The Grouped-School Model:

A Simple Zone-less Assignment Model that Balances
Equity of Access, Closeness to Home, and Choice

Peng Shi MIT Operations Research Center

Outline of Report:

1. The Grouped-School Model

An ideal assignment system should allow every family to choose from

- The schools near their home
- Quality alternatives if neighborhood schools are unsatisfactory

And allow every family to decide what is best for their children.

The Grouped-School Model accomplishes exactly this, across the BPS system: it offers each family a choice between the

- **4 closest schools** (plus any additional school in their walk-zone)
- Plus "**quality partners**" of these schools, which are designated as needed to balance access to quality

To designate which schools are "quality partners," the model groups every under-performing school with 1-2 quality alternatives, so that each group as a whole is of sufficiently high quality. The schools in the same group are called quality partners.

The groupings are calculated to minimize total distances among schools from the same group, subject to each group meeting a baseline quality threshold. The groupings can be presented in a simple and transparent way on a map.

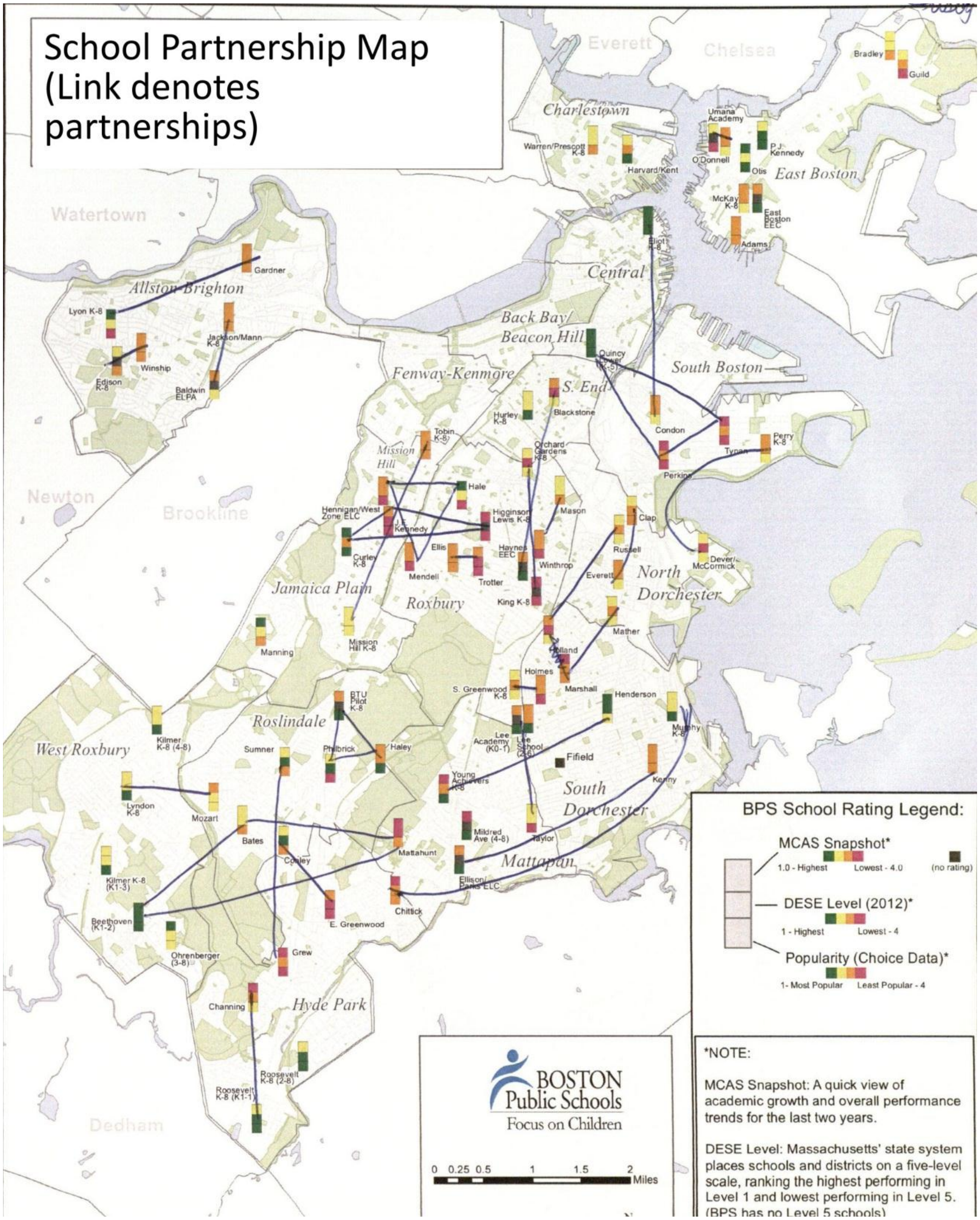
Compared to BPS models and Grouped-Zone models, the Grouped-School model

- **outperforms all others** in providing **equitable access to quality;**
- **outperforms all but** the **23-zone** model in **proximity** to home, **choice** and **predictability**, **transportation savings**;
- is similar to the 6 and 9-zone model in socio-economic and racial diversity, and outperforms the 11 and 23-zone models.

The quantitative analysis is presented in Section 5.

3. Proposed map of groupings and examples of choice menus

The following map shows which schools are "quality partners" if we use BPS MCAS snapshot as quality metric. This map stays mostly constant across years so families can plan for the future.

