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**Bethlehem Central School District
Fleet, Routing, and Technology Assessment
April 17, 2020**

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Table of Contents

Executive Summary

Fleet Management Assessment

This study evaluated existing replacement criteria and the determination of annual replacement needs, determined current fleet replacement requirements, established a ten-year projection of future fleet replacement requirements, and evaluated financing strategies used by the district. The development and implementation of a systematic replacement plan is one of the most essential elements in controlling fleet-related costs. The implementation of a replacement plan facilitates the minimization of total life-cycle costs by achieving the optimal balance between the capital and operating cost components experienced by the fleet, subject to constraints imposed by the availability of funding. Key finding from this analysis include:

- Established fleet replacement criteria indicate a need for approximately 11 units per year, on average.

- Project fleet replacement expenditures will maintain some volatility given the mix of units being replaced annually.

- The department has developed a projected replacement strategy that attempts to balance annual replacements and represents a sustainable strategy in the medium term.

- The use of state contracts for purchasing is a reasonable and appropriate approach to acquiring replacement buses and vehicles.

- The inclusion of modern technologies on the buses can provide additional operating benefits but must be actively managed.

- Once the impacts of COVID-19 are fully understood and the new bell times are operational, Transpar will pursue routing efficiencies that will target reduction of buses (132 current bus count) and better alignment of assets (bus size/type) to the new system.

Routing Assessment

TransPar believes the bell time scenario can be accomplished using a total of 90 buses with 90 bus drivers. This represents a reduction of two route buses from the current system. Further reduction of 1-5 buses from this system is feasible. TransPar will partner with BCSD during the next school year to assess and monitor operations and work towards further bus reductions during the 2020/21 Winter Break.

Regarding the new bell times, the morning tier can be accomplished without risk because there is a wide spacing of arrival times. One hour and twenty minutes between the two tiers ensures that every bus can perform two trips. The afternoon is more difficult because after High School dismissal, buses have 49 minutes to perform their trip and return for an Elementary trip. Middle

School routes only have 37 minutes to perform the trip and return to an Elementary for the second tier.

Lastly, there would be substantial change to what each driver would be assigned to do throughout the day. An analysis of existing driver payroll suggests that drivers fall under a wide range of weekly hours. Many drivers only work in the afternoon, and many others work two shifts of drastically different hours such as two morning hours and five afternoon hours.

Technology Assessment

BCSD has invested in Tyler Technologies Routing, Field Trip, and Maintenance software packages. The technology represents some of the best products on the student transportation market. However, the lack of GPS integration is severely limiting the use and potential performance of these systems. Operationally and from a student safety perspective, GPS device on all route buses should be BCSD's highest priority. The GPS data will provide several immediate operational and safety improvement opportunities, to include:

- **Route Planning and Analysis:** With data provided by GPS, you can view the route taken versus the planned route, including traffic and bus stop trends, and all route delays.
- **Performance Accountability:** GPS units enable managers to assess consistently late routes, lengthy bus stops and under-utilized bus stops.
- **Environmental Responsibility:** GPS-equipped school buses record engine idling and speeding, so BCSD can develop targeted driving behavior training focused on reducing these incidents.
- **Safety & Security:** The safety and security of the students is the most important aspect of student transportation; with that comes *assurance* of a particular student's safety.
- **Cost-Savings:** Off-route detours often use more gas than a standard route. With GPS on school buses, you can measure excessive idling and unplanned route detours.
- **Payroll Planning:** See exactly when the buses leave the yard and when they return at the bus depot. Telematics data from your GPS can synchronize with your payroll and scheduling system to more effectively manage costs and staffing.

The immediate and most pressing technology need for BCSD are GPS devices for all route buses. If additional funding is available, there are several opportunities to add valuable technology products that will improve the overall performance and safety of the department. TransPar has prioritized the remaining technology opportunities as follows:

1. **Driver Tablets and Student Ridership Software**
   a. Higher dollar investment (+$200k) but provides dramatic improvement to the overall operation and provides the most advanced technology available to drive the highest levels of safety, customer service, and operational efficiency.
2. **Time and Attendance Software and Hardware (timeclocks)**
   a. Low to medium ($18k) annual investment. Provides best in class dispatch and time/attendance system. Addresses pain points related to effective management of daily operations, payroll accuracy, school/bus stop on-time performance,

and provides an elevated level of cost control for all hourly employees. Requires GPS for optimal performance.

3. **Cloud Camera Upgrade**
   a. Access video on demand from any location to expedite incident and safety reviews.

4. **Learning Management System for Driver and Safety Training**
   a. Lower dollar (<$12k) investment that will enhance delivery and management of driver training.

5. **Incident Management System (IMS)**
   a. Lower dollar (<10k) investment that will improve internal command and control of all transportation issues and incidents. Ability to perform trend analysis and make data driven decision to improve overall performance.

6. **Bus Wi-Fi**
   a. Lower dollar investment (<10k) to outfit and pilot 2-4 buses with Wi-Fi. Assess student/community need for Wi-Fi buses.

7. **Electric Buses**
   a. Higher dollar investment (>$350k) that includes capital expenses for buses and charging infrastructure.
   b. Recommend pursuing Federal grants for partial funding opportunities.
   c. Follow impact of COVID-19 on Utility company funded electric bus pilots. Utility backed pilots offer BCSD the best opportunity to test electric buses with minimal cost to the district.

Fleet Management

BACKGROUND AND INTRODUCTION

This technical memorandum documents the findings and recommendations from an evaluation of fleet replacement practices at the Bethlehem Central School District (BCSD). This study evaluated existing replacement criteria and the determination of annual replacement needs, determined current fleet replacement requirements, established a ten-year projection of future fleet replacement requirements, and evaluated financing strategies used by the district.

The development and implementation of a systematic replacement plan is one of the most important elements in controlling fleet-related costs. The implementation of a replacement plan facilitates the minimization of total life-cycle costs by achieving the optimal balance between the capital and operating cost components experienced by the fleet, subject to constraints imposed by the availability of funding. As such, it is a logical first step in any effort designed to gain an understanding of fleet costs, and in developing an overall strategy for reducing these costs over time.

This study was conducted in the context of other changes and activities within the transportation operation including a revision to the existing bell schedule. Consequently, consideration was given the appropriateness of the overall size and composition of the district school bus fleet. Furthermore, changes to the manner in which buses are outfitted, such as the inclusion of automated vehicle locating devices (commonly referred to as GPS) and the use of mobile data terminals (commonly referred to as tablets), was also considered.

Description of current fleet

The BCSD owns and operates a mixed fleet of 132 buses that includes both Type C and Type A assets. Additionally, there are a limited number of Suburban passenger vehicles and other small unit types used for specialized transportation services. The following table summarizes the fleet composition by the manufacturer's rated capacity (MFRC) of the unit. A detailed inventory is included in the Appendix.

*Table 1: Count of Units by Type*

MFRC	Count of Units
24	2
27	7
28	2
30	25

66	37
70	23
72	32
21/3WC	4
Grand Total	**132**

Our analysis of the district's fleet indicated that the composite average age of the fleet is 6.1 years. The implication of this value is that the district, assuming a normal distribution of replacements, is replacing its vehicles every 12.2 years on average. This would, generally, be highly consistent with the desired replacement criteria established by the district given the 10-year timeline for small vehicles and the 12-year timeline for larger buses.

However, as the following chart of model year of the units indicates, the age of the fleet is not normally distributed. The graph depicts a notable consistency in fleet acquisition since 2017. Prior to that year replacement was more volatile and is reflective of necessary decision making at the time of the financial crisis. This volatility will have some influence on out year replacement projections and becomes a key point of consideration for the replacement process.

Figure 1: Distribution of Fleet by Year in Service
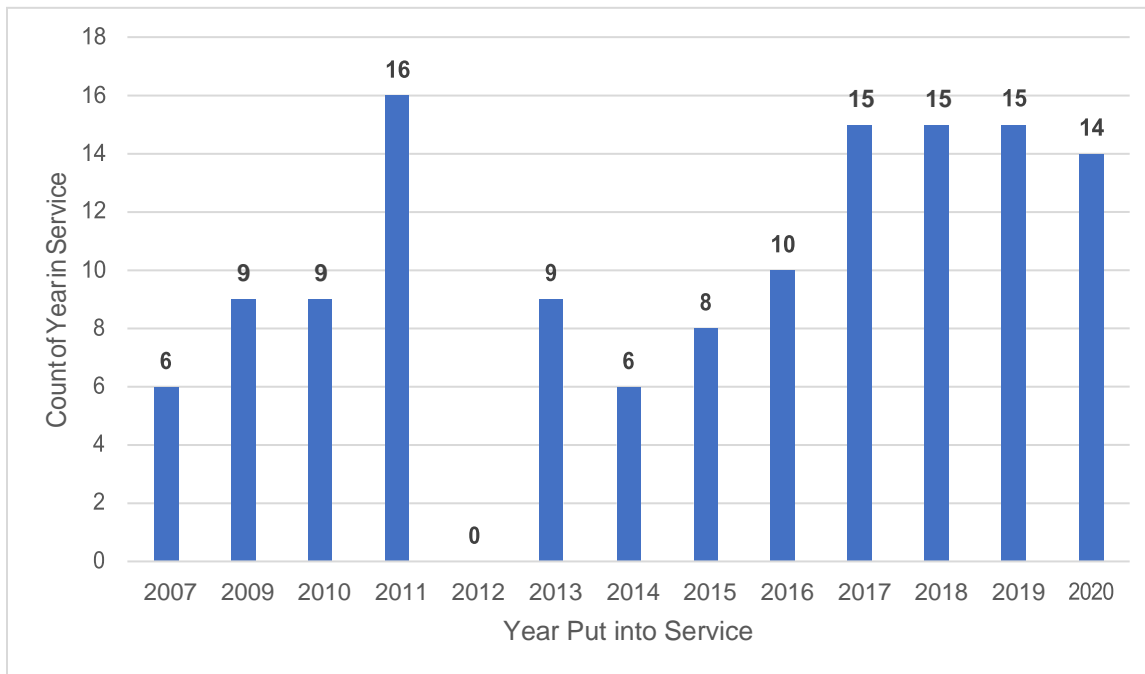
The district has undertaken significant efforts to address a previous replacement backlog and should be *commended for its understanding of the relationship between replacement strategies and safety, total cost of ownership, vehicle reliability, and staff satisfaction*.

Replacement planning process

Interviews with staff provided a detailed understanding of the process used to establish the annual projections for buses where replacement is being considered. The process, as defined, incorporates the accumulated age and mileage of the current unit, maintenance history, equipment and outfitting, and any unique operating characteristics that may influence the assignment of a vehicle. The formal and informal inclusion of these considerations in the replacement planning process is considered a best practice and reflects well on the department's approach to determining needs.

The process generally beings in the early fall with a review of the units that are coming due based on the established age criteria of 12-years for large buses and 10-years for smaller buses or vehicles. The department has a practice of regularly reviewing the mileage of the fleet and shifting vehicles between routes to balance mileage to the degree possible. This is an excellent practice that supports a better balancing of annual replacement needs. Once units are identified as possible replacements, a review of the maintenance history and operating conditions is conducted by the Director, Assistant Director, and Fleet Manager. During this review a determination is made as to whether a unit can be extended for any additional time and/or if any units require an accelerated replacement. There have been limited instances where replacement has to be accelerated as a result of significant repair costs or accidents, but the review process can accommodate those contingencies. Subsequent to the vetting of the initial list, a desired replacement list is submitted to administrative and financial leadership for consideration and inclusion in the budget process. Overall, this approach provides for a reasoned and appropriate methodology for determining annual replacement needs.

The stability of replacement funding has also been a key contributor to the effectiveness of replacement practices in the district. The commitment of funds using a municipal financing strategy is also consistent with best practices and has allowed the district to mitigate much of the negative operating impacts (i.e., decreased reliability, increased maintenance costs, inappropriate size and/or composition of the fleet) of the replacement backlog that was developing prior to approximately 2016.

Determining Projected Fleet Replacement Requirements

The economic theory of replacement holds that there are two primary costs associated with owning a single vehicle or a fleet of buses. These costs are the capital costs associated with retaining the asset for a period of time and the operating costs associated with maintaining and utilizing the vehicle. As the graph below illustrates, as vehicles are retained the capital costs

associated with the unit decrease. Conversely, operating costs will increase as more repairs are required to keep the vehicle in working order.

Figure 2: Representative Total Cost of Ownership Graph
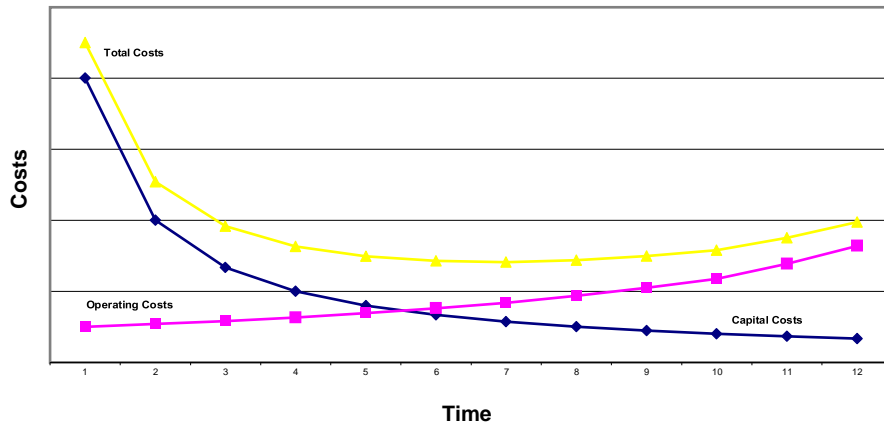
The goal of every replacement management strategy is to set replacement criteria such that it matches the lowest total cost of ownership along the total cost continuum. However, the lowest total cost is typically best defined as not being any single point in time, but rather a range that can span several years. Therefore, replacement criteria should be developed based on a pragmatic analysis of the relationship between vehicle age and cumulative usage, and vehicle operating costs and reliability. It should be noted, that deferring vehicle replacements beyond a certain point will actually result in an increase to total annual vehicle costs making it more costly to own and operate the vehicle or a fleet of vehicles.

