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Bell Time Study and Transportation Impact Analysis

Bethlehem Central School District
August 30, 2019

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September 9, 2019

Ms. Jody Monroe
Superintendent
Bethlehem Central School District
700 Delaware Avenue
Delmar, NY 12054

Dear Ms. Monroe:

School Bus Consultants (SBC) is pleased to submit the enclosed report covering our work for Bethlehem Central School District (BCSD). BCSD recognizes importance of the national push to delay the start of the school day as a strategy to allow adolescents to get more sleep. BCSD has formed a "Start School Later Task Force" to work with important stakeholders to work towards a solution. In the report that follows, SBC evaluated several school Bell Time Alternatives to identify a structure that allows the District's high school to commence later. SBC examined the impacts of each Bell Time Alternative and estimated the cost and service impacts of each alternative on the overall transportation operation. We are confident that the recommendations in this report will enable the school district to accomplish their goal of moving high school times back without dramatically increasing the need for additional resources.

Sincerely,

Emil Brooks Brenkus

E. Brooks Brenkus
TransPar
Managing Director

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Introduction and Background

Bethlehem Central School District (BCSD) provides educational services to approximately 5,000 students residing across its service area of 52 square miles. Transportation is provided to approximately 4,800 students to and from the District's 5 elementary schools, middle school, high school, and other various parochial schools, education centers, and career centers. Services are provided on 92 district-owned and operated route buses that perform 317 runs per day within a three-tiered system. All aspects of transportation services are self-provided and self-managed.

BCSD is in the process of evaluating the bell time schedule with the objective of moving the District's high school to a later start time. To assist in this endeavor, BCSD contracted with School Bus Consultants (SBC) to develop potential bell time alternatives and conduct a detailed analysis that identifies how these alternatives would impact the District's transportation operations.

Our work plan commenced with establishing an operational baseline which was necessary to support a comparison of the current bell time structure with any proposed alternative model and to determine if the system is operating in an efficient, effective, and cost competitive manner compared to per and industry benchmarks. Multiple alternative bell time scenarios were analyzed to understand how changes to the bell structure would affect transportation operations.

During this entire process, our study sought to answer the following questions and make specific recommendations on where exactly there are opportunities for improvement:

- Does the District have well documented and up to date policies that reinforce efficient and effective service?
- How do the current cost and service performance indicators compare to accepted industry standards and benchmarks?
- What do the cost related performance metrics say about the cost efficiency of the operation?
- What impact does the current bell time structure have on transportation?
- What changes to the bell time structure would allow for service improvement and cost savings?

The balance of this assessment aims to answer these questions, as well as to satisfy the described objectives and work plan above. Additionally, it will address key observations that are based off qualitative information received from interviews with key staff members followed by general system conclusions and key recommendations.

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Executive Summary

Financial Performance

As determined by the analyses of expenditures, the key cost metrics including the percentage of costs to the general fund, the cost per bus, and the costs for both regular and special needs students are slightly higher than the expected ranges. One noted factor that would contribute to higher costs is the limited asset utilization which is a symptom of the routing structure that prevents many routes from achieving three runs each.

Current Bell Time Structure

It is evident that the transportation team is employing many best practices when it comes to over planning high school routes and collecting daily ridership counts. However, based on ridership counts, run times, and underutilized buses there are opportunities to increase the efficiency of the system by utilizing count data to make route adjustments to increase the number of students riding on underutilized routes.

1. It is evident that the goal of the department is to design and implement a routing network that maximizes the use of each of the fleet assets effectively minimizing the overall number of buses required. Given the time and district constraints that exist when providing service over such a large geographical area, a process for the regular calculation of key performance indicators such as ride times and on-time performance should be considered to ensure that the desired levels of service are also maintained.
2. The daily collection of student counts is a best practice as it provides insight on day-to-day service demands. Utilizing these counts to identify routes that have historically low ridership may offer opportunities to increase routing efficiency.

Alternative Bell Time Structure Analysis

BCSD is seeking to revise their bell schedule to move the District's high school closer to the recommended 8:30 AM school start time. While the science is becoming clearer on the benefits of later start times for high school students, it is important to recognize that there are constraints within the District that make it difficult to simply move start times later in the day. The various scenarios examined throughout this process highlight these known constraints.

Based upon our research and analyses of BCSD transportation operations, SBC concludes that it is possible for BCSD to push back high school starts times. This solution would accommodate two goals: first, allowing for a later start time for the high schools, and, second, retaining the efficiency and service quality of BCSD transportation operations, which is vital to the safety and success of this district.

1. SBC recommends Bell Time Alternative Four-Hybrid. This alternative accommodates students that choose to sleep later by arriving at the beginning of second period and allows the District to pilot starting school later without altering the current structure or increasing resources.

Policy Analysis

Utilizing well documented, well understood, and well-practiced system policies, procedures, and processes, is a key attribute of high performing and successful transportation operations. General departmental policies and administrative regulations are necessary to establish the types and levels of service that will be provided, while internal departmental procedures and guidelines clearly guide staff on how to achieve those expectations. Established, well documented procedures, ensure institutional knowledge and guidelines are not dependent on a single person, and are not at risk if someone leaves the organization.

The benefits of establishing clearly defined, well-written, and widely accepted policy statements include:

- Compliance with Federal and State Department of Transportation regulations;
- Ensures that all stakeholders of transportation services understand the level of service that can be expected;
- Supports budget integrity and expenditure predictability by ensuring that the level of service that is delivered is within the limits and constraints by guiding policies and regulations and that these align within available funding;
- Reduces the amount of time that is required to respond to questions or mitigating complaints based on questions regarding the level of service to be provided;
- Ensures that transportation is planned and delivered within well-defined safety rules and parameters; and
- Supporting an effective route planning process that ensures that an equitable level of service is provided across the district.

The overarching goal of this policy and procedure analysis is to clearly understand the degree of system-wide adherence to BCSD's established policies, procedures, and directives that support effective day to day operations. Policies can, and frequently do, change according to local conditions or situations but should always be maintained in writing and kept up to data with transforming environments and/or changes in law. Districtwide policies, standard operating procedures (SOPS), and all associated training materials and manuals should be considered living documents and edited for content frequently.

More specifically the types of policy statements or defined guidelines that SBC looks for in a review of a transportation system relate directly to the constraints or potential impacts upon service delivery. Prime examples include eligibility standards based upon a specific distance from assigned schools, how long a student may ride the bus, where a bus stop may be placed, and how students will be supervised while in transit.

Results – Policy Analysis

Based on a review of the BOE policy statements and departmental information the following summarize the key provisions that help to guide the annual planning process and day to day operations:

BOE Policies & Transportation Eligibility

- Board Policy 8413 – Public School Transportation states that resident pupils are eligible for transportation between home/childcare location and the District school they legally attend, in accordance to State Education law and regulations and Board of Education Policies. Additionally, the policy establishes K-12 students who wish to utilize an established bus route other than the one that is assigned to them must have a written bus pass filled out and signed by the school principal. While the policy establishes that transportation will be provided, actual service parameters or eligibility standards are not described. As an example, eligibility distances based on the distance between a student's residence and their school of attendance are not defined. While it is recognized that the policy does state that the pupil is eligible in accordance to State Education law, it does not specifically state the eligibility distances established by the state.

  According to NYSED General Information for Parents and Others – "Board of Education of non-city school districts are required by Education Law to provide transportation for all eligible resident pupils in grades K-8 who live more than two miles from school and for pupils in grades 9 – 12 who live more than three miles from school, up to a distance of 15 miles."

  1. For the purpose of determining eligibility for student transportation, measurement shall be made by the shortest route between home and school. Measurements may be made over private roads, with the landowner's consent, and over publicly maintained pathways.
  2. The Commissioner of Education that a board of education lacks authority to transport students who are not otherwise eligible for transportation, even though there may be empty seats on the bus.

- Policy 8413.1 – Non-public School Transportation states that resident pupils attending nonpublic schools outside BCSD will be transported up to a maximum of fifteen miles from their home to school in accordance to State regulations.

  Transportation requests for these students must be made by April 1st the previous year or thirty days of establishing residence in the district.

