 285 | 2010 | GMC 5500 | Glaval | 19 | 6 | 2 | 31' | 274,611 |
| 292 | 2013 | Freightliner | Glaval | 26 | 4 | 2 | 37' | 266,290 |
| 293 | 2013 | Freightliner | Glaval | 26 | 4 | 2 | 37' | 280,841 |
| 294 | 2017 | Ford | Eldorado | 20 | 6 | 2 | 32' | 97,500 |
| 295 | 2017 | Ford | Eldorado | 20 | 6 | 2 | 32' | 25,880 |

| Manufacturer | Range (miles) | Passenger Capacity | Approximate Cost | Source | |
|---|---|---|---|---|---|
| Lightning Systems (Ford E-450) | 80-120 | Up to 27 | $150,000 | Manufacturer's Website |  |
| Lightning Systems (Ford F-550) | 100 | Up to 28 | $250,000 | Manufacturer's Website |  |

| | | | | | |
|---|---|---|---|---|---|
| BYD 30' Transit Bus | 150 | 23 | $600,000 | Manufacturer's Website |  |
| Optimal EV S1 | 125 | 18-23 | $250,000 | Manufacturer's Website |  |
| EV Star | 150 | 20-25 | $80,000 | Manufacturer's Website |  |

## 4.2 Dual CC Local and CC DAR Fleet

| Fleet No. | Year | Chassis Make | Body Make | Fixed Seats | Folding Seats | Wheelchair Positions | Length | Mileage |
|---|---|---|---|---|---|---|---|---|
| 220 | 2017 | Ford | Eldorado | 12 | 4 | 2 | 22' | 21,802 |
| 221 | 2015 | Ford | Eldorado | 18 | 8 | 3 | 24' | 79,810 |
| 286 | 2011 | Ford | Glaval | 14 | 4 | 2 | 25' | 227,535 |
| 288 | 2011 | Ford | Glaval | 10 | 6 | 2 | 22' | 223,086 |

| Manufacturer | Range (miles) | Passenger Capacity | Approximate Cost | Source | |
|---|---|---|---|---|---|
| Lightning Systems LEV60/120 | 60-120 | 12 | $53,000 | Manufacturer's Website |  |
| EV Star | 150 | 20-25 | $80,000 | Manufacturer's Website |  |

## 4.3 CC DAR Fleet

| Fleet No. | Year | Chassis Make | Body Make | Fixed Seats | Folding Seats | Wheelchair Positions | Length | Mileage |
|---|---|---|---|---|---|---|---|---|
| 210 | 2017 | MV-1 | MV-1 | 4 | 0 | 1 | 15' | 21,261 |

| Manufacturer | Range (miles) | Passenger Capacity | Approximate Cost | Source | |
|---|---|---|---|---|---|
| Schetky | 100 | 8 | $70,000 | Manufacturer's Website |  |

## 4.4 Crescent City Local Fixed Route

| Fleet No. | Year | Chassis Make | Body Make | Fixed Seats | Folding Seats | Wheelchair Positions | Length | Mileage |
|---|---|---|---|---|---|---|---|---|
| 230 | 2019 | Ford | Champion | 16 | 4 | 2 | 27' | 3,231 |
| 291 | 2012 | Chev | ARBOC | 17 | 6 | 3 | 26' | 136,663 |
| 2019 | 2019 | Ford | Champion | 16 | 4 | 2 | 27' | 3,260 |

| Manufacturer | Range (miles) | Passenger Capacity | Approximate Cost | Source | |
|---|---|---|---|---|---|
| Optimal EV S1 | 125 | 18-23 | $250,000 | Manufacturer's Website |  |
| Optimal EV | 125 | 18-23 | $450,000 | Manufacturer's Website | |

# 5. Conclusions

Based on the analyses of the regional and intercity routes performed in this report, HATCH LTK has concluded that most of these routes can be served by electric buses while maintaining the current routes, frequency, and service levels. Some modifications to the current operations, however, will be required due to current battery capacity limitations.

- Route 1 & 3, which are currently served by a single vehicle, can be replaced by two electric buses. A single battery-electric vehicle does not provide enough range to cover the entire day of vehicle operation without on-route charging. With two vehicles, one would serve the morning schedule while the other would serve the afternoon schedule.
- Route 2 & 4, which are also currently served by a single vehicle, will need to be served by two electric buses. One would serve the morning schedule while the other would serve the afternoon schedule.
- Route 199 can be transitioned to an electric bus operation without requiring any changes to the operations.
- Route 20 cannot be served by the available electric buses due to its longer travel distances. The operations can be modified, however, such that the North leg (between Cultural Center and Lucky 7 Casino) is served by an electric vehicle while the South leg (between Cultural Center and Arcata) continues to be served by a fossil fuel bus.

The above routes can be served with electric buses without major modification to the routes or schedule. However, there will be impact on the back-end operations, like operator schedule and vehicle assignment. For example, in the case of Route 1 & 3, operators' schedules might require modifications so that shift change coincides with the vehicle change in the new two-vehicle morning /evening operation.

Based on the information that was available to HATCH LTK, the existing electrical capacity on site is deemed to be inadequate for supporting electric fleet operation for the above routes. Hence, additional service will be required for the electric bus operation, as outlined in Section 3.3 of this report. RCTA should communicate the new service requirements with Pacific Power early on and coordinate with them to ensure the electrical service upgrade is planned in conjunction with RCTA's fleet procurement plan.

# 6. Recommendations

Although the regional and intercity routes can be served with electric vehicles without changes to the route schedule, due to the range limitation and charging requirements of the electric buses while operating on the regional and intercity routes, an operational impact analysis needs to be done to study the impact on ridership experience, operator scheduling, and vehicle scheduling.

Additionally, RCTA will need to investigate available options with Pacific Power to fulfill the additional electrical capacity needs from the new electric fleet. Further engagement with the Pacific Power is required to verify current electrical infrastructure. The peak demand data over the past year should also be obtained from Pacific Power in order to evaluate the existing spare electrical capacity at the site. Finally, cost estimates should be obtained from Pacific Power for providing additional 240V 3-phase metered service to the RCTA facility for electric vehicle charging.

This report outlined a simple charging plan that utilizes low-speed Level 2 chargers for each vehicle. The charging and electrical infrastructure can be optimized by implementing charge management tools and more complex charging strategies. HATCH LTK strongly recommends conducting a study to evaluate the charge management options and the financial benefits that could be realized by implementing such options. These benefits could include cost reductions in infrastructure and in ongoing operations cost.

After the operational impact is studied, the necessary information is obtained from Pacific Power, and the charging strategy is developed, the following steps can be completed by RCTA to move ahead with the electric fleet implementation:

1. Establish regular coordination with Pacific Power
2. Assess electrification needs of demand response service
3. Conduct preliminary engineering design for electrical capacity upgrades and charging station installations
4. Develop a fleet transition plan
5. Develop a vehicle procurement plan and schedule
6. Develop an Electric Fleet Operations and Safety Training Plan for staff

# Technical Memorandum

**February 27, 2024**

| | | | |
|---|---|---|---|
| **To** | Joe Rye<br>General Manager<br>Redwood Coast Transit Authority | **Contact No.** | (707) 235-3078 |
| **Copy to** | [Enter text] | **Email** | TMTPConsulting@gmail.com |
| **From** | Frank Penry, PE, TE, PTOE | **Project No.** | 12613489 |
| **Project Name** | RCTA YARD ZEB IMPVT | | |
| **Subject** | Phase 2-Transit Yard Site Evaluation and Bus Bay Parking and Optimization Study | | |

## 1. Project Background and Understanding

Redwood Coast Transit Agency (RCTA) operated by First Transit is planning for an expansion of its transit fleet which will require improvements to be made to the Transit Facility located at 140 Willimas Drive. The transit facility is bordered by CAL Fire City Fire Station to the North, Del Norte County Agricultural Weight and Measures to the East, Suburban Propane & Costal Car Care Center to the West, and Del Norte County Fair Grounds to the South.

RCTA currently has a fleet of 16 revenue transit vehicles. At peak service demands, all 16 vehicles are in service. It is anticipated that an additional of 4 vehicles will be needed to meet growing ridership demand in the near term. This would bring the total anticipated transit fleet size to no less than 20 vehicles to support the increase in ridership demand. The additional 4 vehicles will be 100 percent zero-emission buses (ZEB), with the remainder of the fleet transition to occur in compliance with the Authority's Roll-Out Plan. RCTA determined that the ZEBs will be battery electric bus (BEB) transit vehicles.

To support these goals a variety of key stakeholders including RCTA, TMTP Consulting, Herron Consultants, RCTA Transdev (Frist Transit), and Pacific Power, have been coordinated with to provide for continued fleet operation and maintenance, a new zero emission fleet, renewable energy improvements, electrical vehicle charging, and ancillary facilities at the Williams drive maintenance and operations facility. This site of just 1.23 acres and sits on land leased on the north end of the Del Norte County Fair Grounds. It is understood that under the lease with the Fair Grounds, RCTA has an option for additional land as necessary.

In 2023 RCTA was awarded TIRCP Grant funds thru Resolution 2023-24-08. This funding would provide for three key projects, The first being the electrification of the transit facility yard for to be able to charge electric buses on site, the second being RCTA's Initial purchase of 6 electric buses, and the third being downtown transit center.

# 2. ZEB Fleet and Charging Systems Analysis

Under the initial phase of the RCTA ZEB Improvements Project, Williams Drive Electric Bus Charging Infrastructure Project, a basis of electrical design was prepared. Upon review of this phase 2 memo, the two technical memos will be combined into a final report. Attention is directed to the initial Basis of Design for information regarding the electrical charging infrastructure requirements, analysis, and proposed design. For purposes of layout, two optional electrical and backups equipment locations are shown in the provided alternatives.

For the purposes of evaluating parking and circulation needs, RCTA has selected the Endera Model B Series, CalACT Class ZEB-2 as the new transit buses.

Using the vehicle swept path analysis tool, AutoTurn, it was determined that the vehicle library did not include the Endera Model B Series. Therefore, the custom vehicles were created based on the available vehicle specifications from the vendor. The AutoTurn model used for the analysis can be seen in Figure 1: AutoTurn Vehicle Endera B Series, provided the design parameters noted below.

