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TO: Board of Directors

FROM: Paul Hubler, Chief Strategy Officer

SUBJECT: Zero Emissions Technical Analysis and Antelope Valley Line Pilot Next Steps

Issue

The Zero Emissions Technical Analysis (Analysis) evaluates the available zero emission (ZE) propulsion systems, vehicle types, operational and infrastructure impacts, project cost, safety, and regulatory considerations of implementing and operating a zero emissions rail vehicle. The Analysis also informs Metrolink how to proceed with the Antelope Valley Line pilot funded as part of the 2020 Transit and Intercity Rail Capital Program (TIRCP) Antelope Valley Line (AVL) Capital and Service Improvements Project award.

Recommendation

Receive and file.

Strategic Commitment

This report aligns with the Strategic Business Plan commitment of:

- **Advancing Key Regional Goals:** We will grow the role of regional rail in addressing climate change, air quality, and other pressing issues by advancing toward zero emissions, making rail a compelling alternative to single-occupant automobiles and advancing equity-focused opportunities for all communities throughout Southern California. Decarbonizing and reducing criteria pollutant emissions from Metrolink's revenue fleet is central in Metrolink's key strategic planning documents: Metrolink's Strategic Business Plan and Climate Action Plan. This Analysis is consistent with Metrolink's strategic goals and moves the agency closer to making the transition to zero emissions.

Background

The Metrolink Climate Action Plan (CAP) was approved at the March 2021 Board meeting. The CAP is the agency's first, formal environmentally focused plan, which anchors to the zero emissions commitments set forth in the Strategic Business Plan. One month later, the Board approved the Rail Fleet Management Plan Update and the Locomotive Fleet Modernization Study which recommended pursuing a pilot program with at least one zero-emissions locomotive.

Over the last few years, there have been positive developments in zero emissions rail technology. Foremost is San Bernardino County Transportation Authority's (SBCTA) procurement of a zero emissions multiple unit (ZEMU), which is expected to be delivered to the United States this year. In consideration of the advancements in battery and hydrogen fuel cell technology and the award of 2020 TIRCP grant funding to support a zero emissions pilot on the Antelope Valley Line, Metrolink embarked on the planning effort in late 2021 to thoroughly evaluate the zero emissions alternatives available to Metrolink.

The Analysis commenced in late 2021 and its findings are based on research and interviews with original equipment manufacturers, peer agencies and others in the industry conducted between late 2021 and summer 2022. At the December 2021 Board Workshop, staff presented an update on the challenges and opportunities facing Metrolink as we plan for the transition to a zero emissions fleet.

Developments in zero emissions rail are ongoing and constantly evolving with frequent new partnerships and project announcements. This Analysis captures the best and most accurate information available during the study period. Deployment of alternative propulsion vehicles has been limited in the United States. As a result, there are significant unknowns relating to the rollout of fueling and charging infrastructure, regulatory requirements, modifications required to maintenance facilities, necessary retraining of staff, and the required improvements needed to integrate smaller, lighter multiple unit vehicles into a system designed for heavy locomotive-hauled trainsets.

TIRCP 2020 Antelope Valley Line Pilot

As part of the 2020 TIRCP-funded Antelope Valley Line (AVL) Capital and Service Improvements Project, Network Integration funds totaling \$10 million were awarded to assess the feasibility of a rail multiple unit (RMU) and zero-emission propulsion service through a pilot project on the Metrolink AVL. The project envisioned converting a rail multiple unit from diesel to hydrogen fuel cell, or other zero-emission propulsion technology. However, a diesel multiple unit has not been made available for this conversion effort.

The AVL connects riders along a 76-mile corridor from Lancaster in North Los Angeles County to Los Angeles Union Station. The terrain of the AVL is challenging and the elevation gain of nearly 3,000 feet requires significant energy draw for a battery or hydrogen fuel cell vehicle.

Discussion

Based on the findings of the Analysis, the 2020 TIRCP Network Integration funds will be used

to underwrite the more technical and detailed multiple-unit focused AVL implementation plan. The AVL implementation plan will comprehensively evaluate the operations and required investments to support the use of a zero-emission multiple unit on the AVL. Staff will reassess options for a pilot project once the new AVL plan results are available.

The AVL implementation plan is anticipated to build on the scope of work developed for a similar multiple unit implementation plan, initiated at member agency request, for the San Bernardino Line (SBL). That scope includes a service plan to determine trips that could be carried by rail multiple units (RMUs) in anticipation of a potential blend of locomotive-hauled and RMU service. The AVL implementation plan will identify infrastructure improvements, including station platforms, hydrogen fueling infrastructure, any battery charging infrastructure, improvements to ensure the safe maintenance and operation of a hydrogen fuel cell vehicle, RMU vehicle steps, maintenance facilities and regulatory compliance, as well as identify and estimate signal system enhancements to ensure system shunting compliance for RMUs. This plan will also develop a cost-benefit operations and maintenance comparison between RMU and locomotive-hauled equipment. This new AVL plan is a critical first step that should be undertaken before a pilot program is initiated. Undertaking the SBL and AVL plans simultaneously would be advantageous from a cost-efficiency perspective.

Discussions with Caltrans About Opportunities to Test Caltrans Procured ZE Equipment

Caltrans, Metrolink and other passenger rail agencies in the state have been collaborating to advance zero emissions rail initiatives. Under CalSTA direction, Caltrans staff are leading a robust statewide zero emissions effort to support the research and development of the design, manufacture and testing of new propulsion systems and supporting infrastructure.

