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Memo to: Cindy Heil, ADEC

From: Frank Di Genova and Bob Dulla

Subject: Fairbanks 2012 Home Heating Survey

Summary

In February 2012, Hays Research, under subcontract to Sierra Research, conducted a telephone-based survey of 700 households in the Fairbanks area to determine and document trends and current practices in home heating. Similar surveys were conducted in the winters of 2006, 2007, 2010 and 2011. The main findings are summarized below.

1. Based on the data reported by interviewees, the average cost of heating a home in Fairbanks is \$3,672, with most households paying between \$2,289 and \$4,200. The highest 10% of households each paid upwards of \$6,000 per year for space heating. The average house-size surveyed was about 1,850 square feet.
2. Central heating oil continues to be the principal source of home heating in Fairbanks: 83%¹ of households have a central oil burner, and 68% of residential winter heating (October-March, BTU basis) is provided by central oil (see Figure 1). Additional residential heating from oil includes direct vent heaters and portable heaters (3.4% and 0.01% of total BTUs, respectively). For households that heat with oil, slightly less oil is being burned each year.
3. Wood burning is the second most important source of residential heating, and it is increasing: 39% of households have a wood burning device, and wood burning provides 26% of the heat (BTU basis). This heating contribution consists of woodstove cordwood (21%), outdoor wood boilers (2%), fireplaces with and without inserts (2%), and pellet woodstoves (0.6%).
4. Over the period from 2006 to 2012, wood stoves have grown in popularity from being just 79% of wood burning devices to being 87%, while fireplaces (with and without inserts) have declined in popularity from 21% to 9%. Outdoor wood boilers have increased from near zero to 3%.

¹ Percentages shown here are adjusted for the distribution of ZIP codes in the 2010 US Census and for “don’t know” or “refused to answer” (see text).

5. By a margin of more than 4:1, most survey respondents say they are not being affected by wood smoke from their neighbors, but a 2:1 margin says that the Borough does have a winter time air quality problem.
6. When asked if they would be willing to switch from supplemental wood burning to their primary fuel on days that are forecast to have unhealthy particulate levels, 44.0% said “yes” and 56.0% said “no”; however, when then asked if they would switch if they were compensated for the full cost of using the primary fuel, 72.5% said “yes” and 27.5% said “no.”

Finally, while not a part of the survey, it is noted that residential fuel oil prices in Alaska have roughly tripled over the last decade in real dollars (i.e., after adjusting downward to account for inflation). It is inconceivable that this price increase would not have affected fuel and heating appliance choices in Fairbanks, and it is probably the main reason for greater reliance on wood heat, use of more efficient wood burning practices, and decreased burning of fuel oil.

Methodology

Households were selected for the survey using a stratified random sample of telephone numbers that was designed to collect a representative number of respondents from the six Fairbanks area ZIP codes: 99701, 99703, 99705, 99709, 99712, and 99775. To help minimize sampling bias due to households that may not use landlines, cell phone numbers from the Fairbanks area were also randomly called, and responses from 99 cell phone interviewees were mapped to their reported ZIP codes and included in the survey data. In all, 700 households were successfully surveyed.

Table 1 provides an overview of the distributions of households by ZIP code from the 2000 U.S. Census (on which the survey targets by ZIP code were based); an update from the 2010 Census; and, for comparison, the Hays survey sample, which is seen to closely match the 2000 Census data. As discussed later, to provide the most accurate current representation of the area-wide statistics, the survey results are weighted using the 2010 Census data (in most cases, this adjustment is on the order of 1% or less). However, for analysis of past trends, the self-weighted raw (unweighted) data are used, mainly because of their very close match to the 2000 Census distribution.²

As in previous years, the survey asked about the types of devices that provide space heating for each home, the estimated percentage of heat provided by each, the amounts and cost of fuel used annually and in winter (October through March), and other related questions to help characterize the heating appliances and fuels used. The format, which was devised by Sierra, was a structured series of up to 79 questions (the number was greatly reduced where, as was typical, a home used only one or two heating devices). Several additional questions were asked to help characterize aspects of the fuels and appliances, perceptions about air quality, and to learn about public information sources and willingness to change fuels.

²The difference between self-weighting and Census 2000 weighting is 0.3% or less in all ZIP codes.