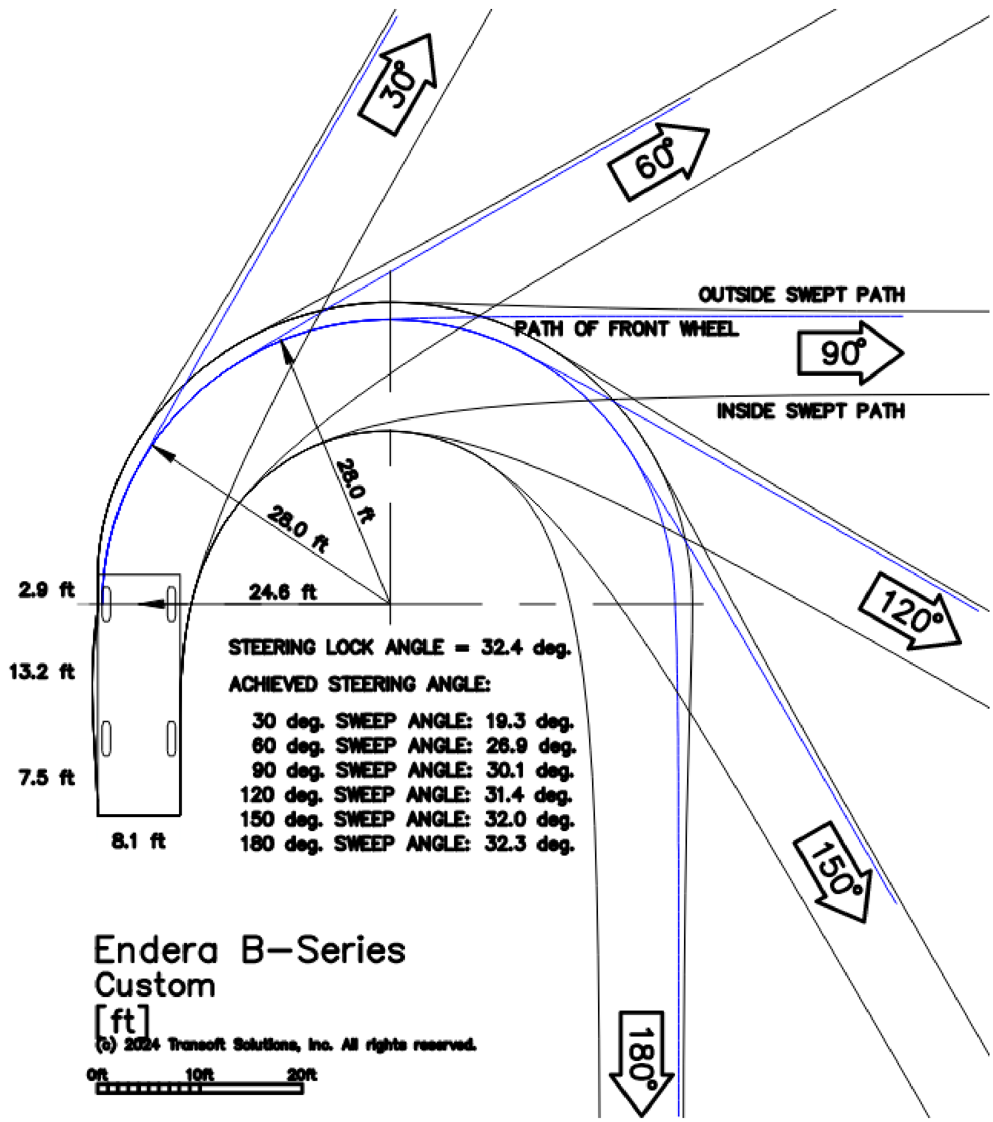


*Figure 1 AutoTurn Vehicle Endera B Series*

# 3. Parking Lot and Solar Layout Analysis

For a conservative evaluation of the site, parking, and circulation, consideration for future solar photovoltaic (PV) arrays were collocated with the charging equipment to provide cover from the elements and facilitate additional power for the facility. It is envisioned that the support structure will be an additional factor in layout of the parking, however basic design parameters taken from similar facilities were used to model layout of the solar PV arrays.

GHD evaluated bus parking options with either saw-tooth bus bay or stacked (first in/ first out) options. The goal being to limit the backing of vehicles (unless necessary) and optimize the available space for parking and circulation.

GHD has collected and reviewed available site and aerial information, studies, and plans within the study area. In addition, GHD has conducted field observations of the site, noting any operational opportunities or constraints. Based on coordination with the project stakeholders, GHD has prepared an analysis regarding the site operations to provide the most efficient circulation.

GHD reviewed vehicle and charging specifications information provided by the ZEB manufacturer, included the operations and fleet management discussions held with First Transit, to determine the operational parameters for vehicle circulation and parking around the site. GHD prepared a swept path analysis using AutoTurn, for review of the circulation and parking maneuvers to understand the benefits for the potential layouts. The primary objective of this exercise was to maximize the number of parked transit buses on the site with suitable circulation for ingress, egress.

## 3.1 Existing Conditions

The current site layout provides parking for 16 transit vehicles South of the administration building, maintenance bays, and bus wash bay along the fence line on a gravel area. There is also a maintenance vehicle and equipment parking area East of the bus wash bay on a gravel area. These existing conditions are show on sheet C-101: Existing Conditions and Constraints of the attached preliminary parking exhibits, with an overlay of limited survey information and an aerial. The exhibit depicts the transit and service vehicles around the site. It can be seen, with the maintenance vehicles parked on the East side of the site, the transit vehicles parked on the south side of the site along the fence line. There is an architectural plan overlay of the administration building, maintenance bays, and bus wash bay.

A review of the site layout contained in RCTA's Electric Fleet Transition Study indicates charging for a maximum of just 11 vehicles, with little room for vehicle maneuvering and employee parking.

## 3.2 Proposed Site Layout A

Proposed Layout Alternative A would expand the proposed site squarely across the private Del Norte County Fairground private driveway, making direct access to the transit facility from the north at the existing gate from Willaims Drive and from the south at a new gate on the private drive leading to the fairgrounds northerly parking lot. The existing easterly fence line and in/outbound gates would be removed to the have access directly to parking from the private driveway along the length of the project site.

The proposed Phase I EV Charging area with 8 dual charges for 16 ZEBs would be collocated with a solar PV array canopy over the charges to the East of the bus wash bay. Roadway widening for access to two potential electrical infrastructure locations on the Northside of the site.

A future phase of chargers may be located under collocated solar PV arrays along the south side of the site. Prior to a future phase, the existing transit fleet, non-revenue, and personal employee vehicles along may use this space, with or without the canopies. Additionally, this area could be provided with passenger car electric chargers for non-revenue and personal vehicles. Proposed Site Layout A is shown on sheet C-102: Site Layout A of the attached preliminary parking exhibits. Sheet C-103: Site Layout A – Endera B-Series Turning Movements shows the ingress and egress to the EV charging area.

## 3.3 Proposed Site Layout B

Layout B is proposed to have similar site fencing and access as Layout A, however with the slight angle of the charging islands, it was envisioned that access and fencing to the site could be accommodated by just moving the south easterly gate and fence line to meet the easterly extents of the site, squarely. Maintaining separate ingress and egress site access from gates off the Del Norte County Fairground private driveway.

The proposed Phase I EV Charging area with 8 dual charges for 16 ZEBs at a diagonal as well as a solar array canopy over the charges to the East of the bus wash bay. Roadway widening for access to two potential electrical infrastructure locations on the Northside of the site. Proposed Phase II charging and surplus bus parking on the South is proposed as noted in Layout A. Proposed Site Layout B is shown on sheet C-104: Site Layout b of the attached preliminary parking exhibits. Sheet C-103: Site Layout b – Endera B-Series Turning Movements shows the ingress and egress to the EV charging area.

# 4. Design Review and Recommendations

Based on the site constraints and circulation requirements of the facility, coupled with the ability to expand the site through lease negotiations with the Del Norte County Fairgrounds, it is expected that Layout B provides the most flexibility to accommodate the needs of the fleet. As provided, with or without the full expansion of the site, east across the private drive, the angled parking allows for a slight swale or green space separating the driveway from the fleet. While the fairgrounds driveway would be expected to have limited use outside the operation of the fair (August), for egress only, the separation provides a measure of security for the fleet given the limited pubic access.

**Accessibility of documents**

*If this Technical Memorandum is required to be accessible in any other format this can be provided by GHD upon request and at an additional cost if necessary.*

*The opinions, conclusions and any recommendations in this memorandum are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.*

*Investigations undertaken in respect of this memorandum are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this memorandum.*

*GHD has prepared this memorandum on the basis of information provided by the Client and others who provided information to GHD (which may also include Government authorities), which GHD has not independently verified or checked for the purpose of this memorandum. GHD does not accept liability in connection with such unverified information, including errors and omissions in the memorandum which were caused by errors or omissions in that information.*

Regards

**Frank Penry**
Senior Traffic Project Manager

# Technical Study

## RCTA Yard ZEB Improvements

Redwood Coast Transit Authority

June 20, 2024

→ **The Power of Commitment**

| Project name | William Drive Electric Bus Charging Infrastructure | | | | | | |
|---|---|---|---|---|---|---|---|
| Document title | Technical Study \| RCTA Yard ZEB Improvements | | | | | | |
| Project number | 12613489 | | | | | | |
| File name | RCTA ZEB Technical Study | | | | | | |
| **Status Code** | **Revision** | **Author** | **Reviewer** | | **Approved for issue** | | |
| | | | **Name** | **Signature** | **Name** | **Signature** | **Date** |
| S0 | 01 | E. Osorno | C.Richards | | C.Richards | | 7/31/2023 |
| S4 | 01 | R. Plaza-Martinez | F. Penry | | F. Penry | | 6/20/24 |
| [Status code] | | | | | | | |
| [Status code] | | | | | | | |


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**The Power of Commitment**

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1. Conceptual Bus Bay Parking and Circulation Plans
2. Conceptual Electrical Plans
3. Generator Cutsheets

# 1. Introduction

## 1.1 Project Background and Understanding

Redwood Coast Transit Agency (RCTA) operated by First Transit is planning for an expansion of its transit fleet which will require improvements that would entail site improvements, electric vehicle charging, a standby power generator, and ancillary facilities. The Transit Facility is, located at 140 Willimas Drive. The transit facility is bordered by CAL Fire City Fire Station to the North, Del Norte County Agricultural Weight and Measures to the East, Suburban Propane & Costal Car Care Center to the West, and Del Norte County Fair Grounds to the South.

RCTA currently has a fleet of 16 revenue transit vehicles. At peak service demands, all 16 vehicles are in service. It is anticipated that an additional of 4 vehicles will be needed to meet growing ridership demand in the near term. This would bring the total anticipated transit fleet size to no less than 20 vehicles to support the increase in ridership demand. The additional 4 vehicles will be 100 percent zero-emission buses (ZEB), with the remainder of the fleet transition to occur in compliance with the Authority’s Roll-Out Plan. RCTA determined that the ZEBs will be battery electric bus (BEB) transit vehicles.

