CITY OF WINNIPEG

Bus Electrification Draft Report

Brandon Avenue Bus Garage, Winnipeg, Manitoba

February 2021 – 20-3181

February 23, 2021

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Attention: Erin Cooke, P.Eng.

City of Winnipeg Bus Electrification Draft Report – Brandon Avenue Bus Garage, Winnipeg, Manitoba

Dillon Consulting Limited is pleased to submit the following report of our findings and recommendations on the Electrical Electrification of the Brandon Avenue Bus Garage.

We look forward to your review of this report. Should you have any inquiries, please contact the undersigned at Benjamin Doucet at (902) 429-0701 (ext. 5077) or Blair Moore at (204) 453-2301 (ext. 4013).

Sincerely,

DILLON CONSULTING LIMITED

Benjamin Doucet, P.Eng.
Electrical Engineer

Blair Moore, P.Eng.
Project Manager

BAD/SLK:lw

Our file: 20-3181

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1.0 Summary

Winnipeg Transit (Transit) and their partners are engaged in the further development of their transit fleet into a more sustainable energy source. The goal of this ongoing initiative is to reduce the carbon footprint of the transit authority by reducing diesel usage in the bus fleet.

As part of this project Dillon Consulting limited (Dillon) has been brought onboard to undertake preliminary site investigation, electrical assessment for implementation of DC fast charging, preliminary level 3 costing and preliminary layouts and designs which are all outlined in the following report.

Following our site review in August 2020 our team has determined that the existing electrical infrastructure in the Brandon bus garage is insufficient to support the addition of nine bus chargers to allow for simultaneous charging. This facility is the proposed location to house the chargers and buses.

2.0 Existing Conditions

2.1 As Found on Site

Dillon performed an initial site review to confirm the existing electrical infrastructure of Transit's bus garage located on Brandon Avenue (Brandon Bus Garage). The existing electrical infrastructure was compared with the electrical Issued for Construction drawings provided by Transit.

The Winnipeg Transit Brandon Bus Garage layout of the existing electrical rooms are as follows; four electrical rooms, labeled #1 through #4.

Electrical Room #1 (Figure 1) is the main electrical room and houses the main 347/600 V distribution equipment, located in the Southeast section of the garage. The sub electrical rooms are Electrical Room #2 (Figure 2), located in the Northeast section of the garage, Electrical Room #3 (Figure 3), located in the Southwest section of the garage, and Electrical Room #4 (Figure 4), located in the Northeast section of the garage.

Note: Figures 1 through 4 (below) were taken from the Issued for Construction drawings provided by Transit.

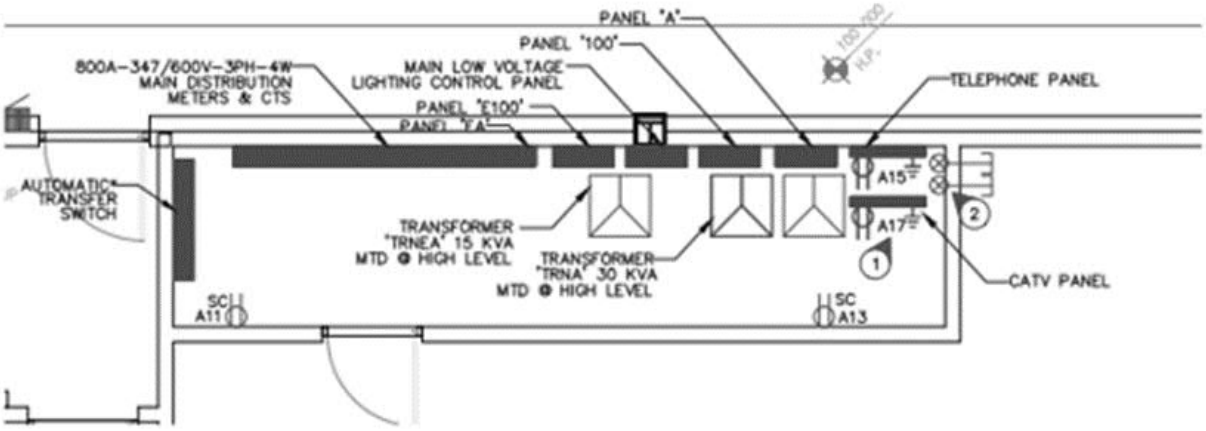


Figure 1: Plan View Layout – Main Floor – Electrical Room #1

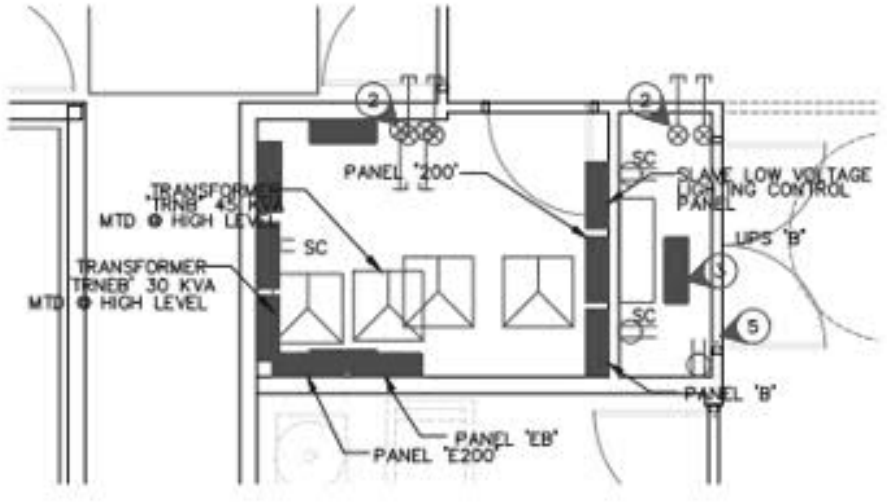


Figure 2: Plan View Layout – Main Floor – Electrical Room #2

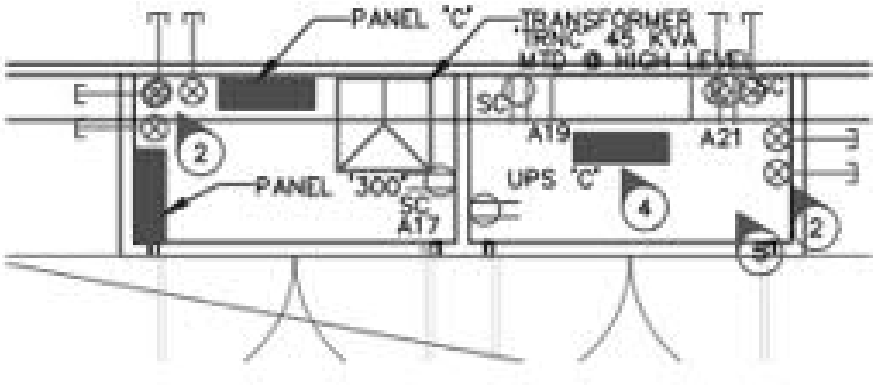


Figure 3: Plan View Layout – Main Floor – Electrical Room #3

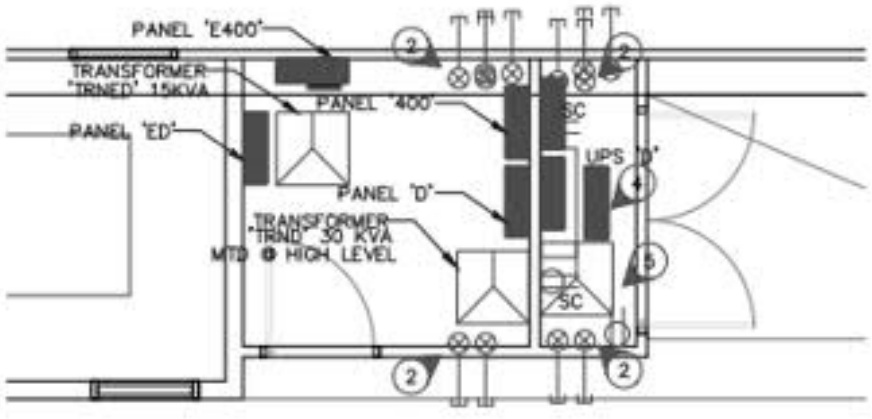


Figure 4: Plan View Layout – Main Floor – Electrical Room #4

The Winnipeg Transit Brandon Bus Garage is powered from a 750 kVA Manitoba Hydro utility transformer, located on the Southeast of the property. The point of termination between the utility transformer's secondary conductors and the line side of the consumer's service is the exterior 1,200 A, 347/600 V, 3 phase, 4 wire Customer Service Termination Enclosure (CSTE), which is located beside the Manitoba Hydro utility transformer. The existing electrical service size for the Brandon Bus Garage is 1,200 A with a supply voltage and configuration of 347/600 V, 3 phase, 4 wire Wye.

