



ITEM ID: 2026-227-0

TRANSMITTAL DATE: September 18, 2026

MEETING DATE: September 25, 2026

TO: Board of Directors

FROM: Justin Fornelli, Chief, Program Delivery

SUBJECT: Multiple Unit (MU) Implementation Plan Final Report

Issue

In 2022 the San Bernardino County Transportation Authority (SBCTA) and Los Angeles County Metropolitan Transportation Authority (Metro) commissioned the Authority to develop a Multiple Unit (MU) Implementation Plan identifying the necessary steps and associated costs to implement a blended service of MUs and Locomotive Hauled Coaches (LHCs) on the San Bernardino Line (SBL) and Antelope Valley Line (AVL). The Final Report summarizes the analysis undertaken, conclusions, approach to implementing a blended service and a possible MU Pilot Plan.

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. The Multiple Unit Implementation Plan addresses opportunities for replacing diesel powered trainsets with zero emission MUs as part of a blended service throughout the San Bernardino and Antelope Valley lines.

Background

Prior to the MU Implementation Plan, a Hybrid Rail Study was completed in 2018 by the Authority, Metro and SBCTA analyzing the feasibility and general operating parameters for supplementing or converting existing Metrolink service on the San Bernardino Line with service operated by MU vehicles. The focus of the Study was to reduce operating costs for rail service in the corridor and providing more frequent service to a convenient schedule for customers.

Since the study, Diesel Multiple Units (DMUs) and a hydrogen fuel cell/battery Zero-Emission Multiple Unit (ZEMU) are now in revenue service operation between the University of Redlands and the San Bernardino Transit Center ("Arrow" service). Further, the Authority was awarded grant funding for the Southern California Optimized Rail Expansion (SCORE) Program which requires service frequencies be increased on the San Bernardino Line with a focus on achieving 30-min all day bi-directional service.

The Authority has undertaken a Service Growth Development Plan, received by the Board on July 26, 2024, with a Final Report on February 27, 2026, focusing on how service will evolve and grow by 2028 and beyond. The Service Plan addresses proposed schedules, crew and equipment cycles, and ridership forecasts.

In 2020, Metro was awarded California Transit and Intercity Rail Capital Program (TIRCP) grant funding, of which \$10M was made available for the Authority to implement a MU Pilot Program on the Valley Subdivision. The funding was however insufficient to allow the Authority to procure a MU train set, or to make the necessary infrastructure modifications to allow MU operation on the Valley Sub.

In September 2022 SBCTA and Metro commissioned the Authority to develop the Multiple Unit (MU) Implementation Plan, as a next step stemming from the Hybrid Rail Study. The purpose of the Plan was to identify the specific necessary steps and associated costs to implement a blended service of Multiple Units (MUs) and Locomotive Hauled Coaches (LHCs) on the San Bernardino Line (SBL) and Antelope Valley Line (AVL), based on a 30 minute all day, bi-directional service plan and associated ridership demand. The Authority developed a scope for the Plan, which was reviewed and approved by Metro and SBCTA.

Generally, the original scope included the following items:

- Service Plan Development
- Infrastructure Improvements
- Signal system enhancements to ensure system shunting compliance for MUs, and
- Operations and Maintenance Cost and Benefit Comparisons between MU and LHC equipment.

Analysis commenced in September 2023, with regular coordination and project development meetings held between SBCTA, Metro, and Authority staff throughout the development of the Plan. Through these coordination meetings, all the stakeholders approved the appropriate service plans and other assumptions utilized in the development of the Plan. The Draft Final Plan Report was completed in December 2024, summarizing the analysis undertaken, results, recommendations and subsequent conclusions. SBCTA and Metro staff provided comments and recommendations in February 2025, with the Final version of the Report released on April

11, 2025 to SBCTA, Metro, and Caltrans staff.

Upon review of the Final Report in April 2025, the stakeholders identified the need to include additional scope items. These included an assessment of utilizing ZEMUs recently procured by the State of California, addressing how a MU Pilot project could be implemented on both the AVL and SBL, further analysis to be undertaken into fleet-wide LHC and ZEMU vehicle acquisition costs, analysis of operational safety implications for use of hydrogen vehicles in tunnels and consideration of the EMF and alternative locations for the maintenance of Caltrans FLIRT sets on the SBL.

The State has commissioned Stadler to manufacture and supply ten 4-car FLIRT ZEMU sets, each of which is a longer design with a higher seating capacity than the current Arrow MU train sets, with the first FLIRT expected to be available in 2028. Only very limited specifications for these sets were available at the time of the original analysis and so they had not been considered.

