

ABAG Non Residential Buildings Analysis

Erin Wardell, Tara Weidner, PB, 11/28/11

Overview

The outcome of this task is a detailed analysis of the relationship between building type, number of employees, and floorspace (Task 5.3). This is used in a second step (Task 5.2) where a control total of building square footage is allocated to building parcels. The final deliverables are the industry-building relationship and the parcel database that includes nonresidential building square footage as an attribute (separate from residential units for MR and HM space).

Data Inputs

1. NETS - Contains the number of employees by SIC industry type (at the parcel level)
2. CoStar - Contains the square footage by building type and space price, previously joined to the fourteen Urban Vision (UV) land use types (at the parcel level)
3. EDD - Contains number of employees by NAICS category (at the census tract level)
4. Census - Contains the area and population (at the census tract level)

Method Overview

The assignment of square footage to non-residential building type parcels is a multi step process, described below.

1. **Background analysis of relationships.** The following relationships were developed from samples of the data. The first two were created with NETS and CoStar data at the parcel level, where matches exist. The latter with just CoStar parcel data, where building type and square footage are available.

- a) Allowed industry use of building types, and frequency of use (global)
- b) Square feet per employee rates for each industry using the allowed building types (global, average, and standard deviation calculated)

2. **Calculate square footage control totals by building type at the Census Tract Level.** Using the relationships above combined with EDD census tract employment data, the following equation will be used to estimate square feet by building type in each census tract. The summation will be over all allowed industry-building combinations (Step 1.a) as well as constrained to the available building types in the census tract. A future enhancement to the process could use standard deviation, since last term can be treated as a distribution:

$$SQFT_{bldg,ct} = \sum Ind_{naics,ct} \times UseShare_{sic,bldg} \times SQFTPerEmp_{sic,bldg}$$

3. **Allocate Square Footage Census Tract control totals to parcels.** The census tract square footage by building type was assigned to parcels, similar to the residential multi-family (HM) units allocation method. This utilized a sampling from square feet per parcel from the parcels data set. When parcels already had square feet, it was

assumed to be the correct total. Where parcel square feet was missing, the sampling procedure calculated a distribution from existing square footage on parcels by building type. The distribution calculation was set up to avoid lumpiness due to limited observations. If there were less than ten available parcels to create the distribution for the tract, then the city was used. If there were less than ten in the city, then the county was used, and if there were less than ten in the county, then the entire model area was used.

Results Summary

Table 1 is the allowed industry use of various building types used in Steps 2+3. Table 2 estimates the average quantity of space (square feet) used per employee for that industry-building combination. The values are based on the NETS-CoStar sample, discussed more thoroughly in Step 1a of the Procedure section. They assume the following aggregations of industry and building types to account for small sample sizes. Since government and school did not occur in the NETS- CoStar sample, their values were artificially added based on expert judgment. These assumed aggregations of industry and building categories are summarized in Table 3. Tables 1-3 are combined in a single input file for use in the Step 3 allocation process (NRESUsageInputs.csv), which can be modified to aggregate categories differently if different relationships are estimated.

Industry aggregations:

- **Manufacturing**, split into Light and heavy: man_lgt (man_bio, man_techm, man_lgt) & man_hvy
- **Services**, split into those using more space (Health, Soc_svc), smaller retail/offices (serv_bus, fire), and serv_pers
- **Office-based**, combined (prof+gov) ; Assumed 20% use share for GV space.
- **Resource-based**, combined (Ag, Natres) ; Assumed 10% use share for GV space
- **Lease and utilities**, combined (lease, util) since they used the similar types and quantities of space.
- **Education**, combined (ed_high, ed_k12, ed_oth) small education sample size; Assumed 50% use share for SCH space, and 20% for GV space.
- **Logistic services**, combined (logis, TpSvc)

Building Type aggregations:

- **Mixed Use**, combined (HM, ME, MR, MT) for use share; Dropped HM and MR for use quantity, since included full residential as well as non-residential space as well. Excluding 1-person firms from NETS data sample, improved these relationships significantly.
- **Retail**, combined (RB, RS)
- **Industrial**, combined (IH and IL). Very few IH building types in the region. Warehouse space was kept separate.

Other assumptions:

- No use of hotel space by resource-based, construction, logistics, or manufacturing industries

Table 1 shows a reasonable allocation across building types for each industry. The expected uses (green shading) were typically of higher values. The use of retail space for heavy manufacturing and warehouse space for several industries may warrant further investigation (bold values). Additionally, the use of school and government space should be reviewed.

Table 2 shows a reasonable space use of 187 to 2066 square feet per employee. The smallest rates are in office, mixed use, and retail space. The largest are in Hotel and Recreation space with industrial and warehouse falling midway, depending on the industry. A few missing values, including that for school and government space were filled by averaging other values for that industry, or in the case of retail, the other retail observations.

Table 1: Cleaned-Up Industry Use by Building Type

	Hotel	Office	Mixed	Retail	Industrial	Warehouse	Rec	School	Gov	Freq
agNatres	0%	9%	21%	10%	6%	43%	0%	0%*	10%*	212
Constr	0%*	17%	8%	28%	18%	28%	0%	0%*	0%*	1,614
man_hvy	0%	5%	5%	45%	31%	14%	0%	0%*	0%*	748
man_lgt	0%*	7%	7%	40%	17%	29%	0%	0%*	0%*	1,850
logisTpSvc	0%	15%	12%	25%	20%	28%	0%	0%*	0%*	3,259
lseUtil	1%	5%	9%	33%	11%	41%	0%	0%*	0%*	303
Info	0%	20%	9%	23%	7%	41%	0%	0%*	0%*	2,200
profGov	0%	10%	6%	16%	4%	44%	0%	0%*	20%*	1,827
healthSocSvc	0%	16%	14%	8%	3%	58%	0%	0%*	0%*	2,402
Hotel	51%	12%	6%	2%	3%	26%	0%	0%*	0%*	303
Eat	3%	23%	50%	4%	3%	18%	0%	0%*	0%*	1,358
Retail	1%	21%	34%	15%	9%	20%	0%	0%*	0%*	4,256
Service	1%	30%	13%	15%	7%	35%	0%	0%*	0%*	6,642
serv_pers	1%	21%	27%	14%	8%	29%	0%	0%*	0%*	3,418
art_rec	0%	21%	26%	13%	9%	32%	0%	0%*	0%*	704
Educ	0%	4%	4%	4%	2%	16%	0%	50%*	20%*	486
										31,582

Notes: Gray – not allowed, * modified; yellow - a priori most likely; Bold red text - unexpected high usage.

Table 2: Use quantity by Building Type and Industry combination (sqft/employee) - Average

	Hotel	Office	Mixed	Retail	Industrial	Warehouse	Rec	School	Gov	Freq.
agNatres		250	294	250	306	449	2,066		310	192
Constr	555	356	227	265	609	913				1,364
man_hvy		187	276	350	818	884				710
man_lgt	553	282	191	327	612	928				1,749
logisTpSvc	1,542	333	299	356	1,258	1,460				2,862
lseUtil	642	208	294	180	475	615				287
Info	798	325	265	356	906	715				1,827
profGov	575	347	211	300	480	818			455	1,652
healthSocSvc	583	378	241	333	515	566				2,091
Hotel	2,022	260	294	221	1,162	1,177				270
Eat	1,030	362	386	356	971	431				1,117
Retail	1,164	438	400	508	794	1,349				3,555
Service	1,351	499	376	373	887	1,389				4,820
serv_pers	1,388	500	345	487	984	1,258				2,796
art_rec	1,354	334	396	443	560	1,163				592
Educ		301	211	248	384	423		470	314	430
										26,314

Note: Gray – not allowed. Red bold values - average of observed values.

Table 3: Assumed aggregations of Industry and Building Type (for Step 1 and Step 2)

SICGroup	IndGroup1	Freq	Freq%
ag	agNatres	971	1%
natres	agNatres	122	0%
art_rec	art_rec	4,005	2%
constr	Constr	9,440	5%
unclass	DROP	580	0%
eat	Eat	7,907	4%
hotel	Hotel	1,565	1%
ed_high	Educ	230	0%
ed_k12	Educ	428	0%
ed_oth	Educ	1,824	1%
health	healthSocSvc	9,469	5%
serv_soc	healthSocSvc	4,831	3%
info	Info	11,836	6%
logis	logisTpSvc	14,412	8%
transp	logisTpSvc	4,393	2%
lease	lseUtil	884	0%
util	lseUtil	807	0%
man_bio	man_lgt	614	0%
man_hvy	man_hvy	3,667	2%
man_tech	man_lgt	5,354	3%
man_lgt	man_lgt	4,670	3%
gov	profGov	977	1%
prof	profGov	9,159	5%
ret_loc	Retail	15,777	9%
ret_reg	Retail	9,905	5%
fire	Service	17,523	9%
serv_bus	Service	22,737	12%
serv_pers	serv_pers	20,614	11%
		184,701	100%

BldType	BldType1	BldType2	Freq	Freq%
HM	Mixed	DROP	3,756	12%
HO	HO	HO	391	1%
IH	Industrial	IH	7	0%
IL	Industrial	IL	5,856	18%
IW	Warehouse	IW	3,089	10%
ME	Mixed	ME	396	1%
MR	Mixed	DROP	1,518	5%
MT	Mixed	MT	540	2%
OF	OF*	OF*	10,556	33%
RB	retail	retail	392	1%
RC	RC	RC	1	0%
RS	retail	retail	5,201	16%
			31,703	100%

Note: BldType1 used for calculating UseShare; BldType2 used for calculating SQFT per employee. Also noted is the number of observations (freq) from NETS-CoStar matches.

