GCL
GLASSBORO-CAMDEN LINE

ATTACHMENT 6

Transit Analysis Technical Report

Glassboro-Camden Line FEIS

February 2021

Prepared by:

STV 100 Years

Prepared for:

DELAWARE RIVER PORT AUTHORITY of Pennsylvania & New Jersey

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NJ TRANSIT

Project information contained in this document, including estimated limits of disturbance that could result with construction or operation of the proposed GCL, is based on conceptual design parameters that represent a reasonably conservative basis for conducting environmental analyses. As the proposed GCL is advanced through preliminary engineering and construction, efforts will continue to be made to further refine the design and minimize the project footprint. These refinements may result in the potential to avoid and further reduce the adverse effects outlined in this document and as described within this Environmental Impact Statement.

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Acronyms

BRT	Bus Rapid Transit
DMU	Diesel multiple-unit
DVRPC	Delaware Valley Regional Planning Commission
EIS	Environmental Impact Statement
PATCO	Port Authority Transit Corporation
PHF	Peak hour factor
VMF	Vehicle Maintenance Facilities
WRTC	Walter Transportation Center

Foreword

Following the issuance of the Draft Environmental Impact Statement (November 2nd, 2020), revisions have been made to this Technical Report (Attachment 6, "Transit Analysis Technical Report") in preparation of the Final Environmental Impact Statement as follows:

- Section 2, Page 8: Revised "Parking facilities are proposed at eight stations," as follows: "Of the fourteen proposed GCL stations, nine will be served by existing or proposed parking facilities (structures or surface parking lots). Parking facilities (surface lots) will be constructed at six stations as part of the proposed GCL (South Camden, Gloucester City, Crown Point Road, Woodbury Heights, Mantua Boulevard, and Mantua-Pitman). Two stations (Woodbury and Glassboro) will be served by existing municipal parking structures, and one station (Red Bank Avenue) will be served by an existing municipal parking lot. (Mantua-Pitman Station will be served by a parking lot constructed as part of the GCL, which if and as demand calls for, may be developed in the future as a parking structure.) In sum, approximately 2,685 new parking spaces in 2025 and 4,310 spaces in 2040 would be available for GCL use. The type and size of the proposed GCL parking facilities are shown in Table 1, "Proposed New GCL Stations." Parking facilities identified as "GCL" would be constructed as a part of the proposed project. Facilities identified as "Other" are either existing or planned as part of municipal redevelopment master plans, and though not part of the proposed project, would provide parking spaces for use by GCL riders."
- Section 3.2.2, Page 14: Revised "(Red Bank)" to "(Red Bank Avenue Station)"
- Section 4, Page 15: Changed "TIM v2.1" to "TIM v2.3"
- Section 8, Page 28: Added Section 8, "References"
- Minor editorial and typographical revisions, as well as formatting adjustments, have been made as appropriate

1 INTRODUCTION

This Transit Analysis Technical Report serves to present the detailed analysis underlying the descriptions and conclusions regarding public transportation presented in the Environmental Impact Statement (EIS) for the Glassboro-Camden Line (GCL). In addition to providing a narrative discussion of the detailed technical analysis, Section 2, "The Proposed GCL," Section 5, "Service Plan," Section 6, "Capacity and Fleet Analysis," and Section 7, "Operating Statistics," of this document will serve as the framework for a GCL Operations Plan going forward.

This document presents the following items:

- A description of the GCL project, with a focus on operationally-significant elements including layover yards, station and parking facilities, track configuration and rolling stock
- A description of existing transit services in the region, and any changes in service expected between the present and the forecast year of 2040
- The proposed GCL service plan, including headways and running times
- A summary of ridership forecasts for GCL and other transit services
- An analysis of capacity and fleet requirements
- A summary of key operating statistics for use in cost estimating

1.1 Project Description

The GCL Project is a proposed 18-mile expansion of transit service in Southern New Jersey that would traverse eleven communities between Camden City and Glassboro Borough. These communities, listed from north to south, include the following within Camden County - Camden City, Gloucester City, and Brooklawn Borough - and the following communities within Gloucester County - Westville Borough, Woodbury City, Woodbury Heights Borough, Deptford Township, Wenonah Borough, Mantua Township, Pitman Borough, and Glassboro Borough (see Figure 1, "GCL Project Corridor Map").

The GCL would restore passenger rail service primarily within an existing Conrail freight right-of-way (ROW) using light rail vehicles similar to the NJ TRANSIT River LINE. The light rail would operate on new dedicated tracks with peak service operating every 15 minutes. There would be two dedicated tracks in Camden and one dedicated track between Camden and Woodbury with a passing siding in Westville and Woodbury. South of Woodbury, the GCL would operate on one new dedicated GCL track and share one track with Conrail. On this shared track, GCL trains would operate during the day and evening hours, with Conrail trains operating in the late evening and overnight.

The proposed project would provide 14 new transit stations in addition to an existing station at the Walter Rand Transportation Center (WRTC) and two vehicle maintenance facilities. With the proposed project, existing levels of freight operations would be unaffected as the current single freight track would remain undisturbed.

The Glassboro-to-Camden corridor comprises substantial railroad ROW and existing rail infrastructure, which interconnects communities in southern New Jersey. Historically, these communities developed around passenger rail service that once had been available in the Glassboro-to-Camden corridor, but which has not been operating since the 1960s. The GCL would reinstate public transportation among these communities and connect them with the broader, regional public transportation network to allow residents access throughout the corridor and to important regional employment centers.

Source: GCL Project Team, 2020.

Figure 1: GCL Project Corridor Map

GCL
GLASSBORO-CAMDEN LINE

1.2 Principal Conclusions

Ridership forecasts for 2040 project that the GCL would have 16,336 daily boardings (11,537 peak boardings and 4,800 off-peak boardings). This would result in an increase in daily boardings between the 2040 No-Build condition and 2040 with the proposed GCL for New Jersey TRANSIT Corridor Buses, New Jersey TRANSIT River LINE, and PATCO Speedline. There would be little to no change in daily boardings for New Jersey TRANSIT Regional Buses.

The proposed GCL would be operated every day of the year. On weekdays, normal hours of revenue service would be from 5:00 a.m. to 12:00 a.m. On weekends and holidays, normal hours of revenue service would be from 6:00 a.m. to 12:00 a.m. Trains would operate at headways of 15 minutes through most of the day, with service at 30-minute headways in the late evening. For purposes of the ridership modeling effort and this EIS, GCL fares were set at $1.50 for a single ride. The one-way run time for the proposed GCL would be approximately 37 minutes. The estimated round trip run time for the GCL system is approximately 73.5 minutes.

The anticipated Peak Hour Peak Direction Load which must be accommodated by the service is 963 passengers in 2025 and 1,042 passengers in 2040. The anticipated Required Peak Hour Capacity which must be accommodated by the service is 1,284 passengers in 2025 and 1,389 passengers in 2040, with a target standee density of 3.1 square feet per passenger. This translates to a target vehicle capacity of 176 passengers, or 352 passengers per two car train. Passengers would experience actual standee densities of 3.8 square feet per passenger in 2025 and 3.2 square feet per passenger in 2040 during the peak of the peak. A total of 7 trains would be required for peak-period service at 15-minute headways. These quantities result in a peak car requirement of 14 light rail vehicles. Assuming a typical rail spare ratio of 20 percent, an additional 3 vehicles would be required. A planned fleet size of 18 vehicles is recommended.