To support these goals a variety of key stakeholders including RCTA, TMTP Consulting, Herron Consultants, RCTA Transdev (Frist Transit), and Pacific Power, have been coordinated with to provide for continued fleet operation and maintenance, a new zero emission fleet, renewable energy improvements, electrical vehicle charging, and ancillary facilities at the Williams drive maintenance and operations facility. This site of just 1.23 acres and sits on land leased on the north end of the Del Norte County Fair Grounds. It is understood that under the lease with the Fair Grounds, RCTA has an option for additional land as necessary.

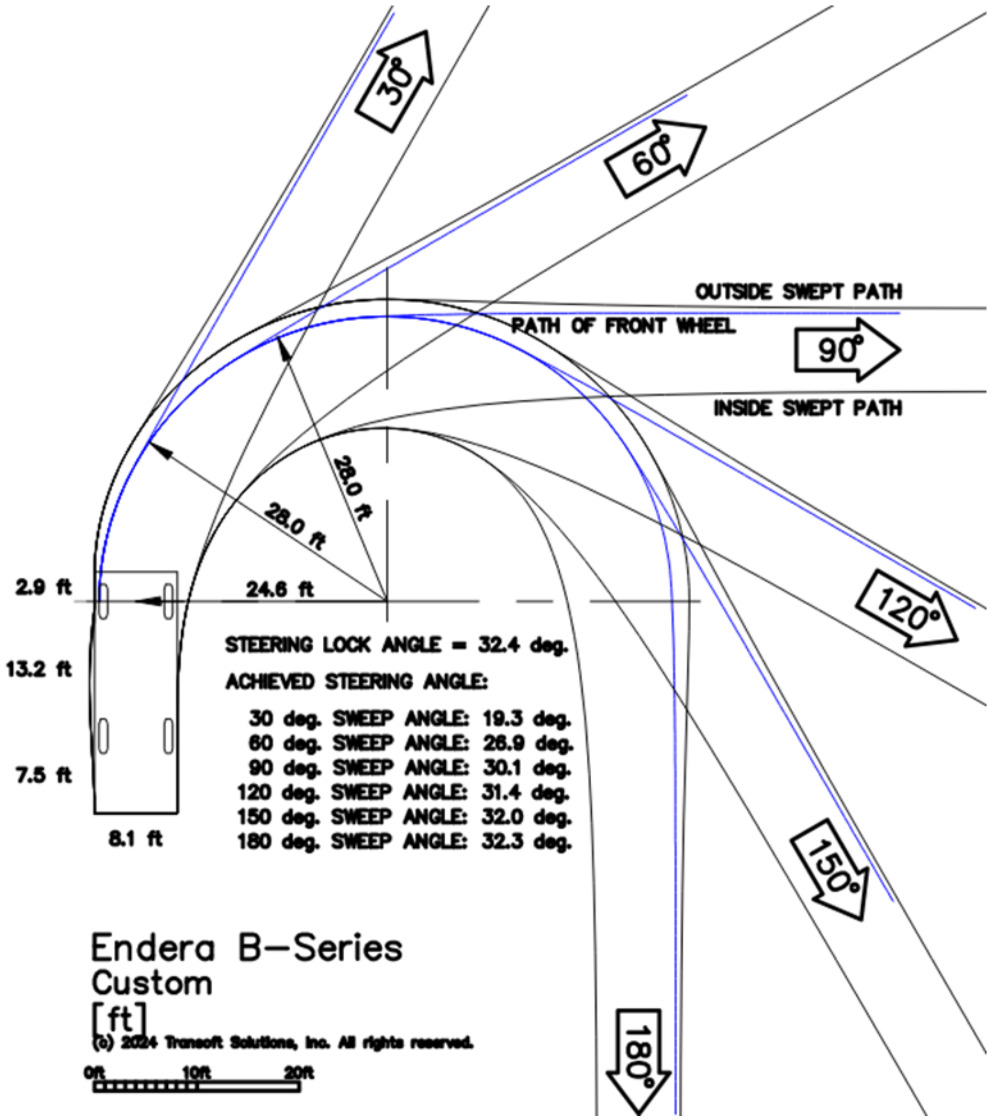
In 2023 RCTA was awarded TIRCP Grant funds thru Resolution 2023-24-08. This funding would provide for three key projects, The first being the electrification of the transit facility yard for to be able to charge electric buses on site, the second being RCTA’s Initial purchase of 6 electric buses, and the third being downtown transit center.

# 2. ZEB Fleet and Charging Systems Analysis

For purposes of layout, two optional electrical and backups equipment locations are shown in the provided alternatives.

For the purposes of evaluating parking and circulation needs, RCTA has selected the Endera Model B Series, CalACT Class ZEB-2 as the new transit buses.

Using the vehicle swept path analysis tool, AutoTurn, it was determined that the vehicle library did not include the Endera Model B Series. Therefore, the custom vehicles were created based on the available vehicle specifications from the vendor. The AutoTurn model used for the analysis can be seen in Figure 1: AutoTurn Vehicle Endera B Series, provided the design parameters noted below.




# 3. Parking Lot and Solar Layout Analysis

For a conservative evaluation of the site, parking, and circulation, consideration for future solar photovoltaic (PV) arrays were collocated on shade canopies with the charging equipment to provide cover from the elements and facilitate additional power for the facility. It is envisioned that the support structure will be an additional factor in layout of the parking, however basic design parameters taken from similar facilities were used to model layout of the solar PV arrays.

GHD evaluated bus parking options with either saw-tooth bus bay or stacked (first in/ first out) options. The goal being to limit the backing of vehicles (unless necessary) and optimize the available space for parking and circulation.

GHD has collected and reviewed available site and aerial information, studies, and plans within the study area. In addition, GHD has conducted field observations of the site, noting any operational opportunities or constraints. Based on coordination with the project stakeholders, GHD has prepared an analysis regarding the site operations to provide the most efficient circulation.

GHD reviewed vehicle and charging specifications information provided by the ZEB manufacturer, included the operations and fleet management discussions held with First Transit, to determine the operational parameters for vehicle circulation and parking around the site. GHD prepared a swept path analysis using AutoTurn, for review of the circulation and parking maneuvers to understand the benefits for the potential layouts. The primary objective of this exercise was to maximize the number of parked transit buses on the site with suitable circulation for ingress, egress.

# 4. Electrical Design Review

## 4.1 Existing Conditions

The current site layout provides parking for 16 transit vehicles South of the administration building, maintenance bays, and bus wash bay along the fence line on a gravel area. There is also a maintenance vehicle and equipment parking area East of the bus wash bay on a gravel area. These existing conditions are shown on sheet C-101: Existing Conditions and Constraints of the attached preliminary parking exhibits, with an overlay of limited survey information and an aerial. The exhibit depicts the transit and service vehicles around the site. It can be seen, with the maintenance vehicles parked on the East side of the site, the transit vehicles parked on the south side of the site along the fence line. There is an architectural plan overlay of the administration building, maintenance bays, and bus wash bay.

A review of the site layout contained in RCTA's Electric Fleet Transition Study indicates charging for a maximum of just 11 vehicles, with little room for vehicle maneuvering and employee parking.

## 4.2 Proposed Site Layout A

Proposed Layout Alternative A would expand the proposed site squarely across the private Del Norte County Fairground private driveway, making direct access to the transit facility from the north at the existing gate from Willaims Drive and from the south at a new gate on the private drive leading to the fairgrounds northerly parking lot. The existing easterly fence line and in/outbound gates would be removed to have access directly to parking from the private driveway along the length of the project site.

The proposed Phase I EV Charging area with 8 dual charges for 16 ZEBs would be collocated with a solar PV array canopy over the charges to the East of the bus wash bay. Roadway widening for access to two potential electrical infrastructure locations on the Northside of the site.

A future phase of chargers may be located under collocated solar PV arrays along the south side of the site. Prior to a future phase, the existing transit fleet, non-revenue, and personal employee vehicles along may use this space, with or without the canopies. Additionally, this area could be provided with passenger car electric chargers for non-revenue and personal vehicles. Proposed Site Layout A is shown on sheet C-102: Site Layout A of the attached preliminary parking exhibits. Sheet C-103: Site Layout A – Endera B-Series Turning Movements shows the ingress and egress to the EV charging area. Sheet C-104: Site Layout A – F-550 Cutaway Turning Movements shows the ingress and egress to the site and parking area. Sheet C-105: Site Layout A – Freightliner Turning Movements shows the ingress and egress to the site and parking area.

## 4.3 Proposed Site Layout B

Layout B is proposed to have similar site fencing and access as Layout A, however with the slight angle of the charging islands, it was envisioned that access and fencing to the site could be accommodated by just moving the south easterly gate and fence line to meet the easterly extents of the site, squarely. Maintaining separate ingress and egress site access from gates off the Del Norte County Fairground private driveway.

The proposed Phase I EV Charging area with 8 dual charges for 16 ZEBs at a diagonal as well as a solar array canopy over the charges to the East of the bus wash bay. Roadway widening for access to two potential electrical infrastructure locations on the Northside of the site. Proposed Phase II charging and surplus bus parking on the South is proposed as noted in Layout A. Proposed Site Layout B is shown on sheet C-106: Site Layout b of the attached preliminary parking exhibits. Sheet C-107: Site Layout b – Endera B-Series Turning Movements shows the ingress and egress to the EV charging area. Sheet C-108: Site Layout A – F-550 Cutaway Turning Movements shows the ingress and egress to the site and parking area. Sheet C-109: Site Layout A – Freightliner Turning Movements shows the ingress and egress to the site and parking area.

## 4.4 Electrical Infrastructure Improvements

### 4.4.1 Electric Bus Charging Infrastructure

A figure showing the proposed options resulting from the analysis is presented in Attachment 2.

#### 4.4.1.1 Preferred Manufacturer

- Green Power Motor-Is the RCTA's preferred manufacturer for the new bus fleet. EV charging station calculations will be based on Green Power Motors EVSTAR+ transit bus. The battery EVSTAR+ is powered by a 118-kWH battery.
- Charge point- RCTA at this time does not have a preferred manufacturer for the EV charging stations, for the purposes of this report Charge Point will be used, as it is an industry standard manufacturer.
- Cummins- RCTA has identified Cummins as the preferred generator manufacturer. The proposed generator data sheet can be found in Attachment 2 of this report.

#### 4.4.1.2 EV Charging Stations

RCTA has expressed that an 8-hour charge with level 2 chargers and 2-hour DC fast charger is desired.

Green Power Motors recommends Clipper Creek chargers by Enphase Energy for EV fleet charging. The largest Clipper Creek level 2 charger is model CS-100 EVSE which can output a maximum of 11-kW of power per station. Currently Enphase does not have a DC fast charger in their line of products.

ChargePoint offers a larger range of level 2 and DC fast chargers. The CP6000 dual level 2 charger can output 19.2-kW of power per charging connection and has a combined capacity of 38.4-kW per station. Charge Point's Express+ Power Link 1000 DC fast charger can output 200-kW using its standard power supply. This can be divided between 2 100-kW charging lines or combined. Additional power supplies can be added to increase this up to 500-kW, but this additional capacity does not appear useful for this project.