ZIP Code	Area	No. (percent) of Households From 2000 Census	No. (percent) of Households from 2010 Census	No. (percent) of Households Surveyed For 2012
99701	Downtown	7,164 (28.0%)	7,824 (22.8%)	196 (28.0%)
99703	Wainwright & Birch Hill	1,822 (7.1%)	1,474 (4.2%)	50 (7.1%)
99705	North Pole	5,329 (20.8%)	8,067 (22.9%)	147 (21.0%)
99709	Airport	8,774 (34.3%)	12,270 (34.8%)	238 (34.0%)
99712	Steese	2,389 (9.3%)	5,472 (15.5%)	65 (9.3%)
99775	University	105 (0.4%)	144 (0.4%)	4 (0.6%)
TOTALS		25,583 (100%)	35,251 (100%)	700 (100%)

Hays Research conducted the primary telephone survey from February 9-14, 2012, and provided the raw survey data to Sierra Research for analysis. Sierra first screened the data, reviewing answers for consistency and reasonableness. This review resulted in the identification of more than 50 respondents who required follow-up calls by Hays to further check the reported information. Most of these cases were the result of inconsistencies, where respondents reported annual fuel oil usage in gallons and annual cost in dollars that implied unrealistically high or low fuel oil cost (e.g., less than about \$1.50 per gallon or greater than about \$7.50/gallon). Other suspicious data included unrealistically small estimates of home sizes (<200 square feet), unbelievable amounts of reported cordwood usage (e.g., 125 cords/year to heat a 256 square foot house). Follow-up calls by Hays between March 9 and 16 reached about 90% of the follow-up list and resolved almost all of these inconsistencies and issues. In those cases where suspect data could not be either resolved or confirmed, the originally reported data were assumed to be flawed and were excluded from further analysis.

Summary of Survey Results

The survey found, as in the past, that the dominant appliance types were central oil heaters and wood burning devices: 82% of households (573/700) reported having a central oil heater, and 36% (254/700) reported having a wood-burning appliance. Compared to last year's survey, these results reflect a slight increase in the fraction of households with central oil heaters (up from 79.2% = 564/712) and a larger increase for the household fraction burning wood (33.7% = 240/712). The results also revealed that 700 households had a total heating device count of 1005 units, which represents a multiple type factor of 43.6% [(1005/700)-1]. These and other results of the survey are reflected in Table 2.

Table 2			
Population of Heating Devices from 2012 Survey (n=700)			
(not adjusted for ZIP code weightings)			
Heating Device Type	No. in Survey Sample	% of Surveyed Households with This Device	% of Heating Devices in Survey Sample
Wood-Burning Devices:	254	36.3%	25.3%
Fireplace without insert	12	1.7%	1.2%
Fireplace with insert	12	1.7%	1.2%
Woodstove	222	31.7%	22.1%
All Inserts & Woodstoves	234	33.4%	23.3%
Stove/Insert, Uncertified	46	6.6%	4.6%
Stove/Insert, Certified	176	25.1%	17.5%
Stove/Insert Using Cord Wood	221	31.6%	22.0%
Stove/Insert Using Pellets	12	1.7%	1.2%
Outdoor Wood Boiler	8	1.1%	0.8%
Central Oil Burner	573	81.9%	57%
Portable Heater	6	0.9%	0.6%
Direct Vent Heater	85	12.1%	8.5%
Natural Gas Heating	32	4.6%	3.2%
Coal Heat	5	0.7%	0.5%
District Heat	20	2.9%	2.0%
Electric	22	3.1%	2.2%
Other	8	1.1%	0.8%
All Heating Devices	1,005	143.6%	100%

Following the device count, interviewees were asked about usage of their appliances, including what percent of heating is done by each device during the winter months, how much fuel is burned in each device both annually and in winter, and how much money is spent annually for each fuel. Additional questions were asked about specific fuels, especially wood, which is typically observed to have higher emission factors and, as a result, to represent a disproportionate part of the winter time emission inventory for PM.³

Survey results about heater usage in 2012 are shown in the right-most column of Table 3, which allows for comparison with results from surveys in four earlier years.⁴

³ Preliminary data from a recent measurement study found that, compared to a central fuel oil burner, wood burning appliances emitted about 70 to 1,000 times more PM per unit of useful heat produced, and that a natural gas burner emitted on the order of one million times less than the oil burner.

⁴ For earlier survey data, see Memorandum (draft) from Mark Hixson and Bob Dulla to Cindy Heil, "Fairbanks 2011 Home Heating Survey Update," June 10, 2011.

