Modernization of SEPTA's Norristown High-Speed Line

J. WILLIAM VIGRASS

The Norristown High-Speed Line (NHSL) is an interurban electric railway connecting the western terminus of Southeastern Pennsylvania Transportation Authority's (SEPTA's) Market-Frankford subway and elevated line at 69th Street, Upper Darby, with Norristown, a distance of 13.4 mi. En route, the NHSL serves 22 stations located in Delaware and Montgomery counties. The NHSL rehabilitation and modernization projects, as currently approved or planned for funding, involve the acquisition of 26 new multiple-unit electric interurban passenger cars capable of 70 mph (all of which will be equipped with cab signals and overspeed protection); capital spare parts for the cars; installation of a new wayside signal system that is compatible with the new cars and provides cab signal information to the motorman and overspeed command to the vehicle propulsion and braking control system as well as automatic and remote control of interlockings; reconstruction of most of the track system; rebuilding of two major passenger terminals; replacement of three electrical substations; rehabilitation of several bridges; creation of a new vehicle maintenance and repair facility; rehabilitation and enlargement of intermediate passenger stations along the line; construction of new pedestrian bridges to replace old ones; and the construction of new or expanded parking facilities for patrons at passenger stations. Accomplishment of this program should enable SEPTA to present a substantially improved level of safety and quality of service to existing and potential NHSL patrons for the 1990s and into the next century. During the period 1972–1988, UMTA had awarded approximately $110 million in federally funded grants to accomplish $153,000,000 in various capital improvement projects related largely to the NHSL. Additional funding is anticipated to complete the intended projects that are part of the overall program.

The Norristown High-Speed Line (NHSL) (Figure 1) and its modernization program are described. The line has a number of unique features and could be a model for others to emulate.

All other electric railways categorized as light rail are designed for medium speeds, generally 45–55 mph maximum. In contrast, the new Norristown cars are designed to operate at 70 mph, yet the line has 22 stations in its 13.4-mi length. End-to-end running time of 22 min (presently 30 min) is planned.

The application of the term "light rail" to the NHSL is done purposefully. The line opened in 1907 as an interurban electric railway. It operated mostly one-car trains, with some two-car trains. At the end of its corporate existence, it legally became a street railway for 1 year before being merged into a company having a street railway charter. Although its physical plant may appear to be similar to some heavy-rail lines in that it is fully grade separated and uses third rail and high platforms, it is its character of operation that places it in the light-rail category.

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The NHSL's technology and operating practices might be applied to new rail transit lines built on abandoned or underutilized railroads in urban or suburban areas where its type of fast, frequent service with one- or two-car trains might be appropriate.

HISTORY

A brief history of the NHSL is appropriate for explaining some of the reasons for that line's unique features. A complete history of the NHSL has been given by Degraw (*1*).

The Philadelphia and Western Railroad (P&W RR) Co. was incorporated as a steam railroad in 1902 by financial interests secretly related to George Gould's transcontinental railroad scheme. George had inherited control of the several western railroads when his father, Jay, died in 1892. George began to build a transcontinental system based on the Missouri Pacific, Wabash, and Denver & Rio Grande Western (D&RGW) stretching from Ogden, Utah, to Toledo, Ohio. He built the Western Pacific (WP) from Ogden to Oakland, California, using the D&RGW's earning power to guarantee WP's bonds. Control of the Wheeling and Lake Erie railroad connected Toledo with Pittsburgh Junction, Ohio, near Wheeling, West Virginia. From there, heavy construction was needed, so Gould formed the Wabash-Pittsburgh Terminal Railroad to enter Pittsburgh and build a hilly extension to Connellsville, Pennsylvania, for a connection with the Western Maryland, which he controlled. The Gould rail empire stretched from Baltimore, Maryland, on the Atlantic Ocean to Oakland, California, on the Pacific Ocean.

The seemingly independent Philadelphia and Western (P&W) was incorporated to build from 63rd Street in western Philadelphia to Parkesburg, Pennsylvania, about 44 mi. The secret plan was to quickly complete the P&W to Parkesburg, then suddenly build on to Lancaster and York, Pennsylvania, connecting with the Western Maryland at the latter point.

By the end of 1906, Gould was in financial trouble and had to give up his eastern objectives. The panic of 1907 and other events caused most of his railroads to be in bankruptcy by 1908, and his dream of a great coast-to-coast railroad collapsed. The P&W stood alone.

The P&W's directors had inquired about steam locomotives, passenger, and freight cars on two occasions, 1902 and 1903, but did not place any orders. In 1905, they decided to operate as an electric interurban railway when it became evident that the Gould plan was failing, and 22 electric interurban cars were ordered from St. Louis Car Company for delivery in 1907.

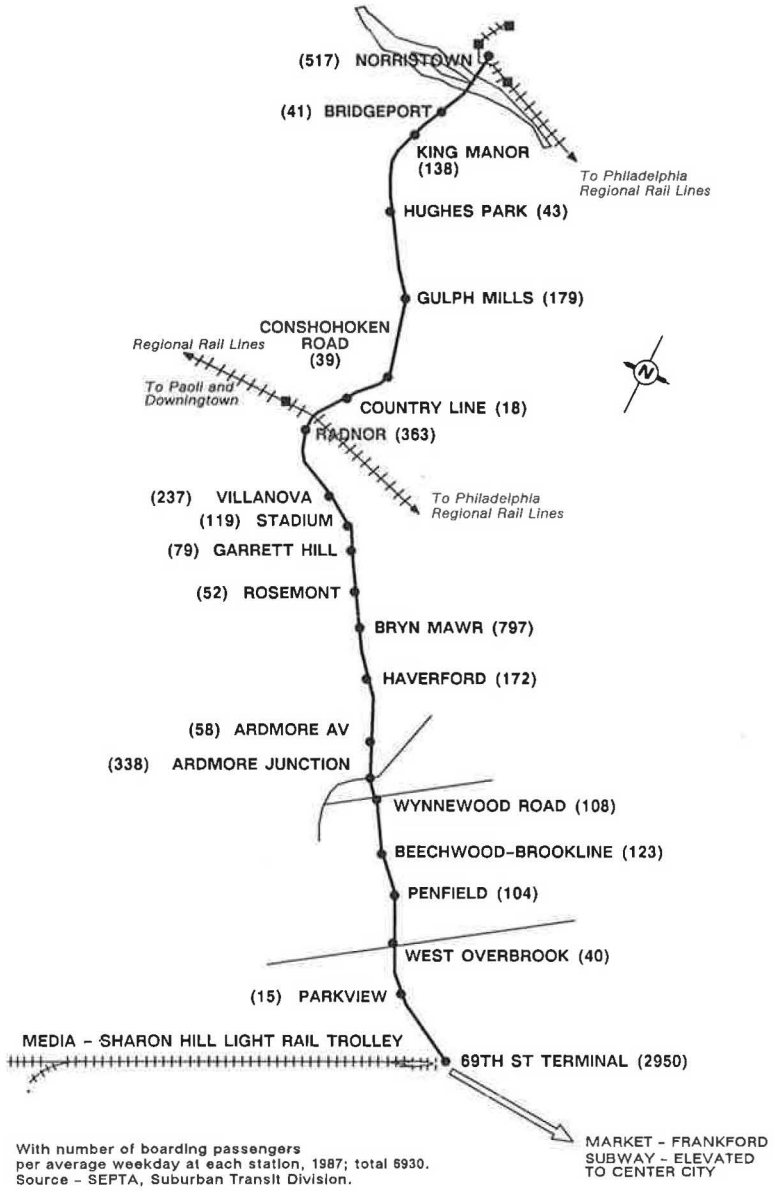

FIGURE 1 Norristown High-Speed Line.

