Federal Transit Administration

Madison Street Corridor Bus Rapid Transit (BRT)

Energy

Technical Memorandum

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Federal Transit Administration

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SDOT

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1 Introduction

This memorandum evaluates potential impacts to energy usage resulting from the construction and operation of the Madison Street Corridor Bus Rapid Transit Project in Seattle, Washington. This report describes the proposed project, the methodology used to assess energy impacts, and the direct and indirect effects of the project on energy consumption.

2 Project Description

2.1 Background

The City of Seattle's Department of Transportation (SDOT) proposes to provide new Bus Rapid Transit (BRT) service on Madison Street between 1st Avenue and Martin Luther King, Jr. Way East (MLK Jr. Way E.), Spring Street between 1st Avenue and 9th Avenue, and 1st Avenue and 9th Avenue between Madison Street and Spring Street as part of the Madison Street Corridor Bus Rapid Transit (Madison BRT) Project.

The Madison BRT Project is located in a dense and rapidly developing area that includes portions of Madison Valley, the Central District, Capitol Hill, First Hill, and Downtown Seattle. These areas are among the densest residential neighborhoods in the City and are sizable employment centers due to the presence of two major medical centers and Seattle University. Providing BRT service along this 2.4-mile corridor is identified in the Seattle Transit Master Plan and listed as a near-term action in the 2016 Move Seattle Strategic Vision. This project would improve transit capacity, travel time, reliability, and connectivity in an area that is highly urbanized and has a lower rate of automobile ownership than other parts of the city.

The Madison BRT Project would connect with dozens of bus routes, the Center City Connector Streetcar, South Lake Union Streetcar, and the First Hill Streetcar, and would improve access to ferry service at the Colman Dock Ferry Terminal, First Hill medical institutions and housing, Seattle University, and Link light rail. As part of the project, pedestrian and bicycle access along the corridor would also be improved and enhancements would be made to the streetscape and public realm to increase comfort, visibility, and legibility in the Madison Street corridor.

2.2 Project Location

The project site is located in Seattle, Washington (Figure 1). The 2.4-mile corridor would begin and end at MLK Jr. Way E in the east. From MLK Jr. Way E the Madison BRT Project would head west on Madison Street for 2.26 miles to 1st Avenue, head north on 1st Avenue for 290 feet, head east on Spring Street for 0.43 mile, south on 9th Avenue for 290 feet, and head east on Madison Street for 1.78 miles (Figure 2). The project corridor traverses several Seattle neighborhoods: Downtown, First Hill, Capitol Hill, Central Area, and Madison Valley.

