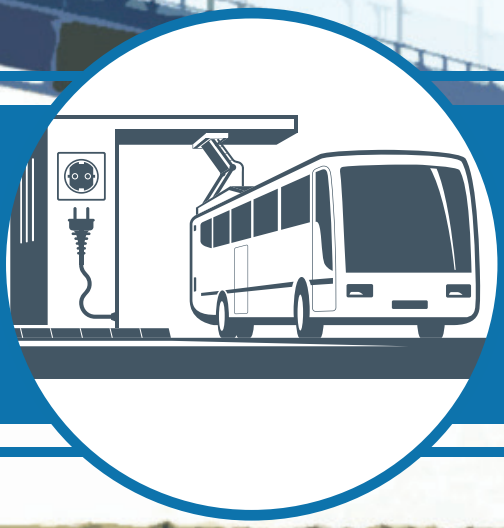

Cape Cod Regional Transit Authority

Operations & Maintenance Facility Cost Benefit Analysis

Rev. 1 | August 25, 2023

Operations & Maintenance Facility Cost Benefit Analysis

8/25/2023	1		Emily Marble	Dan Lang		
Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**	**Approved By**
	HATCH					**Client**

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1. Introduction

Cape Cod Regional Transit Authority (CCRTA) uses a facility at 40 American Way in Dennis, Massachusetts, as its primary Operations and Maintenance building (the Depot). Since 2006, the Depot has remained fully functional without significant investments. However, CCRTA's short-term fleet electrification plans will require significant upgrades at the Depot. Modifications required to support an electric fleet include charging infrastructure, utility upgrades, solar capacity, increased storage capacity, and other forms of resilient infrastructure.

Besides the investments required for CCRTA to meet their electrification goals, CCRTA identified necessary infrastructure improvements at the Depot which include a new bus wash station, canopies to cover parked vehicles and the fueling area, new service bays, and additional parking.

It is important to ensure that the Depot can sufficiently support CCRTA's long-term operational needs and strategic direction. During development of CCRTA's 10 Year Strategic Plan and 5 Year Capital Plan, CCRTA identified three options that would allow the Authority to move forward with electrification and address current needs:

1. **Construction of a new facility designed for a zero-emissions fleet**
   The first option under consideration is the development of a brand-new facility that is purpose-built for electric fleet operation. A new facility can be designed to align with the unique electric vehicle operations requirements and for greater operational efficiency. However, construction of a new facility is the most capital-intensive option. In addition, land acquisition, permitting, facility design, and construction will likely take several years to complete. To follow the transition timeline proposed by Hatch, and to meet CCRTA's established emissions reduction goals, charging infrastructure will need to be developed at the current facility to support the initial rounds of electric vehicle procurement and operations. Thus, this option will still require investments at the Depot.

2. **Upgrading the Depot to meet future needs**
   Option two is for continued operations out of the Depot for the foreseeable future. Under this option, investment will be required to develop the charging infrastructure enabling full fleet electrification. Currently, the fixed-route vehicle parking area is not optimally configured to maximize charging infrastructure and vehicle parking. To accommodate charging infrastructure for a fully electric fleet, CCRTA would need to relocate the high mast lighting poles to the charging islands along with the charging dispensers. Refer to Appendix A for the existing parking configuration and light post location. Appendix B illustrates the required parking area reconfiguration with new light post and charging dispenser locations. This reconfiguration is not necessary for the new facility construction option.

   This option requires much less capital investment. However, there are operational inefficiencies with this alternative which will be discussed in more detail in Section 3.2.2.

3. **Upgrading the Depot and acquisition of nearby, vacant parcels of land to increase the Depot's footprint**
   The third option under consideration involves the purchase of property near the Depot. In the strategic plan, CCRTA identified two parcels of land available for purchase near the Depot. This land could serve as small areas for future expansion; however, the available parcels are located northwest of the Depot's property lines and are not immediately adjacent. This means that developing property would divide the Depot's operations amongst the different plots of land. Integrating these plots with CCRTA's current operations could be challenging or at least suboptimal. With this option, CCRTA can expect to realize similar cost benefits and inefficiencies as Option 2.

Hatch completed a capital cost analysis for the three options outlined above to predict the high-level financial implications associated with each. The cost estimate to develop a new facility and the cost of land acquisition for Options 1 and 3 were obtained from CCRTA's strategic plan. To determine which option provides CCRTA with the best path forward, a qualitative analysis was then conducted which considered various strategic and operations factors and the development cost.

Each of the options present unique challenges, benefits, and opportunities which are expanded upon in the following report.

2. Evaluation Methodology

To determine the best path forward, CCRTA must consider competing criteria during the decision-making process. To assist CCRTA in the options' evaluation based on these criteria, Hatch employed a multicriteria decision making framework, where each option is assigned a score and criteria is assigned a relative weight based on its importance to the decision. The final score for each option is then calculated as the weighted average of the scores by criteria. Such framework is commonly used to help systematically evaluate options against multiple criteria.

A score between 1 and 5 was assigned to each option for each of the criteria discussed above. A higher score indicates a higher preference for the option for the given criteria. A description and criteria for the score assignment is provided in Table 1 below.

Table 1 Scoring Matrix

Score	Description	Criteria
1	Inferior	Significantly worse than other options
2	Below Average	Has noticeable drawbacks compared to the other options
3	Average	On par with the other options/meets the requirements
4	Above Average	Offers distinct advantage compared to other options
5	Excellent	Excels compared to other options

Next each evaluation criteria were assigned a weight based on its relative importance in the decision matrix. The weights were derived in collaboration with CCRTA to ensure that the assigned weight reflects relative importance of each criterion to the Authority. Table 2 provides the summary of the weights by decision criteria.

Table 2 Decision Criteria Weights

Decision Criteria	Weight
Cost	30%
Future Expansion (Space Constraints)	15%
Operational Efficiencies	15%
Electrification (Transition Phase)	10%
Safety	30%

3. Operations and Maintenance Facility Analysis

Hatch identified the following criteria for the evaluation of the three facility options.