The Main Electrical Room #1 houses the main distribution switchboard. The main distribution switchboard is rated for 1,200 A at 347/600 V, 3 Phase, 4 Wire and is protected by a 1,200 A circuit breaker and is complete with 27x space of distribution. The main distribution switchboard is fed underground from the CSTE. There are six existing 3-Pole circuit breakers and one free space in the distribution section of the main distribution switchboard. Refer to Table 1 (below) for circuit breaker capacity and their corresponding loads.

Table 1: Main Distribution Circuit Breakers

Breaker Capacity – Poles	Load
200 A-3P	Panel ' 100'
400 A-3P	Panel '200'
200 A-3P	Panel '300'
400 A-3P	Panel '400'
600 A-3P	CDP-BC
200 A-3P	Transfer Switch

The existing electrical service conditions for the Brandon Bus Garage allow for the addition of two 3-Pole circuit breakers in the main distribution panel for, the KW demand and the remaining capacity of the electrical service will be discussed in detail in the following section.

2.2 Manitoba Hydro Demand

The existing Brandon bus garage facility as noted in Section 2.1 has an existing incoming service of 800 A of capacity at 347/600 V with the Manitoba Hydro Transformer being rated for 750 kVA. This system at unity power factor will accommodate 750 kW of capacity provided the existing main breaker is rated to carry this load continuously. Dillon received the historic data on the existing demand on the service from Manitoba Hydro over the course of the past year which can be seen in Table 2 (below).

Table 2: Recorded kW.h and kW Demand from Manitoba Hydro – June 2019 to July 2020

Serving Month	Electricity kW.h	Electricity Recorded Demand kW
June 2019	126,720	255
July 2019	112,320	240
August 2019	109,440	256
September 2019	104,640	241
October 2019	109,920	254
November 2019	115,680	276
December 2019	141,600	319
January 2020	128,640	317
February 2020	143,520	324
March 2020	134,400	326
April 2020	119,520	306
May 2020	139,680	273
June 2020	102,240	251
July 2020	130,080	233

Using the worst case scenario in Table 2 with the available 750 kW of capacity results in an available capacity of 424 kW to utilize during charging without rework of the existing electrical infrastructure.

3.0 Constraints and Requirements

3.1 Bus Charging Characteristics

The constraints of electrical capacity are directly related to the bus's available battery capacity, distance per kWh, and available charge cycles. As noted in the initial information provided by Transit, any combination of bus and charger must fall within a three hour charge window in order to meet the anticipated scheduling requirements.

During our initial discussions on July 22, 2020 the following parameters were mentioned on bus procurement:

- Eight Buses at 40 feet in length;
- Eight Buses at 60 feet in length; and
- Bus manufacturer to be Newflyer.

Using this information we can see that the Newflyer Xcelsior CHARGE line of buses have multiple charge and capacity options to consider for utilization, and all come equipped with standard charging connector options such as CCS Type 1 and Pantographic charging in compliance with SAE J1772 and J3105 standards respectively. The specification sheets for this bus and the associated charger can be found in Appendix A.

Table 3: Excelsior-CHARGE Bus Capabilities

Bus Length		ESS (kWh)	Maximum Range* (KM)
35 ft. and 40 ft.	Rapid Charge	160	120.7
35 ft. and 40 ft.		213	160.9
40 ft.		267	185
35 ft. and 40 ft.	Long Range	311	257.4
35 ft. and 40 ft.		388	313.8
40 ft.		466	362
60 ft.	Rapid Charge	213	88.5
60 ft.		267	112.5
60 ft.		320	136.6
60 ft.	Long Range	466	217.2

Notes

*Dependant on model, length and motor option.

In order to best provide service to both the 40 foot bus and 60 foot bus models using a similar charging window, both models of buses need to be capable of the same storage capacity. This occurs at three capacities of charge: 213, 267 and 466 kWh. The electrical power required for one charger to have a three hour charge window is therefore 71, 90 and 156 kW respectively.

3.2 Constraints

Herein are detailed the constraints placed upon this report by existing loads, required number of buses and chargers, bus capabilities, etc.:

1. A 3:1 Bus to Charger Ratio:
    1.1. This requires that each bus be able to operate for six hours once fully charged in order to allow for two full charging cycles to take place during its operation;
    1.2. All spaces in tracks 44 and 45 must be electrified; and
    1.3. This requires nine chargers for the 20 buses as detailed in the RFP and our preliminary meeting.
2. Typical Distances Driven by a Bus in an Hour:
    2.1. The average given speed of a transit bus is 20 km/h while on the rapid transit corridor is 35 km/h. For the purposes of this report, a blended speed of 30 km/h will be used to determine operating period.
3. Existing Electrical Capacity:
    3.1. Out of the existing 750 kVA transformer the current peak utilization allows for an additional 424 kW of capacity to be added to the system before upgrading the main distribution.

Using the above three constraints the acceptable bus must meet a minimum distance of 180 km for continual use over six hours without recharging. This eliminates the 213 kWh capacity units out of the acceptable range at both the 40 foot and 60 foot length models, while only the 40 foot length model meets it at the 267 kWh capacity. However both the 40 foot and 60 foot bus models provide ample range at their 466 kWh capacity versions, leading to a charger size of 156 kW per bus, and an overall minimum spare electrical capacity of 1,404 kW.

4.0 Recommendations

Our recommendation therefore is to increase the size of the Brandon bus garage electrical service from 750 kVA to 2,000 kVA. This will provide the required electrical infrastructure to support the addition of seven 150 kW charging stations. This will lead to a slightly longer than three hour charge window, but only if the batteries are below 5% capacity.

This process will include the following:

- Replace existing 750 kVA Hydro transformer with new 2,000 kVA Transformer.
- Replace main incoming feeders with new to accommodate increased capacity:
  - Civil and Structural trenching, cutting and patching required.
- Replace existing 1,200 A Main Distribution board with new 2,000 A Switchgear:
  - Reconfigure existing Main Electrical Room; and
  - Expand electrical room to 8,725 by 12,232 mm.
- Feed nine chargers directly off the new 2,000 A Switchgear.
- Tie in existing infrastructure to new 2,000 A Switchgear.
- Provide temporary generator to accommodate continued building operation during utility transfer.
- Under ideal conditions schedule work for afterhours operations of the facilities to minimize downtime for client operations.

5.0 Costing

5.1 Capital Expenditure

As part of this report Dillon has developed a Class 3 estimate of cost in conjunction with the Winnipeg basis of estimate document. This project will incorporate multiple trades across several disciplines. In order to upgrade the main electrical service for the Brandon garage, the incoming underground service will need to be excavated, and a new service buried. We see this costing $398,690.00 for the new service upgrade plus expansion to the main electrical room to meet code compliance requirements.

The installation of the bus charging infrastructure is an equipment intensive budget for the 9,150 kW electric vehicle chargers combined with 34 remote dispensers to allow for sequential charging and using preliminary budgetary numbers from several manufacturers plus routine labour expectations the approximate cost of this work is $2,247,578.00.

Additionally, there will need to be several consultants on this project including an Electrical consultant, Architect and Structural consultant. These have also been carried in the provided basis of estimate cost spreadsheet as percentage-based fees at 4%, and 1% respectively.

5.2 Operational Costs

Within our Class 3 estimate of cost, we've also evaluated the increase to the yearly electrical costs associated with the increased demand and usage based on the current Manitoba Hydro information. Due to the service upgrade this would be a time in which Transit may consider owning their own transformers under the General Service – Large tariff, however due to the requirement for the system to be above 750 V this becomes cost prohibitive as the building doesn't currently utilize high voltage equipment or cabling and a new main electrical room/vault would need to be constructed with this in mind. Using the demand charges associated with the General Service – Medium for Commercial clients we see the breakdown below.

