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Technical Memorandum

To: David Cohan, NEEA; Charlie Grist, NPCC
From: David Baylon, Ecotope, Inc
CC: Poppy Storm, Project Manager, Ecotope, Inc.
Date: 1/8/09
Re: Building Type Analysis for the “Assembly” and “Other” Categories of the 2002-04 Baseline Study

1. Introduction

The purpose of this technical memo is to describe the characteristics of two commercial new construction building type categories, “Assembly” and “Other” (A&O), that were not included in NEEA’s 2002-04 Non-Residential Baseline Study. NEEA decided to remove them from the study to increase the sampling efficiency of building types of specific interest to both regional stakeholders and NEEA. Removing them lowered the number of buildings in the study sampling frame by 19%, thereby increasing the number of buildings selected in the remaining building type categories. It lowered the square footage in the sampling frame by only 12%, suggesting that these buildings were by and large smaller than the remaining population.

Though removed from the main baseline study, there was regional interest in gaining basic information about the A&O building types. A follow-on task was therefore included in the baseline study contract to characterize, at a regional level, the nature of these buildings in terms of their end-use categories, and, if possible, their energy use. The task had the following four goals:

1. Study the approximately 1,200 A&O buildings using roughly the same sampling techniques and sampling criteria used in the 2002-04 Baseline Study
2. Assess the degree to which the secondary information in the Dodge dataset could be used to assign end-uses to these buildings
3. Assess the degree to which buildings assigned to the A&O category by Dodge were mis-characterized and should have been included in other building categories
4. Obtain billing information on the A&O sample to determine whether these building types were appreciably different than the other commercial building types

The A&O sample frame is shown in Table 1 and Table 2.

Table 1: Regional Assembly and Other Buildings, by State

State	Assembly	Other	Both	Region	
				All	%
ID	122	84	206	1,196	17.2%
MT	34	33	67	257	26.1%
OR	195	139	334	1,780	18.8%
WA	317	236	553	2,846	19.4%
Region	668	492	1,160	6,079	19.1%

Table 2: Regional Assembly and Other Buildings, Area (000s SF)

State	Assembly	Other	Both	Region	
				All	%
ID	1,627	945	2,572	20,522	12.5%
MT	434	308	742	5,144	14.4%
OR	2,668	1,527	4,195	39,173	10.7%
WA	6,600	3,616	10,216	81,303	12.6%
Region	11,329	6,396	17,725	146,142	12.1%

2. Methodology

The principal method used to obtain data on A&O buildings was telephone interviews. The Dodge database had initial contacts, usually general contractors or architects, and those contacts were asked to provide the names of current building operators or owners that might be willing to discuss the buildings. This process was similar to that used in the 2002-04 Baseline Study recruiting process, and had approximately the same results: about a 65% success rate in getting contacts or information from the Dodge contacts (or in finding some secondary method to get those contacts) and then securing an interview to ask general questions about the building’s operation and uses.

The interview protocol for these phone interviews is attached. As can be seen in this attachment, the interviewers were asked to collect information on the building uses, size, and some characteristics of the building such as fuel use and operating schedule. The other main goal of the interview was to secure a release for the billing information for the building. A total of 63 interviews were conducted but very few of the interviews resulted in billing releases or any sort of billing information other than a name of the serving utility.

The study design called for “drive-by surveys” to be conducted on a fraction of the buildings interviewed. The goals of these surveys were to validate interview results, reduce confusion for complex buildings with a variety of end uses, and to review some of the most obvious characteristics in a sample of A&O buildings.

This process also had disappointing results. First, the number of drive-bys was smaller than originally envisioned and second the information that was generally available was not significantly different than that received over the phone. An improved approach here would be

to contact the building a second time and arrange for the drive-by visit to have greater access. This could also help in gathering billing releases.