The P&W RR Co. had been reorganized in 1907 as the P&W Railway Company to allow additional stocks and bonds to be issued. Their efforts were sufficient to allow completion of the line as far as Strafford, Pennsylvania, 10.6 mi from the then-new 69th Street Terminal of Philadelphia Transportation Company's Market Street subway and elevated line to Center City and the ferries.

The line opened to Strafford in 1907. In 1912, the Norristown Branch, 6.5 mi, was opened as a key link in the Philadelphia-Allentown Lehigh Valley Transit Company's interurban line. The Norristown Branch quickly became the functional mainline, whereas the Strafford line remained lightly used and became a branch.

The steam railroad origin left a legacy of a double-tracked, grade-separated railway, with a maximum grade of 2.5 percent, and maximum curvature of 5 degrees. This was substantially better than typical interurban electric railways of that period. An 8-degree curve at Villanova Junction was added in 1912 when the Norristown Branch was built.

The P&W was modernized in the years 1930–1933, under the direction of Dr. Thomas Conway, Jr., a former Professor of Finance at the University of Pennsylvania's Wharton School. He had established a reputation of transforming financially ailing interurban railways into profitable enterprises. Under Conway's direction, track was upgraded with superelevation of curves increased to 8 in. to allow speeds of 80 mph. Signals, substations, and passenger stations were modernized. During 1924 to 1928, 11 cars built, Nos. 60 to 70, were modernized by increasing motor horsepower from 60 to 100, which increased their speed from a modest 44 to 60 mph.

More important, 10 new cars, the design features of which would be a major advance, were ordered. Conway sought a car that would be the fastest possible for the P&W's demanding profile, yet be economical to operate, and attractive to

passengers. Conway realized that if the P&W was to compete with the newly electrified railroads and the ever-increasing number of automobiles, the P&W would have to provide all of the time savings in the interline trip with Philadelphia Rapid Transit Company's (PRT) Market-Frankford subway and elevated line. The latter operated what were probably the slowest rapid transit trains in the United States; they seldom exceeded 25 mph, and PRT had no plans to speed up its service. The P&W had to do it all.

Substantial research went into the new car design. Dr. Felix Pawlowski, Guggenheim Professor of Aeronautics at the University of Michigan, ran wind tunnel tests on more than 30 car body designs. The result of his tests was that his streamlined design would consume 43 percent less power at 70 mph than a conventional box car of similar size.

The new cars were 52 ft. 2 in. long, 9 ft. 2 in. wide, and only 10 ft. 6 in. high, had parabolic streamlined ends, low floors, skirting for both appearance and airflow, and a distinctive roof end that curved down over the cab. The aluminum body helped keep weight down to 52,200 lb. The cars had four GE706 motors of 100 hp each, which drove the car at a speed of 83 mph on straight, level track on 600 volts. However, P&W increased its third-rail voltage to 730 volts to enhance performance still more, with higher speeds having been reported.

Their appearance quickly earned the name "Bullet," a fitting label for what was the first aluminum-bodied, aerodynamically designed railway car in the United States. The Bullets of 1931 preceded the Burlington Railroad's Zephyr by several years, and were without question the fastest suburban rail cars.

The 10 Bullets and the eleven 60s (later 160s) provided all P&W service until recent years. The 60s normally provided Strafford local service until that line was abandoned in 1956. They also customarily provided Bryn Mawr and Wynnewood Road local service. The Bullets were almost always used on Norristown Express runs, which for many years were completed in 21 min.

The P&W shares and bonds were acquired by the Philadelphia Suburban Transportation (PST) Company's Red Arrow Lines in 1948, and P&W was merged into PST's corporate structure in 1953. The P&W Railway Company had been reorganized June 17, 1946, and again became the Philadelphia and Western Railroad Company. To allow merger of the P&W Railroad Company with its steam railroad charter into the Philadelphia Suburban Transportation Company, which operated under a street railway charter, the Philadelphia and Western Street Railway Company was incorporated on May 5, 1925. On December 31, 1952, it acquired the assets of the P&W Railroad Company, which then ceased to exist. On December 31, 1953, the P&W Street Railway Company was merged into the PST Company.

Southeastern Pennsylvania Transportation Authority (SEPTA) became a transit operator on September 30, 1968, when it acquired the assets and business of the Philadelphia Transportation Company. SEPTA had previously subsidized the commuter railroads of Philadelphia through operating agreements. SEPTA took over PST on January 29, 1970, and thereby acquired what had been the P&W. The latter was identified by SEPTA as its Route 100—the NHSL.

The line operated relatively routinely until the latter 1980s. Although its equipment was old, it was not scheduled for replacement because SEPTA had more urgent items needing immediate attention. However, in 1985 to 1986, several events occurred that caused the NHSL to be shut down for several months. A number of cars suffered electrical fires as a result of deteriorated insulation. Several other cars were involved in accidents, including one that rammed a bumping post at the 69th Terminal and penetrated the cinder block wall of the waiting room. The number of operable cars fell so low that operation could not be sustained, and the line was shut down in August 1986. Reduced service was resumed in October as several cars were repaired, but the inner part of the line was served by buses. Ridership plummeted.

SEPTA's Rail Equipment Department surveyed the industry for available used cars that could be operated on the NHSL. Of the few types available, the Chicago Transit Authority's Type 6000 was selected, and 10 married pairs were obtained. Seven were modified slightly and given a light overhaul, and five pairs were placed in service December 1986, which allowed full service to be restored. Two more pairs were put in service later and three were stripped for parts. In 1988, five Bullets and two 160s were also available, but one 160 failed in early 1989.

In the early 1980s, SEPTA staff decided that major renovation of the NHSL would be necessary. The NHSL Recapitalization Task Group was formed May 24, 1984; it was sometimes referred to as the "P&W Committee."