When these criteria are applied to each unit in the fleet, it is possible to establish both the count of units due in any given year and the projected cost of those units. The cumulative costs associated with replacing all units due for replacement in a particular year represents the expenditure total that must be financed to maintain the established replacement schedule. It is our belief that developing a forward-looking understanding of both the unit counts and the financial requirements is critical due to the long-term nature of their use and the relatively static nature of the revenue sources provided to the district. Failure to consider both of these issues typically results in an inability to secure the funding required to replace all fleet assets in a timely manner.

We reviewed the replacement criteria and vehicle inventory and validated these with district personnel. We then applied the established planning criteria to each unit in order to develop projected replacement expenditure requirements for a 10-year period beginning in 2022.

Projected replacement dates were determined by comparing the current age of each unit in the fleet to the replacement criteria for units of that type. After establishing the projected replacement date, we utilized the current replacement cost for the unit and a standardized inflation factor to determine the projected cost of each unit when it is due for replacement. Our findings regarding the projected replacement requirements, and recommendations regarding future funding for fleet replacement, are described below.

Observations and Recommendations

Established fleet replacement criteria indicate a need for approximately 11 units per year, on average. The department operates 132 buses with an unweighted average of 11 years for replacement. Given that the predominance of the fleet are larger buses with longer planned lives it is simpler to determine an average annual need by dividing the total units by the 12-year replacement criteria (132/12 = 11). As was demonstrated in **Figure 1**, prior to 2016 there was substantial volatility in the number of units being replaced. Consequently, it has been and will remain for a limited period of time necessary to continue to purchase more than the 11 units per year to address the replacement backlog.

Project fleet replacement expenditures will maintain some volatility given the mix of units being replaced annually. The following chart shows the projected replacement expenditure requirements by year, utilizing the established replacement criteria without any adjustments. It should be noted that this model is not intended to be representative of *how* you would actually replace vehicles, but it is to provide an indication of what the need would be if we were to just apply the established criteria to the inventory.

Figure 3: Baseline Fleet Replacement Needs
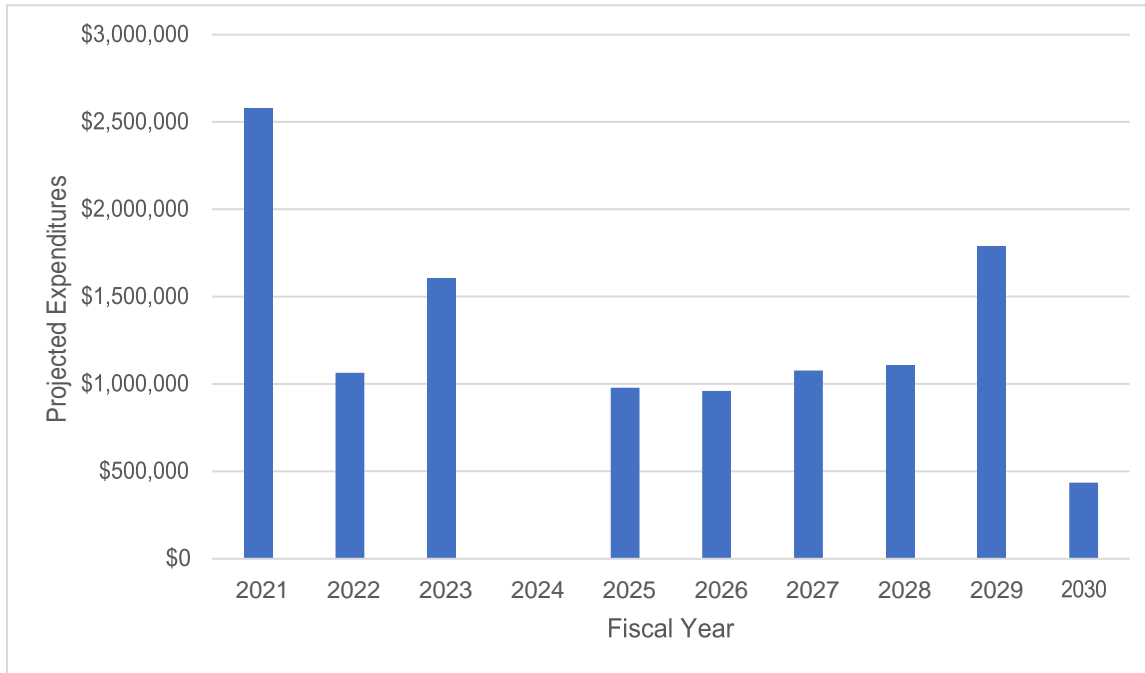
The above chart shows a large expenditure requirement for vehicles programmed for replacement in 2021 and substantial volatility in year-to-year expenditure requirements throughout the planning horizon. This is mostly due to the model being designed to schedule any vehicle due or overdue for replacement in year 1. Consequently, 27 total units were scheduled for replacement in 2021. The reason the expenditure plan detailed in the chart should not be implemented is even if BCSD is willing and able to fund the replacement of nearly 20 percent of its fleet assets in a single year, it would not be desirable to do so for two key reasons. First, this strategy would cause substantial volatility in the fleet maintenance budget in future years as the large group of vehicles purchased in fiscal year 2021 aged simultaneously. Second, it would create substantial "ripple effects" in future fleet replacement budgets since many of these new assets would come due for replacement at the same time.

It is this second factor that is reflective of current conditions in the district when no units were purchased in 2012. Given the 12-year planned life of the buses, this manifests itself in no units being scheduled for replacement in 2024. Avoiding this type of volatility is why the district has worked as diligently as it has in its actual replacement planning and financing process since the period following the financial crises.

The department has developed a projected replacement strategy that attempts to balance annual replacements and represents a sustainable strategy in the medium term. As part of the

![TRANSPAR logo]

data collection, the department provide a projected replacement schedule through the 2028-2029 school year. This plan attempts to remedy the volatility in counts and expenditures demonstrated in the baseline model in **Figure 3.** This was done by manipulating the projected replacement date based on an understanding of usage and maintenance history. **Figure 4** below represents the results of those adjustments.

Figure 4: Adjusted Fleet Replacement Plan[1]
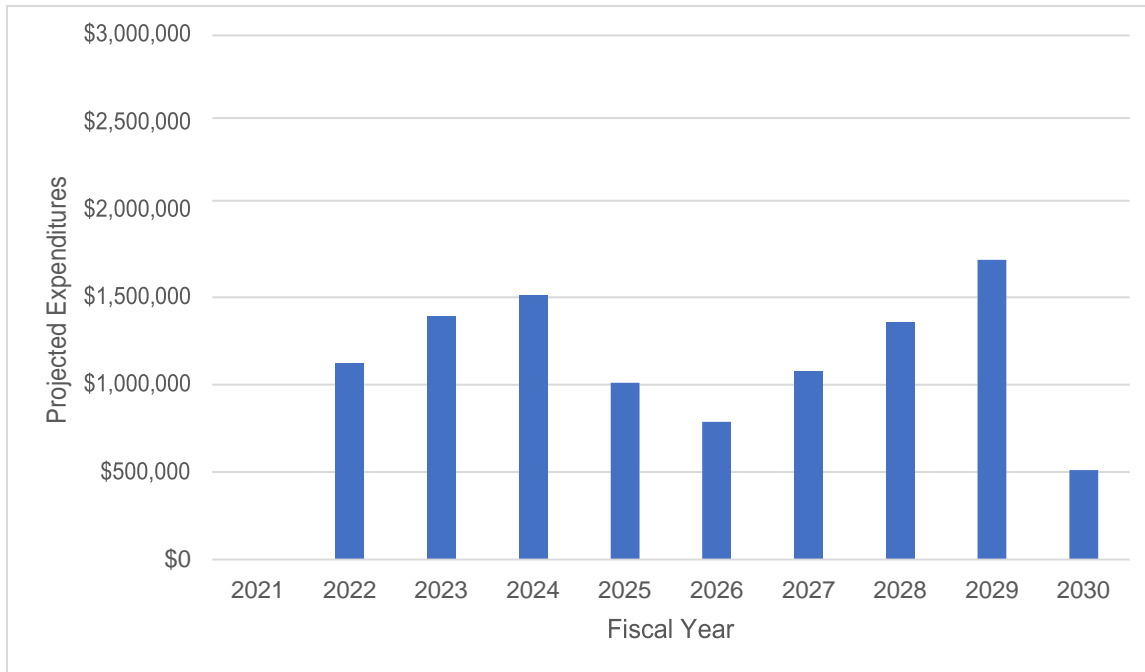
While it is clear that volatility is substantially reduced in this plan, there remains approximately $1.2 million in difference between the peak year (2029) and the trough year (2030). Given the timing of the second replacement of some assets a more apt comparison may be the nearly $900,000 in difference between 2026 and 2029. The district has managed a substantial portion the volatility of these requirements through its use of bond financing. Additionally, TransPar will assess the need for smaller bus replacements during the upcoming school year to mitigate some of the significant variation in bus sizes. BCSD may benefit financially and operationally by removing some large buses from the system and replacing with assets that better meet the needs of the routing system which will be redesigned for 2020/21 school year.

The use of state contracts for purchasing is a reasonable and appropriate approach to acquiring replacement buses and vehicles. The department has traditionally used the statewide contract awarded for school bus purchases to acquire assets. This contract is competitively bid via the New York State Office of General Services to achieve market-based pricing for a variety of school bus types. The use of this procurement vehicle has allowed the district to standardize

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[1] No values are included for 2021 because those units were identified for replacement at the time this analysis was being performed.

the makes and models of its school bus fleet. This standardization has had second-order benefits related to maintenance services including consistent training on common vehicle types, and a reduction in parts inventory and management costs. The use of a consistent make and model has also allowed the department to create a common vehicle setup to facilitate the transition of drivers and substitutes from bus to bus. This can be very helpful in promoting safety as drivers experience less cognitive loading when driving the bus and are able to give more attention to driving responsibilities and the students.

The inclusion of new technologies on the buses can provide additional operating benefits but must be actively managed. The department is actively considering the inclusion of automated vehicle locating technologies and mobile data terminals on the buses. The current plan would include these items in the initial acquisition and outfitting of the bus. This is a sound financial and operational strategy as it would place responsibility and accountability for wiring and installation on the bus vendor and incorporate those concerns in any warranty period.

The proposed technologies offer a host of operational benefits including real time access to location in the event of an incident or emergency, a consistent data stream that will allow for assessments of efficiency, and support for substitute drivers as they drive unfamiliar or uncommon routes. However, we would recommend that the district consider a very deliberate and long-term rollout strategy for any of these technologies. Experience suggests that the impact these technologies have on operations is varied from district-to-district and measuring and assessing those likely impacts should impact the pace and order in which they are implemented throughout the operation. This will be particularly relevant with newer technologies such as the mobile data terminals.

Any transition to alternative fuel vehicles should consider both the total cost of ownership and the operational appropriateness of the technology. While not specifically an element of this replacement assessment, the consideration of alternative fuel vehicles is likely to be an emergent consideration for the district. There is a significant emphasis in school transportation on the feasibility of incorporating alternative fueled vehicles into school fleets given their comparatively shorter duration and the stop and start nature of the routing. Propane, gasoline, and electric are the most common options considered. While each has their own specific characteristics that must be evaluated, there are concerns common to all of the alternatives that must be considered. These include:

- *What impact will the inclusion of alternative fueled vehicles have on the projected replacement expenditures?* The incremental capital costs associated with alternative fuels must be considered when assessing the feasibility of acquiring these types of units. If purchasing these units supplants funding that would have otherwise been used to replacement a continuing use unit, it is likely that the district will, over time, develop a replacement backlog. Additional funding dedicated to replacement would address this concern, but the magnitude of that funding would have to be assessed. For example, the

electric buses acquired for White Plains Bus cost approximately $380,000[2] or roughly three times the cost of a diesel bus. While there are projections that long term operating costs are less, there is a mismatch between when the funding is needed for acquisition and potential savings are realized. Therefore, we believe that the district should extensively analyze the impact that the incorporation of alternative fuel vehicles would have on the existing replacement schedule in the district.

- *What impact will the inclusion of alternative fuels have on the capital needs of the district?* In addition to the cost of acquiring the asset, there will be additional costs for fueling and related infrastructure associated with any alternative fuel vehicle. For propane or natural gas units this would include the standup of a fueling station and the associated hardware such as fill pumps, fire suppression, and site preparations. According to the United States Department of Energy, the cost of establishing a new fueling station for approximately 20 buses would be $60,000 to $70,000[3].

  - Considerations would be similar for any electric vehicle transition. The cost of site standup and preparation are less well defined than for propane given the recency of the technologies but remain a significant consideration. Also requiring consideration would be any changes to shop tooling, equipment, and capacity that may be required. These cannot be determined with a great degree of accuracy until a decision on the acquisition strategy is made. Consideration of these capital costs should serve as a significant variable in any determination of the acquisition strategy.

- *What impact will the impact of alternative fueled vehicles have on daily transportation operations?* The primary concern for any alternative fuel choice would be how well it fits into the routing design and maintenance operation of the district. Addressing the issue of "range anxiety" (defined as the average and most probable distance the unit will travel under different environmental conditions) particularly for electric vehicles would be a significant concern.

Training and equipment need in the maintenance shop would also need to be assessed. While these costs are likely to be incremental, it is at least as important to assess the potential disruption of having some small portion of the fleet that may have complex maintenance requirements. Lastly, defining safety and training requirements for shop and other emergency operations will be critical. For example, addressing the fire hazards and conditions associated with significant

[2] https://www.lohud.com/story/news/education/2018/06/20/white-plains-first-electric-school-buses-new-york/698067002/
[3] Costs Associated With Propane Vehicle Fueling Infrastructure, United States Department of Energy, August 2014
[4] https://afdc.energy.gov/fuels/propane_locations.html#/find/nearest?fuel=LPG&location=Bethlehem,%20NY

numbers of lithium ion batteries would be a critical conversation with local and regional fire services[5].

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[5] https://www.bloomberg.com/news/articles/2019-03-25/tesla-fires-what-first-responders-don-t-know-about-fiery-evs

Bethlehem CSD Bus Route Analysis

The purpose of this section of the report is to comprehensively review the bus routes operated throughout the 2019-2020 school year in order to determine any opportunities to improve efficiency throughout the operation. In addition, a tertiary purpose of this report is to determine the transportation impacts of shifting the High School bell time to an 8:00 AM start time. The results will be focused on the opportunities for efficiency in the longer term, as well as the immediate needs of the transportation department moving into a bell time change.

