

# Making Census of Cambridge, Massachusetts: Schools, Highways, and Historical GIS

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*Northeast Arc Users Group Spring Meeting — Northampton 5-22-2012*

# Faculty-Student Collaboration

- This work began in a junior-year research seminar in Spring 2011, *Cities, Schools, and Space*
  - Urban history and education policy
  - An experiment to encourage faculty-student collaboration in the humanities and social sciences
  - Also an experiment to integrate GIS into the curriculum
  - Of eight students:
    - Two completed history theses that grew out of their class work
    - One expanded their class work and presented at the American Education Research Association conference.
    - Two collaborated on this work (while writing economics theses!)



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# Opportunity & Infrastructure

- Quality of school facilities is a strong predictor of teacher retention and attrition rates
  - Buckley, Schneider, and Shang 2004
- Positive association exists between school's physical environment and students' behavioral problems
  - Kumar, O'Malley, and Johnston 2008
- In Cambridge, school infrastructure is also linked with educational opportunity...



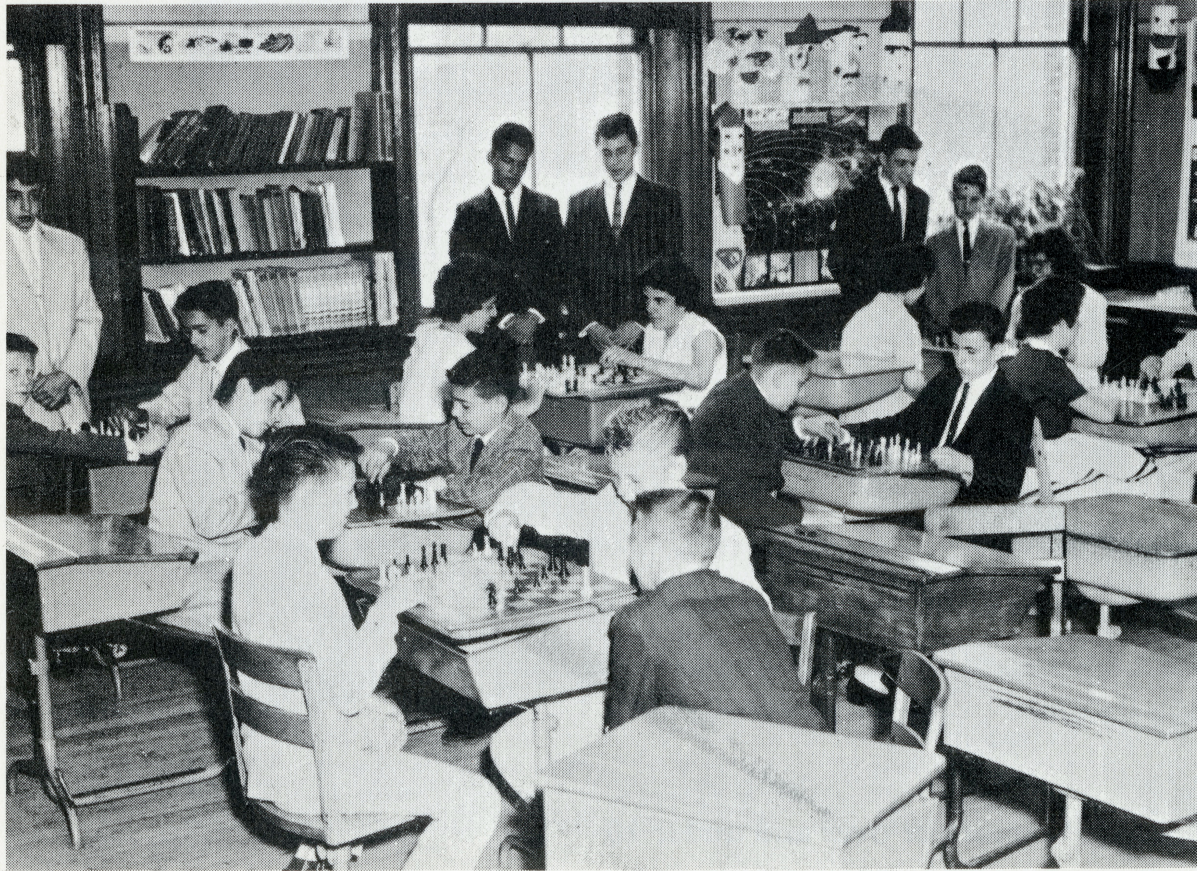
Black School in  
Louisa County, Virginia,  
ca. 1935 (LOC/NAACP)





# Academically Talented Classes

*Learning Number Concepts in Grade I*



*Academically Talented, Grade 6, Peabody School*



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# AT Classes & School Facilities

School	AT Students (1967)	Condition of School Facilities (1967)	Year Opened or Expanded
Agassiz	58%	School freshly painted; rooms light and cheerful. Very pleasant school atmosphere.	1915
Peabody	45%	New, very beautiful building, Library, science room, boys' and girls' gymnasiums, showers, locker rooms, cafeteria, audiovisual room. Auditorium. Heath and dental suites.	1960
Haggerty	24%	Assembly hall, but no gym. Very well kept.	1914
Russell	13%	Assembly hall and gymnasium combined. Home economics and woodworking facilities.	1897, 1924
Longfellow	12%	Light, cheerful classrooms. Assembly Hall converts into gymnasium. Library being set up. Newly installed science room.	1931
Fitzgerald	10%	Attractive building with all facilities such as gymnasiums, cafeteria, home economics and woodworking facilities.	1957
Thorndike	10%	Combination assembly hall and gym. Home economics and woodworking facilities. Though building is fairly old, atmosphere of school is cheerful	1911
Morse	9%	New and very beautiful school. Bright rooms. Ceramic murals. Gymnasiums for boys and girls, cafeteria, excellent facilities for woodworking, sewing and cooking classes. Auditorium; health and dental suites.	1955
Harrington	7%	New, very attractive, and with all facilities, such as gymnasiums, auditorium, and science room.	1959
Fletcher	5%	Assembly hall. No gym, library, or science room. No home economics or woodworking facilities.	1903
Webster	5%	Assembly hall; no gym, library, or science room.	1852, 1885, 1909, 1929
Putnam	4%	Over 100 years old. Lacks all special facilities.	1887
Roberts	4%	Combination of assembly hall and gym.	1929
Houghton	4%	Assembly hall. No gym (physical education held in large room).	1904, 1923