Full model results by county and area type are contained in the tables below. Table 4 shows the percent difference between the allocated square footage and the control total square footage, by county. This shows much variation between the allocated amount and the control total. However, Table 5 shows that much of the square footage allocated already existed on the parcels in the bldg_sqft field. Existing square footage accounts for 95% of the total result (a low of 83% in Solano). Much of the differences seen in between the allocation and control total are due to the fact that square footage was already allocated.

Table 4: Percent Difference between Allocated and Control Total Square Footage

	% difference										Total
	sample	ala	cnc	mar	nap	sfr	smt	scl	sol	son	
GV	88%	-9%	262%	na	-58%	na	na	-77%	-35%	na	32%
HM	529%	386%	295%	114%	225%	605%	327%	265%	-50%	285%	327%
HO	-70%	-51%	-68%	-73%	-38%	2%	-14%	-57%	-74%	-32%	-41%
IH	-62%	-41%	-44%	-90%	na	-53%	-93%	-89%	na	-76%	-66%
IL	99%	111%	17%	-19%	45%	20%	97%	192%	11%	42%	98%
IW	-56%	-5%	-62%	-87%	-44%	-75%	-53%	-70%	-79%	-49%	-50%
ME	-73%	-99%	-99%	-85%	-87%	-57%	-92%	-91%	na	-79%	-75%
MR	-51%	-36%	-81%	-71%	-91%	4%	-72%	-83%	na	-71%	-44%
OF	278%	121%	190%	37%	3%	390%	153%	86%	-64%	325%	158%
RB	-56%	-11%	-40%	-28%	91%	6%	-11%	-19%	na	25%	-15%
RC	-67%	195%	2032%	na	na	na	na	234%	-49%	na	657%
RS	73%	92%	125%	27%	46%	77%	44%	70%	719%	127%	118%
SC	219%	-50%	-35%	-75%	na	285%	-51%	-74%	-70%	1%	5%
Total	78%	67%	43%	-16%	13%	105%	20%	35%	127%	45%	53%
Total w/o HM	26%	-35%	30%	15%	-9%	8%	44%	-9%	166%	22%	21%

Note: Gray cells indicate where percent of allocated square footage already existing in county was greater than 10%.

Table 5: Percent of Allocated Square Footage Already Existing in County

	% already on parcels										Total
	sample	ala	cnc	mar	nap	sfr	smt	scl	sol	son	
GV	80%	28%	99%	na	8%	na	na	71%	11%	na	68%
HM	100%	100%	99%	93%	100%	100%	97%	100%	13%	95%	99%
HO	94%	96%	96%	100%	89%	100%	91%	100%	28%	73%	94%
IH	100%	90%	69%	100%	na	100%	20%	89%	na	48%	78%
IL	97%	94%	95%	87%	83%	100%	99%	97%	65%	79%	94%
IW	82%	99%	100%	99%	100%	100%	53%	97%	100%	88%	91%
ME	79%	0%	100%	100%	100%	100%	66%	74%	na	70%	94%
MR	100%	94%	100%	100%	100%	100%	65%	92%	na	69%	95%
OF	100%	94%	99%	80%	92%	100%	94%	98%	19%	96%	96%
RB	89%	98%	87%	81%	100%	100%	98%	100%	na	84%	94%
RC	54%	95%	100%	na	na	na	na	88%	0%	na	96%
RS	98%	99%	99%	81%	89%	100%	90%	97%	94%	98%	96%
SC	91%	89%	83%	10%	na	100%	0%	12%	1%	35%	80%
Total	97%	96%	98%	87%	92%	100%	87%	98%	83%	90%	95%

Note: Gray cells indicate where percent of allocated square footage already existing in county was greater than 10%.

Rather than relying on the comparison of allocation to control total, the square feet per employee metric was calculated for each county. A reasonable minimum square feet per employee is 200.

Table 6 shows the frequency of average square feet per employee by county. Each county has only a small percentage of parcels falling below 200 square feet per employee. The vast majority of parcels are between 200 and 5000 square feet per employee, which is an acceptable range. The typical trend is for HM and OF (and sometimes IL, RC, Rs, and RB) to be highly overallocated, typically with existing sqft. The other types tend to be underallocated, but assuming they use mixed use or office is a reasonable assumption. Table 4 and 6 indicate the extreme case of not including HM space in the non-residential allocation.

Table 6: Test for Adequate Space Per Employee by Census Tract, with and without HM building type

CensusTract Frequency by average sqft/emp											
Sqft/emp	sample	ala	cnc	mar	nap	sfr	smt	scl	sol	son	Total
<200	1	10	7	4	3	3	4	24	11	4	70
200-1k	14	162	117	48	26	41	95	219	79	74	861
1K-5K	10	164	77	1	7	120	51	107	6	18	551
>5K	4	29	7	1		30	3	15	3	3	91
Total	29	365	208	54	36	194	153	365	99	99	1573
%<200	3%	3%	3%	7%	8%	2%	3%	7%	11%	4%	4%

CensusTract Frequency by average sqft/emp - Removed HM											
Sqft/emp	sample	ala	cnc	mar	nap	sfr	smt	scl	sol	son	Total
<200	5	37	11	13	7	7	26	53	27	8	189
200-1k	21	265	151	38	27	116	124	282	63	91	1157
1K-5K	3	62	42	1	2	67	6	27	6	1	214
>5K		1	4			2		1	3	1	12
Total	29	365	208	52	36	192	156	363	99	101	1572
%<200	17%	10%	5%	25%	19%	4%	17%	15%	27%	8%	12%

Figure 1 and Figure 2 show graphically the calculated square feet per employee by tract. The tracts that fall below 200 square feet per employee are displayed in light green. There does not appear to be a geographic bias to the tracts with this issue. When the large amount of HM square footage is removed, the number of tracts that fall below 200 square feet per employee is much higher, as shown in the tables above.