As School Bus Consultants (TransPar) and the Bethlehem Central School District (BCSD) have been partnering in a transportation review for several months, the report is organized to first summarize the work performed thus far. Following this review, analysis is structured to present results for both overall efficiency as well as bell time action planning. The report concludes with a summary of our findings as well as recommendations for the upcoming school year and beyond.

Summary of Work to Date

In the Fall of 2019, TransPar presented a report that reviewed the transportation operations in a comprehensive way. While the impetus of the study was to determine possible bell time change scenarios, the results included a thorough review of operations.

The study concluded that there are 92 daily route buses serving a total of approximately 4,879 "planned" students, meaning students who are eligible to ride the bus if they choose to ride. The buses are spread out across three sperate "tiers" or "waves" where high school students are picked up and dropped off first, then middle school, then elementary school. Students attending non-public schools are transported as well, often outside of the tier system as non-public schools can set their own independent bell schedules.

The findings that are most relevant to our continued work with Bethlehem CSD in the context of bell time realignment are highlighted below:

- Despite three tiers or waves of schools beginning and ending at distinct times, much of the fleet is not able to perform a run on each of these tiers. Only 24 out of 92 buses can perform three runs in the morning and three runs in the afternoon. This is due in part to the current bell time alignment, with middle school starting only 74% of the fleet is limited to less than a full day of work across all tiers.

- Utilization of the seating capacity is low across all school levels. At the high school level, bus routes are planned to be over capacity because of the knowledge that many students drive personal vehicles, attend sports or other events after school, or for other reasons do not ride the bus. Despite this proactive planning, average ridership at the high school is 39

percent of available seats, or about 19 seats taken out of the 48 available. For elementary students the average capacity utilization is 33 percent, and 29 percent for middle school students.

- The report praised the department for taking daily counts of how many students are riding on each bus run. This is valuable information that can be incorporated into a more in-depth study of the bus routes. Overall, the assessment concluded that there are some potential improvements to the efficiency of the operation, and that a change in bell times can facilitate the improvements to some degree. The bell time scenario that was chosen for implementation suggests that the fleet can be reduced from 92 buses to approximately 84 buses. This estimate was based on a preliminary analysis, and the continuation of that analysis is included throughout the rest of this report. However, Transpar recommends starting the year with 90 route buses to minimize operational disruptions. TransPar will work closely with the BCSD transportation team during the 2020/21 school year to identify bus reduction opportunities.

Bus Route Efficiency Review

The bus route analysis continues with a route by route review of how each bus is scheduled throughout both the morning and the afternoon. The process involves evaluating groups of trips scheduled to take students to an individual school. We evaluate each school as a standalone operation in order to understand whether it's possible to serve the current ridership with fewer buses. In the example below we are reviewing trips for Hamagrael Elementary in order to identify those with less than 75 percent ridership and under 25 minutes of total travel time. These thresholds are chosen because they suggest that there is available seating capacity on the trip, and there is available time to continue driving in order to fill those available seats.

Trip ID	School	Planned Ridership	Total Time
24-B	HAMAGRAEL ELEMENTARY	*73%*	*0:21*
22-B	HAMAGRAEL ELEMENTARY	*73%*	*0:22*
70-A	HAMAGRAEL ELEMENTARY	78%	0:25
23-B	HAMAGRAEL ELEMENTARY	*72%*	*0:31*
30-B	HAMAGRAEL ELEMENTARY	82%	*0:22*
47-A	HAMAGRAEL ELEMENTARY	83%	*0:22*
	AVERAGE ALL HAMAGRAEL TRIPS	**77%**	**0:24**

Figure 1 – Hamagrael Elementary Review of Existing Routes

Figure 1 implies that there are two trips that meet both criteria. In Trip 24-B and 22-B, the ridership is less than 75 percent and total time is less than 25 minutes. Trip 23-B has a 72 percent ridership but a 31-minute ride time. Trips 30-B and 47-A have greater than 75 percent ridership but only 22 minutes of travel time.

The average ridership across all Hamagrael trips is 77 percent. This suggests that there are 277 planned students spread out across the 6 bus trips. According to the counts submitted by bus drivers after each day, the total actual ridership is around 133 students, nearly half of the number of students eligible to ride.

The combination of planned ridership and time; as well as actual ridership and time as reported by drivers; allows TransPar to make some assumptions about the efficiency of routes and design a more efficient network for each building. In the case of Hamagrael, TransPar estimates that 5 buses can serve the same student count, thus eliminating one bus.

The exercise explained above was extrapolated across all of the Bethlehem CSD school buildings and their associated bus network. The results are shown in the figure below.

School Level	Total Buses	Total Planned Riders	Avg. Actual Students	Trips < 25 Minutes Long	Notes
Elementary	37	1633	1108	12	Estimate reduction of 4 trips
Middle	23	1022	511	12	Estimate reduction of 3 trips
High	20	1471	437	3	Estimate reduction of 1 trip
SUMMARY	**80**	**4126**	**2056**	**27**	**Via route redesign, save 8 trips**

Figure 2 – Aggregate Analysis of Existing Routes

Figure 2 suggests a reduction of eight trips throughout the network. Since many buses are doubled up, in that they are performing multiple trips throughout a shift, this does not directly equate to a reduction of eight buses. It is more likely that, if these buses are paired with two trips, it would mean up to four buses could be removed. Removing 4 buses is estimated based upon the 2019-2020 ridership and route structure. Upon making changes to the routes, it is possible that

ridership may change based on the shift in daily routine brought upon by a bell time change. TransPar and BCSD will keep these possibilities in mind as routes are changed.

Bell Time Change and Transportation Feasibility Review
The BCSD Bell Time Committee has been pursuing a scenario that has both the Middle and High Schools starting at 8:00 AM. Because of the difference in length of school day, the High School's day will conclude at 2:31 PM while the Middle School will conclude at 2:43 PM. The Elementary Schools' days will stay the same at 9:20 AM to 3:20 PM. Figure 3 provides a timeline summary of the bell time layout below.
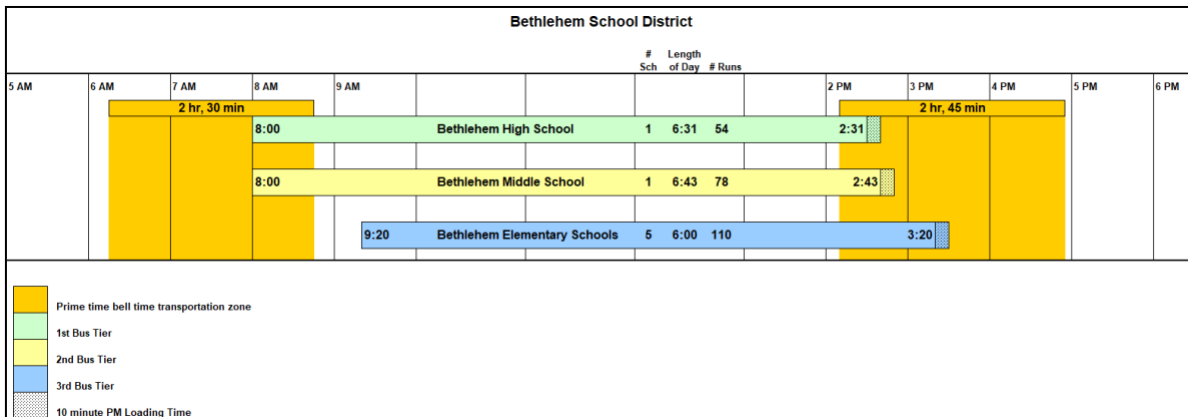
FIGURE 3 – Proposed Bell Time Design

TransPar analyzed every route in order to estimate the total number of buses required for the change. There were several key data points that were reviewed as part of this process. Below are the primary steps of logic taken when reviewing the routes under a new bell time design. The logic was applied to a pairing exercise, the results of which are attached in an appendix to this report.

1. Where are the buses located when they conclude their run, and where do they have to go next? In many cases, such as Eagle Elementary, the attendance boundary is large. While the population of Clarksville is relatively low compared to the remainder of the district area, the buses that go into that section of the district have difficulty turning a second subsequent run.
2. By moving the High School time later, can trips still be paired into groups of two or three under a new design? The average bus performs 3.4 trips in the current route design. If each bus were performing two morning trips and two afternoon trips, the average bus would perform four versus the 3.4 currently. TransPar reviewed the pairings of runs to understand what would be possible and how many buses would be required. The implication is that in many cases, driver hours may change to adapt to the new pairing of trips.
3. Regular education trips must be paired with regular education trips, and likewise for special education trips. The equipment and staffing needs on these trips is unique and

must be kept intact.
4. In this step of the process, no trip times were changed in their total length. A trip that lasts for 30 minutes was assumed to take 30 minutes under a revised bell time. While it is common knowledge that moving bell times later may interfere with rush hour traffic, it is our experience that traffic dissipates as commuters adjust to avoid bell time related bus traffic.

Results and Findings

TransPar believes the bell time scenario can be accomplished using a total of 90 buses with 90 bus drivers. This represents a reduction of two route buses from the current system. The morning is easily accomplished because there is a wide spacing of arrival times. One hour and twenty minutes between the two tiers ensures that every bus can perform two trips. The afternoon is more difficult because after High School dismissal, buses have 49 minutes to perform their trip and return for an Elementary trip. Middle School routes only have 37 minutes to perform the trip and return to an Elementary for the second tier. While many routes are shorter than these two threshold times, it leaves very little room for operational disruption. In the afternoon, unpredictability is more common than in the morning:

- Students dismissing their final class, collecting their things, and taking their seat on the bus.

- Buses leaving without everyone, having to circle back because somebody missed.

- Traffic event in the proximity of school campus, causing a bottleneck at dismissal.

- Mechanical or personnel issue at the onset of dismissal time.

- In the morning, parents, students, and staff file in at a steady pace spread out over 20+ minutes however in the afternoon it is more of a rush to the exit.

The above anecdotes are important to understand when moving forward with the implementation. If they cannot be mitigated, there will likely be more instances of late buses.

In addition to the above findings, there would be substantial change to what each driver would be assigned to do throughout the day. An analysis of existing driver payroll suggests that drivers fall under a wide range of weekly hours. Many drivers only work in the afternoon, and many others work two shifts of drastically different hours such as two morning hours and five afternoon hours. Below Figure 4 illustrates the distribution of staffing.
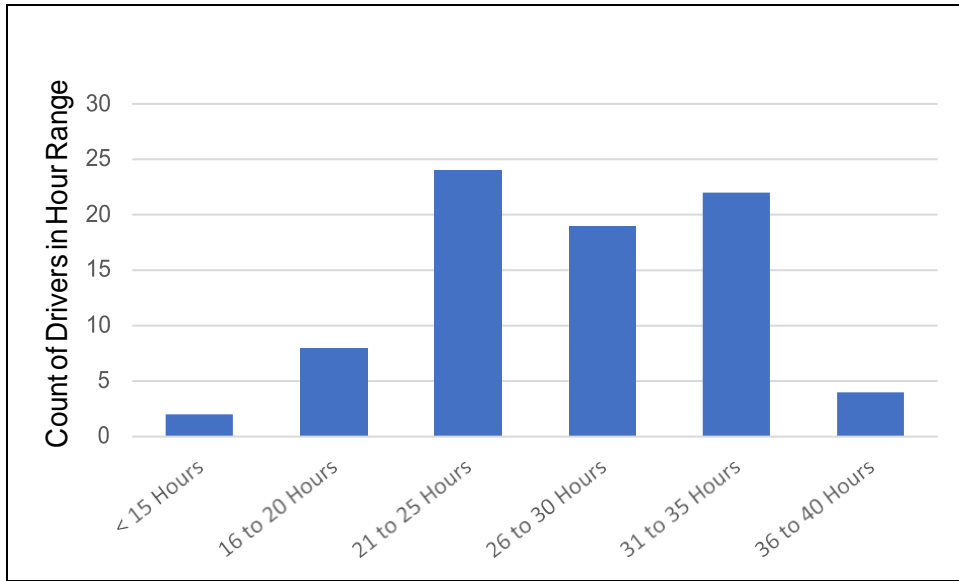
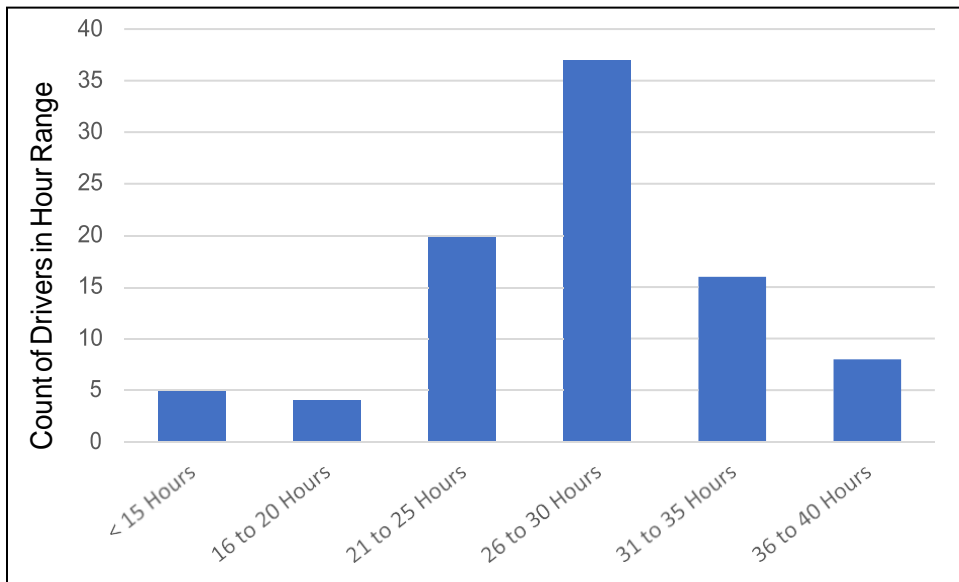**FIGURE 4 – Current Driver Hours Summary**

Figure 5 – Proposed Driver Hour Summary

Figure 5 illustrates that under the new route design, the most significant change is the concentration of drivers in the 26 to 30-hour range. In addition, more drivers are needed in the 31 to 35-hour range and 36 to 40-hour range. While the number of hours drivers may log throughout the week increases overall from 2435 total weekly driver hours now to 2469 in the revised plan, it can be accomplished with two fewer drivers with each driver working more hours on a weekly basis.