Further analysis commenced in September 2025 to address the additional scope items listed above. Monthly stakeholder meetings were held, attended by representatives from SBCTA, Metro and the State, to present and discuss findings, respond to stakeholder questions and universally agree between all parties the proposed service plan and path to be taken forward through the continued analysis. The revised Draft Final Report was released for stakeholder comment on April 10, 2026. Comments were received and addressed, with a final stakeholder meeting being held on June 25, 2026 and the Final Report released to all parties on July 6, 2026. Individual meetings have been held with each stakeholder to provide detailed review of the Draft Final Report.

Discussion

The analysis for both the SBCTA 5-car ZEMU and the Caltrans 8-car ZEMU, is summarized as follows:

1. Service Plan Development:

- Ridership forecasts based on the 2028 mid-term Strategic Growth Development Plan (SGDP) were assessed for the 5-car SBCTA ZEMU with 282 seats, the 4-car Caltrans ZEMU with 244 seats and a coupled 8-car Caltrans ZEMU set with 488 seats. Analysis determined that ZEMU sets could replace LHC trainset daily cycles for:
 1. SBCTA 5-car Service Plan:
 - SBL: one (1) of twelve (12) daily cycles
 - AVL, three (3) cycles operating “bounce back” service between LAUS and Santa Clarita
 2. Caltrans 8-car Service Plan:
 - SBL, three (3) of twelve (12) daily cycles
 - AVL, all three (3) cycles operating the “bounce back” service can be accommodated with the 4-car ZEMU, with two (2) service cycles between LAUS and Lancaster being met by the ZEMU 8-car seating capacity.
- Conditions on the AVL present operational challenges for ZEMUs:
 1. Grades: Steep grades have the potential to effect on-time performance.

2. Refueling: ZEMUs have reduced range and acceleration compared to diesel LHCs, resulting in more frequent refueling, requiring a 4th trainset to meet the daily “bounce back” cycles. For the 2 service cycles between LAUS and Lancaster, a refueling facility would be required at Lancaster for mid-day refueling.
3. Tunnel 25: The safety protocols for a ZEMU train involved in an incident, require the stored hydrogen to be vented via activated safety valves into the surrounding atmosphere, where the hydrogen quickly dissipates. However, with an incident inside a tunnel the vented hydrogen quickly creates a combustible environment around the train. Tunnel ventilation systems cannot practically clear the hydrogen to reduce the risk. Thus, additional safety assessments would be required to ensure protection of the hydrogen tanks to reduce damage and risk of hydrogen release in an incident inside tunnels. Documentation of engineering controls and operational mitigations to reduce risks would be required.

2. Infrastructure improvements:

- Station Platforms:
 1. Level boarding from existing legacy platforms to ZEMUs can be provided using mini-high platforms and bridge plates, as currently provided with LHCs. Ambulatory passenger boarding and alighting on ZEMUs would be accomplished via automatic flip-down steps deployed from the ZEMU vehicle.
 2. Thirteen (13) of the twenty five (25) platforms along the SBL and AVL are too short to accommodate boarding at all doors on an 8-car Caltrans ZEMU. Nine (9) platforms can be extended to accommodate at a cost of \$52.92 million, with four (4) platforms physically constrained. Station and conductor announcements would be required to inform passengers to sit in specific cars, in addition to potential double-spotting of ZEMUs.
 3. Temporary mini-high platforms would be required to accommodate ADA boarding for the Caltrans ZEMU, where ADA accessibility is through different doors than for traditional LHCs for which platform mini-highs are currently configured.
- Maintenance Facilities:
 1. **Arrow Maintenance Facility:** The facility is designed for 2-car ZEMUs and cannot accommodate the Caltrans 4-car ZEMUs. No significant expansion is possible due to property constraints.
 2. **SBL: Eastern Maintenance Facility:** Seven 4-car Caltrans ZEMUs are required. To accommodate the larger ZEMU fleet and expansion of the LHC fleet, a full service maintenance facility accommodating both vehicle types was developed at a cost of \$448.8 million.
 3. **Central Maintenance Facility:** Hydrogen fueling infrastructure for midday refueling of ZEMUs can be accommodated, estimated to cost \$22.2 million. The maintenance areas do not accommodate 4-car ZEMUs, which are permanently coupled.
 4. **Lancaster Facility:** The mixed fleet plan would require five 4-car Caltrans ZEMUs and 6 LHC sets to be stored at Lancaster layover facility, for which there is insufficient room. The Lancaster facility can accommodate infrastructure to support midday hydrogen refueling of ZEMUs.
 5. **AVL: New ZEMU Facility Near Santa Clarita:** A new, full service maintenance facility to accommodate all ten (10) 4-car Caltrans ZEMUs sets required for the AVL service plan was developed at a location close to Santa Clarita Station, providing operational efficiencies. Land acquisition, design and construction costs

are estimated at \$479.3 million. Note that if a mixed fleet plan were implemented for both lines together, heavy maintenance would only be required at one location and so the cost of the other facility could be significantly reduced.