- Policy 8413.2 – Transportation to Childcare Locations for Grades K-8 states that resident pupils in grades K – 8 attending public and nonpublic schools located with BCSD boundaries will be transported between before/after childcare locations and school.

  Transportation requests for these students must be made by April 1st the previous year or thirty days of establishing residence in the district.

- Policy 8411-R – School Bus Scheduling and Routing Regulation states that bus stops will be established by the District Transportation supervisor with the following conditions

  - Dead-end and loop streets will not be serviced by school buses.
  - Walking distance to a bus stop are dictated by grade level
  - Transportation will be provided on side roads as long as they are maintained by town maintenance departments.
  - Transportation will not be provided on private roads.

    - Transportation will be provided to residents living along major highways.
- Policy 8412 – Walking Distance to a Bus Stop states that the District's official walking distance to assigned bus stops are dictated by grade level.
    - K – 5 up to 1/10 mile from home to bus stop.
    - 6 – 8 up to ½ mile from home to bus stop.
    - 9 – 12 up to 1 mile from home to bus stop.

General Transportation Information

Important information is readily available on the DoT webpage, but it lacks a link to the specific transportation policies. Examples of the information that is provided includes:

- Transportation Eligibility Requirements
    - All elementary students
    - Middle School students who live more than a half mile from school.
    - High School students who live more than a mile from the school.
    - Resident students who attend private and parochial schools within 15 miles from their homes.
- Elementary School Boundaries by street name
- Policy behind assigning bus stops and the steps to go through when there is a suggestion for an alternative bus stop.
- All items a student brings on the bus should be backed in a carrying case, which must be small enough to fit on a student's lap.
- A list of musical instruments that can and cannot be brought on a bus.
- Students who will cross the street must get off the bus first, wait for the signal to cross, and listen for a horn warning them of danger. Parents who meet the bus are required to be on the side students disembark.
- Arrive at the bus stop at least five minutes prior to designated pick-up time.
- Students are required to remain seated while the bus is in motion.
- Students are encouraged to use the seatbelts on the bus.
- Students are not allowed to rough house at the bus stop.

Transportation Department Handbook

A detailed and current transportation handbook or manual should provide the necessary level of guidance and information to support both the planning processes and day to day operation of the department. Bethlehem Central School District Transportation Department Employee Handbook contains the employment policies for bus drivers, breakdown and emergency procedures, driving guidelines, fueling, maintenance, polices, and service procedures, special needs transportation,

guidelines for student discipline, procedures for medical emergencies, call-in procedures and work assignments for sub employees, and other miscellaneous items.

A few employee policies that might need to be updated are:

- School Closings - Emergency Call List (page 9) “We all must be flexible and be prepared for school closing due to inclement weather or man-made disasters. The Transportation Department publishes an **Emergency Call List** (phone tree) once a year. However, it can only be effective if every person on the tree follows through with his/her call, make sure you call the next person who is on the list after your name. If the next person does not answer, go to the next one after him/her. You will receive a phone call even if you are scheduled to be absent from work on that date.”
- Snow Delay (page 44) “Regardless if the district goes on one- or two-hour delay, you are to report to work at your regular time. Once you arrive at the bus garage, go to the Director’s Office and SIGN IN your name. You will need to call the supervisor if you’re unable to make it due to weather conditions at your home in which case you will be placed on Personal Leave to cover the time you are not at work. If you are out of personal leave, you will not be paid for this time. Refer to Appendix R for further information regarding Snow Delays or Closures.”
- Summer Work Rules (Page 49) “You are required to call all the parents on your assigned route and give them the approximate pickup and drop-off times.”

Baseline Cost and Service Metrics

To fully understand the financial efficiency and service performance of a student transportation organization, a review and analysis of cost, route, run, and student data is absolutely required. A baseline cost assessment is also necessary to establish a point of comparison of the direct impacts of any recommended changes or alternative service delivery model.

These analyses include the examination of all transportation related expenditures including wages and benefits, fuel, fleet maintenance and repair costs, and capital replacement costs. Capital replacement costs were based on the annual depreciation based on the estimated value of the fleet assets.

In conjunction with the analysis of route design and implementation, several key performance metrics were derived, which are useful not only for a comparison against industry standards, but also to establish a baseline for comparison if BCSD were to further explore operation changes. These results are explained in detail directly below.

Results- Financial Performance

The cost allocation methodology provides an understanding of key financial performance measures including the annual cost per bus, route, and run, and for regular education and students with special needs. These metrics serve as a useful point of comparison of performance against various industry standards and guidelines, and against peer organizations for which SBC has followed an identical methodology.

For the fiscal year 2018-19 budget, the total cost of home-to-school transportation for approximately 4,537 regular and 342 special needs students was calculated to be $6,719,633. Of this total $4,657,767 is for regular education service with the remainder of $2,061,865 allocated to services provided to students with special needs. The annual cost per bus for all types of transportation was calculated to be $73,039 with the average annual cost per student of $1,366.

Further analysis finds an annual cost per regular education student of approximately $1,170 and $7,009 for students with special needs. It should be noted that it is typical for the cost of students with exceptional needs to range from five to ten times higher than the cost for regular education students. The high cost for special needs for BCSD students is directly related to the relatively low number of special needs students transported and as important, due to the routing architecture that only allows one or two runs per bus as opposed to the recommended three runs typical of a three-tier system.

Another key indicator of overall cost performance of a transportation operation is to understand the cost of transportation as a percentage of the total general fund operating budget. Based on transportation expenditures of $6,719,633 and an FY 2018/19 General Fund budget of $98,790,000, transportation costs are approximately 6.8 percent of the total budget compared to an expected range of 4 to 6 percent. These and other cost metrics are summarized in the following table:

Table 1: Cost Related Performance Metrics

Cost Measure	BCSD
Annual Cost per Bus	$73,039
Daily Cost per Bus	$402
Daily Cost per Run	$116
Annual Cost per Student	$1,366
Annual Cost per Reg. Ed Students	$1,170
Annual cost per Students with Special Needs	$7,009
Percentage of Total Cost of Transportation to the 2018-19 General Operating Fund Budget	6.8 percent
Note: The annual cost per bus and student varies greatly between student transportation organizations due to regional differences in wages, health care, and other benefits such as retirement.	

Conclusions and Recommendations: Financial Performance

As determined by the analyses of expenditures and illustrated in **Table 1**, the key cost metrics including the percentage of costs to the general fund, the cost per bus, and the costs for both regular and special needs students are slightly higher than the expected ranges. One noted factor that would contribute to higher costs is the limited asset utilization which is a symptom of the routing structure that prevents many routes from achieving three runs each.

1. Recommendations in the following sections in the areas of route planning and fleet maintenance would likely reduce costs.

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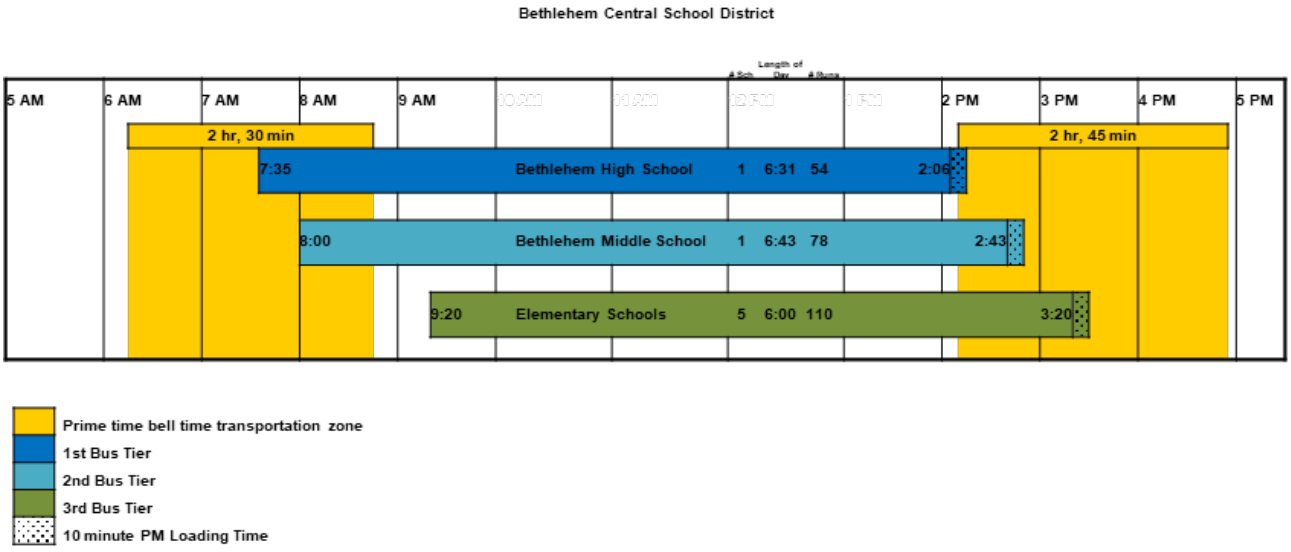
Current Bell Time Structure Analysis