By 1985, the significant decisions had been made, and a list of projects was drawn that included vehicles, shop and yard, track (including third rail), substations, signals, stations, and parking. Passenger terminals were added to the program, and a complete program to rehabilitate or replace bridges was begun. Consultants were engaged to write specifications for certain projects, while SEPTA staff prepared others. A major in-house effort was the car specification.

Funding needs were estimated by SEPTA staff, and a capital program was laid out that covered a number of years. These estimates were the bases of capital grants. The entire program was envisaged as a number of independent projects. No full funding agreement for the program was sought because SEPTA staff had to fit NHSL projects in among many other high-priority projects. It was recognized that certain NHSL projects must be done in sequence and that certain projects had a direct relationship with others. A coordinating committee was established to handle such situations.

Each project has been a separate line item in a grant application or an individual grant. Some projects include funds from several grants.

THE PROGRAM

Table 1 presents a summary of system investments for the years 1976 through 1992, by use of which the following projects will be completed.

Cars

A total of 26 new, multiple-unit, interurban passenger cars will be acquired, including capital spares, at a cost of $55 million. The new cars (see Figure 2) have been designated as SEPTA Type N–5 because they will be the fifth car type to

TABLE 1 SUMMARY OF SYSTEM INVESTMENTS

System Component	Capital Funds	Operating Funds	Total
Car Renovations/Replacement	$ 54,862,980	$750,000	$ 55,612,980
Maintenance Facility Renovations/Replacement	21,337,020	60,000	21,397,020
Track Renewal Program	19,618,000	619,000	20,237,000
Substation Modernization	8,608,000	-0-	8,608,000
Signal System Modernization	15,213,000	-0-	15,213,000
Bridge Improvements	7,230,000	125,000	7,355,000
Stations & Parking Improvements	-0-	214,500	214,500
69th St. Terminal Improvements	14,750,000	-0-	14,750,000
Norristown Transportation Ctr.	11,700,000	-0-	11,700,000
TOTAL	**$153,319,000**	**$1,768,500**	**$155,087,500**

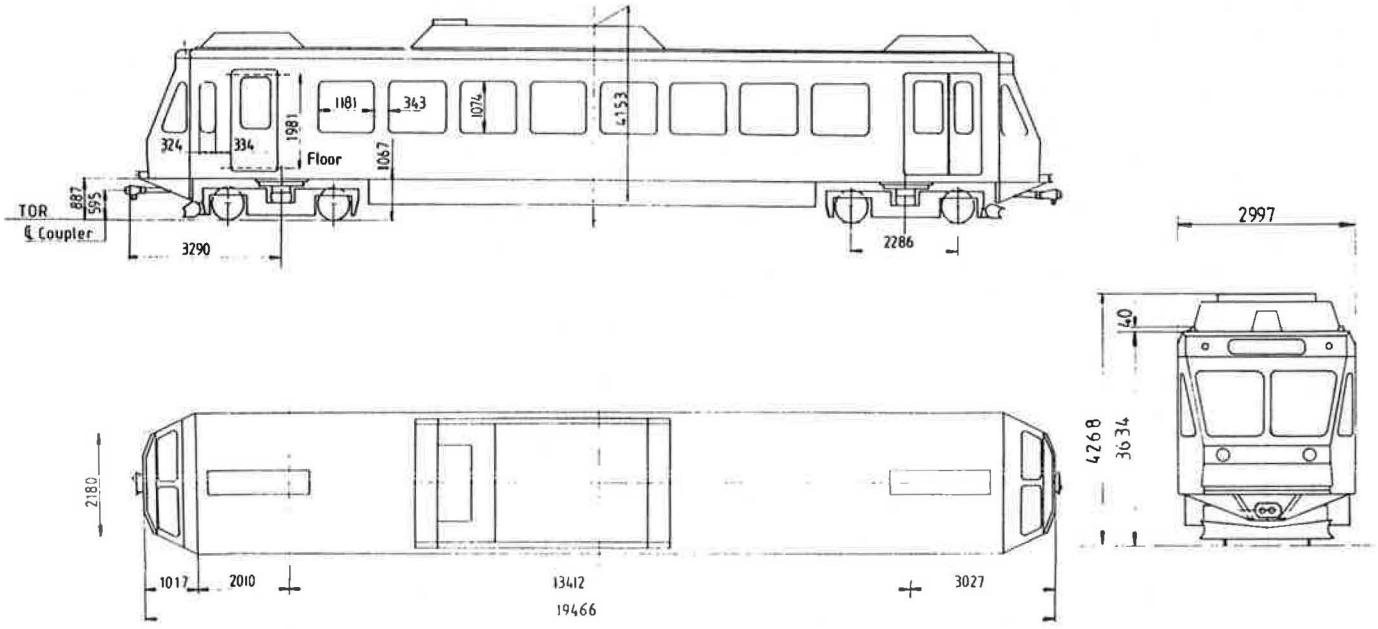

FIGURE 2 General arrangement of car as of October 20, 1989 (dimensions in millimeters).

have served the Norristown line since it opened in 1912. They will succeed the 1931 Brill Bullets and the 1924 to 1928 160 class Brill Strafford cars. The latter, of which No. 162 is the last remaining operable car, may be the oldest rapid transit car type in regular (nonhistoric) revenue service in the United States. The cars will have a stainless steel body 65 ft. 2 in. long, 9 ft. 10 in. wide, and 14 ft. 0 in. high. Trucks will be 7 ft. 6 in. in wheelbase, with truck centers 44 ft. 0 in. Weight should be about 70,000 lb. The car body is the largest that could be fit into the NHSL's clearances without major changes in wayside structures. Some minor changes will be necessary to accept the new cars. The 1931 Brill Bullet cars are 55 ft. long, 9 ft. 2 in. wide, and 10 ft. 6 in. high, and seat 52.

The car builder is a joint venture of ABB Traction/ AMTRAK. ABB is a merger of ASEA (Swedish Electric) and Brown Boveri (Swiss). AMTRAK's Beech Grove, Indiana, shop will assemble the cars; the car body shell will be fabricated by SOREFAME, Lisbon, Portugal, a Budd Co. licensee. The first two shells arrived at Beech Grove in April 1989.

These cars will feature the first three-phase AC drive to be used in a production fleet for use in the United States. Each truck will be driven by its own DC–AC inverter providing variable voltage (0 to 465 volts), variable-frequency (0 to 165 Hz) power to two ASEA MJA 280–2 motors of 155-kW (208-hp) each. With four such motors, the car will have the best power-to-weight ratio of any car built to date, namely about 85 lb/hp. This compares with about 130 lb/hp for the Brill Bullet P&W cars and 136 to 140 lb/hp for the PATCO cars. The motors will be geared 5.65:1 with 28-in. wheels. Maximum motor armature speed is 5,500 rpm for the three-phase squirrel cage motor. The three-phase ac drives provide regenerative as well as dynamic braking. Disc brakes on the wheel cheeks provide friction braking for the final stop (see Figure 3).