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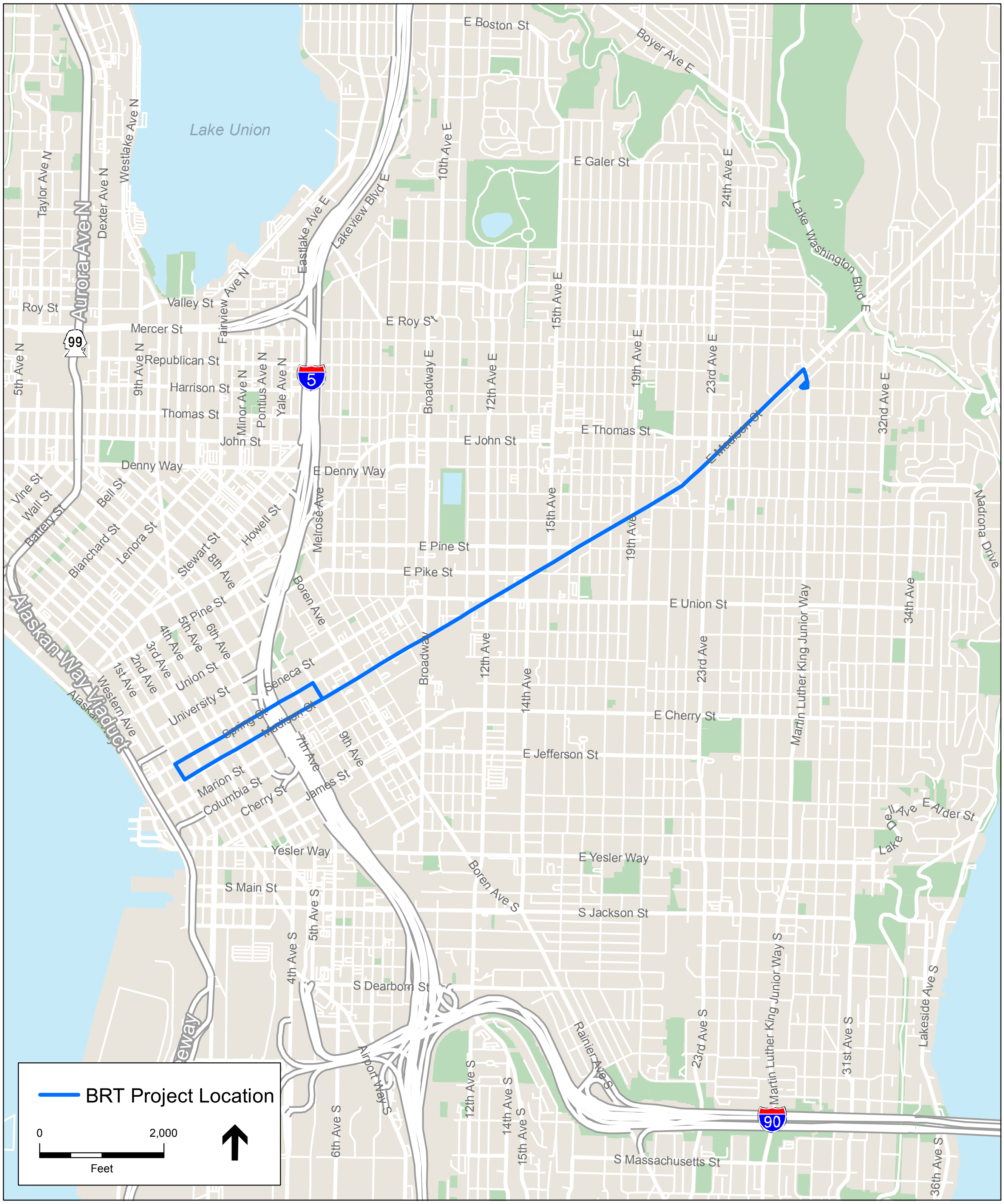
SOURCE:
Wa. Dept. of Ecology 2016; ESA 2016; OSM 2015.

SDOT Madison BRT Design . 150820

Figure 1
Project Vicinity



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SOURCE:
Wa. Dept. of Ecology 2016; ESA 2016; OSM 2015.

SDOT Madison BRT Design . 150820

Figure 2
Project Alignment

2.3 Description of Proposed Work

The Project would create a new BRT line along the Madison Street corridor. It would include 11 BRT station areas with 21 directional platforms along the project corridor, new Transit Only Lanes (TOLs) and Business Access & Transit (BAT) lanes, pedestrian and bicycle improvements, and signal and utility upgrades along the corridor. The Madison BRT Project would replace portions of the King County Metro Route 12 where they would otherwise overlap. Metro anticipates they will revise Route 12 to compliment the BRT and continue to serve the east Capitol Hill areas as it currently does.

The Madison BRT Project would use nine new buses, seven of which would be on the road at any one time. The buses would be 60-foot articulated low-floor vehicles with three doors on the right side and two on the left. The BRT would operate Monday through Saturday from 5 a.m. to 1 a.m. and on Sundays and holidays from 6 a.m. to 11 p.m. They would run every six minutes between 6 a.m. and 7 p.m. on weekdays and every 15 minutes during all other hours of operation.

As part of the Madison BRT Project, Transit Signal Priority (TSP) would be provided at most signalized corridor intersections. Signal priority would be used to hold lights green for approaching BRT vehicles and shorten red times for BRT vehicles at intersections. Separate "queue jump" transit only phases would be employed where BRT vehicles need to go in advance of general purpose traffic. In addition, two new signals would be provided on Spring Street: one at the 8th Avenue intersection and one at the 9th Avenue intersection.

