BOSTON Public Schools Focus on Children

TRANSPORTATIONCHALLENGE
Solving Routing and Bell Times

Welcome!

Welcome to the 2017 Boston Public Schools Transportation Challenge. This document contains everything that you need to know about the 2017 Transportation Challenge. We look forward to seeing your submission and we thank you for helping Boston Public Schools!

-- Boston Public Schools

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The Challenge

Boston Public Schools' (BPS) has a longstanding commitment to provide every Boston student -- regardless of their home address -- with the opportunity to attend a high quality school. We enable this level of school choice by providing transportation for students all across Boston, something which comes at a high cost.

In FY16, transportation costs accounted for $110 million or 11% of the district's budget. On a per pupil basis, BPS's transportation cost is the second highest and more than five times the average of the largest 200 public school districts. Meanwhile, transportation costs have continued to increase, up $33M from FY11, a 7.5% annual increase. While only limited benchmarking exists, a report from the *Council of Great City Schools* found that BPS has higher costs per mile, costs per rider, and costs per bus compared to other similar school districts. To be fair, some of this is due to the structural challenges of Boston. Our city's small and indirect streets pose are a real roadblock to change.

There are, however, factors that we *can* control. But we need your help.

The first of these is the efficiency of our routes. The second is the start and end times of our schools.

Our routing system has evolved since we began busing, when we used pins in a map to represent students and stops, and we connected stops with string. However, we haven't begun to fully incorporate the tremendous potential of advances in transportation and mapping technology. We believe that if we tap into this technology, we will unlock new algorithms and approaches for automating routing and for doing so efficiently and accurately, with just a few clicks of a mouse. ***We hope to use this challenge to learn about new systems of bus routing for future school years. Based on what we learn, we'll announce next steps at the end of the challenge.***

Please note that this challenge is for information and planning purposes only and does not obligate BPS to issue a competitive procurement or award a contract. Your participation or lack thereof in this challenge will have no impact on the evaluation of responses to any future procurement.

Broadly speaking, BPS has three morning school start times -- 7:30a.m., 8:30a.m., and 9:30a.m. -- and its Department of Transportation serves charter, private/parochial, and out-of-district special education-based schools, which for the most part also conform to those times. These bell times, however, are "imbalanced," with more buses serving schools at 8:30a.m. than at 7:30a.m. or 9:30a.m. (there are far fewer at 9:30a.m. than at either of the earlier times). In order to maximize resources, we would like for all of our buses to serve three

schools each morning at each of the three times, but this imbalance causes many of our buses to be used inefficiently (i.e., one or two trips per morning), causing additional and unnecessary costs.

Complicating matters more, is the fact that anecdotally we know that many school communities do not prefer a 9:30a.m. start time, which means we cannot address this imbalance by simply putting more schools at the last of the three bell tiers. Over the last few years we have worked to "balance" our bell times but haven't found an approach that fully works for us while also factoring in school input. ***We need to solve this problem and increase the efficiency of our bell times for the 2018-19 school year.***

This is where you come in: We are hoping that we can reach out to Boston and beyond for your help solving this challenging puzzle with a solution, which we encourage (but do not require) you to open-source. Your expertise could positively impact the lives of nearly 100,000 students and their families across Boston each year. And optimizing bus routes will allow us to shift dollars from the roads into the classroom.

We value your input and invite you to respond to this challenge. Below, you will find more information about our goals, our proposed process, our assets, and what we are looking for from you in your solution. We've also included an appendix -- "Rules of the Road" -- that provides detailed information about the many guidelines that our transportation team follows when routing. You should also be sure to visit our website, bostonpublicschools.org/transportationchallenge for more up-to-date information.

Intellectual Property Rights:

A quick note from our lawyers: All solutions and solution tools submitted to BPS remain the intellectual property of the individuals or organizations that developed them. By submitting an entry, however, the participant agrees that BPS reserves an irrevocable, nonexclusive, perpetual, royalty-free license to use, copy, distribute to the public, create derivative works from, and publicly display and perform all or select portions of the solution output, and to authorize others, including the general public, to use the solution output without restriction on a royalty-free basis. The participant agrees to execute a separate license with BPS, as appropriate, for such purposes.

In summary, BPS will be able to use the optimized bus stop locations, routing, and bell times produced by your solution algorithm or process, but BPS will not have any rights to your algorithm or process, unless you allow it. BPS encourages participants to open source their algorithm or process so that other school systems may benefit as well.

Timeline

We face two challenges: (1) maximizing the efficiency of our routing and (2) improving upon our bell time structure. Due to the deadlines inherent in enacting these solutions, these interrelated challenges will be addressed on different timelines.

While these challenges are similar in some ways -- we believe routing is in some ways a prerequisite to balancing bell times -- we are keeping them slightly separate. **Therefore, any participant can submit a response to just one of the challenges or both**. Since solving the bell times puzzle requires an active routing solution, we imagine that many participants will want to take part in both the routing and the bell time challenge.

Event	**Routing Challenge**	**Bell Times Challenge**
Sample Data and Challenge Overview Posted on Website	Week of March 6th, 2017	
Background Documents Released	April 1st, 2017	
Public Kickoff Event	April 1st, 2017	
Requests can be Submitted for Actual Student Data	April 1st, 2017	
Question Deadline	4/10/2017	5/20/2017
Consolidated Q&A Posted by BPS	4/14/2017	5/26/2017
Submission Deadline for Round 1	4/30/2017	6/18/2017
Round 2 Participants Announced	5/8/2017	6/21/2017
Submission Deadline for Round 2	5/12/2017	6/27/2017
Interviews with BPS*	5/16/2017	6/30/2017
Award Recipient and Next Steps Announced	5/19/2017	7/10/2017

Note: All deadlines -- unless otherwise stated -- are at 11:59p.m. EDT on the date given. All of these dates are subject to change. If we think our participants need more time, we'll add it to make sure that they -- and we! -- get the best possible result.

**These interviews will include student level information (e.g., student locations) and therefore will not be open to the public. Everyone is welcome at both public presentations -- which will not include any private student information.*

Challenge 1: Improve Routing Efficiency

Our ultimate goal is always to get students to school as safely, quickly, and efficiently as possible. Doing so requires smartly placed bus stops and efficient bus routes.

As explained in more depth in “The Data” chapter below, we will provide information on where students live, what school they attend, and how they are supposed to be picked up (either at a corner bus stop or at their door). From there, we want you to tell us your answers to two straightforward, but complex, questions:

1) Where should bus stops be located and which students should be assigned to them?
2) What routes should our school buses take, to which schools, at which times, picking up which students?