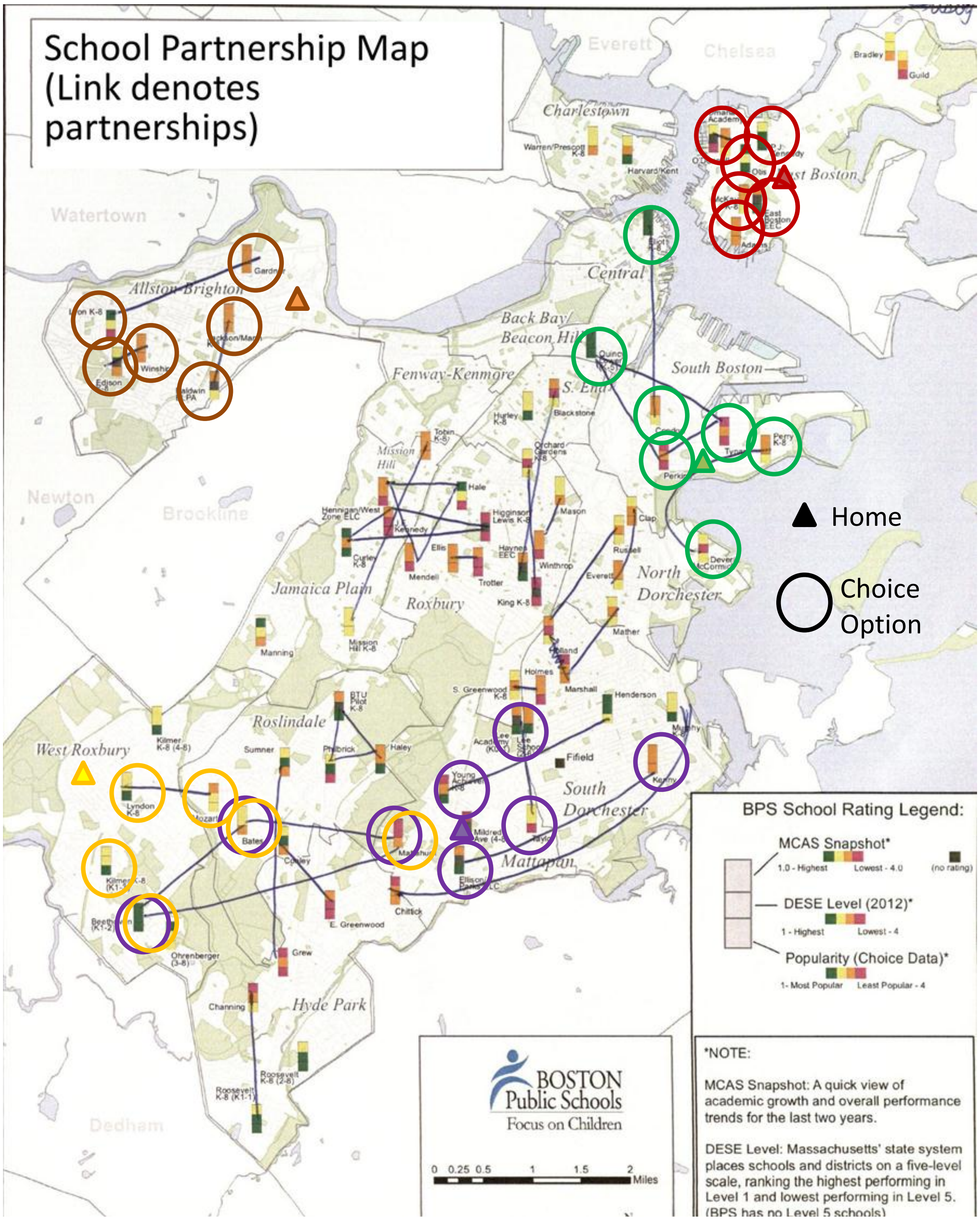


These groupings were calculated in a data-driven way, to minimize total distances while requiring that the weighted average MCAS snapshot of each group is 2.2

or better. (Under BPS scaling, 1 is best, 3 is worst, 2 is about average.) The threshold can be adjusted. Currently we only consider equitable access to quality; other objectives such as diversity can also be added (but this would sacrifice distance).

To find one's choice options using this map, one simply identifies the 4 closest schools, adds to this any additional walk-zone school, and traces the links on the map to find the quality partners. To help families understand their options, we can use an interactive online tool with an address input to explicitly show families their choices.

We illustrate this with 5 example families, living in East Boston, South Boston, Mattapan, Allston-Brighton, and West Roxbury respectively. (A triangle denotes a family's home and the circles of the same color represent their choice options.)



We will go through these examples to illustrate practical implications of this model.

In East Boston, schools are generally all of sufficient quality (according to our metric), so the red family is simply offered their closest schools.

In South Boston, there is a lack of local quality according to the MCAS snapshot, so for the green family, in addition to the 4 closest schools (Condon, Perkins, Tynan, Perry), we offer 3 quality alternatives (Elliot, Quincy, Dever/McCormick).

In Mattapan, there is a mix of high and low quality schools, but the majority is of lower quality than our baseline. So for the purple family, in additional to the neighborhood choices (Mattahunt, Young Achievers, Ellison, and Taylor), we offer quality alternatives Bates, Beethoven, Henderson, and Kenny. We needed to group Mattahunt with 2 quality schools because Mattahunt has a large capacity so needs more quality seats to bring the weighted average to threshold. In the choice menu we also include Lee (classified as low quality) as an option because it is partnered with Taylor. This is necessary to allow outside kids to have some access to Taylor, which according to our metric is a quality school.

In Allston-Brighton, there is again a mix of quality, but there is enough local quality that we do not need to partner these schools with outside alternatives. Thus, the brown family is offered only local choices.

In West Roxbury, there is high proportion of high quality schools, so several of these schools would become “quality partners” to lower quality schools in other neighborhoods. The choice menu for these families (colored orange in example) is Lyndon, Kilmer, Beethoven, Mozart, Bates and Mattahunt, which still meets our quality threshold but unfortunately this may cause West Roxbury children with bad lottery number to be assigned Mattahunt (low quality according to our metric). Note that in our model, even for the low-lottery families at least their predictability is improved over the current model because they can only be assigned to Mattahunt rather than to any of the low quality schools in the West zone.

One real concern is that middle class families assigned to a lower quality schools may simply opt out of the system. While the added predictability of knowing exactly which lower quality school (Mattahunt in this case) they will be assigned to if they get a low lottery number may help them to focus instead on mobilizing the community to improve a specific school, one may argue this is not enough. A promising alternative strategy is to simply treat such school partnerships as true “school mergers,” and combine schools into one big K-8 pathway, much as how Beethoven and Ohrenberger merged in West Roxbury and how Quincy lower and upper merged Chinatown. The benefit of being with all their friends and old teachers and the certainty of the pathway may largely eliminate potential middle class opt-outs. This idea is further discussed in Section 6.

3. Why move away from zones?

Unnecessary constraints: Zones are simply school groupings with additional geographic constraints. Such constraints significantly limit flexibility in how schools can be grouped, thus hampering our ability to simultaneously achieve equity of access, proximity to home, and the right level of choice. The Grouped-School paradigm encompasses zones as a special case and hence can *always* do as good if not better.

Unnatural boundaries: constructing zones with equitable quality requires drawing arbitrary boundaries, which may seem unnatural to families and can divide neighborhoods. Often a family may prefer a closer school across the boundary (but outside the walk zone) and it is hard to justify why we are not offering this “quality-close-to-home” option.

Inability to adapt over time: Even the slightest change in zone boundary drastically affects the choice options of families on the boundary. Therefore with zones it is very difficult to adapt to future changes in quality or demographics once the lines have been drawn. But adaptability is important since BPS is focusing on improving quality over time and since demographic changes add up over time.

4. Benefits of the Grouped-School Model

Equitable Access to Quality: for every under-performing neighborhood school, a family is offered a quality alternative. For every family, the weighted average quality of schools in their choice set will by definition meet our quality threshold.

Options Close to Home: The four (or more) closest schools are always offered to families. (This is not true with zones.)

A Productive Level of Choice: Each choice menu is large enough to offer a number of real alternatives to parents, including a quality alternative for every unsatisfactory neighborhood school. Moreover, non-neighborhood options are only included if it is necessary to balance quality. This limits the redundancy in choice options, and also limits the potential number of scattered and distant options that may tend to separate neighboring families.

Predictability and Transparency: The groups of schools are more limited in number and geographic scope, so the range of possible assignments is better defined for each family. And as with zones, in the Grouped-School model a family can immediately see from a single map what their choice options are. Unlike with zones, the “4 closest school” rule is more natural and justifiable to families than arbitrary boundaries.

Economize on Transportation Cost and Time: Instead of having to pick up from anywhere in an entire zone, buses from a school only needs to pick up from either its close vicinity or the close vicinity of its quality partner. Moreover, the quality partnerships are optimized to minimize distances. In some sense, the Grouped-School Model uses the minimum amount of transportation needed to deliver a given level of equity, and **it does not bus when it does not contribute to equity**.

Ease of Execution: We can use the same BPS choice algorithm and priorities as now, so little new infrastructure is required. The framework of school partnerships (in a more general context than simply quality grouping) is also useful for capacity planning because if there is an especially high student population in one area but insufficient local supply we can partner local schools with nearby outside alternatives to help meet the demand.

Conducive to Adaptations over Time: Once the performance of a previously low quality schools sufficiently improve, we may choose to "dissolve" or rearrange its quality partnerships. This does not drastically affect anyone because for any family at most one out of many options would change. In contrast in a zoned model redrawing zones is difficult and no matter how small the change in zone boundaries the choice options of families on the boundary will be drastically affected.