Table 4: Manitoba Hydro General Service Medium

Charge	Cost
Basic Monthly Charge	$31.55
First 11,000 kWh	9.002 ¢/kWh
Next 8,500 kWh	6.656 ¢/kWh
Balance of kWh	4.206 ¢/kWh
First 50 kVA of monthly recorded demand	No Charge
Balance of recorded demand	$10.77 per kVA

In order to assess the operational costs of the bus system we've evaluated the electrical service based on 15 hours per day of operational time for the nine chargers. This amounts to 7,686,900 kWh of additional load per year, and a peak demand of 1,405kVA higher than the current demand. This results in a charge of $332,520.00 per year for usage and $217,930.00 for demand before inflation factors for year over year operational budgets. In addition we've allowed for the replacement of 1 remote dispenser per year due to potential collision damage.

Appendix A

Bus and Charger – Specification Sheets

NEW FLYER®

INFRASTRUCTURE SOLUTIONS™

Charger Catalog

March 2020

Explore what Infrastructure Solutions can do for you.
Contact infrastructuresolutions@newflyer.com for details.

Index

Plug-In Chargers

Opportunity Chargers

NEW FLYER®

INFRASTRUCTURE SOLUTIONS™

Contact infrastructuresolutions@newflyer.com for details.

newflyer.com/infrastructuresolutions

Plug-in Chargers

HVC-C 100 & 150 KW

MODEL	HVC-C	HVC-C
Power Output (kW)	100 kW	150 kW
Max Output Current	166A	200A
Voltage Range	150-850 VDC	150-850 VDC
Operating Temperature (C°)	-10 to 50 (C°) (Standard) -35 to 50 (C°) (Optional)	-10 to 50 (C°) (Standard) -35 to 50 (C°) (Optional)
Outdoor Rated	Yes	Yes
User Interface	N/A	N/A
Remote Monitoring	Optional	Optional
Charge Protocol	SAE J1772 OCPP 1.6	SAE J1772 OCPP 1.6
Connector Type	CCS Type 1	CCS Type 1
Cord Length	3.5 meters (std) (11.5 feet) 7 meters (opt) (22.9 feet)	3.5 meters (std) (11.5 feet) 7 meters (opt) (22.9 feet)
Dispenser Holster Mounting	Remote Pedestal/Wall Mounted	Remote Pedestal/Wall Mounted
Number of Remote Dispensers	Up to 3	Up to 3
Dimensions (Inches)	Cabinet: 82.36" x 46.06" x 30.31" Dispenser: 27.52" x 9.44" x 6.65"	Cabinet: 82.36" x 46.06" x 30.31" Dispenser: 27.52" x 9.44" x 6.65 "
Weight (kg)	Cabinet: 1,340 kg Dispenser: 65kg (w/ 7m cable) 45kg (w/o cable) 55kg (w/ 3.5m cable)	Cabinet: 1,340 kg Dispenser: 65kg (w/ 7m cable) 45kg (w/o cable) 55kg (w/ 3.5m cable)
Buy-America Compliant	Yes	Yes
Certified	UL/CSA	UL/CSA

Plug-in Chargers

MODEL	TERRA 54HV
Power Output (kW)	50 kW
Max Output Current	125A
Voltage Range	150-920 VDC
Operating Temperature (C°)	-35 to 55 (C°)
Outdoor Rated	Yes
User Interface	Yes
Remote Monitoring	Optional
Charge Protocol	SAE J1772 OCPP 1.6
Connector Type	CCS Type 1
Cord Length	3.9 meters (std) (12.8 feet) 6 meters (opt) (22.9 feet)
Dispenser Holster Mounting	Cabinet Mounted
Number of Remote Dispensers	N/A
Dimensions (Inches)	48" x 32" x 85"
Weight (kg)	375 kg
Buy-America Compliant	No
Certified	CSA/UL

TERRA 54HV 50 KW

Plug-in Chargers

chargepoint

MODEL	CPE250
Power Output (kW)	Single Station Output: 62.5 kW When Paired: 125 kW
Max Output Current	Single Station: 156A Paired Station: 200A
Voltage Range	200 - 1000 VDC
Operating Temperature (C°)	-30 to 50 (C°)
Outdoor Rated	Yes: NEMA3R IP54
User Interface	10" LCD
Remote Monitoring	Included with Cloud Service
Charge Protocol	SAE J1772 OCPP 1.6
Connector Type	CCS Type 1
Cord Length (feet)	12.5 feet (3.8 meters)
Dispenser Holster Mounting	Cabinet Mounted
Number of Remote Dispensers	N/A
Dimensions (inches)	88" x 46" x 17"
Weight (kg)	Standard: 250 kg With Power Modules: 340 kg
Buy-America Compliant	Yes
Certified	Yes

CPE250

Plug-in Chargers

SIEMENS

VERSICHARGE™ MAXXHP

MODEL	VERSICHARGE™ MAXXHP
Power Output (kW)	150 kW
Max Output Current	200A
Voltage Range	500-800 VDC
Operating Temperature (C°)	-25 to 50 (C°)
Outdoor Rated	IP54/NEMA 3R
User Interface	7" Touch Display
Remote Monitoring	Available
Charge Protocol	SAE J1772 OCPP 1.6
Connector Type	CCS Type 1
Cord Length (Meters)	7.62 meters (25 feet)
Dispenser Holster Mounting	Pedastal Mounted/Wall Mounted
Number of Remote Dispensers	Up to 4
Footprint (Inches)	55.1" x 43.2"
Dimensions (Inches)	77.9" x 49" x 79.3"
Weight (kg)	2,395 kg
Buy-America Compliant	Yes
Certified	NRTL Field Inspected for UL Compliance until UL Certification is completed. UL Certification is pending.

Plug-in Chargers

EV QVC 90 B

EV QVC 150 B

HV175

efacec

MODEL	EV QVC 90	EV QVC 150	HV175
Power Output (kW)	90 kW	150 kW	175 kW
Max Output Current	120A	200A	200A
Voltage Range	250-750 VDC	250-750 VDC	250-920 VDC
Operating Temperature (C°)	-25 to 50 (C°) (Standard) -35 to 50 (C°) (Optional)	-25 to 50 (C°) (Standard) -35 to 50 (C°) (Optional)	-25 to 50 (C°) (Standard) -35 to 50 (C°) (Optional)
Outdoor Rated	Yes	Yes	Yes
User Interface	6.4" TFT	6.4" TFT	6.4" TFT
Remote Monitoring	Optional	Optional	Optional
Charge Protocol	SAE J1772 OCPP 1.6	SAE J1772 OCPP 1.6	SAE J1772 OCPP 1.6
Connector Type	CCS Type 1	CCS Type 1	CCS Type 1
Cord Length (Feet)	12 feet (3.66 meters)	12 feet (3.66 meters)	12 feet (3.66 meters)
Dispenser Holster Mounting	1	1	1
Number of Remote Dispensers	N/A	N/A	N/A
Dimensions (Inches)	70.9" x 31.5" x 31.5"	70.9" x 39.4" x 31.5"	74.5" x 40" x 32"
Weight (kg)	775 kg	1,000 kg	1,098 kg
Buy-America Compliant	No	No	No
Certified	UL Field	UL Field	UL Field