Step 1: Optimize Bus Stop Locations

We are working to consolidate bus stops to increase efficiency and decrease student ride time, while also ensuring that students are able to walk safely to a nearby bus stop. Based on where students live, their destination schools, and the type of service required (i.e., Corner Stop, Door to Door, Wheelchair -- more details on these differences in *Appendix 1: Rules of the Road*) how will you assign students to their bus stops?

We have historically chosen bus stops based on a number of qualitative features (e.g. safe location, crosswalks, etc.). We have provided you with this list of historic stops -- not all of which are currently in use -- for you to start with. That said, we are also open and excited about the potential of new stops. We believe that better accounting for traffic flow, optimal location on routes, and other factors could improve our stop locations and overall route efficiency. If you do choose to place new stops, please explain how this has led to additional savings and how you accounted for the safety of those stops.

Optimizing bus stop locations is important because greater efficiencies in where bus stops are located will minimize the amount of “**service time**” -- that is, time spent driving with students on the bus.

Step 2: Link Bus Stops in Efficient Routes

We are working to get all students to school as safely and quickly as possible in time for the start of the school day. Given the location of bus stops, how would you (a) link stops together to form individual trips serving distinct schools and (b) link schools together to create multi-school routes that maximize the use of the buses and that start and end at a given bus yard? Generally speaking, a system of efficient routes will lead to very little “**dead-head**” -- that is, time spent driving with an empty bus to a pick-up spot or a bus yard.

In addition, there are a number of other factors to consider. For example, how will you account for different types of services required (Corner Stop, Door to Door, Wheelchair)? How will your routes adjust based on various school start times? Building flexibility into your model around as many assumptions -- particularly bell times -- as possible is a helpful practice as it will allow us to use your solution for this year and beyond.

Review Criteria

This section outlines the specific criteria that we are asking all participants to submit in order to be eligible for any award. When considering your proposed solutions, we'll look at four primary factors:

1. Are all of the rules of the road followed (outlined in Appendix 1)?
2. What is the total 'score' of your routing solution (see below)?
3. How sustainable and adaptable is your approach? That is, can you easily incorporate changes in assumptions and help us estimate savings from policy changes (e.g. different walk-to-stop assumptions)?
4. How efficient is the routing process? How many hours will your algorithm take to reach a viable and efficient solution?

Additionally, we want to know how you envision a partnership working between you and BPS. What additional information or collaboration would you need from us? What would be your business model/plan for bringing your solution to scale?

Although we want to learn about what a successful partnership could look like, **this challenge is for information and planning purposes only.** Boston Public Schools will **not** award a contract on the basis of responses to this challenge, nor otherwise pay for the preparation of any information submitted, for any presentation, or for the City's use of such information.

Based on what we learn through this challenge, we may issue a request for proposals (RFP) or Invitation for Bids (IFB) in the future. Your participation in this challenge -- or lack thereof -- does not help or hurt your chances of partnering with us in the future.

In order to compare and evaluate answers and maximize our learning from this process, we are asking all participants to submit:

- A Powerpoint or Word document (8 pages or less; 12 point font; one-inch margins) that includes, across three clearly marked sections of the document:
    - A high level overview of how you solved this problem -- including how you assigned students to stops and how you connected routes. This is also where you should highlight any assumptions that you made or rules that you tweaked.
    - The number of unique buses needed in your proposed solution.
    - BPS may consider a future procurement of a system/process to assist with routing efficiencies and would like to learn about potential business models. Please describe not only the routing solution but also what, if any, business

model you have or intend to have for your process. Are you willing to open source your process? If you have an existing business model for your process, what is it? Do you offer or intend to offer some other model for use of your process? Please describe.

- The following table:

Scenario	# of Buses Required	Service Hours	Service Miles	Dead-Head Hours	Dead-Head Miles
Current System	**630**	**3,600**	**44,500**	**1,400**	**23,000**
Your Proposal	###	###	###	###	###
Additional Proposals (As Need)	###	###	###	###	###

Note: these terms are defined in depth at the end of Appendix 1. For Round 1 of the routing scenario, submissions will be primarily judged upon their ability to reduce the number of buses required. Later rounds will consider a broader range of characteristics.

- To help us check that your solution is feasible, please include an excel file detailing which students are assigned to each stop, the walk to stop distance between that student and the stop, what route they are on, and what bus they are on. Understanding the timeline of each trip (i.e., the expected drive time between stops) will also be helpful.
    - *Note: an example of this sample output is included on our website.*
- An interface that easily allows for us to spot-check your solution. That is, an interface that allows us to easily examine in depth a sizable random sample of your stop assignments and proposed routes (both between bus stops and between schools). We realize that this check could be done in a number of ways (i.e., an online tool, an excel document, or even printed directions!) so we're excited to work with you to figure out how best to make sure that your solution is both feasible, effective, and sensible.
- If you elect to open source your code, a sample or all of your code that explains how you do stop assignment and routing.

Submissions must be sent to Will Eger (weger@bostonpublicschools.org) by the deadline.

In general, we'd ask you to spend more time on the solution than the submission -- the submission is meant to simply help get all your thoughts in one place and to make it easy for us to check your submission methodology for accuracy, feasibility, and impact.

Timeline

Because we may want to make changes based on what we learn through this challenge for the upcoming school year (and need to test out all of our assumptions!) and/or issue an RFP or IFB, our deadline is accelerated. Here are more specifics on selected milestones listed above.

- **Submission Deadline for Round 1 (4/30/2017) --** Please be prepared to submit all of the information outlined above in the evaluation section.
- **Round 2 Participants Announced (5/8/2017) --** BPS will determine, based on the criteria outlined above, an undefined number of participants to advance. Those participants will be asked a series of tailored questions based on their response and may be asked to demonstrate the efficacy of their model with updated data for the next school year.
- **Submission Deadline for Round 2 (5/12/2017) --** Participants will be asked to submit answers to their tailored questions and, in some cases, a modified Round 1 submission.
- **Interviews with BPS (5/16/2017)** -- Some participants from Round 2 may be brought in for a series of more in-depth questions or to demonstrate the efficacy of their output.
- **Award Recipient and Next Steps Announced (5/19/2017)** -- More detail on this will be posted on our website closer to the day of the event. It is anticipated that some or all of the proposed solutions may be posted on the BPS website, at the City's discretion and without any student information.