- Cost
- Operational Considerations:
  - Future Expansion (Space Constraints)
  - Operational Efficiencies
  - Electrification (Transition Phase)
  - Safety

Hatch evaluated the criteria delineated above for each of the three options under consideration. A summary of the analyses is discussed in the following section.

3.1 Cost

When evaluating multiple development options, cost is arguably the most significant factor to be considered. For each option, Hatch estimated the cost of developing charging infrastructure to support a fully electrified fleet. These charging infrastructure cost estimates include the cost for chargers, associated electrical equipment and installation. The infrastructure size used for the cost estimate directly aligned with Hatch's infrastructure recommendations provided in CCRTA's *Zero Emission Vehicle (ZEV) Fleet Transition Recommendations Report*.

The cost estimate to develop a new facility and the cost of land acquisition for Options 1 and 3 were obtained from CCRTA's strategic plan. The resulting estimated total cost for each of the three options is summarized in Table 3 below.

Table 3 Cost Estimate Summary

	Option 1: New Facility	Option 2: Depot Upgrades	Option 3: Depot Upgrades & Nearby Land Acquisition
Charging Equipment	$4,286,917	$4,286,917	$4,286,917
Civil & Installation	$1,107,943	$1,478,860	$1,478,860
Utility Connection	N/A	$30,000	$30,000
New Facility Development*	$25,000,000	N/A	N/A
Land Acquisition*	N/A	N/A	$1,400,000
Facility Redesign for buses and other vehicles*	N/A	$775,000	$775,000

Solar Canopy*	N/A	$900,000	$900,000
Security Building*	N/A	$50,000	$50,000
Service Bay Expansion*	N/A	$1,250,000	$1,250,000
Contingency @ 20%	$6,078,972	$1,754,155	$2,034,155
Total	**$36,473,832**	**$10,524,933**	**$12,204,933**

* Cost inputs obtained from CCRTA's Strategic Plan.

Detailed cost estimates for Option 1, Option 2 and Option 3 are provided in Appendix C, Appendix D and Appendix E respectively.

As shown in Table 3, construction of a new facility is the most capital-intensive option. The estimated cost for Option 1: New Facility is approximately $36.5 million which is 71% more than Option 2: Depot Upgrades. The development of charging infrastructure at the Depot, alone, is estimated to be $10.5 million. When comparing the three options from a cost perspective only, Option 1 is significantly inferior to the other two options warranting a score of one. Option 2 was assigned a score of five for being the cheapest alternative while Option 3 was assigned the score of four because it is more expensive compared to Option 2 but still significantly cheaper than Option 1. Table 4 below summarizes these scores.

Table 4 Score Summary for Costs

	Scores
Option 1: New Facility	1
Option 2: Depot Upgrades	5
Option 3: Depot Upgrades and Nearby Land Acquisition	4

3.2 Operational Considerations

The costs outlined in 3.1 provide a baseline economic comparison of the three options but do not fully consider the operational impacts, benefits, and constraints of each. Though these factors cannot be easily quantified or monetized, they have a material impact on CCRTA's long-term success and must be considered. Analyzing these non-financial aspects provides CCRTA with a holistic understanding of the three alternatives and their respective impacts to the Authority's long-term strategy. Hatch evaluated the following operational considerations: future expansion, operational efficiencies, electrification, and safety and a discussion surrounding each alternative is included below.

3.2.1 Future expansion (Space Constraints)

An important evaluation criterion with large operational implications for CCRTA's business is space and capacity for expansion. According to the Authority, the Depot has been space constrained for years with some of the major issues being parking and lack of space for maintenance upgrades. Now, with full fleet electrification on the horizon, and CCRTA's fleet projecting to grow along with that process, this is becoming a more pressing issue.

Option 1 – New Facility:

The Depot has limited parking for revenue vehicles, non-revenue vehicles, and employee parking. There is need for four additional maintenance bays to service future battery electric and diesel buses while the existing wash bay requires upgrades for wastewater recycling. Some battery electric buses (BEBs) have batteries located on the vehicle roof and may require access during routine maintenance. This would mean that greater roof clearances may be necessary and CCRTA should account for height restrictions. Lastly, to improve security access to the Depot, CCRTA plans to build a structure at the entrance to station an employee. With a new facility design under Option 1, CCRTA could address these upgrades and space constraints.

Aside from the upgrades related to space, maintenance, and security discussed above, fleet electrification will require supporting electrical infrastructure. For resiliency planning, CCRTA would need both power generation capability and power storage capacity. Option 1 would allow CCRTA to design a facility with vehicle canopies to both protect the fleet from the elements as well as host solar panels for power generation as part of a microgrid.

Lastly, the Depot sits on an 11-acre parcel of land. If CCRTA were to purchase land in Barnstable, it was decided that the Authority would purchase, at minimum, twenty acres. The opportunity for future fleet and operational capacity expansion in response to ridership growth is important to CCRTA. For all these reasons, building a new facility under Option 1 could be advantageous. It must be noted that if CCRTA aims to nearly double their land holding with the purchase and development of a new operations facility, specific plans for expansion should be developed. Without a concrete expansion plan in place, CCRTA faces the risk of a larger facility footprint than needed and potential public scrutiny.

Option 2 – Depot Upgrades:

When evaluating Option 2 as it relates to future expansion criterion there are several factors for CCRTA to consider. As part of CCRTA's ZEV fleet transition planning, Hatch performed a space-proofing exercise for the Depot. During site layout development, measurements for revenue service vehicle parking, electrical charging infrastructure, and maintenance bay expansion were calculated. Hatch determined that the Depot has space to store revenue service vehicles with adequate room for some fleet expansion and the necessary service bay upgrades. The exercise revealed that the Depot has potential space to accommodate an additional ten 29-foot transit buses and six fixed-route cutaway vehicles. This aligns with Hatch's operational simulations and analysis, completed as part of CCRTA's ZEV transition planning, which indicated that CCRTA will require only minimal fleet expansion (four additional vehicles) for successful fleet electrification. However, the Depot will not have enough space to accommodate the recommended 10% spare capacity for charging infrastructure, which is typically recommended for resiliency planning and to minimize operational risk. Instead, space will allow for 6% spare capacity, introducing slightly higher operational risk to the authority. Also, development and installation of a solar canopy to cover the fleet and fueling areas would only exacerbate space constraints, especially in the central portion of the site where CCRTA parks the larger, fixed-route vehicles.