GHD recommends ChargePoint vehicle charging system for the City's Zero Emission Bus (ZEB) Rollout Plan. ChargePoint will be used as the basis of design for the ZEB charging infrastructure to evaluate the system electrical loads and provide a conceptual layout of the ZEB charging infrastructure. Each EV charging station will be equipped with dual charging ports to connect and charge two vehicles at the same time.

Features included in ChargePoint EV chargers are:

- Chargers have internal metering capability and are able to measure power and usage parameters to enable reporting of the metrics.
- After loss of power, provided the connector to vehicle has not been removed, the charger can return to its post-configuration state (i.e., persistent communication and registration configurations. This does not include continuing user sessions when authorization is required to start a session).
- Reset option, which returns the device to its pre-charge state.
- Can be equipped with WiFi and/or cellular communications options for remote maintenance and remote reporting.

### 4.4.1.3 Preferred Generator Type

RCTA has indicated that an outdoor fixed generators with sound attenuation enclosures and LPG/Natural gas fuel is preferred at this site.

During the kickoff meeting, RCTA expressed interest in alternate generator fuel types, a brief description of fuel types is included in this report.

#### 4.4.1.3.1 Fuel Type

The most common fuel types in use for industrial or commercial standby power generators are diesel fuel and natural or propane gas. Note that while natural gas and propane are different fuels, most generators that use one can use both (referred to as "spark ignited generators" as opposed to diesel). For generator in the larger range (500-kW and up) a diesel generator should be considered as they are reliable, provide an excellent source of energy and typically have a smaller physical footprint. While spark ignited generators in the 500-1,000-kW exist, there is more limited supply and a smaller number of manufacturers to choose from.

RCTA has noted that natural gas is the preferred fuel type, so this report will be based on the use of spark ignited generators.

#### 4.4.1.3.2 Load Bank

As the generator will often be running at less than full load, and in many cases below half load, if a diesel engine is selected there is a potential for a condition known as "wet stacking". When running at or below 50% loading, the generator may not reach its designed operating temperature. When it operated below its design temperature for extended periods, unburned fuel is passed through the engine to the exhaust system, where it shows up as a visible wetness in or around the exhaust stack, known as "wet stacking". Wet stacking causes build-up in injectors and carbon buildup in the exhaust valves and stack. Significant wet stacking increases pollution and will shorten the life of the generator.

To address this condition, GHD recommends the purchase of a load bank, which is device that provides resistive load when the generator runs below 30% load and can be connected to the generator to ensure that it is loaded sufficiently to achieve its design operating temperature and burn off the carbon buildup.

GHD recommends the purchase of an ASCO/AVTRON pad mounted load bank, which is suitable for operating and testing generators This or an equivalent load bank can be periodically connected to the generator for testing and maintenance runtime, allowing the RCTA to maintain the unit without taking it to a service center. In most cases during an outage no user interaction is required.

While wet stacking is not an issue for spark ignited engines, a load bank for those options serves to allow load testing without transferring the building load and without making or breaking electrical connections. Though it is a lower priority for spark-ignited engines, it is still a recommended accessory.

### 4.4.1.4 Clean Energy Options

Though some cleaner energy options for standby power exist, such as fuel cells and battery backup systems, they are not typically used in remote systems. Fuel cells are reliant on either a natural gas or hydrogen gas fuel source that is less common and less reliably sourced than diesel fuel, further their load profiles and resiliency are not as robust as the profiles for standby generators. Batteries are more appropriate for short run-time applications, or applications associated with modest to large photovoltaic system installations. Though batteries are more frequently being used for reliability in some designs, they are still not generally considered as easy to manage, repair, service, and implement as a standby generator. As such, a spark ignited generator is still the preferred equipment for this application.

In terms of clean operation of a generator, all generators installed in California are required to be equipped with significant and effective emissions control equipment by the California Air Resources Board (CARB). For diesel generators, CARB requires particulate filters and other emissions control devices, and for gas burning engines, selective catalytic reduction is often required except for certain engines that meet the strict NoX requirements. Based on the minimal runtime of standby generators, meeting CARB requirements is generally considered sufficient for effective operation, and additional means are not commonly employed to further reduce emissions from CARB compliant equipment. It is anticipated that all generators considered for this project will meet US EPA Tier 4 requirements for standby operation. While the requirements may be relaxed somewhat for emergency applications, it is our opinion that this generator does not qualify as an “emergency” generator as it is not directly supplying life safety loads. We do not interpret “Mission Critical” and other descriptions of importance to ongoing operations to reach the legal standard of “emergency” for this site.

## 4.4.2 Site Evaluation

### 4.4.2.1 Transit Vehicle Facility

#### 4.4.2.1.1 Existing system

Site evaluation is based Google imagery and 2003 architectural record drawings.  The existing onsite power system consists of a single phase 240/120V service. The power is derived from a pole mounted utility single phase transformer located on William Drive. A cable riser from that pole extends underground to a main switchboard located in an electrical closet that can be accessed on the north side of the building. Interior branch panelboards provide power to interior loads within the building that consist of general lighting and receptacles for conference rooms, dispatch rooms, offices, break rooms, restrooms, storage rooms, a service bay, and three bus bays.

RCTA at this time does not have a backup generator installed at this site but recently purchased a 60-kW Cummins natural gas generator that will be used as a backup source of power for the transit vehicle facility existing building only. This generator will not be integrated into the new EV charging system improvements. The ZEB improvements will be connected to a new separate backup generator system.

#### 4.4.2.1.2 Electrical Load

The electrical loads are tabulated below:

| Load Calculation – Transit Vehicle Facility | | |
|---|---|---|
| **Load Name** | **Qty** | **KW** |
| **ZEB Equipment Loads** | | |
| CP6000 Dual Charger (2x19.2-kW) | 8 (16 Charge positions) | 307 |
| Express Plus Dual Charger (2x100-kW) | 2 (4 Charge Positions) | 400 |
| | **Sub Total** | **707** |
| **Transit Building Existing Loads** | | |
| Interior Lights (Estimate) 1-watt per sqft | 9,000 sqft | 9 |
| Receptacle (Estimate) 2-watt per sqft | 9,000 sqft | 18 |
| AC Equipment (Estimate) | 1 | 5 |
| Misc Loads (Estimate) | 1 | 10 |
| | **Sub Total** | **42** |
| | **Total KW** | **749** |
| | **Total Amps (480 3PH)** | **900 Amps** |

#### 4.4.2.1.3 Utility Power Improvements

Pacific Power is the electric utility company that provides power to this site. GHD is currently coordinating with Pacific Power representatives, and we have requested that the utility infrastructure leading to this site be evaluated for the additional EV charging loads estimated for this project. It is assumed that the existing utility infrastructure can handle the new loads or improvements to the utility infrastructure to meet new load requirements is feasible. Based on the calculated loads a new 480/277V 3-phase 1200-amp service is anticipated. A new pad mounted utility transformer will be required for this new service (assumed to be 1MVA, actual size to be determined by utility company). The new service will provide sufficient power to the existing facility and new ZEB improvements.

#### 4.4.2.1.4 EV Chargers

GHD is proposing to use (2) Express Power Link Dual DC fast charging stations and (8) CP6000 Dual charging stations. The Express Power link has an output power of 200-kW per station (or 100-kW each to 2 busses) and a full charge time for 4 connected EVSTAR+ busses would be approximately 2 hours. The CP6000 charger has an output power of 38.4-kW per station (or 19.2-kW each to 2 busses) and approximate charge time on the EVSTAR+ is 8-9 hours. Charge times are based on the EVSTAR+ 118kwh battery. It's important to note that calculated time for charging is typically accurate for first 70% of the total battery capacity, the last 30% usually takes significantly longer to charge. A 30%-time buffer was added the calculated values and are included in the approximate charge times above. If the busses are typically kept between 20% and 80%, the charge times will be notably faster.

Note that the battery chemistry of the EVSTAR+ busses is based on Lithium Iron Phosphate, which is a newer and improved battery over common lithium ion. These batteries have significantly reduced memory effects and the manufacturer may recommend charging nightly to a full 100%, or at least weekly to allow the charging systems to maintain proper track of battery life and status.

#### 4.4.2.1.5 Generator Size

GHD is proposing two options to provide standby power for the EV charging stations.

Option 1: Provide a 750-kW generator sized to provide standby power to all new EV infrastructure.

Option 2: Provide a 300-kW generator sized to provide power to half the CP6000 chargers. This would allow RCTA to maintain approximately half of the fleet charged during a power outage. More than half could be operated in an emergency if daytime charging was done to cycle busses, but that would require on-site monitoring and shifting busses to chargers as needed.

Option 3: Provide 800A 480V 3PH, 4 Pole MTS and CAM Lock connectors in NEMA 3R enclosure. This would allow RCTA to maintain a third of the fleet (4 CP6000 Dual Chargers) charged during a power outage. Cycling busses during the daytime in an emergency would allow for at least half of them to be operated.

#### 4.4.2.1.6 Proposed Site Modifications and System Description

GHD recommends the following for the installation of a new EV charging infrastructure:

- Provide utility pad mount transformer (coordinate provision responsibilities with the Utility).
- Provide utility pole with riser to new transformer (coordinate provision responsibilities with the Utility).
- Provide NEMA 3R main switchboard “MSB-1” with utility pull section, meter and main circuit breaker section and distribution section with circuit breakers.
- Provide 1600-amp Amp utility power service.
- Provide NEMA 3R 100KVA 480:240/120V single phase transformer with feeder from MSB-1 and intercept existing ATS that’s connected to an existing 60-kW standby generator providing backup power to existing MSB in transit facility.
- Provide NEMA 3R distribution board DP-1 with circuit breakers and feeders to new EV charging infrastructure.
- Provide (2) Express Plus Dual Chargers with 200-kW power block each, total of 4 charging ports with feeders from DP- 1.
- Provide NEMA 3R 300-KVA 480:208/120V pad mount transformer and 208/120V Distribution Panel DP-A with feeders from transformer.
- Provide (10) CP6000 Dual Chargers with 38.4-kW of output power each, total of 20 charging ports with feeders from DP-A and DP-B (5 dual chargers per panel).
- Construct new slab for generator based on current code requirements.
- Provide outdoor spark ignited standby generator in weatherproof sound attenuation enclosure.
    - Provide an 800A 3P MTS with generator cam lock connectors. Connect MTS upstream of DP-1 to provide back up power to all new EV infrastructure except LV-DP-B.
    - Provide 300-kW standby generator and 400A ATS. Connect ATS upstream of T-4 to provide backup power to LV-DP-B.
- Provide 120-volt underground circuit for generator battery charger and block heater.
- Provide underground generator start/stop signal wires to ATS.
- Provide natural gas lines to generator or LPG tank.