Table 3
Summary of Key Results from 2006, 2007, 2010, 2011 and 2012 Home Heating Surveys
(Raw, self-weighted survey results)

Statistic	Parameter	Survey Results ^a				
		2006	2007	2010	2011	2012
Average Winter Device Use by Type (% of Household Use based on Respondent Perceptions)	Central Oil	68.0%	63.6%	67.3%	68.0%	68.2%
	Wood	10.1%	11.8%	17.2%	14.8%	18.3%
	Portable	0.7%	0.5%	0.2%	0.9%	0.1%
	Direct Vent	8.6%	7.4%	8.2%	9.2%	6.8%
	Natural Gas	2.6%	2.3%	4.5%	3.3%	3.5%
	Coal Heat	n/a	n/a	0.5%	0.6%	0.4%
	District Heat	2.8%	1.1%	1.3%	1.9%	2.3%
	Electric Device	n/a	n/a	n/a	0.5%	0.1%
	Other	7.2%	13.4%	0.7%	0.9%	0.3%
Wood Burning Type, cordwood except as noted (% of Wood-Burning Devices)	Fireplace	13.0%	17.5%	5.8%	5.3%	4.7%
	Fireplace+Insert	8.3%	5.6%	6.8%	5.7%	4.4%
	Woodstove	78.8%	76.9%	86.4%	85.0%	82.6%
	Pellet Stove/FP insert	-	-	-	-	5.1%
	Wood Boiler	n/a	n/a	1.0%	4.0%	3.1%
Wood Stove/Insert Cert Type (% of Woodstoves/Inserts)	<1988(Un-Certified)	52.4%	46.8%	34.1%	22.4%	20.7%
	≥1988 (Certified)	47.6%	53.2%	65.9%	77.6%	79.3%
Stove/Insert Wood Use (cords)	Winter Season	2.87	2.85	3.60	3.19	3.75
Fireplace Wood Use (cords)	Winter Season	0.76	0.74	4.60	1.6	3.00
Central Oil Use (gals)	Winter Season	1,099	1,011	818	977	876
Portable Heater Fuel Use (gals)	Winter Season	91.7	152.7	107.3	216.0	21 ^b
Direct Vent Heater Fuel Use (gals)	Winter Season	296	472	444	383	365
Coal (tons)	Winter Season	-	-	-	-	3.0 ^b
Natural Gas Heating Fuel Cost(\$)/Winter	Winter Season	\$553	\$947	\$1,260	\$1,692	\$1,730
Municipal Heating Fuel Cost (\$)/Winter	Winter Season	n/a	n/a	\$1,350	\$1,258	\$1,038

a. Winter usage in 2006-07 encompassed October–May; winter usage in 2010–2012 spanned October–March.

b. Limited sample, may not be representative.

Keeping in mind that the 2012 survey data are based on the perceptions of the respondents, which (as in prior years) may have unintended biases or errors, the data shown in Table 3 suggest several trends over the six-year period of the surveys, as noted below.