The vehicles would be electrically powered using either electric trolley bus (ETB) technology requiring overhead contact systems (OCS) or some combination of ETB/OCS and emerging battery-powered technology allowing for substantial "off wire" operation. In order to power the line, new overhead wires would need to be installed in the following areas:

- 1st Avenue from Madison Street to Spring Street (approximately 300 feet);
- Spring Street from 1st Avenue to 3rd Avenue, and from 7th Avenue to 9th Avenue (approximately 0.5 mile);
- 9th Avenue from Spring Street to Madison Street (approximately 300 feet);
- Madison Street from 19th Avenue to MLK Jr. Way E (approximately 0.7 mile); and
- MLK Jr. Way E from Madison Street to E Harrison Street (approximately 800 feet).

In addition, a new traction-powered substation (TPSS) would be needed somewhere near the eastern end of the project, where the existing overhead catenary system would need to be extended.

Construction would start in 2018 and conclude in the fall of 2019.

3 Methodology

The methodology for determining project level effects includes analysis of both construction and operation energy effects. Operational-related energy consumption includes the electricity required for proposed transit buses that would travel on the corridor. Construction-related energy consumption includes fossil fuel expenditures required to construct the project using various equipment and materials.

3.1 Construction Energy Use

The proposed project would require energy to construct and maintain the project. Construction includes energy used by construction equipment and other activities at the worksite, in addition to the energy used to manufacture the equipment, materials, and supplies, and to transport them to the worksite. Energy for maintenance includes that for day-to-day upkeep of equipment and systems, as well as the energy embedded in any replacement equipment, materials, and supplies.

3.2 Operational Energy Use

Energy used to operate transportation systems includes energy used by vehicles transporting people or goods (propulsion energy), plus energy used to operate facilities such as transit stations, amenities, and other system elements. Over the life of a transportation project, operational energy consumption is usually the largest component of the project's total energy use. In assessing operational energy use, consideration was given to electricity usage per mile for the proposed buses.

4 Affected Environment

Project construction activities and operation of the proposed transit buses would consume energy. The proposed trolley buses would be powered by electricity; therefore, in addition to reviewing impacts on energy use by the project it also evaluates potential impacts from electromagnetic fields (EMFs), which are produced wherever electricity is used.

4.1 Existing Energy Use and Supply

In the City of Seattle, Seattle City Light is the main provider of electricity, which is generated using a number of resources. Some of these are self-generated, with the remaining power purchased from other producers. In 2012, hydroelectric power accounted for nearly 90% of the utility's power generation portfolio. In 2013, Seattle City Light sold approximately 9.5 million megawatt hours to residential and commercial customers (Seattle City Light, 2013). Of this total, the utility had about 6.1 million megawatts of company-controlled power-generating capacity. The remaining power supply came from long-term contracts and wholesale power contracts with other providers, including Bonneville Power Administration, other utilities, independent power producers, and energy marketers across the western United States.

Transportation energy consumption within the proposed BRT corridor includes the fuel required for passenger vehicles, commercial trucks, and transit buses. A mix of natural gas, electricity, gasoline, and diesel fuel provide the energy source for transportation within the corridor. Passenger vehicles primarily utilize gasoline as fuel, where heavy trucks primarily utilize diesel fuel. Natural gas can also be used by motor vehicles (i.e., passenger and heavy truck). Electricity can be used for motor vehicles; however, most motor vehicles depend on gasoline and diesel fuel.

King County Metro operates about 1,400 diesel and hybrid motor buses and electricity-powered trolley buses (King County Metro, 2016). The trolley system operates on 70 miles of two-way overhead wire in Seattle. Metro is currently replacing its trolley fleet with 174 new buses, which would represent over 12% of Metro's fleet (King County Metro, 2015).

4.2 Electromagnetic Fields

Electromagnetic fields (EMFs) are produced wherever electricity is used. EMFs create electromagnetic interference, which can cause disruptions and possibly malfunctions in some types of equipment. In addition, EMF can interfere with utilities, causing corrosion and reducing the effective life of the utilities. Power lines, overhead trolley bus cables, and the passing of truck traffic can all result in EMF in the project corridor. Although electric fields can be easily shielded by conducting objects, such as buildings, magnetic fields generated by electrical equipment and appliances cannot be shielded by such objects. In the absence of observed health effects from environmental electric fields, scientific research on potential health effects has focused on magnetic fields.