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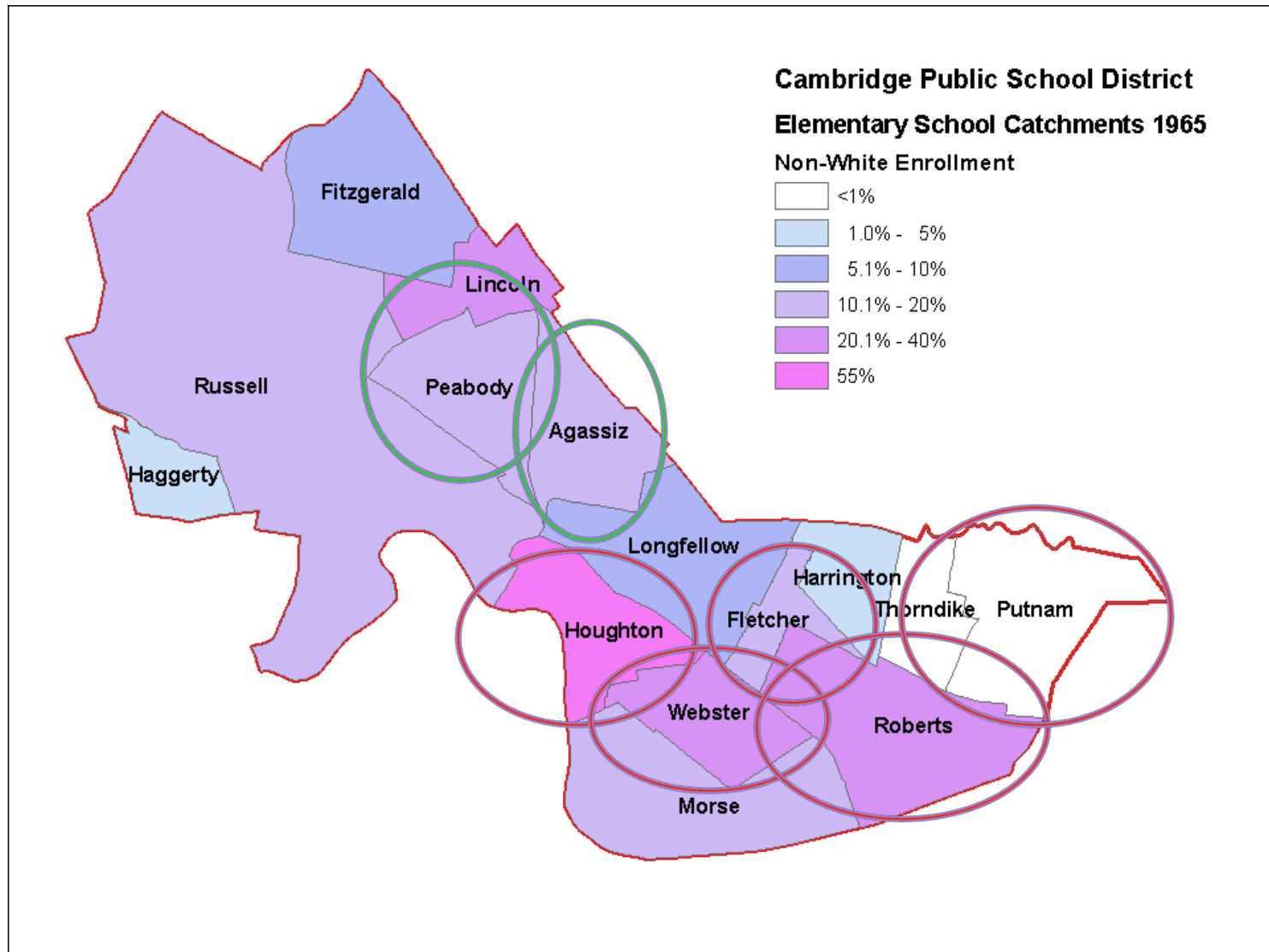
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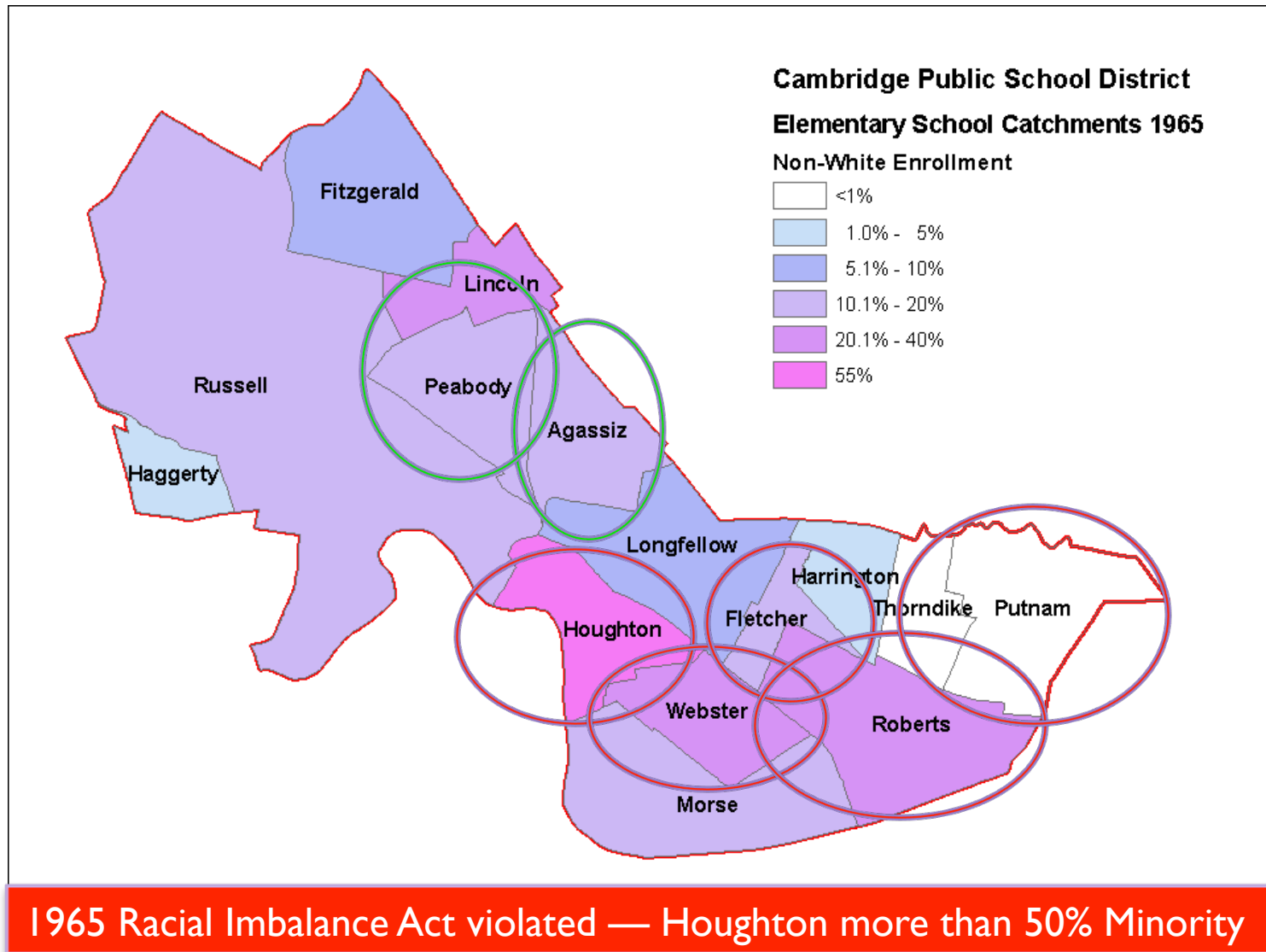
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# School Catchments & Minorities



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# School Catchments & Minorities



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# School Construction in the '60s

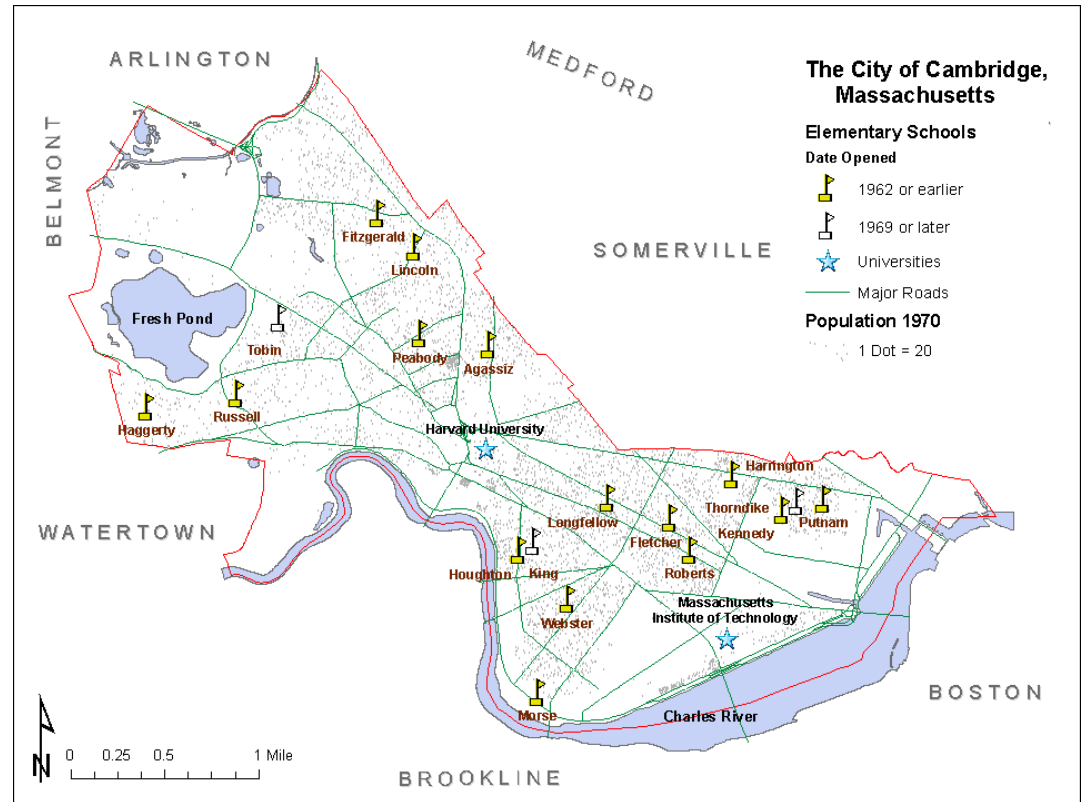
- The School Committee:

- Built three new schools:

- King
    - Kennedy
    - Tobin

- Instituted open enrollment:

- At first just whites *into* and minorities *out of* Houghton/King — no takers
    - Later any school if enrollment allowed — but this only increased imbalance.