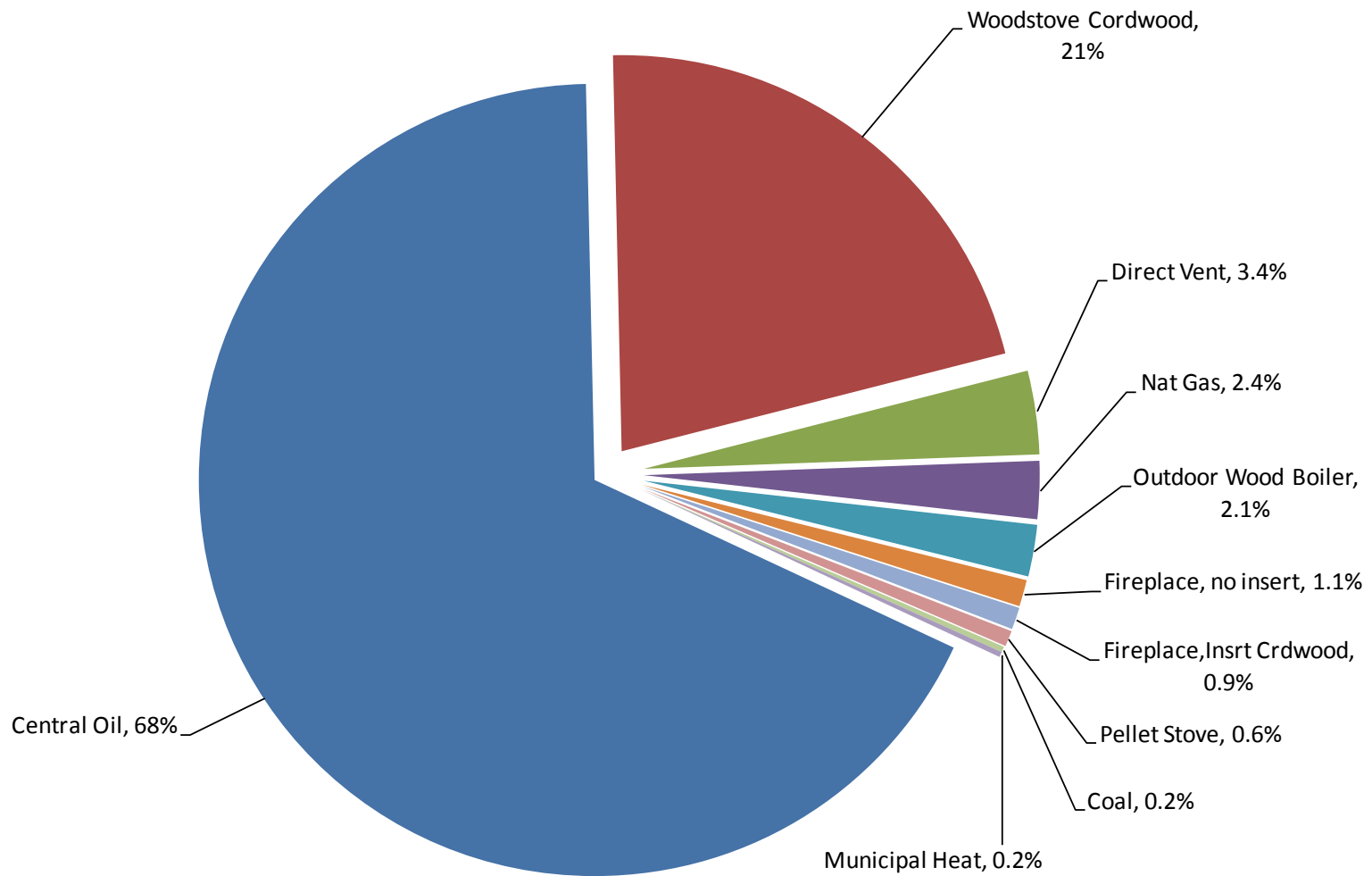
1. Usage of central oil heating, the dominant heating source for most respondents, has remained reasonably constant over the survey period, satisfying, on average, 67% of winter heating demand in the Fairbanks area. For those who heat with central oil, the usage satisfies, by their estimates, an average of 83% of their heating demand. Users of direct vent devices and portable heaters, both of which

- burn fuel oil, are likewise relatively flat and add about 8% and 0.5%, respectively, to the central heater fraction, bringing the total for heating oil to 75.5%.
2. Wood use has tended to satisfy an increasing fraction of heating demand, averaging about 1.2% more each year and increasing from about 10% to 18% over the six-year period. Wood stoves are the preferred appliance by 88% of the households that burn wood, which is an increase from 77% five to six years ago. Conversely, the choice of fireplaces (total, with or without inserts) has declined among wood users from about 23% to 9%. Wood boilers are smaller in number, but have increased from an unmeasurably small percentage 5-6 years ago to about 3% of wood burners in 2012.
 3. For wood stove users, the average winter cord wood usage per household has trended generally upward from about 2.9 cords in 2006 to 3.8 cords in 2012, a 34% increase⁵ over the period. However, the fraction of wood stoves in use that are EPA-certified (post-1988), and are therefore expected to have much lower emission factors (lbs of PM emitted per ton of wood burned) and higher efficiency on average, increased from 48% to 79%.
 4. Other space heating sources are either very small as a percentage in any year (e.g., residential coal heating), or have insignificant PM emissions compared to wood burning (e.g., natural gas).

Figure 1 summarizes current winter heating sources in Fairbanks on a BTU basis. The values shown in the figure differ slightly from the percentages in the top section of Table 3, for two reasons. First, to provide the most accurate and up-to-date representation of survey results, the survey percentages shown in the graph have been adjusted for the most current (2010) U.S. Census data of numbers of households in each ZIP code. We did not make this adjustment for the data in the table, because to do so could have distorted (albeit by a relatively small amount) the trends shown by comparing with previous years' data. Second, the appliance/fuel usage results shown in the figure are primarily based on amounts of fuel used as reported by respondents, rather than respondent's estimates of percentages of heat supplied (which were shown in the table). While neither parameter is considered to be 100% reliable (each relies on the respondent's memory and knowledge of fuel information), the latter ultimately derives from a measurement or count (e.g., gallons of oil or cords of wood) and a bill that the homeowner sees, while the former is strictly a percentage estimate by the homeowner. Furthermore, although a few exceptions were found in the telephone survey (and later corrected or screened out of the survey data), most Fairbanks residents appear to be acutely aware of their home heating demands, fuel, and/or energy costs.

⁵ This follows a somewhat surprising and inexplicable drop from 3.60 cords/yr in 2010 to 3.19 cords/year in 2011.