SBC's bell time structure analysis provides a detailed examination of critical factors such as school bell times, run times, asset utilization, capacity utilization, and buses per 100 students. Results of these analyses provide key operation performance measurements that will help to diagnose and understand the overall effectiveness and efficiency of the current bell time structure. The following results are based on the analysis of the provided data and are designed to illustrate both the current level of performance and to serve as a baseline comparison for potential bell time changes.

Service Description and Bell Times

Services are being provided in a three-tier transportation structure with 92 routes buses performing a total of 317 runs for approximately 4,879 planned students. In addition to typical home to school transportation, the system includes shuttle runs between schools and provides transportation to BCSD's alternative programs. The current three-tiered bell time structure commences with high schools at 7:35 AM and ending at 2:06 PM. The second tier serves middle school with starting bell times at 8:00 AM and ending at 2:43 PM. The final tier serves elementary schools and starts at 9:20 AM and finishes at 3:20 PM. The current bell time structure allows 37 minutes and 80 minutes between the first and second and second and third tier respectively in the morning. In the afternoon, there are 37 minutes separating each of the tiers. The amount of work time between tiers serves as the maximum time a run can be to have successful multi-tiered routes. The current bell time structure which aids in illustrating available work time between current tiers is presented in the following **Figure 1**.

Figure 1: BCSD Current Bell Time Structure

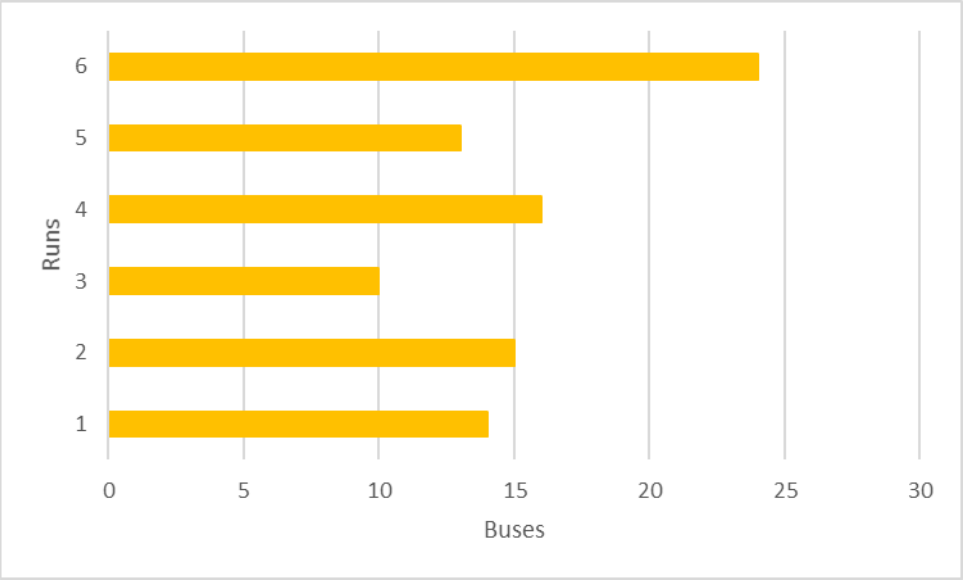


Average Runs per Bus

The analysis for this area began with understanding the average number of runs that each bus is able to perform throughout the course of each operational day. This concept is also known as fleet utilization and helps to provide an understanding of the overall efficiency of the routing network. While the ideal minimum number of runs that each bus would be able to perform in a three-tier system would be at least three each in the morning and the afternoon, the actual number of runs that each bus is able to perform is typically impacted by simple time and distance constraints. As an example, runs that primarily serve the more traditional "neighborhood" or schools in densely populated are able to pick-up and transport students within a more localized area to schools on each tier and in some instances, may be able to perform more than one run on a tier. Buses that serve students that reside in the more rural or outlying areas are typically limited by time and distance constraints which limit the number of students a bus can load and still be timely to the school. These time and district constraints typically reduce the number of runs that each bus is able to perform in the morning or afternoon time panels.

The BCSD currently operates 92 route buses providing service on 317 runs or an average of 3.45 runs per bus per operational day. Further analysis finds that 24 (or 26 percent) of the route buses are able to perform 6 runs per day. As discussed above and illustrated in the following figure, this is lower than typical three-tier operations and is indicative of a planning process that could potentially make improvements.

Figure 2: Number of Runs per Bus



Figures 3 and 4 aides in further highlighting the impact of bell times and asset utilization. Each figure illustrates the number of buses that are currently deployed that are carrying students for each of the morning and afternoon tiers. The peak deployment for the morning and afternoon is during the elementary school tier (third tier), which requires around 24 buses more than the peak deployment for the high school tier. The morning deployment between tier-two and tier-three illustrates characteristics of a well-functioning system as there are distinct peaks indicating the

utilization of assets and distinct valleys that indicate there is enough “work time” between tiers for buses to dead head to the next run in their route. The time between tier-one and tier-two is limited requiring many middle school runs to commence before high school runs are complete.

The afternoon deployment lacks the distinct peaks and valleys described in parts of the morning deployment. This is due to the consolidation of “work time” between the second and third tier from 80 minutes in the morning to 37 minutes in the afternoon. The consolidation of time between the second and third tier causes some of the middle school runs to overlap with the elementary school runs limiting the number of route buses that can complete both middle school and elementary school runs leading to the peak deployment demand of 75 buses in the afternoon.