Figure 1: Square Feet Per Employee by Tract

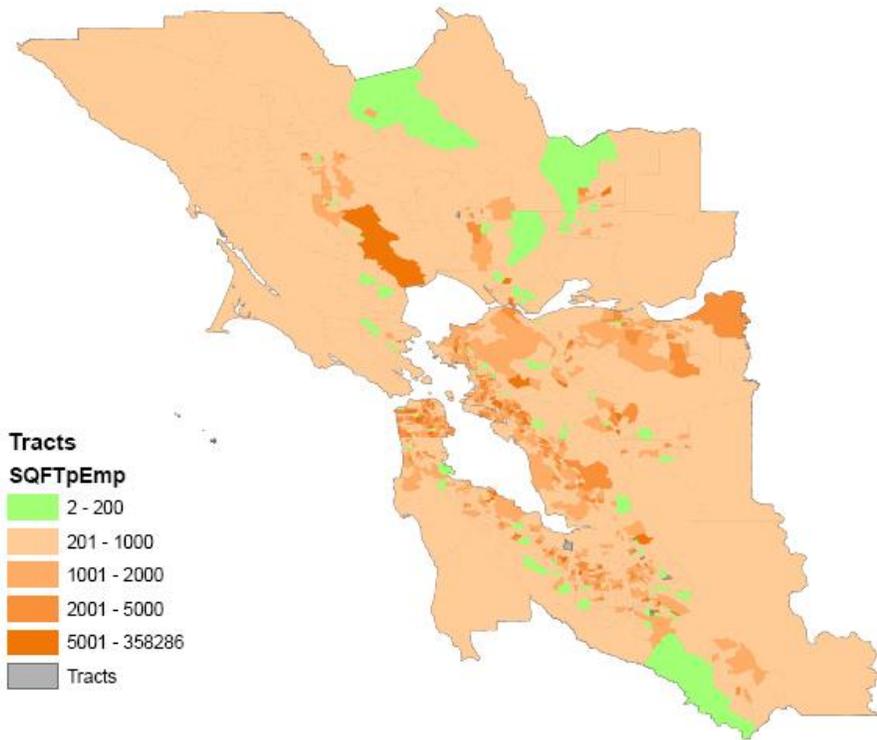


Figure 2: Square Feet Per Employee, HM parcels removed

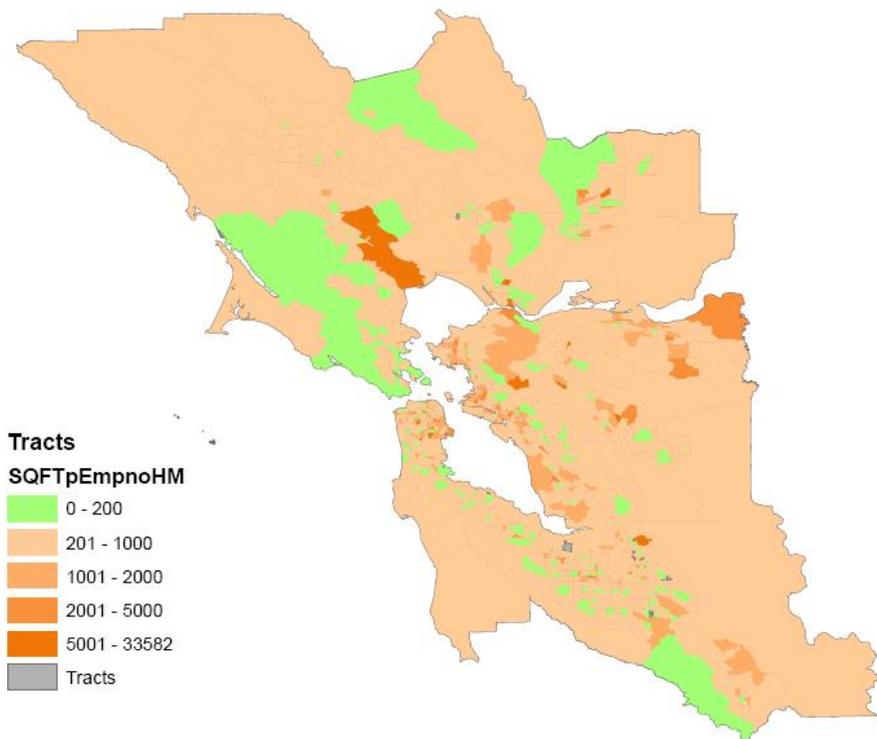


Table 7 shows the frequency of building types per county. Not all building types were represented in all counties.

Table 7: Frequency of Parcels by Building Type by County

	ala	cnc	mar	nap	sfr	smt	scl	sol	son
GV	6,733	4,938		261			128	4,132	
HM	13,049	4,095	2,514	2,852	32,645	9,925	10,867	6,148	5,095
HO	276	172	24	130	508	160	213	84	268
IH	116	207	2		8	26	70		417
IL	2,929	1,335	355	1,667	1,583	1,491	5,843	1,390	1,639
IW	3,269	812	99	154	783	2,095	1,233	2	755
ME	1	1	23	11	474	47	120		62
MR	1,188	88	104	7	4,181	423	346		283
OF	4,649	3,024	3,443	358	2,409	1,669	5,352	444	2,315
RB	153	174	389	19	14	42	98		86
RC	37	389					141	29	
RS	7,652	4,691	1,421	848	4,119	2,988	7,093	3,601	2,883
SC	199	516	11	318	361	485	64	348	199

Table 8 shows the total amount of square footage allocated to each county, by building type. This table shows how much square footage is allocated to HM parcels.

Table 8: Amount of Square Footage Allocated by Building Type by County

	ala	cnc	mar	nap	sfr	smt	scl	sol	son
GV	8,257,846	15,696,275		402,692			628,070	2,247,055	
HM	176,221,627	69,885,657	14,226,895	11,423,387	180,327,092	64,635,695	164,752,768	4,969,664	34,254,744
HO	12,861,204	4,320,273	1,029,086	2,770,043	25,291,627	10,372,863	13,551,378	2,070,669	5,461,759
IH	7,600,564	5,083,634	37,163		392,709	280,444	1,542,148		1,556,972
IL	86,972,507	22,932,841	5,169,415	8,482,517	24,609,559	27,955,844	166,795,917	11,604,022	17,862,000
IW	113,224,809	21,296,952	1,886,089	6,620,009	13,965,109	36,704,973	38,877,197	122,082	16,260,973
ME	1,947	1,500	217,824	92,739	8,239,994	459,339	1,231,064		444,392
MR	8,493,335	424,777	518,237	30,427	24,922,507	2,550,031	2,910,350		1,845,243
OF	81,534,415	56,409,122	9,596,932	3,392,684	130,989,725	40,134,902	91,989,180	3,332,406	39,218,823
RB	8,815,700	6,061,577	926,466	480,730	3,113,139	3,530,565	5,843,506		4,386,370
RC	162,324	1,807,721					654,461	6,085	
RS	76,458,182	48,414,404	9,906,555	7,675,125	53,288,365	25,740,772	94,389,666	97,718,602	23,198,975
Total	580,604,460	252,334,733	43,514,663	41,370,353	465,139,825	212,365,428	583,165,705	122,070,584	144,490,252

Additionally, maps showing the percent difference between the allocation and control total by tract and building type were prepared and are included as an attachment to this document.

Detailed Sample Results Summary

A sample of 29 tracts was selected for more in-depth analysis. The major finding from this selected analysis confirms what was observed in the full dataset. Many parcels (94%) already have square feet (60% of total after allocation), so the allocation process has far fewer gaps to fill in than it did for the Residential Allocation, and some of the issues that arise result from a limited number of parcels that can be modified. Another finding is that the bulk of the available NRES parcels is HM (over 50% of the selected set), IL, RS, IW, MR, OF; with very few GV, HO, ME, and almost no RB, IH, RC. As noted above, the HM building type is treated as a mixed use-retail building and this leads to issues in the allocation. Without HM, it would be significantly more difficult to meet the employee space requirements within most parcels. Table 8 shows the percentage difference between the square feet allocated and the control totals for the 29 selected census tracts randomly selected from all counties. Shaded cells show where there was no allocation made because there was already square footage on the parcel. Although these are large differences, the control total for this project was synthesized based on average relationship assumptions across the region and may differ from the conditions on the ground in a particular tract.

The comparison to control totals is complicated. Over allocation can be interpreted as a vacancy rate, indicating space beyond that needed by the (average employee). Additionally, since the space by building type is an average, and the standard deviation of square feet per employee rates was typically over 50% of the mean, and sometime up to 3 times the mean (Industrial and Office types in particular), a healthy over or under allocation relative to the tract's control total is not cause for concern. This also applies to reasonable under allocations. To check that enough overall square feet was allocated to the parcel, the square feet per employee in each census tract was calculated based on the final allocated space and the control total employees. This is shown in Table 11. A general guideline adopted for this metric is that each employee needs at least 200 square feet of space at a minimum. Both of these systems follow that rule, with the exception of the allocated total for Tract 390200, which only has 141 square feet per employee. However, that particular tract was not allocated any additional square feet because each parcel already had existing square footage that was not changed. Therefore, this anomaly is not the result of the allocation procedure.

Looking by space type at the %Difference to control total table, and zeroing in on those types that were assigned in the allocation process, one finds one-third matching exactly. However, as with the residential HM process there are quite a few underallocations, typically by less than 50% (61% of sample), which is reasonable given the variability identified in the SD values noted above. Additionally, typically when one type is underallocated, the surplus is made up for in either HM (mixed use) or OF space (typically an over allocation from pre-existing space), which is a reasonable substitution for most employees. The net result is a closer match and less under allocations when comparing the target space summed across all building types. In the cases of more significant under allocation, an examination of the remaining parcels that could be used to improve the allocation shows that, like the residential issue, very few parcels remain and those that remain are of the wrong type (e.g. , tract 607900 needs IW but only has HM and OF).

Looking at the parcels that were not modified, their square footage comparison to the control totals varied significantly. Hotel (HO) and Warehouse (IW) were always under allocated (in the sample) with HM, MR, OF, and RS typically over allocated. In particular, HM is allocated nearly half the time by about 5-10 times the control total for that building type. If HM cannot be treated as MR, the overall sqft/employee check by tract jumps from 1 occurrence (3%) to ten percent of the tracts. Including HM as a part of the non-residential allocation should be further examined.

To further review the HM issue, a few parcels with high HM were reviewed in more detail in order to check that the significant (largely pre-existing) HM allocations were reasonable. Figure 1 shows an example of an HM parcel in tract 1512001. This parcel has a very large existing square footage, which was retained in the processing. Analysis of the aerial imagery however shows that this is clearly a residential parcel that should not be treated as a non-residential employment center. The square footage allocated to this parcel seems to be the size of the apartment complex, separate from the 'units' field. Although some of the HM space is likely used by employees, such as building management and landscaping for large complexes or businesses run out of their homes, not all of the residential space should count towards the space used by employees.