Opportunity Chargers

HVC-P 150

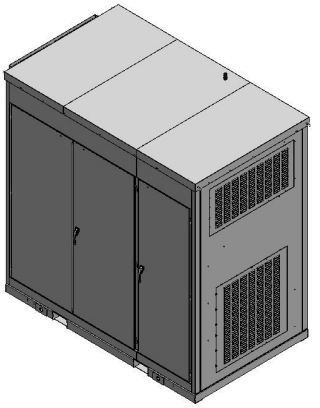
HVC-P 300

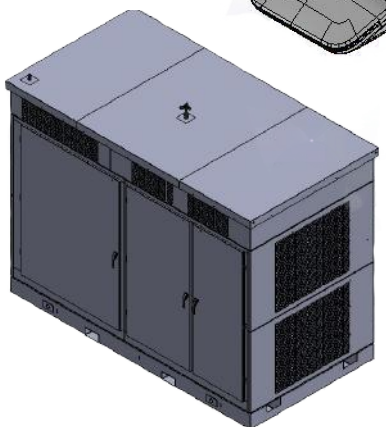
HVC-P 450

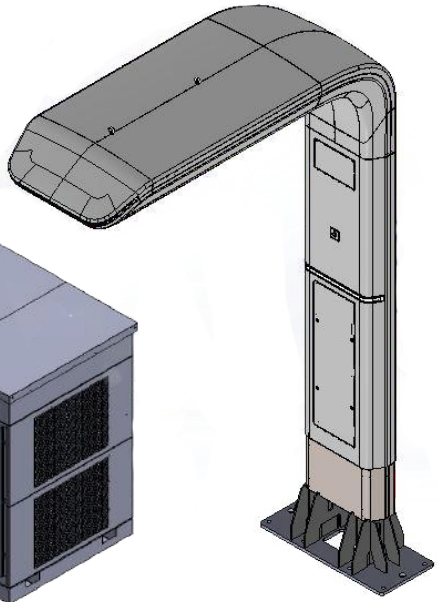
MODEL	HVC-P	HVC-P	HVC-P
Power Output (kW)	150 kW	300 kW	450 kW
Max Output Current	250A	500A	600A (limited by pantograph)
Voltage Range	150-850 VDC	150-850 VDC	150-850 VDC
Operating Temperature (C°)[1]	-35 to 45(C°)	-35 to 45 (C°)	-35 to 45 (C°)
Outdoor Rated	Yes	Yes	Yes
User Interface	N/A	N/A	N/A
Remote Monitoring	Optional	Optional	Optional
Charge Protocol	SAE J3105 IEC 61851-23-1 OCPP 1.6	SAE J3105 IEC 61851-23-1 OCPP 1.6	SAE J3105 IEC 61851-23-1 OCPP 1.6
Max Distance to Cabinet Overhead	20 m (standard) (65.6 feet) 150 m (optional) (492.1 feet)	20 m (standard) (65.6 feet) 150 m (optional) (492.1 feet)	20 m (Standard) 150 m (Optional)
Dimensions (Inches)	Cabinet: 82.36" x 46.06" x 30.31" Mast: 206.3" x 183.8"	Cabinet: 82.36" x 46.06" x 30.31" Mast: 206.3" x 183.8"	Cabinet: 82.36" x 46.06" x 30.31" Mast: 206.3" x 183.8"
Weight (kg)	Cabinet: 1,340 kg Mast: 1,706 kg	Cabinet: 2,680 kg Mast: 1,706 kg	Cabinet: 4,020 kg Mast: 1,706 kg
Origin	Cabinet: Italy/ USA Mast: Netherlands	Cabinet: Italy/ USA Mast: Netherlands	Cabinet: Italy/USA Mast: Netherlands
Buy-America Compliant	Yes	Yes	Yes
Certified[2]	UL/CSA	UL/CSA	UL/CSA

1 Low temperature package has to be selected for this temperature rating
2 The ACM/cabinet are UL/CSA certified. Pantograph is certified on site.

Opportunity Chargers







SIEMENS

V2.1 COMPACT CHARGER 300

V2.1 COMPACT CHARGER 450 & 600

SIEMENS MAST

MODEL	V2.1 COMPACT CHARGER	V2.1 COMPACT CHARGER
Power Output (kW)	450 kW[1]	600 kW
Max Output Current	600A	800A
Voltage Range	200-1000 VDC	200-1000 VDC
Operating Temperature (C°)	-25 to 45 (C°)	-25 to 45 (C°)
Outdoor Rated	Yes	Yes
User Interface	N/A	N/A
Remote Monitoring	Optional	Optional
Charge Protocol	SAE J3105 OCPP 1.6 J	SAE J3105 OCPP 1.6 J
Max Distance to Cabinet Overhead	100 m (328 feet)	100 m (328 feet)
Dimensions (Inches)	Cabinet: 94.8" W x 61.6" D x 84" H Mast: 228.6" x 149.22"	Cabinet: 94.8" W x 61.6" D x 84" H Mast: 228.6" x 149.22"
Weight (kg)	Cabinet: 4,990 kg Mast: 1,996 kg	Cabinet: 4,990 kg Mast: 1,996 kg
Origin	USA	USA
Buy-America Compliant	Yes	Yes
Certified	NRTL Field Inspected for UL Compliance	NRTL Field Inspected for UL Compliance

1 300kW charger available upon request

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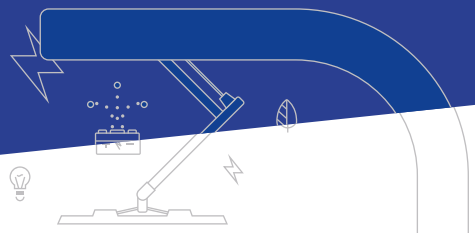

Supporting Mobility Projects from Start to Finish.

New Flyer Infrastructure Solutions™ is a service dedicated to providing safe, reliable, smart, and sustainable charging and mobility solutions.

Support

Guide mobility projects from start to finish

Optimization

Focus on maximizing energy transfer and usage

Planning

Infrastructure planning and development

Transition

Cohesive shift to zero-emission electric technology

New Flyer Infrastructure Solutions™ provides a full suite of comprensive charging deployement services, with the ability to:

- **Optimize** energy management strategies between grid and the bus
- **Determine** wayside and depot charging requirements.
- **Install** chargers.
- **Oversee** make-ready utility services.
- **Offer** aftermarket support for service and parts.
- **Coordinate** UL certification.
- **Conduct** site visits.
- **Deliver** onsite grid-to-bus testing and commissioning to ensure safe and reliable infrastructure.
- **Provide** design and engineering services for infrastructure.

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Revision Date 03.19.20.

xcelsior CHARGE™

Our zero-emission battery-electric bus.

NEW FLYER

Smart Mobility.

Zero emissions, lower operating costs, interoperable charging systems — New Flyer's Xcelsior CHARGE™ is a sophisticated battery-electric bus that is ready to meet tomorrow's transportation demands today.

Available in 3 lengths.

Benefits of Xcelsior CHARGE™.

Fuel Economy

Highest passenger per mile fuel economy of any zero-emission vehicle based on FTA Altoona fuel economy test protocol.

Energy Savings

Save up to $400,000 in fuel costs over the 12-year life of the bus. Actual savings will depend on regional energy costs and charging methods.

Maintenance Savings

With no engine, transmission, intake or exhaust, customers can save up to $125,000 in maintenance costs over 12 years.

Environment First

Reduction of 100 - 160 tons of greenhouse gas per year compared to a 40′ diesel bus and 75 - 110 tons compared to a 40′ diesel-hybrid bus.

Noise Reduction

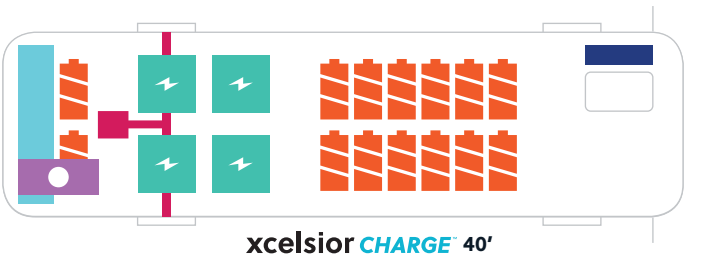
Electric motors emit very little external noise making for a greater rider experience.

newflyer.com/CHARGE

How it Works.

The Xcelsior CHARGE™ uses an electric motor powered by energy stored in rechargeable batteries.

- Battery Energy Storage System (ESS)
- Electric Heating, Venting & Air Conditioning (HVAC)
- Drive Auxiliary System/ Power Electronics
- Traction Motor (No Transmission Required)
- Battery Cooling System
- Electric Power Steering Unit



Electric Drive System

- Features a Siemens high-efficiency permanent magnet (PEM) motor.
- Supplies three-phase alternating current (AC) power to drive the traction motor by converting direct current (DC) power from the batteries.
- Direct drive: No transmission required, reducing cost, weight, maintenance and propulsion complexity.
- Regenerative braking while decelerating recharges the batteries, reducing energy consumption and extending range.

Energy Storage Systems

- Industry-leading range capability from 160 kWh to 466 kWh of electricity.
- US battery suppliers: XALT Energy and A123 Systems.
- Battery configuration available for long-range depot charging and on-route high-power charging.
- Monitored by a battery management system for added protection, longevity, and charging efficiency.
- Thermal management for maximum battery life in rapid charge applications and extreme ambient temperatures.

Functionality & Accessibility

- Improved traction and gradeability with a high-gradeability motor available on all lengths.
- SmartRider™ enables kneeling to variable heights and minimizes the slope difference between a low-floor ramp and the bus floor.
- SmartRider™ ramp achieves a 1:6 slope ratio with a self-leveling feature that can withstand up to 1000lbs.
- Industry-leading passenger carrying capacity with up to 82 total (40 seated and 42 standees).