Nevertheless, the overall drive-by results were able to confirm the results of the interview in addressing the building size and end uses. In almost all cases, the interviews resulted in building areas and end uses that were confirmed by the visit. In one case the drive-by survey identified a building that had been demolished since the original interview (a period of less than a year). In another case the process of “recruiting” (by calling in advance and arranging the audit visit) resulted in sufficient access to get some added details on building characteristics and to get sufficient permissions to allow bills to be collected. Unfortunately, this was not repeated for the rest of the sample and the drive-by methodology generally used (arriving at the building unannounced) did not get similar results in other buildings.

Table 3 shows the sample distribution for all the buildings with valid interviews collected during the interview phase. As buildings dropped out during the recruiting phase, they were randomly replaced.

Table 3: Sample Distribution and Total Area

	Assembly		Other		Both	
	N	Area (sf)	N	Area (sf)	N	Area (sf)
Total	33	1,808,650	30	2,197,919	63	4,006,569

The size of the sample was afterwards enhanced using 17 applicable buildings from the Baseline Study. These buildings were originally classified by Dodge as non A&O building types and thus were included in the sampling frame for the 2002-04 Baseline Study. The information collected for these buildings during the 2002-04 Baseline Study showed them to in fact be A&O buildings, making them relevant data points for the A&O summary.

Table 4 summarizes the final sample, including the 17 additional buildings.

Table 4: Enhanced Assembly and Other Sample

	Assembly		Other		Both	
	N	Area (sf)	N	Area (sf)	N	Area (sf)
Total	41	1,986,924	39	2,381,288	80	4,368,212

Note that the sample, as drawn and analyzed, is a regional sample. To avoid confusion, state-level distribution of the sample is not shown in Table 3 and Table 4. All the further summaries in this report focus on the overall distribution within the A&O categories and not on any particular feature of any particular state.

One of the primary goals of the interviews was to get billing “releases” that would allow the utilities to identify and provide the energy bills for the particular building. In this project utilities have generally insisted on full customer releases no matter what level of non-disclosure executed between Ecotope and the utility. Sometimes this even went so far as to require a specific form

that had to be filled out by the building owner. This places a significant burden on an interview format since it always requires a secondary contact to complete the billing release.

Unfortunately, the technique used to get billing information proved nearly impossible in the context of an interview-only format, and thus the development of billing information for this group was abandoned.

3. Space End-Use Distributions

A primary focus of this review was to determine the types of building uses included in the A&O categories. Ecotope developed the list of building types consistent with the previous baselines and with the commercial building categories used by the NPCC in assessing conservation potential. The categories were created by collapsing the Dodge descriptions into 12 building types used in developing the samples both in this group and in the 2002-2004 Baseline. Table 5 shows the distribution of “descriptions” as originally described in Dodge. Dodge only presents the dominant end use for each building.

Table 5: F.W. Dodge Sub-Uses by Building Type (N=1160)

Assembly		Other	
Use	%	Use	%
Churches	38	Terminals	13
Exhibit	20	Animals	5
Other Assembly	16	Communications/Servers	6
Club/Lodge	6	Recreation	7
Recreation	19	Vehicles/Service	65
Other	1	Other	4
Total	100	Total	100

The Dodge Assembly and Other categories, particularly the Other category, included many uses, sometimes quite diverse. These buildings were often classified in these categories because they were mixed-occupancy and had no dominant use. Table 6 and Table 7 show the distribution of building types as observed in the interview and survey process. Table 6 shows that a large percentage of the square footage in the A&O sample fell into building types that were summarized in the 2002-04 Baseline Study.

This distribution is based on sub-uses within any particular space. Thus, the portion of a mixed-use building that was partially a hotel, partially an office building, and partially vehicle sales appears in the appropriate categories in the table.