Good Long Term Solution without Sacrificing Short Term Equity: As BPS implements its quality improvement plans, over time most quality partnerships may be able to be dissolved and we achieve the ideal quality-choice-close-to-home model. But as long as any school continues to perform below our baseline quality, families living near it will have access to a quality alternative via its quality partner. In other words, while the Grouped-School model integrates well with school improvement efforts, instead of settling on future promises **it holds BPS accountable for quality improvements** because groups can only be dissolved once sufficient improvement is attained.

5. Comparisons with BPS and Grouped-Zone Proposals

Using BPS data and EAC criteria, we evaluate the Grouped-School Model and compare with the BPS zoned proposals, as well as two computer-optimized grouped-zone models (built on BPS's 23 zones; see appendix 2 for details of the zone grouping). To compare all models side-by-side, we use the common reference geography of the 16 neighborhoods in BPS data (Allston-Brighton, Back Bay, Central Boston, etc.) In this section we only show the mean or variation across neighborhoods. For neighborhood-by-neighborhood breakdown and technical details, see Appendix 3.

Our findings are that (using our metrics) the Grouped-School Model

- outperforms all others in providing equitably access to quality;

- outperforms all but the 23-zone model in proximity to home, predictability, and transportation savings;
- is similar to the 6 and 9-zone model in socio-economic and racial diversity and outperforms the 11 and 23-zone models.

Equitable Access to Quality

Using MCAS snapshot as a proxy for quality, we compute for each model the weighted average MCAS snapshot of family's choice menus and compare across neighborhoods. (We use geocodes as proxies for family's locations, average K-5 enrollment for demand, average K-5 capacity in Reg. Ed. seats for supply, and we aggregate results into neighborhood averages.) The following table tabulates the variation in the average MCAS snapshot of choice menus across neighborhoods. (The lower the number the better, and the smaller the variation from 2.05 the better since this is the district weighted average.)

	3-Zone	**6-Zone**	**9-Zone**	**11-Zone**	**23-Zone**	**Grouped Zone 1**	**Grouped Zone 2**	**Grouped-School**
Variation across neighborhood of average MCAS of choice menu	1.78-2.33	1.52-2.29	1.52-2.32	1.27-2.37	1.27-2.61	1.73-2.18	1.83-2.19	**1.68-2.16**

As shown above, in the Grouped-School Model the worst-off neighborhood receives choice menu that averages 2.16 in MCAS (the lower the better), and this is better in quality than what the worst-off neighborhood gets in any other plan. In this sense, the Grouped-School Model offers the most equitable access to quality.[1] Note that the two Grouped-Zone models also perform better than all BPS proposals.

Proximity to Home

We calculate for every family the average distance to a random seat in the family's choice menu, and compare across neighborhoods. This is different from BPS measure of distance to home because it is the average distance to choice option rather than to predicted assignment. (However without access to micro-level preference data

[1] However, if we judge by variation from mean of 2.05 the two Grouped Zone models perform better in equity, but only by decreasing the quality offered to the best-off neighborhood; in either case the School Partnership model outperforms all BPS proposals.

we cannot accurately predict assignments.) We tabulate both the mean distance and the variation across neighborhoods.

Distance to Option (miles)	3-Zone	6-Zone	9-Zone	11-Zone	23-Zone	Grouped Zone 1	Grouped Zone 2	Grouped-School
Mean	3.46	2.13	1.78	1.38	0.93	1.44	1.86	**1.3**
Variation across neighborhoods	2.49-5.89	1.25-4.00	1.09-3.99	1.09-2.78	0.53-2.19	1.07-2.82	1.19-3.15	**0.67-2.42**

As shown, on average the Grouped-School Model offers closer to home options than all but the 23-zone model. This conclusion continues to hold if instead of mean we compare the worst-off neighborhood (furthest from home) across models or the best-off neighborhood across models.

<u>Choice and Predictability</u>

We compute the average number of choices offered for each family and compare across the 16 neighborhoods. We tabulate both the mean and the variation below.

Average # of Choices	3-Zone	6-Zone	9-Zone	11-Zone	23-Zone	Grouped Zone 1	Grouped Zone 2	Grouped-School
Mean	25.1	14.9	10	8.6	5.1	8.8	9.2	**7.9**
Variation across neighborhoods	22.0-27.2	6.0-20.3	6.0-13.4	3.3-12.3	1.8-7.8	5.3-12.7	6.0-12.7	**5.3- 10.6**

There is a tradeoff between choice and predictability because the higher number of options the greater the choice (but the lower the predictability because one can potentially be assigned to many schools); conversely the lower the number of options the lower the choice (but the greater the predictability). It is best to offer a balance of not too many choices and not too few.

As shown above, whether comparing district averages or the neighborhood with most # of choices (least predictable), the Grouped-School model achieves better predictability (in terms of offering fewer choices) than all but the 23-zone model. For the neighborhoods offered the least options, whereas in the 11-zone or 23-zone models sometimes they only get 1, 2, or 3 options, in the Grouped-School model they get slightly more than 5. So the Grouped-School model strikes a good balance between predictability and choice.

Transportation Savings

In addition to average distance to choice option, we compute two other measures of transportation savings: the % of seats in choice option not in walk-zone and the bus coverage area of the average school (this is the size of the area outside of the school's walk-zone but families there are still offered this school as a choice). For transportation savings the smaller the two measures the better.

	3-Zone	6-Zone	9-Zone	11-Zone	23-Zone	Grouped Zone 1	Grouped Zone 2	Grouped-School
% Choice menu not in walk-zone	85%	75%	63%	58%	30%	58%	61%	**54%**
Average bus coverage area (sq. mile)	21.81	10.59	6.49	4.76	1.62	5.18	5.62	**4.75**

As shown, the Grouped-School model again outperforms all but the 23-zone model. Compared to the current 3-zone model it decreases the area buses from an average school needs to cover from 21.8 square miles to 4.8—a reduction of over 4 times.

Diversity

While the level of actual level diversity in the assignment depends on families choices, we can still obtain a meaningful proxy of diversity offered to a family by examining the demographics make up of all other families that share one or more choice options. (These are the "potential peers.") We estimate the % Free/Reduced lunch, % Racial Demographics of potential peers using past data and tabulate the variation across neighborhoods below.

Neighborhood	3-Zone	6-Zone	9-Zone	11-Zone	23-Zone	Grouped Zone 1	Grouped Zone 2	Partnership
% Free/Reduced Lunch	71%-77%	64%-79%	61%-79%	47%-79%	46%-80%	61%-79%	56%-79%	60%-79%
% Black	28%-46%	10%-47%	10%-48%	4%-48%	4%-54%	4%-47%	10%-47%	4%-49%
% White	8%-14%	6%-20%	5%-22%	5%-40%	4%-42%	6%-28%	5%-29%	5%-26%

% Asian	2%-7%	2%-16%	2%-16%	1%-16%	2%-16%	2%-16%	3%-16%	2%-15%
% Hispanic	37%-52%	38%-60%	36%-60%	32%-77%	32%-77%	35%-77%	36%-61%	34%-77%
% Other	3%-3%	2%-4%	2%-4%	1%-4%	1%-4%	1%-4%	2%-4%	1%-4%

The range is expected to be greater for models with larger bus coverage, and indeed the current 3-zone model has highest diversity in potential peers. The Grouped-School Model performs similar to the 9-zone model and not much behind the 6-zone model in all the metrics except for % Hispanics, in which the highest is 77% in Grouped-Schools but only 60% in 6 and 9 Zones. This is due to the outlier of East Boston, which under the proposed school partnership map is not integrated with the rest of the city since it already has good quality schools (see Appendix 3 for neighborhood breakdowns). The Grouped-School Model generally outperforms the 11-Zone and 23-Zone BPS models in diversity.