CalSTA and Caltrans have identified funding to procure several zero emissions multiple units as well as to advance the research and development of at least one additional zero emissions rail vehicle. The development of the vehicles and infrastructure will be complex and costly. Exploring the possibility of field testing a Caltrans-procured vehicle could allow Metrolink to test at least one zero emissions vehicle without assuming the risk of ownership of unproven technology. Any testing arrangement would need to meet Metrolink's operational, financial, safety and regulatory requirements. Should the Caltrans effort not align with Metrolink's goals, Metrolink could pursue seeking grant funds to secure a zero emission vehicle that more optimally aligns with Metrolink's requirements.

Overview of the Zero Emissions Technical Analysis Document

Other than full-scale electrification using overhead catenary, practical zero emissions rail rolling stock solutions are still in early stages of development and no "off the shelf" solution is available that would meet Metrolink's needs. Metrolink is faced with a complex decision concerning the available funding and exploring possible partnerships and seeking additional grant funding if needed to advance its zero emissions goals. The Analysis will assist Metrolink in maximizing the benefits of a pilot while mitigating risks.

The Analysis informs Metrolink's planning by evaluating the chosen propulsion technology holistically by considering its performance, reliability, maintainability, infrastructure requirements, constraints imposed on operations, capital, and operating costs in revenue service-like operations. The Analysis will help Metrolink to gather the knowledge and experience to support a pilot program and ultimately attain the end goal of having a zero-emission fleet. Staff notes that the In-Use Locomotive Rule approved by the California Air Resource Board would require passenger railroads to purchase only ZE vehicles starting in

2030, a deadline subject to a technology assessment to be published in 2027.

The Analysis focused on promising, but not yet mature, battery electric and fuel cell propulsion technologies that present the potential for leading Metrolink to a zero emissions fleet and operations in the long term. Among the zero emission propulsion technologies, full overhead catenary electric propulsion technology was not examined for a pilot as it is already proven but has high capital costs. However, in the strategic assessment sections of the Analysis, it is considered as an enabler technology that can complement battery propulsion technology along select segments of the railroad.

When Metrolink embarked on this Analysis development, the original objective was to determine the most optimal technology and vehicle solution for Metrolink to procure and deploy. After completing much of the analysis, the opportunity to partner with Caltrans on a zero-emission demonstration warranted a technology reassessment.

Propulsion Technology Assessment Findings

Neither battery nor hydrogen fuel cell technology provide solutions that are a one-for-one operational replacement with Metrolink's existing diesel internal combustion engines in terms of range and fueling time. All zero emission propulsion technologies have challenges and tradeoffs that need to be evaluated and resolved through field testing.

Collaboration and partnership among agencies may help address many unknowns about each potential technology. As mentioned above, SBCTA has procured a fuel cell battery hybrid multiple unit (ZEMU) with delivery to the United States expected in 2023 and with testing to follow. The vehicle will be the first of its kind operating in the US. Metrolink can take advantage of lessons learned regarding the unknowns and risks associated with fuel cell propulsion during the deployment of the Arrow ZEMU. In evaluating each propulsion type for suitability for Metrolink, this Analysis concludes that testing battery electric technology will be less costly and technologically complex compared to fuel cell battery hybrid technology.

The technology benchmark results are summarized below:

- Battery electric propulsion is superior to fuel cell battery hybrid propulsion in terms of system efficiency, well-to-wheel greenhouse gas emissions, technology maturity, hardware/software complexity, vehicle cost, and synergistic opportunity with other propulsion technologies (diesel engine and overhead catenary).
- Fuel cell battery hybrid propulsion is superior to battery electric propulsion in terms of range and refueling time.
- Fuel cell technology has a greater level of technical complexity in comparison with batteries and has not been service proven to the same extent. Maintenance facilities, and possibly rail tunnels, would need to be modified for hydrogen gas leak detection and enhanced ventilation systems.

Vehicle Assessment Findings

Metrolink's system and facilities are designed to support the operations and maintenance of locomotive-hauled coach fleets. Significant capital costs would be required to enhance Metrolink's wayside infrastructure as well as facilities to support rail multiple units. The Analysis finds that testing a locomotive is less capital intensive and complex in implementation. However, recognizing that the 2020 TIRCP grant application specified testing a ZEMU, it will be critical to conduct an in-depth multiple-unit focused implementation plan to

more deeply explore the costs and improvements required to operate multiple units on the AVL. Piloting rail multiple units in Metrolink's system will introduce additional requirements, which are highlighted below:

- Additional maintenance facility upgrades would be required, primarily due to the need for synchronized lifting jacks to perform maintenance such as truck replacements.
- A notable concern with rail multiple units relates to loss of shunt, which could result in delayed or failed activation of crossing gates or a loss of track occupancy detection in dispatch. Significant capital costs are anticipated to mitigate the signal system shunting issues anticipated with a smaller, lighter rail vehicle. Increased operational costs are also expected for mitigation measures such as frequent track brushing.
- Rail multiple units typically have a lower seating capacity on an equivalent length basis (approximately half that of a comparable length bilevel coach car consist).
- A locomotive could utilize existing coach cars, avoiding potential ADA compliance issues with station platforms. Access to any new passenger car (locomotive-hauled or multiple unit) would need to be compatible with existing platforms. This is currently understood to involve steps and the use of mini-highs for ADA purposes, but changes in ADA regulation or enforcement may require different solutions. If platforms need to be modified, this would represent a significant expense.

Next Steps

Staff will update the Board as AVL and zero emission project milestones are reached.

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Attachment(s)

[Attachment A - Metrolink Zero Emissions Technical Analysis - Executive Summary](#)
[Attachment B - Metrolink Zero Emissions Technical Analysis - Full Report](#)
[Presentation - ZE Technical Analysis](#)