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# School Construction Choices

- The School Committee's stated priorities for rebuilding schools were:
  - Expectations of increased enrollment.
    - But Houghton and Putnam/Thorndike actually declined in the '60s.
  - Deficient in facilities.
    - But several schools were in far worse shape than Russell.
- Excluded from these plans:
  - Fletcher
  - Webster
  - Roberts

Why?

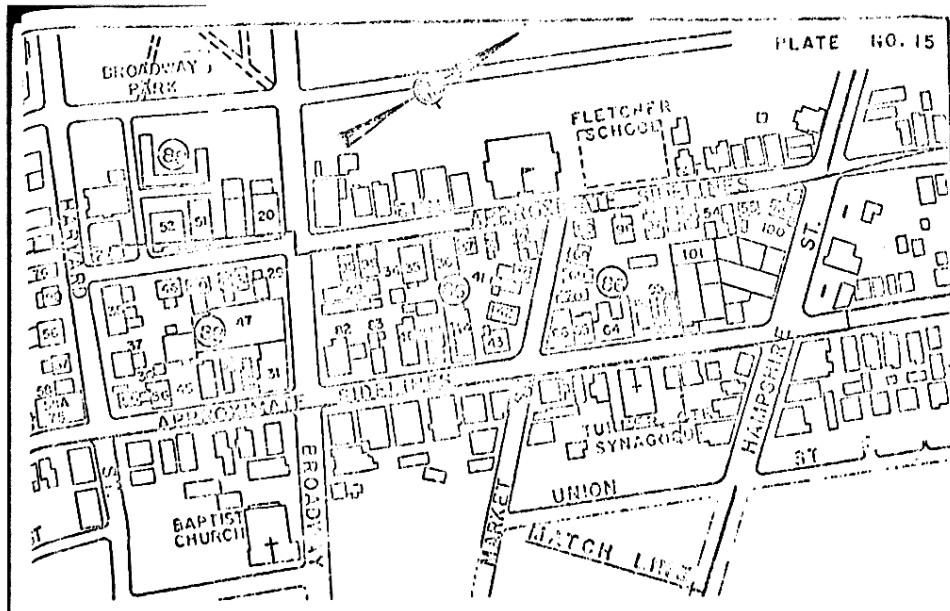


Fletcher (now Cambridgeport)  
School, Cambridge



# Fletcher School

- Fletcher School was an exception due to its proximity to the route of the expected “Inner Belt” Highway



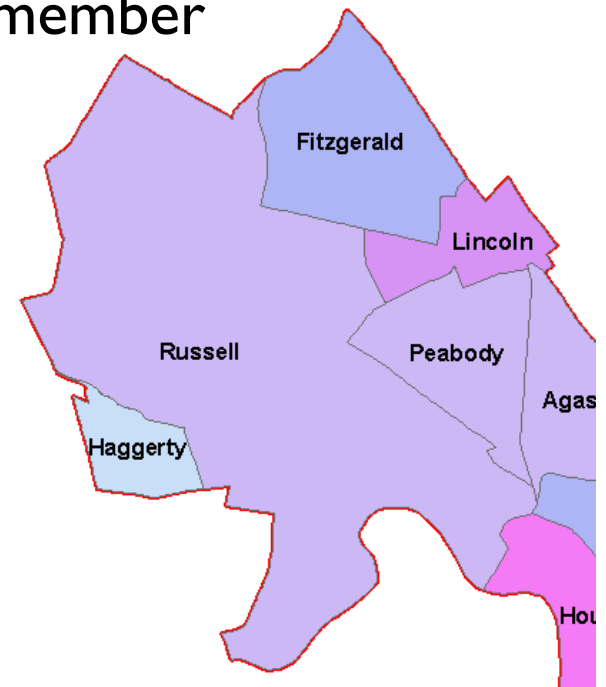
- First identified on maps as an issue, later confirmed in School Committee minutes.

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# Silent Segregation?

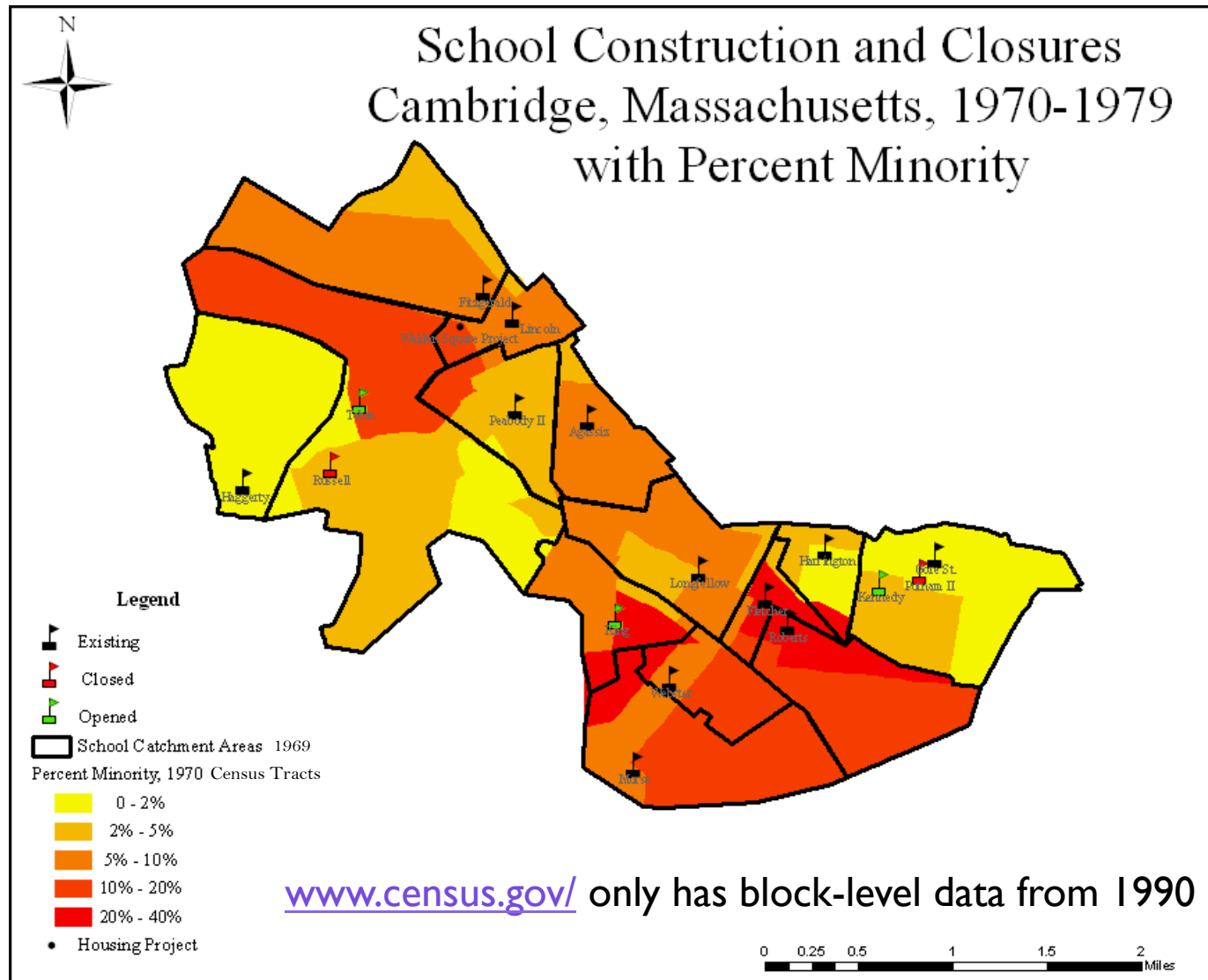
- Even with new schools, long waiting lists existed for the “better” schools, and the School Committee continued to receive complaints.
- In 1976, one School Committee member responded with an accusation of past segregation: Peabody’s zone was drawn “to exclude an established community of blacks in the Concord Avenue area”.