6. How the model fits within the larger picture

<u>SPED and ELL</u>

For SPED and ELL, one option is to keep the BPS proposed overlay zones. Another option is to also adopt a partnership framework, with a different overlay "specialized partnership map" for each of these programs. We then offer each family say the 2 closest programs that meet their need plus the "specialized partners" of these programs. Here the partnerships are either formed to balance some kind of quality or to simply help meet supply and demand. For example, if in an area for one year we have an unexpectedly high amount of demand, these partnership links would help us to meet some of this demand using further away schools. In essence, whenever in the current proposals we have "overlay zones," we can replace with an "overlay specialized school partnership map."

<u>School Mergers into K-8 Pathways</u>

While in most of this report we viewed school partnerships as simply a tool to help provide equity in assignment, in many cases it may be useful to interpret partnerships in more substantive terms. At a minimum, partner schools can share best practices and specialized programs. Sometimes it may be best to actually merge the partner schools into one big K-8 pathway, much as what happened with Beethoven and Ohrenberger in West Roxbury and Quincy Lower and Upper in the North End. Many studies have shown that having K-8 pathways is beneficial to students so this would not only provide more equitable access to quality, but directly improve quality itself.

Such mergers would be especially useful in cases in which a good quality school from a higher socio-economic neighborhood is grouped with a lower quality school from a lower socio-economic neighborhood. In this case we may worry about families from the higher socio-economic neighborhood opting out if they are assigned to the further away, lower quality school. However, if we merge the schools into one big K-8 pathway, and start the lower grades in the better quality school, families may be comforted that their children would have a strong foundation and can travel together to the other school building with all their friends and teachers. This may largely eliminate such middle-class opt outs. This strategy also improves diversity as children from different socio-economic backgrounds will be classmates. This merger can take place via a gradual transition process, with only one grade moving at a time, much as what happened with Beethoven and Ohrenberger.

To decide which partnerships to keep as separate schools and which partnerships to perform mergers into K-8 pathways, BPS would take into consideration size of the programs, proximity, and input from school communities.

<u>Other Compatible Reforms:</u>

This framework can also accommodate the following additional reforms:

- Parent compacting to under-selected schools as in Quality Choice Plan (this would not be limited to families' choice menus but can be to any under-selected school in the city)
- City-wide magnets (these schools or programs within schools would not participate in the regular city-partnerships, but all families may pick this as one option).
- Optional changes in the assignment algorithm (see Appendix 1 for details):
    - To guarantee more explicitly equitable access to quality
    - To make sure every kid is assigned to at least one of their choice options
    - To improve community cohesion (probability that kids from same local neighborhood go to school together, even if it's not a neighborhood school.)

Appendix 1. Model Details

How often to revise school grouping?

The timeframe in which a school reliably changes in quality in maybe 5-10 years, so quality partnerships, once formed, should only be dissolved at least this many years later. To maintain predictability, we also want to enforce that for each family, at most one of their choice options can change once every say 3-4 years. Changing quality partnerships too often also increases transportation costs because after a change we need to maintain a bus route for maybe 8 years to grandfather previously assigned kids. However, the ability to evaluate each school partnership independently and potentially change a few say once every 5-10 years is still much more adaptable than zones. (The current 3-zones were drawn 25 years ago and despite many attempts every change has so far been blocked.)

Walk-zone Priorities?

While this model can function using the same assignment algorithm and walk/sibling priorities as currently, because we are eliminating arbitrary boundary lines and always offering the closest schools, it may be that we can eliminate walk-zone priorities. This would enhance the equitable access properties of this model, because walk-zones inherently distort equitable access.

A fuller analysis of the effects of walk-zone priorities in this model requires access to BPS micro-level preference data, which we are requesting but have not been able to get. This is because whether or not walk-zone priorities matter for a school depends on how many families from within and from outside the neighborhood demand a school. With past choice rankings we can deduce reasonable estimates of how families would choose in a new model, but without this data we cannot assess impacts accurately. This analysis has not been done for any of the proposed models.

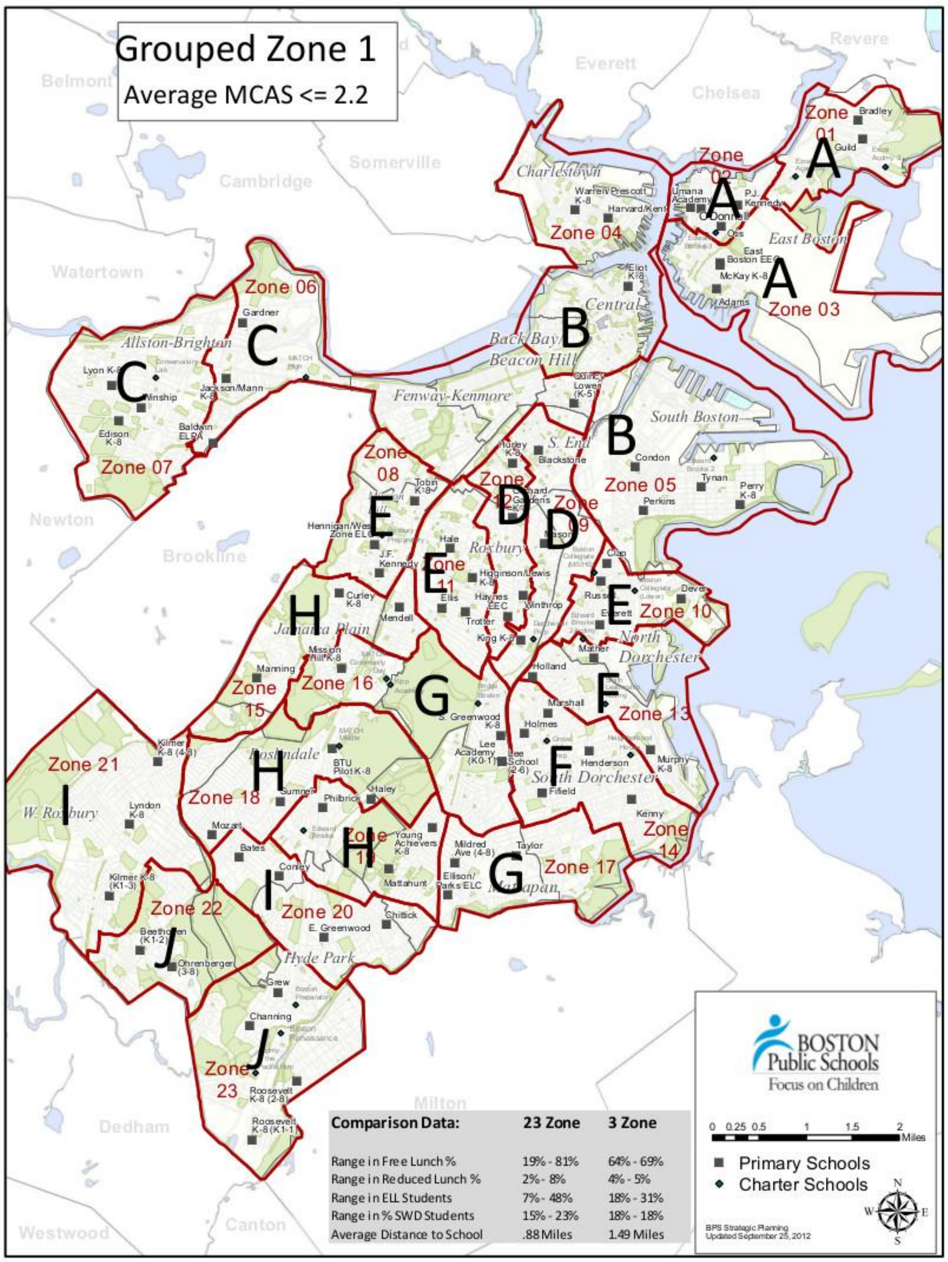
Optional modification to the assignment algorithm