Acceleration and deceleration are to be 3.0 mph/sec, with 0 to 70 mph to be reached in 51 sec. The high horsepower should allow the cars to maintain 70-mph track speed up the several 2.5 percent grades on the NHSL. The specification calls for a balancing speed of 80 mph and a normal, governed, running speed of 70 mph. Stopping distance is specified as 1,295 ft.

They will seat 60 persons in comfortable seats having 42-in.-wide cushions. A conscious decision was made to provide comfortable seating to attract the offpeak discretionary rider, even though this may result in 2 to 4 more peak-hour standees.

Floor heat will be provided by chopper-controlled 600-volt dc power. Lowest power will be 1 Hz (i.e., one dc pulse per second). Precise control will be possible, with resultant efficient use of power.

A roof-mounted package air conditioning unit is similar to that used on SEPTA's Kawasaki LRVs delivered in the early 1980s. It will be a sealed, ac unit powered by an auxiliary inverter under the car. Blower motors and other auxiliaries will be ac to reduce maintenance needs.

Couplers, similar to those on the Kawasaki LRVs, may be used. ASEA-designed fabricated frame bogies with chevron primary suspension will be produced in the United States. The chevrons will permit self-steering. That, plus flange lubricators, should nearly eliminate flange wear on the NHSL on which 40 percent of track is curved. These features, plus disk brakes, are expected to result in a 10-year wheel life with a 10-year truck overhaul cycle. Maintainability was integrated into the design concepts of the car specification.

The new cars will have a double-stream front door and a single-stream rear door. The latter is normally used only at terminals. The double-stream front door is provided to reduce dwell time. The suburban NHSL has zone fares, so passengers must be checked in and out. The old cars with their single-stream doors sometimes encounter excessive dwell time. With 60 versus 52 seats in the old cars, the new cars have a real need for two streams.

The new N–5 cars are expected to be as much of an advance over current cars as was the 1931 Brill Bullet over its contemporaries. They will provide a new level of speed and comfort for suburban passengers.

Maintenance Facility

It was recently decided to rehabilitate the original 1908 P&W car shop building near 69th Street Terminal, Upper Darby, Pennsylvania. A study was completed by a general engineering consultant of SEPTA's and the building was found to be basically sound, although in need of renovation. The roof and floor, in particular, need renewal. Design work will commence soon. Construction will be scheduled after the last new N–5 car is accepted.

An earlier plan called for an entirely new shop to serve both the standard-gauge, third-rail-powered NHSL and the broad-gauge (5 ft. 2¼ in.) Media-Sharon Hill light-rail trolley lines. Review of the design indicated high costs and operating problems. A study indicated that rehabilitation of existing facilities would be more cost-effective.

The proposed new shop and yard would have had overhead trolley wire for both the Media-Sharon Hill trolleys and NHSL cars because it allowed sharper curves in the yard. Underbody equipment will foul the third rail or coverboard on sharp curves. With elimination of the new car shop, it was possible to delete pantographs from the new cars. Provision for them remains in case future line extension or other needs require them.

Track Renewal

Much of the old 85-lb/yd bolted track of the NHSL has been replaced with new 115-lb/yd continuous welded rail. Concurrently, the old 75-lb/yd third rail was replaced with 150-lb/yd third rail, having curved plastic coverboard in deference to NHSL's largely unfenced right-of-way. A $5 million grant was received in early 1989 and is expected to be sufficient to replace most of the remaining mainline track.

The 69th Street Terminal area will remain to be done, with its numerous turnouts. This track is relatively recent by P&W standards, having been installed in 1963 when the present three-track terminal was built by the PST Co.

Substation Modernization

All three substations on the NHSL will have all their equipment replaced with new silicon rectifiers and associated new

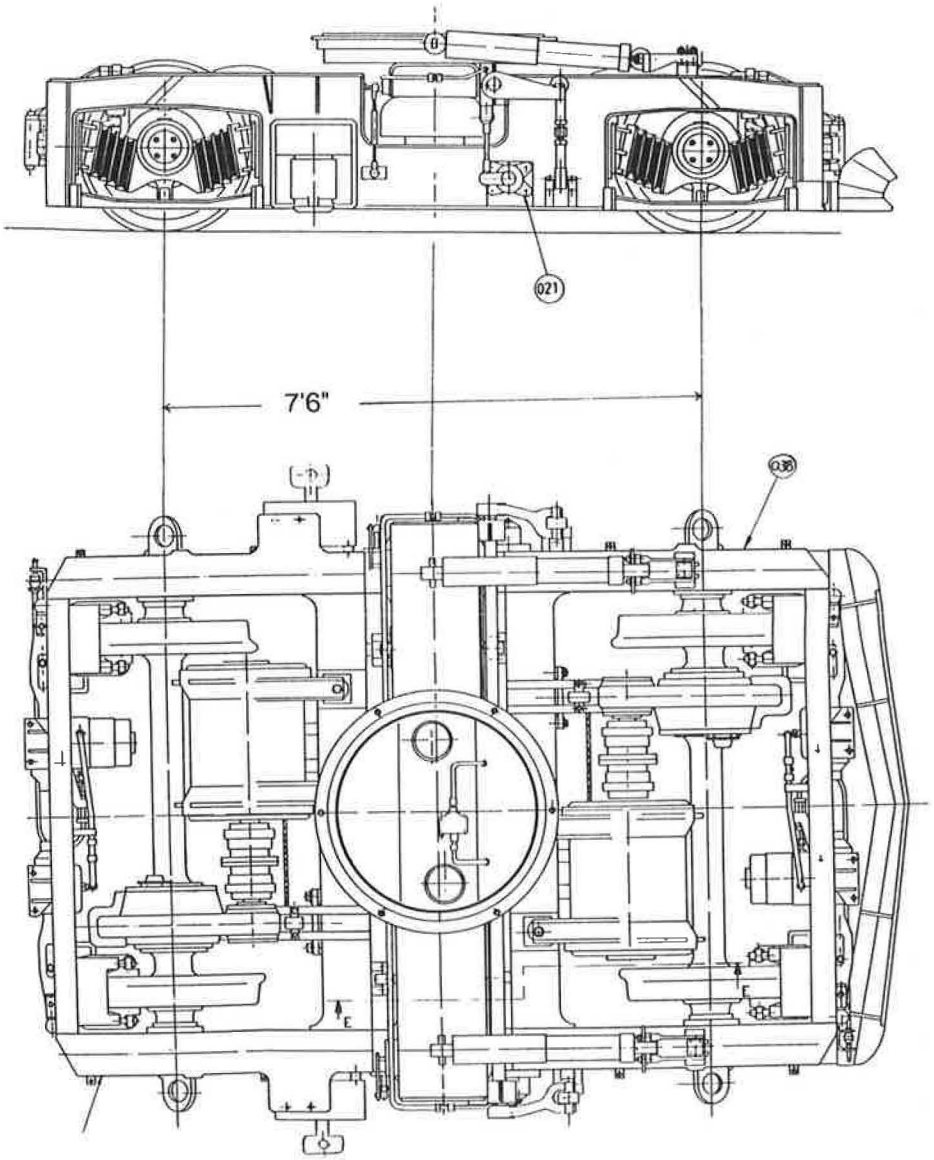

FIGURE 3 ASEA-designed car truck being fabricated by Capital Engineering & Manufacturing Co., Inc., Harvey, Ill. (source: ABB Traction).