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# Cambridge Minority by Tract



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# Clearer Picture: Census Blocks

Table 2. **Characteristics of Housing Units and Population, by Blocks: 1970—Con.**

Middlesex County, Mass.

[Data exclude vacant seasonal and vacant migratory housing units. For minimum base for derived figures (percent, average, etc.) and meaning of symbols, see text]

Blocks Within Census Tracts	Percent of total population				Year-round housing units				Occupied housing units															
	Total popu- la- tion	Ne- gro	In group quar- ters	Un- der 18 years and over	Total	Lack- ing some or all plumb- ing facili- ties	Units in —		Owner				Renter				1.01 or more persons per room		With room- ers, board- ers, or lodg- ers					
							One- unit struc- tures	Struc- tures of 10 or more units	Total	Lack- ing some or all plumb- ing facili- ties	Aver- age num- ber of rooms	Aver- age value (dol- lars)	Per- cent Negro	Total	Lack- ing some or all plumb- ing facili- ties	Aver- age num- ber of rooms	Aver- age con- tract rent (dol- lars)	Per- cent Negro				Total	With all plumb- ing facili- ties	One- person house- holds
3522	1461	1	-	29	13	538	26	84	1	109	2	5.1	15700	-	405	21	4.1	74	1	50	48	135	50	13
101	59	-	-	44	7	21	1	7	-	5	-	5.4	-	-	-	-	-	-	-	-	-	-	-	-
102	178	2	-	26	16	70	7	5	-	15	1	4.9	-	-	-	-	-	-	-	-	-	-	-	-
103	98	-	-	31	14	40	1	7	1	5	1	4.0	-	-	-	-	-	-	-	-	-	-	-	-
104	100	-	-	39	9	29	2	11	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
105	31	-	-	26	23	14	1	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
106	52	10	-	50	2	12	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
107	91	-	-	35	10	27	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
108	101	-	-	26	20	40	5	8	-	12	-	4.8	-	-	-	-	-	-	-	-	-	-	-	-
109	96	-	-	30	10	38	2	4	-	8	-	5.1	-	-	-	-	-	-	-	-	-	-	-	-
110	107	-	-	28	15	41	1	9	-	10	-	5.4	-	-	-	-	-	-	-	-	-	-	-	-
111	203	-	-	23	16	67	1	16	-	18	-	5.7	-	-	-	-	-	-	-	-	-	-	-	-
112	153	-	-	26	14	61	3	9	-	17	-	5.6	-	-	-	-	-	-	-	-	-	-	-	-
114	96	-	-	25	13	37	-	2	-	7	-	4.9	-	-	-	-	-	-	-	-	-	-	-	-
115	67	-	-	24	8	26	-	3	-	6	-	5.0	-	-	-	-	-	-	-	-	-	-	-	-
116#	29	-	-	38	7	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-



- Discovery in the MIT archives: early block-level data does exist!

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# Census Block Data Extraction

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101	59	-	-	44	7	21	1	7	-	5	-	5.4	...	-	14	1	4.6	72	-	3	3	5	2	-
102	178	2	-	26	16	70	7	5	-	15	1	4.9	...	-	54	6	4.0	72	2	7	7	21	8	1
103	98	-	-	31	14	40	1	7	1	5	1	4.0	...	-	33	-	4.1	66	-	2	2	12	2	-
104	100	-	-	39	9	29	2	11	-	4	...	...	...	-	24	2	4.1	80	-	7	5	6	1	1
105	21	-	-	24	23	14	1	2	-	1	-	...	...	-	11	1	2.0	26	-	1	1	4	1	-

- Last year we transcribed the block data and created block layers for 1940 – 1970
- New this year: some block data now available from the National Historical GIS, [www.nhgis.org/](http://www.nhgis.org/) including 1970 — and raw values rather than percents

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# Census Block Data Suppression

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	Total population	Negro	In group quarters	Under 18 years and over	Total	Lacking some or all plumbing facilities	One-unit structures	Structures of 10 or more units	Total	Lacking some or all plumbing facilities	Average number of rooms	Average value (dollars)	Percent Negro	Total	Lacking some or all plumbing facilities	Average number of rooms	Average contract rent (dollars)	Percent Negro	Total	With all plumbing facilities	One-person households	With female head of family	With roomers, boarders, or lodgers	
3522	1461	1	-	29	13	538	26	84	1	109	2	5.1	15700	-	405	21	4.1	74	1	50	48	135	50	13
101	59	-	-	44	7	21	1	7	-	5	-	5.4	...	-	14	1	4.6	72	-	3	3	5	2	-
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104	100	-	-	39	9	29	2	11	-	4	...	...	...	-	24	2	4.1	80	-	7	5	6	1	1
105	31	-	-	26	23	14	1	2	-	1	...	...	...	-	11	1	3.9	65	-	1	1	4	1	-
106	52	10	-	50	2	12	1	1	-	-	-	-	-	-	12	1	4.8	82	8	3	3	-	4	-
107	91	-	-	35	10	27	1	-	-	1	...	...	...	-	26	1	4.3	79	-	4	4	3	3	1
108	101	-	-	26	20	40	5	8	-	12	-	4.8	25200	-	27	4	4.0	67	-	3	3	12	3	-
109	96	-	-	30	10	38	2	4	-	8	-	5.1	...	-	29	2	3.8	79	-	2	2	13	2	-
110	107	-	-	28	15	41	1	9	-	10	-	5.4	...	-	28	-	4.0	78	-	4	4	10	3	1
111	203	-	-	23	16	67	1	16	-	18	-	5.7	11700	-	47	1	4.9	72	-	4	4	9	7	4
112	153	-	-	26	14	61	3	9	-	17	-	5.6	11900	-	40	2	3.7	74	-	7	7	19	6	-
114	96	-	-	25	13	37	-	2	-	7	-	4.9	-	-	30	-	4.2	79	-	-	-	11	4	5
115	67	-	-	24	8	26	-	3	-	6	-	5.0	...	-	18	-	4.1	83	-	1	1	4	4	-
116#	29	-	-	38	7	15	-	-	-	-	-	-	-	-	12	-	3.4	73	-	2	2	6	-	-

- Many values at the block level are *suppressed* where there are small numbers of people or housing units (...)
- Intended to protect privacy

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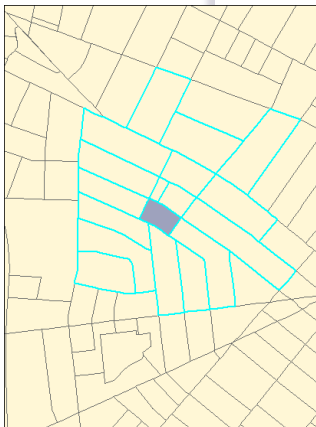