The only transit service in the region that would be expected to experience a major change in service patterns following the introduction of GCL would be the PATCO Speedline. In the 2040 Build Scenario, PATCO is forecast to carry 37,500 daily trips, an increase of approximately 1,000 trips over the No-Action Scenario. However, as there are approximately 4,100 transfers forecasted between GCL and PATCO in 2040, a shift of roughly 3,100 trips from PATCO to GCL is expected with the introduction of GCL. This reflects the shift to GCL of some park-and-ride travelers who drive to PATCO today.

2 THE PROPOSED GCL

2.1 Alignment Configuration

The proposed GCL alignment would use a combination of existing and new rights-of-way to restore passenger rail service between Camden and Glassboro. At the northern end of proposed alignment, GCL would operate within an urban environment along the existing New Jersey TRANSIT (NJ TRANSIT) River LINE alignment from WRTC to Haddon Avenue in Camden. Continuing from WRTC, the GCL would operate as a stand-alone service southward to Glassboro with two dedicated tracks dedicated for light rail

passenger service. In general, the GCL would operate at-grade; however, some portions of the proposed GCL alignment would be elevated to traverse existing roads and waterways.

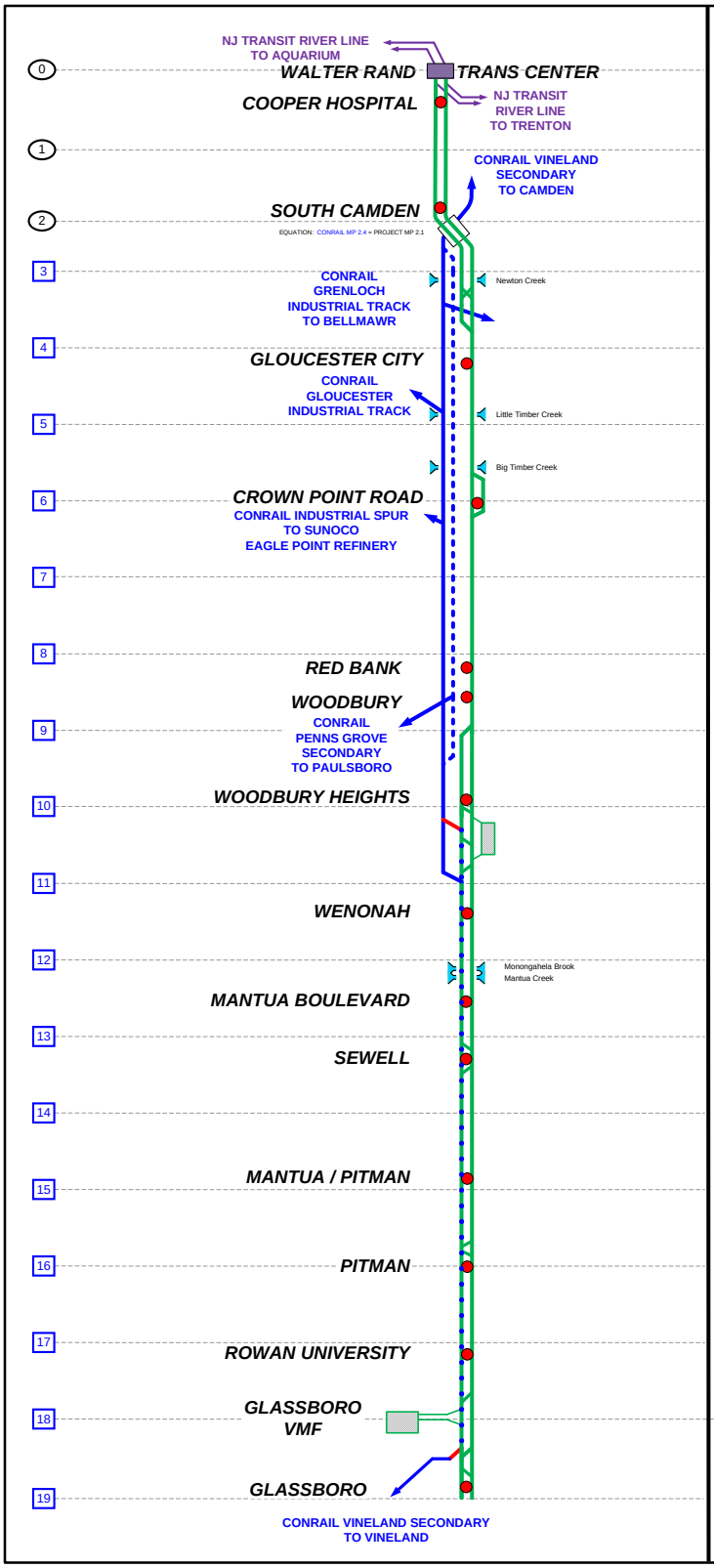
A more detailed description of the proposed GCL alignment is provided in the following section. A track chart for the proposed GCL alignment is shown in Figure 2, "Proposed GCL Alignment Track Chart."

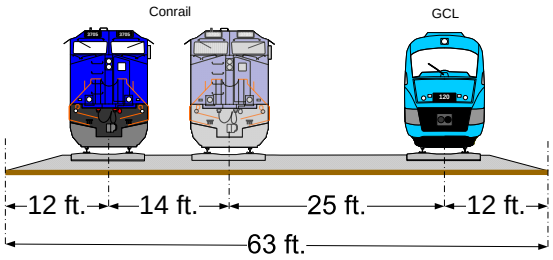
2.1.1 Detailed Alignment Description

The proposed GCL alignment begins at WRTC in Camden, following the existing in-street River LINE alignment along a portion of Dr. Martin Luther King Boulevard before diverging onto its own elevated structure at approximately Haddon Avenue. The elevated structure would curve southward and continue adjacent to Interstate 676 (I-676), crossing Martin Luther King Boulevard. The alignment would remain elevated on a combination of aerial structure and retained embankment, crossing Newton Avenue, Pine Street, Chestnut Street, Sycamore Street, Kaighns Avenue, and Atlantic Avenue. The alignment would remain elevated south of Atlantic Avenue crossing the Conrail tracks, Carl Miller Boulevard/Van Hook Street, Ferry Avenue, Chelton Avenue, the Conrail Beesley's Point Secondary Spur track and Morgan Boulevard. The proposed alignment would then return to grade and shift to the Conrail right-of-way along the east side of the existing freight track between Morgan Boulevard and Newton Creek. The alignment would then continue east of, and parallel to, the existing freight track at-grade to Woodbury; the GCL Alignment would consist of one dedicated track to the east of the existing Conrail freight track with space preserved for a future second Conrail track.

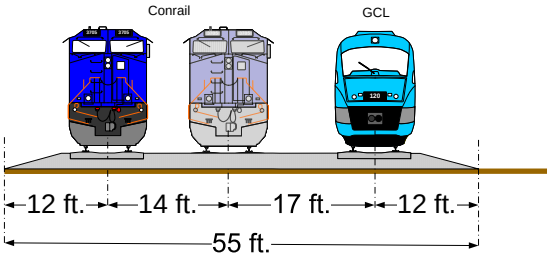
En route to Woodbury, the proposed GCL alignment would cross over Newton Creek and pass beneath Interstate 76 (I-76)/Walt Whitman Bridge. The proposed alignment would traverse Gloucester City, cross Little Timber Creek, extend through Brooklawn Borough, cross Big Timber Creek, and enter into Westville. The alignment would include a passing siding (two GCL tracks) in Westville between Big Timber Creek and Olive Street to allow GCL trains to pass each other at a 15-minute headway service. The proposed GCL alignment would then cross beneath Interstate 295 (I-295) and cross over Red Bank Avenue and Woodbury Creek as it continues to Woodbury.