Table 6: Percent Floor Areas in Baseline Categories

Building Type	Assembly	Other	Both
School	7.5	0.3	4.7
Institution	0.9	0.0	0.6
Office	23.3	29.6	25.7
Residential/Lodging	6.3	3.8	5.3
Restaurant / Food Prep	2.4	6.3	3.9
Retail	7.1	9.5	8.0
Warehouse	2.2	12.1	6.0
Total	49.6	61.4	54.2

Table 7 shows the distribution of the remaining spaces by building types. Many of the Assembly buildings in the sample are associated with churches or other religious use (41 percent of the total area in this category). The amount of this building type that is actually assembly space for worship or other purpose is a fraction (about 25%) of the space constructed in this building type.

The “Other Assembly” sub-category dominates the Assembly category and appears in the Other category. This category includes conference rooms, multi-purpose rooms with large gathering spaces (usually associated with schools or public buildings), theaters and similar spaces, ballrooms, and meeting rooms (usually part of conference centers).

The “Exhibit” category included both exhibit spaces for conferences and related activities, as well as exhibition arenas for large gatherings (usually for fair grounds) or similar enclosed arenas.

Table 7: Percent Floor Areas, Non-Baseline Categories

Assembly		Other	
Use Type	%	Use Type	%
Church	10.8	Vehicle Service	20.8
Exhibit/Arena	5.2	Testing	3.9
Casino	2.6	Manufacture	2.8
Recreation	7.0	Animals	0.7
Other Assembly	21.5	Communications, Server	2.0
		Vacant, Unheated	3.3
		Other Assembly	4.1
Total	47.1		37.6
All Other Uses	3.3		1.0

The summaries in Table 6 and Table 7 are case weighted for the stratification used in the original sampling. This resulted in a reduced impact for the large exhibition and convention facilities. Nevertheless, the size of these facilities is much of the reason for the dominance of the “Other Assembly” sub-category as this is the category that includes the conference and meeting rooms that are part of this use type.

The Other category shows a distribution with a much larger emphasis on vehicle service and maintenance. In general, while Dodge uniformly classifies uses related to vehicles to the Other category, for our purposes, auto sales or any other type of retail sales were classed as retail (and included in Table 6), while the service departments (garages and other kinds of parts and maintenance facilities) are classified as service. About 3% of the Other category was classified as manufacturing. This is generally the result of buildings that were not inherently manufacturing based, but had a manufacturing use in part of the building. Typical manufacturing uses were screened out of both the 2002-04 Baseline Study and the A&O study, before the samples were drawn. Finally, we have some space associated with communications and server facilities which are either server farms or communication stations. Usually these are parts of buildings with separate facilities for communications such as fire, emergency dispatch, and 911 calls. The category for animals, in this sample, was exclusively based on humane society shelters or related type facilities.

The Other sub-category of both groups is a catch all. The category is dominated by public works projects such as water treatment and transportation. These projects were generally removed when they were not building projects the cases here are actual buildings associated with these infrastructure projects.

Tables 5, 6, and 7 are combined in Table 8 to show the contrast between the original Dodge descriptions and the building uses observed in the survey. In the case of the sample, a total of approximately 29% of the buildings had actual onsite review with some detailed effort to assess the veracity of the interview results. These results are reflected in Table 8.

Table 8: Percent Buildings Conditioned, Heating, Cooling

Assembly			Other		
	Dodge	Survey		Dodge	Survey
Use Type	%	%	Use Type	%	%
Church	38	11	Terminals*	13	0
Exhibit	20	5	Animals	5	1
Club/Lodge/Casino	6	3	Communications/Servers	6	2
Recreation	19	7	Recreation	7	0
Other Assembly	16	22	Vehicles/Service	65	21
Other	1	3	Other	4	4
			Other Assembly	0	4
			Manufacture/Testing	0	7
Baseline Categories		50	Baseline Categories		61
Total	100	100	Total	100	100

*The terminal in this survey was demolished by the time of the drive-by survey.