Figure 3: Current Deployment AM

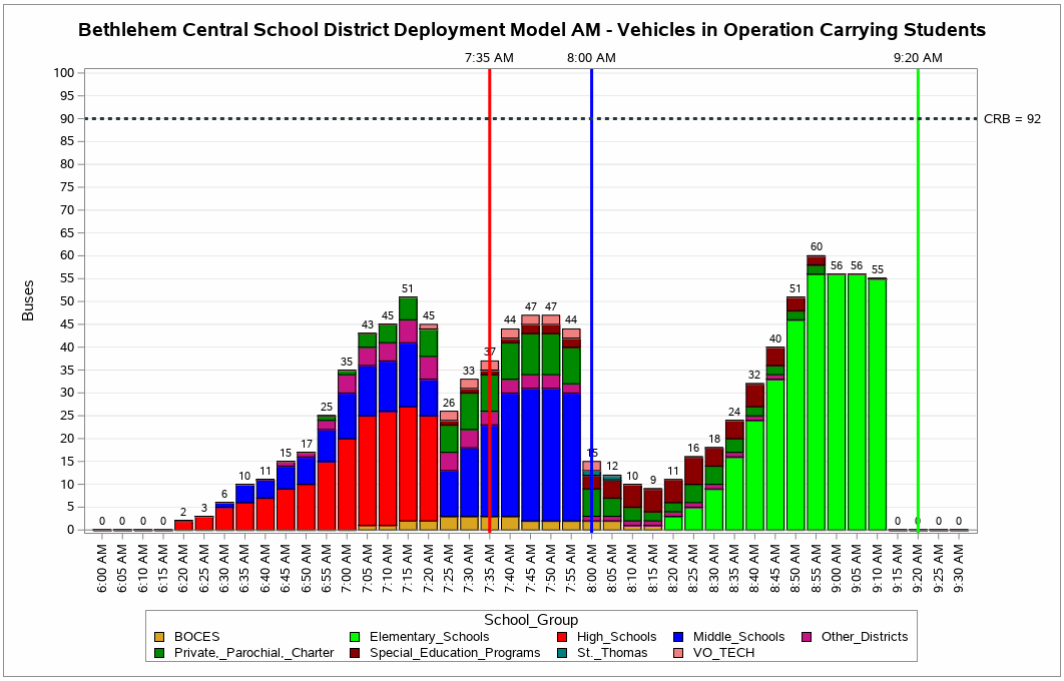
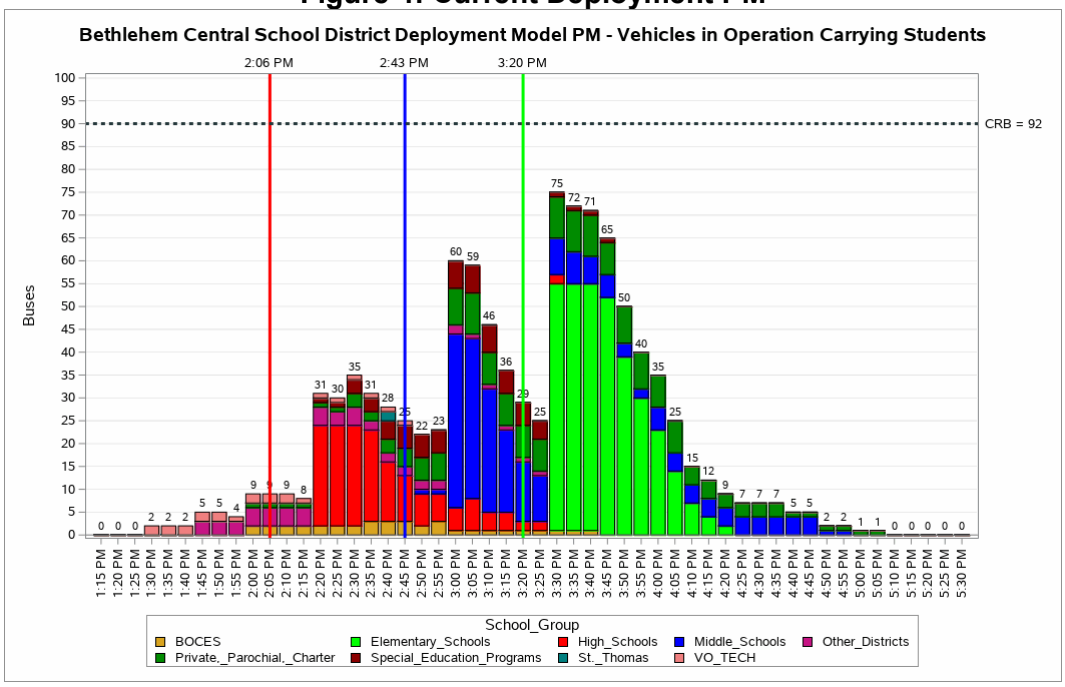


Figure 4: Current Deployment PM



Capacity Utilization

In addition to reusing the bus as many times per day as possible, achieving a high rate of seating capacity utilization (within limits established by policy to support safety and student comfort) further supports the effective use of fleet assets and ultimately serves to limit or lower the number of required buses in the fleet. Based on a system wide analysis of all 317 runs, the simple planned capacity is approximately 56 percent. The calculation is based on dividing the number of planned students by the seating capacity guidelines for each school type with elementary runs at capacity of 72, 60 for middle, and 48 for high. Capacity guidelines such as these are commonly applied as it considers the physical size of secondary students and the value of promoting a more comfortable transportation experience. It is recommended that capacity utilization is planned for a rate of 70 percent or higher. The results of these calculations indicate that there may be opportunities to create efficiencies throughout the system by increasing the number of students on bus runs that currently have low capacity utilization.

BCSD collects daily student counts for each of their routes which is a best practice as it provides insight to actual ridership levels that can be used for planning purposes. Based on the ridership counts from the average capacity utilization is 25 percent and 27 percent for the months of October and March respectively. This indicates that there are opportunities to increase the number of students on buses which may result in fewer route buses needed for home to school runs. **Table 2 and 3** shows the average planned and actual capacity utilization across the system.

Table 2: General Education Capacity Utilization

School Type	Planned Average Capacity Utilization	October Average Capacity Utilization	March Average Capacity Utilization
Elementary School Runs	60 percent	33 percent	36 percent
Middle School Runs	58 percent	25 percent	29 percent
High School Runs	130 percent	39 percent	38 percent
St. Thomas Runs	42 percent	12 percent	11 percent
Private, Parochial, and Charter School Runs	24 percent	10 percent	10 percent

Table 3: Special Education Capacity Utilization

School Type	Planned Average Capacity Utilization	October Average Capacity Utilization	March Average Capacity Utilization
Elementary School Runs	38 percent	27 percent	29 percent
Middle School Runs	26 percent	20 percent	22 percent
High School Runs	24 percent	20 percent	20 percent
BOCES Runs	9 percent	9 percent	9 percent
Other District Schools	6 percent	5 percent	6 percent
Private, Parochial, and Charter School Runs	2 percent	5 percent	5 percent
Special Education Programs	16 percent	12 percent	12 percent

Run time

The analysis of run times provides a key indication of the level of service provided by a transportation organization. Based on the analysis of BCSD provided run data, the average run time is 30 minutes. As **Figures 5 and 6** illustrates, average run times for general education are reasonable at 29 minutes and 27 minutes for the morning and afternoon respectively. As would be expected, special education run times are longer with an average of 36 minutes and 34 minutes in the morning and afternoon respectively. It is common for special education runs to be longer due to the additional load time for students in wheelchairs and other safety considerations. Further analysis finds that 31 percent of all runs are under 20 minutes. This provides an opportunity to add additional stops to certain runs with available work time between the tiers.

Figure 5: General Education Run Times

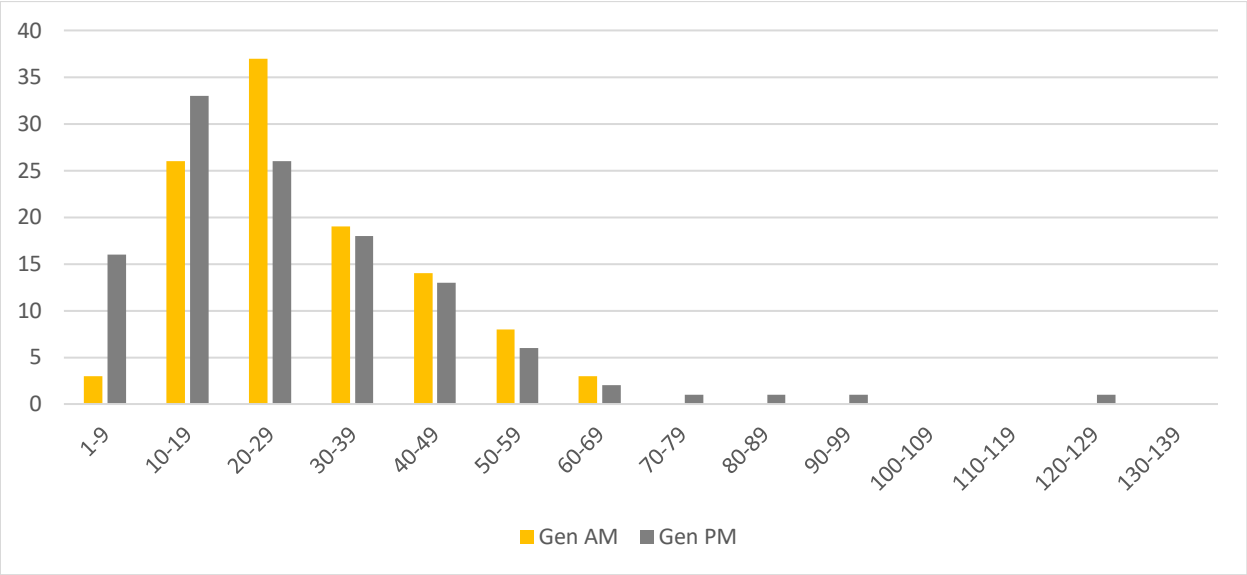
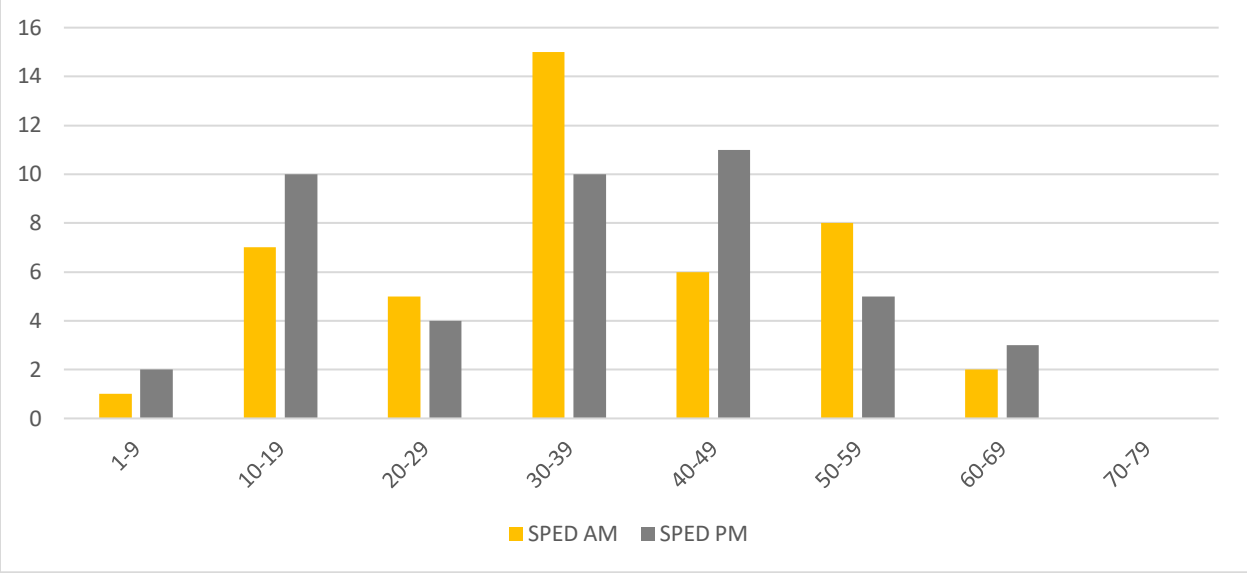