Figure 1
Winter Home Heating Sources in Fairbanks (BTU basis) from 2012 Household Space Heating Survey



Note: Includes (minor) adjustment for distribution of households according to 2010 Census.

Based on the 2012 survey fuel use data that underlie Figure 1, we find the following:

1. Central oil is by far the main source of winter heating in Fairbanks, providing about 68% of residential heating needs (on the basis of BTU heat release);
2. Cordwood burning in woodstoves is the next largest source and satisfies about 21% of heating needs; and
3. Direct vent heaters (3.4%), natural gas (2.4%), outdoor wood boilers (2.1%), fireplaces without and with inserts (1.1%, 0.9%), pellet stoves (0.6%), and municipal heat (0.2%) provide most of the remaining heat.

Other Findings from the Survey

This section attempts to highlight additional information about the various fuels and appliances in the survey, and is organized in that order. The last topic, “Miscellaneous,” addresses survey responses about public information, willingness to change fuels, etc. The analyses and observations presented here are not intended to be comprehensive.

Oil Burning – 82.2% (83.0% adj)⁶ of respondents said they have a central oil burner (Q2). Average tank size was 599 gallons (Q41), with 500 and 1,000 gallons being the most common. For central oil users, average annual (Q42) and wintertime (Q43) gallons used were 1,115 and 875, respectively—i.e., October through March usage was about 78% of the annual total. The average annual central oil fuel bill (Q44) was \$3,667, which implies a fuel cost of \$3.29/gal. (For perspective, the average home size in the survey was about 1,850 square feet.)

Direct Vent Heaters – Direct vent heaters are another important oil burning source, with 12.3% (12.9% adj) reporting their use (Q4). Average annual and winter fuel use was 378 and 365 gallons, (Q51, Q52) respectively, and annual fuel cost was \$1,305 (q53), which implies a fuel cost of \$3.45/gal. For households that used direct vent heaters, those heaters were estimated to satisfy, on average, 55% of the heat demand.

Portable heaters – These were few in number (Q3) and are not discussed further.

Wood Burning – 36.5% (38.9% adj) of respondents said they have a wood burning device (Q1). ZIP codes 99701 (Downtown) and 99703 (Wainwright and Birch Hill) had the lowest percentages of wood burning respondents: 16% and 18%, respectively. Other ZIP codes each had 43% or more. Wood stoves and fireplaces with inserts overwhelmingly (94.8%, 94.9% adj.) used cord wood rather than pellets (5.2%, 5.1% adj). Reported daily burning profiles (see Table 4) show that about 90% of wood burning households are regular, everyday users.

⁶ For this and the statements that follow, we first report the raw percentage of “yes” answers, expressed as a percentage of the sum of “yes” and “no” answers, i.e., we discount answers of “don’t know” and “refuse to answer.” The “adj.” percentage, where provided, is adjusted for the percent of households in each ZIP code based on the 2010 US Census. “Q2” refers to question 2 of the Survey.

Burning Profile	Percent of the WS/FP Households that Identify with Each Profile	Cumulative Percentage of WS/FP Households
Day	5.2%	5.2%
Evening	7.8%	13.0%
Day and Evening	65.9%	78.9%
Weekend	1.3%	80.2%
Evening and Weekend	10.3%	90.5%
Occasional	9.1%	99.6%
Not currently using	0.4%	100%

By about a 60:40 margin, most users report cutting their own wood rather than buying it (Q14), and, of the wood cutters, only about one-third report getting a permit (Q15).

Seasoning of Wood – Question 16 asked “How many months do you season your wood?” Most woodcutters responded that they season for 12 or 24 months; however, it seems unlikely that most people harvest their firewood through the winter exactly one year or two years before they burn it. According to Borough staff, the Cold Climate Housing Research Center (CCHRC) recommends that people harvest wood in springtime (i.e., beginning in March), and then split, stack, and cover it before use the following winter. This advice is, we understand, based on CCHRC research and the expectation that with proper splitting, stacking and storage, seasoning through one summer will be adequate to achieve about 20-30% moisture content. Based on this, we assume that most people who say they season for 12 months really mean they burn the wood in the winter following the spring or summer when they harvest it.

Wood Moisture – As far as the actual moisture content of wood burned (Q17), the majority of wood burners declined to answer or said that they don’t know. Others gave an estimate, but many of the estimates were unbelievably high or low. The one conclusion that can be drawn here is that most people simply don’t know the moisture content of the wood that they burn.