South of Woodbury, the proposed GCL alignment would continue at-grade to Glassboro. The existing infrastructure is proposed to be expanded to a two-track railroad with the addition of one new track and other modifications. It is the intention for both light rail service and freight movements to operate over this two-track railroad between Woodbury and Glassboro as freight traffic levels south of Woodbury are significantly lower than on the segment between Woodbury and Camden. One or two trains travel the segment south of Woodbury overnight daily, while several trains travel the segment north of Woodbury throughout the day.

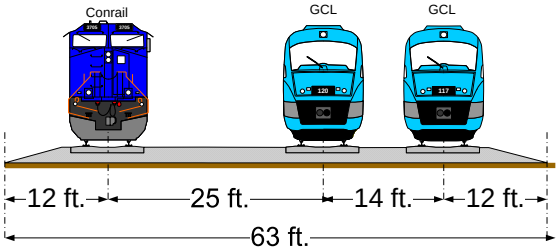




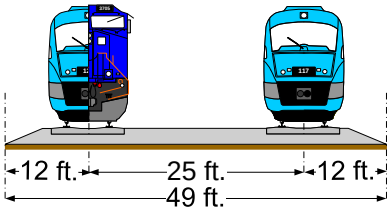
Cross Section in Gloucester City / Brooklawn Borough / Woodbury



Cross Section in Westville



Cross Section in Woodbury Heights



Cross Section in Wenonah and points south

Source: GCL Project Team, 2020.

Figure 2: Proposed GCL Alignment Track Chart

GCL
GLASSBORO-CAMDEN LINE

En route to Glassboro Borough from Woodbury, the proposed GCL alignment would cross beneath the New Jersey Turnpike through Woodbury Heights, continue through Wenonah and Mantua Township, then cross over New Jersey Route 55 and enter Pitman. South of Pitman, the proposed GCL alignment would enter Glassboro and continue adjacent to Rowan University as it crosses US Route 322. The southern segment of the proposed alignment in Glassboro would follow a new right-of-way, diverge from the existing freight track at Zane Street, cross Union and Main Streets, continue northward within a former rail spur between and parallel to Main and Academy Streets, and terminate south of High Street in Downtown Glassboro.

2.1.2 GCL-Conrail Interface

Under the current planned configuration, Light Rail and freight operations would share the right-of-way between South Camden and Woodbury. In this section, one new light rail track would be constructed within the Conrail right-of-way to east of the existing freight track. The alignment would continue at-grade, parallel to the existing freight track to Woodbury.

South of Woodbury, beginning at the point where the Salem and Penns Grove secondary branches diverge from the GCL corridor, two tracks would be used for light rail service; the existing track and a new track that would be constructed. Both tracks would be available for the proposed GCL during GCL operating hours.

A shared operations strategy over the GCL corridor must be developed between the project sponsors and Conrail. Preliminary discussions with Conrail led to the development of the proposed single track configuration, whereby Conrail would maintain space in the right-of-way for a second freight track to be constructed in the future. South of Woodbury, Conrail service would operate in a window overnight when GCL service is reduced or shut down; one of the two tracks south of Woodbury would be able to be handed over to Conrail after GCL moves to a 30-minute headway in the late evening period, via a temporal separation solution similar to the River LINE today.

This full shared operations strategy to be developed would consist of some combination of full physical separation, temporal separation, and/or simultaneous operations over different portions of the corridor. Issues for consideration include, but are not limited to: crash safety and compliance with Federal Railroad Administration vehicle requirements; providing sufficient capacity for future levels of both freight and passenger traffic; capacity requirements during peak vs off-peak vs nighttime operations; signal system considerations related to grade crossing protection and special trackwork between freight and passenger portions of the alignment.

2.2 Stations

The proposed GCL alignment would serve 14 new stations and 1 existing station (15 total stations) between Glassboro and Camden. Each new station and key features are displayed in Table 1, “Proposed New GCL Stations.”

Three types of new stations are proposed along the corridor, based on the surrounding characteristics of the communities and the needs of the GCL system in that location:

- Walk-up: Stations serving the center of established communities along the corridor with no parking provided.
- Park-and-Ride: Station areas with significant amounts of parking targeted at auto commuters.
- Moderate Park-and-Ride: Stations scaled like Walk-up stations with small amounts of parking available; parking for these stations is typically planned to be shared with proposed municipal or other developments in the station areas.

Of the fourteen proposed GCL stations, nine will be served by existing or proposed parking facilities (structures or surface parking lots). Parking facilities (surface lots) will be constructed at six stations as part of the proposed GCL (South Camden, Gloucester City, Crown Point Road, Woodbury Heights, Mantua Boulevard, and Mantua-Pitman). Two stations (Woodbury and Glassboro) will be served by existing municipal parking structures, and one station (Red Bank Avenue) will be served by an existing municipal parking lot. (Mantua-Pitman Station will be served by a parking lot constructed as part of the GCL, which if and as demand calls for, may be developed in the future as a parking structure.) In sum, approximately 2,685 new parking spaces in 2025 and 4,310 spaces in 2040 would be available for GCL use. The type and size of the proposed GCL parking facilities are shown in Table 1, "Proposed New GCL Stations." Parking facilities identified as "GCL" would be constructed as a part of the proposed project. Facilities identified as "Other" are either existing or planned as part of municipal redevelopment master plans, and though not part of the proposed project, would provide parking spaces for use by GCL riders.

With the exception of the Cooper Hospital Station and South Camden Station, located on elevated structure, stations would be located at existing ground level. There are three station platform configurations: single center platform stations, single side platform stations, and two side platform stations. There are three stations with a single center platform: Cooper Hospital, South Camden, and Crown Point Road. There are three stations with a single side platform: Gloucester City, Red Bank Avenue, and Woodbury. Eight stations have two side platforms: Woodbury Heights, Wenonah, Mantua Boulevard, Sewell, Mantua-Pitman, Pitman, Rowan University, and Glassboro. Note, the existing WRTC would have a center platform as well as two side platforms.

Platforms would be approximately 280 feet long to accommodate a two-car train consist; where possible, space would be set aside for future platform extensions to accommodate longer consists. All stations would include facilities for bicyclists and pedestrians, including bike racks, sidewalks and crosswalks. The proposed project would also include connections to the regional bus system. Ancillary facilities such as signal houses and crossing cases, as well as a maintenance and storage facility would also be constructed.

2.3 Rolling Stock

The GCL fleet would consist of diesel multiple-unit (DMU) light rail vehicles, similar to the vehicles used on systems like the NJ TRANSIT River LINE and the Denton County Transportation Authority A-train. DMU

vehicles generate their own electric power via an on-board diesel engine, eliminating the need for any third rail or overhead electric power infrastructure. Vehicles would travel at speeds up to 65 mph, but would be limited to lower speeds in heavily developed areas.

This technology can operate on an exclusive guideway or in-street (as in Camden), but cannot integrate with the PATCO Speedline to directly access Center City Philadelphia. The vehicles would be designed with at least 70 percent low-floors to serve low-level platform stations, providing full Americans with Disabilities Act accessibility.