Figure 6: Special Education Run Times



Buses per 100 Students

While the number of runs per bus and capacity utilization percentages can be illustrative, combining these analyses to understand the total number of buses currently being utilized can provide insight into the overall effectiveness and efficiency of the system. Typically, a system that is able to effectively use its fleet assets achieves a value between 1.1 and 1.34 buses per 100 students. Based on the approximately 4,879 planned riders being transported across the 317 runs, the number of buses per 100 students is approximately 1.87 providing a further indication that there may be opportunities to increase efficiencies by examining the current route structure.

Recommendations and Conclusions: Current Bell Time and Routing Analysis

It is evident that the transportation team is employing many best practices when it comes to over planning high school routes and collecting daily ridership counts. However, based on ridership counts, run times, and underutilized buses there are opportunities to increase the efficiency of the system by utilizing count data to make route adjustments to increase the number of students riding on underutilized routes.

1. It is evident that the goal of the department is to design and implement a routing network that maximizes the use of each of the fleet assets effectively minimizing the overall number of buses required. Given the time and district constraints that exist when providing service over such a large geographical area, a process for the regular calculation of key performance indicators such as ride times and on-time performance should be considered to ensure that the desired levels of service are also maintained.
2. The daily collection of student counts is a best practice as it provides insight on day-to-day service demands. Utilizing these counts to identify routes that have historically low ridership may offer opportunities to increase routing efficiency.

Alternative Bell Time Structure Analysis

BCSD wanted to determine how moving high school start times from 7:35 AM to a later time would affect transportation operations. SBC utilized guidance from the BCSD transportation staff and members from the School Start Time Group to develop constraints such as length of day, earliest acceptable arrival time, and latest acceptable dismissal to develop four alternative bell time structures. The goal of these alternatives is to move the high school bell time back towards the optimal start time of 8:30 AM without compromising the current level of efficiency of the transportation operation, without reducing the level of customer service currently provided, while considering the importance of the optional 9th period for high school students.

The following alternatives use the exact same runs as the current system and only adjusts the start and end time of each run to adjust it to its associated school bell times. All non-BCSD runs were kept consistent as these programs' bell times would not be altered in the process. While this report only includes four alternative bell time structures, other alternatives were examined, but were not included because they failed to meet the goals of this endeavor.

Alternative One

This alternative moves the morning high school bell later to 8:00 AM creating a two-tier system with the high school and middle school sharing the same start time in the morning. High school would end at 2:31 PM (optional 9th period ending at 3:25 PM) and middle school would still end at 2:43 PM due to the variance in instructional days. The last tier would remain elementary school maintaining a start time of 9:20 AM and an ending at 3:20 PM. Under this structure, the initial analysis showed that the peak deployment will potentially increase the need of route buses to 80 during the last tier in the afternoon. **Figures 7 and 8** show the morning and afternoon deployment for Alternative One.

Figure 7: Alternative One Deployment AM

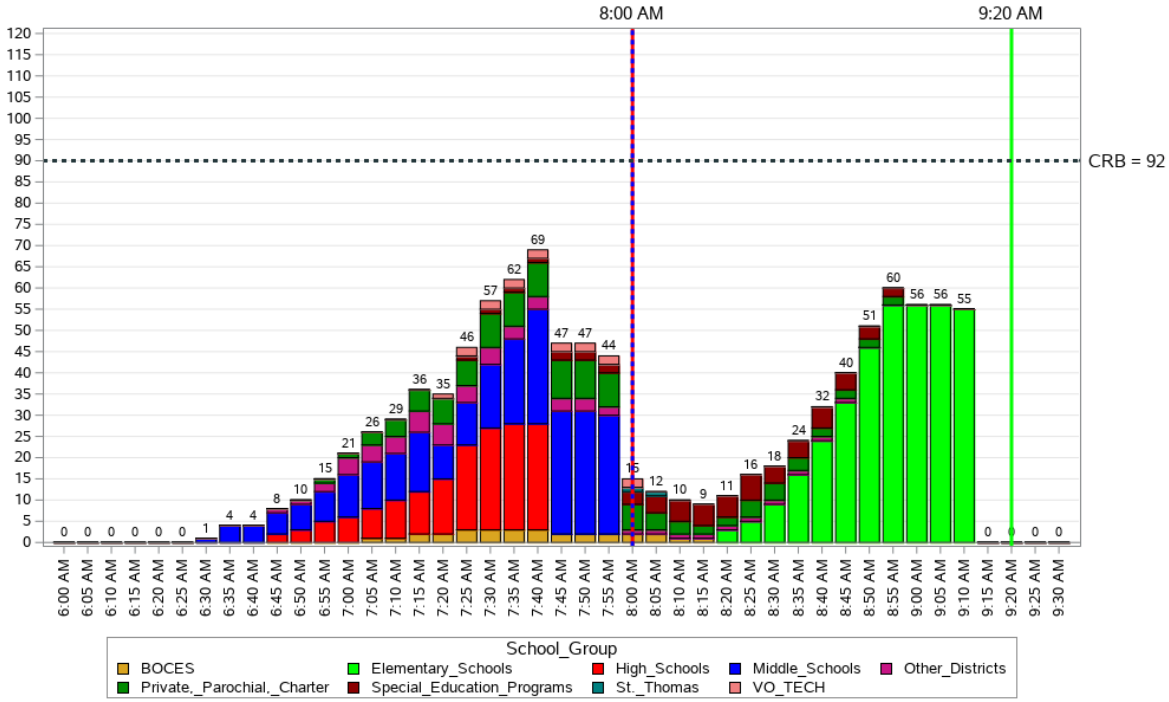
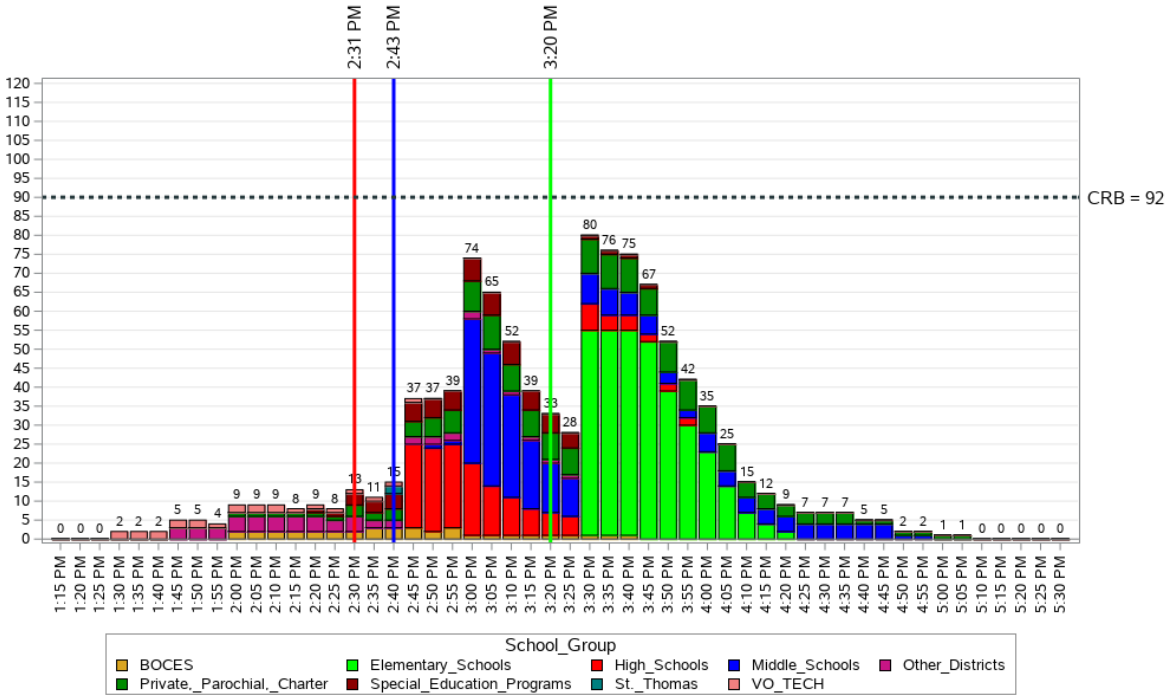