Table 9: Percent Difference, Allocation Compared to Control Total

% Difference Allocated from Control Total													
Tract	GV	HM	HO	IH	IL	IW	ME	MR	OF	RB	RC	RS	Total
13300	na	595%	-88%	na	-96%	na	-83%	-14%	178%	na	na	-48%	46%
17700	na	51%	-91%	na	276%	-39%	-82%	-60%	324%	-95%	na	221%	32%
21800	na	3061%	na	na	-96%	na	na	330%	-84%	na	na	13%	560%
22802	na	2140%	na	na	541%	-9%	na	139%	6668%	na	na	51%	920%
25403	na	6004%	na	na	54%	na	842%	714%	766%	na	na	-18%	1262%
31100	na	264%	na	na	-71%	na	-96%	4%	-60%	na	na	-51%	-8%
151201	na	1412%	-10%	-98%	329%	-34%	na	-93%	95%	-9%	na	324%	129%
201200	-73%	836%	-5%	na	0%	-99%	na	na	na	na	na	0%	27%
250502	-13%	0%	na	na	-78%	na	na	na	-48%	na	na	0%	-34%
390200	na	na	na	na	na	na	na	na	-56%	na	na	-63%	-60%
402900	-50%	-12%	-99%	na	-94%	na	na	-79%	471%	na	-81%	-16%	14%
405200	0%	11598%	-88%	na	-58%	na	na	-64%	386%	na	na	10%	1622%
422500	0%	3417%	na	na	na	na	na	na	0%	na	na	143%	1042%
451701	0%	-48%	na	na	na	na	na	na	0%	na	na	na	-21%
502102	na	1452%	na	na	-89%	-98%	na	na	425%	na	96%	174%	146%
502907	na	na	na	na	na	na	na	na	-97%	na	na	255%	89%
503601	na	32%	na	92%	585%	46%	-62%	-95%	-32%	na	na	122%	90%
504412	na	458%	na	na	na	na	na	na	-88%	na	na	0%	113%
504506	na	na	-72%	na	376%	-69%	na	na	-64%	na	na	-96%	-10%
505203	1609%	91%	-42%	na	433%	-81%	na	58%	160%	na	na	73%	71%
505301	na	302%	na	na	-70%	na	na	na	na	na	na	na	82%
505303	na	5083%	na	na	125%	na	na	na	-62%	na	na	486%	1234%
506605	na	830%	na	na	na	na	na	na	-72%	na	na	34%	246%
603700	na	139%	na	na	na	-70%	na	na	0%	na	na	59%	-19%
607900	na	0%	na	na	na	-100%	na	na	118%	na	na	-24%	-51%
610100	na	3364%	-73%	na	-67%	-93%	na	na	81%	na	na	102%	254%
610303	na	0%	na	na	na	na	na	na	na	na	na	na	0%
611000	na	2171%	na	na	na	-51%	na	na	0%	na	na	110%	239%
611400	na	-93%	na	na	na	-31%	na	na	na	na	na	-24%	-38%

Table 10: Calculated Square Feet Per Employee, Allocated and Control Total

Tract	Total Emp	TOTAL - Allocated	SqFt per Emp	TOTAL - Control	SqFt per Emp
13300	3474	2,271,882	654	1,554,372	447
17700	9537	6,657,287	698	5,028,805	527
21800	334	879,084	2,632	133,194	399
22802	369	2,040,058	5,529	199,971	542
25403	108	570,031	5,278	41,864	388
31100	2179	777,382	357	844,651	388
151201	7304	9,476,750	1,297	4,137,756	567
201200	1407	1,194,529	849	937,506	666
250502	166	45,244	273	68,566	413
390200	342	48,077	141	119,438	349
402900	14684	7,828,412	533	6,847,051	466
405200	289	2,318,424	8,022	134,608	466
422500	364	1,436,060	3,945	125,753	345
451701	244	67,870	278	86,161	353
502102	1770	2,519,094	1,423	1,023,614	578
502907	345	227,577	660	120,486	349
503601	1985	2,014,317	1,015	1,060,735	534
504412	638	468,833	735	219,816	345
504506	2044	1,272,312	622	1,408,265	689
505203	2241	2,228,496	994	1,303,163	582
505301	579	530,440	916	291,243	503
505303	313	1,736,394	5,548	130,167	416
506605	615	733,296	1,192	211,892	345
603700	223	100,578	451	123,601	554
607900	5403	1,476,442	273	2,994,702	554
610100	185	413,111	2,233	116,549	630
610303	510	170,613	335	170,613	335
611000	486	911,925	1,876	269,374	554
611400	1323	488,359	369	788,038	596

Figure 3: Tract 151201 HM Analysis



Step 1 Procedure Details

For this first step, the NETS and CoStar parcel data were used to provide the disaggregate relationships that would be applied in Step 2 to the EDD control total of employees to arrive at building square footage. Both the NETS and the CoStar data are joined to parcel IDs, while the EDD data is available at the tract level. Some processing was done on the files before they could be combined.

The CoStar data was cleaned using the following rules: records were deleted if they had zero price or zero square feet, and if the building code did not equal 'Existing.' The NETS data can have more than one data point joined to each parcel data. The NETS data was aggregated so that the employment by industry was summarized at the parcel level. The CoStar and NETS were then merged.

Initial data analysis was conducted with the goal of finding a relationship between price and square footage. The results, across industry, density, and building type, showed no strong relationships. The variable for price was the most problematic. Since price can be a subjective measure impacted by many factors unrelated to the number of employees, further analysis did not include the price variable. Further effort in this area may want to investigate using an index other than the CPI to put the price data in the same year dollars. During the last decade, real estate prices have not followed CPI.

With the CoStar and NETS data combined, it was possible to determine the amount of square feet per employee within each parcel and industry. Each parcel also has a building type assigned, making it possible to compare square feet per employee by industry and building type. The results were analyzed to determine what industry employees use which building types and how much square footage is used by each employee by industry.

Table 11 shows the records lost in the matching of NETS and CoStar data at the parcel level. Significant numbers of education industry workers did not find matches and were dropped, as well as with ag, natres, and gov, relative to other sectors.

Table 11: Percent of Records Lost in Matching NETS and CoStar Data

NetsSIC	Nets Emp	%Lost in Merge	%Lost in cleaning
ag	28,978	-87.05	-26.11
art_rec	62,642	-81.93	-35.16
constr	202,443	-65.57	-34.00
eat	175,085	-70.60	-31.20
ed_high	48,896	-84.19	-32.69
ed_k12	111,274	-93.90	-31.97
ed_oth	26,284	-72.46	-33.46
fire	332,939	-51.35	-32.55
gov	131,780	-82.11	-24.60
health	272,730	-72.94	-37.32
hotel	56,626	-57.60	-32.06
info	317,254	-36.23	-30.36
lease	11,137	-50.93	-23.18
logis	227,953	-54.68	-37.88
man_bio	16,769	-38.94	-48.01
man_hvy	103,825	-64.57	-37.44
man_lgt	103,437	-65.50	-34.75
man_tech	218,894	-38.12	-36.14
natres	4,229	-91.30	-30.71
prof	184,265	-48.84	-39.30
ret_loc	230,635	-73.08	-23.88
ret_reg	151,868	-66.34	-23.54
serv_bus	470,778	-68.03	-35.13
serv_pers	204,358	-71.68	-29.49
serv_soc	92,480	-75.69	-25.05
transp	58,288	-61.67	-27.30
unclass	3,234	-57.95	-40.74
util	32,379	-73.16	-18.00
Total	3,881,460	-62.86	-32.97

Three building classifications received little inclusion in the matched NETS-CoStar dataset while there was significant inclusion of multi-family HM. Investigation of these issues follows:

- Schools:** There are no parcels classified as 'SC,' the UV code for schools. Education employees are matched with other building types in the NETS-CoStar sample, but as shown in Table 11, a significant number found no match and were dropped. Investigation of the parcel data shows that schools are often classified frequently as 'GV' (government). Some are also classified as 'OF' (office) and 'RS' (retail storefront). The Berkeley campus is coded 'NA'. The image below shows a middle school, which is classified as GV. This could be a problem with the building code or the NETS geocode of the education employee's work location.

Figure 4: Middle School Building Classified as Government Building Type (GV)



- **Heavy Industrial:** There were very few matches to parcels with building type IH (0.1% of total NETS-CoStar matches). On review, this is consistent with the prevalence of IH in the region (0.04% of all parcels in the 9-county region).
- **Recreation space:** There were very few matches to parcels with building type RC, Recreation space. Because the space is so unique, the values were retained, but may warrant further review.
- **Multi-Family:** Over 10% of all NETS-CoStar matches occurred on HM building parcels. To remove single-person firms that are recorded at the home address, 1-person firm were excluded from NETS in the final building of these relationships. It could also indicate a miscoding of HM parcels that should be MR mixed use. For the analysis, these parcels were assumed to act like MR, mixed use residential focus.

Step 1a - Industry and Building Type

Tabulations were made to identify the building types used by the various industries. Table 12 shows the proportion of each industry’s (row) employees occurring in each building type. The industries were grouped into clusters. Table 13 shows the same data, but the proportions are by building type (column) employee matches. The latter table is helpful to understand usage for low-frequency building types, such as IH.

Based on these disaggregate data, building types and industries were combined where they had similar use shares, and to address small sample sizes. The aggregated results, shown earlier in Table 1, were used in the allocation process.