As part of CCRTA's long-term strategic goals, the Authority is considering "right-sizing" the fleet during their electric transition as well as moving to smaller-sized demand-response vehicles for a portion of their fleet. Though this could potentially allow for more parking and storage space at the Depot, the amount of space and number of vehicles are unknowns at this time.

Option 3 – Depot Upgrades & Nearby Land Acquisition:
If CCRTA purchases additional land adjacent to the Depot under Option 3, those areas could be used for employee parking. However, due to the location of the land parcels and their distance from the building, the additional space would not support any infrastructure improvement to the Depot's physical structure (like maintenance bays), nor would it be the most optimal solution for revenue and non-revenue vehicle parking as reconfiguration and operational changes would be required.

Though Option 3 gives CCRTA some flexibility to reconfigure the site for employee parking and vehicle storage potential at the Depot, the purchase of new land offers very limited space for future expansion. For these reasons, Option 3 was assigned a score of three. Option 2 offers only a modest expansion space. It would leave the Depot congested with less-than-optimal spare chargers for contingency and was the least desirable option from a future expansion vantage point. Option 2 was assigned a score of one. Option 1, a new facility, would provide substantial benefits to the Authority - the facility would be built for ZEV operation with adequate space for expansion, charging infrastructure, and contingency. Therefore, Option 1 was assigned a score of five. Table 5 below summarizes these scores.

Table 5 Score Summary for Future Expansion (Space Constraints)

	Scores
Option 1: New Facility	5
Option 2: Existing Facility Upgrades	1
Option 3: Existing Facility Upgrade and Purchase Abutting Parcel	3

3.2.2 Operational Efficiencies

Another evaluation criterion important to CCRTA's business is operational efficiency. CCRTA, like any transit authority, strives to provide safe and reliable public transportation to its ridership. Although fleet electrification is important to the Authority so too is maintaining normal operations during the transition period. The impact each of the three options will have on CCRTA's operations is a critical piece of the evaluation.

Option 1 – New Facility:
During a previous study conducted by CCRTA, results showed that a large percentage of CCRTA's demand-response services originate and terminate in Barnstable. CCRTA concluded that a more centralized location closer to Route 6 would be an optimal location for a new operations and maintenance facility to address vehicle range concerns associated with CCRTA's electrification goals, a bus depot in closer proximity to high ridership areas would allow for mid-day charging with reduced deadhead. In addition, Cape Cod Community College (CCCC) is also located in proximity which may be beneficial should CCRTA and CCCC partner to develop electric vehicle training curriculum and associated apprenticeship programs. Beyond the location, a new facility can be designed in concert with CCRTA's unique operating environment for efficiency and the Authority's strategic goals and long-term plans for a near-zero emissions fleet.

Option 2 – Depot Upgrades:
Electric vehicle range is a concern that CCRTA raised at the beginning of their transition planning efforts. Many of their fixed routes and even demand responses services involve long blocks or operator shifts. This is not an issue for the Authority, currently, as they operate fossil fueled vehicles. However,

operational strategy will be required to address range issues as CCRTA moves to an electric fleet. There are operational strategies that CCRTA can implement to remain at the Depot while addressing these concerns. Rather than mid-day charging strategies at a new facility, CCRTA could opt for on-route charging in locations identified as high ridership areas. To maintain existing service levels while operating an electric fleet, CCRTA must develop on-route charging infrastructure regardless of whether a new operations and maintenance facility is built or not. So, mid-day charging should not be the only case for building a new facility.

Option 3 – Depot Upgrades & Nearby Land Acquisition:
As mentioned previously, additional parcels of land near the Depot can be purchased and developed for space. However, the distance of the parcels from the physical depot structure would introduce additional operational challenges. One of the two identified parcels of land is completely disjointed from the Depot's main base. This would require CCRTA to essentially operate two separate bases, use the land only as remote overnight parking, or reconfigure the entire site to support parking for revenue vehicles, non-revenue vehicles, and employee parking. To utilize these additional parcels for parking revenue-service fleet, a small building would need to be built or a trailer would need to be purchased for use as an operator breakroom. If CCRTA decided to use the space for employee parking, staff would have to walk a far distance to access the building and revenue fleet and in inclement weather, this would be less optimal. While there is possibility for development of a passage to the second parcel of land, the passage would be narrow due to the adjacent storm water basin.

Options 2 and 3 introduce operational challenges making them less favourable choices. Because Option 3 may involve splitting the Authority's operations into two lots, resulting in suboptimal operations, Option 3 is a less desired option compared with Option 2 and was assigned a score of one. Option 2 was assigned a score of three because it meets CCRTA's operational requirement and keeps the operations consolidated but does not provide any additional, distinct benefit. Option 1 was assigned a score of five because it provides CCRTA the opportunity to meet strategic plans by designing a facility for optimal, future electric operations. Table 6 below summarizes these scores.

Table 6 Score Summary for Operational Efficiencies

	Scores
Option 1: New Facility	5
Option 2: Existing Facility Upgrades	3
Option 3: Existing Facility Upgrade and Purchase Abutting Parcel	1

3.2.3 Electrification (Transition Phase)

As outlined in Hatch's recommended transition timeline, CCRTA's fleet electrification will happen over the span of many years. During this transition, CCRTA will operate both electric and fossil-fueled vehicle types simultaneously. Supporting charging infrastructure will need to be built while maintaining the Authority's daily transit operation. Hence, CCRTA will face operational challenges during the transition. However, the facility option that CCRTA selects will ultimately dictate the nature of these challenges.

Option 1 – New Facility:
Developing a new facility will allow for CCRTA to maintain existing service without any impacts to operations; while construction of a facility in Barnstable is on-going, operations can continue at the Depot

without disruption. However, there are costs to ownership of two properties. The depot's overhead costs and general maintenance and repair will still be a factor spanning the duration of new construction. Additionally, CCRTA's ZEV fleet transition will not be slowed to account for new construction. The first delivery of electric vehicles is scheduled for August of this year. Utility connection, additional power capacity, and charging system infrastructure planning at the Depot is underway. Once the new facility is commissioned, charging system infrastructure installation will be required, and is a duplication of resources.