Challenge 2: Balance Start Times

As previously mentioned, our school start times are imbalanced. They are imbalanced not just in the sense that there are varying amounts of buses on the road (increasing costs), but also imbalanced from an equity perspective. Some schools have less ideal bell times than others.

We know there is no perfect solution: there will always be peak in the number of buses on the road, and, there will always be some schools at less than ideal bell times. Nevertheless, we believe there is an opportunity to reduce the burden at peak time -- freeing up funds for investment back into schools -- which will improve overall school satisfaction regarding bell time.

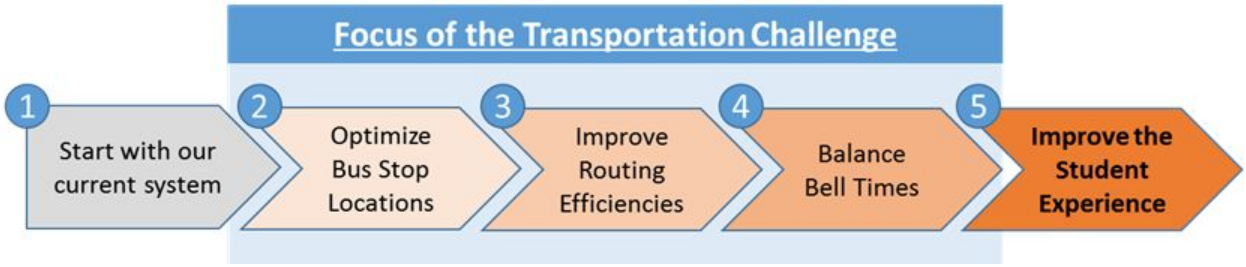
We conduct an in-depth routing process each year. Because of this, the routing challenge could help inform a competitive procurement process that leads to a sustained investment by BPS. We view the bell time challenge as an episodic event -- something we are not going to revisit on a recurring basis. Therefore, we know the bell time challenge will **not** lead to a sustained investment by BPS. We will recognize the most promising solutions and may implement some solution(s), but BPS will **not** award a contract on the basis of responses to this competition, nor otherwise pay for the preparation of any information submitted, for any presentation, or for the City's use of such information.

Adaptive Routing, a Pre-Requisite

Although this competition is focused on bell times, routing still matters for two reasons. First, different bell times have different conditions for route lengths. For example, a bus that drops students off at a 7:30a.m. school will have a full hour to pick up students (the maximum time to pick up students). However, a bus serving an 8:30a.m. or 9:30a.m. school will have to drive from the 7:30a.m. school to the first stop on the 8:30a.m. route. If this dead-head takes ~15 minutes, the pickup time is reduced from an hour to ~45 minutes.

Second, having buses start trips at the 8:30a.m. and 9:30a.m. tiers at schools near large pockets of students can reduce the amount of "dead-head time" -- that is, time spent driving with an empty bus to a pick-up spot or a bus yard

This means that in order to balance our bell times today, a good solution will have to include -- at least at some level -- the ability to calculate what routes would look like at various bell times. Because of this, we believe that solving our bell times challenge is the final step in a three step process (see below).



Step 3: Adjust Bell Times

We believe that our start times need to change. Over the last year, we have received a large amount of feedback from elementary schools whose hours next year will be 9:30a.m. to 4:10p.m. We plan to analyze, compile, and release on our website more comprehensive school feedback soon, in order to test the initial input we have heard and to check some of our assumptions (e.g., elementary schools want earlier start times, and high schools want later start times). The result of this challenge -- and your work! -- might be a compelling solution to maintain three tiers but at different times. But we encourage you to think outside the box. Would shifting to a two-tiered model with the bell times spaced further apart, variously staggered start times, or something else entirely maximize school satisfaction and efficiency? Based upon this comprehensive feedback we will establish and share some parameters for school start times, but aside from that and certain compliance matters, we hope to keep this challenge as flexible and boundless as possible.

There are a couple of nuances to note:

- Don't forget to balance bell times in the afternoon -- the morning may be successfully balanced but you may have created an even larger peak time in the afternoon, requiring us to own and operate an increased number of buses each day.
- As mentioned, we are going to share with you data on school preferences (more on that in the data section below). Be sure to think about how you would weight their preferences with overall efficiency gains. Strong answers will be able to show the potential tradeoffs between overall efficiency and school preferences, allowing us and our community to choose between different scenarios.
- Finally, being able to optimize bus stop locations, improve routing efficiencies, and understand how general fleet management[1] works are all prerequisites for successfully completing the challenge.

[1] By fleet management we mean two things: 1) the ability to link buses (i.e. have a bus serve three schools in the morning and the afternoon) and 2) the ability to manage the different types of buses we operate (e.g., using wheelchair buses appropriately). If your ideal bell time solution, does not properly account for seemingly peripheral elements like wheelchair buses and what schools they serve, then it will likely not be able to be implemented).

We encourage you to think creatively about both the cost savings we'd see from your solution and the broader impact on our school communities. We expect that the best solutions will lower costs **and** ensure that schools are given a start time that works for their staff and families.

Review Criteria

This section outlines the specific criteria that we are asking all participants to submit in order to be eligible for any award.

In many ways, this challenge builds off of the routing solution challenge. As mentioned earlier, we believe that to effectively balance bell times, a complete solution needs to take into account different routing solutions presented at each bell time. Therefore, a portion of the evaluation here will consider your routing solution -- although the bulk of the challenge will most certainly focus on how effectively you balanced bell times. This is necessary because to be effective, any bell time solution must consider the efficacy of the routes.

These are the questions we will be asking about your proposed solution:

1. Are all of the rules of the road followed (as outlined in Appendix 1)?
2. How well is school preference accounted for?
3. What is the total estimated cost savings of of your solution?
4. How sustainable and adaptable is your approach? Can we easily use it in future years with varying sets of assumptions? Can we easily see the impact of changing one school's start time?