Action Plan

The work of making the necessary changes for implementation of a bell time shift can occur over the summer of 2020. The timeline is slightly compromised by the current state of school closures, however many of the steps can be performed remotely.

1. Establish the new routes within the VersaTrans software system for 2020-2021 school year. *This work is ongoing and will continue through the summer in collaboration with Transportation staff. Due to the closure of schools, key dates for student enrollment in BCSD and Non-Public schools must be factored into route design.*

2. Configure a staffing plan for the drivers. With new routes and new workloads, routes may need to be redistributed to drivers in a strategic manner. *TransPar is prepared to work with the Transportation Department and driver labor representation in order to follow proper process in distributing or bidding routes. In some cases, former part time drivers will become full time and in many cases driver hours will increase.*

3. Communicate transportation changes to parents and students. *In many cases, the time a bus drops off and picks up students; the bus number; and the bus driver may change for the 2020-2021 school year. This must be communicated. TransPar is prepared to leverage the route data stored in VersaTrans to assist in facilitating communication to affected families.*

4. Perform dry runs of new routes by drivers throughout the summer. *When building new routes, it is important to ensure that the timing and turn by turn direction are correct. In some cases, new routes must be driven several times in order to get it right. After TransPar presents Bethlehem CSD with a completed route set, the driving staff will perform "dry runs" and work with TransPar on necessary feedback.*

5. Establish the desired key performance measurements and begin recording them upon the start of school. *It is important to leverage GPS technology in order to monitor timeliness, as well as other factors such as speed, diversions from assigned route, and idle time. TransPar can provide examples of reports summarizing key performance indicators (KPI) using manual entry data until GPS is installed.*

The above list of actionable items represents TransPar's goals as we enter the late spring and early summer planning periods. With the onset of school closures as a result of COVID-19, it is important to work collaboratively with BCSD in order to establish key deadlines and stick to plan. The positive working relationship that has been established with BCSD is appreciated, and TransPar is excited to continue being a part of this important endeavor.

BCSD Technology Assessment

Routing and GPS

Overview:
The goal of a routing function of a transportation department is to plan and provide safe and efficient service to students. By using routing software, routers can determine the shortest, fastest and safest routes to transport students. Routing software manages all the students, runs, routes, schools, and fleet activities within one central database. Based on the school district policies, the software determines which students are eligible for transportation. Organizing, developing, and testing efficient routes is accelerated through routing software. Routing software also assists users by determining how many buses are needed to transport students, taking into account constraints like:

- Hazards
- Geography
- Grade level
- IEP directions
- Traffic

These constraints are often built into the database or plotted on a map upon which routes can be designed. The routing software program supports all operational functions and staff responsibilities of a transportation department including the department manager, operations supervisors, dispatchers, and the drivers themselves. In addition, the data stored in the routing software can store and report information that is relevant to other stakeholders such as administrators, school building personnel, and parents.

GPS Technology:
Global Positioning Systems (GPS) technology over the last decade has integrated into our daily lives. GPS enabled devices are in our cars, in our phones, on our bikes, and on our school buses. Today, GPS units provide far more than just directional navigation, the benefits for utilizing GPS-enabled school buses include:

- **Route Planning and Analysis:** With data provided by GPS, you can view the route taken versus the planned route, including traffic and bus stop trends, and all route delays. Tracking historical route data makes it easy to analyze suggested route changes or tracks this data for route optimization studies provided by an outside vendor.

- **Improved Bus Maintenance:** With accurate mileage reporting, technicians can properly upkeep maintenance schedules, thus reducing bus downtime and unforeseen breakdowns.

- **Performance Accountability:** Being accountable to parents and students for your transportation performance is important. GPS units enable managers to assess consistently late routes, lengthy bus stops, under-utilized bus stops, and how long the school bus door was open during each stop. GPS performance data streamlines performance benchmarks, enables improvement, and helps improve overall customer service.

- **Environmental Responsibility:** GPS-equipped school buses record engine idling and speeding, so your district can develop targeted driving behavior training focused on reducing these incidents.

- **Safety & Security:** The safety and security of the students is the most important aspect of student transportation; with that comes *assurance* of a particular student's safety. If a parent calls the district to enquire about their child's bus, bus location information can immediately answer those questions.

- **Cost-Savings:** Off-route detours often use more gas than a standard route. With GPS on school buses, you can measure excessive idling and unplanned route detours.

- **Payroll Planning:** See exactly when the buses start to roll and when they return at the bus depot. Telematics data from your GPS can sync with your payroll and scheduling system to more effectively manage costs and staffing.

GPS units help set clear performance benchmarks by which you can judge and improve your system.

BCSD System Use:
Based on interviews and observations with the BCSD staff, the VersaTrans system is being used as a database to store information about the bus routes. The capabilities of the VersaTrans software to be leveraged as a planning, designing, and monitoring tool are not presently being utilized. Some of this is due to the lack of GPS tracking functionality.

There are many components that make up an effective routing system. These are explained below along with a summary of how BCSD employs each of them for the purposes of their operation:

Dataset	Example Attributes	Source of Data	Observation of BCSD
Students	Name, Address, School of Attendance, Special Education Requirements	This data is typically downloaded from the district student information system on a daily basis.	A regular student data exchange is occurring however some information is missing, notably IEP information.

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TABLE 1 – Route Database Summary

Dataset	Example Attributes	Source of Data	Observation of BCSD
Schools	Name, Location, Grade Range, Bell Times, Bus Arrival Times, Program Offerings	Data is typically entered by the route planner, software support, or other department management. School information does not often change.	All schools are loaded into the database and all of the information fields are complete.
Fleet	Vehicle Identification, Make, Model, Capacity, Year, Inspection, Assigned Driver, Special Equipment	The fleet management staff, or route planning staff can enter information.	The system does not contain complete fleet information, and many routes are assigned to incorrect bus numbers. Other buses may be performing the route in actuality.
Stops	Description, Location, AM Time, PM Time	Stops are created by route planning personnel and can be changed from year to year, or even within a given year depending on enrollment.	The system contains all bus stops and associated schedules. Due to the lack of GPS validation, the schedules are static and estimated by algorithm.
Runs	Begin Time, End Time, Stop Listing, Student Listing (Roster)	The runs are built from a combination of stops. Stops have students assigned to them, and then the stops are assigned to a run thus providing a roster and schedule for a given run.	The system contains all bus runs as designed by transportation management.
Routes	Begin Time, End Time, Run List, Fleet Information	The routes are built from a combination of runs. When a runs' start and end times allow one run to be completed, and then linked with a subsequent run to be performed by the same bus. This forms a route.	The routes are contained within the software and are used to generate turn by turn directions as well as driver schedules for payroll.

As shown in Table 1, while many functions of the VersaTrans routing software are being utilized, there is room for added functionality. The core functionality of the current VersaTrans data is used to support the following tasks:

- Creating turn by turn directions for drivers;
- Creating bus rosters for drivers, schools, and state reporting;
- Providing data required for state reporting such as mileage; and
- Providing lists of bus stops and bus routes for stakeholders wishing to know the appropriate bus and stop assignment.

The data stored within VersaTrans must be maintained on a more frequent basis if BCSD were to expand on the functionality of the software. When maintained more frequently, improvements to the following data points allow for improved functionality:

- Daily transfer of student information including address, school enrollment, and special programming;
- Daily transfer of special education information such as IEP requirements;
- GPS fed information regarding vehicle timing at its designated geographic locations such as bus stops and school driveways; and
- Fleet management and GPS collaboration in order to assist with proper assignment of vehicles to routes, maintenance planning, and capacity planning.

Routing software is most effective when paired with GPS units. GPS data allows users to determine if buses are following prescribed turn by turn directions and allows managers to see what is impacting performance. An important ancillary benefit of routing software is the ability to eliminate routes based on scenario modeling that identifies inefficient routes and allows users to quickly create or update an existing route.

Modern GPS systems lower maintenance and fuel costs by collecting engine, tire and system data. Notifications are provided when there is a potential maintenance or system issue. GPS telematics provide data supporting the operation by allowing for:
- Early detection of engine issues
- Engine diagnostics and alerts
- Prioritization of repairs and maintenance scheduling
- Reduction of fuel costs by identifying aggressive acceleration and idling
- Notifications to inform of harsh braking, acceleration, and speeding

Additionally, GPS systems can assist in the route planning, design, and reporting functions of a transportation department. This is made possible by providing location and telematics data organized in a way that allows for:
- Actual arrival time at bus stop locations and school drop-off locations
- Actual times that buses depart and arrive at the bus parking lot
- Instances of amber and red-light activations, as well as stop arm and door opening activations
- Deviations from the planned turn by turn route as designed by the routing software

The above items help paint a picture for what types of activities are occurring and compared against the planned activity. These data points are not intended to "catch" bus operators in the wrong, but rather to inform the planning and operations functions of the department. Routes are designed from a computerized map, and as such the speed of a vehicle is largely estimated. The resulting schedule of stop times and arrival at school times is developed by an algorithm and then validated by a route planner. Having actual data reported from many days and weeks of operating a route can better inform the schedules and improve customer service. The data can also be used to address driver schedules and resulting payroll, deviations from the route, excessive idling, and other behaviors that can be corrected by management.

Bus Tracking and Parent Facing Application:
VersaTrans maintains a feature that allows parents to view information regarding their students' bus routes, bus stops, and related schedules. This information can be static data from an established bus schedule as well as a live time approximated bus arrival based on GPS tracking. At present, the static format is the only portion of the functionality that can be used by BCSD due to the lack of GPS integration. The addition of live data to the parent facing application can drastically increase service quality and reduce calls into the transportation office for information.

It is important to note that when rolling out something like this to the public, two main validation points must be completed before it is released:
- A security protocol must be established so that parents can only view data pertinent to the bus(es) that their children utilize. This can be accomplished by establishing a process for user sign-up and validation.
- Data and data feeds must be validated by the operation before moving to share data with the public. For example, if a bus schedule is incorrect to begin with, the system will think a bus is off schedule every day, and the public will see this. Another example of this validation is that all buses must be linked to their correct route otherwise parents will view the wrong schedule. When buses are taken out of service for repair or maintenance, the substitute bus must be added to the route so that application users see the updated bus number that is substituting for the repair vehicle. BCSD currently doesn't have the people or processes in place to ensure accurate data is available for a parent facing application.

The technology behind GPS systems can promote operational efficiency as well as customer service within the BCSD. The parent facing bus tracker application is one example of the improved customer service. As such it is recommended that BCSD pursue the expansion and roll-out of this system at some point in the 2020-2021 school year as part of the planned engagement of TransPar contractual support.

Recommendations:
TransPar has several recommendations that begin with and are hinged upon the first and primary recommendation. ***It is recommended that BCSD work with the GPS vendor in order to establish the ability for BCSD***

to retrieve and manage data reported through the GPS systems. Upon establishing this data exchange, the following recommendations can be followed:

- Establish a position within the transportation department dedicated to "Routing and Reporting." This position will plan and execute the bus routes at the onset of every school year, a responsibility that had previously been shared by supervisors of the department. Additional to these responsibilities, the router will be responsible for:
  - o Day to day maintenance of all bus routes;
  - o Inquiries from various stakeholders regarding information pertaining to route schedules, rosters, stop locations, and other related attributes;
  - o Reporting to the necessary stakeholders on predetermined performance related data points; and
  - o Lastly working collaboratively with dispatchers, bus drivers, and other transportation staff in order to maintain the most accurate and up to date information within all transportation databases.

  TransPar recommends this position be filled as early as the 2020-2021 school year. TransPar offers TransPar's contractual support in order to establish this position and build regular reporting into the department functionality.

- *TransPar recommends that regular and routine reporting is established and developed within the culture of the transportation staff and upward to district operations administration as needed.* Reporting from the routing database and GPS database can and is recommended to include the following:
  - o Total driving time versus planned driving time for every route
    - ▪ Informs payroll and scheduling functions
  - o Schedule adherence for every route, targeting a 98 percent on-time rate
    - ▪ Informs scheduling and route planning functions
  - o Daily mileage reporting for every vehicle
    - ▪ Informs maintenance in order to plan and predict preventive maintenance schedules
  - o Aggressive braking, acceleration and speeding
    - ▪ Informs supervisors to correctable driver behavior and can benefit insurance rates
  - o Deviations from turn by turn directions
    - ▪ Informs route planners and supervisors to possible alternate directions, construction blockages, or other events on the roadways
- In addition to the internal operations support that live GPS tracking can provide the department, the VersaTrans software contains a parent facing application to track buses and receive live time arrival information. *TransPar recommends the GPS data management begin in the Fall of the 2020-2021 school year in order to validate data and functionality. Subsequently, a timeline to roll out a parent facing application can begin.*

SIS, IEP and Routing Systems

Student Data and IEP Information
At present, the student data file is not updated on a regular basis to include student information pertaining to IEP and other special needs. VersaTrans maintains the ability to store this information and share data on a regular sharing cycle with the student information system (SIS).

The following process can be used:
- The SIS notes a change in any student's record, or any new student record being created;
- The SIS sends this information to the routing software program (VersaTrans) overnight on a daily basis;
- The transportation staff receives a report of all student record changes from the night before, and makes the necessary changes to bus routes, bus stops, and bus rosters; and
- The VersaTrans database then sends this updated transportation information to the SIS overnight daily thus ensuring that within a span of three business days, both the SIS and VersaTrans databases contain the same student information that assists each respective end user (transportation staff, administration, faculty, and student's family).
- Add bullet regarding IEP and expected data flows

This cyclical exchange of student information is helpful for the planning of transportation bus routes in that any specialized equipment, bus stop information, schedule information, and any other information can be readily exchanged to ensure proper transportation service. Special education students often experience changes throughout the year so having a well-established process for data exchange is helpful to all involved. Special Education staff and administration will benefit greatly by having all transportation information stored in a single and centralized location. Instead of maintaining manual documents and spreadsheets, approved staff can log-in to their account and search for information by student, by bus, by school, or other filtering options.

Recommendations
TransPar is actively working with representatives from Tyler Technology to pinpoint the issues that are preventing data from flowing in and out of Versatrans. Once the technical issues are resolved, TransPar will coordinate with managers of the IEP, SIS, and Versatrans systems to review their data requirements and ensure processes are working as planned.