Based on the assumption of a vehicle of a similar size as the Denton County vehicle, GCL vehicles would have a capacity of approximately 175 passengers (seated and standing), or approximately 350 passengers per 2-car train. Performance assumptions for the operations analysis were based on the Denton County vehicle to reflect the latest standards in vehicle performance.

It is estimated that GCL will require a fleet of 18 vehicles to provide the desired level of passenger capacity and necessary maintenance spare ratios. Section 6, “Capacity and Fleet Analysis,” discusses the development of this figure in detail.

Table 1: Proposed New GCL Stations

Station	Location	Access	2025 Parking Spaces*		2040 Parking Spaces*		Platforms
			GCL	Others	GCL	Others	
Cooper Hospital	Camden	Walk-up	0	0	0	0	Center
South Camden	Camden	Moderate Park-and-Ride	100		100		Center
Gloucester City	Gloucester City	Moderate Park-and-Ride	160	0	160	0	Single side platform
Crown Point Road	Westville Borough	Moderate Park-and-Ride	325	0	325	0	Center
Red Bank Avenue	Woodbury	Park-and-Ride	0	200	0	500	Single side platform
Woodbury	Woodbury	Park-and-Ride	0	600	0	1200	Single side platform
Woodbury Heights	Woodbury Heights	Moderate Park-and-Ride	25	0	25	0	Two side platforms
Wenonah	Wenonah Borough	Walk-up	0	0	0	0	Two side platforms
Mantua Boulevard	Mantua Township	Park-and-Ride	300	0	300	0	Two side platforms
Sewell	Mantua Township	Walk-up	0	0	0	0	Two side platforms
Mantua/Pitman	Mantua Township	Park-and-Ride	475	0	1200	0	Two side platforms
Pitman	Pitman Borough	Walk-up	0	0	0	0	Two side platforms
Rowan University	Glassboro	Walk-up	0	0	0	0	Two side platforms
Glassboro	Glassboro	Park-and-Ride	0	500	0	500	Two side platforms

*Parking assumptions include both spaces identified in GCL Station Area Plans and spaces identified in current master plans and development proposals along the corridor.

2.4 Shop and Yard Facilities

The proposed GCL EIS configuration calls for two Vehicle Maintenance Facilities (VMF) to provide maintenance and storage for the new GCL rail service. The facilities would be capable of providing the GCL project's needs for regular preventative and unscheduled corrective vehicle maintenance and maintenance-of-way, in addition to vehicle storage.

The main VMF site being studied is located west of Glassboro at the former Owens Corning site. This site would be a full service VMF capable of providing the GCL project's needs for regular preventative and unscheduled corrective vehicle maintenance and maintenance-of-way.

A secondary site being studied is located mid-line at the currently vacant Mamco site in Woodbury Heights, near the Woodbury Heights Station. This facility would provide supporting maintenance functions and additional storage capacity to limit the non-revenue mileage of out-of-service trains during the course of a normal day.

The proposed sites would include sufficient storage capacity for the total GCL fleet. Maintenance activities preliminarily planned for the two sites are summarized in Table 2, "Summary of Maintenance Activities."

Table 2: Summary of Maintenance Activities

Activity	Glassboro VMF	Woodbury Heights VMF
Vehicle Storage	X	X
Daily Vehicle Inspections	X	X
Periodic (Bi-wk, Monthly, etc) Vehicle Inspections	X	
Vehicle Interior Cleaning	X	X
Vehicle Exterior Cleaning (Car Washer)	X	
Diesel Fueling	X	X
Wheel Truing / Sanding	X	
Truck Repair / Change-out	X	
Painting / Body Work	X	
Maintenance of Way staging	X	
Electronic component repair	X	
Milling / Welding / Mechanical component repair	X	

Source: The GCL Project Team, 2019

3 EXISTING PUBLIC TRANSIT NETWORK

Two agencies operate and maintain public transit systems serving southern New Jersey: NJ TRANSIT and DRPA's Port Authority Transit Corporation (PATCO). NJ TRANSIT is the nation's third largest provider of bus, light rail transit and commuter rail. As New Jersey's public transportation corporation, NJ TRANSIT operates within a service area covering 5,325 square miles in New Jersey, New York and Pennsylvania. NJ TRANSIT operates approximately 250 bus lines and 11 rail lines statewide, accommodating about 223 million passenger trips each year. PATCO operates a single rapid transit line between Lindenwold, NJ and Philadelphia, PA via the Ben Franklin Bridge through downtown Camden, NJ.

3.1 Services and Infrastructure

Southern New Jersey public transit services operated by NJ TRANSIT and PATCO are summarized here and considered throughout the transportation assessment. The primary passenger rail routes are shown in Figure 3, "Regional Rail Transportation Network."

3.1.1 PATCO Speedline

PATCO Speedline is a 14.2-mile heavy rail operation, serving the northern and eastern edges of the regional study area. It connects Center City Philadelphia and Lindenwold, New Jersey with 13 stations, four in Center City Philadelphia and nine in New Jersey, and provides 24-hour rail service 7 days a week. PATCO connects with the NJ TRANSIT River LINE at the Walter Rand Transportation Center in the City of Camden and with NJ TRANSIT bus lines at stations in Camden and Lindenwold.

3.1.2 NJ TRANSIT River LINE

The River LINE light rail system provides service from Trenton to the City of Camden, where riders can transfer to PATCO or NJ TRANSIT bus services. The line is 34 miles in length and has 21 station stops. Typical service frequency is approximately 15 minutes during peak periods and 30 minutes during off-peak periods.

3.1.3 NJ TRANSIT Atlantic City Line

The Atlantic City Line is a commuter rail line providing service between Atlantic City and Philadelphia 30th Street Station, stopping at nine stations. It makes 12 eastbound trips and 12 westbound trips daily with an average duration of approximately 95 minutes. The Atlantic City line connects with River LINE service at the Pennsauken Transit Center and with the PATCO Speedline at Lindenwold.

Source: GCL Project Team, 2020.

Figure 3: Regional Rail Transportation Network

GCL
GLASSBORO-CAMDEN LINE

3.1.4 NJ TRANSIT Bus Services

Approximately 30 bus lines operate within the region, providing service between Southern New Jersey and the Walter Rand Transportation Center. Roughly half of these provide continuing service to Central Philadelphia to Race Street, Arch Street and the Greyhound Terminal located at Filbert Street and 9th Street. Five routes (401, 402, 408, 410, 412) provide service parallel to all or part of the GCL corridor, serving the communities targeted by this project. The numerous bus services that operate through the Walter Rand Transportation Center continue on to destinations in Camden, Gloucester, Salem, Cumberland, Atlantic and Cape May counties.

Bus service frequencies vary by geography and time of day, with some bus lines running as frequently as five per hour and others as infrequently as two or three total trips per day.

3.2 Changes to Existing Network

The following sections describe the changes to the Southern New Jersey public transportation network expected to occur between the present and the introduction of GCL service. These include both small changes resulting from the introduction of the GCL, as well as any modifications to transit service expected to occur regardless of the GCL.

3.2.1 PATCO Speedline

No changes or expansion to PATCO service are planned during the study period through 2035.