# Census Block Data Enhancement

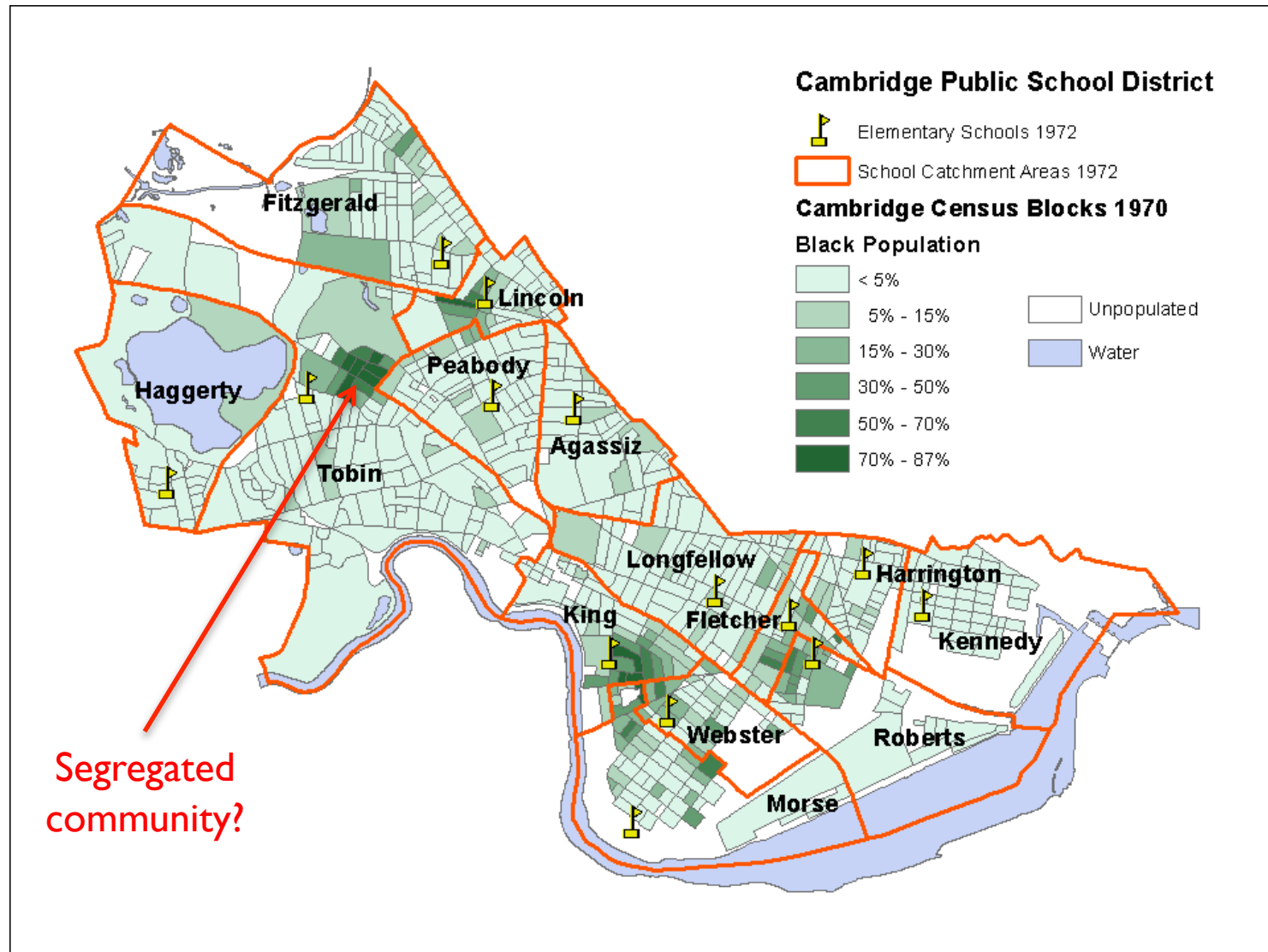
ROW	Tract Block FIPS TRACT BLOCK	Census Tract TRACT	Within Census Tract BLOCK	Count of population				Year-round housing units				Owner				Total Reported Rooms OWNRMSTOT	Units Reporting Values OWNVALCNT	Total Reported Value (Dollars) OWNVALTOT	Count of Negro Units OWNBLKCNT	
				Negro BLACKCNT	In group quarters GRPQTRCNT	Under 18 years AGE18CNT	62 years and over AGE62CNT	Total UNITS TOTAL	Lacking some or all plumbing facilities UNITSNOPLMB	Units in one-unit structures UNITS1Seq1	Units in structures of 10 or more units UNITSge10	Total OWNER OCC	Lacking some or all plumbing facilities OWNNOPLUMB	Average number of rooms OWNRMMSAVG	Average value (dollars) OWNVALAVG					Percent Negro OWNBLKPCPT
27	552200000	3522	000	9	0	430	192	538	26	84	1	109	2	5.1	15700	0	560	36	566500	0
28	ReportingSum	3522	RS	9	0	430	192	538	26	84	1	109	2	5.2	16300	0	534	18	293000	0
29	ReportingDiff	3522	RD	0	0	0	0	0	0	0	0	0	0	0	0	0	26	18	273500	0
30	Total	3522	TT	9	0	430	192	538	26	84	1	109	2	4.9	15700	0	534	36	566500	0
31	352200101	3522	101	0	0	26	4	21	1	7	0	5	0	5.4	0	0	27	1	14400	0
32	352200102	3522	102	4	0	47	28	70	7	5	0	15	1	4.9	0	0	73	4	55700	0
33	352200103	3522	103	5	0	30	14	40	1	7	1	5	1	4.0	0	0	20	1	13450	0
34	352200104	3522	104	0	0	39	9	29	2	11	0	4	0	0.1	0	0	0	1	15900	0
35	352200105	3522	105	0	0	8	7	14	1	2	0	1	0	0.1	0	0	0	0	0	0
36	352200106	3522	106	5	0	26	1	12	1	1	0	0	0	0.0	0	0	0	0	0	0
37	352200107	3522	107	1	0	32	9	27	1	0	0	1	0	0.1	0	0	0	0	0	0
38	352200108	3522	108	0	0	26	20	40	5	8	0	12	0	4.8	25200	0	58	6	151250	0
39	352200109	3522	109	0	0	29	10	38	2	4	0	8	0	5.1	0	0	41	3	44250	0
40	352200110	3522	110	0	0	30	16	41	1	9	0	10	0	5.4	0	0	54	3	47550	0
41	352200111	3522	111	0	0	46	33	67	1	16	0	18	0	5.7	11700	0	102	5	58500	0
42	352200112	3522	112	0	0	40	22	61	3	9	0	17	0	5.6	11900	0	95	7	83250	0
43	352200114	3522	114	0	0	24	12	37	0	2	0	7	0	4.9	0	0	34	3	49350	0
44	352200115	3522	115	0	0	16	5	26	0	3	0	6	0	5.0	0	0	30	2	32900	0
45	352200116	3522	116	0	0	11	2	15	0	0	0	0	0	0.0	0	0	0	0	0	0
46	352300000	3523	000	13	0	726	272	808	126	141	2	199	14	5.1	13400	0	1016	88	1180500	0
47	ReportingSum	3513	RS	13	0	726	269	808	124	134	2	190	13	5.1	13500	0	933	71	962000	0
48	ReportingDiff	3523	RD	0	0	0	3	0	2	7	0	9	1	0	0	0	83	17	218500	0
49	Total	3523	TT	13	0	726	272	808	128	186	2	199	43	4.7	13400	0	933	88	1180500	0
50	352300101	3523	101	0	0	0	3	2	1	8	0	1	2	0.2	0	0	0	0	0	0
51	352300102	3523	102	0	0	11	9	21	7	0	0	5	0	4.6	0	0	23	1	12850	0
52	352300103	3523	103	0	0	18	10	26	5	5	0	7	1	5.3	11800	0	37	5	58750	0
53	352300104	3523	104	0	0	52	17	66	11	10	0	22	4	5.2	14400	0	115	6	86250	0
54	352300105	3523	105	0	0	50	18	50	18	8	0	13	0	5.5	12500	0	71	6	75000	0
55	352300106	3523	106	0	0	22	8	24	5	4	0	3	0	0.1	0	0	0	1	12350	0
56	352300107	3523	107	2	0	24	6	28	2	2	0	5	1	5.6	0	0	28	1	12850	0
57	352300111	3523	111	0	0	0	5	4	1	16	0	3	6	0.1	0	0	0	1	11950	0
58	352300215	3523	215	0	0	5	1	3	1	12	0	2	4	0.2	0	0	0	1	12750	0
59	352300301	3523	301	0	0	20	13	24	6	1	0	9	1	4.8	0	0	43	4	50550	0
60	352300302	3523	302	0	0	74	11	38	24	4	0	3	6	0.1	0	0	0	1	12450	0
61	352300304	3523	304	0	0	10	5	18	1	10	0	11	0	5.6	13100	0	62	9	117500	0
62	352300305	3523	305	0	0	84	28	91	14	22	0	22	1	5.1	21500	0	112	11	236250	0
63	352300306	3523	306	0	0	56	36	79	14	12	0	14	0	5.1	9800	0	71	5	48750	0
64	352300307	3523	307	7	0	51	12	65	2	9	0	9	0	5.1	13800	0	46	5	68750	0
65	352300308	3523	308	2	0	90	22	90	5	15	0	22	2	4.9	11000	0	108	11	121000	0
66	352300309	3523	309	0	0	69	34	86	6	7	2	17	2	5.1	9700	0	86	8	77250	0
67	352300310	3523	310	0	0	25	13	31	2	4	0	11	1	4.8	0	0	53	4	52100	0
68	352300311	3523	311	2	0	9	6	20	1	7	0	6	0	4.8	14500	0	29	5	72500	0
69	352300312	3523	312	0	0	56	11	38	1	4	0	11	0	4.5	0	0	49	3	40650	0
70	352300313	3523	313	0	0	8	1	4	1	16	0	3	6	0.1	0	0	0	0	0	0

- Many suppressed values (yellow) can be determined by comparison with the tract summary
- Other values (gray) can be estimated using averages of nearby blocks ( $\leq 0.1$  mi), constrained by tract (except \$)