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Dispatch, Time and Attendance, and Payroll

Overview:
In student transportation, driver wages account for 45-55 percent of most operating budgets, and wages for operations staff can bring this total to 60 percent or higher. This places considerable emphasis on the ability to accurately control costs through an efficient and effective time and attendance system, which is a combination of three key components:

Personnel
- Dedicated and professionally trained personnel must oversee this function
- Comprehensive understanding of all BCSD and State operating protocols
- Intimate knowledge of daily routes and driver schedules
- Ability to manage a diverse group of hourly employees
- All employees must be trained to record time using a timesheet or preferably a timeclock

Policies and procedures
- Clear and concise regarding all aspects of timekeeping and scheduling
- Reconcile scheduled versus GPS/actual (time and costs)
- Coordinate with appropriate personnel to adjust planned schedules
- Policies in place to manage absenteeism

Technology
- Utilize routing software to determine 'scheduled' driver time
- GPS and timekeeping system to determine 'actual' driver time
- Timekeeping, routing, GPS and payroll interface preferred

Time and Attendance/Payroll
BCSD lacks the technology systems that integrate routing, GPS, and payroll data and would enable supervisors and managers with the ability to actively and accurately monitor scheduled versus actual hours worked for all hourly employees. BCSD uses manual timesheets and the "honor system" to manage payroll. The form below shown on Figure 5 is submitted to payroll for review and processing.

Figure 5 BCSD Timecard

The manual timesheet makes it incredibly challenging to identify if drivers are padding their timecard with extra time or submitting timesheets for activities/trips that were shorter than planned. Transportation departments that have GPS devices are able to validate daily schedules and manage exceptions by adjusting paid time prior to payroll. ***Without Timeclocks and GPS data, BCSD lacks the checks and balances to validate the accuracy of payroll.***

Dispatch
Dispatch is essential and critical role that manages the transportation departments daily operations. Dispatch best practices involve the use computer-aided dispatch/automatic vehicle location systems. These systems act as the central software used by dispatchers for operations management. Particularly, the core uses are as follows:

- Dispatchers can receive real-time updates on fleet vehicle locations.
- Dispatchers can monitor schedule and route adherence based on real time bus location.
- Dispatchers can leverage the capabilities of the systems to address on time performance and related issues.

The BCSD Dispatch team operates vacant any substantive technology systems. The team does interact with Versatrans to make routing changes, address changes, student drop off changes. However, BCSD Dispatch lacks the technology to effectively manage operations and enhance customer service and internal/external communications.

Commendable. Dispatch at BCSD is primarily conducted using manual processes and is dependent upon the local knowledge of the two-person dispatch team. The dispatch team performs readiness checks to ensure drivers are not impaired in any way and are fully fit for duty. The team successfully manages a fast paced and high stress environment where they handle substitute drivers, out of service vehicles, field trip scheduling, incidents, and communicate with drivers on their routes. The team shows excellent organizational skills and is intimately familiar with all routes, the district, and BCSD transportation policies and procedures.

However, BCSD Dispatch lacks the data and supporting technology to address common operational questions such as;

- When did the bus actually leave the yard vs scheduled?
- Was the bus on time to first stop? To school?
- What time did the bus return vs scheduled?
- What time did the driver clock in/out vs scheduled?
- What should the driver be paid (scheduled vs actual)?
- Did a driver clock in or out early?
- Why was the bus late to school? To a bus stop?

The BCSD Dispatch team would greatly benefit from technology that enables better transparency of daily operations and provides the data to evaluate and improve operations.

ByteCurve is a software dedicated to student transportation that integrates formerly disparate dispatch, time/attendance, and payroll processes. A comprehensive operations and data analytics platform that enables greater reliability and efficiency in operations via the system's robust scheduling, dispatch, and time and attendance functions. The system works in coordination with GPS and routing systems to harness the power of your existing data enabling BCSD to make data driven business decisions. The platform allows for direct analysis of issues specific to BCSD. The system's primary benefits include:

1. Proactive management of daily routes / tasks assignments.
2. Measure and improve on-time school arrival.
3. Improve route efficiency by reviewing and eliminating "dead stops", ability to quickly update routes and run, and ability to review and optimize routes.
4. Enable efficient use of assets – system allows users to quickly identify and reassign assets with low productivity / usage.
5. Provide data and system controls that enables managers to better manage task exceptions.

Dispatch tools include the ability to view the actual stop by stop route of the bus vs the planned school bus route. This provides dispatchers with a tool to quickly locate buses and for planning and problem-solving purposes, assess the drivers route for accuracy and efficiency opportunities. On Figure 6 the red icons represent the scheduled route and the blue icons represent the GPS data of the actual route the bus followed. Route replays provide a quick and efficient method to assess root cause analysis of bus stop and school arrival delays.
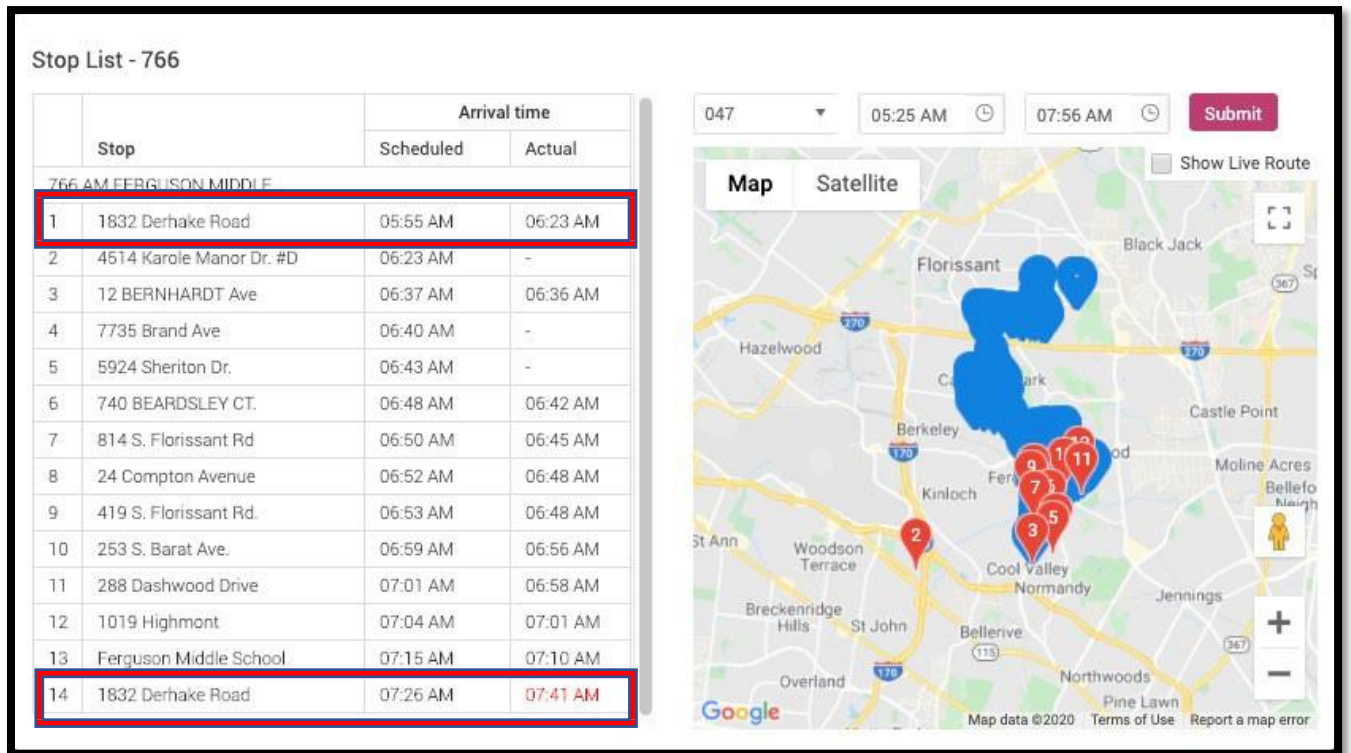
Figure 6 ByteCurve Route Replay with GPS Data

The GPS data provides operations managers with tools to improve performance and payroll managers with the missing information required to consistently pay drivers fairly and accurately.

ByteCurve Reporting

The *reports* section is divided into Payroll, Operations and Dashboard sections. The reports section of ByteCurve comes with several standard reports that will assist users in effectively using the data.

- Payroll reports include labor distribution, daily clock activity, paid hours by task code, and overall location payroll report.
- Operations reports include yard depart times, school arrivals, route schedules, route packages, locations hours etc.
- Dashboard has interactive reports that provide users a quick and efficient method to address operational challenges such as on time performance (schools and stops), route adherence, and stop usage.

Example:

On-Time Performance

The opening graph shows On-Time Performance (OTP) by early, on time and late buses. The system lets users go deeper into the data to better understand what is causing 21.8 percent of buses to be late. Clicking on the red late bus column opens up a new screen that shows OTP by school. From here users can export or continue to review in BC. By clicking on the column header "Late", BCSD can sort the data by most late arrivals.
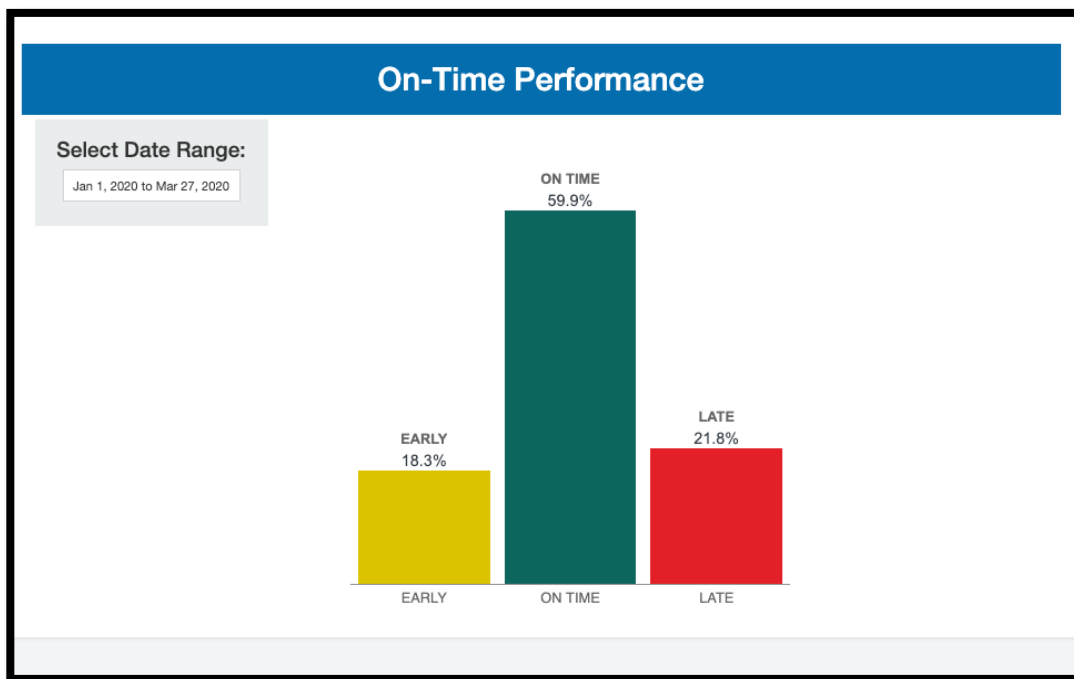
Figure 7 ByteCurve OTP

By clicking into the "Foreign Language Academy" cell the next layer shows late arrivals by route name. The reports continue down to the transactional level where managers can review route level details to conduct root cause analysis of OTP challenges.

Figure 8 ByteCurve Reports

Incident Management

Customer service and communication are critical components to a student transportation operation's success. This mindset applies to service and communication with all drivers, monitors, operations staff, transportation managers, students, parents, campus administration, and district leadership. When drivers in the field experience any kind of difficulty impacting their daily routes, dispatchers are the primary point of contact.   At times, incidents will present themselves which need to be accurately recorded and communicated. In order to assist with the management of these incidents, school districts leverage various technologies to successfully manage and track incidents.

The ability to record, track, and tabulate complaints and accidents in a consistent manner, along with the ability to sort and make reports for internal and external use are overall safety of student transportation department. Figure 9 and 10 provides an example of an Incident Management System(IMS) , the system displays tickets by priority and tracks each ticket based on the creation date, date of last modification, and the code used to categorize the incident. Additionally, the system provides the impact to the daily schedule along with vehicle number, route, school and student.

Use of incident management technology provides greater opportunity to ensure that the most critical incidents, or inquires requiring follow-up, do receive the attention and response they

require. It ensures that a resolution is communicated to the parent, campus administrator, community member, or other relevant stakeholder.

Ticket#	Priority	Created	Modified	Code	Off Schedule Minutes
23999	Important	08/13/2019 12:38 PM	11/06/2019 11:01 AM	Bullying on Bus	25 Minutes
23875	Standard	07/30/2019 03:13 PM	08/11/2019 11:17 AM	Bus Early	15 Minutes
18810	Standard	02/11/2019 05:27 PM	08/11/2019 11:16 AM	Bus Early	15 Minutes
23063	Standard	05/28/2019 11:43 AM	05/28/2019 11:43 AM	Complaint about Employee	Select Off Schedule Minutes
19043	Standard	02/18/2019 10:27 AM	04/02/2019 06:55 PM	Off Schedule-Route	25 Minutes
18784	Standard	02/11/2019 11:25 AM	02/11/2019 11:25 AM	Change of Address	Select Off Schedule Minutes
18724	Important	02/08/2019 10:26 AM	02/08/2019 10:26 AM	Bullying on Bus	Select Off Schedule Minutes
18722	Informational	02/08/2019 09:32 AM	02/08/2019 09:32 AM	Collision-Minor	Select Off Schedule Minutes
18670	Critical	02/07/2019 09:28 AM	02/07/2019 09:28 AM	Bullying on Bus	15 Minutes
12429	Standard	07/12/2018 10:17 AM	02/05/2019 05:25 AM	Bus Breakdown	Select Off Schedule Minutes

Figure 9 IMS Dashboard

Assigned To	Vehicle	Route	School	Student	Employee	Open Days
Allen			Moore Jr High		-	245
-			Highland West Jr	Doe	-	259
Brown			Highland West Jr	soto	-	428
-	124	258	McLain JR		-	322
Ristoff			Academy Central School		-	421
-			Central Junior High School		-	428
-	4601	4601	Central ES	Howlett	-	431
-	4604	4611	Central JR High		-	431
-	4601	4601	Tulsa Tech	Doe	-	432
Allen	4646	4630	Plaza Towers	utley	-	642

Figure 10 IMS Dashboard

A lack of follow-up has the potential to lead to poor customer service to parents, students, campus administration, and district leadership. In the fast-paced environment of student transportation operations, a pattern of poor customer service interactions can lead to a loss of

trust from parents, the district's community, and the district's leadership in the transportation department's ability to provide safe and reliable services at the highest levels possible.