Cordwood Usage – Average annual and winter time cord wood usage for wood stoves and inserts was 4.07 and 3.75 cords, (Q18, Q19) respectively, with the highest annual value, 5.17 cords, reported for North Pole, and the lowest, 3.29 cords, reported for Downtown. Fireplaces are a much smaller source of heating, but average wood consumption there was about 3 cords (Q29, Q30).

OWBs – For outdoor wood boilers, seven units were identified (Q1A). The average annual and winter fuel usage was 13.4 and 12.1 cords, respectively. By comparison, data provided by FNSB staff⁷ from the current change-out program show that the average

⁷ Personal communication with T. Thompson, FNSB, March 2012.

cord wood usage reported by the owners of 38 retired outdoor wood boilers was 22.3 cords.⁸

Coal – Five respondents reported coal burning (Q6) but insufficient information was provided to estimate annual or winter time fuel usage. Three of those five respondents estimated that 90% or more of their heat was provided by coal (Q9). Three of the stoves were reported to be indoor, and the other two respondents didn't know or refused to answer (Q60).

Miscellaneous – When asked whether they burned more wood this winter to minimize the cost of heating oil (Q64), 24.8% (26.1% adj) said “yes” vs. 75.2% (73.9% adj.) “no.” This opinion appears to contradict the reported cord wood usage per wood burning household, which is up significantly in 2012 over 2011, and the drop observed in average fuel oil usage.

Impacted by Wood Smoke – When asked if they are being impacted by wood smoke from their neighbors (Q65), 18.9% (18.4% adj) said “yes” and 81.1% (81.6% adj.) “no”. And when asked if the Borough has a winter time air quality problem (Q66), 66.4% (67.3% adj) said “yes” and 33.6% (32.7% adj) said “no.” In contrast, a survey in the winter of 2007-08 reported that 702 out of 722 respondents (97%) would rate wood smoke in the neighborhood as “no problem” or “only an occasional problem.” This seems to suggest either that the air quality problem has become more serious, or people are becoming more aware that a problem exists, even if most continue to say they do not have a problem with smoke from their neighbors.

More Information – When asked if they would like the Borough to provide information on new fuels for home heating (Q70), results were about evenly split, with 48.6% (49.3% adj) saying “yes” and 51.4% (50.7% adj) saying “no.”

Willingness to Switch Fuels – Finally, respondents were asked the following two questions:

- Q71A: “The Borough has determined that wood burning is a significant contributor to particulate concentrations recorded at local air quality monitors. If you burn wood for supplemental heat, would you be willing to switch to your primary heating fuel (e.g. oil, propane, district heat) on days that are forecast to have unhealthy particulate levels?” 45.6% (44% adj) answered “yes” and 54.4% (56.0% adj) answered “no.”
- Q71B: “Would you be willing to switch fuels if you were compensated for the full cost of using the primary fuel?” 72.1% (72.5% adj) answered “yes,” and 27.9% (27.5%) answered “no.”

⁸ However, just three of these boilers burned, in aggregate, 225 cords. If these are removed from the totals, the Borough's average drops to 17.8 cords per boiler. The true average for OWBs in the field is unknown, but we estimate that it may lie in the range between 13.4 and 17.8 cords per year.