In one case, this resulted in identifying a building that was actually demolished between the time the interview was conducted in 2007 and the time the field review was conducted in 2008. In most cases, these reviews resulted in slight alterations to the uses that were determined in the interviews, except in cases where the mixed-use was extremely complex and only the field work information was used. However, the general picture from the drive-bys, even with these alterations, changed relatively little, except for when the building was actually demolished.

4. Other Characteristics

The interview protocol is included in the attachment. In general this format was designed to get a small amount of information beyond the type of building uses. Questions were asked about building use, schedule, alterations or other changes, as well as building area. In addition, the interviewers tried to get information on the serving utility and the participation of the building in any utility programs. Finally the interviewer asked questions on building ownership and decision making with respect to energy use and energy efficiency.

For the most part, the interview process did not yield enough consistent data regarding building operation, ownership, or utility participation to be useful. It is apparent from reviewing the interview results that the person interviewed did not generally have much information about the building and the utility bills. Questions on issues such as participation in utility programs received next to no response from the informants. In the end, only about 30% of the interviews actually yielded any reasonable responses to the various questions which made it difficult to summarize in any meaningful way. The one exception to this are the heating and cooling types. Interviewers asked if the building was heated or cooled, and received answers in 92% of the interviews. Table 9 summarizes the fraction of heated and cooled space in the A&O categories.

Table 9: Building Conditioning, Heating, and Cooling

Conditioning	Assembly	Other	Both
Heating (% Floor Area)			
No	1	9	4
Yes	99	86	94
Partly	0	5	2
Gas Heat	93	85	91
Cooling (% Floor Area)			
No	20	27	22
Yes	65	42	57
Partly	25	31	21

As can be seen for Assembly, 99% of the buildings were heated. For Other, a noticeable fraction, almost 10%, were either unheated or partially heated. This category included buildings that were vacant or contained unheated shop or warehouse space. The use of “Gas Heat” was inferred from the description of the gas utility. The assumption was that if there was a gas bill then it would be used for space heating (at a minimum).

A somewhat smaller amount of cooling was noted in both categories with about 65% of the Assembly fully cooled and 40% of Other fully cooled. In general, the Other category had substantially less cooling than the Assembly category. For comparison, approximately 70% of the buildings in the 2002-04 Baseline study had fully cooled space.

5. Conclusions

Overall, the A&O review indicates that about 50% of the spaces assigned to Assembly and Other could have been easily assigned to some other category within the 2002-04 Baseline Study. The tendency for this group, and most commercial operations, to have multiple uses within a single building type suggests that, at least within the limits of a characteristics analysis, these buildings can be characterized within the categories that were used in the baseline typology.

It is a matter of convenience that, for analytical and sampling purposes, we characterize buildings in broad categories. This is a useful but not necessarily accurate fiction. The A&O categories tended to be more diverse than most other building types. But the fact is that all buildings types have elements of this diversity that can appreciably change their characteristics and their energy performance. That said, the fact is that there is not a big enough sample or a big enough population to account for the individuality of these buildings and correctly categorize all of them into neatly comparable categories. For this reason, buildings should continue to be combined into categories that are useful and provide analysts with a typology that can be used to analyze and target energy efficiency for the commercial building sector. Further, the consistency of this typology should be a principal goal of future analysis. In this context, it may be time to revisit these categories with the goal of clarifying the building types (largely invented in the 1980s for Bonneville forecasting purposes) to reflect both the changing nature of commercial building use and the needs of energy conservation planners to realistically assess the markets and goals of such programs.

The A&O sample was the result of a trade-off between a more informative review of major building types in the region where programs and energy had been concentrated, and buildings that were thought to be less significant in both size and opportunities for energy efficiency. In this sense the impact of removing these two building types from the larger baseline had the effect of allowing more detailed review of several building types (especially Retail and Schools) that might not have been possible within the limitation of the larger project. The result of this decision on the characterization of the A&O building classification was not as successful. A very abbreviated approach to gathering minimal but useful information should be possible. However, this particular attempt was not particularly helpful. The resources available for this analysis must be able to secure the information necessary to compute EUIs and to assess the overall areas and end uses in these buildings. The process used here was successful in the later cases, but fairly inadequate in the former.