Consistent use of incident management technology clearly documents the transportation department's commitment to not only ensuring that critical incidents and complaints are resolved in a timely manner, but a commitment to better understanding the types of incidents and complaints it is receiving over time, in an effort to eventually make proactive attempts to prevent the same issues from occurring in the future, where and when possible.

There has been minimal investment in processes and systems to manage inbound calls and incidents. There are minimal processes and systems in place to ensure:

- A call was received, and the problem documented.
- The issue or problem is assigned to the right owner.
- The initiator/caller receives a return call/notification with a status of their issue.
- Review of calls/incidents for trends and using data as part of continuous improvement efforts.

Recommendations

TransPar has a custom-built Incident Management System (IMS) built specifically for Student Transportation. TransPar recommends partnering with BCSD to conduct a pilot of the IMS software. TransPar would install, configure, and train users on the software in preparation for school start 20/21. The IMS will improve internal and external communication and enable BCSD to perform routine trend analysis of safety and customer services issues.

Once the BCSD bus fleet is equipped with GPS devices TransPar and BCSD should assess the cost vs benefits for purchasing the ByteCurve Dispatch + Time and Attendance software. TransPar in partnership with ByteCurve can perform a zero-cost pilot to determine if ByteCurve has the ability control costs, improve customer service and enhance daily dispatch operations. If the pilot results in significant cost savings and/or improved customer service then TransPar can assist with procurement and implementation of the software and hardware.

Student Ridership and Bus Onboard Technology

Bus Onboard technology has increased significantly in recent years and the trend continues to grow as the needs of School Districts evolve. During the COVID shutdown, districts across the country are leveraging Wi-Fi enabled buses as mobile hot spots for students. Emerging technologies like telematics to enable predictive maintenance and ambient sensing nodes are now becoming more common in school buses. The following section detail the latest technologies and their ability to improve student transportation operations.
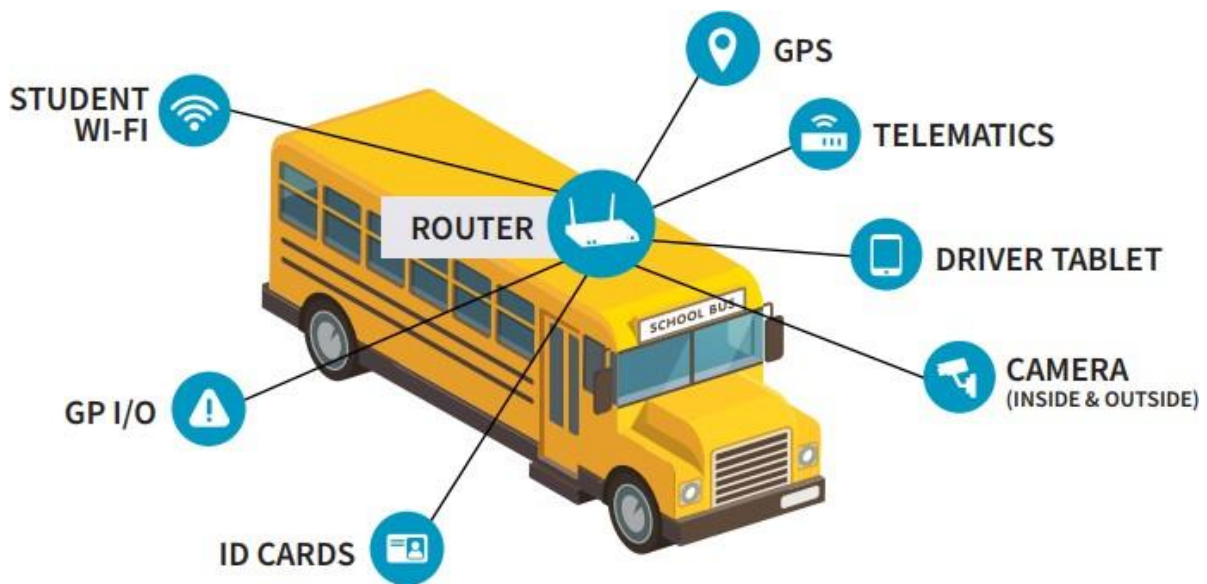
Student Ridership
One of the most important data points to track and manage is actual student ridership. BCSD does an excellent job of manually compiling the number of students on each bus. The data collected is used to better plan bus utilization capacity. However, the manual collection is challenging for drivers, the data is not linked to a database to allow for detailed analysis, and it doesn't provide real time student location data. Furthermore, onboard technologies now include driver tablets that increase safety by providing turn by turn directions and provide Wi-Fi for bus riders. The ability to quickly find and validate where a specific student is can only be achieve by integrating RFID technology to the school bus and pairing with a RFID enable student card.

The ability to track student ridership in real time represents the power of technology to deliver a solution with benefits for parents, drivers and administrators. It provides an extra layer of safety

by preventing students from departing at the wrong stop or entering the wrong bus. Parents feel a greater connection to their students with real-time alerts as they board and depart the bus while drivers have an extra layer of protection preventing students from getting off at the wrong stop. Additionally, managers have a powerful reporting tool essential to tracking Medicaid reimbursements for special needs students.
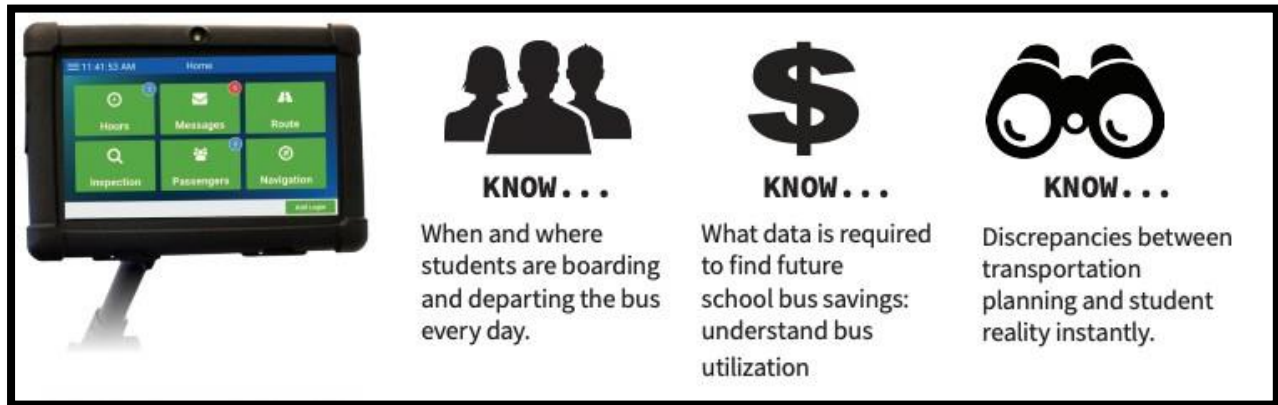
Technology Overview

The leading products on the market are provided by Tyler, Zonar, and Synovia technology firms;
1. Zpass /Zpass+
2. Synovia Solutions
3. Tyler Drive

Essentially the companies that are offering student tracking technology are providing similar functionality. However, the pricing and overall approach vary drastically between the different companies. The following provides an overview of how the software and hardware work together to provide student tracking,

1. **Driver tablets**.   Provides the driver with guidance to each stop and provides visual confirmation that the student entering the correct bus.
   a. Get visual or audio-only navigation directions
   b. Reroute for obstacles or missed stops as needed
   c. Rely on built-in location tracking

   Customer Feedback
   "Our drivers were literally using printed out directions and three-ring binders to keep track of student names, bus assignments, everything. Now, everything will be in the tablet so our drivers can pay attention to the road and not a stack of papers sitting nearby."
   Cheryl Dalton Director of Transportation – Saratoga Springs City School District

School bus drivers typically manage a variety of materials such as maps, student rosters, radios, and operations manuals. The challenge is making the data easy to access while minimizing potentially risky distractions for the driver. In-vehicle tablets help districts increase driver accountability, safety, and efficiency. Tablets allow drivers to better organize their daily tasks and provides dispatch with insight into what's happening and what issues need to be addressed on the road. Tablets replace the need for drivers to rely on their cell phones to access maps, routing, and student information.

2. **Ridership management.** Integrated tracking solutions help drivers know and manage riders.
    a. Shows assigned student information at each stop
    b. Alerts driver to students disembarking at unassigned stop
    c. Track students whenever they enter or exit the bus instantly when they swipe their ID card
    d. Effectively manage daily transportation operations and accurately track ridership
    e. Quickly and effectively respond to and manage emergency situations
    f. Receive bus rider status automatically and immediately (available to transportation personnel, principals, parents and school administration via a secure website)
    g. Continuously optimize bus routes according to ridership
    h. Get security alerts when a student deviates from his or her assigned stop or bus
    i. Network the data for display on more than one computer at a time
    j. Provide access to parents for peace of mind when they are concerned with the safety of their children

3. **Mobile time clock**. Eliminate manual timesheets and improve management of driver time and attendance.
    a. Allows drivers, aides, and monitors to log in from the tablet
    b. Helps meet ACA and state requirements
    c. Eliminate extra paid walk from bus to clock time
    d. Manage early and late clock in/out of hourly employees

4. **Driver Management**. Assists transportation staff manage operations from anywhere.
    a. Provides access to assigned routes and student information
    b. Sends messages from managers to drivers
    c. Reduces distractions caused by paper route sheets
    d. Tracks inspections and driver signatures

Bus Wi-Fi

As more school districts implement digital learning initiatives requiring students to complete online assignments outside the classroom, students who lack internet access at home will fall further behind their classmates. Bus Wi-Fi extends the classroom to the school bus with safe, CIPA-compliant Internet access for students. Leading providers equip school buses with 4G LTE connectivity preconfigured with CIPA-compliant, education-only filters, keeping students focused only on approved educational websites and application.

Kajeet is leading provider of Wi-Fi systems for the K-12 market. Kajeet technology controls all filtering, data management, and routers. With plans designed to fit the unique needs of individual schools and districts, Kajeet Education Broadband is compatible with all industry-standard, Wi-Fi capable devices across all operating systems. The Kajeet Sentinel cloud portal analyzes and categorizes millions of new URLs every day and provides customizable filtered Internet access to keep students focused on homework. This means schools and districts can filter out both inappropriate and non-educational content and reduce unnecessary use of bandwidth, which drives down costs for the entire program.

Kajeet provides detailed views into usage, destinations, and management of student limits or bandwidth. The system also can run or schedule reports that allow users to view data usage totals and web traffic activity for district owned devices. Kajeet provides the ability to pool and share data among buses. The data is then pooled and placed in the account, available for use across all buses. Data does not expire and rolls forward each month. Additional data can be added to the account at any time.

- Student Usage: Manage data consumption limits per bus and per fleet. Time-of-day management and access controls allow you to further customize, monitor, and control student usage.

- Web Filtering: Blocks other protocols, applications, and security features such as intrusion detection and threat prevention.

- Wi-Fi Bus drivers can use Wi-Fi when the bus is stopped—for example, during field trips or sporting events. They can also connect a driver-specific tablet to Wi-Fi.

Data Router

A router provides the bus with Wi-Fi connectivity. Bus specific routers are required to work effectively in the unique environment of a passenger vehicle and to meet the specific requirements of a connected school bus. Ruggedized routers with the latest LTE Advanced capabilities, 3-in-1 or 5-in-1 antennas aggregate multiple bands and provide GPS while managing a local Wi-Fi and Gigabit Ethernet network.

These rugged style routers used in police and first responder vehicles and utility and service vans, with the added capability of supporting up to 128 simultaneous Wi-Fi clients.

Leading technology firms like Kajeet provide districts with the ability to choose two wireless carriers and switch between networks based on coverage needs. If one network is stronger than another in certain areas of the district, the router will switch to the stronger network.

Cameras

Commendable. BCSD effectively employs SEON cameras to identify bullying, vandalism, student discipline problems, and driver safety issues. The team is continuing to order new buses with SEON cameras and has a defined process for collecting and reviewing video footage to make informed decisions regarding bus incidents.

Camera systems today not only monitor student behavior and driver performance inside the vehicle, they can also be used to record what's going on outside the bus, providing all-around enhanced safety and security. ***BCSD should consider upgrading to the SEON cloud environment which provides:***

- Archived Storage/Digital Video Recorder (DVR) Mobile DVR can capture and store footage of both the internal and external environment as well as signals from the bus, including braking, turning, warning lights, and stop-arm deployment. With archived video footage, administrators have well-documented evidence for identifying problematic student behavior and investigating incidents without having to rely solely on personal accounts.

- Real-Time Access Closed-circuit television systems have been used by buses for years, but one feature they can't easily offer is the ability to review video footage in real time. A bus equipped with a wireless IP video system allows for real-time access with remote reviewing, essential in the case of an emergency when an immediate response is critical.

Additional Bus On-Board Technology

EVIR – Enhanced Vehicle Inspection and Reporting

A handheld device records the daily pre-trip inspection and alerts dispatch and the maintenance team of any variances. Through a direct interface with our vehicle maintenance system, mechanics are notified when a repair is needed.

Crossing Control Arms

A bright yellow arm mechanically extends in front of the bus bumper when loading or unloading students. It reminds students to move to a safe distance in front of the bus before crossing and to stay out of the danger areas.

Sleeping Child Prevention

The Child Check-Mate System® requires the driver to walk through the bus and check for sleeping children. Failure to follow procedure triggers visual and audible alarms. Interior motion sensors further protect against unauthorized persons on the bus. This technology is not needed if BCSD decides to invest in a student ridership and management system. Drives would be alerted by the on-board driver tablet if a student didn't leave the bus at their assigned stop.