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# Black Population by Block 1970



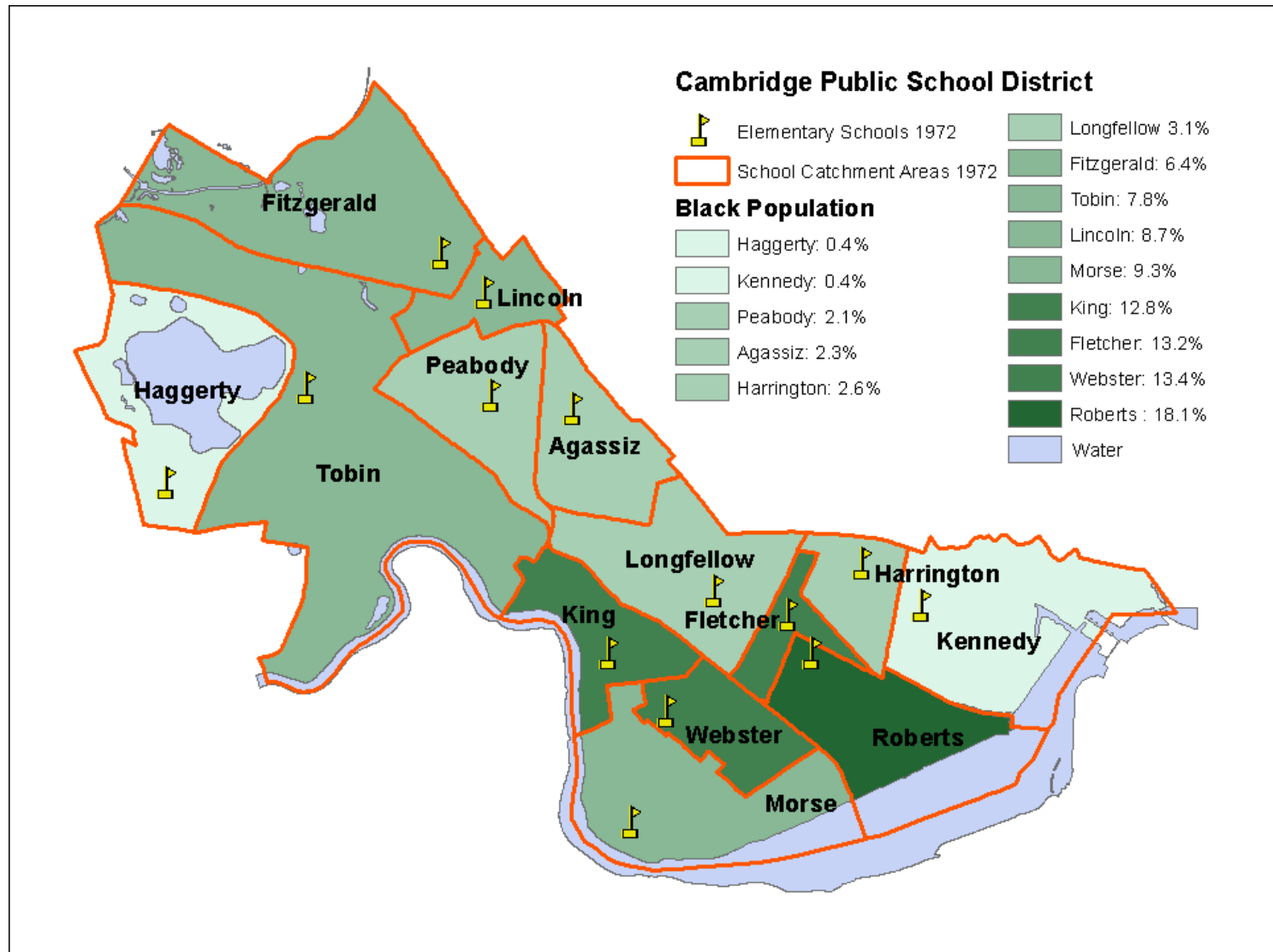
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# Census Block Integration

- Integrating block-level data into the school catchments is far more accurate than estimation using tracts, but still requires some approximation.
  - Some blocks must be split — assume constant areal density (average values must first be totaled).
  - “Union” with school catchments distributes block data into sub-catchments, which can then be “dissolved” back into the catchments.



# Black Population by School 1970

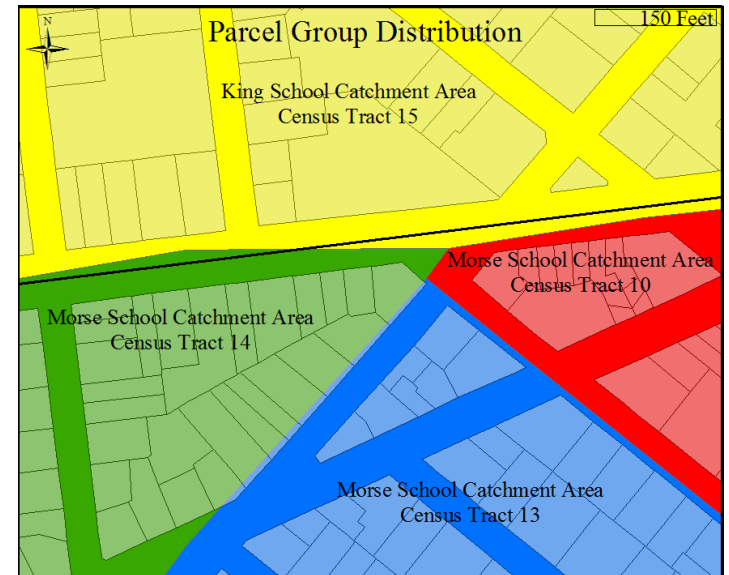


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# Census Block Modeling

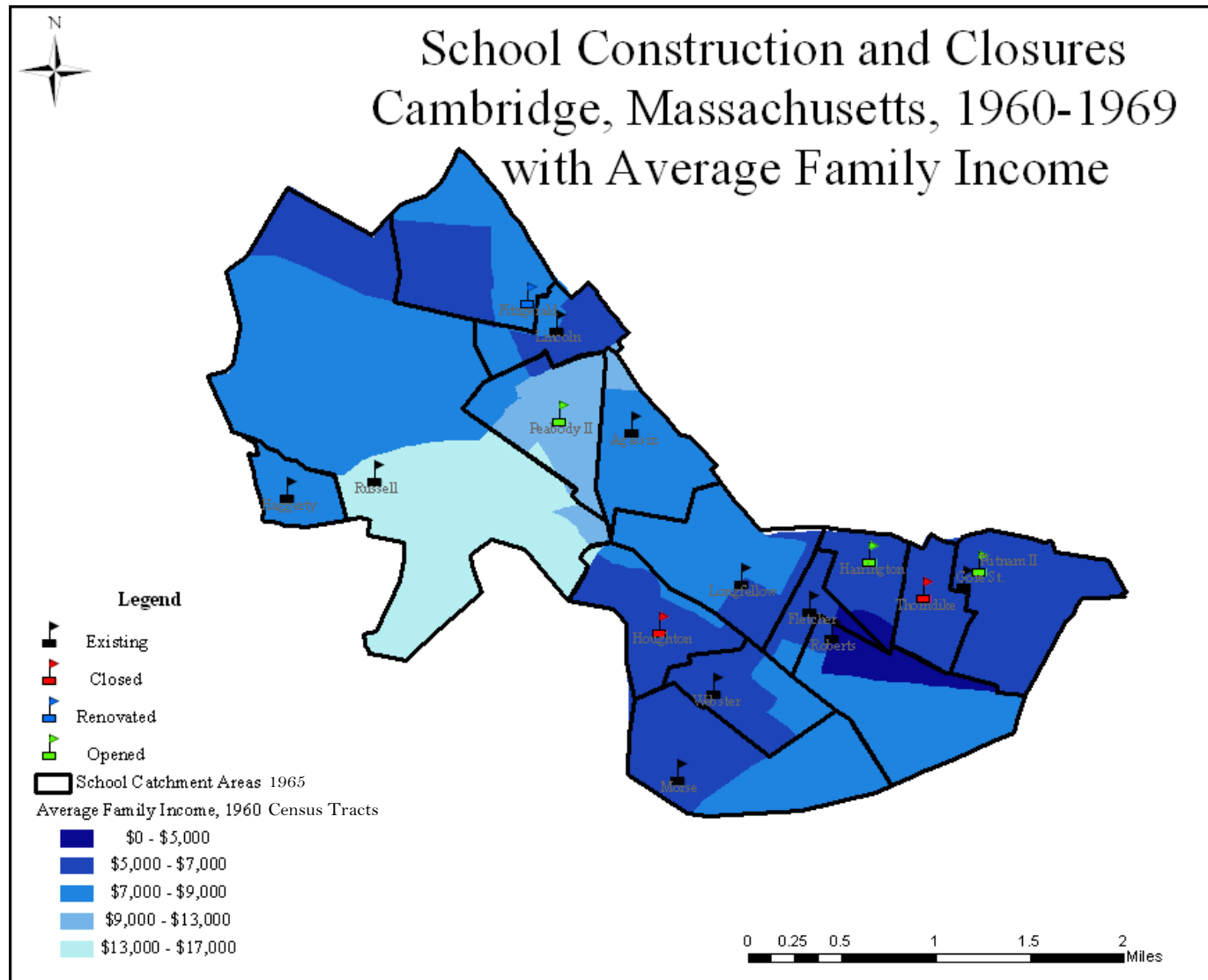
- Block data is focused on basic population and housing
- Tract-level data is more extensive but can be *weighted* by block-level population or occupancy:



$$\text{Household Income} = \frac{\sum_{\text{Sub-catchment}} \text{Tract Household Income} * \text{Residences}}{\text{Total Residences}}$$

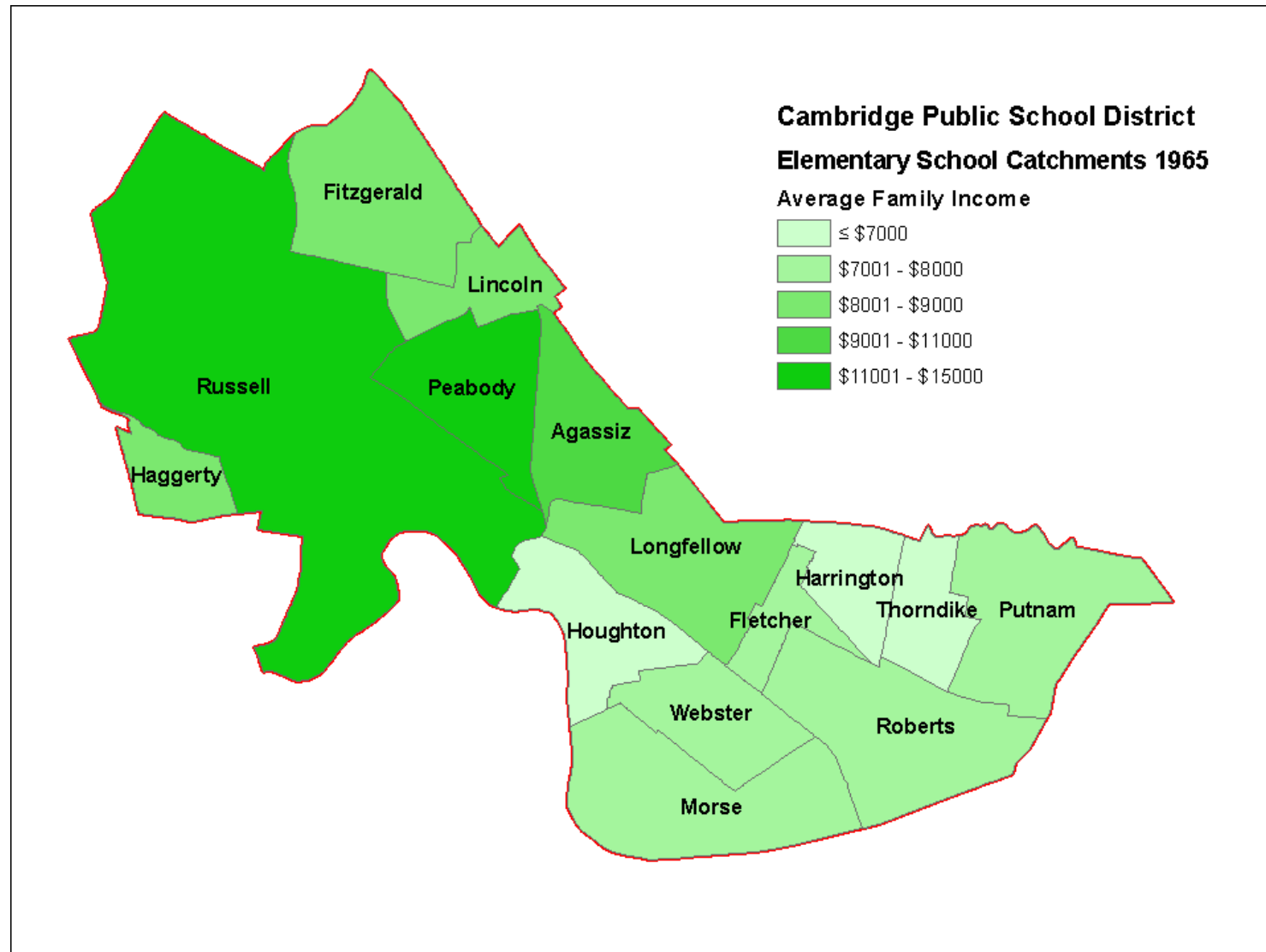


# Cambridge Income by Tract



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# Average Family Income 1965



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# Higher Education: MIT & Harvard

- Provided consulting support to the School Committee and influenced school construction choices.
- Recommended faculty members live in certain neighborhoods with better schools (Peabody and Agassiz).
- Produced assessment reports that were used to steer home buyers and renters.