Figure 8: Alternative One Deployment PM

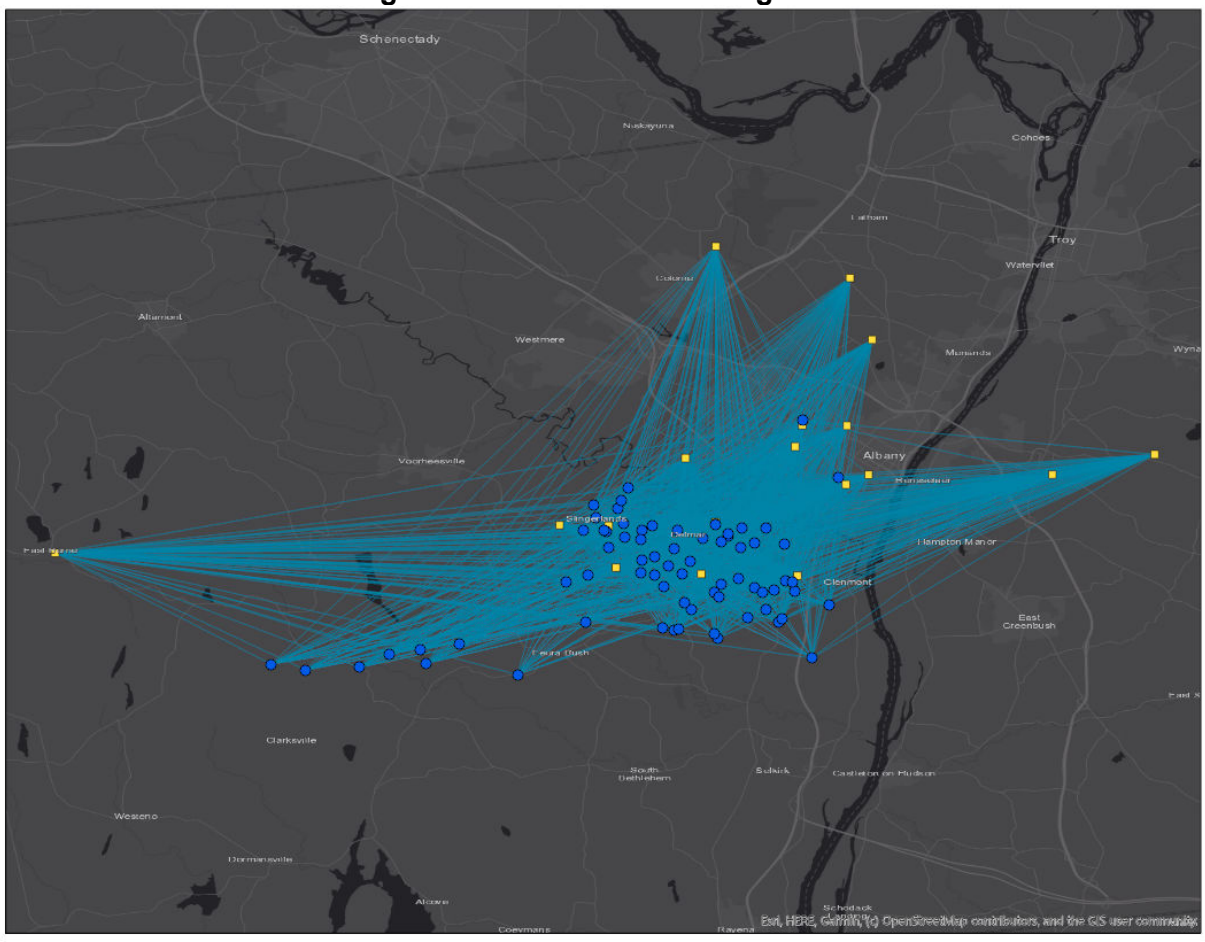


Pairing Results

The initial analysis (deployment model) indicates how the alternative bell times affect transportation by determining if there is an increase to the runs that overlap given the change in time between tiers. The increase in runs that overlap indicates the need for additional resources. However, it does not consider if the "work time" provided between each of the tiers is adequate for accommodate the current run pairings.

An additional analysis is performed that consists of identifying and geocoding the location of the last stops in the first tier runs and the first stop in tier runs (this was also done between second and third tier runs). We conducted geospatial analysis that calculated the time between each of the first tier' final stops and the second tier's first stop. This incorporated the local street network and historical traffic conditions to provide a more accurate representation of what occurs on the roads during BCSD's peak transportation windows for the alternative bell times. We then utilized a statistical model that applied the available time between each pairing option to identify the most efficient pairings. Below **Figure 9** illustrates the potential pairing results for Alternative One.

Figure 9: Two-Tier Run Paring Results



With further analysis it was discovered that 82 buses are actually required instead of the potential 80 route buses due to time constraints. There are also 9 pairings with 5 minutes or less turn around time, which might lead to an issue of late buses if traffic is heavier than usual.

Alternative Two

This alternative flips the middle and high school tiers with the elementary tier remaining the same. The first tier for this alternative would be middle school, which would start at 7:35 AM and end at 2:18 PM. The second tier would be high school starting at 8:00 AM and would end at 2:31 PM (optional 9th period ending at 3:25 PM). The last tier would remain elementary school starting at 9:20 AM and ending at 3:20 PM. Under this structure, the peak deployment will potentially decrease the need of route buses by one to 74 during the last tier in the afternoon. This was confirmed when the run pairing analysis was performed on Alternative Two. However, 6 pairings were identified as having 5 minutes or less turnaround time. **Figures 10 and 11** show the morning and afternoon deployment for Alternative Two.