transformers and switchgear. Old and new equipment is shown below:

Substation	*Original P&W Equipment*	*New SEPTA NHSL Equipment*
Beechwood	Three 750-kW rotaries (one later replaced with ex-Baltimore 1,000 kW)	Two 1,500-kW rectifiers
Villanova	Two 750-kW rotaries	Two 1,500-kW rectifiers
Hughes Park (originally at Bridgeport)	Two 750-kW rotaries (one later replaced by 1,000-kW rotary, ex-Omaha)	Two 1,200-kW rectifiers
Total	5,250 kW (later 5,750 kW)	8,400 kW

Output of the new substations is specified to be 630 Vdc under full load.

During reconstruction of Beechwood and Villanova in 1988 through 1991, each was replaced by a mobile 2,000-kW unit originally obtained for temporary use, while Media-Sharon Hill LRT substations were rebuilt. There is a proposal to permanently install one of these at 69th Street.

With three substations on a 13.4-mi route, the spacing is double or triple that for the typical urban rapid transit line. Yet there is sufficient power available for anticipated peak use. There is a hidden benefit in that the regenerated energy from the new cars' braking will have a relatively good chance to be received by a car in motion. With a high percentage of service to be provided by frequent one-car trains, receptivity should be reasonably good, particularly on the more densely used south end of the line.

Signal System Modernization

The project that will tie the program together will be an entirely new bidirectional cab signal and control system.

The P&W was built with conventional three-color, wayside railroad-type signals having no rapid transit-type track trips. One of the early decisions of the modernization program made in the 1970s was to install a cab-signal system with overspeed control. The accidents of 1986 substantiated the need for such a system.

The 100-Hz system used on the Northeast Corridor where SEPTA's Regional Rail Division commuter trains operate was adopted. (A similar system is used by PATCO.) The following codes have been specified:

Pulses Per Minute, 100-Hz Carrier	*Authorized Speed (mph)*
0	0
75	15
120	30
180	45
270	55
420	70

A control panel will be provided at Suburban Transit Division's Victory Avenue, Upper Darby, Control Center. It will include an indicator panel with remote control of interlockings. Two signal power supply 100-Hz motor generators will be supplied under the signal contract, one at each end of the line. All switch machines will be new—electric with hand-throw capability.

Included in the signal system and car procurement is a Vetag system to permit train operators to remotely control regularly used interlockings. This system will include both terminals as well as intermediate turn-back pocket tracks. The result is that all scheduled operations are automatic or controlled by train operators and need no intervention by a controller. The signal system was completed in late 1989 with an anticipated award date of early 1990, to be followed by about 2 years of construction. Completion is scheduled for early 1992.

A grant for $15 million was received, but it is expected that several million more may be needed. Associated and concurrent with the signal system will be an entirely new pole line the entire length of the NHSL. It is under a different design contract. The new signal and control system will bring the NHSL up to the same standards as the most modern heavy rapid transit lines.

Bridge Improvements

Bridges of the NHSL date from 1906 to 1908, when the 69th Street-Villanova segment was built, and from 1911 to 1912, when the Villanova-Norristown portion was built. All had suffered from benign neglect of a hard-pressed private owner followed by an underfunded public agency.

All bridges were inspected in recent years and were placed in three categories. Critical bridges were to receive immediate attention; priority bridges would receive attention as soon as critical bridges were attended to, and the others were placed in annual programs, 3 to 5 years in the future.

The Schuylkill River Bridge, about 3,800 ft in length, between Bridgeport and Norristown, was renovated under grants received in 1983 and 1984. Track and steel-aluminum composite third rail were included.

Three critical bridges at Mileposts 3.46, 5.19, and 7.28 are in final design and will go out for bid in 1989. Bridge 3.46 at Ardmore Junction will be completely replaced. New abutments will be built inside the old and will be tied together by an integrated roadway to provide a solid *U*-shaped structure. A multiple-girder deck will replace the old through-girder bridge over the SEPTA busway, a former PST Co. trolley right-of-way retained because the parallel public street is too narrow for safe bus operation.

Bridge 5.19 over Landover Road will be renovated. Bridge 7.28 over Aldwyn Lane at Villanova Junction will have the deck replaced, one abutment replaced, and the other renovated and repaired. That will complete the critical bridges.

Five priority bridges on the south end of the line were included in a study and design contract awarded in April 1989. The study phase was largely completed by year's end. It was determined that most can be rehabilitated.

Several road bridges over the NHSL are in poor condition, but SEPTA contends that they are the responsibility of the public agency whose road uses the bridges. Some of these are before the Public Utility Commission of Pennsylvania for a decision as to responsibility. Meanwhile, SEPTA has made emergency repairs when necessary. One such bridge, County Line Road, Bridge 8.54, was replaced by highway agencies in 1989.

The bridge program is moving ahead methodically. Four pedestrian footbridges were completely replaced under a $975,000 project during 1987 through 1989. These are at Parkview, Haverford, Bryn Mawr, and Villanova. All-new precast concrete deck girders replaced fabricated steel through-trusses that were seriously deteriorated. The only old-type footbridge remaining is Bridge 7.79 at Radnor. Its replacement is planned for 1990.

Station and Parking Improvements

Station and parking improvements are listed on the capital program but have received only about $200,000 from the operating budget for minor repairs.

Not included in the present program was modernization of the Gulph Mills parking lot as part of a highway relocation project.

69th Street Terminal Improvements

Restoration of 69th Street Terminal to its original 1906 grandeur was carried out under a $14,750,000 project that culminated in a rededication on October 27, 1988. The terminal had been designed to an excellent functional plan, so no major changes were necessary or desirable. A clutter of retail stands was removed, the skylight over the great hall was restored (it had been blacked out with paint during World War II), and lighting fixtures were restored to their original appearance. The renovation work related to the NHSL provided an expanded waiting area with improved access to buses and new electronic signs on platforms.

69th Street is served by the Media-Sharon Hill light-rail trolley lines, the NHSL, and 12 suburban transit division bus

lines that all feed the Market-Frankford subway and elevated as well as three-city transit division bus lines. It is the busiest transit facility in the Philadelphia region. It may well be the only one in the United States where three suburban light-rail routes feed an urban heavy rail route. It is always busy. The project included accessibility for the handicapped.