CONNECT 360™

Connect 360™, operated by New Flyer Connect®, is a customizable performance dashboard that provides smart analytic reporting to expand insight and intelligence for managing your Xcelsior CHARGE™ battery-electric bus.

Connect 360™ is included on every new Xcelsior CHARGE™. Learn more at newflyer.com/connect.

- **Additional range** capability with improved driver performance.
- **Decision-making information** to optimize charging strategies.
- **Intelligence** on how to preserve battery energy throughout the day.
- **Reduced operating cost** and maximum fleet utilization.

NEW FLYER® / INFRASTRUCTURE SOLUTIONS™

New Flyer Infrastructure Solutions™ is a service dedicated to providing safe, reliable, smart and sustainable charging and mobility solutions.

Learn more at **newflyer.com/infrastructuresolutions.**

What our New Flyer Infrastructure Solutions™ can do for you.

- ✓ Support mobility projects from start to finish.
- ✓ Focus on energy management optimization.
- ✓ Provide infrastructure planning and development.
- ✓ Provide cohesive transition of bus fleets to zero-emission electric technology.

Committed to Smart Mobility.

- ○ Joined CharIN to support industry charging standards for all electric vehicles.
- ○ Became the first licensee outside the Volvo Group to join OppCharge in North America.
- ○ Supported the CUTRIC launch of the Pan-Canadian Electric Bus Demonstration and Integration Trial.
- ○ Became the first bus manufacturer to sign on to the Shared Mobility Principles for Livable Cities.
- ○ Committed to CALSTART's Global Commercial Drive to Zero Pledge.
- ○ Signed on to the U.S. Transportation Electrification Accord.

VIC | VEHICLE INNOVATION CENTER

Learn more about this technology at New Flyer's Vehicle Innovation Center.

newflyer.com/vic

50 Years Experience.

New Flyer has been manufacturing zero-emission buses since 1969. We've delivered over 7,300 buses powered by electric motors and batteries in North America, and are the only bus manufacturer to offer all three types of zero emission propulsion systems—battery-electric, fuel cell-electric and trolley-electric.

	xcelsior CHARGE 35′	xcelsior CHARGE 40′	xcelsior CHARGE 60′
Measurements			
Length	36′ 3″ (11.05m) Over bumpers; 35′ 5″ (10.80m) Over body	41′ 0″ (12.50m) Over bumpers; 40′ 2″ (12.24m) Over body	60′ 10″ (18.54m) Over bumpers; 60′ 0″ (18.29m) Over body
Width	102″ (2.6m)	102″ (2.6m)	102″ (2.6m)
Roof Height	11′ 1″ (3.3m) Over charging rails	11′ 1″ (3.3m) Over charging rails	11′ 1″ (3.3m) Over charging rails
Step Height	14″ (356mm)	14″ (356mm)	14″ (356mm)
Front Step Height (Kneeled)	10″ (254mm)	10″ (254mm)	10″ (254mm)
Interior Height – Floor to Ceiling	79″ (2m) Over front and rear axle; 95″ (2.4m) Mid-coach	79″ (2m) Over front and rear axle; 95″ (2.4m) Mid-coach	79″ (2m) Over front and rear axle; 95″ (2.4m) Mid-coach
Tire Size	305/70R22.5	305/70R22.5	305/70R22.5
Wheelbase	226.75″ (5.8m)	283.75″ (7.2m)	229″ (5.8m) Front / 293″ (7.4m) rear
Propulsion			
Motor	Siemens ELFA2 electric drive system; Standard or optional high gradeability motor	Siemens ELFA2 electric drive system; Standard or optional high gradeability motor	Siemens ELFA2 electric drive system; ZF AVE130 in-wheel motor center drive axle; Standard or optional high gradeability motor
Energy Storage System			
Rapid Charge	160 kWh, 213 kWh	160 kWh, 213 kWh & 267 kWh, 320 kWh	213 kWh, 267 kWh, 320 kWh
Rated Power	160 kW	160 kW	210 kW
Long Range Charge	311 kWh, 388 kWh	311 kWh, 388 kWh & 466 kWh	466 kWh
Rated Torque	1,033 lb-ft	1,033 lb-ft	1,475 lb-ft
Passenger Capacity (*Based on 160 kWh ESS configuration)			
Seats	Up to 32*	Up to 40*	Up to 52 (with one exit door)*
Standees	Up to 35*	Up to 42*	Up to 73 (with one exit door)*
Accessibility			
Doors	2	2	2 or 3 (option for up to 5 doors)
Wheelchair Accessibility	32″ (813mm) Wide, 1:6 slope; Flip out NFIL ramp, front door	32″ (813mm) wide, 1:6 slope; Flip out NFIL ramp, front door	32″ (813mm) wide, 1:6 slope; Flip out NFIL ramp, front door
Wheelchair Locations	2 - Front location, rear location also available (other options available)	2 - Front location, rear location also available (other options available)	2 - Front location, rear location also available (other options available)
Weight (Approximate weights; *Varies with ESS configuration)			
Curb Weight	28,556 lb (12,953 kg)*	28,751 lb (13,041kg)*	45,662 lb (20,712 kg)*
Approach Angle			
Approach/Departure/Breakover Angles	9°/9°/12°	9°/9°/9°	9°/9°/12° (front) 9° (back)
Turning Radius (Body, with aluminum wheels; *Varies with wheel type)			
Turning Radius	39′ (11.9m)*	43.5′ (13.3)*	44′ (13.4m)*
Main Components			
Floor	Marine grade plywood floor; Optional composite floor; Composite rear interior step; Tarabus, Altro, RCA floor covering	Marine grade plywood floor; Optional composite floor; Composite rear interior step; Tarabus, Altro, RCA floor covering	Marine grade plywood floor; Optional composite floor; Composite rear interior step; Tarabus, Altro, RCA floor covering
Electrical System	Parker Vansco	Parker Vansco	Parker Vansco
Cooling System	Electric cooling fans	Electric cooling fans	Electric cooling fans
HVAC	Thermo King TE15 (rear)	Thermo King TE15 (rear)	Thermo King RLFE (front) TE15 (rear)
Axles	MAN VOK 07 Front disc brakes; MAN HY-1350 Rear disc brakes; Single reduction axle	MAN VOK 07 Front disc brakes; MAN HY-1350 Rear disc brakes; Single reduction axle	MAN VOK 07 Front disc brakes; ZF AVE 130 Center disc brakes; MAN HY-1350 Rear disc brakes; Single reduction axle

12-Year comprehensive warranty available on batteries, inverters and electric motors.

Six minutes of rapid recharge time with a 450 kWh charger equals 1.5 hours of operation.

Rapid charge configuration fully compliant with OppCharge and charging protocols.

OPPcharge SAE

Charging.

New Flyer buses are interoperable with charging equipment that supports all heavy-duty electric vehicles. You can customize your Energy Storage Systems (ESS) and charging solutions so you can develop the right ESS and infrastructure solution for your needs.

Xcelsior CHARGE™ is interoperable with charging systems available from:

SIEMENS

chargepoint

ABB

On-Route Charging

The on-route rapid charger provides the means for the Xcelsior CHARGE™ to stay in service 24 hours daily. To charge, the bus stops underneath the charger and the pantograph makes contact with the charge bars.

Plug-In Charging

Plug-in chargers are available as a supplement or alternative to on-route rapid chargers and can be used for overnight, mid-day and off-route charging. A full charge requires 3.2 hours for a 466 kWh ESS.

Range Capability

The 40' Xcelsior CHARGE™ has a range of up to 225 miles (466 kWh)* on a single charge, but with on-route, charging range is unlimited.

** Range per FTA Altoona test protocol - HVAC off*

Industry Leading Range Capability.