In order to compare and evaluate answers and maximize our learning from this process, we will ask all participants to submit several documents:

- A Powerpoint or Word document (8 pages or less; 12 point font; one-inch margins) that includes:
    - A high level overview of how you solved this problem -- with particular attention paid to how you accounted for school preference. This is your primary chance to explain your solution to us.
    - A brief narrative detailing the tradeoffs considered when constructing this model and how your model adapts to changes in those tradeoffs. That is, detailing out how you thought about balancing maximizing community preferences versus route efficiency.
    - A table that looks similar to the one below:

Scenario	# of Buses Required	Service Hours	Service Miles	Dead-Head Hours	Dead-Head Miles	Community Satisfaction Score (*More to come*)
Current System	**630**	**3,600**	**44,500**	**1,400**	***23,000***	***TBD***
Most Efficient System (e.g., fewest buses, lowest cost)	###	###	###	###	###	*Text*
Maximizing School Preferences	###	###	###	###	###	*Text*
Your proposed optimal solution (blend of efficiency and school preference)	###	###	###	###	###	*Text*
Others (*Optional*)	###	###	###	###	###	*Text*

Note 1: There is a trade-off between the most efficient system and the one which most accommodates community input. Your scenarios - and model - should show several balances between those two considerations when different weights are applied to each.
Note 2: The Community Satisfaction Score will be based on survey data from the school communities

- Two tabs in one excel file (*Note: an example of this sample output is included on our website)*:
    - One that details which students are assigned to each stop, what route they are on, and what bus they are on.
    - A second that details your proposed start and end times for each school and how these differ from the school's times during the current school year.
- An interface that easily allows for us to spot-check your solution. That is, an interface that allows us to easily examine in depth a sizable random sample of your stop assignments and proposed routes (both between bus stops and between schools). We realize that this check could be done in a number of ways (i.e., an online tool, an excel document, or even printed directions!) so we're excited to work with you to figure out how best to make sure that your solution is both feasible, effective, and sensible.
- If you elect to open source your code, a sample or all of your code that explains how you do stop assignment and routing.

Submissions must be sent to Will Eger (weger@bostonpublicschools.org) by the deadline.

Please note that all submissions will be public records available for any person to view. Do not submit any confidential or proprietary information. BPS reserves the right to edit or amend submissions if deemed necessary to protect student confidentiality.

Timeline

We envision bell times changing for potentially many schools across the district as a result of this project, and we expect those schools to operate under their new times as of September 2018. The changes, however, would need to be communicated to school communities as early as this October 2017, to allow for proper school-level engagement and general awareness before the school registration period beginning in December 2017.

While our routing deadline is in May 2017, we've pushed our timeline back slightly to allow participants sufficient time to participate in both challenges and have more time on the bell time portion for participants who are looking to move at a slightly slower pace. That aside, we need the Challenge to end in time to potentially fine-tune the submission(s), to discuss with our school communities, and to tweak submissions for public discussion in the fall.

- **Submission Deadline for Round 1 (6/11/2017) --** Please be prepared to submit all of the information outlined above in the evaluation section.
- **Round 2 Participants Announced (6/19/2017) --** BPS will determine, based on the questions outlined above, several participants to advance. Those participants will be asked a series of tailored questions based on their response and may be asked to demonstrate the efficacy of their model with updated data for the next school year.
- **Submission Deadline for Round 2 (6/25/2017) --** Participants will be asked to submit answers to their tailored questions and a potentially modified Round 1 submission.
- **Interviews with BPS (6/30/2017)** -- Some participants from Round 2 may be brought in for a series of more in-depth questions or to demonstrate the efficacy of their output.
- **Awards and Next Steps (7/10/2017)** -- More detail on this will be posted on our website closer to the day of the event. It is anticipated that some or all of the proposed solutions may be posted on the BPS website, at the City's discretion and without any student information.

Award Information

BPS is grateful to the donors who have made monetary awards possible for each of our challenges. The specific terms and conditions of receiving these awards and how they will be distributed will be outlined in a separate file on our website, bostonpublicschools.org/transportationchallenge. Additionally, see the presentation

The Data

For both challenges, you will need to assign students to stops, and link stops through routes, all while operating within our current fleet of buses. Posted on our website you will find a fake dataset in a .xls file. Through the support of Boston University's Hariri Institute, we have used student enrollment patterns and false address to build a school database that assigns these fictitious addresses to schools (all named after current Red Sox players or members of the Red Sox Hall of Fame). The first tab, "Student Information," includes the same headers that we use in the real file that we will share with you later in the process. Those headers include:

- **Student ID**
- **Street Number**
- **Street Name**
- **Zip Code**
- **Full Address**
- **Latitude**
- **Longitude**
- **Pickup Type: Corner or Door-to-Door**
- **Grade**
- **Geocode:** BPS tracks various neighborhoods by census 'geocodes' which we use to analyze student neighborhoods.
- **Neighborhood Safety Score**: This is based on the amount of reported violent crime in the neighborhood -- 7 reflects a high level of reported violent crime and 1 represents a low level of reported violent crime.
- **Proposed Maximum Walk to Stop Distance**: This is the maximum distance that this student should walk to a stop. This is **not** straight line distance but rather actual walking distance along a common path. Each student will have a specific maximum walking distance which varies based on their grade and the rates of reported crime within their neighborhood.
- **Assigned School**: This is the school that the student is required to be transported to and from each day.
- **Current School Start Time**: Students need to arrive at school between 10-15 minutes before the start of school (no earlier and no later). While the bus needs to arrive 10-15 minutes before the start of school, the bus should plan to leave at the start of school. This allows time for buses to unload and builds in "recovery time" to account for unexpected delays on the route. (More detail in *Appendix 1: Rules of the Road*)
- **Current School End Time**: The time between school start time and school end time is the length of the school day for that school. Assume all students go home at the end of the day (i.e., they attend no after school activities). As detailed in *Appendix 1: Rules of the Road* buses should arrive by the school's end time and leave no later than 15 minutes afterward.

- **School Address**
- **School Latitude**
- **School Longitude**

Below these headers is a series of rows, in which each row represents exactly one student. Assume all students need to be transported to and from school.

There is a second tab, “Bus Yards,” that provides real information about our buses and their assigned bus yards. This information will not change as the competition proceeds, and it includes the following headers:

- **Bus Number**
- **Bus Yard**: An abbreviated version of the name of the bus yard.
- **Bus Yard Address**: The location at which each bus must start and end the day. Be sure to include the drive time distances between this bus yard and the first and last trip for this bus.
- **Bus Yard Latitude**
- **Bus Yard Longitude**

The real dataset will include two additional datasets that are not fully included in the fictional datasets: the list of our current corner bus stops and the list of our current routes. We are not including this in the fictional dataset because it is very difficult to meaningfully assign fictional students to fictional stops and fictional stops to routes in a way that mirrors reality. However, you will be able to see the headers that we will share with you in the third (“Stop Locations”) and fourth (“Route Assignments”) tabs.