Although, the use of interviews to establish building end-use characteristics was fairly successful, the interview format did not lend itself to determining detail about the building itself. Assessing other details such as ownership characteristics, building components and characteristics, and (especially) for securing billing releases this method proved much less effective. This type of analysis would be desirable for collecting data in a much less expensive manner than the full audits done for the 2002-04 Baseline Study. For the potential of this approach to work, however, several improvements in this scope would be necessary:

- Sufficient follow-up time to ensure that the interviews are conducted with informed respondents. This is always easier with a site visit, and in this study the information available on site was more detailed and more likely to be useful in assembling the energy use characteristics than any of the interviews.

- The level of cooperation from utilities on releasing billing data without direct building owner permission is probably essential. Collecting sufficient permissions and utility meter information to reliably request the bills from a utility and assess the efficacy of those bills requires either a great deal of interaction with the utility or substantial interaction with the building. At this point the level of cooperation from most utilities implies that there be a much larger amount of data collected at and from the buildings.
- While a detailed audit seems unnecessary, some field time is probably required to ensure that the data collected is as useful and accurate as possible. This could be done with a modified recruiting approach that would allow the field visit to be guided by a building owner, operator or other informed person. Such an interaction greatly improves the data collected even with a minimal field protocol.

The issues raised by this protocol for the A&O categories probably apply to any other sector where detailed information is not essential. Any of the other sectors could have similar issues of diverse building uses that appreciably impact the performance of the building and our ability to understand its efficiency. To establish the characteristics necessary to develop the engineering or marketing approaches to any of these building types, a detailed review is probably essential but this review (however imperfect) does show the potential to get reasonable information on building area and space types from a very brief telephone survey. It also shows the need for more follow-up in that process to turn such interviews into useful information.

Attachment:

Baseline Interviews 2007 – Other/Assembly

Dodge Number: _____
Ecotope ID Number: _____
Building Name: _____
Address: _____
City: _____
State: _____
Zip: _____

Contact: _____
Contact Address: _____
City: _____
State: _____
Zip: _____
Phone Number: _____

Basic Building Information

1. When was this building built? (month and year, if possible)
2. When was this building occupied? (month and year, if possible)
3. How many stories does the building have?
4. What is the approximate square footage of the building?
5. What is the building used for? (i.e., church, gas station).

[Try to get as much detail as possible. Does the gas station have a small store inside? Is there office space in the back? Approximate square footage of each space]

Use	% Floor area
1	
2	
3	
4	
5	
6	

6. Is the building connected to another structure? (yes or no)
 6. a. If yes, what is it connected to?
7. Is the building heated and/or cooled?
8. What are the hours of operation?
9. Has this building ever been remodeled? When and what was done?
10. What energy code applied to this project? [Don't know is an acceptable answer]
11. When did the project start construction?

Utility Information

1. Who is your electric utility? (name and location)
2. Who is your gas utility? (name and location)
3. Does this building use any other fuels (e.g. oil, propane)?
 3. a. If yes, what, quantity, and from whom?

4. May we have your permission to ask your utilities for information on your building's energy use? The only data we will ask for is kWh and therm usage (or propane, oil, etc.) What fax number may we use to send the billing release for signature?

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5. Is this building separately metered?
 6. When this building was built did it participate in any utility energy efficiency programs?

Building Ownership and Operation

1. What best describes the building ownership:
 - Individual
 - Corporation
 - Religious
 - Federal Government
 - Local/State Government
 - Syndicated Partnership (REIT)
 - Other Partnership
 - Non-Profit
 - Private University/College
 - Public University/College
 - Other
2. Does the owner manage the building?
3. Does this building have a facility manager or building operator assigned to it? (yes or no)