Length		ESS (kWh)	Maximum Range* (Miles)
35' & 40'	Rapid Charge	160	75
35' & 40'		213	100
40'		267	115
35' & 40'	Long Range	311	160
35' & 40'		388	195
40'		466	225
60'	Rapid Charge	213	55
60'		267	70
60'		320	85
60'	Long Range	466	135

*dependent on model, length and motor option

NEW FLYER

xcelsior CHARGE™

newflyer.com/CHARGE

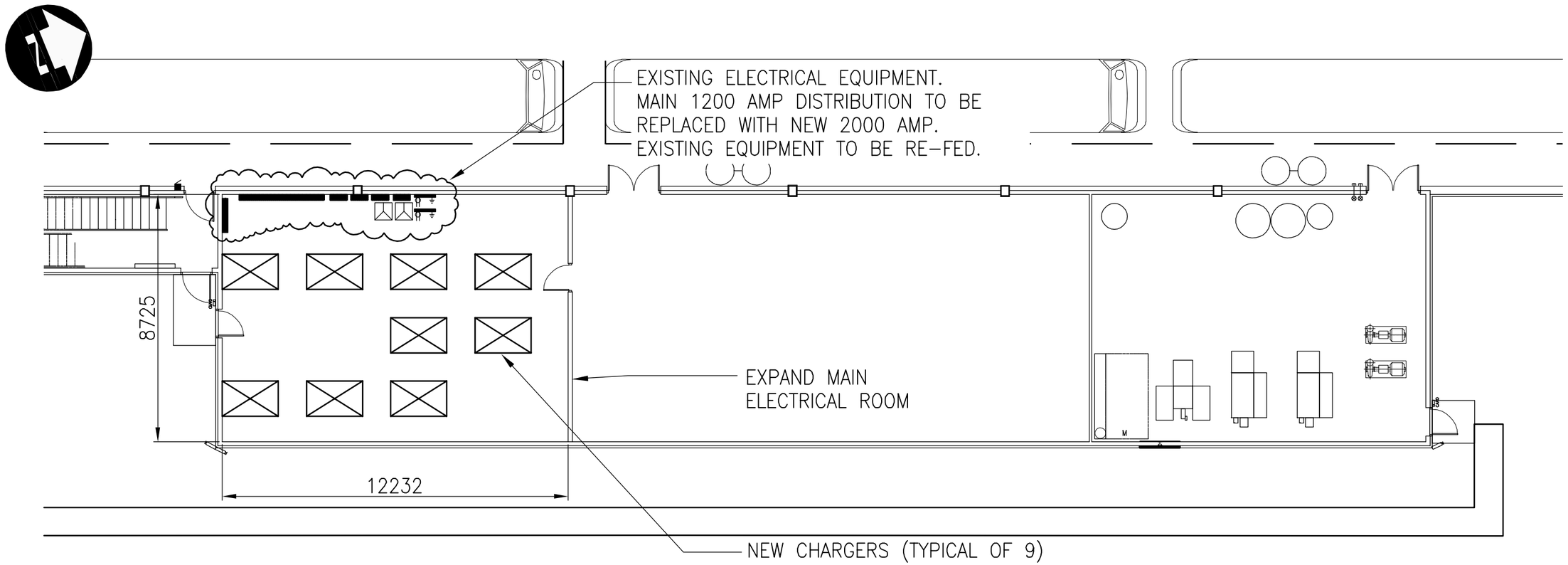
VIC | VEHICLE INNOVATION CENTER

Learn more about this technology at New Flyer's Vehicle Innovation Center

newflyer.com/vic

Appendix B

Preliminary Design Sketches



ELECTRICAL ROOM

1:150

CONSTRUCTION NOTES

1.

DILLON CONSULTING

DATE 2021-02-19

PROJECT CITY OF WINNIPEG BUS ELECTRIFICATION
BRANDON GARAGE

PROJECT NO. 203181

TITLE EXISTING MAIN ELECTRICAL ROOM
MODIFICATIONS AND ADDITONS

FIGURE NO. E01

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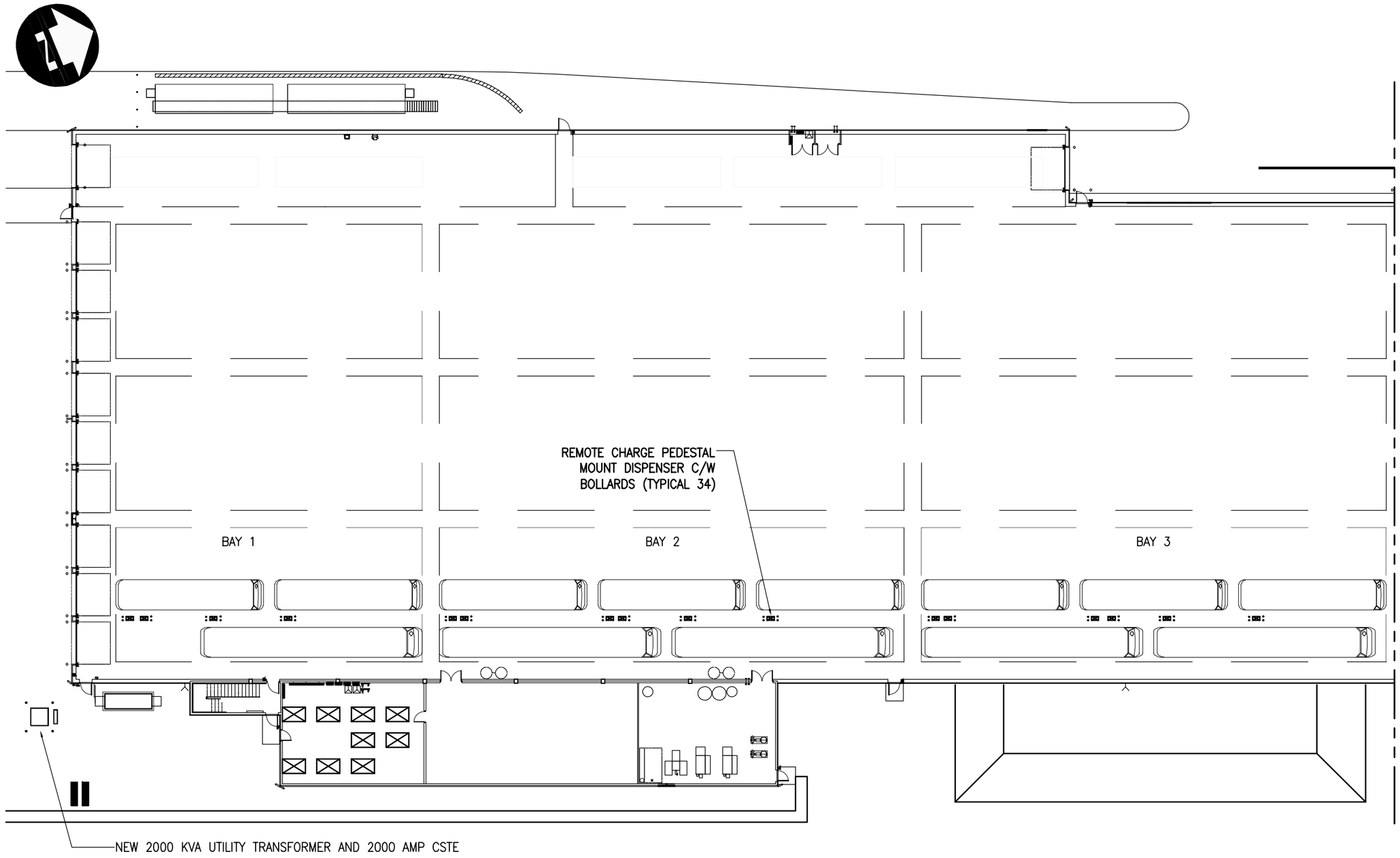

CONSTRUCTION NOTES

1.