In order to participate in Phase 2 of either challenge, you must have requested and received the real dataset. This dataset will be given out after the Kickoff Event (on April 1, 2017) on a rolling basis to participants who submit the following **two** documents:

- A brief (less than a page) note summarizing why you are interested in solving this problem, what qualifications you have, and how you would think about solving this problem based on the sample data.
- A signed non-disclosure agreement (see Appendix 2) signed by everyone on your team who will be using the confidential BPS data.

For the bell time challenge, we will also be providing participants who complete the NDA with information on school start time preferences and more detailed guidelines on the factors to consider in this challenge. Please indicate that you would like to receive this information when you submit your non-negotiable NDA and realize that the start time survey data may be a bit slower in coming (as we are still collecting it from principals and school communities).

Please submit scanned copies of the two documents above to Will Eger (weger@bostonpublicschools.org) on or after the kickoff event (and please allow several days

for processing on our end). Your two documents will be reviewed for compliance and to ensure that we are only sharing our student level data with participants who can be trusted to hold this data securely and who will use it effectively. If necessary, BPS reserves the right to ask further questions about your qualifications, or to deem any participant ineligible to receive this data.

Please note: As part of agreeing to participate in this process, you are agreeing to delete any and all traces of the student data shared with you. You are responsible for keeping the data safe and secure per Massachusetts General Law.[2] Please see the attached Non-Disclosure Agreement for more information about this.

[2] A more detailed note from our legal team: *By participating in this challenge, the participant agrees to maintain the security and confidentiality of all City Data for which the participant becomes a holder, either as part of performance or inadvertently during performance, with special attention to restricting access, use and disbursement of personal data and information under G.L. c. 93H and c. 66A. The participant is required to comply with G.L. c. 93I for the proper disposal of all paper and electronic media, backups or systems containing personal data and information. provided further that the participant shall immediately notify the City in the event of any security breach including the unauthorized access, disbursement, use or disposal of personal data or information, and in the event of a security breach, the participant shall cooperate fully with the City and provide access to any relevant information relating to the security breach and participant shall be fully responsible for any damages associated with the participant's breach including but not limited to G.L. c. 214, s. 3B.*

Frequently Asked Questions

Because this process is slightly non-traditional, we thought that it might be helpful to answer what we believe might be some commonly asked questions:

Are there any prerequisites to participating?
We want to cast as wide a net as possible for potential participants. You don't have to be part of a large firm or affiliated with a university to participate -- you just have to be qualified, interested, and eager.

Can we participate as a team?
Yes! We welcome teams, groups, or individuals of any background.

What happens after the hackathon is over?
It depends a bit on the challenge. For the first challenge (on routing), based on the complexity of the chosen models we may seek to form partnerships based in our learnings from the challenge. These partnerships could take a number of different forms, which could include pilots, an open-source solution in the public domain, or a formal procurement and contract.

For the second challenge (on bell times), we plan on implementing that suggestion and revisiting bell times periodically.

Am I guaranteed a contract with BPS if I win?
This challenge will help us develop our strategy and future investment plans. But to be very clear, your participation -- or lack thereof -- in this process does not help or hurt your chances of partnering with us in the future. It also does not obligate us to issue a formal procurement or enter into a contract at any point.

There is some data BPS has not shared but that I think would be helpful -- how can I go about getting it?
Email weger@bostonpublicschools.org. If additional information is released to one entrant it will be shared with all entrants.

If I have a question on the process (e.g., deadlines, event information, or what my submission should contain), what should I do?
Email weger@bostonpublicschools.org by the question deadline for each section. Answers to these questions will be posted on our website.

Will BPS check any early submissions for accuracy or efficacy?
No, but we are happy to answer specific questions that come up as part of this process before our question deadline. You are welcome to send specific questions about your submission to

weger@bostonpublicschools.org, but due to volume we may not be able to respond to all requests about your specific submission.

I don't want to participate in the Challenge, but I have some thoughts on how BPS could improve transportation -- who should I reach out to?
Email our Director of Transportation, Jonathan Steketee, at jsteketee@bostonpublicschools.org.

How will my submission be reviewed?
We are compiling a detailed panel of experts from a variety of fields (computer science, transportation, applied math, and other qualified individuals). More detail on the experts and their backgrounds will be posted on our website after the kickoff event.

Will BPS cover any of the costs of travel or other costs associated with participating in this Challenge?
Unfortunately, BPS will not be able to cover or defray any costs you may incur as part of this challenge.

Can I publish any of my findings?
You can publish any of your findings with explicit permission from BPS. Additionally, any published information must be rolled up to groups above 10 students so it is impossible to identify any one student from any published findings.

Appendix 1: Rules of the Road

Below are the general rules that need to be followed under all of your potential routing scenarios.

Ridership Rules

- Students cannot ride the bus for longer than one hour.
- Students need to be dropped off 10 to 15 minutes before the start of school -- they cannot be dropped off earlier because staff may not be there to receive them. Buses need to arrive at schools in the afternoon at dismissal time and should leave no later than 15 minutes afterward.
- Currently, all students need to be dropped off at the door of their school.

Bus Stop Rules

- Currently, buses only serve one school per bell time. We are considering allowing buses that have only a handful of students on them to serve multiple schools on the same trip.
- About half of our students are Door to Door (D2D) students -- they are required to be picked up at their homes due to an accommodation given to them in an Individualized Education Program (IEP) or a 504 plan.
    - We have explored having corner students walk to the addresses of D2D students' houses and use these addresses as new bus stops for corner and D2D students. However, for now, you should plan on keeping corner stops and D2D stops separate.
    - D2D students can ride with corner students.
- All students need to walk less than 0.5 miles to their nearest bus stop
    - We put some limits on this for students living in more dangerous neighborhoods or for younger students -- we're working on refining these distances.
- Each bus stop should have fewer than 30 students per bell time (i.e., no more than 90 students at one stop in the morning -- 30 at each tier)
    - When you do see the data set, you'll notice that there are some bus stops that can host a large number of students (e.g., MBTA stops). These buses are to help get the students from the MBTA station to school. The stops are not used by corner-to-corner students currently, and instead by students that use public transportation to get to and from school. However, they could be used by corner-to-corner students.
- Each stop should be budgeted for 30 seconds per stop and five seconds per student. (i.e., a stop with 5 students would be 55 seconds; a stop with 10 students would be 1 minute and 20 seconds).
    - Stops with one or more students using wheelchairs should be budgeted for 5 minutes per student (i.e., wheelchairs need to be secured in the bus and therefore loading takes longer).