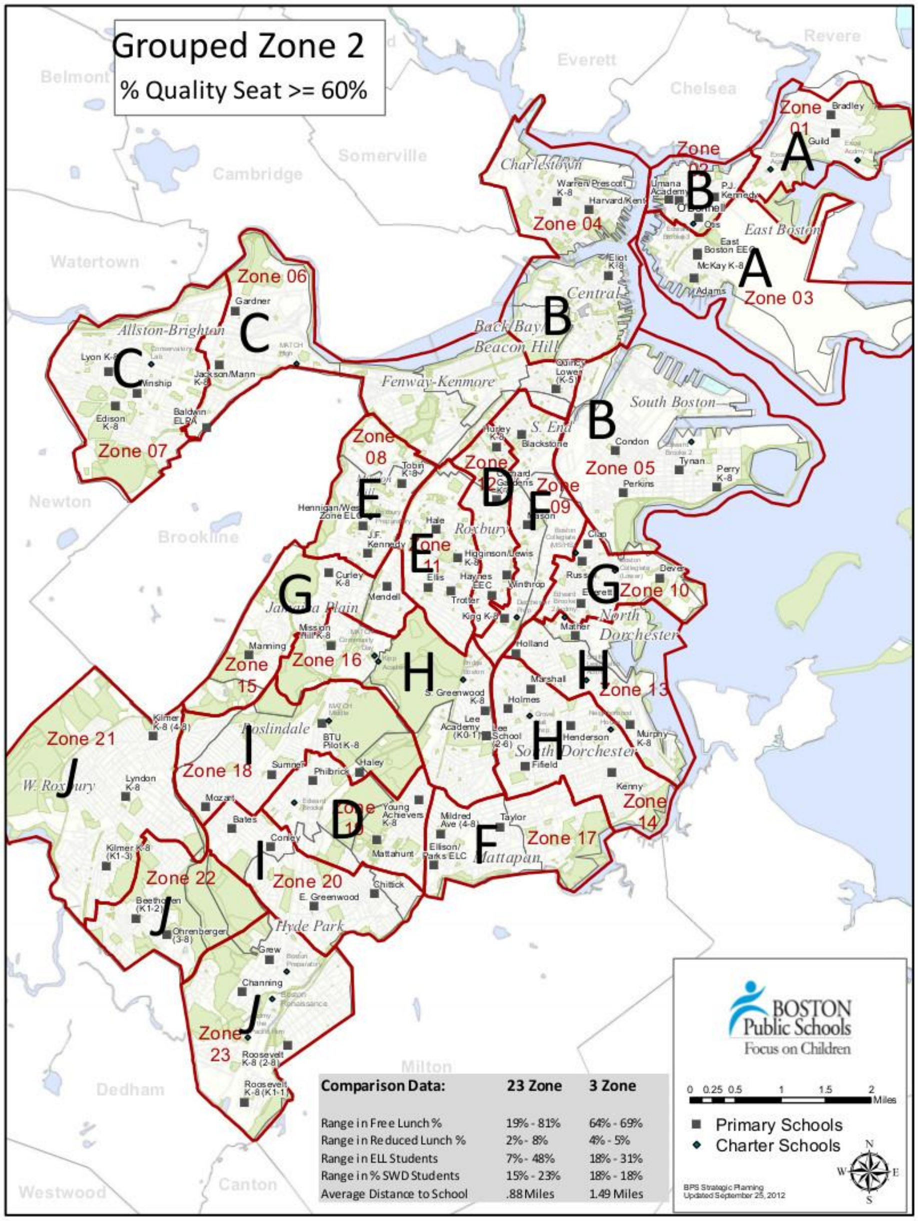
While the current algorithm will work with this model we recommend the following modifications to

- Decrease unassigned kids: if all of a child's choice options become full but his/her lottery number is not high enough to get in, we can slightly bump up his/her lottery number to guarantee assignment in one of the choice options (provided we started with enough capacity).
- Increase Community Cohesion: use the math trick described in http://www.mit.edu/~pengshi/papers/community-cohesion-short.pdf to increase chances neighbors go to the same school while keeping everyone's individual assignment probabilities fixed.

Appendix 2. Grouped-Zone Models and Analysis

Using the BPS 23 zones, we also computed two zone-based models with possibly geographically discontinuous zones by pairing/grouping zones to balance quality. Note that better results would likely be achieved by creating zones specifically with pairing in mind, but for now we use the zones already created by BPS. For the first model we used zone average MCAS Snapshot<=2.2 as the equity requirement and minimized between group distances; for the second model, we requires every zone to have at least 60% seats with MCAS Snapshot<=2.25 (BPS definition of quality). The maps are shown below.





The following charts show the summary statistics of these models. To allow comparisons we also include our estimates for the 6-zone and 9-zone models (because unlike with BPS we use only Reg. Ed. Capacities and Reg. Ed. enrollment data, and there might be other small discrepancies in assumptions so it is hard to compare directly.)

Grouped Zone 1[2]

The benefit of this model is that it keeps the average MCAS snapshot of every zone <=2.19, which is reasonably close to the district average of 2.05.

Zone	# Schools	Average Distance to Option (mile)	K-5 Enrollment	# of Seats (Reg. K-5)	% Seats High Support/Turn Around	% Seats Quality (MCAS<=2.25)	Weighted Average MCAS Snapshot
A	9	1.16	1704	1557	0%	100%	1.73
B	8	2.1	1467	2542	49%	51%	1.97
C	6	1.68	985	1215	44%	79%	2.11
D	7	1.24	2224	1615	32%	86%	2.05
E	12	1.14	2842	2665	44%	59%	2.18
F	7	1.06	2786	2369	20%	69%	2.05
G	4	1.3	1761	938	44%	56%	2.06
H	10	1.79	1750	2325	40%	60%	2.19
I	6	2.12	1397	1595	40%	60%	2.09
J	4	1.81	1021	1144	49%	51%	2.07
Range	4 - 12	1.06 - 2.12	985 - 2842	938 - 2665	0% - 49%	51% - 100%	1.73 - 2.19

Zone	% Free/Reduced Lunch	% Black	% White	% Asian	% Hispanic	% Other
A	61%	4%	15%	3%	77%	1%
B	66%	18%	33%	9%	37%	3%
C	74%	18%	18%	16%	43%	4%
D	80%	43%	6%	7%	41%	3%
E	83%	45%	2%	2%	49%	2%
F	74%	45%	8%	14%	30%	3%
G	78%	52%	5%	3%	38%	3%
H	62%	27%	22%	2%	46%	3%
I	53%	31%	28%	2%	36%	2%
J	70%	37%	15%	3%	43%	2%
Range	53% - 83%	4% - 52%	2% - 33%	2% - 16%	30% - 77%	1% - 4%
District Average	72%	34%	13%	6%	44%	3%

[2] Computed using Reg. Ed. demand and capacities only, and only considering schools that have positive grade 1 capacity.

Grouped Zone 2

The benefit of this model is that if one measures equity of access by requiring every zone to have at least 60% of seats be of "high" quality (MCAS<=2.25 according to BPS definition of top 66% in MCAS), then this model achieves this in 10 out of 10 zones.