BUILDING SOUTH END PLAN

1:350

DILLON CONSULTING

DATE 2021-02-19

PROJECT CITY OF WINNIPEG BUS ELECTRIFICATION
BRANDON GARAGE

PROJECT NO. 203181

TITLE MAIN GARAGE - SOUTH END
ELECTRIC CHARGER DISPENSER LOCATION

FIGURE NO. E02

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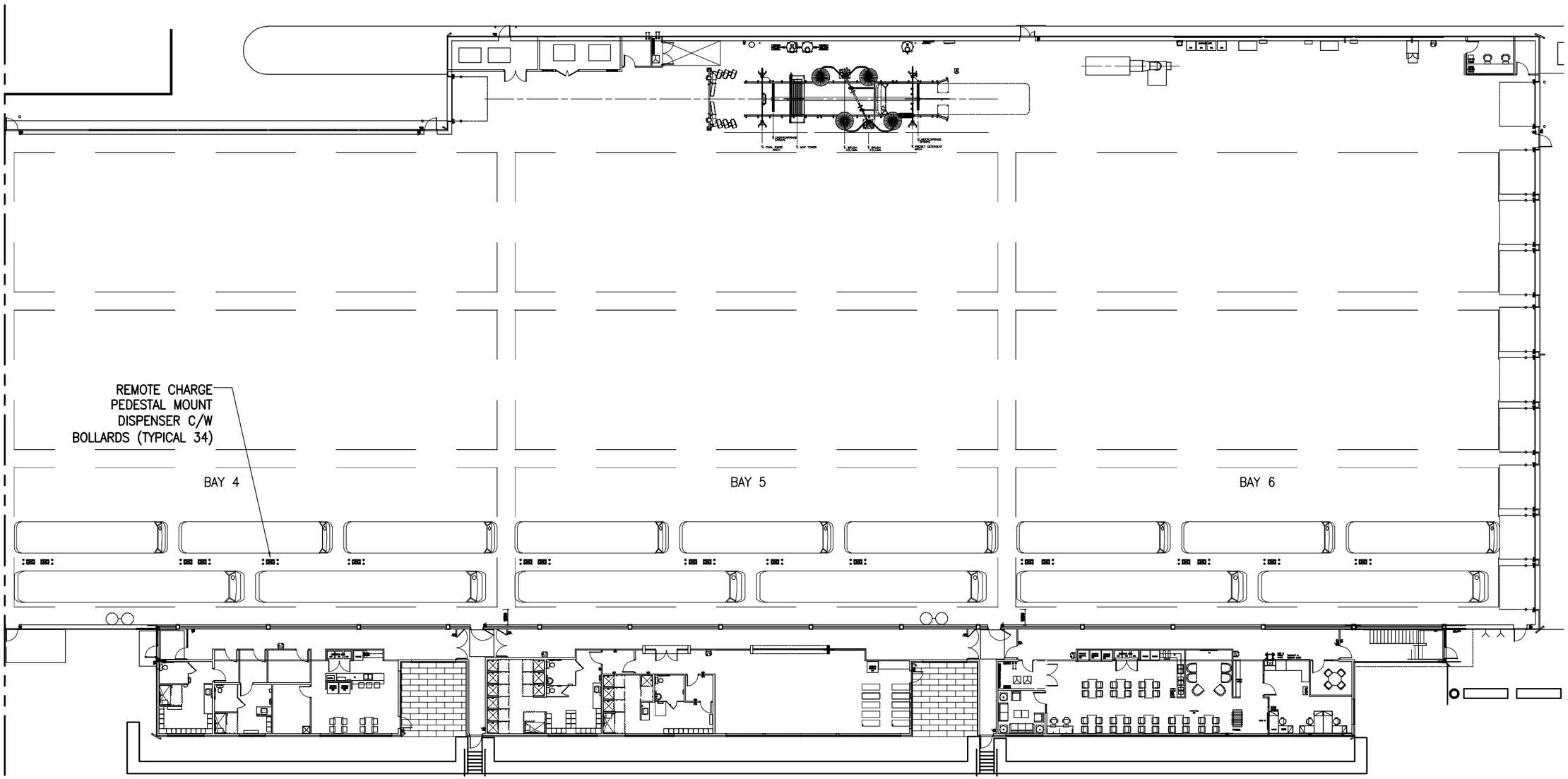

CONSTRUCTION NOTES

1.

BUILDING NORTH PLAN

1:350

DILLON CONSULTING

DATE 2021-02-19

PROJECT CITY OF WINNIPEG BUS ELECTRIFICATION
BRANDON GARAGE

PROJECT NO. 203181

TITLE MAIN GARAGE -NORTH END
ELECTRIC CHARGER DISPENSER LOCATION

FIGURE NO. E03

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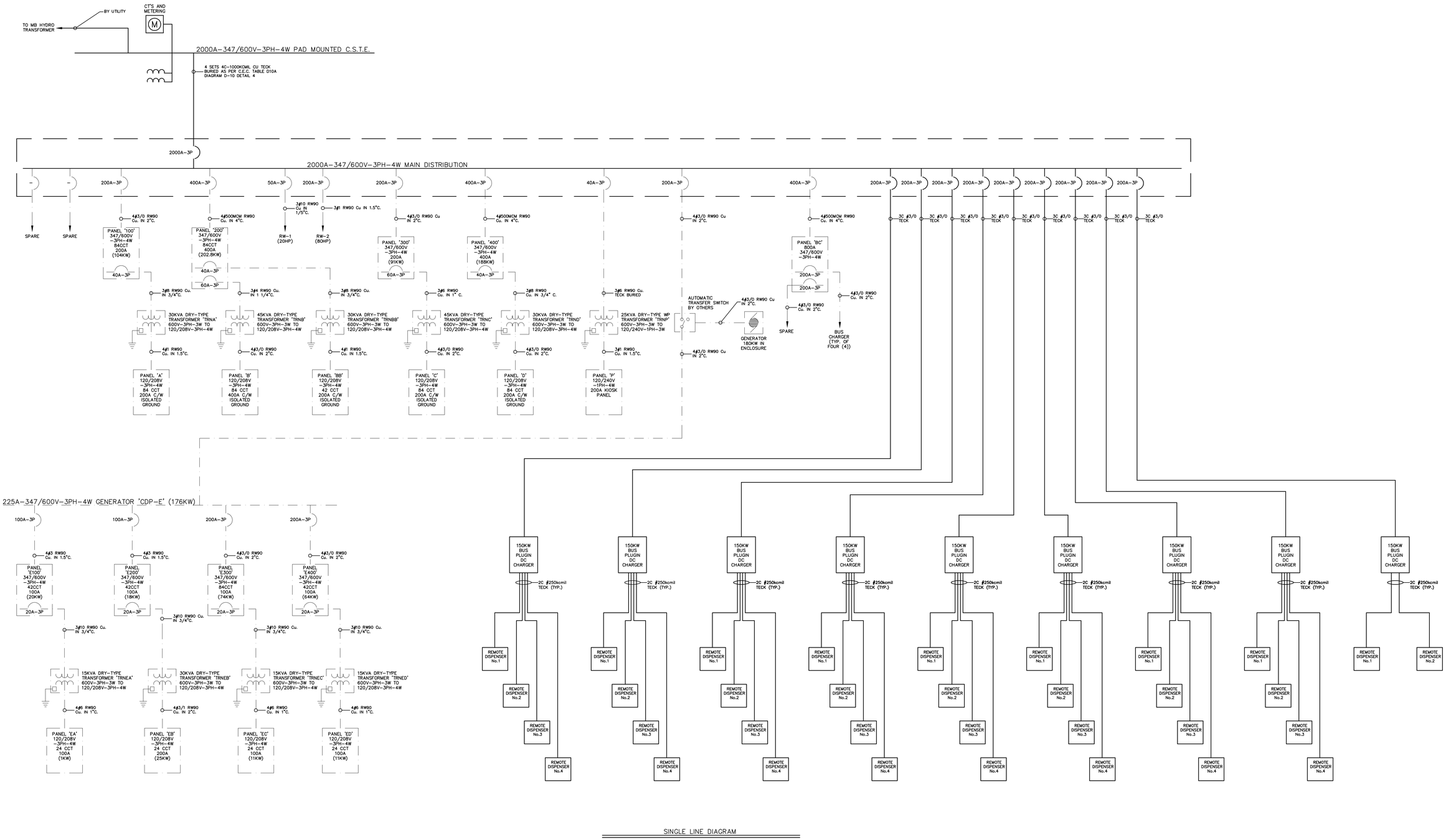

SINGLE LINE DIAGRAM

N.T.S

Conditions of Use

Verify elevations and/or dimensions on drawing prior to use. Report any discrepancies to Dillon Consulting Limited.

Do not scale dimensions from drawing.

Do not modify drawing, re-use it, or use it for purposes other than those intended at the time of its preparation without prior written permission from Dillon Consulting Limited.