5 Project Effects

5.1 Construction Impacts

Construction of the project would require consumption of fossil fuels, labor, and construction materials. Construction includes energy used by construction equipment and other activities at the worksite (i.e., median removal, excavation, paving), in addition to the energy used to manufacture the equipment, materials, and supplies to transport them to the worksite. Within the proposed BRT corridor, electric power supply is distributed through a combination of overhead and underground electrical lines. In order to power the proposed project, approximately 1.5 miles of new overhead wires would need to be installed. In addition, a new traction-powered substation (TPSS) would be needed somewhere near the eastern end of the project, where the existing overhead catenary system would need to be extended. Energy for maintenance includes that for day-to-day upkeep of equipment and systems, as well as energy embedded in any replacement equipment, materials, and supplies. These expenditures would be, for the most part, irrecoverable; however, they are not in short supply, and their use would not have an adverse effect upon continued availability of these resources.

5.2 Operational Impacts

The proposed new 60-foot-long articulated New Flyer Xcelsior brand trolley buses, with battery backup, that would be utilized by the project are estimated to consume an average of 3.14 kilowatt hours (kWh) per mile. The project would have up to seven buses on the road at one time. The roundtrip route length would be 4.6 miles. Thus, each bus would consume approximately 14.44 kWh per roundtrip.

The route would operate for 20 hours per day, Monday through Saturday (5 a.m. to 1 a.m.), and 17 hours per day on Sundays and holidays (6 a.m. to 11 p.m.). Seven buses would share a total of 157 round trips every day Monday through Saturday (total of 722 daily miles), and three buses would share a total of 67 round trips every Sunday and holiday (total of 308 daily miles). Each bus would also travel from and back to the Atlantic Street base bus storage yard once each day, an additional 7.2 miles roundtrip. Therefore, the Madison BRT route would conservatively consume approximately 15,587 kWh per week.

The project will replace portions of the King County Metro Route 12 (which is also served by an electric trolley) where they would otherwise overlap. Metro anticipates they will revise Route

12 to compliment the BRT and continue to serve the east Capitol Hill areas as it currently does. Therefore, depending on the ultimate length of the revised Route 12, the energy consumed by buses on this route could be more or less than without the proposed project.

The project would indirectly reduce future automobile vehicle miles traveled (VMT) by providing public transportation to residents of Downtown, First Hill, Capitol Hill, Central Area, and Madison Valley. This reduction in VMT would result in a corresponding decrease in energy consumed by private automobiles, whether gasoline-powered, electric, or by other alternative sources. It is estimated that the project would serve approximately 12,000 daily riders, which represents an approximate 70% increase compared to the existing ridership.

5.3 Electromagnetic Fields

Electric trolley buses have been operating in Seattle since the 1940s. King County Metro currently operates 14 routes that use electric trolley buses running on more than 70 miles of two-way overhead wire. The electric trolley bus network carries about 74,000 daily rides, or about 20% of the countywide network. In addition to the buses themselves, the trolley network infrastructure includes overhead wires and poles, substations, Atlantic Base and the Power Distribution building. Power to the trolleys is delivered to 40 Metro substations scattered across the city. Each substation houses electrical equipment that converts the incoming 26,000-volt AC (alternating current) power into the 700-volt DC (direct current) power used by the trolleys (King County Metro, 2011). The TPSS needed for the proposed BRT project could be located in an aboveground, enclosed structure such as a prefabricated metal building or custom building, or within an existing structure adjacent to the alignment, such as a parking garage (Seattle Department of Transportation, 2016). The converted electricity is fed into the overhead wires via conduits that travel underneath Seattle streets and then to the poles that support the overhead system. Construction and operation of the electric system required to power the proposed project would have similar effects regarding EMFs as the existing system. No negative impacts caused by EMFs from the proposed project are anticipated. See also the Hazardous Materials Discipline Report (ESA, 2016) prepared for the Madison BRT Project for additional information on EMF affects.

6 Mitigation

Standard construction best management practices (BMPs) would minimize energy consumption by maintaining all construction equipment in good operating condition. Proper maintenance reduces fuel consumption. Project construction would include setting up active construction areas, staging areas, and material transfer sites to reduce equipment idling time. In addition, construction workers could be encouraged to use public transportation or ridesharing to reduce temporary energy use during travel to the construction site.

7 References

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