A figure showing fixed generator and site improvements can be found in attachment 1 of this report.

# 5. Conclusions

Based on the site constraints and circulation requirements of the facility, coupled with the possible ability to expand the site through lease negotiations with the Del Norte County Fairgrounds, it is expected that Layout B provides the most flexibility to accommodate the needs of the fleet. As provided, with or without the full expansion of the site, east across the private drive, the angled parking allows for a slight swale or green space separating the driveway from the fleet. While the fairgrounds driveway would be expected to have limited use outside the operation of the fair (August), for egress only, the separation provides a measure of security for the fleet given the limited public access

Based on the site evaluation of two yard layout options that included electrical improvements, site improvements, and ZEB Vehicle circulation, the following estimate for components can be seen on Table 1. .

**Table 1: Project Elements**

| **Project** | Cost Estimate Metrics | **Total**<br>**(Per 16 Buses)** | Source |
|---|---|---|---|
| **Infrastructure Planning and Design** | PAED &Final Design –<br>15-25% of Total Construction Value | | |
| **Site Improvements (Paving, Drainage, etc.)** | Design /Construction: $60k per Bus | $1,000,000 | Comparable Estimate |
| **Electrical Infrastructure (Electrical Equipment, Conduits, Concrete Pads)** | Design, Construction, & Equipment: $64k per Bus | $1,050,000 | Comparable Estimate |
| **Solar Photovoltaic Arrays (PV Array& Canopy Structure)** | Equipment & Installation: $800k | $800,000 | Comparable Estimate |
| **Charging Equipment** | Equipment & Installation: $52k per Bus | $850,000 | Comparable Estimate |

Key assumptions:

- PV arrays: 405W/ panel, 20.7 sf/panel, 531 panels, 1.66 kW.
- Charging equipment Eight dual chargers (2x 19.2kW), Two dual express chargers (2x100kW)
- Total number of ZEB 16 with room for and additional 4 equating to a fleet of 20 transit buses.


0 10' 20' 40'

N

## GENERAL NOTES

1. THESE PLANS ARE PRELIMINARY, PROVIDING GENERAL SCOPE OF IMPROVEMENTS, AND ARE PROVIDED FOR EVALUATION OF ALTERNATIVE LAYOUT OF PROPOSED BATTERY ELECTRIC BUS CHARGING INFRASTRUCTURE, FACILITIES AND CIRCULATION ONLY.
2. BUILDING AND SITE LAYOUT IS PROVIDED FROM OVERLAY OF COUNTY OF DEL NORTE TRANSIT FACILITY PLANS, DECEMBER, 2003.
3. UNDERLYING AERIAL IS BASED ON PROVIDED DRONE IMAGERY, NON-RECTIFIED, NOVEMBER, 2023.
4. SITE AND FEATURE CONTOURS PROVIDED BY USGS, JULY, 2023.
5. PRELIMINARY ASSUMPTION ARE NOT BASED ON ANY TERRESTRIAL TOPOGRAPHIC SURVEY, CONTROLS, OR BOUNDARY MAPPING.

## SHEET KEYNOTES

1. (E) UTILITY POLE SERVICE LINES
2. (E) CULVERT
3. (E) PROPANE STORAGE TANK, PROTECT IN PLACE
4. (E) FENCE, PROTECT IN PLACE
5. (E) MAINTENANCE VEHICLE EQUIPMENT LAYOUT AND PARKING AREA.
6. (E) TRANSIT VEHICLE PARKING AREA.
7. (E) DEL NORTE COUNTY FAIRGROUNDS NORTH PARKING FIELD.
8. (E) DEL NORTE COUNTY COUNTY FAIRGROUNDS ACCESS ROADWAY.
9. (E) ACCESS GATE
10. PROPOSED FENCE
11. PROPOSED CANOPY (SOLAR ARRAY)
12. PROPOSED EV CHARGERS
13. PROPOSED EMPLOYEE PARKING AREA.
14. PROPOSED PHASE I EV CHARGING
15. PROPOSED PHASE II SURPLUS BUS PARKING
16. PROPOSED PAVEMENT WIDENING FOR ACCESS AND CIRCULATION
17. PROPOSED EV CHARGING INFRASTRUCTURE LAYOUT OPTION 1
18. PROPOSED PAVEMENT WIDENING FOR ACCESS OPTION 2
19. PROPOSED EV CHARGING INFRASTRUCTURE LAYOUT OPTION 2
20. PROPOSED POINT OF SERVICE

## LEGEND

- PROPOSED PAVEMENT
- PROPOSED CONCRETE
- PROPOSED CANOPY (SOLAR ARRAY)
- PROPOSED FENCE
- EXISTING FENCE
- PRESUMED EXISTING FLOW LINES
- PRESUMED EXISTING SITE DRAINAGE

## 35% - NOT FOR CONSTRUCTION

| No. | Issue | Checked | Approved | Date |
|---|---|---|---|---|
| | | | | |

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Designer R. PLAZA — Design Check — Project Director K. VEDULA

Bar is one inch on original size sheet
0 1"


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Client: REDWOOD COAST TRANSIT AUTHORITY
Project: WILLIAMS DRIVE ELECTRIC BUS CHARGING INFRASTRUCTURE

Title: EXISTING CONDITIONS AND CONSTRAINTS

Size: ANSI D

Project No. 12613489 — Date 2024-06-20 — Scale 1" = 20'

Sheet No. C-101 — Sheet 1 of 9

Plot Date: 20 June 2024 - 11:00 AM — Plotted By: Ramon Plaza-Martinez — Filename: N:\US\Santa Rosa\Projects\561\12613489\Tech\06 - Digital_Design\ACAD 2022\Sheets\12613489_C101.dwg


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## LEGEND

- PROPOSED PAVEMENT
- PROPOSED CONCRETE
- PROPOSED CANOPY (SOLAR ARRAY)
- PROPOSED FENCE
- EXISTING FENCE
- PRESUMED EXISTING FLOW LINES
- PRESUMED EXISTING SITE DRAINAGE

0 10' 20' 40'

N

**35% - NOT FOR CONSTRUCTION**

| No. | Issue | Checked | Approved | Date |
|---|---|---|---|---|
| | | | | |

Author R. PLAZA | Drafting Check F. PENRY | Project Manager F. PENRY
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Bar is one inch on original size sheet
0 1"

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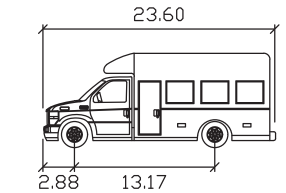
Client REDWOOD COAST TRANSIT AUTHORITY
Project WILLIAMS DRIVE ELECTRIC BUS CHARGING INFRASTRUCTURE

Title SITE LAYOUT A

Size ANSI D

| Project No. | Date | Scale |
|---|---|---|
| 12613489 | 2024-06-20 | 1" = 20' |

Sheet No. C-102
Sheet 2 of 9


Endera B-Series

feet

Width : 8.08
Track : 7.20
Lock to Lock Time 6.0
Steering Angle : 32.4

0 10' 20' 40'

N

**35% - NOT FOR CONSTRUCTION**

| No. | Issue | Checked | Approved | Date |
|---|---|---|---|---|
| | | | | |

Author R. PLAZA — Drafting Check F. PENRY — Project Manager F. PENRY

Designer R. PLAZA — Design Check — Project Director K. VEDULA

Bar is one inch on original size sheet

0 1"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Client **REDWOOD COAST TRANSIT AUTHORITY**

Project **WILLIAMS DRIVE ELECTRIC BUS CHARGING INFRASTRUCTURE**

Title **SITE LAYOUT A - ENDERA B-SERIES TURNING MOVEMENTS**

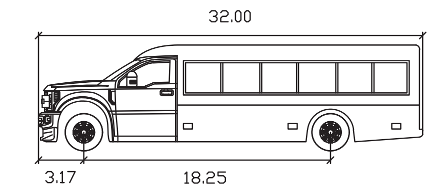
Size **ANSI D**

| Project No. | Date | Scale |
|---|---|---|
| 12613489 | 2024-06-20 | 1" = 20' |

Sheet No. C-103

Sheet 3 of 9

Plot Date: 20 June 2024 - 11:01 AM Plotted By: Ramon Plaza-Martinez Filename: N:\US\Santa Rosa\Projects\561\12613489\Tech\06 - Digital_Design\ACAD 2022\Sheets\12613489_C101.dwg


0 10' 20' 40'

N

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0 1"

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|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Author | R. PLAZA | Drafting Check | F. PENRY | Project Manager | F. PENRY |
| Designer | R. PLAZA | Design Check | | Project Director | K. VEDULA |


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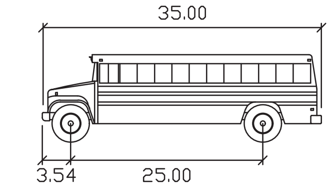
Title **SITE LAYOUT A - F-550 CUTAWAY TURNING MOVEMENTS**

Size **ANSI D**

| Project No. | Date | Scale | Sheet No. | Sheet |
|---|---|---|---|---|
| 12613489 | 2024-06-20 | 1" = 20' | C-104 | 4 of 9 |

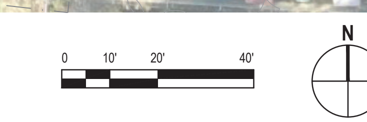
Plot Date: 20 June 2024 - 11:01 AM    Plotted By: Ramon Plaza-Martinez    Filename: N:\US\Santa Rosa\Projects\561\12613489\Tech\06 - Digital_Design\ACAD 2022\Sheets\12613489_C101.dwg


StarTrans Frieghtliner

feet

Width : 8.01
Track : 8.01
Lock to Lock Time : 6.0
Steering Angle : 37.6

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Project **WILLIAMS DRIVE ELECTRIC BUS CHARGING INFRASTRUCTURE**

| Project No. | Date | Scale |
|---|---|---|
| **12613489** | **2024-06-20** | **1" = 20'** |

Title **SITE LAYOUT A - FREIGHTLINER TURNING MOVEMENTS**

Size **ANSI D**

Sheet No. **C-105**
Sheet 5 of 9

Plot Date: 20 June 2024 - 11:01 AM Plotted By: Ramon Plaza-Martinez Filename: N:\US\Santa Rosa\Projects\561\12613489\Tech\06 - Digital_Design\ACAD 2022\Sheets\12613489_C101.dwg


## GENERAL NOTES

1. THESE PLANS ARE PRELIMINARY, PROVIDING GENERAL SCOPE OF IMPROVEMENTS, AND ARE PROVIDED FOR EVALUATION OF ALTERNATIVE LAYOUT OF PROPOSED BATTERY ELECTRIC BUS CHARGING INFRASTRUCTURE, FACILITIES AND CIRCULATION ONLY.
2. BUILDING AND SITE LAYOUT IS PROVIDED FROM OVERLAY OF COUNTY OF DEL NORTE TRANSIT FACILITY PLANS, DECEMBER, 2003.
3. UNDERLYING AERIAL IS BASED ON PROVIDED DRONE IMAGERY, NON-RECTIFIED, NOVEMBER, 2023.
4. SITE AND FEATURE CONTOURS PROVIDED BY USGS, JULY, 2023.
5. PRELIMINARY ASSUMPTION ARE NOT BASED ON ANY TERRESTRIAL TOPOGRAPHIC SURVEY, CONTROLS, OR BOUNDARY MAPPING.