The Norristown Transportation Center

The Norristown Transportation Center (NTC) (Figure 4) replaced the old P&W terminal with a new multimodal terminal, which includes a new NHSL elevated station, with spur, a bus loop with an enclosed waiting room at ground level, and direct access to the DeKalb Street Regional Rail Division (formerly the Reading Co.) station and its parking lot. The NTC is at Mile 13.4, whereas the old P&W terminal was at Mile 13.7. The old terminal and elevated structure beyond the NTC was demolished during the period May 17 through June 15, 1989. The NTC was occupied and in use June 16 although the spur track will not be used until the new signal system is in operation. Dedication of the NTC occurred on July 14, 1989.

The NTC is approximately an $11.7-million project integrated with the urban renewal program undertaken by Montgomery County and the Borough of Norristown.

Six Frontier Division bus routes converged on the hour (and two on the half-hour) at the curb opposite the old P&W Terminal in Norristown. These routes now use the off-street bus loop of the NTC where passengers are able to wait inside a new climate-controlled, fully enclosed building.

Bus passengers have immediate access to the NHSL by escalator and an elevator for the handicapped. The only other accessible station at the present time on the NHSL is 69th Street Terminal. Bus passengers have convenient access to the DeKalb Street Regional Rail Station by a short walkway with a pedestrian underpass under RRD tracks to the inbound platform and parking lot. The NHSL platform has a direct stairway to the expanded RRD parking lot.

The NTC is a bright, cheerful design featuring glass walls

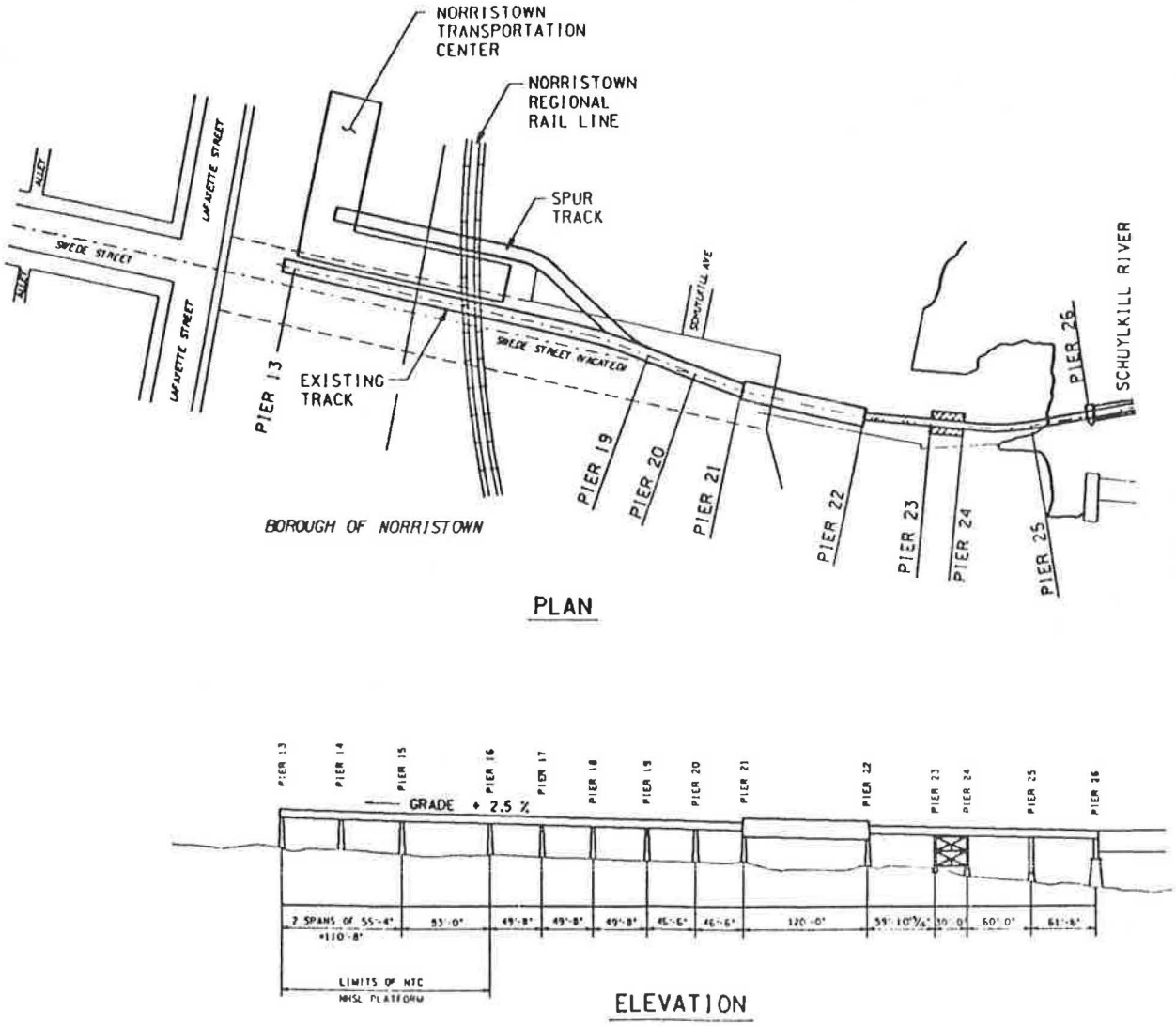

FIGURE 4 Norristown Transportation Center.

and attractive sturdy light fixtures that are suspended from the overhead canopies. Both features enhance security as well as appearance.

The NTC is an attractive and useful facility for SEPTA patrons and an asset for the urban development of the surrounding area. It is the only suburban transportation center in the United States that combines regional railroad commuter, high-speed light-rail, and bus services.

Remaining Proposed Projects

The rehabilitation and modernization of the NHSL is an ongoing program. Several projects not yet funded remain to be done. Among these are the following:

Stations and Parking. All present NHSL platforms are not long enough to accept a two-car train of new 65-ft N–5 cars. Indeed, some NHSL platforms are only a half-car long, sufficient for the front door of one car. This reflects the line's interurban railway heritage.

The SEPTA plan includes lengthening all platforms to at least 1½ car lengths so that the front door of the trailing car of a two-car train would be platformed. Selected stations would be given two-car platforms where use of all doors would be desirable.

Radnor Station may be relocated, a turn-back track built, and a new footbridge provided. Radnor Station is adjacent to a suburban employment center and is the primary destination of reverse commuters. It has excellent potential for growth.

It is desired to expand parking at selected stations where demand warrants and where land can be obtained. This is delayed until after the new cars are in operation and response of the riding public can be assessed.