Option 2 – Depot Upgrades:
Operating a mixed fleet out of the Depot could be challenging given the space constraints. With both battery electric and fossil fuel vehicles parked in the same space, dispatching vehicles can become a more complicated task. Additional efforts and considerations will need to go into staging vehicles at the end of the day to ensure a smooth and error free dispatch operation the following day. If CCRTA were to develop a new facility with adequate available space, the electric and fossil fuel vehicles can be parked and staged separately; streamlining the dispatch operation to reduce errors. Additionally, the fixed-route vehicle parking area will require reconfiguration to maximize parking and charging infrastructure installation by relocating the existing light poles. During this construction, the current fossil fuel vehicles will have to be parked elsewhere. Though the training area lot could be a temporarily solution for this, it would require the operators to walk a far distance from the Depot building to the training lot every morning and makes this option less than ideal.

Option 3 – Depot Upgrades & Nearby Land Acquisition:
Purchasing the adjacent vacant parcels of land outlined in the strategic report could help alleviate some of the space constraints at the Depot during the transition. The land can be developed to park and dispatch fixed-route vehicles while the charging infrastructure is being constructed and installed. Since the distance from the Depot building to the land parcels is quite significant, it is advisable to develop employee parking and a temporary office building or trailer on one of the parcels.

From a transition standpoint, Option 1 would be more advantageous compared to the other two options since it would allow the Depot's current operation to continue uninterrupted while a purpose build facility is constructed for zero-emission vehicles. The disadvantage Option 1 presents is in the additional cost of maintaining two properties for the time being. Because of this, Option 1 was assigned a score of four. Option 2 was assigned a score of two because of the distinct disadvantage of operating a mixed fleet in a constrained space during the transition phase. There are potential for errors and additional operation efforts required associated with this option. Lastly, Option 3 was assigned a score of three because it could allow for a relatively less complex operation compared to Option 2. However, arguably, it does not offer any distinct advantages. Table 7 below summarizes these scores.

Table 7 Score Summary for Electrification (Transition Phase)

	Scores
Option 1: New Facility	4
Option 2: Existing Facility Upgrades	2
Option 3: Existing Facility Upgrade and Purchase Abutting Parcel	3

3.2.4 Safety

Safety must be considered during CCRTA's decision-making process. Fleet electrification is a major operational shift and known safety risks need to be understood. Moreover, there are other, unknown risks that are difficult to anticipate at this stage. Therefore, CCRTA should select the option that puts the Authority in the best position to manage risks and improve system safety.

One known safety risk associated with electric vehicles is thermal runaway, a condition which causes battery fire. Although the chance of a given battery catching fire while charging is very low, battery fires are notoriously difficult to put out once they ignite. There is also potential for a chain-reaction where one battery overheating and igniting will cause other nearby batteries to overheat as well. The chain-reaction can carry over to the adjacent vehicles if vehicles are parked very close together. Hence, the best defence against fire propagation from vehicle to vehicle is to charge and park the vehicles outdoors with adequate space in-between. Additional fire suppression and other safety systems are also critical elements of electric bus infrastructure modifications.

The second known safety risk is associated with the construction of charging infrastructure on a fully operational depot. During the transition phase, the Depot will go through substantial construction and modification. Because of the current space constraints at the Depot, conducting construction activities increases the safety risks associated with slips and trips, falling objects, noise, vibration, chemical exposure, heavy equipment operation, and others.

Option 1 – New Facility:

If a new facility is purpose built for ZEV operation, it can be designed from the ground up to include state-of-the-art safety systems including fire detection and suppression systems. Additional provisions can be included in the design such as dedicated battery storage rooms. Storage rooms are necessary to store any stand-alone battery packs when they are removed from a vehicle. The biggest safety advantage of a new, larger facility and associated footprint is the ability to park vehicles with sufficient distance apart to avoid fire propagation in the unlikely event of vehicle fire. New facility construction on a separate site would also eliminate any safety risks associated with interaction between construction and the Depot's operation.

Option 2 – Depot Upgrades:

Option 2 will involve the greatest interaction between construction and the activities and the Depot's operation. As previously mentioned, because of the current space constraints at the Depot, conducting construction activities increases the safety risks associated with slips and trips, falling objects, noise, vibration, chemical exposure, heavy equipment operation, and others. In addition, reconfiguration in the fixed-route parking area to allow for both vehicles and supporting electrical infrastructure (chargers) will result in vehicles being stored near to one another thus increasing the risk for fire propagation if a vehicle were to catch fire.

Option 3 – Depot Upgrades & Nearby Land Acquisition:

Option 3, purchasing nearby land, could help minimize the interaction between construction activities and the Depot's operation. Similarly, if the parcels are developed for vehicle parking and dispatching, configuration for space optimization would be a step to mitigate fire propagation risk.

From the fire propagation mitigation and interactions between the construction and depot operations point of view, Option 1 would provide a distinct advantage over the other two options. Hence, this option was assigned a score of five. Although the safety risks during the construction phase can be managed with Option 2, the risk remains higher compared to the other two options. In addition, the scale of property damage would be significantly higher with Option 2 in the event of battery fire. Option 2 was assigned a score of two, reflecting these significant drawbacks. With the expansion of property size under Option 3, there is potential to park with sufficient space between vehicles as well the opportunity to minimize interactions with on-going construction activities. Thus, Option 3 has advantages over Option 2 and is assigned a score of four. Table 8 below summarizes these scores.

Table 8 Score Summary for Safety

	Scores
Option 1: New Facility	5
Option 2: Existing Facility Upgrades	2
Option 3: Existing Facility Upgrade and Purchase Abutting Parcel	4

4. Conclusions & Recommendations

Each option evaluated above has benefits and drawbacks. Option 1 is the most expensive option, but it has significant advantages from operations' efficiency, transition, and safety points of view. On the other hand, Option 2 is the least expensive but carries drawbacks that could impact CCRTA's abilities in the long term. Lastly, Option 3 is a potential middle ground.