## SHEET KEYNOTES

1. (E) UTILITY POLE SERVICE LINES
2. (E) CULVERT
3. (E) PROPANE STORAGE TANK, PROTECT IN PLACE
4. (E) FENCE, PROTECT IN PLACE
5. (E) MAINTENANCE VEHICLE EQUIPMENT LAYOUT AND PARKING AREA.
6. (E) TRANSIT VEHICLE PARKING AREA.
7. (E) DEL NORTE COUNTY FAIRGROUNDS NORTH PARKING FIELD.
8. (E) DEL NORTE COUNTY COUNTY FAIRGROUNDS ACCESS ROADWAY.
9. (E) ACCESS GATE
10. PROPOSED FENCE
11. PROPOSED CANOPY (SOLAR ARRAY)
12. PROPOSED EV CHARGERS
13. PROPOSED EMPLOYEE PARKING AREA.
14. PROPOSED PHASE I EV CHARGING
15. PROPOSED PHASE II SURPLUS BUS PARKING
16. PROPOSED PAVEMENT WIDENING FOR ACCESS AND CIRCULATION
17. PROPOSED EV CHARGING INFRASTRUCTURE LAYOUT OPTION 1
18. PROPOSED PAVEMENT WIDENING FOR ACCESS OPTION 2
19. PROPOSED EV CHARGING INFRASTRUCTURE LAYOUT OPTION 2
20. PROPOSED POINT OF SERVICE

## LEGEND

- PROPOSED PAVEMENT
- PROPOSED CONCRETE
- PROPOSED CANOPY (SOLAR ARRAY)
- PROPOSED FENCE
- EXISTING FENCE
- PRESUMED EXISTING FLOW LINES
- PRESUMED EXISTING SITE DRAINAGE

0 10' 20' 40'

N

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Designer R. PLAZA Design Check Project Director K. VEDULA

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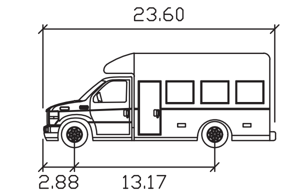
Project No. 12613489 | Date 2024-06-20 | Scale 1" = 20'

Title SITE LAYOUT B

Size ANSI D

Sheet No. C-106 | Sheet 6 of 9

Plot Date: 20 June 2024 - 11:01 AM Plotted By: Ramon Plaza-Martinez Filename: N:\US\Santa Rosa\Projects\561\12613489\Tech\06 - Digital_Design\ACAD 2022\Sheets\12613489_C101.dwg


Endera B-Series

feet

| | |
|---|---|
| Width | : 8.08 |
| Track | : 7.20 |
| Lock to Lock Time | 6.0 |
| Steering Angle | : 32.4 |

0 10' 20' 40'

N

**35% - NOT FOR CONSTRUCTION**

| No. | Issue | Checked | Approved | Date |
|---|---|---|---|---|

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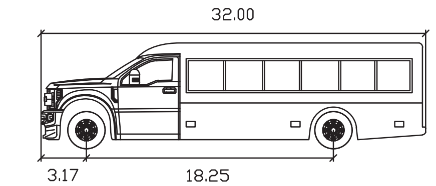
Title **SITE LAYOUT B - ENDERA B-SERIES TURNING MOVEMENTS**

Size ANSI D

Project No. 12613489 | Date 2024-06-20 | Scale 1" = 20'

Sheet No. C-107 | Sheet 7 of 9

Plot Date: 20 June 2024 - 11:02 AM Plotted By: Ramon Plaza-Martinez Filename: N:\US\Santa Rosa\Projects\561\12613489\Tech\06 - Digital_Design\ACAD 2022\Sheets\12613489_C101.dwg


F-550 Cutaway

| | feet |
|---|---|
| Width | : 8.00 |
| Track | : 7.22 |
| Lock to Lock Time | : 6.0 |
| Steering Angle | : 33.5 |

0 10' 20' 40'

N

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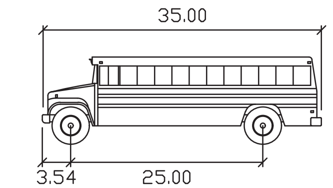
Project No. 12613489 | Date 2024-06-20 | Scale 1" = 20'

Title **SITE LAYOUT B - F-550 CUTAWAY TURNING MOVEMENTS**

Size ANSI D

Sheet No. C-108 | Sheet 8 of 9

Plot Date: 20 June 2024 - 11:02 AM | Plotted By: Ramon Plaza-Martinez | Filename: N:\US\Santa Rosa\Projects\561\12613489\Tech\06 - Digital_Design\ACAD 2022\Sheets\12613489_C101.dwg


StarTrans Frieghtliner
feet

| | | |
|---|---|---|
| Width | : | 8.01 |
| Track | : | 8.01 |
| Lock to Lock Time | : | 6.0 |
| Steering Angle | : | 37.6 |

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| | | | | |

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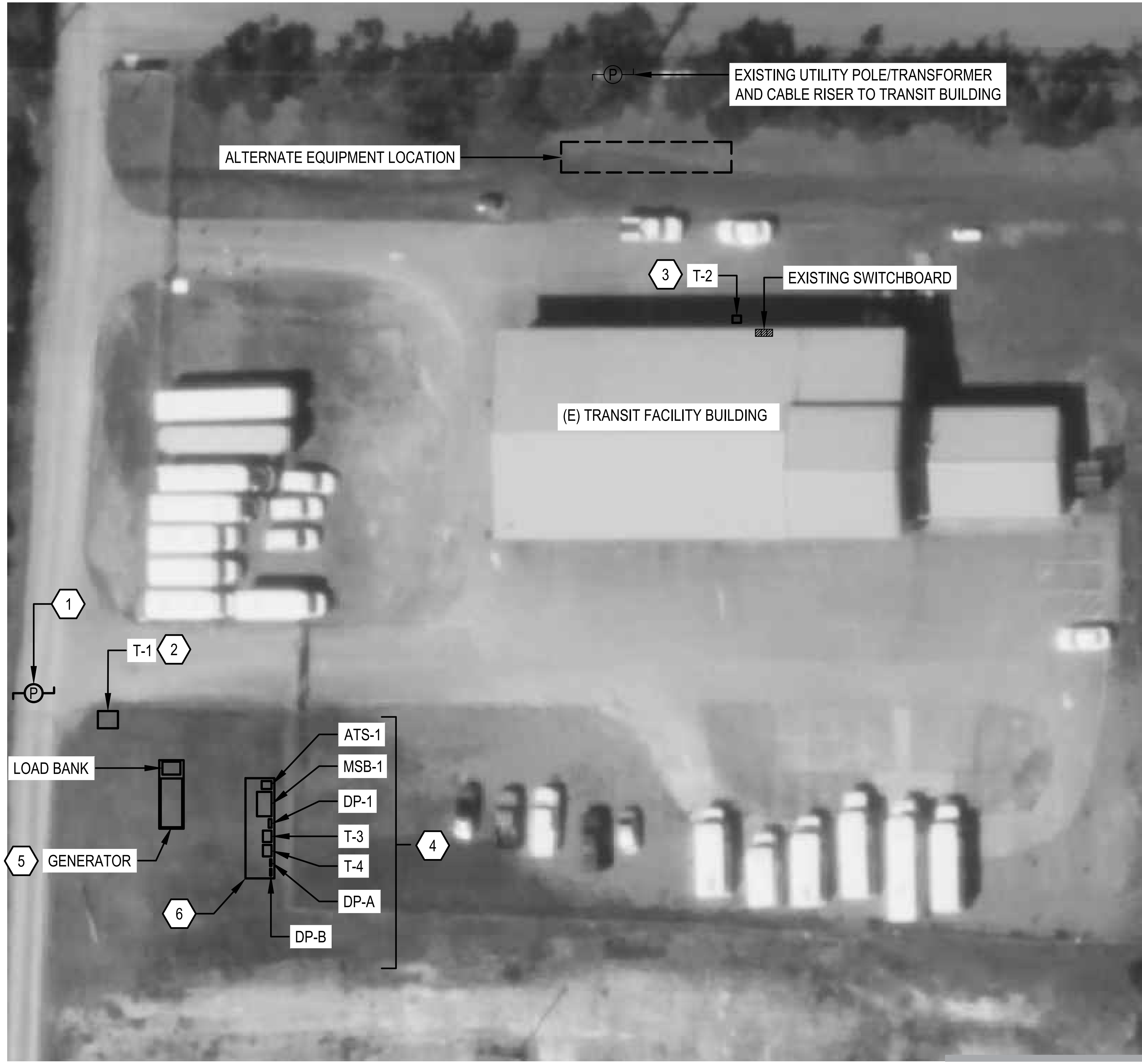
Project **WILLIAMS DRIVE ELECTRIC BUS CHARGING INFRASTRUCTURE**

Title **SITE LAYOUT B - FREIGHTLINER TURNING MOVEMENTS**

Size ANSI D

| Project No. | Date | Scale | Sheet No. | Sheet |
|---|---|---|---|---|
| 12613489 | 2024-06-20 | 1" = 20' | C-109 | 9 of 9 |

Plot Date: 20 June 2024 - 11:02 AM Plotted By: Ramon Plaza-Martinez Filename: N:\US\Santa Rosa\Projects\561\12613489\Tech\06 - Digital_Design\ACAD 2022\Sheets\12613489_C101.dwg




## SHEET GENERAL NOTES

1. PROVIDE (2) CHARGEPOINT DUAL EXPRESS PLUS CHARGERS WITH 200-kW POWER BLOCK EACH AND FEEDERS FROM DP-1. LOCATION OF CHARGERS TBD.
2. PROVIDE (8) CHARGEPOINT CP6000 CHARGERS AND FEEDERS FROM DP-A AND DP-B. LOCATION OF CHARGERS TBD.