- At the end of the day, buses should arrive at the school before the day ends and leave 15 minutes after the last bell

Fleet Rules

- There are several types of buses, each with its own capacity range, which varies based on student age (e.g., a Big Bus can seat more kindergarten students than middle school students; use the capacity maximums for now). We have
    - Big Buses (can seat 55-71 students): This is likely what you think of as a "traditional" bus.
    - Half-bus (28-35 students): These are smaller, more nimble buses.
    - Mini-buses (12 students): These are smaller buses with extra harnesses for students with special needs.
    - Wheelchair Buses: (12 students and 3 wheelchair stations).
- Buses start the day in a specific bus yard, return to that bus yard after their morning routes. In their afternoon, the buses leaves the yard and drops students off at school and then returns to their initial bus yard at the end of the day.
- Buses can't travel on certain streets (e.g., streets that are too narrow, streets with overpasses that are too low to allow for bus access, etc.)
- Students may require a bus monitor. If they do, then there needs to be capacity in seating for the monitor on the bus.
    - Students may have one of two monitor accommodations:
        - 1:1 monitor: the student requires a dedicated monitor.
        - General monitor: the student requires a monitor to be on the bus, but not dedicated solely to him/her.
            - For example, if there were three students requiring a general monitor and two students requiring a 1:1 monitor there would be a total of three monitors on the bus.

Bell Time Rules

- We prefer for schools to start after 7:30a.m. and to end before 4p.m. However, we acknowledge that a solution may require some schools to start or end outside of these constraints. However, no BPS or Charter school can end after 5:30p.m. nor start before 7a.m.
- The start times of schools outside of our nexus of control cannot be changed. Specifically, we are unable to change the start or end times for private schools, parochial schools, or private special education programs.

Dream Big

We're thinking big: While we are required to follow these rules in the short term, we're interested in exploring the tradeoffs involved. For example, if we expanded the maximum route length from sixty minutes to eighty minutes, could we invest in Wi-Fi in all of our buses? 50 more teachers? We really want to see models that are flexible and agile enough to allow us to see these tradeoffs in action.

Key Terms

One of the goals of this challenge is to create the most efficient system. As there are a number of potentially maximally "efficient" systems, we've taken some steps to help define efficiency.

- **Number of Buses Required**: How many buses do you need during the course of a day? Put another way, given what you know about our fleet, how many unique bus IDs are in your proposed solution?
- **Service Hours**: The total time driving for a given day while students *are riding the bus*. That is, the aggregate time spent across all buses between picking up their first student on each trip and then dropping them off at their school. This should include time spent waiting for students to board the bus at bus stops.
- **Service Miles**: The miles covered during all service hours for a given day.
- **Dead-Head Hours**: The total time spent driving for a given day when students *are not on the bus.* That is, the time spent driving from a school or bus yard to the first stop of a trip.
- **Dead-Head Miles**: The miles covered during all dead-head hours for a given day.

Note: the sum of service hours/miles and dead-head hours/miles will equal the total hours/miles of your system.

To help make this concrete, we've provided an example below of how and when individual buses would be driving under these situations. For simplicity, we're assuming that this solution requires 600 buses.

Example 1: Bus 100 leaves the Charlestown Yard at 7a.m. It drives 2 miles in 5 minutes to pick up Student A. It then drives 15 miles in 60 minutes while picking up other students before dropping them off at School A. With no students on the bus, Bus 100 then drives 8 miles in 30 minutes to pick up Student B. It then drives 5 miles in 30 minutes while picking students up before dropping them off at School B. Bus 100 then drives 4 miles in 25 minutes to arrive back at the Charlestown Yard (where it started).

- **Service Hours/Miles**: In between picking up Student A and dropping them off at School A, Bus 100 drives for 15 miles in 60 minutes. Then, in between Student B and School B, Bus 100 drives 5 miles in 30 minutes. This is a total of 20 service miles and 90 service hours.
- **Dead-Head Hours/Miles**: Bus 100 drives 2 miles in 5 minutes from the Charlestown Yard to Student A. It then drives 8 miles in 30 minutes from School A to Student B. It then drives 4 miles in 25 minutes from School B to the Charlestown Yard. This is a total of 14 miles in 60 minutes.

Scenario	# of Buses Required	Service Hours	Service Miles	Dead-Head Hours	Dead-Head Miles
Result of Example 1	**600**	**1.5**	**20**	**1**	**14**

You may have some questions about how to categorize some nuanced categories:

- **What if a bus is idling in between stops**? This is called “dwell time” and should count towards dead-head hours (and no miles) assuming no students are on the bus.
- **What if the bus is stuck in traffic**? With students on board, this would count as service hours. Without students on board this would count as dead-head hours.
- **What if a bus parks in a location not at a yard in between a morning and afternoon shift**? This may be desirable (for example, having a bus wait for an out of district student rather This would count towards dead-head hours. Generally speaking, all buses should return to yards when done with their morning and afternoon shifts.
- **What happens if I get to a school earlier than the start of school?** Buses should always take the most efficient routes between stops. If a route is scheduled to get to school continually early, the route should start later so that the students arrive at an appropriate time. This additional dwell time would count towards dead-hear hours

Over the course of the competition, we will continue to provide more detail on the specific weights to assign to each of these variables. Your model should have the flexibility required to adjust these weights when necessary.

Appendix 2: Non-Disclosure Agreement

Please note: this is for reference only. Please print, sign, and submit the NDA listed on our website.

NON-NEGOTIABLE CONFIDENTIALITY AND NON-DISCLOSURE AGREEMENT: TRANSPORTATION CHALLENGE 2017

This Confidentiality and Non-Disclosure Agreement ("Agreement") is entered into by and between _____ (hereafter referred to as "Vendor)" and the Boston Public Schools, 2300 Washington Street, Roxbury, MA 02119 ("BPS"), each being a "Party" and both being the entities of the City of Boston, hereinafter the "Parties," to this Agreement.

This Agreement refers to the transportation data challenge posted on the BPS website that will take place between April 1st, 2017 and June 30, 2017. This event is described in greater detail in the Transportation Challenge Overview document available on the BPS website, http://www.bostonpublicschools.org/transportationchallenge.