Future Projects Not Yet Definitely Planned or Funded. After the new substations are in operation in 1991, one of the mobile 2,000-kW substations may be moved to the 69th Street Terminal. This procedure would ensure adequate voltage for trains ascending the 2.5 percent grade between the car shop and

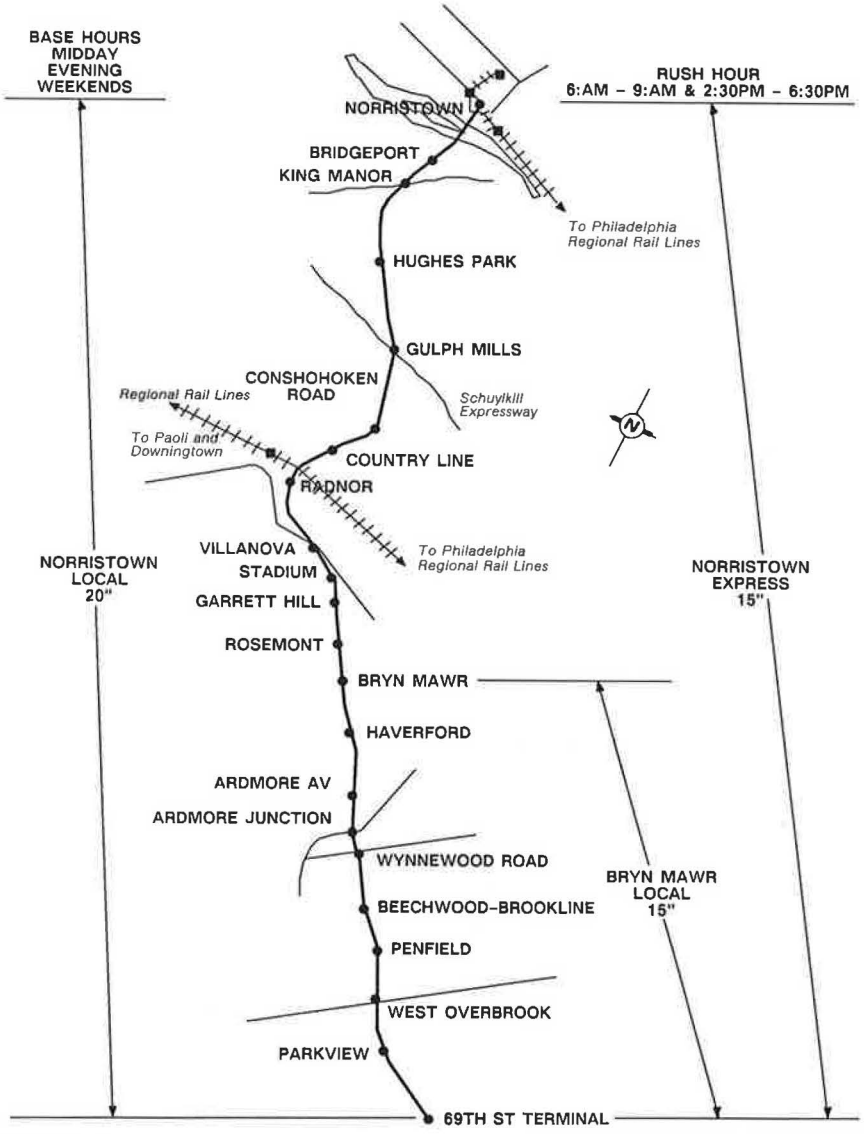

FIGURE 5 Norristown High-Speed Line service plan (1989).

Parkview-West Overbrook. It could also feed the Media-Sharon Hill light-rail trolley terminal to ensure good voltage.

King of Prussia Extension. A branch extension of about 3 mi from a junction near Hughes Park to the King of Prussia Mall and industrial center has long been considered. The PST Company had proposed a variation in the 1960s.

Such a branch might change the entire character of the NHSL because the line would then directly serve one of the largest suburban employment centers in the Delaware Valley. Sufficient new cars have been ordered to service the proposed branch.

Operating Plans. Operation of the NHSL has always been based on frequent operation of one- and two-car trains on as fast a schedule as is feasible. A line only 13.7 (now 13.4) mi with 22 stations would seem to be inherently slow, but by innovative operation, speeds have been high. All stations are unattended, and fare collection is on board.

At present, rush-hour service consists of Norristown express trains and Bryn Mawr locals. All trains stop at Ardmore Junction. Norristown trains run express, 69th Street to Bryn Mawr, then local beyond. Yet even where running local, station stops are conditional flag stops. An intending passenger must push a button to light a lunar white signal to alert the train operator to stop. A stick circuit with a timer keeps the light on until a train stops at the station and contacts an offside fourth rail to extinguish the light. An express train contacts the fourth rail too briefly to extinguish the light. This homemade P&W device is unique to the NHSL.

NHSL's rush hour is relatively long, 6:30 to 9:30 a.m. and then 2:30 to 6:30 p.m. Offpeak service is by Norristown local trains (see Figure 5).

After sufficient new cars are available and the Radnor turn back is in service, an improved operating plan (see Figure 6) will inaugurate four classes of service: Norristown Express, Radnor Express, Bryn Mawr Local, and Wynnewood Road Local. Initially, single-car trains are planned. If ridership grows as anticipated, certain services would receive two-car trains, as required.