3.2.2 NJ TRANSIT Bus Services

No significant changes or expansion to regular NJ TRANSIT bus service are planned during the study period through 2040. The Project Team and NJ TRANSIT have developed several small routing changes in GCL station areas to make transfers more convenient between GCL and regional bus routes:

- South Camden – Route 450 realigned to serve the station via 6th Street; no changes to routes 401/402/410/412
- Woodbury (Red Bank Avenue Station) – Station area redevelopment plan (being developed by the municipality) will include transfer facilities between GCL light rail service and NJ TRANSIT routes 401/402/410/412, 455, and 463

No changes were proposed at other station locations, as bus routes either pass directly by the proposed stations or do not serve the nearby area at all.

3.2.3 NJ TRANSIT River LINE

No changes or expansion to River LINE service are planned during the study period through 2040. The proposed GCL service plan and proposed modifications to WRTC are configured to not interrupt current River LINE operations.

3.2.4 NJ TRANSIT Atlantic City Line

No changes or expansion to Atlantic City Line service are planned during the study period through 2040.

4 RIDERSHIP FORECASTS

The GCL Project Team performed ridership and travel demand forecasts for the Build Scenarios using the FTA-developed STOPS model. This model has been used to determine travel patterns, trip origins and destinations and corridor level travel times both during the planning and design stages of the GCL and also to support the transportation analyses reported in the EIS.

The Delaware Valley Regional Planning Commission (DVRPC), the metropolitan planning organization for the Philadelphia region, including Camden and Gloucester Counties, provided additional regional demographic data, and travel demand data for the Base Year and No-Build scenarios, using their Travel Improvement Model (TIM v2.3). The GCL Project Team incorporated this information into the ridership forecasting effort.

4.1 Base Year

The 2015 Base Year model (e.g., “existing conditions”) estimates the following ridership levels for the regional public transit services. When discussing current ridership levels on public transit routes in the region, the 2015 Base Year model is used to provide an appropriate comparison to the No-Action and Build models for the Forecast Year 2040.

- PATCO: approximately 36,000 daily trips
- River LINE: approximately 9,600 daily trips
- NJ TRANSIT buses: approximately 78,000 daily trips

4.2 No-Action

Table 3, “Projected Transit Services Daily Boardings – No Action Alternative (2040),” summarizes the ridership levels projected by the DVRPC model for the GCL corridor in the Base Year 2015 model and the No-Action Alternative 2040 model. Daily ridership forecasts are provided for River LINE and PATCO, as well as NJ TRANSIT bus routes including the 5 bus routes parallel to the GCL corridor (Corridor Buses) and the remaining routes serving WRTC (Regional Buses).

Table 3: Projected Transit Services Daily Boardings – No-Action Alternative (2040)

System / Routes		Daily Boardings	
		2015 Base	2040 No Action
NJT	Regional Buses	68,875	72,428
	Corridor Buses	9,181	10,864
	Bus Total	*78,056*	*83,292*
PATCO	River LINE	9,585	9,941
	Speedline	35,711	36,532

Source: GCL Project Team, 2020

NJ TRANSIT River LINE and PATCO ridership levels are expected to grow modestly (approximately 8% and 5%, respectively) between the current year forecast and the 2040 forecast. This reflects the limited projected population and employment growth in Camden County and the planned maintenance of current transit service levels included in the model. NJ TRANSIT bus ridership is forecast to grow by about 8% across all routes.

4.3 Build

Table 4, "Projected Transit Services Daily Boardings – The Proposed GCL (2040)," summarizes the ridership levels for the GCL corridor projected by the DVRPC travel demand model in the No-Action Scenario and by the STOPS model in the Build Scenario.

Table 4: Projected Transit Services Daily Boardings – The Proposed GCL (2040)

System / Routes		2040 Daily Boardings		Percent Change
		No-Action	Build	
NJT	Corridor Buses	10,864	11,751	8%
	Regional Buses	72,428	72,446	0%
	Bus Total	*83,292*	*84,197*	*1%*
PATCO	River LINE	9,941	10,340	4%
	Speedline	36,532	37,377	2%
GCL		--	16,336	--

Source: GCL Project Team, 2020

NJ TRANSIT buses paralleling the GCL corridor would see the largest increase in ridership due to the introduction of the GCL and the encouragement of transfers between routes, while the remaining NJ TRANSIT buses would see no growth or loss in ridership due to the GCL.

Both PATCO and River LINE would see small increases in total daily ridership following the introduction of the GCL; however, these ridership gains primarily represent GCL riders transferring to the existing services. Comparing the approximately 4,100 daily transfers between GCL and PATCO to the increase in ridership of 800 daily trips on PATCO between the No-Action and the proposed GCL indicates that roughly 3,300 current daily PATCO trips will be become GCL-only trips in the Build scenario. Table 5, "Projected Daily

Transfers to/from GCL – The Proposed GCL (2040)," summarizes the forecast number of transfers between GCL and existing routes.

Table 5: Projected Daily Transfers to/from GCL – The Proposed GCL (2040)

System / Routes		Transfers to/from GCL
NJT	Bus Total	2,520
	River LINE	242
PATCO	Speedline	4,144
Total		**6,906**

Source: GCL Project Team, 2020

The STOPS model also provided ridership results in terms of total linked trips, that is, counting trips linked by a transfer as one trip. According to this analysis, the Build Scenario would generate approximately 11,000 new transit trips daily, with the remaining GCL trips representing existing transit riders of PATCO, River LINE, and the bus network.

4.4 GCL Ridership

GCL ridership forecasts were developed through periods throughout the day in the Forecast Year of 2040. Table 6, "Projected GCL Station Boardings – The Proposed GCL (2040)," summarizes the total daily boardings at each station. Boardings during the peak and off-peak periods are approximated based on ridership modeling performed by DVRPC during earlier project phases.

Table 6: Projected GCL Station Boardings – The Proposed GCL (2040)

Station	Daily Boardings	Peak Boardings	Off-Peak Boardings
Walter Rand	980	652	328
Cooper University Hospital	1,303	746	558
South Camden	580	417	163
Gloucester City	719	503	215
Crown Point Road	666	446	220
Red Bank Avenue	657	476	181
Woodbury	462	332	130
Woodbury Heights	605	427	178
Wenonah	1,358	989	369
Mantua Boulevard	1,446	1,031	416
Sewell	852	571	281
Mantua-Pitman	737	552	185
Pitman	964	659	304
Rowan University	796	627	169
Glassboro	4,211	3,109	1,101
Totals	16,336	**11,537**	**4,800**

Source: GCL Project Team, 2020

Of these total daily trips, approximately 30% would be auto-access trips and 70% would be walk-access or transit-access trips. It was estimated that roughly 22% of the auto-access trips would be kiss-and-ride (drop-off) trips, with the remainder being parking trips requiring roughly one space for every two trips. Glassboro, Mantua-Pitman, and Woodbury Stations would experience the greatest number of drive-access boardings, given the park-and-ride facilities provided there. WRTC and Rowan University Station would experience the greatest number of walk- and transit- access boardings.

5 SERVICE PLAN

5.1 Planned Service Schedule

The proposed GCL would be operated every day of the year. On weekdays, normal hours of revenue service would be from 5:00 a.m. to 12:00 a.m. On weekends and holidays, normal hours of revenue service would be from 6:00 a.m. to 12:00 a.m.

The proposed headways and train consist lengths by time of day for regularly scheduled revenue service are shown in Table 7, “Regularly Scheduled Service Headways.” (Detail supporting the planned consist lengths is provided in Section 3.2, “Changes to Existing Network”).