The goal of this analysis is to objectively determine the option that delivers a net benefit to CCRTA and for that, Hatch used a multicriteria decision making model. The benefits and drawbacks were assigned scores based on the qualitative analyses against scoring criteria. These scores are summarized in Table 9 below.

Table 9 Multicriteria Decision Matrix

Considerations	Option 1	Option 2	Option 3
Cost	1	5	4
Future Expansion (Space Constraints)	5	1	3
Operational Efficiencies	5	3	1
Electrification (Transition Phase)	4	2	3
Safety	5	2	4

The total scores for each option were calculated, using the weights established in Section **Error! Reference source not found.**, and are summarized in Table 10 below:

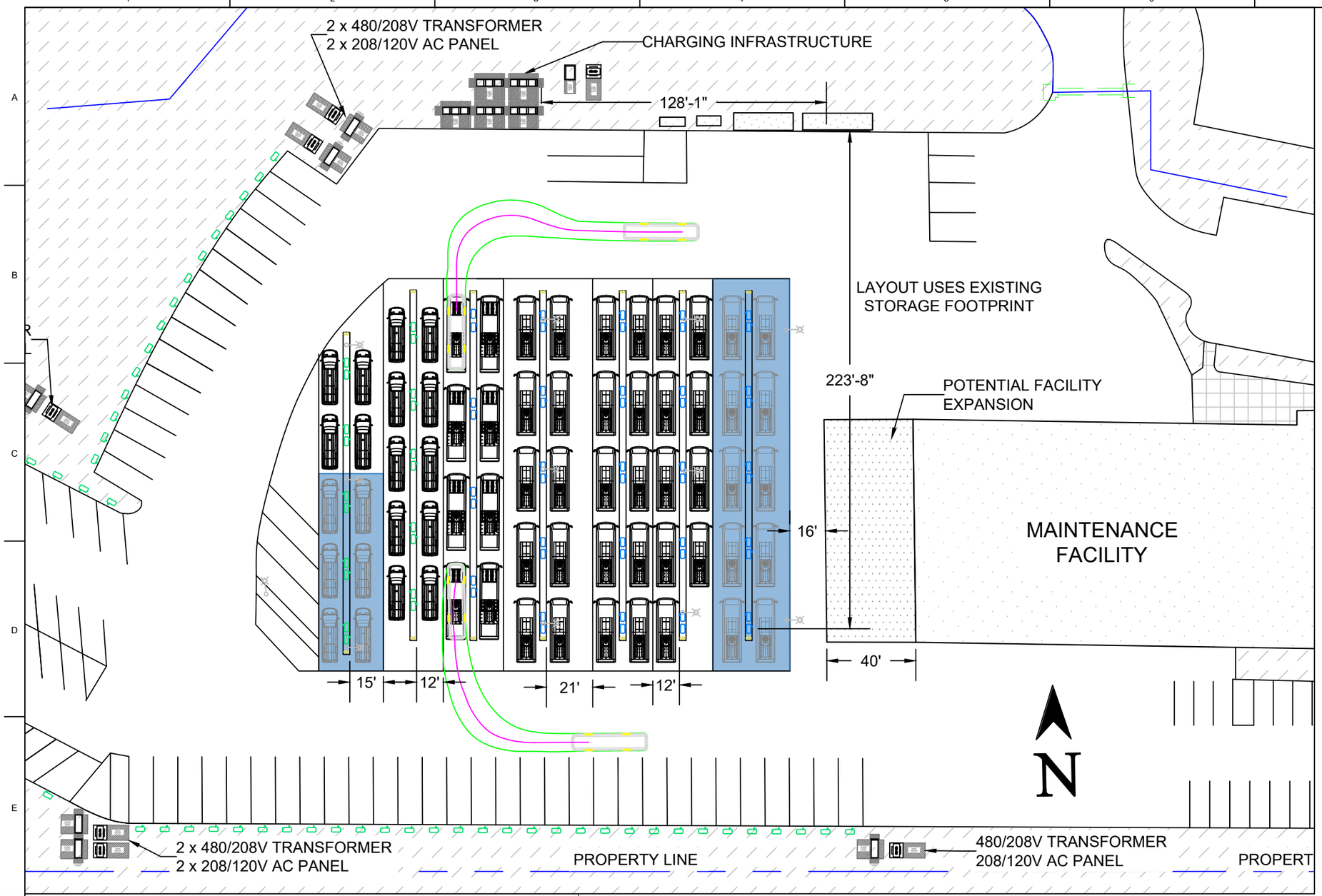
Table 10 Final Scores

	Final Scores
Option 1: New Facility	3.7
Option 2: Existing Facility Upgrades	2.9
Option 3: Existing Facility Upgrade and Purchase Abutting Parcel	3.3

The above scores indicate that Option 1: New Facility would yield the most benefit to CCRTA compared to the cost incurred. However, it is important to note that the scores are based on future expansion capabilities. Since CCRTA does not have immediate plans for specific expansion, adjusting the score to account for this can show different results. Without a service expansion plan, CCRTA may face challenges getting stakeholder and public buy-in, and by extension, securing the necessary funding for a new facility. In the absence of service expansion needs, Option 3 could become a preferred alternative since its score is a very close second.

CCRTA might consider developing a population growth and service requirement projection for a ten-to-20-year time horizon. If expansion is projected for the future, it would solidify the justification for a new facility. It would also prevent CCRTA from making investments in the current facility that it is destined to outgrow in the coming years.