Table 12: Building Type Use by Industry

		Industrial			Mixed Use				Retail					
Industry	HO	IH	IL	IW	HM	ME	MR	MT	OF	RB	RS	RC	Total	Freq.
agNatres														
ag	0%	0%	11%	6%	4%	1%	6%	2%	43%	1%	27%	0%	100%	971
natres	4%	0%	24%	17%	6%	0%	5%	0%	40%	0%	4%	0%	100%	122
constr														
constr	0%	0%	28%	18%	11%	1%	3%	1%	29%	0%	8%	0%	100%	9440
eat														
eat	2%	0%	4%	3%	5%	2%	12%	4%	17%	3%	47%	0%	100%	7907
educ														
ed_high	0%	0%	10%	5%	4%	1%	5%	2%	68%	0%	4%	0%	100%	230
ed_k12	0%	0%	15%	13%	22%	0%	1%	2%	37%	0%	9%	0%	100%	428
ed_oth	0%	0%	13%	4%	6%	2%	3%	2%	54%	5%	12%	0%	100%	1824
healthSocSvc														
health	0%	0%	8%	3%	7%	2%	5%	2%	58%	2%	14%	0%	100%	9469
serv_soc	1%	0%	9%	4%	9%	2%	4%	2%	60%	0%	10%	0%	100%	4831
hotel														
hotel	42%	0%	3%	3%	6%	1%	6%	1%	30%	1%	8%	0%	100%	1565
info														
info	0%	0%	23%	7%	12%	2%	3%	2%	41%	1%	9%	0%	100%	11836
logisTpSvc														
logis	0%	0%	27%	20%	7%	1%	3%	2%	26%	2%	11%	0%	100%	14412
transp	1%	0%	19%	14%	11%	3%	3%	2%	36%	2%	9%	0%	100%	4393
lseUtil														
lease	2%	0%	31%	13%	3%	0%	4%	0%	32%	3%	12%	0%	100%	884
util	1%	1%	37%	9%	2%	0%	1%	1%	41%	0%	6%	0%	100%	807
man_hvy														
man_hvy	0%	0%	44%	29%	4%	0%	1%	1%	14%	1%	5%	0%	100%	3667
man_lgt														
man_bio	0%	0%	37%	11%	0%	0%	0%	0%	48%	1%	3%	0%	100%	614
man_lgt	1%	0%	28%	23%	4%	1%	3%	1%	25%	2%	11%	0%	100%	10638
man_tech	0%	0%	50%	12%	2%	0%	0%	1%	32%	1%	2%	0%	100%	5354
profGov														
gov	1%	0%	13%	7%	5%	1%	0%	1%	64%	0%	8%	0%	100%	977
prof	0%	0%	21%	5%	5%	2%	3%	2%	54%	1%	7%	0%	100%	9159
retail														
ret_loc	1%	0%	13%	9%	9%	1%	9%	3%	18%	2%	35%	0%	100%	15777
ret_reg	2%	0%	17%	9%	7%	2%	7%	3%	24%	3%	26%	0%	100%	9905
serv_pers														
serv_pers	1%	0%	14%	8%	10%	1%	8%	2%	29%	1%	26%	0%	100%	20614
service														
fire	1%	0%	12%	5%	19%	2%	4%	2%	41%	1%	13%	0%	100%	17523
serv_bus	1%	0%	18%	8%	22%	1%	4%	2%	31%	1%	11%	0%	100%	22737
art_rec														
art_rec	0%	0%	12%	9%	8%	2%	6%	4%	31%	3%	23%	0%	100%	4005
DROP														
unclass	0%	0%	8%	2%	3%	2%	3%	2%	64%	2%	13%	0%	100%	580
Total	1%	0%	18%	10%	11%	1%	5%	2%	34%	1%	17%	0%	100%	184701

Table 13: Industry Use by Building Type

Industry	HO	Industrial			Mixed Use				OF	Retail			Total
		IH	IL	IW	HM	ME	MR	MT		RB	RS	RC	
agNatres													
ag	0%	0%	0%	0%	0%	0%	1%	1%	1%	0%	1%	3%	1%
natres	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
constr													
constr	2%	8%	8%	9%	5%	4%	3%	2%	4%	2%	2%	0%	5%
eat													
eat	8%	0%	1%	1%	2%	5%	11%	9%	2%	9%	12%	0%	4%
educ													
ed_high	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
ed_k12	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
ed_oth	0%	0%	1%	0%	1%	1%	1%	1%	2%	4%	1%	0%	1%
healthSocSvc													
health	2%	0%	2%	1%	3%	6%	5%	5%	9%	7%	4%	12%	5%
serv_soc	1%	0%	1%	1%	2%	3%	2%	2%	5%	1%	2%	0%	3%
hotel													
hotel	29%	0%	0%	0%	0%	1%	1%	0%	1%	0%	0%	0%	1%
info													
info	2%	4%	8%	5%	7%	7%	4%	6%	8%	3%	3%	0%	6%
logisTpSvc													
logis	3%	22%	11%	17%	5%	6%	5%	6%	6%	9%	5%	0%	8%
transp	1%	0%	3%	4%	3%	5%	2%	2%	3%	4%	1%	0%	2%
lseUtil													
lease	1%	0%	1%	1%	0%	0%	0%	0%	0%	1%	0%	0%	0%
util	0%	4%	1%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%
man_hvy													
man_hvy	0%	7%	5%	6%	1%	1%	0%	1%	1%	1%	1%	0%	2%
man_lgt													
man_bio	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
man_lgt	1%	4%	4%	6%	1%	3%	2%	2%	2%	3%	2%	0%	3%
man_tech	0%	0%	8%	4%	1%	1%	0%	1%	3%	1%	0%	0%	3%
profGov													
gov	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	1%
prof	2%	0%	6%	3%	2%	6%	3%	5%	8%	4%	2%	0%	5%
retail													
ret_loc	7%	16%	6%	8%	7%	8%	15%	12%	5%	9%	18%	18%	9%
ret_reg	8%	4%	5%	5%	4%	8%	7%	9%	4%	10%	8%	0%	5%
serv_pers													
serv_pers	12%	7%	8%	9%	10%	10%	17%	12%	10%	10%	17%	18%	11%
service													
fire	8%	5%	6%	5%	17%	11%	8%	9%	12%	9%	7%	18%	9%
serv_bus	10%	17%	12%	11%	26%	11%	10%	11%	11%	7%	8%	6%	12%
art_rec													
art_rec	1%	3%	1%	2%	2%	4%	3%	4%	2%	4%	3%	26%	2%
DROP													
unclass	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Freq. 2250 153 33787 17650 19604 2597 9360 3640 61888 2647 31091 34 184701

Step 1b - Space Per Employee

For each industry-building type combination, a distribution of space quantity used per employee is desired. The average space usage values are shown in Table 14. Figure 5 shows the variation of space usage across all industries using office space, a well utilized building space with good sample size for all industries.

In some cases, only a portion of all employees using the parcel's building space matched, so square feet/employee rate is inflated. For this reason, the highest 3 percent of the values for each industry-building combination were dropped. Typically those had low sample sizes and showed the less smooth distributions, but not always. Where sufficient sample size existed, the space use was reasonable, and compared favorably with Seattle/PSRC Urbansim and Oregon PECAS space usage assumptions, as shown in Table 15.

Based on these disaggregate data, building types and industries were combined where they had similar distributions, and to address small sample sizes. The aggregated results, shown earlier in Table 2, were used in the allocation process.

Table 14: Mean Use Quantity by Building Type and Employee Combination (sqft/employee)

		Industrial			Mixed Use					Retail			
Row Labels	HO	IH	IL	IW	HM	ME	MR	MT	OF	RB	RS	RC	Total
agNatres													
ag	1,290		257	450	1,082	955	572	388	264	283	299	2,066	719
natres	729		192	544	809		45		190		118		375
constr													
constr	1,504	774	643	976	3,185	312	884	440	379	2,396	398		1,081
eat													
eat	1,163		920	736	1,676	782	660	508	483	391	503		782
educ													
ed_high			661	2,979	98	297	203	168	372		145		615
ed_k12			425	434	289		29	368	458		241		321
ed_oth	37		441	563	1,122	204	750	411	269	157	494		445
healthSocSvc													
health	806		649	796	2,272	506	468	422	398	133	484	2,539	861
serv_soc	1,227		747	846	2,023	345	491	347	355	1,378	484		824
hotel													
hotel	1,892		926	1,708	1,869	255	939	792	250	2,245	339		1,122
info													
info	1,270	375	843	806	2,935	445	857	403	378	454	423		835
logisTpSvc													
logis	2,395	1,999	1,113	1,536	3,430	430	751	550	392	449	595		1,240
transp	709		758	834	4,623	703	1,231	277	399	96	328		996
lseUtil													
lease	954		375	792	1,648		455		250	164	270		614
util	1,437	141	371	543	3,588		177	394	230		502		820
man_hvy													
man_hvy	501	774	667	870	1,779	444	958	329	232	481	562		691
man_lgt													
man_bio			430	309					165	343	47		259
man_lgt	635	68	585	953	3,172	205	469	421	317	237	394		678
man_tech	655		513	662	2,042	282	1,499	158	289	489	544		713
profGov													
gov	457		406	359	1,801	263	578	300	363		585		568
prof	602		504	809	2,682	313	459	293	345	183	391		658
retail													
ret_loc	1,039	2,652	1,018	1,282	3,082	722	990	574	524	719	645	2,697	1,329
ret_reg	2,209	68	872	1,379	3,142	906	925	592	459	623	791		1,088
serv_pers													
serv_pers	1,822	1,742	949	1,319	2,964	712	911	560	595	405	756	2,697	1,286
service													
fire	1,588	265	906	1,113	4,962	742	909	465	461	217	570	528	1,061
serv_bus	1,840	707	1,004	1,361	3,694	413	920	496	464	231	573	2,555	1,188
art_rec													
art_rec	1,150	339	598	1,321	2,447	266	638	606	411	263	704	1,492	853
DROP													
unclass	1,119		736	603	1,478	403	126	254	255	462	268		570

Figure 5: All Industry Quantity Distributions of Office Building Type (sqft/employee, capped at 5K)