Table 7: Regularly Scheduled Service Headways

Day of Week	Time of Day	Time Period	Headway (minutes)	Consist Length
Monday to Friday	Early AM	5:00 a.m. to 6:29 a.m.	15	2
	AM Peak	6:30 a.m. to 8:59 a.m.	15	2
	Midday	9:00 a.m. to 3:59 p.m.	15	2
	PM Peak	4:00 p.m. to 6:59 p.m.	15	2
	Evening	7:00 p.m. to 9:59 p.m.	15	1
	Late Night	10:00 p.m. to 12:00 a.m.	30	1
Saturday, Sunday, and Holidays	Daytime and Evening	6:00 a.m. to 9:59 p.m.	15	1
	Late Night	10:00 p.m. to 12:00 a.m.	30	1

Source: GCL Project Team, 2020

5.2 Fare Structure

For purposes of the ridership modeling effort and this EIS, GCL fares were set at $1.50 for a single ride. This fare level is similar to fares on other transit services in the area: a one-way fare on the River LINE is $1.60; a one-way intra-New Jersey fare on PATCO is $1.60; NJ TRANSIT bus fares range from $1.60 to $3.35 depending on how many zones are traversed.

5.3 Run Time Estimates

Station-to-station and end-to-end run times were estimated using the Train Operations Model (TOM). TOM uses inputs including vehicle acceleration and deceleration rates, distances between stations, horizontal curvature, and vertical gradients to model travel times on a rail corridor.

Maximum speed limits were set to different levels along the corridor depending on surrounding conditions. The maximum authorized speed for train movements in an exclusive operating environment was set at 65mph. The authorized speed for train movements in a semi-exclusive operating environment in a roadway or operating in an at-grade alignment close to adjacent roadways would be the same as the posted auto speed limit.

All of the previously mentioned speed limits would be further subject to the considerations of civil limitations, train performance capabilities, station spacing, adjacent development, and traffic interference.

Based on the results of the simulation, the one-way run time for the proposed GCL would be 37 minutes. Peak and off-peak run times were assumed to be the same for purposes of this level of planning. Table 8, “Cumulative Run Times (Total time to departure),” presents cumulative run times in both directions.

Table 8: Cumulative Run Times (Total time to departure)

Station	Northbound	Southbound
Glassboro	**0:00:00**	**0:37:00**
Rowan University	**0:03:30**	**0:34:00**
Pitman	**0:06:30**	**0:31:00**
Mantua-Pitman	**0:09:00**	**0:28:30**
Sewell	**0:11:00**	**0:26:00**
Mantua Boulevard	**0:13:00**	**0:24:00**
Wenonah	**0:15:00**	**0:22:00**
Woodbury Heights	**0:17:30**	**0:19:30**
Woodbury	**0:20:30**	**0:16:30**
Red Bank Avenue	**0:22:00**	**0:15:00**
Crown Point Road	**0:25:00**	**0:11:30**
Gloucester City	**0:28:30**	**0:08:30**
Ferry Avenue	**0:31:30**	**0:05:30**
Cooper Hospital	**0:34:00**	**0:03:00**
Walter Rand	**0:36:30**	**0:00:00**

Source: GCL Project Team, 2020

5.4 Cycle Time

Based on the run time analysis in the previous section, the estimated round trip run time for the GCL system is approximately 73.5 minutes. Cycle time, the total time a train takes to operate through the system, consists of both the round trip run time and total terminal time. Cycle times must be an even multiple of the headway to allow for regular repeatable departures and arrivals at the terminals.

The minimum acceptable terminal time was established to be 20 minutes (25% of roundtrip run time) to allow for recovery time from delays over the single track segments.

Table 9, "GCL Cycle Times," summarizes the projected cycle times for the operation of the GCL system at different headways planned throughout the day.

Table 9: GCL Cycle Times

Headway (min)	15	30
Roundtrip Run Time (min)	73.5	73.5
Minimal Terminal Time (min)	20	20
Cycle Time (min)	105	120
Actual Terminal Time (min)	31.5	46.5
Trains in Service	7	4

Source: GCL Project Team, 2020

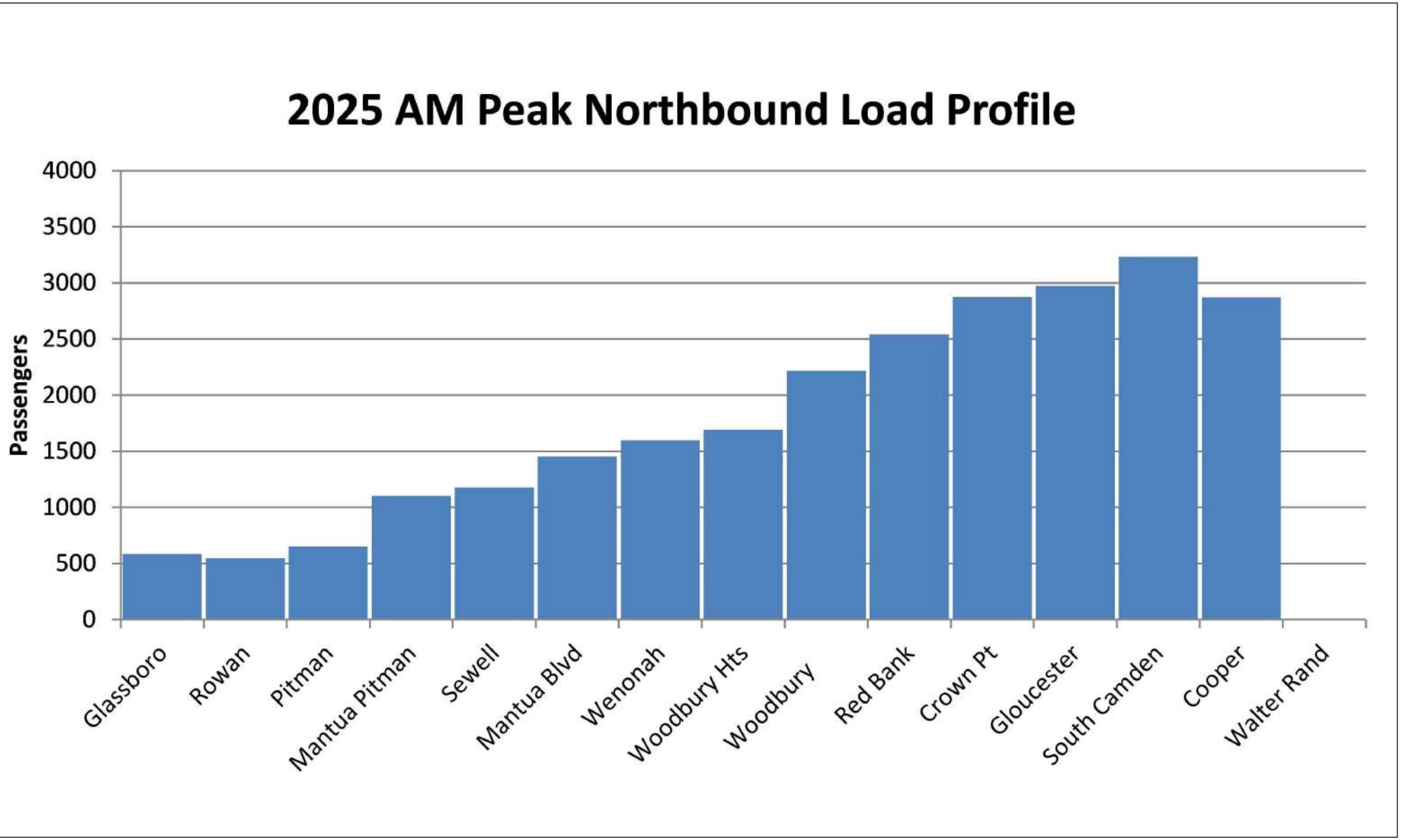
6 CAPACITY AND FLEET ANALYSIS

This section describes the ridership forecasts produced in the travel demand model, an analysis of system capacity and the train consist sizes necessary to carry the forecasted ridership, and the resulting total fleet size required to operate the GCL.