3. Signal system enhancements to ensure system shunting compliance for ZEMUs:

- ZEMU sets are lighter than conventional LHCs and therefore more susceptible to a loss of electrical conductivity between the vehicle wheels and the rail, resulting in the railroad signal system circuitry not recognizing the presence of a ZEMU (not shunting) and failing to operate crossing warning equipment.
- On-board Shunt Enhancement (OSE) has been identified as the preferred solution, consisting of an antenna mounted under the vehicle that induces a current within the track circuit. Testing to demonstrate effectiveness and a “fail-safe” plan in the event of OSE failure would be required prior to use in Metrolink service. Cost estimated at \$200,000 per vehicle.
- The alternative would be to make physical improvements within the right-of-way signal system infrastructure to ensure shunting at a total estimated cost of \$85 million for both the SBL and AVL.

4. Operations and Maintenance Cost and Benefit Comparisons between ZEMU and LHC equipment:

- Costs for the variables of labor, fuel and maintenance were analyzed to estimate costs per train revenue mile (TRM).
- The lower end cost for a 4-car ZEMU is similar to that of a 4-car LHC set. Coupled ZEMU sets cost more to operate through higher operational costs, additional crew requirements, maintenance of additional components and increased fuel demands (***Refer Attachment A - Table 4.1 Cost Per Revenue Service Mile Comparison***).
- Application of cost per TRM to the blended operating service plans provides annual cost scenarios (***Refer Attachment A - Table 4.2 Blended Operating Service (Caltrans ZEMU) Annual Costs and Table 4.3 Blended Operating Service (SBCTA ZEMU) Annual Costs***).

5. Mixed Fleet Vehicle Acquisition Costs:

- The SGDP, on which future ridership projections are based, requires future fleet expansion that could be accomplished through the purchase of either LHC or ZEMU units.
- Unit cost assumptions priced on recent procurements and escalated to 2026 dollars are:
 - 4-car LHC - \$28.6 million (Locomotive \$13.9 million, Coach \$5 million, Cab Car \$5.6 million)
 - 4-car Caltrans ZEMU Coaches - \$25 million
 - 5-car SBCTA ZEMU - \$25 million
- LHC (locomotives and coaches) may be purchased as individual units and are scalable, where ZEMUs require to be purchased as a continuously coupled set
- Total expansion costs for the blended service scenarios (\$ millions) on both the SBL and AVL combined were calculated (***Refer Attachment A - Table 5.1 Total Expansion Cost for Blended Service on both the SBL and AVL***).

6. Caltrans ZEMU Pilot Plan Scenarios:

- **AVL:** LAUS to Burbank Airport South/Van Nuys – additional service with no gradient issues.
- **SBL:** LAUS to Montclair – direct LHC replacement with a 4-car ZEMU

- Two 4-car Caltrans ZEMU sets, borrowed from Caltrans are assumed
- Temporary light maintenance facility:
 - Keller Yard or Rondout Street (AVL/SBL) – estimated \$15.4 million
 - Railroad Avenue (SBL) – estimated \$15.4 million
- Hydrogen fueling by truck
- On-Board Shunt Enhancement is assumed to be achievable, however initial testing would be required to prove effective shunting prior to revenue service operation
- Total Cost would be \$20.2 million for either the AVL or SBL pilot plan, and similarly \$20.2 million for a combined pilot plan assuming a shared maintenance facility.

7. Conclusions:

- The Capital requirements and associated costs for a blended service plan were calculated for both the SBCTA and Caltrans ZEMU service plans (***Refer Attachment A - Table 8.1 Capital Cost Requirement SBCTA ZEMU Service Plan and Table 8.2 Capital Cost Requirement Caltrans ZEMU Service Plan***).
- Additional Considerations:
 - Hydrogen fuel long-term availability and associated cost is unpredictable
 - Luggage from Brightline West transfers at Rancho Cucamonga has not been considered in the assessment of ridership capacity

The Final Report is included as Attachment B.

Next Steps

The Authority will respond to any future requests provided by SBCTA, Metro or the State regarding implementation of ZEMUs on the Metrolink system.

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Attachment(s)

[Attachment A - MU Implementation Plan - Tables](#)
[Attachment B - Final Multiple Unit Implementation Plan](#)
[Presentation - Multiple Unit Implementation Plan](#)