WHEREAS the parties wish to confirm their understandings with respect to the nature of the relationship between the parties relating to the confidential transmission, use and protection of certain student routing information,

WHEREAS BPS has authorized only the VENDOR and its employees and/or representatives to have access to certain directory, student, and routing information for portions of the year 2017 for the purpose of supporting BPS in improving our routing calculations and supporting the creation of more equitably and efficiently balanced school bell times,

WHEREAS, VENDOR and its employees and/or representatives have agreed and understand that BPS will provide only to VENDOR certain directory, student, and routing information subject to the terms of this Agreement,

WHEREAS, BPS deems this work to be of interest and value to BPS, as it will contribute toward the educational and professional goals of BPS, and

WHEREAS, VENDOR and BPS desire to cooperate with each other in connection with provision of such a solution.

NOW THEREFORE, in consideration of the mutual covenants set forth herein and for other good and valuable consideration, the receipt of which is hereby acknowledged, VENDOR and BPS agree as follows:

1. ***DEFINITIONS***

Vendor and its employees and/or representatives. Any individual person or organization who is identified to receive and utilize the confidential information applicable to the related Challenge,

whether as an employee or representative, must be disclosed to and approved by BPS and sign this agreement prior to commencing work on or engaging in participation in the Transportation Data Challenge. BPS reserves the right to request proof or copies of any and all signed agreements by any vendor and its employees or representatives at any time, for any reason.

Confidential Information. VENDOR acknowledges that in the course of providing services to BPS and its students, only VENDOR and its employees or representatives will be given or have access to certain directory, routing, and confidential student information ("Confidential Information") which may typically protected from disclosure with or without prior consent by various laws including the Family Educational Rights and Privacy Act (FERPA) 20 U.S.C. § 1232g et seq., 34 C.F.R. § 99 et seq., and 603 C.M.R. 23.00 et seq. VENDOR acknowledges and agrees to comply fully with these federal and state privacy and student record confidentiality laws. VENDOR, its employees and/or representatives, hold the Confidential Information in trust for BPS's benefit, and shall, in addition to their respective obligations hereunder, use best efforts at all times to adopt and follow procedures and practices to protect the confidentiality of the Confidential Information and prevent its disclosure to others without the express written consent of BPS. VENDOR further acknowledges that BPS's willingness to disclose Confidential Information to VENDOR is predicated on VENDOR entering into and committing to abide fully by the terms of this Agreement and applicable laws and regulations.

Data Set. The data set includes all City of Boston students eligible for school bus transportation from the Boston Public Schools. In this dataset, specific student information has been changed slightly to protect student confidentiality.

Routing Information. The district will share the data below, along with potentially other data as may be deemed necessary and helpful. Specifically:

1. ***Student home location:***
   a. *Address*
   b. *Latitude and Longitude*
2. ***Student characteristics:***
   a. *School assignment*
   b. *Ridership status (i.e., corner stop, door-to-door ("D2D"), or wheelchair)*
   c. *Grade*
3. ***Bus Stop Location:***
   a. *Corner intersection*
   b. *Latitude and Longitude*
4. ***Survey data relating to school preferences on start time***

Of note, Vendors will not be provided with the students' corresponding names, or other non-directory information that would require consent pursuant to 603 C.M.R. 23.00.

2. TERMS OF AGREEMENT

*1. **Data Sharing**. VENDOR shall maintain and administer a secure database ("the Database") for delivery and evaluation of information, and reporting purposes. VENDOR will use a secure database for managing and sharing routing data. The Database will meet government data management and security protocols and will incorporate security features within the platform to*

ensure privacy and confidentiality is maintained while providing the Parties the key information they require to understand impact. The VENDOR, its employees and/or representatives shall be responsible for transmitting all data or other record of all data requested and received pursuant to the Agreement, including confirmation of the return or destruction of data as described herein.

Reasonable security precautions and protections include, but are not limited to:

A. *Creating, distributing, and implementing data governance policies and procedures which protect Confidential Information through appropriate administrative, technical, and physical security safeguards, and outline staff responsibilities for maintaining data security.*
B. *Potentially encrypting all Confidential Information carried on mobile/ computers/electronic/devices.*
C. *Potentially encrypting Confidential Information before it is transmitted electronically.*
D. *Requiring that users be uniquely identified and authenticated before accessing Confidential Information.*
E. *Establishing and enforcing well-defined data privilege rights which restrict users' access to the Confidential Information necessary for them to perform their job functions.*
F. *Ensuring that all persons accessing Confidential Information sign a confidentiality agreement, and maintaining copies of signed agreements.*
G. *Securing access to any physical areas/electronic devices where sensitive data are stored.*
H. *Installing a firewall to permit or deny network transmissions based upon a set of rules.*
I. *Installing anti-virus software to protect the network.*

*2. **Nondisclosure**. Nothing in this Agreement may be construed to allow any Party to maintain, use, disclose, or share Confidential Information in a manner not allowed under federal or state law or regulation, or outside the scope of this agreement. Authorized vendors shall strictly comply with all federal and state laws that apply to the use and release of Confidential Information, including but not limited to FERPA and its regulations, set forth at 34 C.F.R. § 99. VENDOR, its employees and/or representatives, shall use the Confidential Information and routing data solely in connection with performance by VENDOR of the services provided to BPS as outline by this agreement and pursuant to the Challenge Document and for no other purpose. Neither VENDOR nor any of its employees and/or representatives, shall sell, release, transfer, reprint, duplicate, recreate, disclose or permit the disclosure to any other person or entity of any of the Confidential Information or of any files, compilation, study, report or analysis or data base containing, based on or derived from the Confidential Information without the express written consent of BPS, and in full compliance with applicable state and federal privacy laws. VENDOR shall maintain the privacy of protected personal information and shall be financially responsible, if and to the extent that any security breach relating to protected personal information results from acts or omissions of VENDOR, its employees and/or representatives for any notifications to affected persons (after prompt consultation with BPS), and to the extent requested by BPS, administratively responsible for such notification. VENDOR shall protect the Confidential Information and shall not permit the release of such information to parties other than BPS officials and their authorized agents.*

*3. **Background Checks**: VENDOR, its employees and/or representatives, acknowledge that BPS reserves the right to conduct an appropriate background check on any and all participants with access to the Confidential Information pursuant to this agreement.*

*4. **Disclosure Sought Under Legal Process**. VENDOR shall immediately notify BPS (see below) in writing of any subpoena, court order or other legal process seeking or purporting to compel disclosure of any of the Confidential Information and shall challenge, oppose or appeal any such subpoena, order or legal process to the extent deemed appropriate by BPS. In no event shall VENDOR voluntarily, without a court order, disclose or permit the disclosure of any of the Confidential Information in response to legal process unless and until VENDOR has given the required notice to BPS and VENDOR has exhausted any and all legal remedies available to it to limit or prevent the disclosure.*