6.1 Peak Period Ridership Demand

The Travel Demand Model projected ridership levels of 15,100 total daily boardings in 2025 and 16,300 total daily boardings in 2040. For purposes of this Capacity Analysis, ridership during the higher volume Peak Period must be examined to calibrate fleet size to the highest point of demand during the day. However, the STOPS model does not provide ridership by time of day directly. Using factors developed from previous ridership modeling efforts by DVRPC, total AM boardings are estimated at 5,300 in 2025 and 5,600 in 2040.

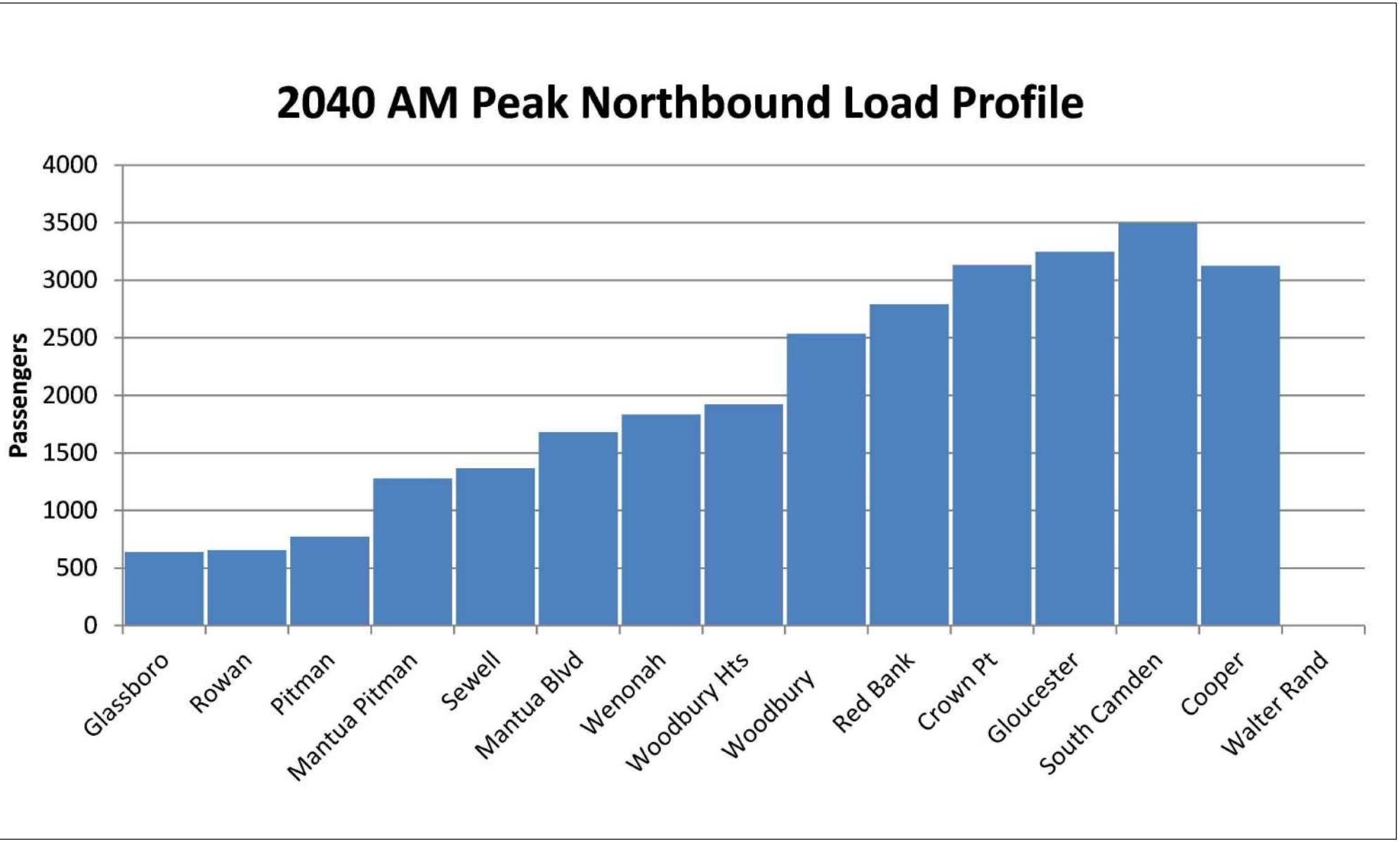
Figure 4, "2025 AM Peak Northbound Load Profile," and Figure 5, "2040 AM Peak Northbound Load Profile," show the distribution of these AM boardings along the GCL corridor. The flows are derived from total boardings and alighting at each station during the AM Peak Period in the Peak (NB) Direction, with each segment's height corresponding to the total number of passengers that will travel over that segment in the peak direction during the AM Peak Period. The peak load segment in both forecast years falls between South Camden and Cooper Hospital stations, with a peak period peak direction volume over this segment of 2,888 passengers in 2025 and 3,125 in 2040.



Source: GCL Project Team, 2020.

Figure 4: 2025 AM Peak Northbound Load Profile

GCL
GLASSBORO-CAMDEN LINE



Source: GCL Project Team, 2020.

Figure 5: 2040 AM Peak Northbound Load Profile

GCL
GLASSBORO-CAMDEN LINE

6.2 Required Peak Hour Capacity

Additional factors are considered to convert the Peak Period Peak Direction Volume over the Peak Load Segment to the Required Peak Hour Capacity that must be provided.

Based on boarding data from the NJ TRANSIT River LINE and shown in Table 10, "Development of Required Peak Hour Capacity," AM peak hour demand is estimated at 33% of the demand during the entire 4-hour AM Peak. Thus, the anticipated Peak Hour Peak Direction Load which must be accommodated by the service is 963 passengers in 2025 and 1,042 passengers in 2040.

To account for variations in demand within the peak hour, a peak hour factor (PHF) is applied in determining the Required Peak Hour Capacity that the combination of peak headways (15-minutes) and train consists (2 vehicles per train) must accommodate. A typical PHF value for Light Rail of 0.75 was applied (Source: TCRP 165 TCQSM). Thus, the anticipated Required Peak Hour Capacity which must be accommodated by the service is 1,284 passengers in 2025 and 1,389 passengers in 2040.