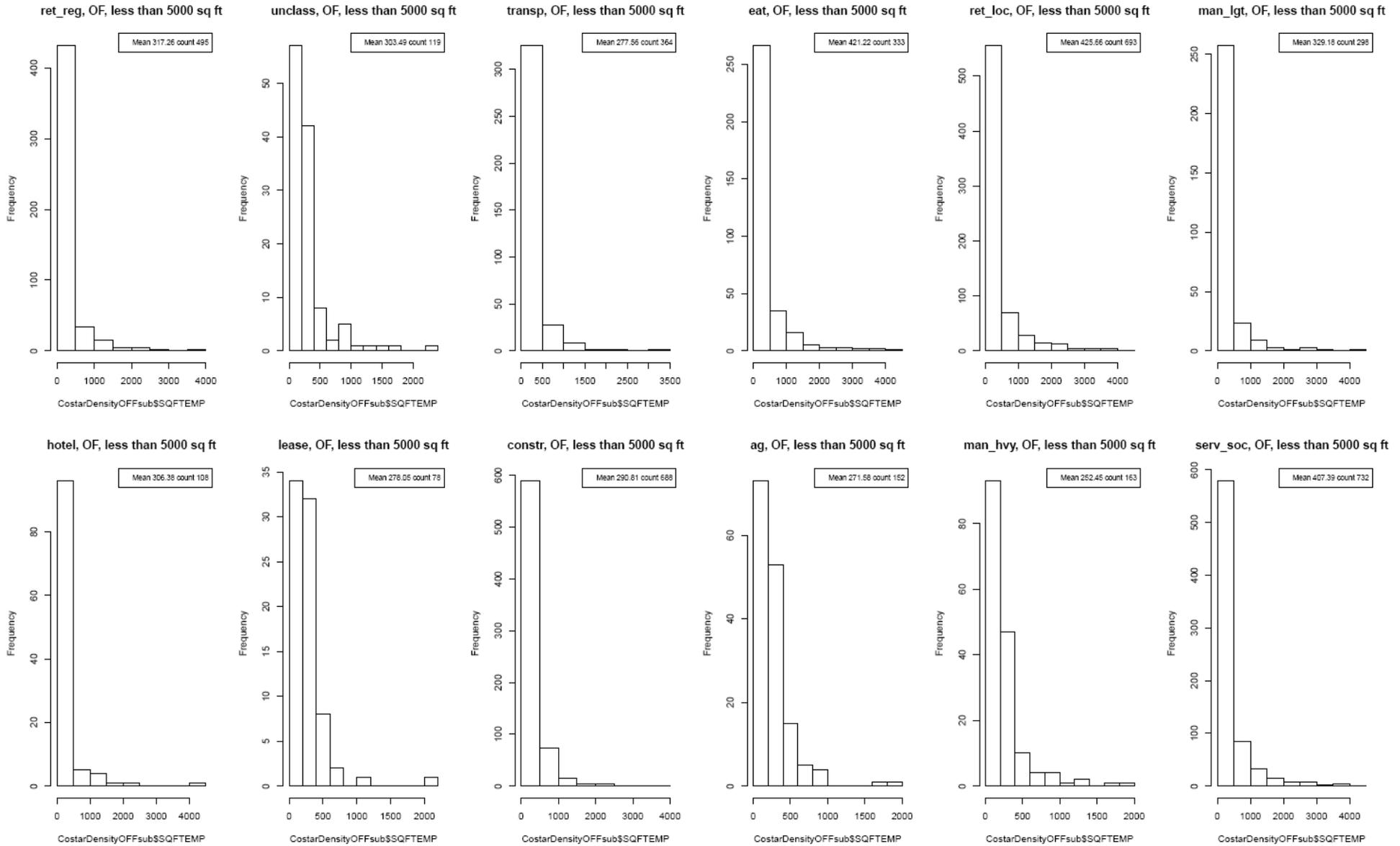


Figure 6: All Industry Quantity Distributions of Office Building Type (sqft/employee, capped at 5K)

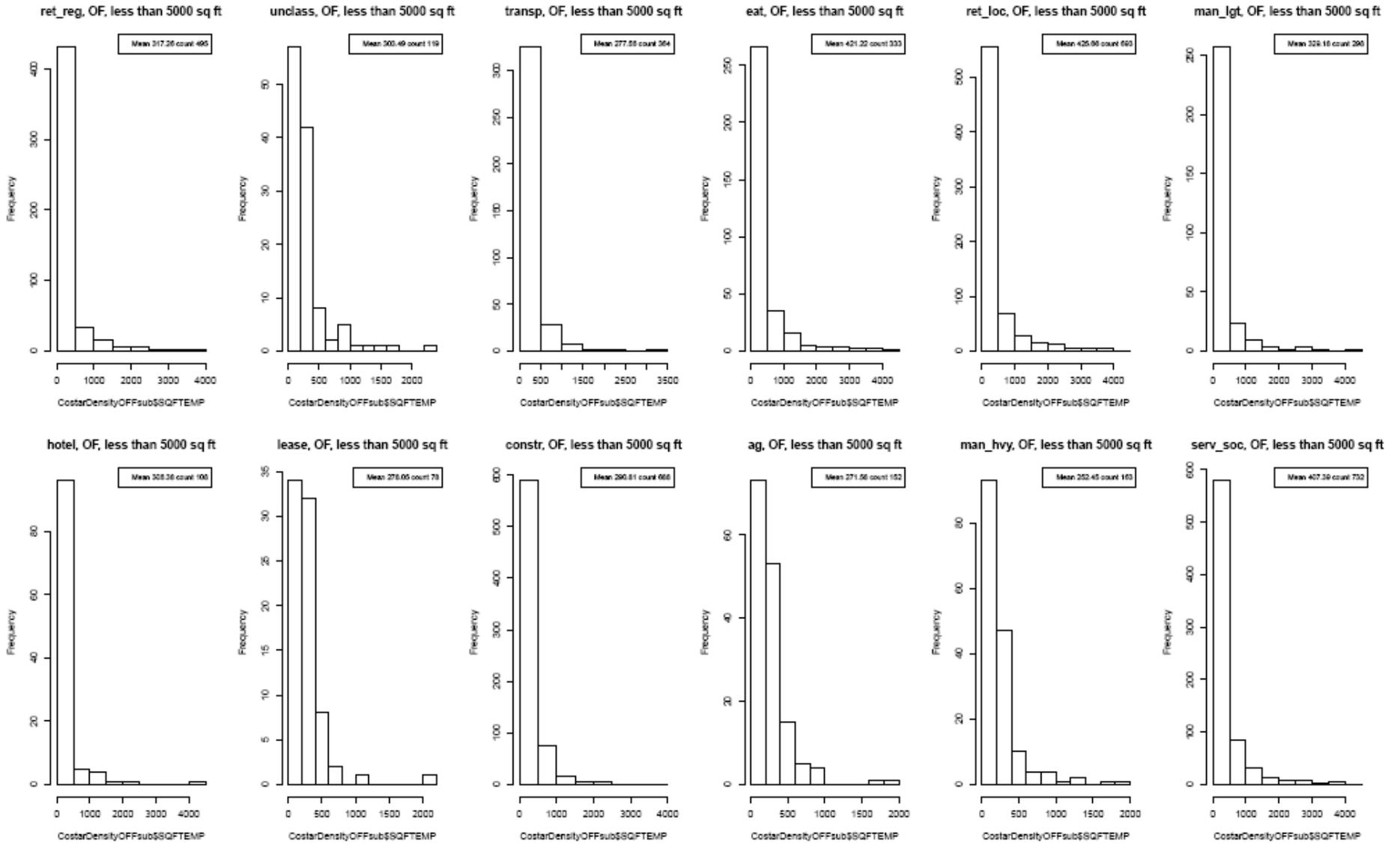


Table 15: Use Quantity by Building Type Comparison (sqft/employee)

Seattle					
	Type	Units	min	ave	max
14	Outbuilding	Bldg sqft	25	123	2000
3	Commercial	Bldg sqft	25	290	2000
13	Office	Bldg sqft	25	345	2000
10	Mixed-Use	Bldg sqft	25	383	2000
1	Agriculture	Bldg sqft	25	414	2000
8	Industrial	Bldg sqft	25	417	2000
21	Warehousing	Bldg sqft	25	453	2000
18	School	Bldg sqft	25	483	2000
7	Hospital / Convalescent Center	Bldg sqft	25	520	2000
20	Transp Comm Utilities	Bldg sqft	25	535	2000
5	Government	Bldg sqft	25	737	2000
6	Group Quarters	Bldg sqft	25	893	2000
2	Civic and Quasi-Public	Bldg sqft	25	974	2000
9	Military	Bldg sqft	1234	1,234	1234
17	Recreation	Parcel sqft	25	658	2000
16	Parking	Parcel sqft	25	881	2000
15	Park and Open Space	Parcel sqft	729	1,365	2000

Oregon			
Type	min	ave	max
FLR Retail	259	379	554
FLR Office	0	163	259
FLR Light Industry	0	469	1,178
FLR Heavy Industry	412	720	1,178
FLR Warehouse	1,719	1,720	1,720
FLR K12	732	732	732
FLR Hospital	248	248	248
FLR Institutional	252	252	252
FLR Gov Support	214	214	214
FLR Accommodation	259	534	808

ABAG	
Type	Ave
RS+RB	445
OF	355
IL	661
IH	825
IW	960
HO	1,161

Step 2 Building Type-Square Footage Census Tract Control Total Details

The industry-building relationships of Step 1 were applied in Step 2 to the EDD control total of employees to arrive at building square footage target. The EDD data is available at the tract level by NAICS. The SIC-based Steelhead industry groupings were mapped to 2-digit EDD NAICS code in a lookup table. For each EDD industry type, a 'use share' by building was calculated using the above processes (Table 1). This use share was then adjusted to accurately reflect the building types available in a particular tract. For example, if the previous work showed that a particular industry uses 50% each of two building types, but only one of those building types was available in the tract, then the use share was adjusted to 100%.