Zone	# Schools	Average Distance to Option (mile)	K-5 Enrollment	# of Seats (Reg. K-5)	% Seats High Support/Turn Around	% Seats Quality (MCAS<=2.25)	Weighted Average MCAS Snapshot
A	5	1.33	834	799	0%	100%	1.78
B	12	3.66	2337	3300	38%	62%	1.9
C	6	1.68	985	1215	44%	79%	2.11
D	8	2.11	1894	2112	36%	64%	2.32
E	9	0.99	1813	1969	45%	61%	2.23
F	5	2	1816	1048	49%	78%	2.09
G	6	1.35	1402	1247	36%	61%	1.85
H	9	1.31	3711	2931	30%	60%	2.09
I	7	1.56	1648	1636	39%	61%	2.1
J	6	2.28	1495	1708	33%	67%	1.97
Range	5-12	0.99 - 3.66	834 - 3711	799 - 3300	0% - 49%	60% - 100%	1.78 - 2.32

Zone	% Free/Reduced Lunch	% Black	% White	% Asian	% Hispanic	% Other
A	63%	6%	20%	2%	70%	2%
B	63%	12%	25%	7%	55%	2%
C	74%	18%	18%	16%	43%	4%
D	75%	45%	8%	6%	38%	3%
E	82%	44%	2%	2%	50%	2%
F	81%	49%	3%	5%	40%	3%
G	76%	38%	8%	2%	49%	3%
H	75%	45%	8%	11%	33%	3%
I	64%	33%	18%	1%	45%	2%
J	55%	26%	31%	4%	36%	3%
Range	55% - 82%	6% - 49%	2% - 31%	1% - 16%	33% - 70%	2% - 4%
District Average	72%	34%	13%	6%	44%	3%

6-Zone

Zone	# Schools	Average Distance to Option (mile)	K-5 Enrollment	# of Seats (Reg. K-5)	% Seats High Support/Turn Around	% Seats Quality (MCAS<=2.25)	Weighted Average MCAS Snapshot
1	13	3.29	2512	2842	0%	100%	1.52
2	6	1.68	985	1215	44%	79%	2.11
3	20	1.89	4697	4841	55%	53%	2.29
4	8	2.01	2024	1718	34%	66%	1.89
5	12	1.71	4651	3441	22%	69%	2.02
6	14	2.41	3069	3908	50%	50%	2.25
Range	6-20	1.68 - 3.29	985 - 4697	1215 - 4841	0% - 55%	50% - 100%	1.52 - 2.29

Zone	% Free/Reduced Lunch	% Black	% White	% Asian	% Hispanic	% Other
1	61%	8%	22%	6%	63%	2%
2	74%	18%	18%	16%	43%	4%
3	79%	40%	8%	5%	45%	3%
4	67%	30%	19%	2%	46%	3%
5	77%	48%	6%	9%	34%	3%
6	63%	36%	20%	2%	39%	3%
Range	61% - 79%	8% - 48%	6% - 22%	2% - 16%	34% - 63%	2% - 4%
District Average	72%	34%	13%	6%	44%	3%

9-Zone

Zone	# Schools	Average Distance to Option (mile)	K-5 Enrollment	# of Seats (Reg. K-5)	% Seats High Support/Turn Around	% Seats Quality (MCAS<=2.25)	Weighted Average MCAS Snapshot
1	13	3.29	2512	2842	0%	100%	1.52
2	6	1.68	985	1215	44%	79%	2.11
3	9	0.99	1813	1969	45%	61%	2.23
4	11	1.55	2883	2872	62%	48%	2.33
5	5	1.67	1298	1113	52%	48%	1.93
6	6	1.33	2164	2006	14%	84%	1.89
7	6	1.2	2487	1435	32%	48%	2.19
8	7	1.43	1376	1774	43%	57%	2.37
9	10	2.33	2418	2739	44%	56%	2.08
Range	5-13	0.99 - 3.29	985 - 2883	1113 - 2872	0% - 62%	48% - 100%	1.52 - 2.37

Zone	% Free/Reduced Lunch	% Black	% White	% Asian	% Hispanic	% Other
1	61%	8%	22%	6%	63%	2%
2	74%	18%	18%	16%	43%	4%
3	82%	44%	2%	2%	50%	2%
4	78%	37%	11%	7%	41%	3%
5	72%	37%	12%	2%	45%	3%
6	80%	45%	4%	9%	40%	3%
7	74%	50%	7%	10%	30%	3%
8	64%	30%	20%	2%	45%	3%
9	60%	34%	23%	3%	39%	2%
Range	60% - 82%	8% - 50%	2% - 23%	2% - 16%	30% - 63%	2% - 4%
District Average	72%	34%	13%	6%	44%	3%

Appendix 3. Technical Details and Additional Charts

Data Sources for Estimates

We computed all estimates using only Reg. Ed. capacity and demand. We also only consider schools that have positive grade 1 capacity (so not schools with only grades 3-8 because entering families cannot directly choose these.) For cases such as Beethoven K1-2 (which feeds into Ohrenberger 3-8), Kilmer K1-3 (feeding into Kilmer K-8) and Lee Academy (feeding into Lee school 2-6), we treated them as one school. We left out Hernandez in all analysis. For demand estimate, we averaged the current enrollments from grades K2 to grade 5.

For distribution of demand across geography, we used BPS geocodes, which are 800+ small divisions of the city. We have the centroids of these locations and the area of each, and we used these coordinates as proxies for family location and the area to compute bus coverage.

For distances, we queried Google Maps to obtain walking distances from every geocode to every school. We estimate school location using the centroid of the geocode the school resides in.

None of our analysis examines the effects of sibling and walk-zone priorities, but to truly study these we need micro-level preference data (which we are requesting but do not yet have) to produce estimates on the distribution of families' preferences under the new model.

The following pages show neighborhood by neighborhood details of our analysis in Section 5.

Equitable Access to Quality

Weighted Average MCAS Snapshot of Choice Options								
Neighborhood	3-Zone	6-Zone	9-Zone	11-Zone	23-Zone	Grouped Zone 1	Grouped Zone 2	Grouped-School
All-Bri	1.78	2.11	2.11	2.11	2.11	2.11	2.11	2.11
Back-Bay/BH	1.78	1.8	1.8	1.67	1.7	2.01	1.98	2.04
Central Bos	1.78	1.56	1.56	1.36	1.36	1.98	1.91	2.04
Charlestown	1.78	1.52	1.52	1.27	1.27	1.97	1.9	1.94
East Boston	1.78	1.52	1.52	1.73	1.7	1.73	1.83	1.68
Fen/Kenmore	1.78	2.16	2.14	2.14	2.21	2.13	2.14	2.09
Hyde Park	2.28	2.25	2.1	2.37	2.41	2.12	2.07	2.16
Jamaica Pla	1.89	2.15	2.11	2.11	2.11	2.14	2.13	2.11
Mattapan	2.29	2.07	2.18	2.2	2.28	2.18	2.18	2.16
N. Dorchest	2.23	2.21	2.21	2.21	1.92	2.02	2.19	2.11
Roslindale	1.97	2.04	2.27	2.33	2.05	2.15	2.12	2.12
Roxbury	1.99	2.21	2.2	2.2	2.19	2.17	2.16	2.14
S. Boston	2.32	2.29	2.32	2.32	2.61	1.96	1.9	2.11
S. Dorchest	2.33	2.03	2.12	2.12	2.13	2.07	2.09	2.15
South End	1.78	2.06	2	2	1.92	2.02	1.87	2.12
W. Roxbury	1.94	2.23	2.1	1.6	1.56	2.08	1.97	2.07
Across Neighborhood Variation	1.78-2.33	1.52-2.29	1.52-2.32	1.27-2.37	1.27-2.61	1.73-2.18	1.83-2.19	1.68-2.16