Figure 10: Alternative Two Deployment AM

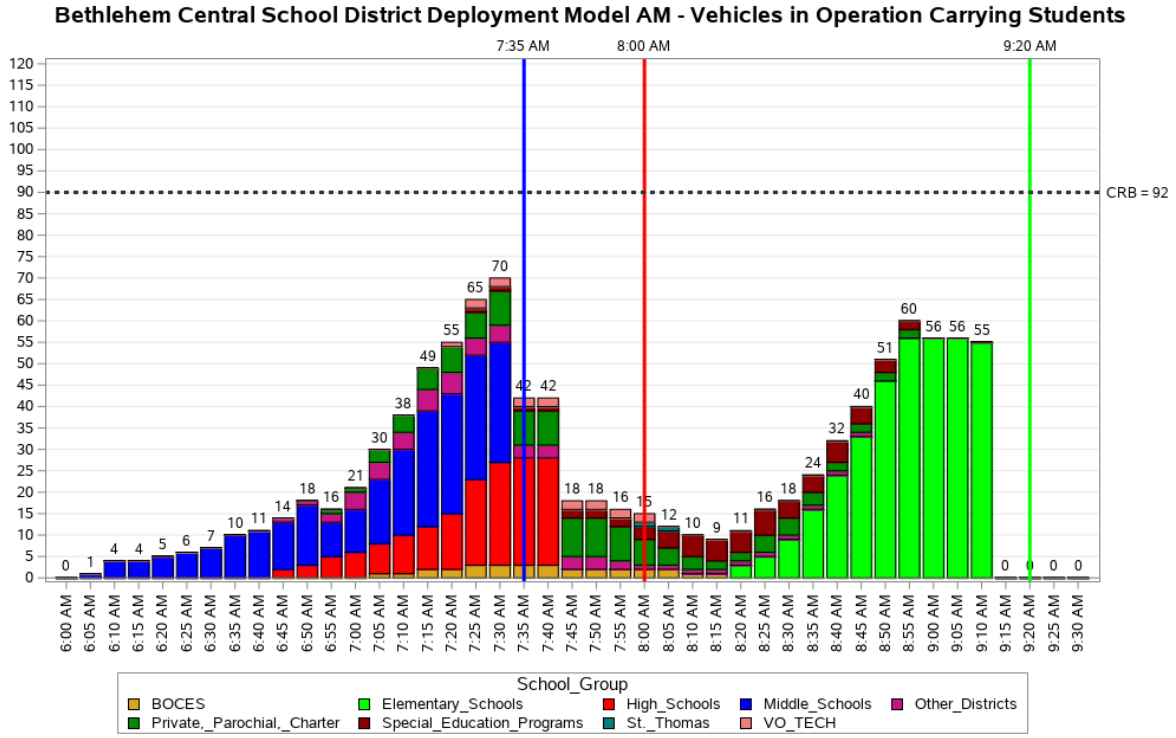
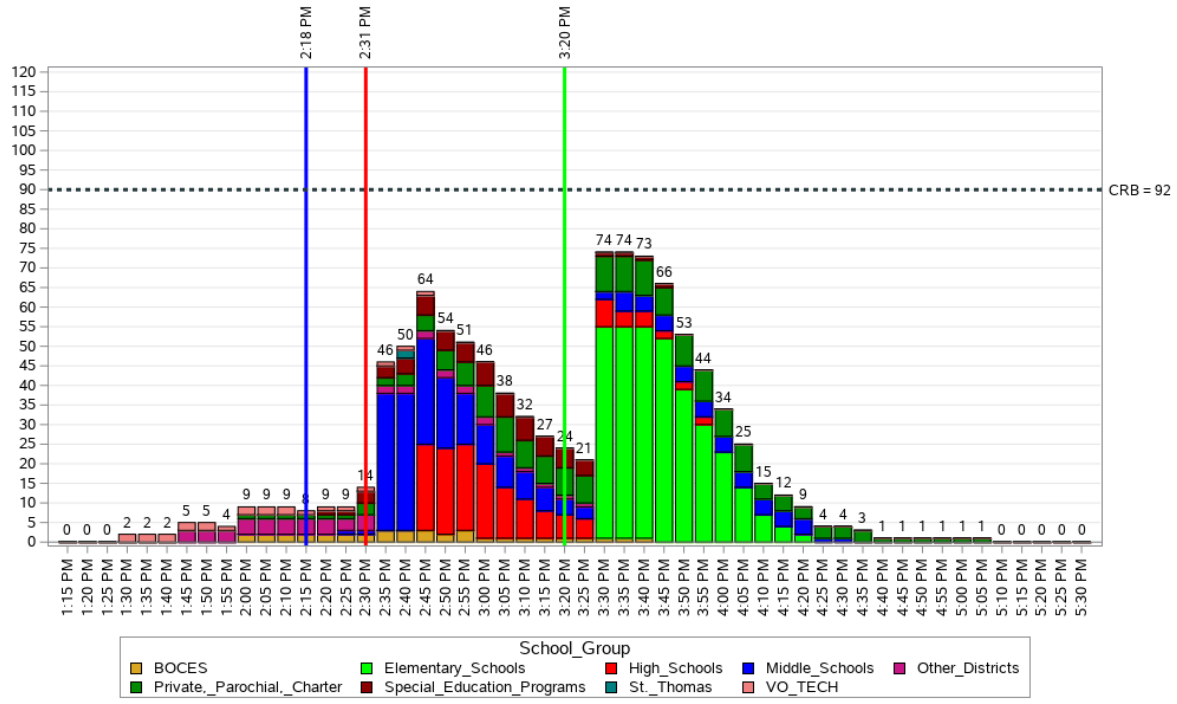


Figure 11: Alternative Two Deployment PM



Alternative Three

This alternative adjusts the tier sequencing with elementary serving as the first tier starting at 7:35 AM and ending at 1:35 PM. Middle school would remain in the second tier starting at 8:00 AM and ending at 2:43 PM. High school would move to the last tier starting at the optimal time of 8:30 AM and ending at 3:01 PM (optional 9th period ending at 3:55 PM). Under this structure, the peak deployment will potentially increase the need of route buses to 84 in the first tier in the morning. This occurs due to elementary schools having the highest transportation demand combined with a consolidated amount of “work time” with 25 minutes between tier 1 and tier 2. In addition, the run pairing analysis was performed on this alternative indicating a requirement of 94 buses with 5 pairings having 5 minutes or less turnaround time. **Figures 12 and 13** below shows the morning and afternoon deployment for Alternative Three.