The use share was multiplied by the calculated average square feet per employee for that industry group and building type (Table 2), and by the total number of employees in the tract. The result of this calculation is the employee-based control total of square footage by building type in the census tract, to be allocated to the parcels in Step 3.

Step 3 Allocation of Building Type-Square Footage Control Total to Parcels Details

This step allocates square feet to parcels that do not already have square footage. Most parcels already have a square footage amount, which came from the parcels dataset. For the parcels with missing square footage, the methodology described in Part 3 of the methodology was used to create a distribution. Values from the distribution were applied to available parcels until there were no more parcels, or the total amount allocated within the tract equaled the Control Total.

Suggested Future Revisions

The following ideas could be further explored and incorporated into the allocation process in order to potentially improve the process.

Calculation/Use of Standard Deviation in Allocation Process

The space use per employee relationship of Step 1b is a distribution, thus the Step 2 calculation of the target square footage by building type by census tract is also a distribution. The analysis to date has only used the average of this distribution, and then given the final allocation within the census tract, checked that the overall average square feet per employee (over all types) was reasonable. An alternative way to check for the minimum value in the tract would be to calculate a standard deviation (SD) in addition to the mean (e.g., minimum value of average-1 standard deviation). Table 16 and Table 17 show the observed SD values for the aggregated industry and building types, with the latter table indicating the ratio of SD to mean. The SD seems to be quite large in most cases, typically ranging from 0.6 to 2.0 times the mean. The SD seems to be smallest for Hotel and Mixed Use space and largest for industrial and warehouse, with office and retail falling between.

To use this SD value at the census tract level, these relationships by industry-building type, would need to be processed by the allocation script similar to how the average is calculated for each census tract.

Table 16: Use Quantity by Building Type and Industry Combination (sqft/Employee) - Standard Deviation

	Hotel	Office	Mixed	Retail	Industrial	Warehouse	Rec
agNatres		166	147	197	50	288	1,033
constr		712	151	295	1,324	1,305	
man_hvy		170	119	361	947	945	
man_lgt		476	151	259	909	1,322	
logisTpSvc	1,435	598	195	429	3,928	2,377	
lseUtil	321	138	147	110	421	1,242	
info	470	433	203	310	1,796	734	
profGov	548	414	134	340	675	923	
healthSocSvc	440	583	124	424	820	676	
hotel	2,093	216	147	142	1,155	936	
eat	808	587	373	472	1,789	428	
Retail	1,120	986	328	721	1,590	2,360	
Service	965	1,623	325	517	2,480	2,922	
serv_pers	1,075	803	304	669	1,463	1,795	
art_rec	677	391	336	536	678	1,285	
Educ		537	62	202	727	349	

Note: Red bold values has 1 or no observations and were set to 50% of mean values

Table 17: Use quantity by Building Type and Industry combination (sqft/employee) – SD/Mean

Row Labels	Hotel	Office	Mixed	Retail	Industrial	Warehouse	Rec
agNatres		0.67	0.50	0.79	0.16	0.64	0.50
Constr	-	2.00	0.66	1.11	2.18	1.43	
man_hvy		0.91	0.43	1.03	1.16	1.07	
man_lgt	-	1.69	0.79	0.79	1.49	1.43	
logisTpSvc	0.93	1.80	0.65	1.20	3.12	1.63	
lseUtil	0.50	0.66	0.50	0.61	0.89	2.02	
Info	0.59	1.33	0.77	0.87	1.98	1.03	
profGov	0.95	1.19	0.64	1.13	1.40	1.13	
healthSocSvc	0.75	1.55	0.52	1.27	1.59	1.19	
Hotel	1.04	0.83	0.50	0.64	0.99	0.80	
Eat	0.78	1.62	0.96	1.32	1.84	0.99	
Retail	0.96	2.25	0.82	1.42	2.00	1.75	
Service	0.71	3.25	0.87	1.39	2.79	2.10	
serv_pers	0.77	1.61	0.88	1.37	1.49	1.43	
art_rec	0.50	1.17	0.85	1.21	1.21	1.10	
Educ		1.79	0.29	0.81	1.89	0.82	

Note: Red bold values has 1 or no observations and were set to 50% of mean values

Revisit of School/Government space

School and Government space were not addressed well in this effort due to lack of clear data and UV parcels coding (e.g., per Figure 2 schools are coded as SC and GV, and other building types). Neither building type showed up in the Nets-CoSTAR matches (see Table 11) that were used to derive the UseShare and SqftPerEmployee relationships of Step 1. Assumptions on these relationships were made in Tables 1 and 2 so space would be allocated to these parcels in the census tracts where they exist. These assumptions are easily changed (modify NRESUsageInputs.csv) and the allocation process re-run.

Distinguish Space Use within Building Groups

Table 1 and Table 3 aggregated building types into groups of retail, mixed use and industrial, to allow the allocation process to use whichever specific building types were available in the census tract. However, these types could be disaggregated particularly for the quantity of space used per employee (Table 3), to allow for more variation.

Some indication of the variation can be observed in Table 2. Industrial is difficult to split into heavy and light space, since there are so few instances of IH space. Two of the four mixed use building types (HM, MR) includes residential as well as the non-residential square feet leading to very large space usage per employee rates. However, mixed use shows some pattern that ME (employee-based) uses more space per employee than MT (retail-based). Likewise Retail RB (big-box) is typically larger than RS (stripmall). These are not strong patterns and do not fully concur with expectations.

Note that currently the Step 3 allocation script is written to assume the Use Share (Table 1) and the square feet per employee (Table 2) use the same industry and building aggregations, defined in the

NRESUsageInputs.csv input file. It is simple to update the aggregations if they are consistent across the 2 steps. However, if these aggregations differed by step, the Step 3 allocation script would need to be updated to accommodate this.

Distinguish Office Space by Class

One expansion of the current method could be to distinguish use share and square feet per employee rates by office class space. Using the "Bldg_class" field in the BA* parcel dataset, office data was summarized by Class A, B, C, and F (only one parcel mapped to class F). The results are shown in Table 18. The shaded cells indicate some variation across office class that might be used to better allocate and/or quantify the space usage. For use share, the most variation was found by Office class in the industries of Hotel, HealthSocSvc, Serv_pers (class A differed from B+C), as well as LseUtil, Man_hvy, and agNatRes (where A+C differed from B). For sqft/employee office share seemed to exhibit more widespread differences. The one observation of class F was insufficient.

To use this in the script would require disaggregating the input file to include the class disaggregations, as well as updating the script.

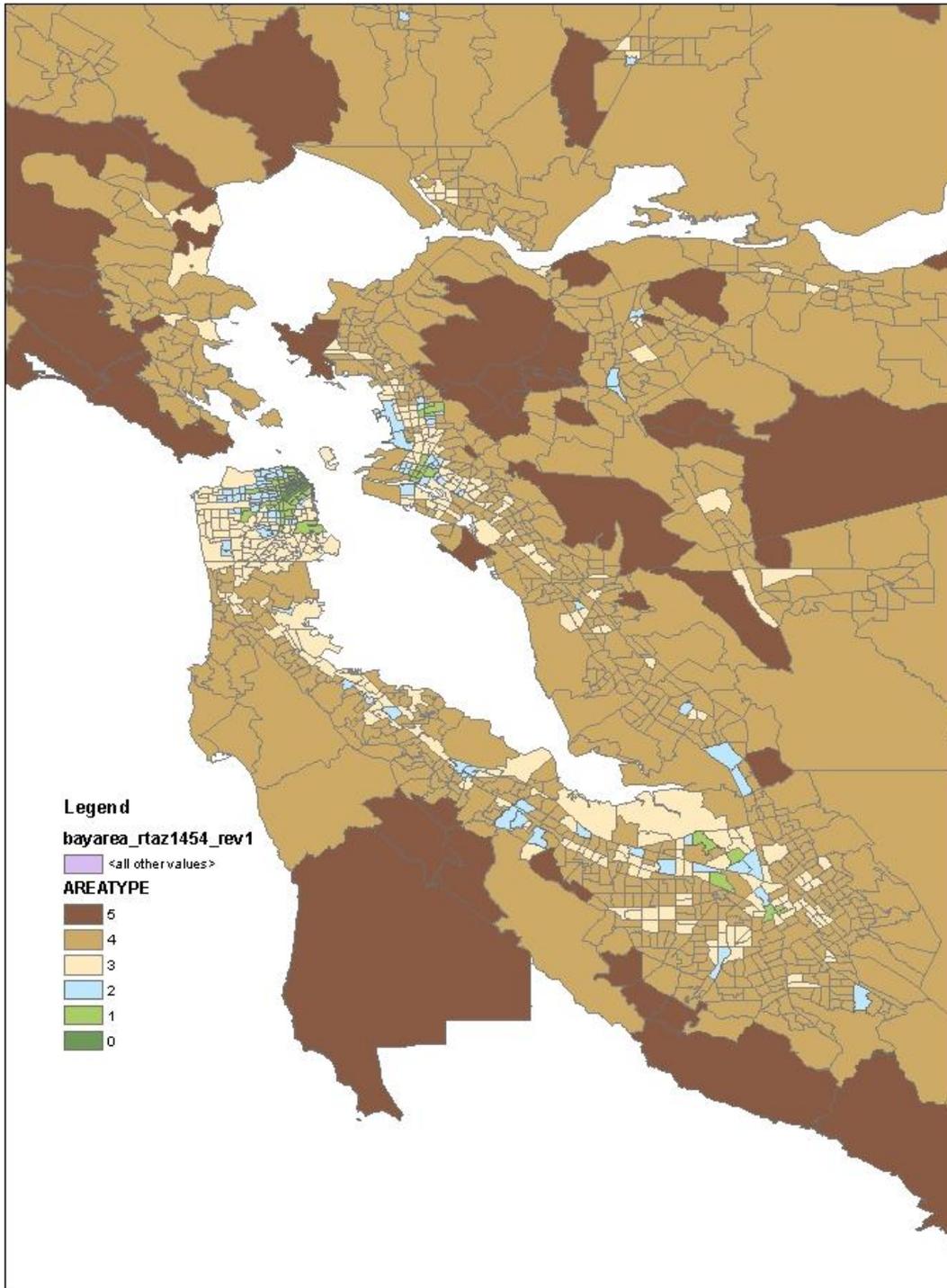
Table 18: Share and Use Quantity by Office Class