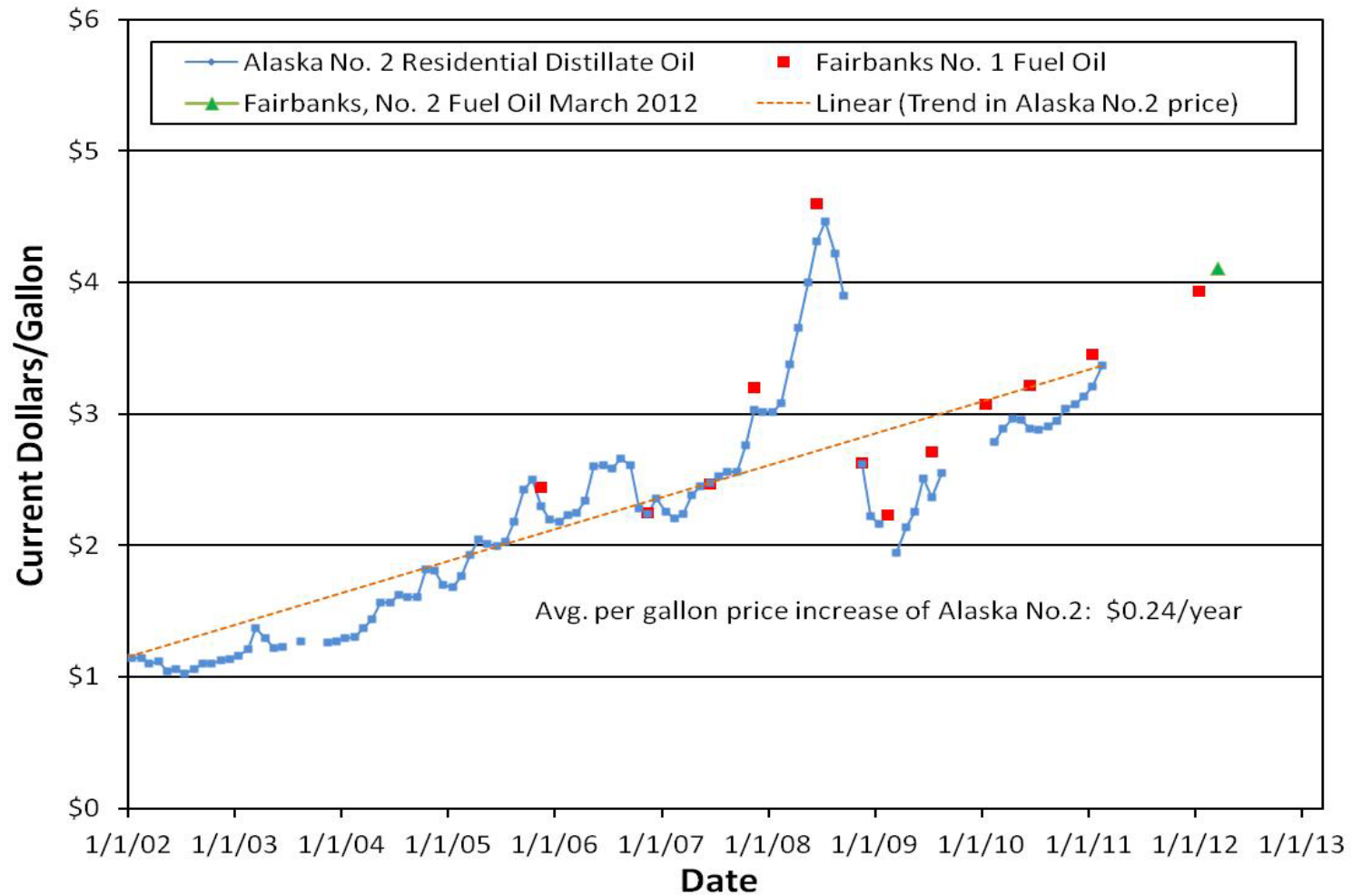
Effect of Fuel Oil Prices on Appliance and Fuel Choices

There is a general trend over the surveyed period from 2006 to 2012 of increasing numbers of wood heaters (including now measurable numbers of outdoor wood boilers), an increasing fraction of EPA certified stoves, and increasing amounts of cord wood burned. Over the same period, the use of fireplace heating with and without inserts has declined significantly. Also in decline is the average amount of oil burned in each central oil heater. Related to these trends are significant changes in the price of fuel oils that occurred around the same period. As shown in Figure 2, the current price of residential fuel oil in Alaska increased from just over one dollar per gallon in January 2002 to approximately four dollars per gallon in January 2012. Even after adjusting for inflation (shown in Figure 3), the oil price nearly tripled over the same decade from just over one dollar per gallon to about three dollars per gallon (constant 2002 dollars).⁹ Thus, while price inflation worsened the trend for consumers, most of the increase was “real” and not the result of price inflation.

It is inconceivable that the heating oil price increase of the last decade would not have affected fuel and heating appliance choices in Fairbanks. Nevertheless, central heating with fuel oil remains the dominant heating source for the vast majority of households in Fairbanks. But the increases in wood burning appliances, the amount of cordwood usage per household, and the overall increase in BTUs provided by wood have potentially important air quality implications for Fairbanks, because all of the forms of wood burning that are commonly practiced in Fairbanks and that are the subject of this survey and memorandum have significantly higher PM_{2.5} emission factors than No. 2 fuel oil. One mitigating factor is that a number of relatively inefficient combustion sources (e.g., fireplaces and non-EPA-certified wood stoves) are being replaced by more efficient and lower-emitting wood combustion sources, including EPA-certified/qualified wood burning appliances.