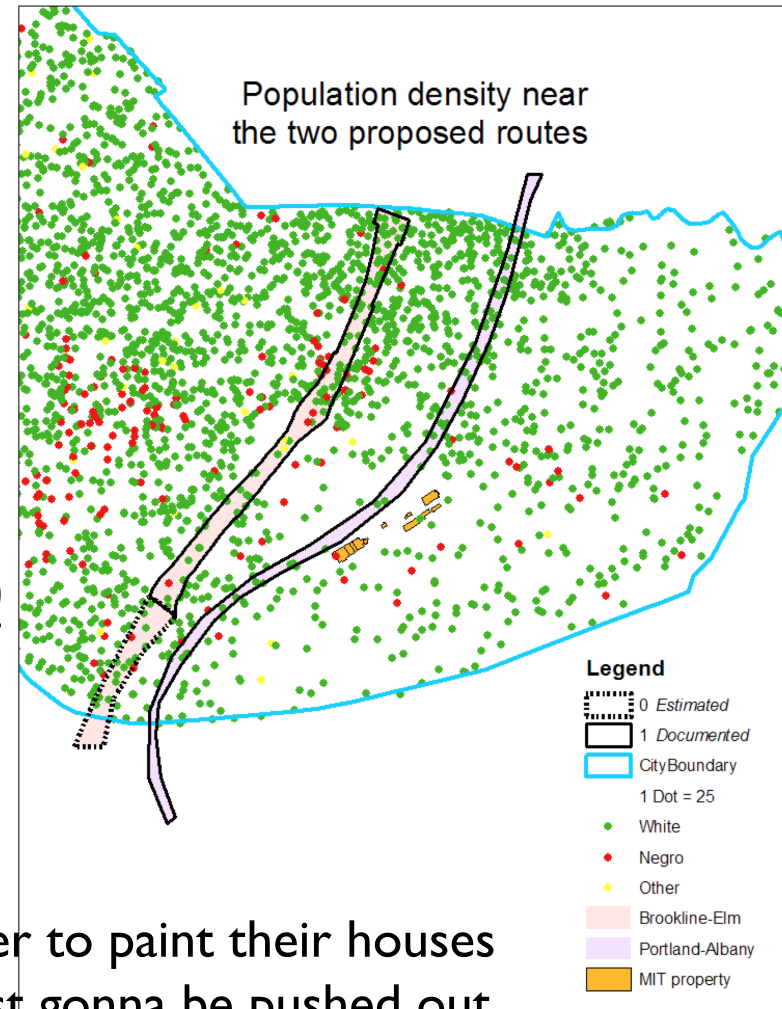
Massachusetts Institute of Technology



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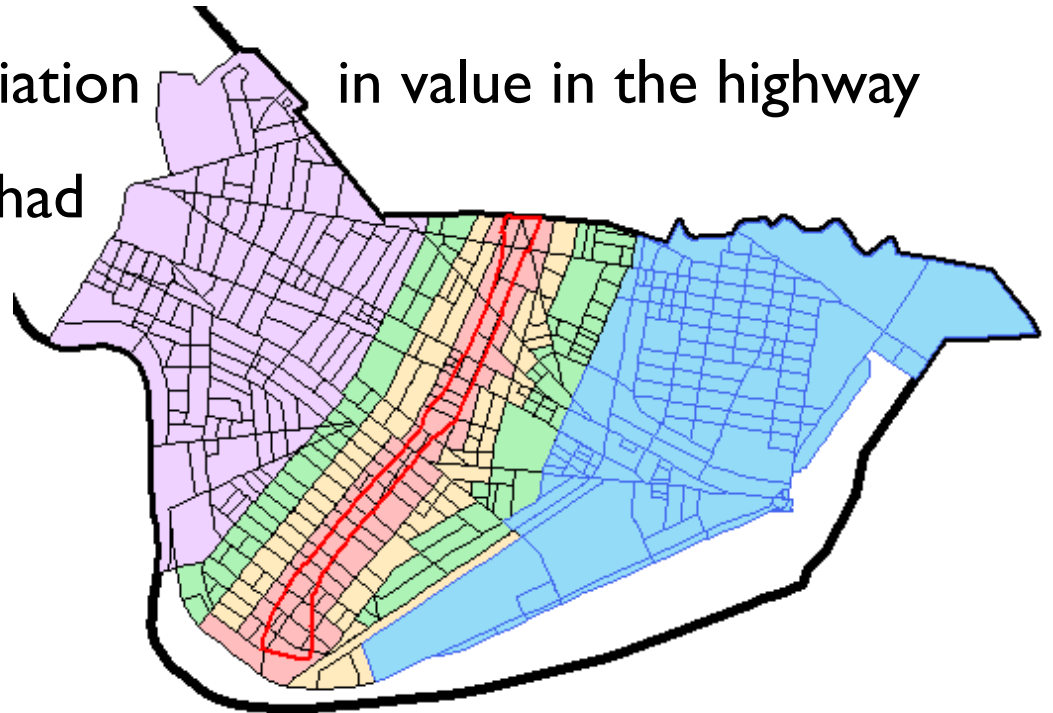
# The Inner Belt Highway Effects ...

- Interstate 695:
  - Planned from the 1940s, final route in 1967
  - MIT doesn't want the highway adjacent.
  - Brookline-Elm residents don't want it, either!
- End result: *neither* is built! Canceled in 1972.
- Even so, damage to the neighborhood:
  - local residents “didn't bother to paint their houses – they figured they were just gonna be pushed out of them...they didn't fix the shingles or roofs.”



## ...Property Values

- Census blocks grouped by proximity to the highway.
- Using census data, average property values calculated for 1960 and 1970.
- Relative to appreciation in value in the highway band, other areas had enhanced value:
  - yellow: +23%
  - green: +37%
  - overall: +166%





# Thanks!

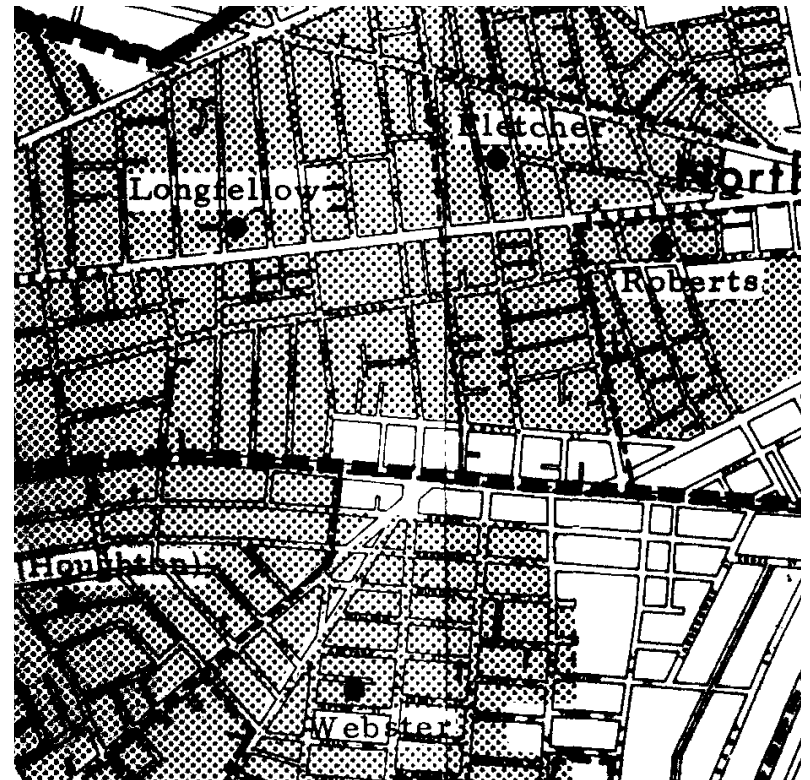
- Cambridge GIS! Jeff Amero, et al.
- Cambridge Assessor
- Cambridge Historical Society
- MIT Archives
- National Historical GIS @ U. Minn
- Mellon Foundation



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# Catchment Questions

- Catchment boundaries are not always clear
  - Some obviously pass through the middle of blocks (we followed parcel bounds).
  - Some appear just off street edges — rough drawing or to keep streets together?

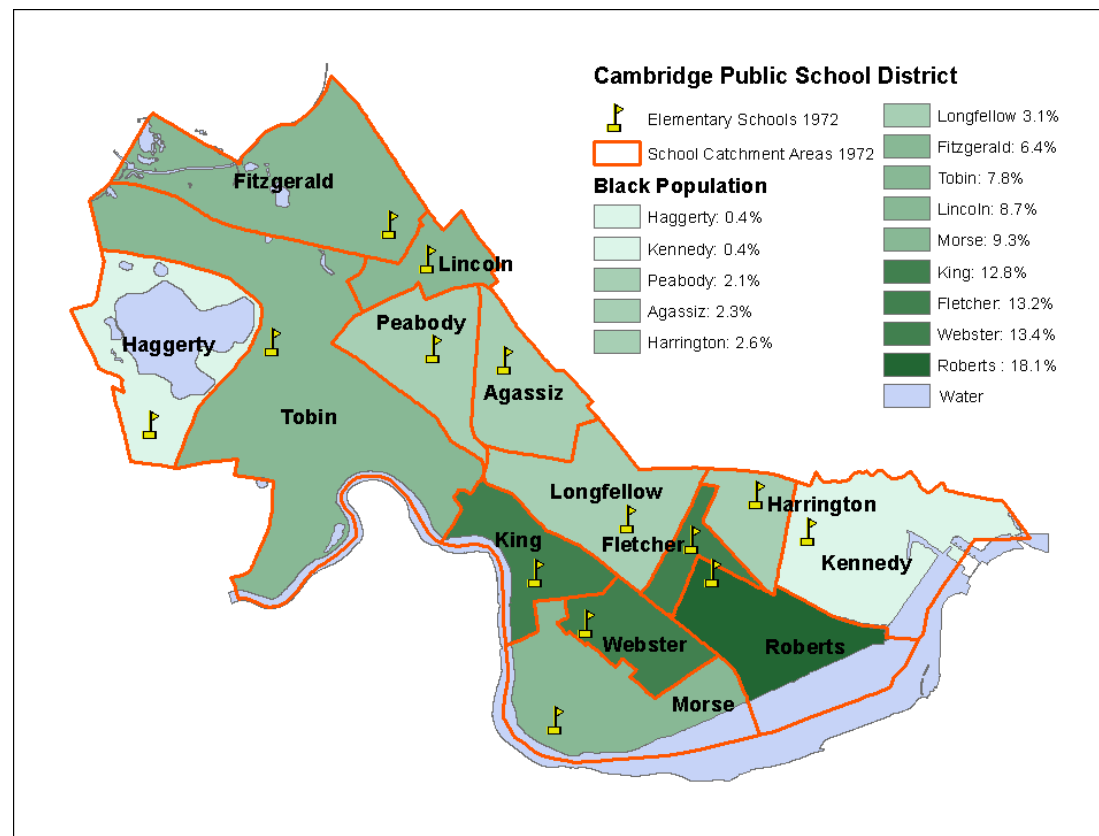


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# Future Research 2...

- A distinct dividing line between the Roberts and Kennedy districts led to conflict in the 1970s...



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