*5. **Notices**: The following BPS representative shall be notified of any occurrence outlined in this agreement that so requires:*

***Name**:*	*William Eger*
***Title**:*	*Strategic Projects Manager*
***Email**:*	*weger@bostonpublicschools.org*
***Phone Number**:*	*914-523-9675*
***Office Location**:*	*Bolling Building* *2300 Washington Street* *Roxbury, MA 02119*

*6. **Return or Destruction of Materials**. Upon request of BPS at any time, VENDOR shall return all or such part of the Confidential Information as BPS may designate to be returned. In addition, upon the completion of the services provided by VENDOR to BPS as outlined in this Agreement, VENDOR shall return or destroy, as BPS may instruct, all Confidential Information in VENDOR'S possession or control, whether in printed, electronic or any other format, including all duplicates and copies thereof of any files, compilation, study, report, analysis or data base containing, based on or derived from the Confidential Information.*

*7. **Publication**. BPS has the right to report, present, publish, or otherwise use data to which it has produced or received from VENDOR. Acceptable disclosure includes, but is not limited to, disclosure of aggregate or de-identified data in reports and presentations, including for grant reporting purposes, disclosure of aggregate or de-identified data to VENDOR, public entities and community based organizations, and use of aggregate or de-identified data in program planning, evaluation and research not related to the BPI initiative. VENDOR shall not publish, present, or use reports without explicit written consent from BPS. BPS has the right to review and require approval of any publicly reported document prior to its release.*

*8. **Disclosure, Breach & Penalties**. VENDOR'S disclosure of Confidential Information to third parties without BPS's authorization, or VENDOR'S failure to sign or comply with this agreement or return or destroy Confidential Information per Provision 4 above, may constitute a breach of this Agreement and may result in the BPS or the U.S. Department of Education denying VENDOR access to Confidential Information and other such penalties as dictated by law or equity.*

*9. **Injunctive Relief**. VENDOR acknowledges and agrees that the breach or threatened breach by VENDOR, or its employees and/or representatives of their obligations under this Agreement will cause serious and irreparable harm to BPS that cannot be adequately compensated by monetary damages alone and that BPS may seek injunctive relief from an appropriate court to protect BPS from such harm without necessity of bond or other security.*

*10. **Immediate Notice**. VENDOR shall give BPS immediate written and verbal notice of any unauthorized use or disclosure of the Confidential Information, or of any breach or threatened breach by VENDOR or its employees and/or representatives of their obligations under this Agreement, upon learning of same.*

*11. **Appropriate Forum**. VENDOR and BPS agree that this Agreement is entered into in the State of Massachusetts, and that the courts located in the State of Massachusetts are the appropriate forum in the event any party seeks legal action or injunctive relief under this Agreement. All parties consent to venue and personal jurisdiction in the appropriate court in the State of Massachusetts.*

*12. **Termination**. BPS may terminate this agreement with VENDOR at any time, for any reason, with either written or verbal notice. VENDOR must give the designated BPS representative 3-day written and verbal notice of any termination of this agreement with BPS. Termination of this Agreement, however, does not affect any Party's obligations, duties or rights imposed or granted by separate instrument such as a grant or other contract.*

*13. **Indemnification**. Unless otherwise exempted by law, VENDOR shall indemnify and hold harmless the City of Boston, Boston Public Schools, and its Departments, agents, officers, and employees against any and all claims, liabilities, and costs for damages that the City may sustain which arise out of or in connection with VENDOR'S performance of this Agreement, including but not limited to the negligent, reckless or intentional conduct of VENDOR, its employees and/or representatives, officers, or other related personnel. After prompt notification of a claim by the City, VENDOR shall have an opportunity to participate in the defense of such claim and any negotiated settlement agreement or judgment. The City and its departments shall not be liable for any costs incurred by VENDOR arising under this paragraph. Any indemnification of VENDOR shall be subject to appropriation and applicable law. Indemnification specifically includes, but is not limited to, claims related to (i) the indemnifying Party's improper sharing of data, (ii) improper use of data by the indemnifying Party or any of the indemnifying Party's employees, agents, officers, volunteers, or other related personnel, or (iii) breach of the indemnifying Party's IT system.*

*14. **Relationship of Parties**. The VENDOR, its employees, and/or representatives shall not be construed, deemed or otherwise held to be employees, agents, or officers of BPS. VENDOR and its employees and/or representatives shall not be entitled to compensation or other benefits that ordinarily accrue to employees of BPS. Nothing herein shall create or be deemed to create any relationship of agency, association, joint venture, partnership as defined by law, or employer/employee between BPS and VENDOR or its employees or representatives. Neither party shall have the authority to bind or obligate the other in any manner, except as expressly provided in this agreement.*

*15. **Conflict of Interest**. The parties' attention is called to General Laws c. 268A (the Conflict of Interest Law). No party shall act in collusion with any other party, person or entity to circumvent such law.*

*16. **Assurances**. The Parties agree that all activity pursuant to this Agreement shall be in accordance with this Agreement and all applicable current or future federal, state, and local laws, and all applicable rules and regulations.*

*17. **Termination**. This Agreement shall survive the termination of the services to be provided by VENDOR or any other agreement by and between the parties.*

*18. **Severability**. All of the provisions of this agreement are severable. If any provision of this Agreement is rendered invalid or unenforceable by State or Federal statute or regulations or declared null and void by any court of competent jurisdiction, the remaining provisions of this Agreement will remain in full force and effect.*

*19. **Entire Agreement; Amendments**. This Agreement is intended as the complete, final and exclusive statement of the parties with respect to the subject matter hereof, and supersedes any prior agreements or understandings between the parties hereto. This Agreement may be amended, modified or supplemented only by a written agreement signed by VENDOR and BPS. Any waiver of the terms and conditions of this Agreement must be in writing signed by the party granting such waiver and shall not operate as a waiver of, or estoppel with respect to, any subsequent or other failure to perform.*

IN WITNESS WHEREOF, and intending to be legally bound, the parties have executed this Agreement by their duly authorized representatives.

The Boston Public Schools ("BPS")
Signature: _____ *Date:* _____

*Print Name:*_____

Title: _____

(VENDOR) _____

*Signature:*_____ *Date* _____

*Print Name:*_____

Title: _____

If the vendor is not an individual, each individual of a particular vendor who will be working with this data is required to submit a signed NDA.