Recommendations

The expansion of bus on-board technologies provides a number of innovative capabilities to drastically improve transportation operations. However, the pricing for just the Driver tablets and Student Ridership software/hardware under a 5-year contract range from $300,000 to $525,000. After the upfront costs the annual cost for service is approx. $60,000 - $70,000 a year. The Kajeet Bus Wi-fi system is approx.. $700 to $1100 per bus per month.

TransPar recommends partnering with BCSD to develop a prioritized list of their technology needs. Once established, we recommend issuing an RFP out to technology vendors to collect proposals that cover the vendors approach, services and pricing. For future bus purchases BSCD can start to request some items such as, Wi-Fi, GPS, Cameras. TransPar recommends a phased implementation of any new technologies to minimize costs and to not overwhelm the transportation staff.

1. Identify specifications and requirements for each software.
    a. GPS
    b. Driver Tablets/Student Tracking
    c. Bus WIFI
    d. Camera Upgrade
    e. EVIR
    f. Crossing Control Arm
    g. Sleeping Child Prevention
2. Develop and disseminate RFP for Student Transportation Technology
3. Collect and evaluate responses

Alternatively, BCSD could select some of the lower cost technology items to conducted pilots to further explore the products and assess long term needs and use of the technology. Items like WIFI , Crossing Control Arm, Sleeping Child Prevention or good candidates for pilots.

TRANSPAR

Fuel Management

Managing Fuel Costs

Transportation directors have little control over what is the second largest cost item in most budgets: fuel. Fuel costs can be unpredictable as they're impacted by several environmental factors, such as the state of the economy and foreign trade agreements. A best practice is to assess your current situation and control what you can control and let the market address price concerns.

Controlling what you can control:
Basic economics tells us that the more buying power we have the better price we get. This is true, but only to a certain extent, in how you purchase fuel. The following are some best practices for fuel purchasing:

1. **Enter or establish a fuel buying cooperative**: When a collection of school districts enters into a cooperative, it vastly increases their buying power by pooling their potential volume.
2. **Share services with other local entities**: Jointly acquiring infrastructure and fuel through surrounding agencies including cities and counties also provides additional volume for cost control.
3. **Establish a formal bid for fuel**: The idea of bidding for a projected volume of fuel is less common in school district operations than in municipal operations. These contracts do not necessarily take all the volatility out of fuel prices, but it does help to control overhead costs.
4. **Change the fuel drop amounts**: The impact of volume pricing is evident at both the macro and micro level. Given that a substantial portion of the cost you pay is associated with transporting the fuel to you, the more fuel you buy, the lower that cost is on a per gallon basis. For example, if you were able to upgrade from a 5,000 to a 10,000-gallon fuel tank and transport costs remained the same, the per gallon cost of transport would be cut in half. Implementing this strategy may require expensive capital upgrades that would have to be balanced against projected reductions in transport costs to determine if the effort was worthwhile.

Control points in the fuel management function begin with how you acquire the fuel and end with how you analyze your use of fuel. A focus on how you purchase fuel can help reduce your exposure to both market volatility and the burden of overhead costs. While certainly no substitute for substantial reductions in price, these approaches can help you reduce the total costs.

TRANSPAR

Importance of Fuel Management Systems

Fleet maintenance
A fuel management system helps you track data on fuel usage for individual vehicles, whether through refueling patterns or automatic tank monitoring. If one vehicle's fuel usage is especially high, your fuel management system will detect that instantly, allowing you to immediately schedule a maintenance check and resolve the problem.

Optimize fuel usage
How and where your employees drive makes a difference in fuel usage. The ability to track driver behavior and determine who might need more training or suggestions to lower fuel consumption.

Ensure compliance
CO_2 emissions are regulated and making sure your fleet adheres to emission standards is vital both to minimizing liability and decreasing your overhead costs. Tank gauging systems can also indicate when a containment sump might be failing so the issue can be addressed ensuring your vehicles aren't environmental hazards and are in compliance.

BCSD Fuel Management Systems – Petro Vend

Petro Vend Fuel Island Terminal
The terminal includes modular options that make it scalable for a wide range of unattended fueling needs. Petro Vend provides 24-hour fuel control to unattended BCSD fleet fueling operations. The terminal includes dual card reader operation, an alpha keyboard, and a receipt printer. According to Petro Vend, "The PV200's 'future-proof' functionality offers flexibility to keep up with changing management and reporting needs.[*] The PV200 features a thermostatically controlled heater and aluminum construction, which provides for reliable operation in harsher outdoor environments.

Recommendations
TransPar recommends BCSD review their current fuel management system to determine if an upgrade is needed. If the current Petro Vend system is providing the necessary reports and the system is working as planned to disperse and manage fuel, then there is no compelling need to upgrade this technology.

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[*] https://www.schoolbusfleet.com/news/726600/opw-unveils-scalable-petro-vend-200-fuel-island-terminal?page=31

TRANSPAR

Fleet Maintenance

Commendable. The BCSD Director of Fleet Management is leveraging Fleetvision software to effectively manage vehicle maintenance activities. The system is used to monitor periodic maintenance, track and review completed work orders and leverage system data to make informed decisions.   The system is being used as prescribed for; preventive maintenance scheduling, inventory maintenance and tracking and work order management.

Currently, BCSD is only lacking Telematic integration to enhance fleet maintenance operations. As described below, integration of GPS and Telematic hardware would enable a transition from traditional preventative maintenance to predictive maintenance.

Transition from Preventative Maintenance to Predictive Maintenance

Preventative Maintenance (PM) is carried out with the goal of increasing an assets useful life by preventing or reducing excess reactive repair costs, vehicle down time, or untimely breakdowns. Preventative maintenance includes, but is not limited to, adjustments, cleaning, lubrication, repairs, and parts replacements. Due to the unique needs of different assets, the type and amount of preventive maintenance required varies. The basic PM process is found below in Figure 11:

| Select Bus | → | Define the PM Interval based on asset specifications | → | Time interval is reached | → | PM task is assigned | → | Maintenance is performed | → | Repeat |
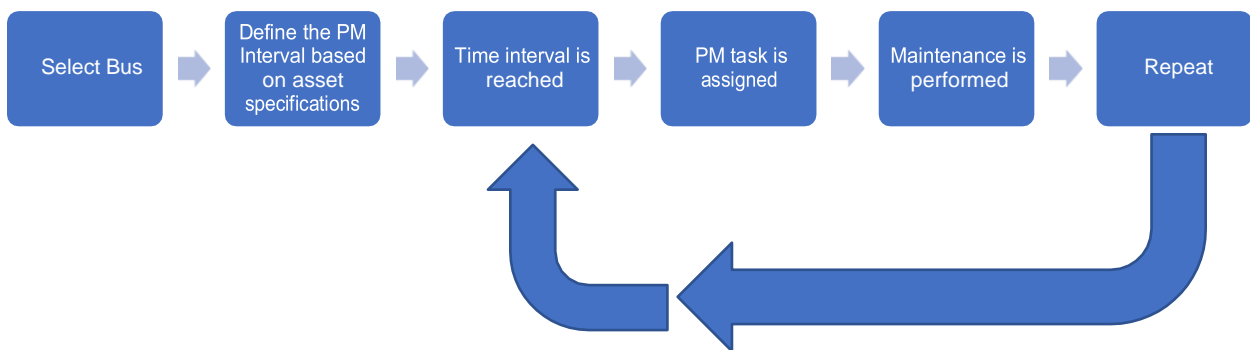
Figure 11 Preventative Maintenance

Preventive maintenance has a major impact on total maintenance costs. With a well-planned PM schedule, Fleet Managers can establish the optimal maintenance zone that minimizes the overall asset costs related to expensive corrective maintenance. However, with emerging GPS and Telematics technology "Predictive Maintenance" is next level of Fleet Maintenance operations. Today, most commercial carriers all use Telematics as a principal component of their maintenance operation.

Predictive Maintenance

Advanced telematics, which connect to all electronics on the bus, allows for the transmission of vehicle data back to the fleet manager. Telematics has the potential to make school buses more efficient, safer, and easier to maintain, leading to a lower total cost of ownership. The key abilities and benefits of Telematics and predictive maintenance are:

1. **Start/Stop Events** Collect and analyze data about start/stop events (i.e. hard breaking or fast starts) to identify and reduce harmful driving behaviors that could endanger students.

2. **Engine Diagnostics** Make informed service decisions within minutes of an engine fault event so that you only service vehicles when needed, increasing vehicle uptime.

3. **Fuel Consumption** Track fuel efficiency to detect potential unsafe driver behaviors. For example, speeding and sharp acceleration are detrimental to the vehicle's fuel efficiency

4. **Engine Idle Time** Reduce fuel costs, emissions, and engine wear-and-tear with systems that automatically record excessive idle time, send alerts to dispatch and fleet managers, and provide fleet managers with necessary data to evaluate driver performance.

5. **Tire Pressure** Get real-time alerts to manage one of your fleet's biggest consumable items and ensure buses operate safely. In addition to pressure monitoring, automatic tire inflation systems can inflate tires whenever the detected pressure is below the target, reducing bus inoperable time.

6. **Impact Sensors** Get immediate notification of an emergency – such as an accident, fire, or other incident – so that appropriate measures can be initiated as quickly as possible.

7. **Vehicle Speeds** In addition to monitoring speeds, new speed-limiting technology can use GPS to automatically limit vehicle speed in real time according to posted speed limits.

Parts Management

A low-cost technology that can offer improved cost control and improve overall organization of the parts room is a Barcoding System.

Barcoding and Handheld Data

Fleetvision has built-in barcoding software that's ready to use out-of-the-box. The barcoding system provides the following benefits to your operation:

- Provides error-free input
- Allows for less manual data entry
- Produces bin tags and parts tags
- Allows for accurate parts inventories

Barcode Scanner

Streamline parts, fluids, and fuel management with a barcode scanner. Wireless scanners provide operations with the ability to easily track parts management and perform parts inventory.

Recommendations

1. Once GPS devices are integrated into BCSD's bus fleet a logical next step is to connect the GPS to Fleetvision. Fleetvision is equipped with GPS hardware and software to collect valuable engine data automatically through the vehicle's On-Board Diagnostic (OBD) port. If an engine fault is reported, the data will be instantly transmitted to the Versatrans Onscreen Collector through your GPS cellular connection. The Collector decipherers the fault code and sends it to Fleetvision where a work order request is automatically created.

   GPS solution's added features include:

   - **Automatic Data Exchange between Tyler Telematic GPS** via Versatrans onscreen interfaces automatically with your GPS equipped vehicles through the OBD connection.
   - **Automatic Creation of Work Order Requests in Fleetvision** - transmit and identify engine faults and automatically create work order requests without manual entry.

2. Integrate a barcode scanner and labels into the Parts Room to improve parts management and improve cost control measures.

Safety and Driver Training

Overview

Pupil transportation is regulated by numerous agencies that place certain requirements and standards upon the industry. It is up to local management to ensure that all applicable rules, regulations, laws, and standards are adhered to. According to the New York State public website the following are minimum training requirements;

NY State Safety and Training Basic Requirements

- Pre-service, safety training, and refresher training for school bus drivers.
    - Pre-services – each driver shall have received at least two hours of instruction on school bus safety practices. Each driver of a vehicle transporting pupils with disabilities exclusively shall have received an additional hour of instruction concerning the special needs of a pupil with a disability.
    - During the first year of employment, shall complete a basic course of instruction in school bus safety practices approved by the commissioner, which shall include two hours of instruction concerning the special needs of a pupil with a disability.
    - During the first year of employment, shall complete a basic course of instruction in school bus safety practices approved by the commissioner, which shall include two hours of instruction concerning the special needs of a pupil with a disability. Each school bus driver shall complete such course within the first two years of such employment.
    - All school bus drivers shall receive a minimum of two hours of refresher instruction in school bus safety at least two times a year.

Additionally, and in accordance with NY Vehicle and Traffic laws under article 19-A there are several specific requirements for bus drivers that require extensive time from Safety/Driver training leads to manage, document and store for audit purposes.

SPECIAL REQUIREMENTS FOR BUS DRIVERS	
Section	**Description**
509-a	Definitions.
509-b	Qualifications of bus drivers.
509-bb	Reexamination of bus drivers.
509-c	Disqualification of bus drivers generally.
509-cc	Disqualification of drivers of school buses.
509-d	Qualification procedures for bus drivers, maintenance of files and availability to subsequent employers.
509-e	Annual review of driving record.
509-f	Record of violations.
509-g	Examinations and tests.
509-h	Operation by person not licensed to drive a bus.
509-i	Notification of a conviction resulting from a violation of this chapter in this state or a motor vehicle conviction in another state and license revocation.
509-j	Compliance required.
509-k	Ill or fatigued operator.
509-l	Drugs, controlled substance and intoxicating liquor.
509-m	Duties of the department.
509-n	Exempt carriers; reporting requirements.
509-o	Penalties.

Figure 12 19A Requirements

Safety and Training
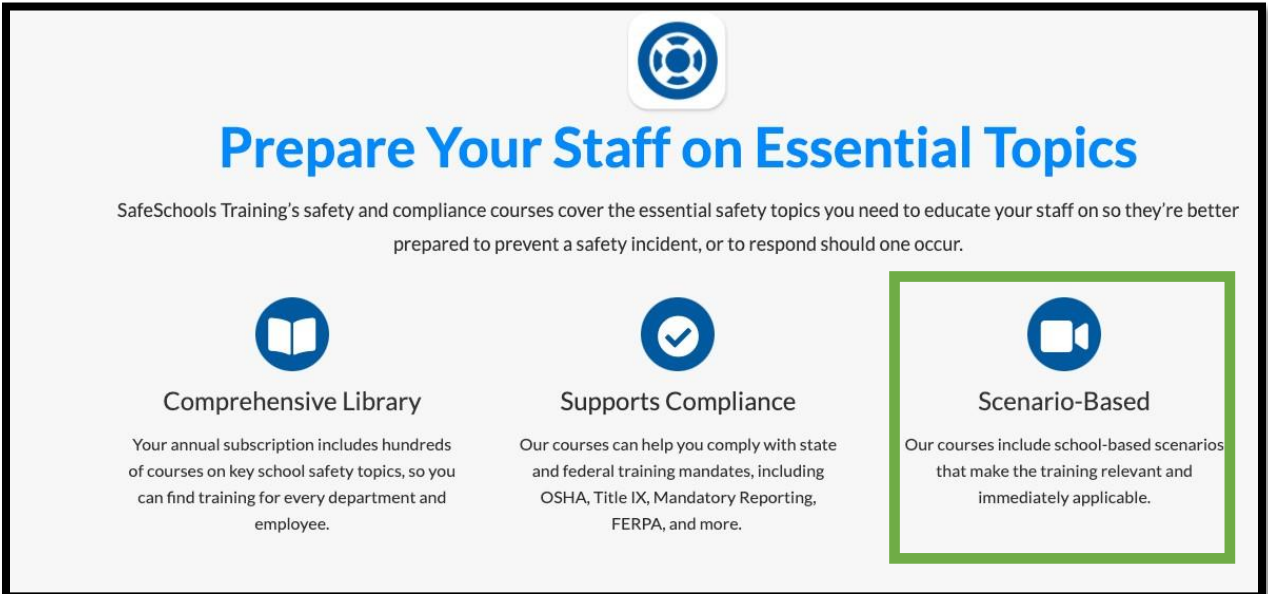
Commendable.
BCSD safety and training has been led by the current director who is also a New York certified student transportation safety and training instructor. The department under her leadership has performed admirably. The department provides targeted training to drivers based on real world situations and uses available accident data to inform driver training.