Table 10: Development of Required Peak Hour Capacity

	2025	2040
Peak Period, Peak Dir Load *(AM NB in both years)*	2,888	3,125
Peak Hour / Peak Period Factor	33%	
Peak Hour, Peak Dir Load *(AM NB in both years)*	963	1,042
Peak Hour Factor	0.75	
Required Peak Hour Capacity (*Peak Hour Load ÷ PHF)*	1,284	1,389

Source: GCL Project Team, 2020

6.3 Vehicle Capacity and Passenger Loading Standards

The DMU vehicle used on the Denton County A-Line (a more modern variation on the Stadler GTW for the River LINE) was used to develop peak hour vehicle capacity assumptions. The Denton vehicle has a seated capacity of 104 passengers, with 258 square feet of floor area for standees. TCRP 165 TCQSM discusses passenger loading standards and the comfort impacts of increasing standing capacity. The Manual indicates that standee densities of 4 of between 3.1 to 2.2 square feet per passenger represent the maximum peak hour schedule load for design.

Taking a conservative approach, a target peak hour standee density of 3.1 square feet per passenger (3.5 passengers per square meter) is assumed for the GCL system. This translates to a target vehicle capacity of 176 passengers, or 352 passengers per two car train.

6.4 Peak Hour Design Capacity

At the vehicle capacities assumed in the previous section and at 15 minute peak headways, a Peak Hour Design Capacity of 706 passengers on one-car trains or 1,412 passengers on two-car trains would be provided. Thus, two-car trains must be provided to accommodate the Required Peak Hour Capacities of 1,284 in 2025 and 1,389 in 2040. At these loads, passengers would experience actual standee densities of

only 3.8 square feet per passenger in 2025 and 3.2 square feet per passenger in 2040 during the peak of the peak.

6.5 Fleet Size

Based on the cycle time analysis in Section 5.4, "Cycle Time," a total of 7 trains would be required for peak-period service at 15-minute headways. These quantities result in a peak car requirement of 14 light rail vehicles. Assuming a typical rail spare ratio of 20%, an additional 3 vehicles would be required.

A planned fleet size of 18 vehicles is recommended. This would provide a generous spare ratio of 28%, assuming only 14 vehicles are needed for peak service. Future analysis of operations and reliability may necessitate an additional train to be put into service, either via longer terminal times or as a standby train. This slightly larger spare ratio and fleet size will accommodate these potential operating scenarios to increase reliability in the future.

6.6 Capacity on Other Services

The only transit service in the region that would be expected to experience a major change in service patterns following the introduction of GCL would be the PATCO Speedline.

In the 2040 Build Scenario, PATCO is forecast to carry 37,400 daily trips, an increase of approximately 1,000 trips over the No-Action Scenario. However, as there are approximately 4,100 transfers forecasted between GCL and PATCO in 2040, a shift of roughly 3,100 trips from PATCO to GCL is expected with the introduction of the GCL. This reflects the shift to GCL of some park-and-ride travelers who drive to PATCO today.

Applying ridership distribution factors based on actual PATCO boardings during 2017, it is estimated that AM Peak Hour ridership on PATCO would be 6,600 in the No-Build scenario and 6,800 in the Build Scenario in 2040. Although this represents an absolute increase in ridership of 200, the GCL passengers transferring to PATCO discussed (estimated at 600 in the AM Peak Hour) above must be accounted for: 6,200 PATCO-only trips and 600 GCL-PATCO trips in the AM Peak Hour.

Assuming that 85% of PATCO-only trips (based on PATCO boardings from 2017) and 100% of GCL transfers (making a very conservative assumption) are crossing the Ben Franklin Bridge, we can estimate that 5,900 PATCO trips will travel into Philadelphia during the AM Peak Hour.

To comfortably accommodate these riders, the PATCO system would have to provide capacity for approximately 6,300 passengers per hour, using a Peak Hour Factor of 0.93 (based on actual PATCO boardings data from 2017) to account for variations in passenger crowding during the peak hour. At current PATCO service levels (12 trains per hour), there is sufficient capacity for approximately 5,500 seated passengers per hour; thus, roughly 800 riders per hour (16% of riders) would be required to stand in the 2040 Build scenario – a loading factor of 1.15. Applying this analysis to current PATCO ridership, we estimate that on average during the peak hour today, the loading factor is 1.08 with 8% of riders standing.

Several possible strategies exist for accommodating this increased ridership over the Ben Franklin Bridge:

- It could be assumed that current PATCO levels can accommodate the additional ridership with some additional standing and potential crowding on trains. Such an approach would require a more detailed analysis based on current ridership levels and capacity.
- PATCO trains could be lengthened to 8 cars; this would bring passenger loading densities below current levels even with the introduction of GCL riders.
- PATCO train frequencies could be increased to accommodate more riders. Moving from 12 to 15 trains per hour over the Ben Franklin Bridge would bring passenger loading densities below current levels even with the introduction of GCL riders. The theoretical maximum frequency of the PATCO system is 20 trains per hour; however, the current ability of the system to accommodate more frequent service would need to be studied.

7 OPERATING STATISTICS

Operating statistics have been calculated based on the proposed GCL's preliminary operating plans. The operating parameters and their corresponding operating statistics are presented in Table 11, "Operating Statistics."

Table 11: Operating Statistics

Weekdays

Service periods	Headway	# of Round Trips	Consist Size	Cycle Time (min)	Trains in Service	Vehicles in Service	Revenue Train Hours*	Revenue Car Hours*	Revenue Train Miles	Revenue Car Miles
Early (5a-6:30a)	15	6	2	105	7	14	**7**	**15**	**222**	**444**
AM Peak (6:30a-9:00a)	15	10	2	105	7	14	**12**	**25**	**370**	**740**
Midday (9:00a - 4:00p)	15	28	2	105	7	14	**34**	**69**	**1,036**	**2,072**
PM Peak (4:00p-7:00p)	15	12	2	105	7	14	**15**	**29**	**444**	**888**
Evening (7:00 - 10:00p)	15	12	1	105	7	7	**15**	**15**	**444**	**444**
Late Night (10:00p- 12:00a)	30	6	1	120	4	4	**5**	**5**	**148**	**148**
Total Round Trips per weekday		**72**					**88**	**157**	**2,664**	**4,736**

Saturday / Sunday / Holiday

Service periods	Headway	# of Round Trips	Consist Size	Cycle Time (min)	Trains in Service	Vehicles in Service	Revenue Train Hours	Revenue Car Hours	Revenue Train Miles	Revenue Car Miles
Midday (6a - 10p)	15	64	1	105	7	7	**78**	**78**	**2,368**	**2,368**
Late Night (10p -12a)	30	6	1	120	4	4	**5**	**5**	**148**	**148**
Total Round Trips per Sat, Sun & hol		**68**					**83**	**83**	**2,516**	**2,516**

Total Days per Year		Totals			
Weekday	252	**22,226**	**39,514**	**671,328**	**1,193,472**
Sat / Sun / Holiday	113	**9,413**	**9,413**	**284,308**	**284,308**
	365	**31,639**	**48,927**	**955,636**	**1,477,780**

System Length (miles)	18.5
Track Mileage	**33.5**
Peak Fleet (railcars)	**14**
Spare Cars (20%)	**4**
Total Fleet (railcars)	**18**

*Revenue Hours are running time only; no terminal time

8 REFERENCES

Delaware Valley Regional Planning Commission (DVRPC) Glassboro-Camden Line Regional Model (from Travel Improvement Model (TIM v2.3), 2017.

Federal Transit Administration (FTA), Simplified Trips-on-Project Software (STOPS) Model (version 2.01), 2018.

The GCL Project Team, 2019 & 2020.

NJ TRANSIT (NJT) River LINE Boarding Survey Data, 2009.

Train Operations Model (TOM), Version 3.3.3.