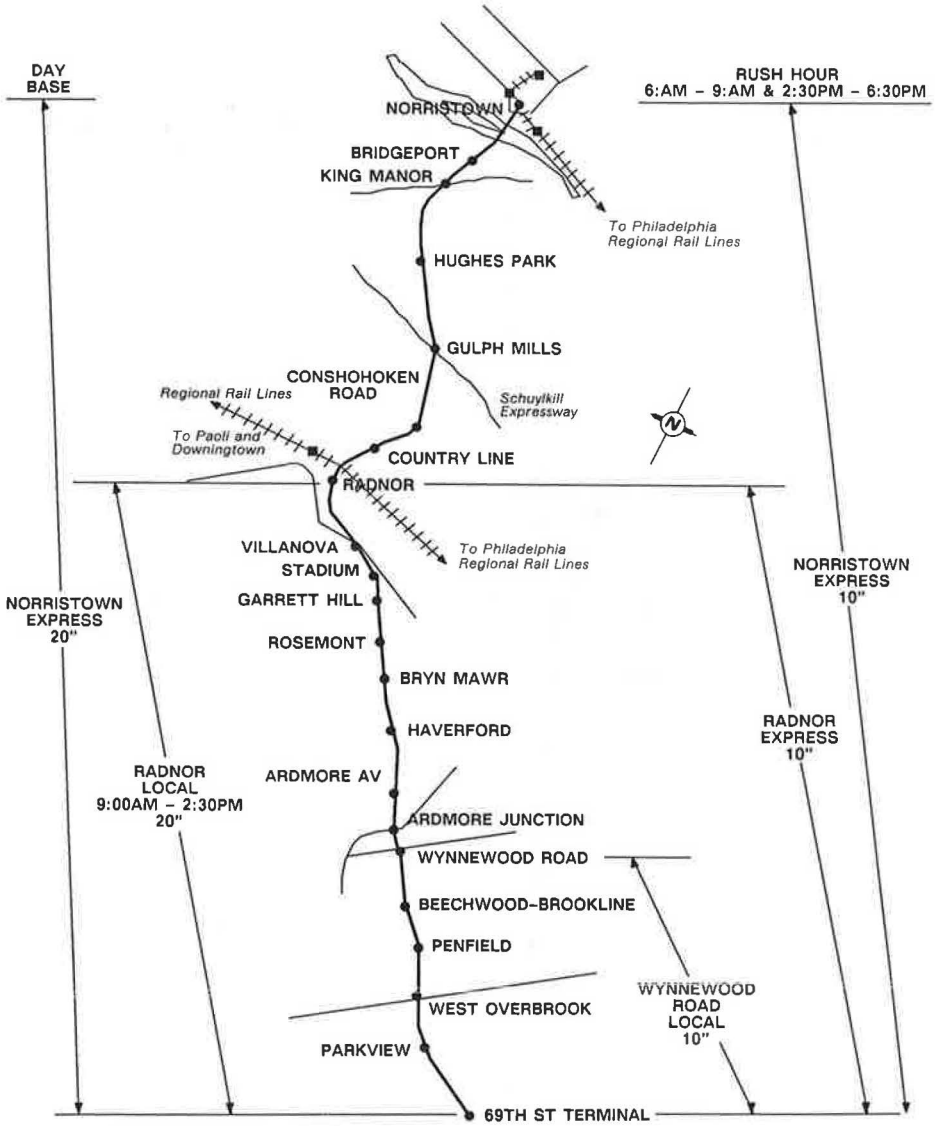

FIGURE 6 Norristown High-Speed Line—future service plan with new cars (1991).

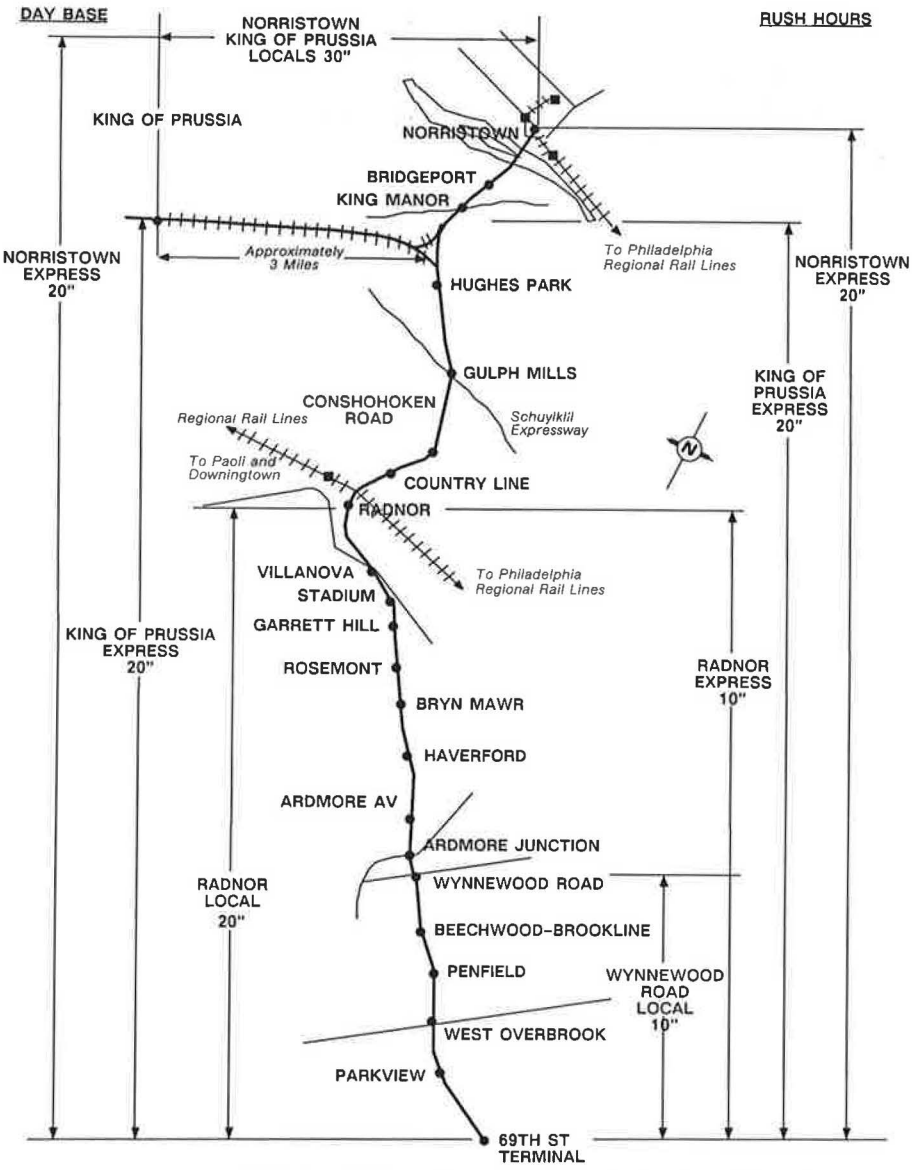

FIGURE 7 Norristown High-Speed Line with proposed branch to King of Prussia.

Should the King of Prussia branch be built, an augmented operating plan (see Figure 7) would add 69th Street to King of Prussia trains, but would also add a one-car shuttle between Norristown to King of Prussia. The latter would provide a quick connection for Frontier Division bus riders at Norristown.

CONCLUSION

The projects presently being built plus those planned for the near future will transform the NHSL into a suburban transit facility that will provide a substantially improved level of service and safety to existing and potential new NHSL patrons for the 1990s and into the next century.

The modernized NHSL provides an example that could be of use to transit agencies where abandoned or underutilized railroad rights of way may be available. Its light-rail characteristics of one- or two-car trains operating frequent service provide a higher level of service than commuter railroad at a lower operating cost and allows a lower investment than typical heavy-rail installations.

Its concept of a low-density, high-performance, high-frequency feeder to a major heavy-rail line may have application where extension of heavy-rail service into distant suburbs cannot be justified by potential patronage.

The NHSL does not fit any conventional modal definition and that, perhaps, is a definite virtue. Its existence can encourage planners to consider its unconventional yet very successful features that have served the public for over 80 years.

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REFERENCE

1. R. Degraw. *The Red Arrow*. Haverford Press, Inc., Haverford, Penn., 1972.

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