Appendix A: Existing Fixed Route Vehicle Parking Configuration



Notes/Assumptions:

- Chargers shall be placed in well-lit and visible locations to avoid vandalization.
- Chargers shall not be installed on sloped or pitched roadway.
- 350ft. maximum trenching from power cabinets to furthest charger
- This schematic assumes that new medium voltage service is required from the utility.
- Layout provides storage and charging for:
  - 14 fixed route cutaways
  - 29 29ft. buses
  - 8 35ft. buses
- 139 total charging locations
  - 38 Level 3 charging locations
  - 101 Level 2 charging locations
  - Space for 16 additional charging locations for future expansion
- All dimensions provided are generic and subject to change.
- Layout assumes the removal of existing street lights and installation of new street lights

KEY

- FIXED ROUTE CUTAWAY
- 29' BUS
- 35' BUS
- EXISTING STREET LIGHT
- PROPOSED STREET LIGHT
- LEVEL 2 CHARGER
- LEVEL 3 CHARGER
- BOLLARD
- FUTURE EXPANSION
- SIDEWALK
- GRASS / OTHER PROPERTY
- BUILDING

DO NOT SCALE

No.	DESCRIPTION	BY	CHK'D	DATE
B	Addition of Level 2 Chargers	E.L.	M.B.	8/3/23
A	Initial Release			

REVISIONS

HATCH LTK

ROLE	NAME	SIGNATURE	DATE
DESIGNER	Edward Lopez	E.L.	6/22/23
DSGN. APPROVER	Mihir Bodarya	M.H.	6/22/23
PROJ. MANAGER	Emily Marble	E.M.	6/22/23

DRAWING APPROVAL STATUS:

CONCEPTUAL SKETCH

CCRTA

DENNIS DEPOT
CHARGING LAYOUT AND ANALYSIS
WITH EXISTING STREET LIGHTING

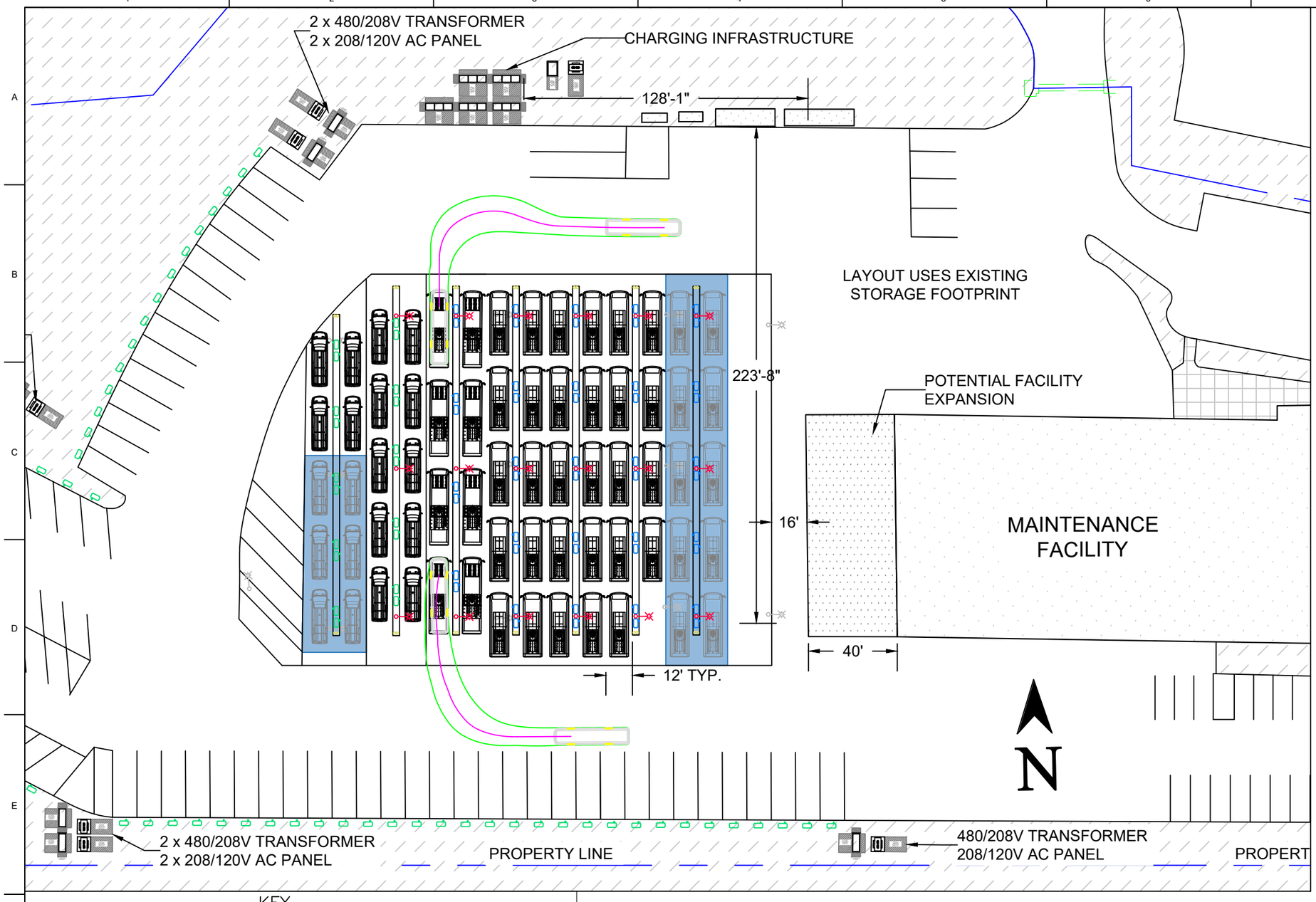
SCALE 1:50 OR AS NOTED

DWG. No. CCRTA-CS-100

REV B

SHEET SIZE: ANSI-D

Appendix B: Optimized Fixed Route Vehicle Parking Configuration



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FIXED ROUTE CUTAWAY
29' BUS
35' BUS
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PROPOSED STREET LIGHT
LEVEL 2 CHARGER
LEVEL 3 CHARGER
BOLLARD
FUTURE EXPANSION
SIDEWALK
GRASS / OTHER PROPERTY
BUILDING

DO NOT SCALE

No.	DESCRIPTION	BY	CHK'D	DATE
B	Addition of Level 2 Chargers	E.L.	M.B.	8/3/23
A	Initial Release			

REVISIONS

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PROJ. MANAGER	Emily Marble	E.M.	6/22/23

DRAWING APPROVAL STATUS:

CONCEPTUAL SKETCH

CCRTA

DENNIS DEPOT
CHARGING LAYOUT AND ANALYSIS
OPTIMIZED LAYOUT

SCALE 1:50 OR AS NOTED | DWG. No. CCRTA-CS-103 | REV B

SHEET SIZE: ANSI-D

Appendix C: Option 1 - New Facility Cost Estimate

Appendix C: Option 1 - New Facility
Cost Estimate

PAY ITEM	DESCRIPTION	EST QTY	MEAS UNIT	UNIT COST	TOTAL COST
10	**Charging Equipment**				**$ 3,670,000**
10.1	150 kW Plug-in Charging System (includes charging cabinets and 3 dispensers)	17	EA	$ 150,000	$ 2,550,000
10.2	19.2 kW Level 2 Charger (208V)	112	EA	$ 10,000	$ 1,120,000
11	**Electrical Infrastructure/Equipment**				**$ 616,917**
11.1	Low Voltage Switchgear - 4000A @ 480V	2	EA	$ 74,864	$ 149,727
11.2	250A 3P Circuit Breaker	23	EA	$ 5,296	$ 121,811
11.3	Low Voltage Copper AC Cable - THWN-THHN - 3/0	2550	ft	$ 5	$ 12,597
11.4	Low Voltage Copper DC Cable - THWN-THHN - 4/0	20684	ft	$ 6	$ 129,689
11.5	Fiber optics cable, 12 strand, multi mode	6021	ft	$ 2	$ 10,236
11.6	500 KVA 480V/208V 3-phase Transformer	6	EA	$ 18,673	$ 112,039
11.7	Low Voltage Switchgear - 1200A @ 208V	6	EA	$ 11,658	$ 69,950
11.8	80A 1P Circuit Breaker	112	EA	$ 59	$ 6,584
11.9	Low Voltage Copper AC Cable - THWN-THHN - #14 AWG	3211	ft	$ 1	$ 4,283
12	**Civil**				**$ 63,777**
12.1	12' sq. ft. 28" deep concrete pads	8	EA	$ 5,059	$ 40,473
12.2	Concrete Island (3' wide)	150	ft	$ 23	$ 3,500
12.3	Conduit, excavation, concrete, bedding, backfill and compaction (3 @ 4" conduit 6' deep)	150	ft	$ 86	$ 12,888
12.4	Surface Improvements	150	ft	$ 11	$ 1,650
12.5	Demolition	9%	EA	$ -	$ 5,266
	Sub-total				**$ 4,350,694**
13	**Soft Costs**	**1**	**EA**		**$ 1,044,167**
13.1	General Contractor Overhead	9%	EA	$ -	$ 391,562
13.2	General Contractor Profit	6%	EA	$ -	$ 261,042
13.3	Insurance and Bond	3%	EA	$ -	$ 130,521
13.4	Permits	1%	EA	$ -	$ 43,507
13.5	Mobilization	5%	EA	$ -	$ 217,535
14	**Utility Costs**	1	EA	$ -	**$ -**
14.1	Utiity interconnection costs	1	EA		
15	**Expansion**				**$ 25,000,000**
15.1	New site development	1	EA	$ 25,000,000	$ 25,000,000
	Sub-total				**$ 30,394,860**
	Contingency	20%			**$ 6,078,972**
	Total				**$ 36,473,832**

NOTES:

1 Service kiosk and utility transformer are assumed to be utility owned and supplied equipment and are not included in the cost estimate.
2 The estimate includes full construction cost assuming that the construction costs are not covered by Eversource's EV make-ready program.
3 The charger cost estimate is based on a vendor quote
4 All the other unit costs are Q1 2023 estimated obtained from RSMeans for Hyannis region
5 The cable length estimates include additional slack of 20 ft for the termination points
6 This is a class 5 estimate that is intended for feasiblity study.
7 The conduit runs consists of three parallel runs, two for power and one for fiber optic cable
8 The cost of new site development is obtained from CCRTA's 10 year strategic plan

Appendix D: Option 2 - Depot Upgrades Cost Estimate

Appendix D: Option 2 - Depot Upgrades Cost Estimate

PAY ITEM	DESCRIPTION	EST QTY	MEAS UNIT	UNIT COST	TOTAL COST
10	**Charging Equipment**				**$ 3,670,000**
10.1	150 kW Plug-in Charging System (includes charging cabinets and 3 dispensers)	17	EA	$ 150,000	$ 2,550,000
10.2	19.2 kW Level 2 Charger (208V)	112	EA	$ 10,000	$ 1,120,000
11	**Electrical Infrastructure/Equipment**				**$ 616,917**
11.1	Low Voltage Switchgear - 4000A @ 480V	2	EA	$ 74,864	$ 149,727
11.2	250A 3P Circuit Breaker	23	EA	$ 5,296	$ 121,811
11.3	Low Voltage Copper AC Cable - THWN-THHN - 3/0	2550	ft	$ 5	$ 12,597
11.4	Low Voltage Copper DC Cable - THWN-THHN - 4/0	20684	ft	$ 6	$ 129,689
11.5	Fiber optics cable, 12 strand, multi mode	6021	ft	$ 2	$ 10,236
11.6	500 KVA 480V/208V 3-phase Transformer	6	EA	$ 18,673	$ 112,039
11.7	Low Voltage Switchgear - 1200A @ 208V	6	EA	$ 11,658	$ 69,950
11.8	80A 1P Circuit Breaker	112	EA	$ 59	$ 6,584
11.9	Low Voltage Copper AC Cable - THWN-THHN - #14 AWG	3211	ft	$ 1	$ 4,283
12	**Civil**				**$ 362,903**
12.1	12' sq. ft. 28" deep concrete pads	8	EA	$ 5,059	$ 40,473
12.2	Concrete Island (3' wide)	150	ft	$ 23	$ 3,500
12.3	Conduit, excavation, concrete, bedding, backfill and compaction (3 @ 4" conduit 6' deep)	150	ft	$ 86	$ 12,888
12.4	Surface Improvements	150	ft	$ 11	$ 1,650
12.5	Acquired land development (earth work and paving) - 1.06 acres	45738	sqft	$ 6	$ 274,428
12.6	Demolition	9%	EA	$ -	$ 29,964
	Sub-total				**$ 4,649,820**
13	**Soft Costs**	**1**	**EA**		**$ 1,115,957**
13.1	General Contractor Overhead	9%	EA	$ -	$ 418,484
13.2	General Contractor Profit	6%	EA	$ -	$ 278,989
13.3	Insurance and Bond	3%	EA	$ -	$ 139,495
13.4	Permits	1%	EA	$ -	$ 46,498
13.5	Mobilization	5%	EA	$ -	$ 232,491
14	**Utility Costs**	1	EA	$ -	**$ 30,000**
14.1	Utiity interconnection costs	1	EA		$ 30,000
15	**Expansion**				**$ 2,975,000**
15.1	Facility Redesign for buses and other vehicles	1	EA	$ 775,000	$ 775,000
15.2	Solar Canopy	1	EA	$ 900,000	$ 900,000
15.3	Security Building	1	EA	$ 50,000	$ 50,000
15.4	Service Bay Expansion	1	EA	$ 1,250,000	$ 1,250,000
	Sub-total				**$ 8,770,777**
	Contingency	20%			**$ 1,754,155**
	Total				**$ 10,524,933**