UseShare	OFFICE			obs	Sqft/emp	OFFICE			
	A	B	C			A	B	C	F
agNatres	26%	46%	27%	91	247	237	272	-	
art_rec	15%	43%	41%	202	300	287	428	2,833	
Constr	18%	43%	39%	430	481	278	294	-	
Eat	22%	42%	36%	213	735	335	368	-	
Educ	15%	53%	32%	239	334	240	300	-	
healthSocSvc	9%	41%	50%	1234	1,006	264	345	-	
Hotel	43%	30%	27%	70	211	279	328	-	
Info	15%	50%	35%	847	363	310	448	-	
logisTpSvc	19%	48%	33%	854	316	318	340	-	
lseUtil	34%	47%	19%	118	276	194	271	-	
man_hvy	12%	59%	29%	98	277	185	234	-	
man_lgt	21%	47%	31%	519	378	290	324	-	
profGov	15%	48%	37%	946	356	286	338	-	
Retail	18%	48%	34%	769	373	339	450	-	
serv_pers	11%	40%	49%	828	397	335	380	2,833	
Service	12%	46%	42%	2131	453	469	404	-	
Average	15%	46%	39%	9673	401	293	345	2,833	

Distinguish Space Use by Area Type

In Step 1a and 1b, the NETS-CoStar data were tabulated by not only by industry-building type, but also by area type. Initially census population was combined with EDD employment in a density measure. But it was decided to instead map the parcels to the MTC model's area type field (range 0-5 with 5 least dense; 0 only occurs in SF market street area), as shown in Figure 7.

Figure 7: MTC Area Type (0-5, 0 = most dense)



The square feet per employee variations by area type, a surrogate for price effects, are provided in Table 19. In most cases there is not a strong pattern of square footage usage variation and in some cases the relationships were counter intuitive (increased space per employee in denser areas) often explained by small sample sizes. Isolated pockets of industry-building type did show reasonable variation by area type that may warrant disaggregation to gain more accuracy. These include artrec in warehouse space, eat employees in Hotel and industrial space, and generally for LseUtil and Hotel employees. Man_lgt in mixed use and profgov in industrial space and retail in hotel showed some trends with outliers that may result from small sample size.

Table 19: Use Quantity Variation by Density for Building and Industry Combination (sqft/employee)

Row Labels	Hotel	Industrial	Mixed	Office	Rec	Retail	Warehouse	Freq.
agNatres								
1			766	275		108	640	28
2		589	978	105		385	257	20
3		197	1,115	320		231	439	56
4		132	371	205		274	461	81
5				346	2,066			2
art_rec								
0	1,354		598					41
1		496	1,073	486		276	432	103
2		436	1,211	265		374	892	112
3		948	1,317	437		725	1,926	198
4		362	1,253	331		453	1,402	246
5			188	151				4
constr								
0		214						45
1	877	563	1,237	389		248	697	145
2		575	1,399	340		343	788	189
3	729	607	2,020	425		255	903	667
4	60	1,084	1,267	271		250	1,264	566
5			37			179		2
eat								
0	956		476					76
1	637	288	922	661		593	250	241
2		293	754	260		325	293	181
3	1,013	1,156	835	662		308	673	461
4	1,515	2,149	868	154		409	510	388
5			37	74		174		11
educ								
1		207	482	339		249	379	65
2		640	483	375		273	280	54
3		400	499	462		210	464	183
4		290	409	219		260	570	160
5				109				1

Row Labels	Hotel	Industrial	Mixed	Office	Rec	Retail	Warehouse	Freq.
healthSocSvc								
0		304	1,234					274
1	37	365	940	461		646	300	277
2		468	571	465		260	399	857
3	918	1,016	1,047	443		263	1,019	876
4	792	420	1,242	328		319	545	15
5			112	190				
hotel								
0	1,277		943					40
1	2,117	518	1,936	233		359		46
2	1,339		309	429		38	517	28
3	2,746	57	1,268	194		61	1,017	88
4	2,632	2,910	1,875	185		427	1,998	101
info								
0	941		1,688					99
1	976	730	1,151	397		386	782	291
2		754	1,034	355		416	496	354
3	478	1,384	1,631	466		271	902	786
4		758	1,063	247		299	679	657
5			1,157	162		408		13
logisTpSvc								
0	1,673		1,625					129
1	3,516	2,448	1,026	501		467	1,413	368
2	418	1,254	1,319	317		314	1,081	404
3	562	1,361	1,815	374		323	1,418	1287
4		614	1,279	358		376	1,927	1068
5				116				3
lseUtil								
0	553							29
1		724		235		33	409	36
2	376	500	1,357	154		164		24
3	1,051	331	2,040	233		146	572	96
4	589	348	6,574	208		393	863	118
man_hvy								
1		966	1,035	212		518	659	50
2		752	1,844	143		167	836	90
3		690	1,057	233		407	1,089	310
4		864	2,961	160		490	953	288
man_lgt								
0	553							45
1		622	864	374		226	1,061	148
2		623	1,131	439		348	706	283
3		630	1,125	312		252	928	749
4		573	1,164	177		284	1,015	622

Row Labels	Hotel	Industrial	Mixed	Office	Rec	Retail	Warehouse	Freq.
5			37	110		727		3
profGov								
0			1,236					111
1	421	281	799	500		465	1,033	265
2		507	1,337	437		359	774	245
3	729	546	1,698	369		276	776	676
4		587	1,465	288		182	687	522
5			37	141				8
retail								
0	2,046		1,552					191
1	1,352	967	1,372	520		740	1,517	506
2	702	909	1,327	704		366	667	623
3	776	1,046	1,420	458		509	1,446	1460
4	944	525	1,300	425		574	1,764	1450
5			183	83		429		26
serv_pers								
0	1,689		1,933					122
1	1,139	1,072	1,249	663		887	1,239	441
2	999	919	1,516	407		497	960	447
3	1,183	1,097	1,703	579		365	1,530	1262
4	1,930	849	1,282	665		555	1,303	1133
5			112	184		174		13
service								
0	1,229		2,200					267
1	1,260	992	1,394	635		696	1,707	867
2	1,093	1,064	1,435	719		364	1,108	1001
3	1,593	1,069	1,993	564		341	1,572	2269
4	1,579	656	1,836	402		335	1,168	2196
5			781	174		210		42

Deliverables

The scripts are run in a similar fashion as the residential allocation scripts.

Allocation

Inputs

- ABAG_EDD_Request2.csv – EDD data
- BGtoTract.csv – Block group to tract lookup
- NaicstoIndGroup.csv – NAICS to Industry group lookup
- NRESUsageInputs.csv – Non-Red building usage rates
- ReleventEDDData.csv – EDD data used

Scripts

- ABAG_NonRes_Allocation_V2_Master.R – main allocation script
- ABAG_NonRes_Allocation_V2_Slave.R – allocation script called by main script
- ABAG_NonRes_SummarizeOutput.R – script to summarize outputs

Outputs

- NonResidentialAllocatedParcels.csv – parcel allocation results
- Plots of Percent Difference Between Allocated and Control by Tract by Building Type: *.pdf

Target Data

Inputs

- ReleventCostarData.csv – CoStar data input
- nets09_ba_trim1d.csv – Nets data input
- DensityCalcParcel.csv – Density input
- SICGroups.csv – SIC mapping input
- BldgTypeGroupings.csv – Building type groupings input
- OfficeClass.csv – Office class input

Scripts

- CalcSQFTperEmp_NetsandCostar.R – target data creation script

Outputs

- NETS-CoStar summaries: SQFTperEmp*.csv (mean, median, standard deviation, and number of observations, calculated for the building groups, for each building type (*UV extension) and for the Office building type with additional Office class type dimension (*OF extension))