Proximity to Home

Average Distance to Choice Options								
Neighborhood	3-Zone	6-Zone	9-Zone	11-Zone	23-Zone	Grouped Zone 1	Grouped Zone 2	Grouped-School
All-Bri	5.09	1.25	1.25	1.25	0.91	1.25	1.25	1.25
Back-Bay/BH	3.88	3.6	3.6	2.31	1.93	2.59	2.99	1.82
Central Bos	3.95	4	3.99	1.32	1.31	1.7	2.61	1.52
Charlestown	4.08	3.27	3.27	1.3	1.3	2.52	2.93	2.42
East Boston	5.89	3.22	3.22	1.16	0.53	1.16	3.1	0.67
Fen/Kenmore	4.13	3.03	2.78	2.78	2.19	2.82	2.78	1.48
Hyde Park	4.31	2.33	2.32	1.66	1.2	1.94	2.02	1.93
Jamaica Pla	3.05	2.08	1.3	1.3	1.08	1.6	1.48	1.02
Mattapan	2.8	2.29	1.7	1.65	0.87	1.34	2.07	1.48
N. Dorchest	3.08	1.7	1.34	1.34	0.85	1.09	2.03	1.1
Roslindale	2.55	2.03	1.51	1.47	1.04	1.65	1.77	1.5
Roxbury	2.91	1.79	1.35	1.35	0.88	1.21	1.19	1.06
S. Boston	3.59	2.07	1.32	1.32	0.76	1.82	3.15	1.19
S. Dorchest	2.49	1.46	1.09	1.09	0.87	1.07	1.26	1.19
South End	4.06	2.42	2.07	2.07	1.22	1.74	1.96	1.36
W. Roxbury	3.64	2.82	2.46	1.45	0.99	2.12	2.13	2.1
District Average	3.46	2.13	1.78	1.38	0.93	1.44	1.86	1.3
Across Neighborhood Variation	2.49-5.89	1.25-4.00	1.09-3.99	1.09-2.78	0.53-2.19	1.07-2.82	1.19-3.15	0.67-2.42

Choice and Predictability

# of Choices								
Neighborhood	3-Zone	6-Zone	9-Zone	11-Zone	23-Zone	Grouped Zone 1	Grouped Zone 2	Grouped-School
All-Bri	25	6	6	6	3.6	6	6	6
Back-Bay/BH	25	9.9	9.9	5.5	4	7.5	9.4	7.9
Central Bos	25	13.5	13.4	4.5	4.4	8.4	12.4	7
Charlestown	25	13	13	4	4	8	12	7
East Boston	25	13	13	9	4.8	9	10.1	5.3
Fen/Kenmore	25.1	10.1	7.2	7.2	4	8	7.2	6.1
Hyde Park	25.6	14.1	10.2	7.2	3.8	5.3	6.8	7.3
Jamaica Pla	24.2	17	8.6	8.6	6	11.3	9.6	8
Mattapan	25.9	11.7	6.9	6.7	3.4	6	8	7.3
N. Dorchest	27.2	20	11.6	11.6	6	8.5	10	8.1
Roslindale	22.2	11.9	8.3	7.6	4.7	9.7	8	7.7
Roxbury	25.1	20.3	12.3	12.3	7.8	12.7	11.1	10.6
S. Boston	26	20	11	11	4.7	8.7	12.7	7.5
S. Dorchest	26.2	12.9	7.9	7.9	5.5	7.7	9.1	7.9
South End	25.2	15.6	9.5	9.5	4.8	10.7	7.5	8.7
W. Roxbury	22	13.7	9.9	3.3	1.8	5.5	6.2	6.5
District Average	25.1	14.9	10	8.6	5.1	8.8	9.2	7.9
Across Neighborhood Variation	22.0-27.2	6.0-20.3	6.0-13.4	3.3-12.3	1.8-7.8	5.3-12.7	6.0-12.7	5.3-10.6

Transportation Savings

% of Seats in Choice Option Not in Walk Zone								
Neighborhood	3-Zone	6-Zone	9-Zone	11-Zone	23-Zone	Grouped Zone 1	Grouped Zone 2	Grouped-School
All-Bri	91%	62%	62%	62%	35%	62%	62%	62%
Back-Bay/BH	93%	83%	83%	73%	68%	82%	84%	83%
Central Bos	92%	86%	86%	70%	70%	84%	87%	80%
Charlestown	87%	76%	76%	46%	46%	73%	79%	71%
East Boston	85%	71%	71%	47%	0%	47%	57%	13%
Fen/Kenmore	96%	91%	87%	87%	76%	89%	87%	79%
Hyde Park	93%	88%	83%	75%	55%	69%	74%	78%
Jamaica Pla	83%	80%	58%	58%	38%	69%	60%	45%
Mattapan	93%	81%	67%	67%	31%	59%	74%	70%
N. Dorchest	84%	76%	62%	62%	25%	45%	56%	50%
Roslindale	86%	76%	67%	65%	38%	70%	66%	66%
Roxbury	73%	69%	49%	49%	18%	48%	40%	43%
S. Boston	88%	80%	67%	67%	30%	64%	72%	57%
S. Dorchest	83%	65%	46%	46%	27%	50%	56%	46%
South End	86%	79%	70%	70%	37%	68%	55%	63%
W. Roxbury	95%	94%	91%	74%	54%	83%	86%	86%
District Average	85%	75%	63%	58%	30%	58%	61%	54%
Across Neighborhood Variation	73%-96%	62%-94%	46%-91%	46%-87%	0%-76%	45%-89%	40%-87%	13%-86%

Average Bus Pick-up Area for a School (sq. miles)								
Model	3-Zone	6-Zone	9-Zone	11-Zone	23-Zone	Grouped Zone 1	Grouped Zone 2	Grouped-School
Area (sq. miles)	21.81	10.59	6.49	4.76	1.62	5.18	5.62	4.75

Socio-Economic Diversity

% of Free/Reduced Lunch Among Potential Peers								
Neighborhood	3-Zone	6-Zone	9-Zone	11-Zone	23-Zone	Grouped Zone 1	Grouped Zone 2	Grouped-School
All-Bri	74%	74%	74%	74%	75%	74%	74%	73%
Back-Bay/BH	74%	70%	69%	72%	74%	73%	71%	76%
Central Bos	74%	68%	67%	71%	72%	72%	68%	74%
Charlestown	74%	64%	64%	68%	68%	69%	65%	70%
East Boston	74%	64%	64%	61%	61%	61%	64%	61%
Fen/Kenmore	73%	77%	77%	77%	79%	78%	77%	79%
Hyde Park	76%	65%	61%	66%	68%	64%	61%	65%
Jamaica Pla	71%	77%	79%	79%	77%	77%	79%	76%
Mattapan	76%	73%	74%	75%	77%	75%	78%	75%
N. Dorchest	74%	78%	79%	79%	79%	79%	77%	79%
Roslindale	72%	69%	65%	68%	64%	66%	67%	63%
Roxbury	72%	77%	78%	78%	80%	78%	78%	79%
S. Boston	77%	79%	79%	79%	74%	72%	68%	72%
S. Dorchest	76%	78%	77%	77%	77%	78%	77%	78%
South End	73%	76%	76%	77%	80%	78%	77%	78%
W. Roxbury	71%	65%	61%	47%	46%	61%	56%	60%
Across Neighborhood Variation	71%-77%	64%-79%	61%-79%	47%-79%	46%-80%	61%-79%	56%-79%	60%-79%