## SHEET KEYNOTES

1. PROVIDE UTILITY POWER POLE WITH RISER. LOCATION OF POWER POLE TBD BY UTILITY COMPANY.
2. PROVIDE TRANSFORMER PAD AND SUBSTRUCTURES FOR NEW POWER SERVICE. TRANSFORMER BY UTILITY. COORDINATE EXACT LOCATION WITH UTILITY.
3. PROVIDE TRANSFORMER. INTERCEPT (E) BUILDING FEEDER AND RECONNECT BUILDING TO NEW SERVICE EQUIPMENT.
4. PROVIDE OUTDOOR FREESTANDING NEMA 3R ELECTRICAL POWER INFRASTRUCTURE, COMPLETE WITH INTERCONNECTIONS AND MOUNTING AS REQUIRED. SEE SINGLE LINE DIAGRAM FOR EQUIPMENT TYPES AND SIZES.
5. PROVIDE SPARK IGNITED GENERATOR, 50% RATED PAD MOUNT LOAD BANK, AND CONCRETE PAD .SEE SINGLE LINE DIAGRAM FOR ALTERNATE OPTIONS.
6. PROVIDE CONCRETE EQUIPMENT PAD.

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**ENGINEERING SERVICES WILLIAMS DRIVE**
**ELECTRIC BUS CHARGING INFRASTRUCTURE**

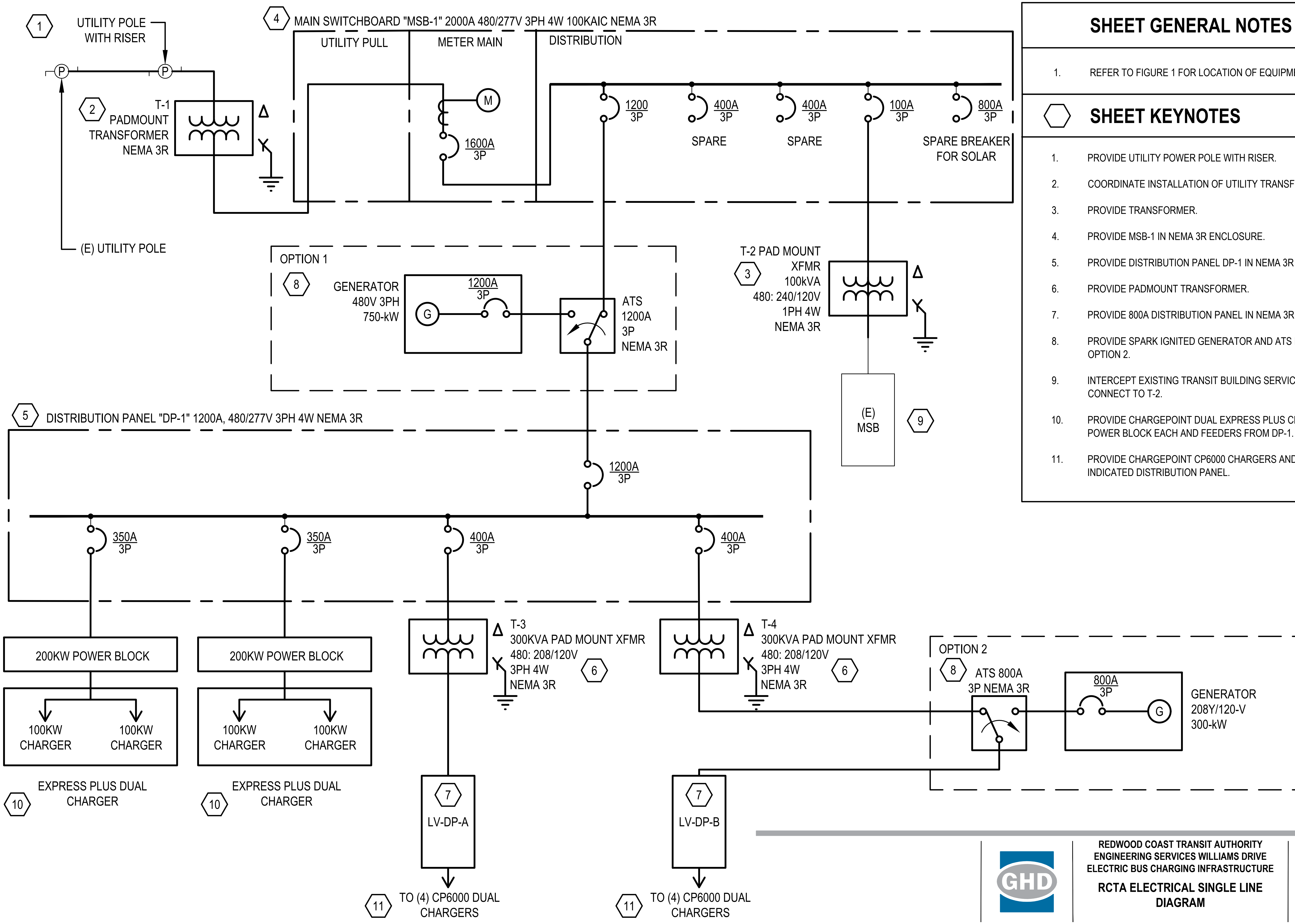
**RCTA ELECTRICAL SITE PLAN**

Project No. **12613489**
Report No.
Date **JULY 2023**

**FIGURE 1**

Filename: \\ghdnet\ghd\US\Santa Rosa\Projects\561\12613489\Tech\12 - Electrical\Figures\FIGURE 1.dwg
Plot Date: 1 August 2023 - 9:37 AM

Source:




## SHEET GENERAL NOTES

1. REFER TO FIGURE 1 FOR LOCATION OF EQUIPMENT.

## SHEET KEYNOTES

1. PROVIDE UTILITY POWER POLE WITH RISER.
2. COORDINATE INSTALLATION OF UTILITY TRANSFORMER, SEE SITE PLANS
3. PROVIDE TRANSFORMER.
4. PROVIDE MSB-1 IN NEMA 3R ENCLOSURE.
5. PROVIDE DISTRIBUTION PANEL DP-1 IN NEMA 3R ENCLOSURE.
6. PROVIDE PADMOUNT TRANSFORMER.
7. PROVIDE 800A DISTRIBUTION PANEL IN NEMA 3R ENCLOSURE.
8. PROVIDE SPARK IGNITED GENERATOR AND ATS FOR OPTION 1 OR OPTION 2.
9. INTERCEPT EXISTING TRANSIT BUILDING SERVICE FEEDER AND CONNECT TO T-2.
10. PROVIDE CHARGEPOINT DUAL EXPRESS PLUS CHARGERS WITH 200-kW POWER BLOCK EACH AND FEEDERS FROM DP-1.
11. PROVIDE CHARGEPOINT CP6000 CHARGERS AND FEEDERS FROM INDICATED DISTRIBUTION PANEL.

**REDWOOD COAST TRANSIT AUTHORITY**
**ENGINEERING SERVICES WILLIAMS DRIVE**
**ELECTRIC BUS CHARGING INFRASTRUCTURE**

**RCTA ELECTRICAL SINGLE LINE DIAGRAM**

Project No. **12613489**
Report No.
Date **JULY 2023**

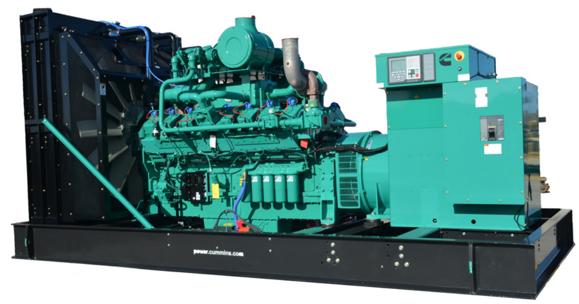
**FIGURE 2**

Filename: \\ghdnet\ghd\US\Santa Rosa\Projects\561\12613489\Tech\12 - Electrical\Figures\FIGURE 2.dwg
Plot Date: 1 August 2023 - 9:37 AM
Source:

Specification sheet

# Gaseous fuel generator set

## GTA 50E engine series
600 kW - 750 kW 60 Hz



## Description
The Cummins GTA 50E engine series commercial generator set (GenSet) boasts an EPA-certified fully-integrated power generation system providing optimum performance, reliability and versatility for stationary non-emergency standby power applications.

## Features
- Cummins engine - cutting-edge diesel technology since 1919
- Cost-saving EPA-certified GenSet - no site emissions testing
- Designed, tested and certified to UL 2200 standards (See Fuel installation requirements on page 4)
- Stamford rugged and reliable alternator with state-of-the-art technology
- One-year warranty supported by a worldwide Cummins twenty-four hour, seven days-a-week, distributor network
- Accepts 100% rated load in a single step
- Surge rating - 110% of nameplate
- The GenSet accepts full rated load in a single step in accordance with NFPA 110 Type 10 (ten seconds) for Level 1 and Level 2 Emergency or Standby Power Supply Systems (EPSSs)
- Standard Power Command Control (PCC) 3300 technology provides digital (precise) frequency and voltage regulation
- Efficient and localized operation monitoring and control options:
  - Modbus over the Internet (monitor and control)
  - Remote HMI (monitor and control)
  - Field server reliable interface to a building management system Supervisory Control and Data Acquisition (SCADA) (monitor, only)

| Model | Standby power rating* 60 Hz kW (kVa) | Emissions compliance | Engine data sheet |
|---|---|---|---|
| C600N6 | 600 (750) | EPA SI Stationary Non-Emergency Certified | FR 60378 |
| C650N6 | 650 (813) | | |
| C750N6 | 750 (937) | | |

* Tested at 0.8 power factor (PF) per NFPA 110.

## GenSet specifications

| | |
|---|---|
| Voltage regulation, no load to full load | ±1% |
| Random voltage variation | ±1% (three-phase only) |
| Frequency regulation | Isochronous |
| Random frequency variation | ±0.5% |

## Engine specifications

| | |
|---|---|
| Base Engine | Cummins Model GTA50E |
| Displacement | 50.3 L (3069 $in^3$) |
| Regenerative Power | TBD |
| Cylinder Block Configuration | Cast iron with replaceable wet cylinder liners |
| Cranking Current | 1800 CCA at ambient temperature of 0 °C (32 °F) |
| Battery Charging Alternator | 43 amps |
| Battery Type | 8D (x4) |
| Starting Voltage | 24-volt, negative ground |
| Standard Cooling System | See derates on Engine Data Sheet |
| Lube Oil Filter Types | Four spin-on canisters-combination full flow with bypass |

## Alternator specifications

| | |
|---|---|
| Design | Brushless, 4-pole, drip-proof revolving field |
| Stator | 2/3 pitch |
| Rotor | Direct-coupled by flexible disc |
| Insulation System | Class H per NEMA MG1-1.65 or better |
| Standard Temperature Rise* | 125 °C |
| Exciter Type | Permanent Magnet Generator (PMG) |
| Phase Rotation | A (U), B (V), C (W) |
| Alternator Cooling | Direct-drive centrifugal blower |

* For UL 1004 ratings, refer to temperature rise at 120 °C or below, and ambient temperature up to 40 °C

## Full-load amperage (FLA) at rated voltage

| Model | Rating | Voltage* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 120/240 (1 Ph) | 120/208 | 127/220 | 139/240 | 220/380 | 240/416 | 254/440 | 277/480 | 347/600 |
| C600N6 | Standby | N/A | 2082 | 1968 | 1804 | 1140 | 1041 | 984 | 902 | 722 |
| C650N6 | Standby | N/A | 2255 | 2132 | 1955 | 1235 | 1128 | 1066 | 977 | 782 |
| C750N6 | Standby | N/A | 2602 | 2460 | 2255 | 1424 | 1301 | 1230 | 1128 | 902 |

*Three-phase FLA based on 0.8 power factor (PF).