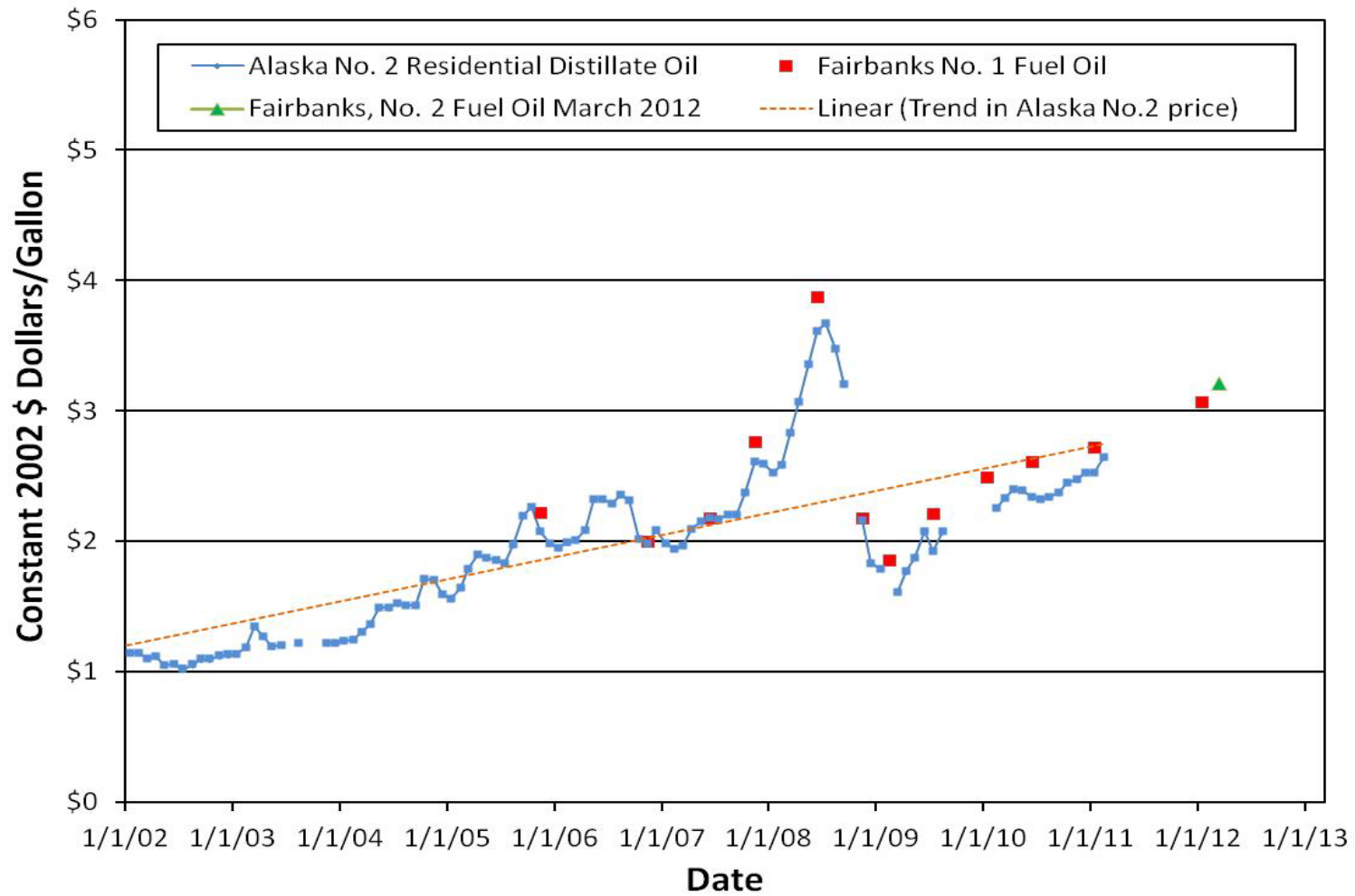
⁹ Prices in Figure 3 have been adjusted to constant 2002 dollars using the consumer price index for Anchorage from the U.S. Bureau of Labor’s Bureau of Labor and Statistics. (Note that No. 2 fuel oil prices for Alaska are available from the EIA through only February 2011.)

Figure 2
Fairbanks No. 1 Fuel Oil Price and Alaska No. 2 Distillate Residential Price by All Sellers



Sources: Alaska Department of Commerce, Community and Economic Development (for Fairbanks No. 1), U.S. Energy Information Administration (for Alaska No.2 Residential Distillate), and FNSB Personal Communication (for March 2012 Fairbanks No. 2)

Figure 3
Fairbanks No. 1 Fuel Oil Price and Alaska No. 2 Distillate Residential Price by All Sellers
Adjusted for Inflation (Constant 2002 Dollars)



Sources: Alaska Department of Commerce, Community and Economic Development (for Fairbanks No. 1), U.S. Energy Information Administration (for Alaska No.2 Residential Distillate), FNSB Personal Communication (for March 2012 Fairbanks No. 2), and U.S. Dept. of Labor, BLS (Anchorage CPI)