Racial Diversity

% Black Among Potential Peers								
Neighborhood	3-Zone	6-Zone	9-Zone	11-Zone	23-Zone	Grouped Zone 1	Grouped Zone 2	Partnership
All-Bri	28%	18%	18%	18%	18%	18%	18%	14%
Back-Bay/BH	28%	20%	18%	23%	23%	24%	21%	34%
Central Bos	28%	19%	17%	25%	24%	25%	19%	30%
Charlestown	28%	10%	10%	19%	19%	19%	12%	21%
East Boston	28%	10%	10%	4%	4%	4%	10%	4%
Fen/Kenmore	28%	30%	31%	31%	27%	32%	31%	41%
Hyde Park	45%	38%	33%	38%	39%	34%	31%	34%
Jamaica Pla	31%	39%	44%	44%	40%	42%	43%	39%
Mattapan	46%	43%	45%	46%	54%	47%	47%	49%
N. Dorchest	41%	43%	43%	43%	44%	44%	45%	44%
Roslindale	37%	37%	36%	39%	31%	34%	36%	32%
Roxbury	35%	42%	43%	43%	45%	43%	45%	44%
S. Boston	46%	41%	43%	43%	29%	26%	19%	28%
S. Dorchest	45%	47%	48%	48%	48%	47%	47%	49%
South End	29%	38%	36%	39%	42%	39%	40%	41%
W. Roxbury	37%	38%	33%	20%	18%	33%	28%	32%
Across Neighborhood Variation	28%-46%	10%-47%	10%-48%	4%-48%	4%-54%	4%-47%	10%-47%	4%-49%

% White Among Potential Peers								
Neighborhood	3-Zone	6-Zone	9-Zone	11-Zone	23-Zone	Grouped Zone 1	Grouped Zone 2	Partnership
All-Bri	11%	18%	18%	18%	18%	18%	18%	21%
Back-Bay/BH	11%	16%	17%	20%	19%	20%	17%	14%
Central Bos	11%	16%	18%	21%	21%	22%	18%	19%
Charlestown	11%	20%	20%	26%	26%	28%	21%	26%
East Boston	11%	20%	20%	15%	15%	15%	21%	15%
Fen/Kenmore	12%	12%	11%	11%	10%	10%	11%	6%
Hyde Park	8%	18%	22%	15%	14%	20%	23%	18%
Jamaica Pla	14%	9%	5%	5%	6%	7%	5%	7%
Mattapan	8%	10%	9%	8%	5%	8%	6%	8%
N. Dorchest	10%	7%	7%	7%	6%	6%	7%	6%
Roslindale	13%	15%	18%	15%	19%	18%	16%	20%
Roxbury	13%	8%	7%	7%	4%	6%	5%	5%
S. Boston	8%	7%	7%	7%	21%	22%	18%	20%
S. Dorchest	8%	6%	6%	6%	6%	6%	6%	5%
South End	12%	9%	10%	9%	6%	8%	8%	8%
W. Roxbury	13%	18%	22%	40%	42%	22%	29%	24%
Across Neighborhood Variation	8%-14%	6%-20%	5%-22%	5%-40%	4%-42%	6%-28%	5%-29%	5%-26%

% Asian Among Potential Peers								
Neighborhood	3-Zone	6-Zone	9-Zone	11-Zone	23-Zone	Grouped Zone 1	Grouped Zone 2	Partnership
All-Bri	6%	16%	16%	16%	15%	16%	16%	15%
Back-Bay/BH	6%	9%	9%	13%	14%	12%	9%	7%
Central Bos	6%	7%	7%	12%	13%	10%	7%	8%
Charlestown	6%	8%	8%	16%	16%	12%	8%	11%
East Boston	6%	8%	8%	3%	3%	3%	6%	3%
Fen/Kenmore	6%	10%	9%	9%	10%	9%	9%	4%
Hyde Park	6%	2%	3%	2%	2%	3%	3%	4%
Jamaica Pla	4%	5%	2%	2%	2%	2%	3%	2%
Mattapan	7%	5%	5%	5%	3%	3%	6%	7%
N. Dorchest	6%	7%	8%	8%	8%	9%	7%	8%
Roslindale	3%	2%	2%	1%	2%	2%	3%	2%
Roxbury	5%	7%	6%	6%	4%	5%	5%	5%
S. Boston	7%	6%	7%	7%	8%	10%	8%	11%
S. Dorchest	6%	7%	7%	7%	9%	9%	8%	8%
South End	6%	7%	8%	8%	6%	7%	5%	5%
W. Roxbury	2%	2%	3%	5%	6%	3%	4%	3%
Across Neighborhood Variation	2%-7%	2%-16%	2%-16%	1%-16%	2%-16%	2%-16%	3%-16%	2%-15%

% Hispanic Among Potential Peers								
Neighborhood	3-Zone	6-Zone	9-Zone	11-Zone	23-Zone	Grouped Zone 1	Grouped Zone 2	Partnership
All-Bri	52%	43%	43%	43%	44%	43%	43%	46%
Back-Bay/BH	52%	53%	52%	39%	41%	40%	50%	42%
Central Bos	52%	56%	56%	38%	39%	39%	54%	41%
Charlestown	52%	60%	60%	36%	36%	39%	56%	39%
East Boston	52%	60%	60%	77%	77%	77%	61%	77%
Fen/Kenmore	52%	44%	46%	46%	50%	46%	46%	47%
Hyde Park	37%	38%	40%	43%	43%	41%	40%	41%
Jamaica Pla	48%	44%	46%	46%	49%	46%	46%	49%
Mattapan	37%	39%	38%	38%	36%	39%	38%	34%
N. Dorchest	40%	40%	40%	40%	39%	39%	38%	38%
Roslindale	44%	42%	41%	42%	45%	43%	43%	42%
Roxbury	44%	40%	42%	42%	44%	43%	43%	43%
S. Boston	37%	44%	41%	41%	40%	39%	52%	38%
S. Dorchest	37%	38%	36%	36%	34%	35%	36%	35%
South End	51%	43%	44%	40%	43%	43%	45%	43%
W. Roxbury	45%	39%	40%	32%	32%	40%	37%	39%
Across Neighborhood Variation	37%-52%	38%-60%	36%-60%	32%-77%	32%-77%	35%-77%	36%-61%	34%-77%

% Other Among Potential Peers								
Neighborhood	3-Zone	6-Zone	9-Zone	11-Zone	23-Zone	Grouped Zone 1	Grouped Zone 2	Partnership
All-Bri	3%	4%	4%	4%	4%	4%	4%	4%
Back-Bay/BH	3%	3%	3%	3%	3%	3%	3%	3%
Central Bos	3%	2%	2%	3%	3%	3%	2%	3%
Charlestown	3%	2%	2%	3%	3%	3%	2%	3%
East Boston	3%	2%	2%	1%	1%	1%	2%	1%
Fen/Kenmore	3%	4%	4%	4%	4%	4%	4%	3%
Hyde Park	3%	3%	3%	2%	2%	2%	3%	3%
Jamaica Pla	3%	3%	3%	3%	3%	3%	3%	3%
Mattapan	3%	3%	3%	3%	3%	3%	3%	3%
N. Dorchest	3%	3%	3%	3%	3%	3%	3%	3%
Roslindale	3%	3%	3%	3%	3%	3%	3%	3%
Roxbury	3%	3%	3%	3%	3%	3%	3%	3%
S. Boston	3%	3%	3%	3%	3%	3%	2%	3%
S. Dorchest	3%	3%	3%	3%	3%	3%	3%	3%
South End	3%	3%	3%	3%	3%	3%	3%	3%
W. Roxbury	3%	3%	3%	3%	3%	2%	3%	3%
Across Neighborhood Variation	3%-3%	2%-4%	2%-4%	1%-4%	1%-4%	1%-4%	2%-4%	1%-4%