The Safety/Training lead does a commendable effort managing the various NYCDOE/19A requirements. The safety/training lead is well versed in all compliance NYCDOE safety and training requirements. The Safety/Training lead demonstrates ability to develop strategies to manage both driver training responsibilities and 19A reporting requirements. The process requires a tremendous amount of documentation, attention to detail and ability to organize the information for audit purposes.

Safety and Training for 2020-21

With the departure of the Transportation Director/Safety and Training Lead, the department may need additional training resources and support to continue performing at a commendable level. From a technology perspective, the best practice is to provide training through a Learning Management System (LMS). Using a holistic view of safety as an organizational culture concern BCSD is more likely to increase both compliance and real understanding of the safety lessons provided. Providing a resource for ongoing professional development increases the organizational and individual commitment to safety.

Figure 13 SafeSchools LMS

Learning Management Systems (LMS) are web-based platforms that allow transportation training managers to provide training and information to employees in a wide variety of topics that are easy to access. Critically important is the ability to provide safety training to bus drivers in a way that lets individuals learn at their own pace and review information in a way that

traditional classroom settings do not allow. LMS provides a tracking and certification functionality that offers greater accountability, liability protection, and more customized training opportunities than a traditional papers system.

Recommendation

Consider piloting a web-based Learning Management Systems (LMS) like SafeSchools to provide scenario-based learning courses and compliance training solutions. SafeSchools provides a broad array of high quality and relevant content that makes student transportation safer and lessens the amount of manual management of training related information.

As tracking and documentation of training are so important, we recommend that the classroom training be delivered over the web, via a Learning Management System. This ensures that evidence exists of each driver going through each program. Tracking will include the date and time taken for each subject. The exams taken at the end of each program will ensure the trainee understands all the concepts taught. If trainees are taught in a group classroom setting, the materials can still be delivered via the LMS, either onto a large smart TV or via a projector onto a screen. Each attendee would be entered into the system with times, dates, subjects, trainer, etc., to best maintain the tracking process.

TransPar can create a custom BCSD portal for your use. Included in the portal is online access to all of the new bus driver training modules and extensive library of driver training and safety courses. In addition to the training content, this portal will be equipped to track progress, add or remove employees, and load more content, if desired.
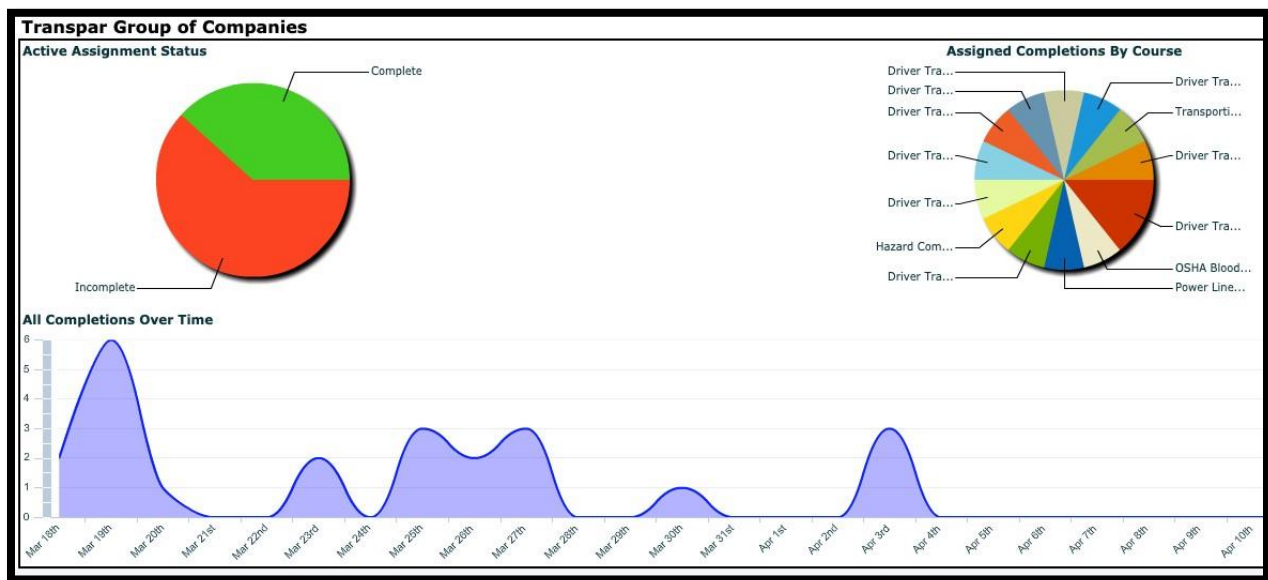
Figure 14 LMS Custom Dashboard

SafeSchools LMS – New Hire Training Plan

Figure 15 New Hire Bus Driver Courses

SafeSchools – Sample - Driver Training Courses

Figure 16 Driver Training Courses

SafeSchools – Sample

Figure 17 Custom Reporting for Compliance

Electric Buses

Since 2015 the school bus industry has seen a considerable increase in the number of Electric Bus pilot programs. Electric buses provide clear long-term financial benefits, but the primary benefits are environmental, and safety related. The U.S. PIRG Education Fund found that switching U.S. school buses from diesel to electric would cut emissions by 5.3 million tons[1]. A study conducted by the New York League of Conservation Voters last year showed that converting the city's roughly 9,000 diesel school buses to electric vehicles would be the environmental equivalent of taking more than 621,000 cars off the road[2]. Take into account that approximately 95 percent of America's school buses, run on diesel fuel. Diesel exhaust is internationally recognized as a cancer-causing agent and classified as a likely carcinogen by the U.S. Environmental Protection Agency. Fine particle pollution from diesel emissions is linked to serious health risks including asthma, cancer, cardiovascular harm, developmental harm, and others. In recognition of the health impacts of diesel emissions, the Diesel Emissions Reduction Act (DERA) was passed as part of the Energy Policy Act of 2005 and, among other things, provides funding to replace vehicles, or improve vehicle engines to reduce emissions[3].

Financial Analysis
The average cost for an Electric school bus is approximately $400,000, which is close to $275,000 more expense than a fully loaded school bus. The price for an Electric bus does not include costly infrastructure for charging stations and batteries. The lifecycle costs of an Electric bus are substantially less than a traditional diesel bus. As shown in Figure 18 the Electric bus fuel costs are minimal at 9.18 cents per kWh vs fuel price that vary but average $2.39 per gallon[4]. Also, Electric buses will greatly reduce maintenance costs. There is minimal annual investment in maintenance when compared to the estimated $20,000 in annual operational costs for a gas-based school bus.

Table 1: Fuel Costs and Fuel Mix used in the Analysis

Key Input	Diesel Bus	Electric Bus
Annual mileage	8,100	8,100
Miles per gallon (per diesel gallon equivalent)	7.7	19.6
Fuel price	$2.39 / gal.	9.18¢ / kWh
Electricity grid fuel mix		Xcel Colorado (2017)

Figure 18 Diesel Fuel vs Electric Bus Costs

Most School Districts that are using or piloting Electric buses are using 3rd party funding from a Federal Grant, environmental non-profit organization, or utility company led joint venture with government support and oversite. As Figure 19 shows the funding for DERA has grown from just $52,000 in 2013 to over $8 million in 2018.

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1 https://uspirg.org/sites/pirg/files/reports/ElectricBusesInAmerica/US_Electric_bus_scrn.pdf
2 https://nylcv.org/

Rebate Funding

Fiscal Year	Total Disbursed	Program
2018	$8.25 million (expected)	School Bus Replacement
2017	$8.20 million	School Bus Replacement or Retrofit
2016	$7.24 million	School Bus Replacement or Retrofit
2015	$6.04 million	School Bus Replacement or Retrofit
2014	$3.94 million	School Bus Replacement
2013	$52,991	Construction Equipment
2012	$1.88 million	School Bus Replacement

Figure 19 DERA Rebate Funding

As shown in Figure 20 there are Federal, State and Non-Profit grant programs are available to help defer the initial costs. In the example below, DERA funding reduces the cost to approx. $200k and with limited future maintenance costs the payback period is only 8 years, compared to over 18 years with a full purchase price.

Payback Analysis - Scenario Development	Purchase Price	Annual Operational Costs, Fuel and Maintenance (based on 15,000 miles annually)	Annual Revenue Generation or Direct Savings to School	Payback Period (years)
Traditional Diesel Bus	$90,000	$20,700	NA	--
Electric School Bus baseline	$349,500	$6,600	NA	18.4
DERA Grant Scenario	$202,125	$6,600	NA	8.0
Joint Ownership, free electricity to schools	$239,500	$3,000	NA	8.4
Joint Ownership, battery lease agreement	$239,500	$3,000	-$2,600	9.9
V2B	$389,500	$6,600	$1,200	19.6
V2G	$462,500	$6,600	$12,000	14.2

Figure 20 Sample of Funding Alternatives

However, Utility companies have become an unlikely emerging leader in providing both initial capital and infrastructure funding to school districts. Dominion Energy in Virginia is leading an effort to put 1,000 electric school buses on VA state roads by 2025[1]. The utility company is offering the pay the difference for the new Electric buses and fund installation of charging stations and other required infrastructure. The utility companies benefit by accessing and harnessing the bus batteries as a resource for its power grid. Company resources say 1,000 buses will produce enough energy to power about 10,000 home for Five (5) hours[1]. In New York a recent pilot program was led by utility firm Con Edison and its interest in using the buses as energy storage assets. Electric bus batteries can store energy when demand is low and discharge it during peak hours to help power the NY grid[2]. According to White Plain officials, a district-wide switch to electric school buses would eliminate 185,000 tons of carbon dioxide annually. Also, Vermont funded an Electric bus pilot by Vermont's $18.7 million share of the Volkswagen Settlement Mitigation Trust, a $2.7 billion national fund set up as part of the resolution of the carmaker's diesel emissions violations of the Clean Air Act[3].

Despite these potential funding opportunities recent case studies show that while the modern technology looks extremely promising, at the current time Electric buses aren't ready for wide-scale deployment. The two major drawbacks to Electric buses are first the cost, defined by the upfront purchase price combined with expense infrastructure required to charge the buses and store batteries. Secondly, the battery and charging technology hasn't performed satisfactorily in recent pilots.

Adoption Challenges
The following section aims to detail some of the adoption challenges that were faced by school districts who have conducted Electric bus pilots.

Harsh Environments
- **Mass schools**. The buses spent a considerable number of days out of service compared to the average diesel bus, with various maintenance problems ranging from relatively minor glitches, such as faulty headlights, to more significant issues. Noted several problems which suggested that more real·world experience with electric school buses would be needed before this technology could be deployed on a national level in school transportation services.[4]
- **Twin Rivers (CA).** Some vehicles were powered by sodium·nickel batteries, didn't function in cold-weather environments. It also emerged that use of the onboard heaters creates a slight drain on the systems and reduces expected charging distance.[4]
- **King County, WA.** Per·mile fuel costs have been higher than for diesel due in part to high electricity demand charges[4]

Battery Range
Most new conventional Electric school buses hitting the market today have a range of around 100 miles. Newer batteries and advanced technologies are currently in development, which will provide extended range at a lower cost.

- **Mass Schools**. A disappointing finding from the evaluation was that energy cost savings

were considerably smaller than expected. In the initial proposal, vehicles' operating efficiency to be 1.3- 1.4 kWh/mile. In reality, usage per mile was higher, at 2.38 kWh/mile.[4]

- **Albuquerque, NM**. Safety and durability issues with its electric buses, as well as subpar battery life, inadequate range and sensitivity to extreme heat, contributed to Albuquerque's electric bus tests in 2018 ending in disappointment.[4]

Recommendations

California was an early adopter to the Electric Bus movement. Unlike most states, CA had the policies, technical infrastructure, and political backing to successfully start transitioning from diesel to Electric school buses. School Districts on the East Coast are behind in terms of the general awareness and education of Electric buses and the programs needed to fund and launch successful pilots. However, major Utility companies are starting to fund and lead pilot programs in NY, NC and VA. If these programs are successful TransPar expects more and broader pilot programs to follow. As the scale increases so do the opportunities for BCSD to obtain funding for a future Electric bus pilot.

TransPar recommends the following steps for BCSD to gain funding and prepare for a potential Electric bus pilot:

1. Check National Grants website for updates to DERA Grant application status, as of this report the application process was closed. Sign up for email notifications.
   a. https://www.epa.gov/dera/national

2. DERA State Grant application process open as of April 2020.
   a. https://www.epa.gov/dera/state#fund16

3. Pursue Joint Ownership Model with Utilities.
   a. Monitor the White Plains SD pilot with ConEdison.
   b. Look for opportunities to join next Utility pilot program

2 https://www.washingtonpost.com/local/trafficandcommuting/electric-school-buses-are-coming-to-virginia/2019/09/07/f69f813e-cf35-11e9-8c1c-7c8ee785b855_story.html
3 https://www.nytimes.com/2018/11/12/climate/electric-school-buses.html
4 https://www.veic.org/docs/resourcelibrary/veic-electric-school-bus-feasibility-study.pdf
5 https://www.eenews.net/assets/2019/10/08/document_cw_02.pdf

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