Figure 12: Alternative Three Deployment AM

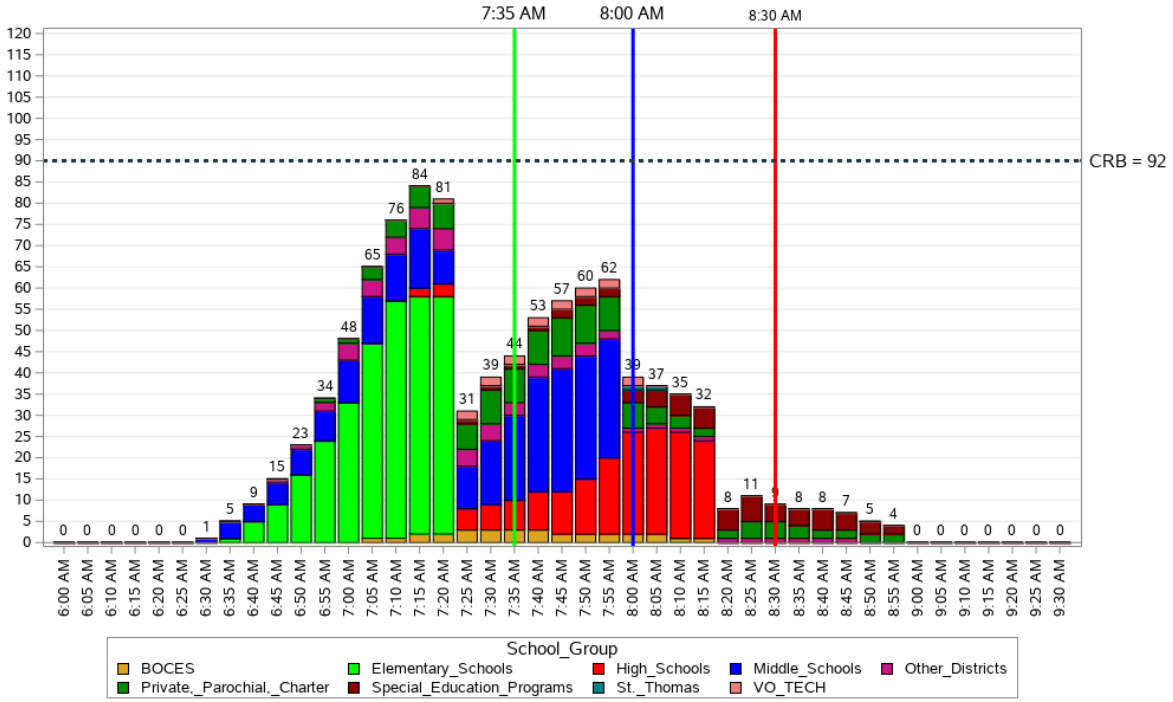
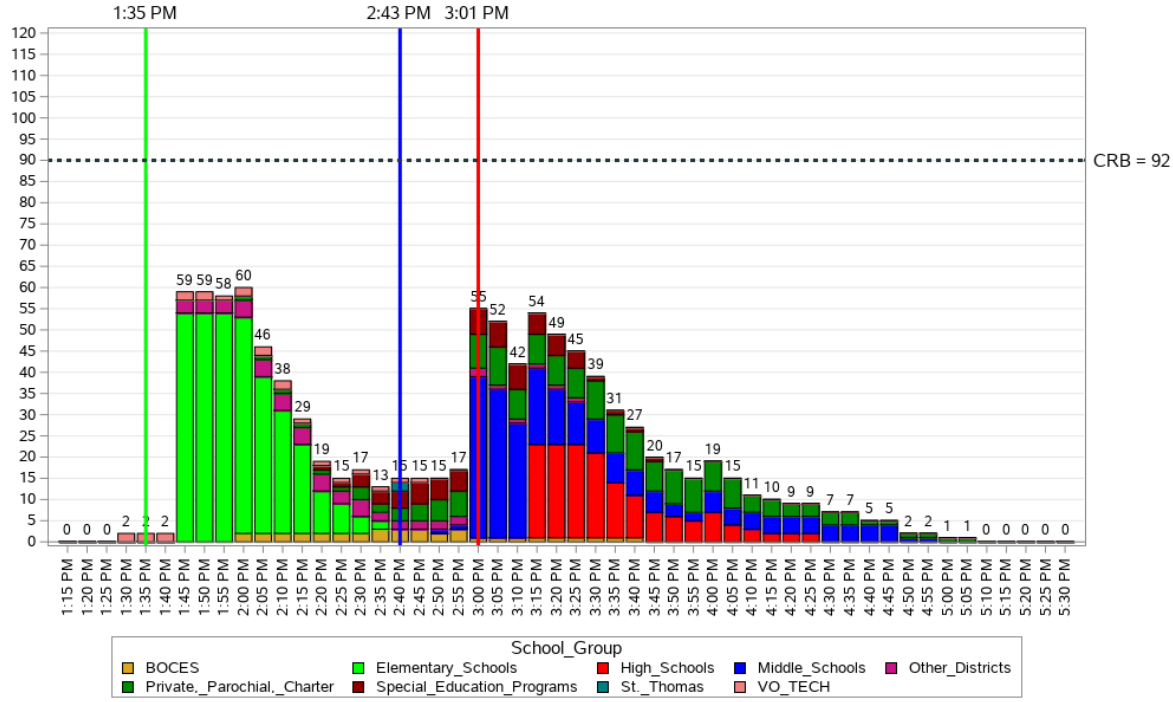


Figure 13: Alternative Three Deployment PM

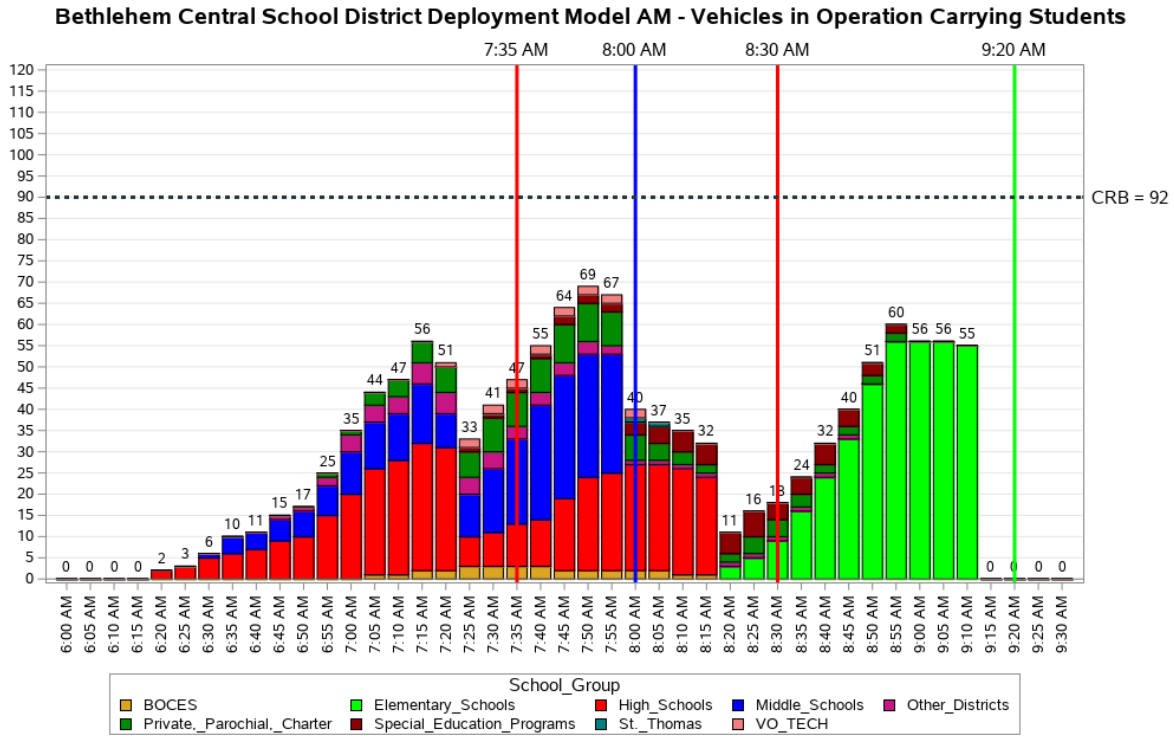


Alternative Four

This alternative was created to offer a hybrid solution that provides an option for high school students to start at 8:30 while maintaining the optional 9th period. This alternative maintains the current tier structure and times for all school groups, but the 25 AM high school runs are rerun allowing for high school students to choose to arrive at 8:15 AM for an 8:30 AM bell time (2nd period begins at 8:36 AM). The initial analysis of this alternative identifies a potential requirement of 69 routes in the morning tier-2, which is less than the required 75 route buses in the afternoon tier-3. **Figure 14** shows the morning deployment for Alternative Four.

After the additional run pairing analysis was performed, it was identified that additional route buses would be required due to limited "work time" that would be required to conduct the runs for a second time. Further analysis was performed on this alternative, and 9 route buses only conduct runs during the third tier. These buses can be utilized to perform the second round of high school runs. Since the hybrid alternative provides high school students multiple time options for transportation, the demand for each period will be reduced.

Figure 14: Alternative Four Deployment AM



Recommendations and Conclusions: Alternative Bell Time Structure Analysis

BCSD is seeking to revise their bell schedule to move the District's high school closer to the recommended 8:30 AM school start time. While the science is becoming clearer on the benefits of later start times for high school students, it is important to recognize that there are constraints within the District that make it difficult to simply move start times later in the day. The various scenarios examined throughout this process highlight these known constraints.

Based upon our research and analyses of BCSD transportation operations, SBC concludes that it is possible for BCSD to push back high school starts times. This solution would accommodate two goals: first, allowing for a later start time for the high schools, and, second, retaining the efficiency and service quality of BCSD transportation operations, which is vital to the safety and success of this district.

Recommendations

1. SBC recommends Bell Time Alternative Four-Hybrid. This alternative accommodates students that choose to sleep later by arriving at the beginning of second period and allows the District to pilot starting school later without altering the current structure or increasing resources.

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