DILLON CONSULTING

No.	ISSUED FOR	DATE	BY
1	ISSUED FOR	#	BLM

DESIGN: BLM | REVIEWED BY: BLM
DRAWN: SCK | CHECKED BY: BLM
DATE: 10/06/2020
SCALE: NONE

CITY OF WINNIPEG BUS ELECTRIFICATION
BRANDON GARAGE

PROJECT NO. 203181

ELECTRICAL
SINGLE LINE DIAGRAM

SHEET NO. E04

Appendix C

Costing

Basis of Estimate Summary

Investment Title	Brandon Bus Garage Electric Charging Infrastructure
Investment Description	
Department	
Date	12-Feb-21
BoE Author	Benjamin Doucet
BoE Estimating Team	Dillon Consulting
BoE Reviewed by	Glen Rockett
Business Case ID	

Investment Capital Cost Summary	
CAPITAL COSTS ($000's)	
Construction/Equipment	$2,725,657
Consultant	$163,541
Utility	
Other	$433,380
Contingencies	$332,258
Administration	$73,197
Interest	

Investment Operating Cost Summary

NET OPERATING IMPACT ($000's)	2022	2023	2024	2025	2026	2027
Operating Costs	$456,445	$465,574	$474,885	$484,383	$494,071	$503,952
Debt & Finance Charges						
Total Direct Costs	456,445	465,574	474,885	484,383	494,071	503,952
Less: Incremental Revenue/Recovery	-	-	-	-	-	-
Net Cost/(Benefit)	456,445	465,574	474,885	484,383	494,071	503,952
Incremental Full Time Equivalent Positions						

Estimate Classification	Class 3
Assumptions	
Risks and Opportunities	
Reference Documents	

Document Control			
Major Changes from Previous Estimate			
Version #	Date	Author	Rationale

Basis of Estimate Capital Cost Detail

Investment Title	Brandon Bus Garage Electric Charging Infrastructure
BC ID	0
Is this a Major Capital project?	No
Estimate Date	February 12, 2021
In Service Year	
Class of Estimate	Class 3

ESTIMATE DETAIL

			Cost Escalation / Capital Inflation	3%	3%	3%	3%	3%	3%	
			Estimate Year	Year Project Work Undertaken						
			2021	2022	2023	2024	2025	2026	2027	Total
Construction/Equipment Costs	% of Const.	($000's)								
Electrical Room Renovation	3%	$73,690		$75,901	$0	$0	$0	$0	$0	$75,901
Bus Charging Infrastructure	79%	$2,102,000		$2,165,060	$0	$0	$0	$0	$0	$2,165,060
Electrical Service Upgrade	15%	$398,690		$410,651	$0	$0	$0	$0	$0	$410,651
Cutting & Patching of Penetrations	1%	$20,000		$20,600	$0	$0	$0	$0	$0	$20,600
Mobilization & Demobilization	2%	$51,888		$53,445	$0	$0	$0	$0	$0	$53,445
	0%			$0	$0	$0	$0	$0	$0	$0
Construction Costs Sub-total	100%	$2,646,268		$2,725,657	$0	$0	$0	$0	$0	$2,725,657
Consultant Costs (Internal & External)	% of Const	($000's)								
Electrical Engineering Consultant	4%	$105,851		$109,027	$0	$0	$0	$0	$0	$109,027
Architectural	1%	$26,463		$27,257	$0	$0	$0	$0	$0	$27,257
Structural	1%	$26,463		$27,257	$0	$0	$0	$0	$0	$27,257
	0%			$0	$0	$0	$0	$0	$0	$0
	0%			$0	$0	$0	$0	$0	$0	$0
Consultant Costs Sub-total	6%	$158,776		$163,541	$0	$0	$0	$0	$0	$163,541
Construction & Consultant Sub-total		$2,805,044		$2,889,198	$0	$0	$0	$0	$0	$2,889,198
Utility Costs	% C&C	($000's)								
Hydro	0%			$0	$0	$0	$0	$0	$0	$0
Communication - MTS	0%			$0	$0	$0	$0	$0	$0	$0
Communication - Shaw	0%			$0	$0	$0	$0	$0	$0	$0
	0%			$0	$0	$0	$0	$0	$0	$0
	0%			$0	$0	$0	$0	$0	$0	$0
	0%			$0	$0	$0	$0	$0	$0	$0
Utility Costs Sub-total	0%	$0		$0	$0	$0	$0	$0	$0	$0
Other Costs	% C&C	($000's)								
Land Acquisition	0%			$0	$0	$0	$0	$0	$0	$0
Taxes	15%	$420,757		$433,380	$0	$0	$0	$0	$0	$433,380
	0%			$0	$0	$0	$0	$0	$0	$0
	0%			$0	$0	$0	$0	$0	$0	$0
Other Costs Sub-total	15%	$420,757		$433,380	$0	$0	$0	$0	$0	$433,380
Project Costs before Contingencies Sub-total		$3,225,800		$3,322,578	$0	$0	$0	$0	$0	$3,322,578
Contingencies Costs	% Proj Cost	($000's)								
10% Contingency	10%	$322,580		$332,258	$0	$0	$0	$0	$0	$332,258
	0%			$0	$0	$0	$0	$0	$0	$0
	0%			$0	$0	$0	$0	$0	$0	$0
	0%			$0	$0	$0	$0	$0	$0	$0
	0%			$0	$0	$0	$0	$0	$0	$0
	0%			$0	$0	$0	$0	$0	$0	$0
Contingencies Costs Sub-total	10%	$322,580		$332,258	$0	$0	$0	$0	$0	$332,258
Project Sub-total before Administrative Charges Subtotal		$3,548,380		$3,654,836	$0	$0	$0	$0	$0	$3,654,836
								% increase from base		103%

Administrative Charges Detail

Administrative Charges (** consult department Finance*)									
Departmental Staff	0.00%	$0	$0	$0	$0	$0	$0	$0	$0
Corporate Admin (max $100,000)	1.25%	$100	$100	$0	$0	$0	$0	$0	$100
Municipal Accommodations charges (if delivering the project)	0.00%	$0	$0	$0	$0	$0	$0	$0	$0
Research (SMIR) (Construction Only, only applies to Public Works)	0.00%	$0	$0	$0	$0	$0	$0	$0	$0
Corporate Interest	2.00%	$70,968	$73,097	$0	$0	$0	$0	$0	$73,097
		$0	$0	$0	$0	$0	$0	$0	$0
		$0	$0	$0	$0	$0	$0	$0	$0
Administrative Charges Sub-total	-	$71,068	$73,197	$0	$0	$0	$0	$0	$73,197
Project Sub-total before Interest Charges Sub-total		$3,619,448	$3,728,033	$0	$0	$0	$0	$0	$3,728,033
TOTAL CAPITAL PROJECT COST		$3,619,448	$3,728,033	$0	$0	$0	$0	$0	$3,728,033

Basis of Estimate Operating Cost Detail

Investment	Brandon Bus Garage Electric Charging Infrastructure
BC ID	0

Operating Budget Impact Detail Table

IN SERVICE YEAR - Please note that interest is charged to the project until the asset is in service at which time interest is then charged to the operating budget.

	Estimate Year	Year of Operating Impact					
NET OPERATING IMPACT ($000's)	2021	2022	2023	2024	2025	2026	2027
Operating Costs		$456,445	$465,574	$474,885	$484,383	$494,071	$503,952
Debt & Finance Charges		$0	$0	$0	$0	$0	$0
Total Direct Costs		$456,445	$465,574	$474,885	$484,383	$494,071	$503,952
Less: Incremental Revenue/Recovery							
Net Cost/(Benefit)		$456,445	$465,574	$474,885	$484,383	$494,071	$503,952
Incremental Full Time Equivalent Positions							
Cost Escalation / Operating Budget Inflation		2%	2%	2%	2%	2%	2%

Budget Impact Detail

OPERATING COSTS

Salaries and Benefits (consult finance/HR) ($000's) — Enter in current dollars in yellow highlighted cells. Inflation will be automatically calculated. — EXPLANATION/ASSUMPTIONS

Position #1							
Position #2							
Position #3							
Position #4							
Sub-total		$0	$0	$0	$0	$0	$0
Sub-total with Inflation		$0	$0	$0	$0	$0	$0

Operation & Maintenance Costs (consult operations) ($000's) — EXPLANATION/ASSUMPTIONS

Electricity Costs per kWh	$ 241,792.43	$241,792	$241,792	$241,792	$241,792	$241,792	$241,792	Assumption based on 15 hours per day of Bus charging utilization
Electricity Costs for increased Demand	$ 135,702.00	$135,702	$135,702	$135,702	$135,702	$135,702	$135,702	Assumption based on baseline building demand remaining the same
Maintenance & Consumables	$ 70,000.00	$70,000	$70,000	$70,000	$70,000	$70,000	$70,000	Assumption based on semi-annual manufacturers maintenance
Sub-total		$447,494	$447,494	$447,494	$447,494	$447,494	$447,494	
Sub-total with Inflation		$456,445	$465,574	$474,885	$484,383	$494,071	$503,952	

DEBT & FINANCING CHARGES

Debt & Finance Charges (consult finance) ($000's) — EXPLANATION/ASSUMPTIONS

Interest							
Principle	2.10%						
Sub-total		$0	$0	$0	$0	$0	$0
Sub-total with Inflation		$0	$0	$0	$0	$0	$0