NOTES:

1. Service kiosk and utility transformer are assumed to be utility owned and supplied equipment and are not included in the cost estimate.
2. The estimate includes full construction cost assuming that the construction costs are not covered by Eversource's EV make-ready program.
3. The charger cost estimate is based on a vendor quote
4. All the other unit costs are Q1 2023 estimated obtained from RSMeans for Hyannis region
5. The cable length estimates include additional slack of 20 ft for the termination points
6. This is a class 4 estimate that is intended for feasiblity study.
7. The conduit runs consists of three parallel runs, two for power and one for fiber optic cable
8. The cost for expansion is obtained from CCRTA's 10 year strategic plan

Appendix E: Option 3 - Depot Upgrades and Nearby Land Acquisition Cost Estimate

Appendix E: Option 3 - Depot Upgrades and Nearby Land Acquisition Cost Estimate

PAY ITEM	DESCRIPTION	EST QTY	MEAS UNIT	UNIT COST	TOTAL COST
10	**Charging Equipment**				**$ 3,670,000**
10.1	150 kW Plug-in Charging System (includes charging cabinets and 3 dispensers)	17	EA	$ 150,000	$ 2,550,000
10.2	19.2 kW Level 2 Charger (208V)	112	EA	$ 10,000	$ 1,120,000
11	**Electrical Infrastructure/Equipment**				**$ 616,917**
11.1	Low Voltage Switchgear - 4000A @ 480V	2	EA	$ 74,864	$ 149,727
11.2	250A 3P Circuit Breaker	23	EA	$ 5,296	$ 121,811
11.3	Low Voltage Copper AC Cable - THWN-THHN - 3/0	2550	ft	$ 5	$ 12,597
11.4	Low Voltage Copper DC Cable - THWN-THHN - 4/0	20684	ft	$ 6	$ 129,689
11.5	Fiber optics cable, 12 strand, multi mode	6021	ft	$ 2	$ 10,236
11.6	500 KVA 480V/208V 3-phase Transformer	6	EA	$ 18,673	$ 112,039
11.7	Low Voltage Switchgear - 1200A @ 208V	6	EA	$ 11,658	$ 69,950
11.8	80A 1P Circuit Breaker	112	EA	$ 59	$ 6,584
11.9	Low Voltage Copper AC Cable - THWN-THHN - #14 AWG	3211	ft	$ 1	$ 4,283
12	**Civil**				**$ 362,903**
12.1	12' sq. ft. 28" deep concrete pads	8	EA	$ 5,059	$ 40,473
12.2	Concrete Island (3' wide)	150	ft	$ 23	$ 3,500
12.3	Conduit, excavation, concrete, bedding, backfill and compaction (3 @ 4" conduit 6' deep)	150	ft	$ 86	$ 12,888
12.4	Surface Improvements	150	ft	$ 11	$ 1,650
12.5	Acquired land development (earth work and paving) - 1.06 acres	45738	sqft	$ 6	$ 274,428
12.6	Demolition	9%	EA	$ -	$ 29,964
	Sub-total				**$ 4,649,820**
13	**Soft Costs**	**1**	**EA**		**$ 1,115,957**
13.1	General Contractor Overhead	9%	EA	$ -	$ 418,484
13.2	General Contractor Profit	6%	EA	$ -	$ 278,989
13.3	Insurance and Bond	3%	EA	$ -	$ 139,495
13.4	Permits	1%	EA	$ -	$ 46,498
13.5	Mobilization	5%	EA	$ -	$ 232,491
14	**Utility Costs**	1	EA	$ -	**$ 30,000**
14.1	Utiity interconnection costs	1	EA		$ 30,000
15	**Expansion**				**$ 4,375,000**
15.1	Land Acquisition	2	EA	$ 700,000	$ 1,400,000
15.2	Facility Redesign for buses and other vehicles	1	EA	$ 775,000	$ 775,000
15.3	Solar Canopy	1	EA	$ 900,000	$ 900,000
15.4	Security Building	1	EA	$ 50,000	$ 50,000
15.5	Service Bay Expansion	1	EA	$ 1,250,000	$ 1,250,000
	Sub-total				**$ 10,170,777**
	Contingency	20%			**$ 2,034,155**
	Total				**$ 12,204,933**

NOTES:

1 Service kiosk and utility transformer are assumed to be utility owned and supplied equipment and are not included in the cost estimate.
2 The estimate includes full construction cost assuming that the construction costs are not covered by Eversource's EV make-ready program.
3 The charger cost estimate is based on a vendor quote
4 All the other unit costs are Q1 2023 estimated obtained from RSMeans for Hyannis region
5 The cable length estimates include additional slack of 20 ft for the termination points
6 This is a class 4 estimate that is intended for feasiblity study.
7 The conduit runs consists of three parallel runs, two for power and one for fiber optic cable
8 The cost for expansion and land acquisition is obtained from CCRTA's 10 year strategic plan