## Rated load fuel consumption in standard cubic feet per hour (CFH)*

| Model | Rating | Fuel type | 100% Load | 75% Load | 50% Load | 25% Load |
|---|---|---|---|---|---|---|
| C600N6 | Standby | NG | 9557 | 7226 | 5424 | 3358 |
| C650N6 | Standby | NG | 10221 | 7707 | 5359 | 3591 |
| C750N6 | Standby | NG | 11401 | 8724 | 6081 | 3872 |

*See Fuel installation requirements on page 4.

NOTE: Fuel inlet pressure, measured at the fuel shut off valve while under full load, must be 356 to 508 mm WC (14 to 20 in. WC). Fuel supply pressure must not exceed 635 mm WC (25 in. WC) under any conditions.

## PowerCommand 3.3 control system

An integrated microprocessor based generator set control system providing voltage regulation, engine protection, alternator protection, operator interface and isochronous governing. Refer to document S-1570 for more detailed information on the control.

**AmpSentry -** Includes integral AmpSentry protection, which provides a full range of alternator protection functions that are matched to the alternator provided.

**Power management -** Control function provides battery monitoring and testing features and smart starting control system.

**Advanced control methodology -**Three-phase sensing, full wave rectified voltage regulation, with a PWM output for stable operation with all load types.

**Communications interface -** Control comes standard with PCCNet and Modbus interface.

**Regulation compliant -** Prototype tested: UL, CSA and CE compliant.

**Service -** InPower PC-based service tool available for detailed diagnostics, setup, data logging and fault simulation.

**Easily upgradeable -** PowerCommand controls are designed with common control interfaces.

**Reliable design -** The control system is designed for reliable operation in harsh environment.

**Multi-language support** - English, Spanish, French (standard); other languages (optional).

## Operator panel features

**Operator/display panel**

- Displays paralleling breaker status.
- 320 x 240 pixels graphic LED backlight LCD.
- Provides direct control of the paralleling breaker.
- Alphanumeric display with pushbuttons.
- Auto, manual, start, stop, fault reset, and lamp test/panel lamp switches.
- LED lamps indicating GenSet running, remote start, not in auto, common shutdown, common warning, manual run mode, auto mode and stop.

**Paralleling control functions**

- First Start Sensor System selects first genset to close to bus.
- Phase Lock Loop Synchronizer with voltage matching.
- Sync check relay.
- Isochronous kW and kVar load sharing.
- Load govern control for utility paralleling.
- Extended Paralleling (baseload/peak shave) Mode.
- Digital power transfer control, for use with a breaker pair to provide open transition, closed transition, ramping closed transition, peaking and base load functions.

**Other control features**

- 150 watt anti-condensation heater.
- DC distribution panel.
- AC auxiliary distribution panel.

**Alternator data**

- Line-to-neutral and line-to-line AC volts.
- Three-phase AC current.
- Frequency.
- kW, kVar, and power factor kVa (three-phase and total).
- Winding temperature (optional).
- Bearing temperature (optional).

**Engine data**

- DC voltage and engine speed.
- Lube oil pressure and temperature.
- Coolant temperature.
- Comprehensive FAE data.

**Other display data**

- GenSet model data.
- Start attempts, starts, running hours, kW hours.
- Load profile (operating hours at % load in 5% increments).
- Fault history – up to 32 events.
- Data logging and fault simulation (requires InPower™).
- Air cleaner restriction indication.
- Exhaust temperature in each cylinder.

## Standard control functions

**Digital governing**

- Temperature dynamic governing.
- Integrated digital electronic isochronous governing.

**Digital voltage regulation**

- Configurable torque matching.
- 3-phase, 4 wire line-to-line sensing.
- Integrated digital electronic voltage regulator.

**AmpSentry AC protection**

- AmpSentry protective relay.
- Over current and short circuit shutdown.
- Over current warning.
- Single and three-phase fault regulation.
- Low oil pressure warning and shutdown.
- High coolant temperature warning and shutdown.
- Low coolant level warning and shutdown.
- Low coolant temperature warning.
- Over and under voltage shutdown.
- Over and under frequency shutdown.
- Overload warning with alarm contact.
- Reverse power and reverse var shutdown.
- Field overload shutdown.
- Fuel-in-rupture-basin warning or shutdown.
- Full authority electronic engine protection.
- AMM arc flash provision

**Engine protection**

- Cranking lockout; overspeed shutdown; and battleshort.
- Sensor failure indication.
- Low fuel level warning or shutdown.
- Fail to start (overcrank) and fail to crank shutdown.
- Full authority electronic engine protection.
- Battery voltage monitoring, protection, and testing.

**Control functions**

- Data logging and cycle cranking.
- Load shed.
- Remote emergency stop.
- Time delay start and cooldown.
- Configurable inputs and outputs (20).
- Real time clock for fault and event time stamping.
- Exerciser clock and time of day start/stop.

## GenSet options and accessories

NOTE: This GenSet may be purchased as a standard unit, a UL-listed unit, and/or a CSA-certified unit.

**Engine**

- 240/480 V, 4000 W coolant heaters (2)
- 240 V, 300 W lube oil heater

**Alternator**

- 80 °C rise
- 105 °C rise

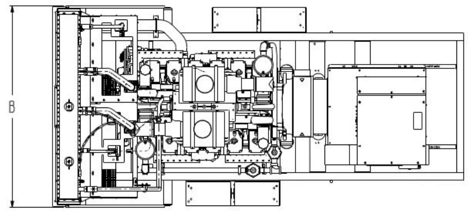
**Fuel System** (See Fuel Installation Requirements on this page.)

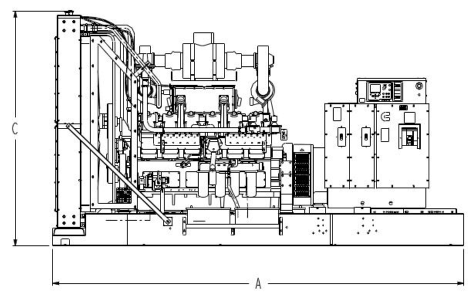
- Flexible fuel connector and fuel strainer
- UL-listed gas train
- Engineered for CSA site compliance

**Exhaust System** - GenSet mounted muffler (enclosure models, only)

**Generator Set**

- Batteries and battery charger
- Main line circuit breaker
- PowerCommand Network Aux 101, 102 module
- Modbus to BACnet module
- Weather protective enclosure (F001) with silencer
- Level I and Level II enclosure w/silencer
- Audible alarm
- Remote drains and remote annunciator panel
- Spring isolators
- Two-year standby warranty
- Five-year basic power warranty




This outline drawing is for reference only.

**Do not use for installation design.**

| | Dim "A" mm (in.) | Dim "B" mm (in.) | Dim "C" mm (in.) |
|---|---|---|---|
| **All Models** | 5182 (204) | 2286 (90) | 2721 (107) |

NOTE: Consult drawings for applicable weights. See enclosure Specification Sheet for enclosure dimensions.

## Codes and standards

Underwriters Laboratory (UL) is a world leader in product safety testing and certification. This GenSet is certified to UL2200 as open set, weather enclosure, and sound-attenuated enclosure configurations. The generator is certified to UL1004. The PowerCommand® Control System is certified to UL508. (See Fuel Installation Requirements on this page.)

CSA Group tests products under a formal process to ensure that they meet the safety and/or performance requirements of applicable standards. This GenSet is certified to: CSA 22.2 No. 100 Motors and Generators; CSA 22.2 No. 0.4-044 Bonding of Electrical Equipment; CSA 22.2 No. 14 Industrial Control Equipment; and CSA 22.2 No. 0 General Requirements - Canadian Electrical Code, Part II. (See Fuel Installation Requirements on this page.)

Engine is certified to Stationary Non-Emergency U.S. EPA New Source Performance Standards (NSPS), 40 CFR 60 subpart JJJJ.
U.S. applications must be applied per EPA regulations.

This product has been manufactured under the controls established by a Bureau Veritas Certification approved management system that conforms to ISO 9001:2015.

## Fuel installation requirements

Gas supply pressure is specified at the inlet to the fuel shut-off solenoid (FSO). If this engine is equipped with two FSOs in series, this value should be measured at the inlet to the downstream FSO. Each FSO can reduce the supply pressure up to 5" W.C. at full load. Additional options added to the fuel train such as those for CSA or UL compliance, strainers and/or flex connections can add restriction that must be considered in the site installation.

## Ratings definitions

**Emergency Standby Power (ESP):**
Applicable for supplying power to varying electrical load for the duration of power interruption of a reliable utility source. Emergency Standby Power (ESP) is in accordance with ISO 8528. Fuel Stop power is in accordance with ISO 3046, AS 2789, DIN 6271, and BS 5514.

**Prime Power (PRP):**
Applicable for supplying power to varying electrical load for unlimited hours. Prime Power (PRP) is in accordance with ISO 8528. Ten percent overload capability is available in accordance with ISO 3046, AS 2789, DIN 6271, and BS 5514.

**Base Load (Continuous) Power (COP):**
Applicable for supplying power continuously to a constant electrical load for unlimited hours. Continuous Power (COP) is in accordance with ISO 8528, ISO 3046, AS 2789, DIN 6271, and BS 5514.

**Demand Response Power Rating - Spark Ignited Gas (DRP):**
Applicable for supplying electrical power in parallel with commercially available power in variable and non-variable load applications. This fuel rating is intended for use in situations where power outages are contracted, such as in utility power curtailment. Engine operation is limited to a total of 500 hours per year. Engines may be operated in parallel to the public utility for up to 500 hours per year, with an average load factor no greater than 80% of rated Demand Response Power. Engines with Standby Power ratings available can be run in Emergency Standby applications up to the Standby Power rating for up to 50 hours per year. The customer should be aware, however, that the life of any engine will be reduced by constant high load operation.


**Warning:** Backfeed to a utility system can cause electrocution and/or property damage. Do not connect GenSets to any building electrical system except through an approved device or after the building main disconnect is open. Neutral connection must be bonded in accordance with National Electrical Code.

Specifications are subject to change without notice.

## Power You Can Rely On

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